Draft

Chemical Data Summary Report
Santa Susana Field Laboratory
Ventura County, California

Prepared for:

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Acronyms and Abbreviations

%R	percent recovery
1,1-DCE	1,1-Dichloroethene
1,2-DCE	1,2-Dichloroethene
AOC	Administrative Order on Consent
ASTM	American Society for Testing and Materials
BaP	benzo[a]pyrene
Boeing	The Boeing Company
C	Carbon
CDD	chlorinated dibenzo-p-dioxin
CDF	chlorinated dibenzofurans
CDSR	Chemical Data Summary Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CO	Consent Order
CoC	Chain of Custody
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
DOE	United States Department of Energy
DPT	Direct Push Technology
DQI	Data Quality Indicators
DQOs	Data Quality Objectives
DTSC	Department of Toxic Substances Control
DUARs	Data Usability Assessment Reports
EMPC	Estimated Maximum Possible Concentration
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
ESADA	Empire State Atomic Development Authority
FSDF	Former Sodium Disposal Facility
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectroscopy
GIS	Geographic Information System
HSA	Historical Site Assessment
LCS	Laboratory Control Samples
LUT	Look-Up Table
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone
mg/kg	milligrams per kilogram
MRL	Method Reporting Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NASA	National Aeronautics and Space Administration
NBZ	Northern Buffer Zone
NDMA	N-Nitrosodimethylamine
ng/kg	nanograms per kilogram

OCY	Old Conservation Yard
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PA/SI	Preliminary Assessment/Site Inspection
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability and Sensitivity
PCBs	polychlorinated biphenyls
PCDDs	polychlorinated dibenzo-p-dioxins
PCDFs	polychlorinated dibenzo furans
PCE	perchloroethylene
pCi/g	picocuries per gram
PCT	polychlorinated triphenyls
PDU	Process Development Unit
QA	Quality Assurance
QAPP	Quality Assurance Project Plans
QC	Quality Control
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RL	Reporting Limit
RMHF/RMDF	Radioactive Materials Handling/Disposal Facility
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
S.E.	Southeast
SAIC	Science Applications International Corporation
SAPs	Field Sampling and Analysis Plans
SDG	sample delivery group
SNAP	Systems for Nuclear Auxiliary Power
SOPs	Standard Operating Procedures
SRAIP	Soils Remedial Action Implementation Plan
SRAM	Standardized Risk Assessment Methodology
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TEF	Toxicity Equivalence Factor
TEQ	toxicity equivalent quotient
TPHs	total petroleum hydrocarbons
UCL	Upper Confidence Limit
VOCs	volatile organic compounds
WHO	World Health Organization

Section 1

Introduction

This Soils Chemical Data Summary Report (CDSR) is a compilation of the soil chemical data collected within Area IV and Northern Buffer Zone (NBZ) at the Santa Susana Field Laboratory (SSFL) in Ventura County, California (Figure 1-1 and 1-2). This CDSR includes the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) results, as well as the results of Phases 1, 2, and 3 soil sampling identified in the 2010 Administrative Order on Consent for Remedial Action (AOC). The document complies with AOC stipulations for presentation of soil chemical results. This CDSR contains a summary of the entirety of the data collection efforts and includes depictions of the horizontal and vertical extent of contamination in the soils that exceed California Department of Toxic Substances Control (DTSC) developed soil chemical Look-Up Table (LUT) values.

1.1 Regulatory Basis

The U.S. Department of Energy (DOE) has developed this Soils CDSR to address the requirement in the 2010 AOC to present a summary of the entirety of data collection, including presenting the horizontal and vertical extent of contamination, for Area IV and NBZ of the SSFL. This Soils CDSR documents all soil investigative activities conducted to define the nature and extent of soils contamination within Area IV and NBZ of SSFL per AOC requirements. The Soils CDSR is not a data interpretative document; interpretation of the sampling results relative to the need for soil cleanup will be presented in the Soils Remedial Action Implementation Plan (SRAIP) documents.

1.2 Soils Investigations Background

This Soils CDSR provides the compilation of all investigation planning and results documents developed during the nearly 25 years of formal[1] site investigation work. The earliest soil investigations within Area IV involved cleanup of spills and releases, primarily for radionuclides. For example, the location of the Radioactive Materials Handling Facility (RMHF) leachfield was investigated with a removal action that occurred in 1978 to address Strontium-90 contamination (Tuttle, 1978; Carroll, Marztec and Stelle, 1982). The need to evaluate chemical contamination was initiated in the mid-1980s when United States Department of Energy (DOE) and Rocketdyne (Division of Rockwell International) engaged in an assessment of environmental issues within Area IV. DOE's first comprehensive look at Area IV environmental issues was conducted in 1988 (DOE, 1989, and DOE and Rockwell International, 1989) that identified several locations requiring further investigation.

The first external review of potential soil contamination issues within Area IV was performed through the Preliminary Assessment/Site Inspection (PA/SI) process performed under U.S. Environmental Protection Agency (EPA) Region IX review (Ecology and Environment, 1989). The

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[1] That is, under the oversight of a regulatory authority, Regional Water Quality Control Board (RWQCB) and/or DTSC.

PA/SI investigators reviewed records available at that time and identified eleven Area IV locations requiring further investigation (Figure 1-3):

- Sodium Burn Pit (B4886) (Former Sodium Disposal Facility)
- Sodium Reactor Experiment (SRE) Watershed,
- Systems for Nuclear Auxiliary Power (SNAP) reactor (B4059),
- Old Landfill (Building 56 Landfill),
- Radioactive Materials Disposal (Handling) Facility Leachfield,
- Old Conservation Yard (OCY),
- Empire State Atomic Development Authority (ESADA) Chemical Storage Yard,
- Building 100 Trench,
- Southeast (S.E.) Drum Storage Yard,
- New Conservation Yard, and
- Sodium Burn Facility (Hazardous Waste Management Facility; B4133).

The PA/SI was followed by a RCRA Facility Assessment (RFA) that was conducted in 1990 by Science Applications International Corporation (SAIC) for EPA Region IX. The RFA report was prepared by SAIC (SAIC, 1994) for EPA Region IX under the Technical Enforcement Support Contract. During the RFA, SAIC reviewed information and records for all of SSFL provided by Rocketdyne, records provided by the California Department of Health Services (lead state agency at that time), identified potential solid waste management units (SWMUs), and conducted site visits to inspect visually for the potential for releases of any hazardous substances. For Area IV, SAIC identified a total 11 SWMUs and Areas of Concern (Table 1-1). These SWMUs were incorporated into the 2007 Consent Order (2007 CO). Figure 1-3 illustrates the locations of the SWMUs/RFI sites identified for Area IV.

Table 1-1
Identification of Solid Waste Management Units in Area IV from RFA and 2007 CO[2]

SWMU Number	SWMU Name
7.1	Building 056 Landfill
7.2	Building 133 Sodium Burn Facility (Hazardous Waste Management Facility)
7.3	Building 866 Former Sodium Disposal Facility (FSDF)
7.4	Old Conservation Yard Container Storage Area and Fuel Tanks
7.5	Building 100 Trench
7.6	Radioactive Materials Handling Facility (RMHF)
7.7	Building 020 - Rockwell International Hot Laboratory (RIHL)
7.8	New Conservation Yard
7.9	ESADA Chemical Storage Yard
7.10	Building 05 Coal Gasification Process Development Unit (PDU)
7.11	Building 029 Reactive Metal Storage Yard (Hazardous Waste Management Facility)
7.12	Area IV Areas of Concern Building 059 (Former SNAP Reactor Facility) Southeast Drum Storage Yard Sodium Reactor Experiment (SRE) Complex Area

[2] Names of some SWMUs have changed since their first identification in the RFA findings.

Table 1-1
Identification of Solid Waste Management Units in Area IV from RFA and 2007 CO[2]

	Building 065 Metals Laboratory Clarifier Building 457 Hazardous Materials Storage Area (HMSA) Area IV Pond Dredge Area IV Leachfields - AI-Z1, Building 003 - AI-Z2, Building 064 - AI-Z3, Building 030 - AI-Z4, Building 093 - AI-Z5, Building 021 - AI-Z6, Building 028 - AI-Z7, Building 010/012 - AI-Z8, Building 005/006 - AI-Z10, Building 383 - AI-Z11, Building 009 - AI-Z12, Building 020 - AI-Z13, Building 373 - AI-Z14, Building 363 - AI-Z15, Building 353 Building 008 Warehouse Building 011 Leachfield (Leachfield AI-Z9)
7.13	SRE Watershed (Area of Concern)

The results and recommendations of the RFA were used to develop the RCRA RFI for SSFL performed under the oversight of DTSC. The first work plan identifying site conditions and data needs was provided to DTSC in October 1993 (ICF Kaiser Engineers, 1993).

Investigations and sampling of the SWMUs was continued under a series of work plans. For example, investigations of Building 4020 (Rockwell Hot Lab), Building 4059 (SNAP), and Building 4065 (Metals Clarifier) were performed under a 2000 Work Plan (Ogden, 2000). Investigation of the Building 56 Landfill SWMU was performed under a 2003 Work Plan (MWH, 2003). In 2003, using information available from the PA/SI efforts, EPA concluded that Area IV warranted no further action under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) statute, and deferred regulatory oversight to the State of California, DTSC (EPA, 2003).

For the RFI, Area IV was separated into four investigation groups that were each evaluated separately (Figure 1-4). Group 5 addressed the central portion of Area IV extending eastward into Area III, Group 6 the northeastern portion, Group 7 in the north central portion, and Group 8 was located in the western portion of Area IV. A small portion of RFI Group 3, which is centered in northern Area II, occurs along the eastern boundary of Area IV with Area III.

In 2007, DTSC issued the Consent Order (2007 CO) for Corrective Action to The Boeing Company (Boeing), the National Aeronautics & Space Administration (NASA), and DOE. The 2007 CO divided the SFFL site characterization into two parallel activities, one for groundwater (termed the Chatsworth formation Operable Unit [OU]) and the second for soils (termed the Surficial Media OU). Surficial media, which is the focus of this CDSR, was defined in the 2007 CO as being saturated and unsaturated soil, sediment, surface water, near-surface groundwater, air, biota, and weathered bedrock. The 2007 CO set forth the process for the investigation, reporting, and cleanup of both OUs.

In 2010, with the signing of the AOC, the process of site soil investigation was changed. The focus of the 2010 AOC was on soils defined as saturated and unsaturated soil, sediment, and weathered bedrock, debris, structures, and other anthropogenic materials. Investigation and cleanup of groundwater, surface water, air, and biota remains under the 2007 CO.

The 2010 AOC phased the soil investigation, first to allow for co-located soil sampling with the EPA. During Phases 1 and 2 of the AOC soil sampling, DOE also analyzed for chemicals many of the soil samples collected by EPA and its contractor for their analysis of radionuclides. Investigation areas identified by EPA followed the RFI boundaries previously identified (Figure 1-5), but subdivided the RFI Group 5 and 8 areas into Subareas. Phase 3 of the AOC soil sampling was based on a data gap analysis that used the results of the RFI soil sampling and AOC Phases 1 and 2 sampling to identify where additional data (data gaps) were needed to complete soils characterization. The data gap exercise was concluded with a 'Go-Back' exercise that evaluated whether the sampling objectives for Area IV had been met.

1.3 CDSR Overview

This CDSR provides a compilation of the analytical information derived from the historic soil sampling events within Area IV and the NBZ and the recently completed AOC-based soils sampling. The resulting database is very large representing more than 8,100 individual soil samples analyzed for up to 300 individual chemicals. Review, evaluation, and presentation of such a large database presents challenges further discussed in Chapter 3. The CDSR presents how the compiled data are being used by DOE to identify the soils chemicals of concern (COCs) and how the COCs are distributed within Area IV and the NBZ. Identification of COCs as a first step is important so that data presentation can focus on those chemicals requiring potential cleanup, ultimately reducing the subsequent data presentation and interpretation efforts. The COC soil analytical data are displayed spatially across Area IV by chemical or chemical group (e.g., metals, PCBs, pesticides, etc.) The chemicals are mapped to illustrate the horizontal and vertical extent of contamination in the soils. However, in keeping with the summary nature of the intent for the CDSR as described in the AOC, the interpretation of the data in terms of what will be cleaned up by DOE will be described in the Soils Remedial Action Implementation Plan (SRAIP).

The remainder of the CDSR provides the following information:

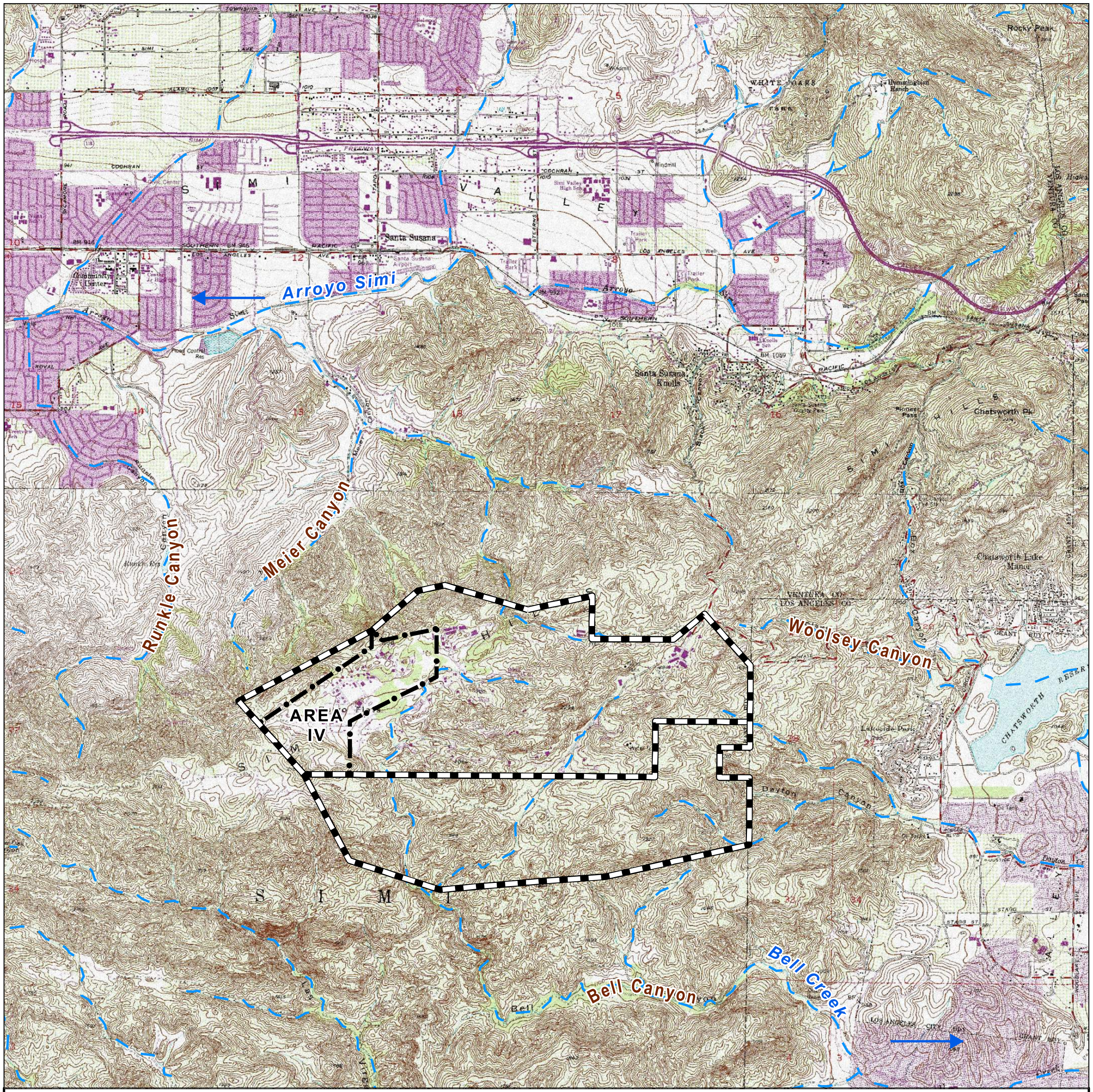
- Section 2, Area IV Soil Characterization Overview – This section provides an overview of the numerous RFI/AOC chemical investigations and soil cleanup actions that occurred within Area IV tying together work plans and reports presenting the results. Copies of the documents supporting the prior investigations are provided electronically in Appendix B.

- Section 3, Identification of COCs - This section provides details on the process used to determine COCs for Area IV, listing of all the chemicals analyzed for during all sampling efforts. This section also describes the process and criteria used to identify site-related chemicals and the differentiation of contamination from background concentrations.

- Section 4, Area IV Characterization Data Presentation - This section presents maps that show the horizontal and vertical extent of contamination in soils within Area IV for the COCs observed in Area IV.

- Section 5, Summary of Data Quality Review and Findings - This section discusses the results of the data quality reviews that have been conducted to demonstrate the generally usability of the database.

- Section 6, References – This section provides a list of references cited within and documents consulted to complete the CDSR.



Legend

Major Drainages

Area IV Boundary

SSFL Property Boundary

Notes:
GIS Layers provided by MWH/Boeing.
Service Layer Credits:
Hydrography Source: National Hydrography Dataset Plus - NHDPlus, v2.10, USEPA and the USGS (2012).

0 2,500 5,000 Feet

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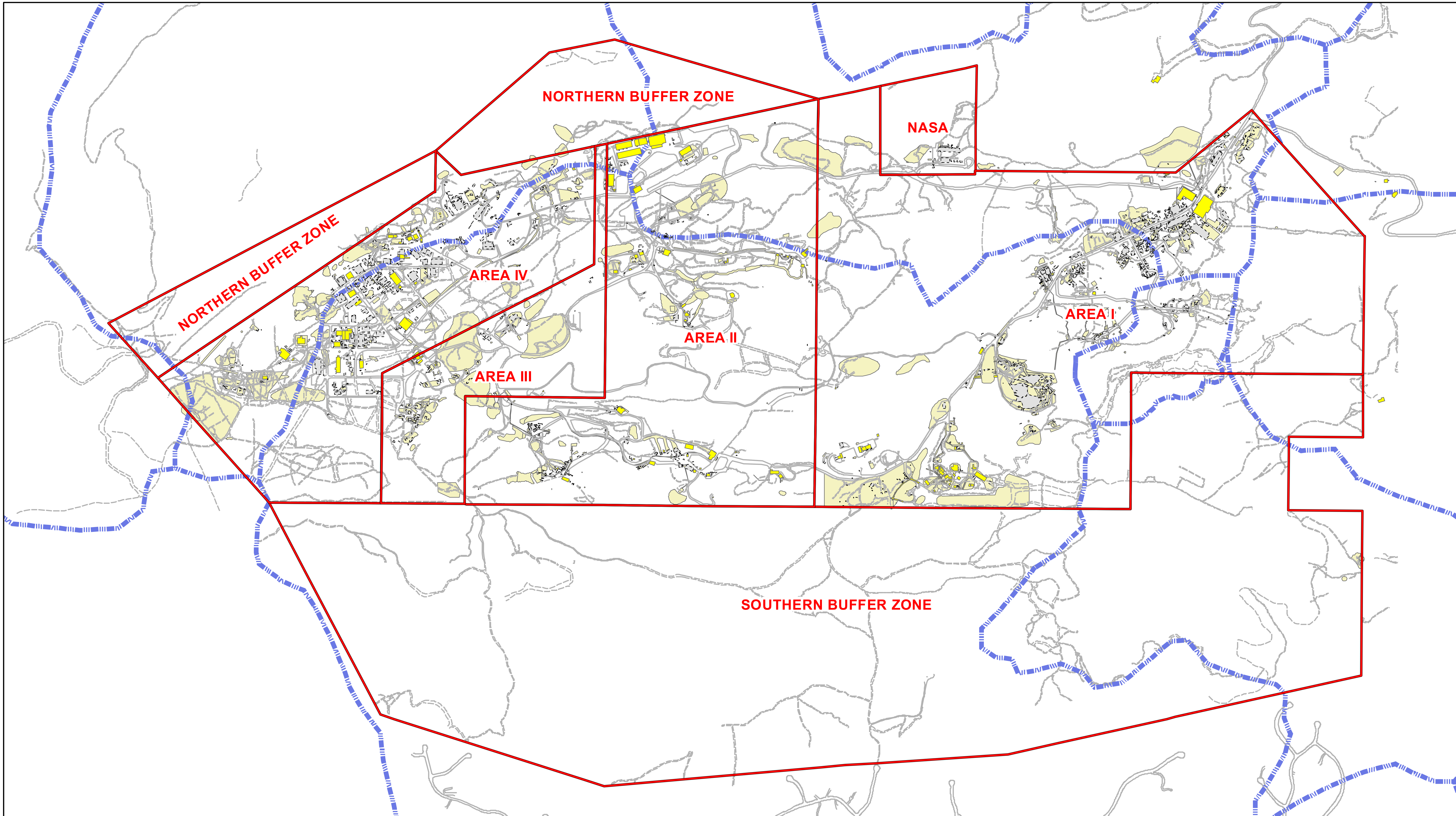
FIGURE 1-1
SSFL Regional Setting



N

Legend

DrainageDivide

Roads

Dirt Road

Paved Road

Site Area

Chemical Use Area

Building - Existing as of May 2011

Removed Building

Note: GIS Layers provided by Boeing.

Santa Susana Field Laboratory Layout

0 500 1,000 2,000 Feet

Santa Susana
Ventura County, California
Figure 1-2

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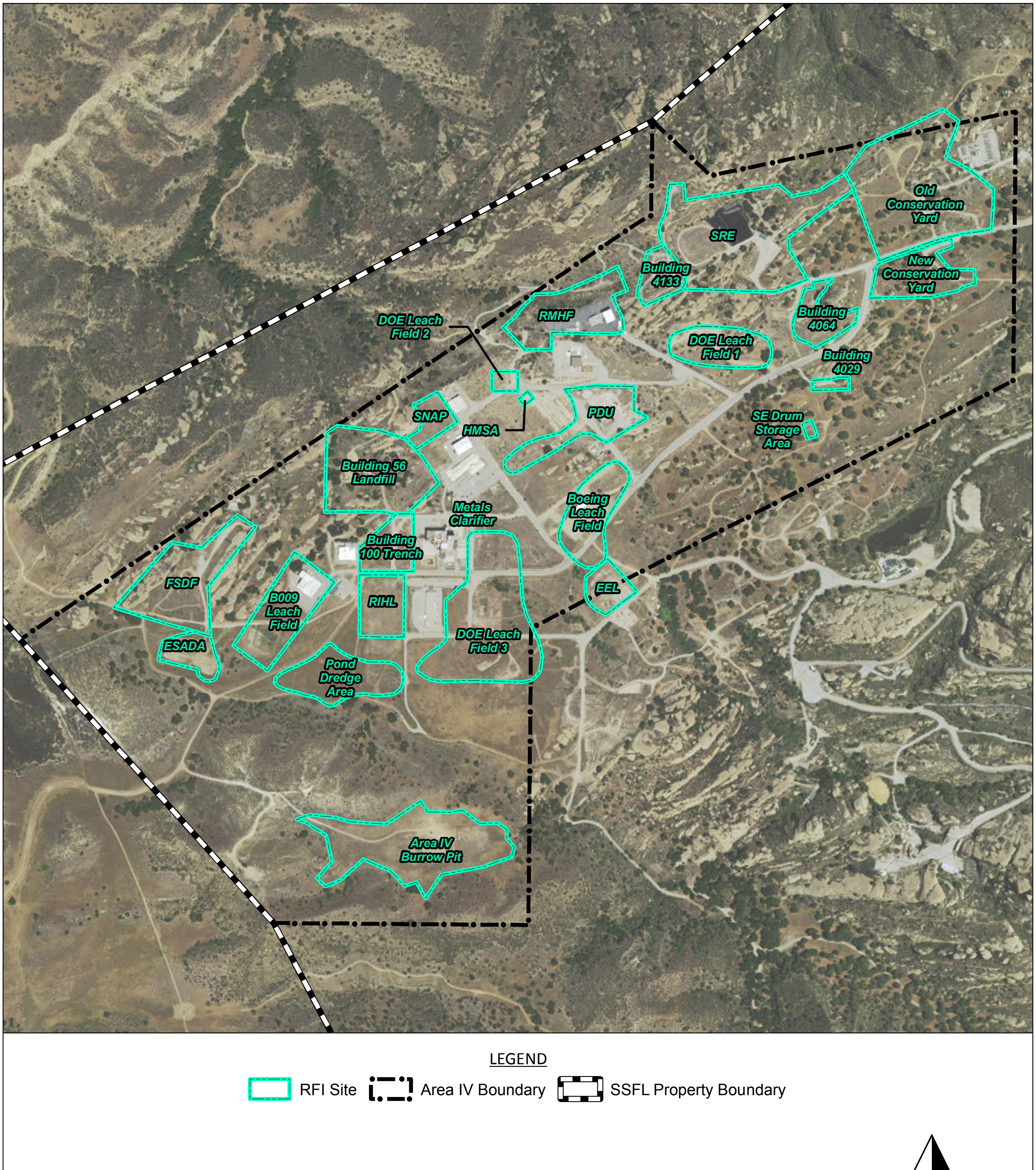

Notes:
- GIS Layers provided by MWH/Boeing.
Service Layer Credits:
- Aerial Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

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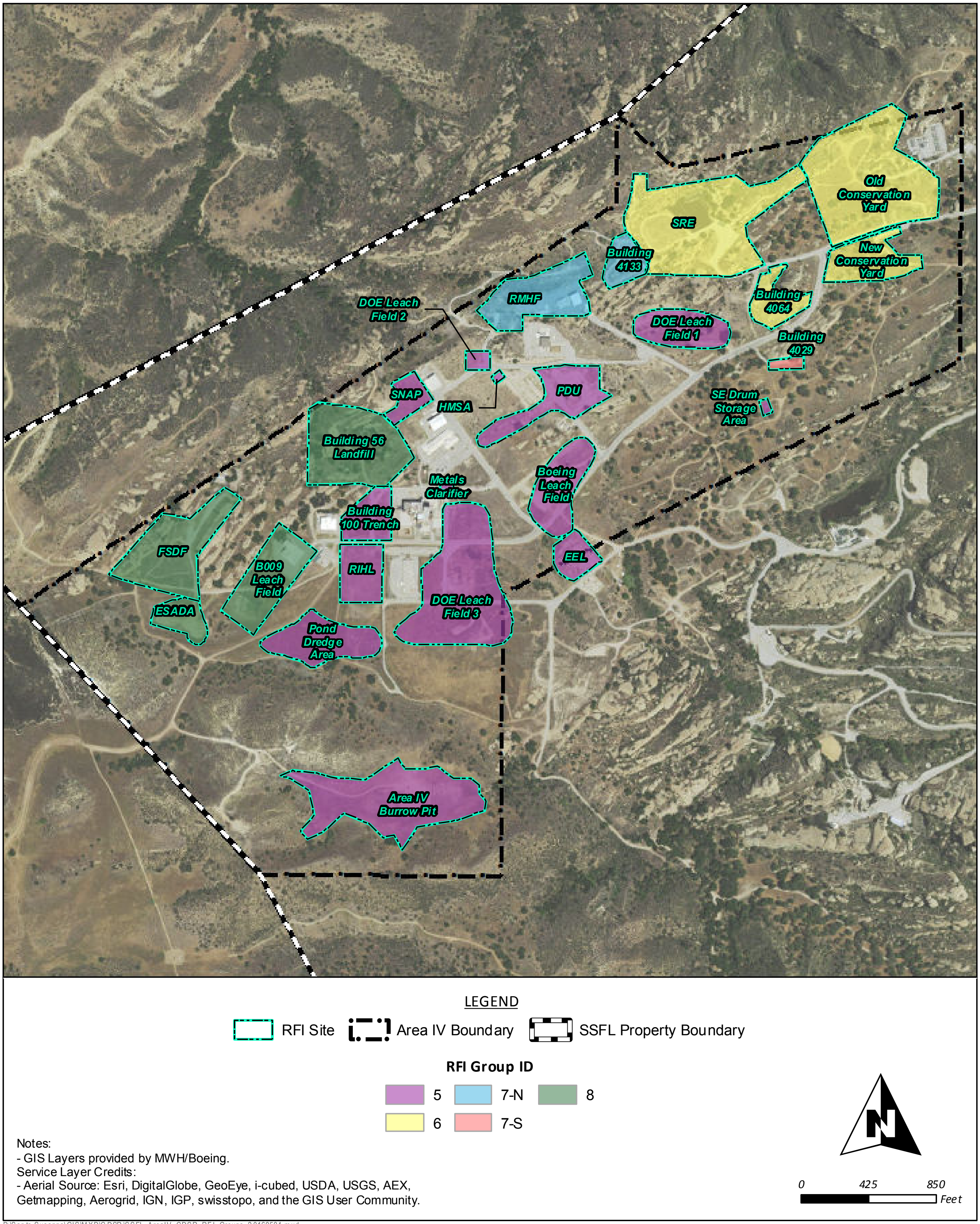
FIGURE 1-3
Solid Waste Management Units/RFI Sites



Notes:
- GIS Layers provided by MWH/Boeing.
Service Layer Credits:
- Aerial Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

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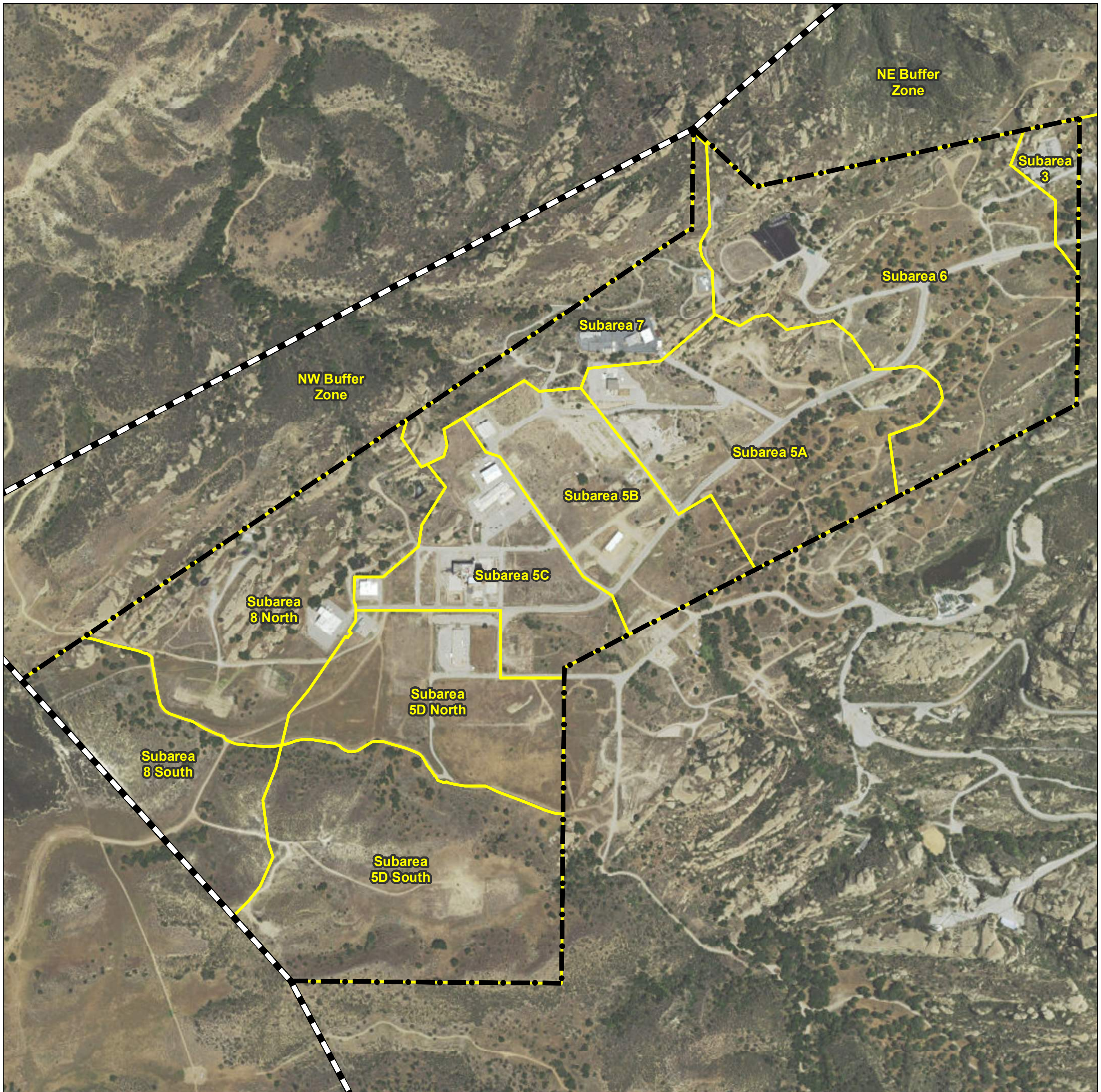
FIGURE 1-4
Area IV RFI Groups



LEGEND

Area IV Subarea — Area IV Boundary — SSFL Property Boundary

Notes:
- GIS Layers provided by MWH/Boeing.
Service Layer Credits:
- Aerial Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

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FIGURE 1-5
USEPA Area IV Subareas

Section 2

Area IV Soil Characterization Overview

This section provides an overview of the RFI and AOC site characterization work and describes the numerous chemical investigations and soil actions that occurred within Area IV. The section links together work plans that described proposed sampling and reports presenting the results of the sampling efforts. Copies of the documents providing soils investigation results for prior investigations are provided electronically in Appendix B.

The Area IV locations sampled during the various investigations, the soil investigation work plans describing the work, and the documents presenting the results are listed in Table 2-1.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
Former Sodium Disposal Facility (FSDF) (B-886)	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - Ebasco, 1991. FSDF Closure Plan	- ICF Kaiser, 1997. Final Former Sodium Disposal Facility Santa Susana Field Laboratory Characterization Report - Rockwell, 1987. CERCLA Program Phase II – Site Investigation. - MWH, 2007. Group 8 – Western Portion of Area IV RCRA Facility Investigation Report Santa Susana, Field Laboratory, Ventura County, California.
Radioactive Materials Disposal Facility (RMHF)	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- MWH, 2009. Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
RMHF Leachfield	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - MWH, 2008. RCRA Facility Investigation Work Plan Addendum Second Amendment, Radioactive Materials Handling Facility RFI Site	- Groundwater Resources Consultants, Inc., 1989. Phase II Report, Investigation of Soil and Shallow Groundwater Conditions, Santa Susana Field Laboratory Area IV, Rockwell International Corporation Rocketdyne Division, Santa Susana Field Laboratory, Chatsworth, California. - MWH, 2009. Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
B-133 Sodium Burn Facility	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- MWH, 2009. Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
ESADA Chemical Storage Yard	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- MWH, 2007. Group 8 – Western Portion of Area IV RCRA Facility Investigation Report Santa Susana, Field Laboratory, Ventura County, California.
Rockwell International Hot Lab	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 1996. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
B100 Trench	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
B056 Landfill	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 1995. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory - Ogden, 1996. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory - MWH, 2003. RCRA Facility Investigation Work Plan Addendum Building 56 Landfill (SWMU 7.1) Investigation	- Rockwell, 1987. CERCLA Program Phase II – Site Investigation. - MWH, 2007. Group 8 – Western Portion of Area IV RCRA Facility Investigation Report Santa Susana, Field Laboratory, Ventura County, California.
Southeast Drum Storage Yard	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Old Conservation Yard	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 1996. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory	- MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
New Conservation Yard	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 1996. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory	- MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
SRE Pond	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- Groundwater Resources Consultants, Inc., 1990. Assessment of Pond Sediments in R2, SRE, and Perimeter Ponds at the Rockwell International Corporation Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California. - MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
SRE watershed; Northern Buffer Zone Drainages	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- Groundwater Resources Consultants, Inc., 1990. Assessment of Pond Sediments in R2, SRE, and Perimeter Ponds at the Rockwell International Corporation Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California. - MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Buildings 007 and 008	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan	- MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Sodium Reactor Experiment (location)	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 64 Leachfield	- DOE/Rocketdyne, 1989. Environmental Survey Preliminary Report, Final Action Plan - ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- MWH, 2006. Group 6 – Northeastern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
Pond Dredge Area	- Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 65 Metals Clarifier	- Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 457, Hazardous Materials Storage Area	- Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 029 Reactive Chemicals Storage	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 059 Former SNAP Facility	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Area IV Leachfields	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Department of Energy Leachfield 1	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Department of Energy Leachfield 2	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Department of Energy Leachfield 3	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
Building 009 Leachfield	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- MWH, 2007. Group 8 – Western Portion of Area IV RCRA Facility Investigation Report Santa Susana, Field Laboratory, Ventura County, California.
Hazardous Materials Storage Area	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan - Ogden, 2000. RCRA Facility Investigation, Santa Susana Field Laboratory	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
Building 005 Coal Gasification PDU	- ICF Kaiser, 1993. Current Conditions Report and Draft RCRA Facility Investigation Work Plan	- CH2MHill, 2008. Group 5 – Central Portion of Areas III and IV, RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California.
RFI Group 5, EPA Subarea 5C	- CDM Smith, 2010a. Work Plan/Field Sampling and Analysis Plan Co-Located Chemical Sampling at Area IV (co-located sampling with EPA)	- CDM Smith, 2011e. Technical Memorandum Co-located Chemical Sampling Results at Historical Site Assessment Subarea 5C in Area IV
All of Area IV	- CDM Smith, 2010b. Master Work Plan/Field Sampling and Analysis Plan, Co-Located Chemical Sampling at Area IV (addressed EPA co-located sampling throughout Area IV and the NBZ)	- See Co-Located Technical Memorandum below
RFI Group 5, EPA Subarea 5B	- CDM Smith, 2011a. Addendum No. 1 to Master Work Plan/Field Sampling and Analysis Plan, Co-Located Chemical Sampling at Area IV EPA Subarea 5B Soil Sampling	- CDM Smith, 2012b. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 5B in Area IV.
RFI Group 5, EPA Subarea 5A	- CDM Smith, 2011b. Addendum No. 2 to Master Work Plan/Field Sampling and Analysis Plan, Co-Located Chemical Sampling at Area IV EPA Subarea 5A Soil Sampling	- CDM Smith, 2012d. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 5A in Area IV.
RFI Group 8, EPA Subarea 8 North	- CDM Smith, 2011d. Revised Addendum No. 3 to Master Work plan/Field Sampling and Analysis Plan, Co-located Chemical Sampling at Area IV, EPA Subarea 8N Sampling	- CDM Smith, 2012e. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 8 North and South in Area IV.
RFI Group 5, EPA Subarea 5D	- CDM Smith, 2011c. Addendum No. 4 to Master Work plan/Field Sampling and Analysis Plan, Co-located Chemical Sampling at Area IV, EPA Subarea 5D North Sampling	- CDM Smith, 2012g. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 5D North and South in Area IV.
RFI Group 6, EPA Subarea 6	- CDM Smith, 2011g. Addendum No. 5 to Master Work Plan/Field Sampling and Analysis Plan, Co-Located Chemical Sampling at Area IV, EPA Subarea 6	- CDM Smith, 2012l. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 3 and 6 in Area IV

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
RFI Groups 3, 5, 7 and 8, EPA Subareas 3, 5D South, 7 and 8	- CDM Smith, 2011f. Addendum No. 6 to Master Work plan/Field Sampling and Analysis Plan, Co-located Chemical Sampling at Area IV, EPA Subareas 3, 5D South, 7 and 8 South Soil Sampling	- CDM Smith, 2012g. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 5D North and South in Area IV - CDM Smith, 2012k. Technical Memorandum Co-Located Chemical Sampling Results at Historical Site Assessment Subarea 7 in Area IV
SNAP Building 4059, KEWB Building 4073, SRE Building 4143, and STIR Building 4028.	- CDM Smith, 2012c. Addendum No. 7 to Master Work plan/Field Sampling and Analysis Plan, Co-located Chemical Deep Borehole Soil Sampling at SNAP Building 4059, KEWB Building 4073, SRE Building 4143, and STIR Building 4028.	- CDM Smith, 2012o. Technical Memorandum Co-Located Chemical Sampling Results for Deep Borehole Results at Historical Site Assessment Subareas 5A, 5C, 6 and 7
NBZ co-located sampling with EPA	- CDM Smith, 2012f. Addendum No. 8 to Master Work plan/Field Sampling and Analysis Plan, Co-located Chemical EPA Northern Buffer Zone Sampling; Phase 1 Co-Located Soil Chemical Sampling; Phase 2 Co-Located Chemical Random Sampling	- CDM Smith, 2013a. Technical Memorandum Co-Located Chemical Sampling Results for EPA Northern Buffer Zone Sampling; Phase 1 Co-Located Soil Chemical Sampling; Phase 2 Co-Located Chemical Random Sampling
All of Area IV Phase 3 soil sampling based on the RFI and AOC Phase 1/ Phase 2 data gap analysis	- CDM Smith, 2012h. Work Plan for Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV.	- See Phase 3 reports below.
RFI Group 5, EPA Subarea 5C	- CDM Smith. 2012q. Addendum No. 1 to Master Field Sampling Plan for Chemical Data Gap Investigation, Phase 3 - Subarea 5C.	- CDM Smith, 2013b. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results-Subarea 5C
RFI Group 5, EPA Subarea 5B	- CDM Smith, 2012p. Addendum No. 2 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subarea 5B	- CDM Smith, 2013g. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results - Subarea 5B
Drainage Sediment Sampling in Area III	- CDM Smith, 2012j. Addendum No. 3 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Drainage Sediment Sampling in Area III	- CDM Smith, 2013c. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Drainage Sediment Sampling in Area III
RFI Group 5, Subarea 5A	- CDM Smith, 2012m. Addendum No. 4 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subarea 5A - DOE, 2014. Phase 3 Subarea 5A North Implementation Plan	- CDM Smith, 2015a. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results - Subarea 5A
RFI Groups 3 and 6, EPA Subareas 3 and 6	- CDM Smith, 2012n. Addendum No. 5 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subareas 3 and 6	- CDM Smith, 2013i. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Subareas 3 and 6.

Table 2-1
Relationship of Area IV Facilities, Work Plans, and Investigation Result Reports

Facilities Addressed	Soil Investigation Work Plan	Soil Investigation Report of Results
RFI Group 7, EPA Subarea 7	- CDM Smith, 2013c. Addendum No. 6 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subarea 7	- CDM Smith, 2014b. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Subareas 7 and Northern Buffer Zone
RFI Group 8, EPA Subarea 8	- CDM Smith, 2013d. Addendum No. 7 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subarea 8	- CDM Smith, 2014c. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Subareas 8 and 5D.
RFI Group 5, EPA Subarea 5D	- CDM Smith, 2013f. Addendum No. 8 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Subarea 5D	- CDM Smith, 2014c. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Subareas 8 and 5D.
Northern Buffer Zone	- CDM Smith, 2013h. Addendum No. 9 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Northern Buffer Zone	- CDM Smith, 2014b. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Subareas 7 and Northern Buffer Zone
RFI Groups 3, 5, and 6, EPA Subareas 5B, 5C, and 3/6 for Go-Back Sampling	- CDM Smith, 2014a. Addendum No. 10 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Go-Back Soil Chemical Sampling Subareas 5B, 5C, and 3/6	- CDM Smith, 2015b. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Go-Backs, Trenches and Soil Vapor Locations
RFI Groups 5, 8 and the Northern Buffer Zone, EPA Subareas 5A, 5D, 8, and Northern Buffer Zone for Go-Back Sampling	- CDM Smith, 2014d. Addendum No. 11 to Master Field Sampling Plan for Chemical Data Gap Investigation Phase 3 – Go-Back Soil Chemical Sampling Subareas 5A, 5D, 8, and Northern Buffer Zone	- CDM Smith, 2015b. Technical Memorandum Phase 3 Chemical Data Gap Investigation Sampling Results – Go-Backs, Trenches and Soil Vapor Locations
Addresses soil vapor data gap throughout Area IV operational areas	- MWH, 2014a. Addendum No. 12 to Master Field Sampling and Analysis Plan for Chemical Data Gap Investigation Phase 3 Soil Vapor Implementation Plan	- MWH, 2014b. Technical Memorandum, Summary of Phase 3 Soil Vapor Sampling in Area IV.

2.1 Elements of the Soils Investigations

The soils investigations included multiple activities as part of the planning for and implementing the field investigations. These included review of facility records, interviews with former workers, site inspections, and analysis of aerial photographs. Field activities that were conducted prior to sampling included walk-overs to look for debris, staining, or other signs of disturbance; geophysical surveys to identify buried debris, tanks, leach fields, or utilities; and digging of test pits for observations of buried debris or features.

2.2 Records Reviews

Multiple record reviews have been conducted to inform soil investigators where sampling should be conducted. The 1989 PA/SI (Ecology and Environment, 1989) was based on records made available to the investigators at that time. The first comprehensive review of Area IV records was performed by Sapere Consulting in 2005 (Sapere Consulting, 2005). Although focused on radiological uses of Area IV, Sapere reviewed the history of operations and provided useful details as to key building features. Each of the RFI reports developed for Area IV (Group 5 – CH2MHill, 2008; Group 6 – MWH, 2006; Group 7 – MWH, 2009; and Group 8 – MWH, 2007) included descriptions of facilities within each group area based on a records review. EPA conducted an additional records review during 2009 to 2011 in preparation for the Area IV soil radiological investigation (HGL, 2011). Findings from this records review were used to inform sample locations for the Phase 1 Co-Located sampling effort with EPA.

2.3 Worker Interviews

The review of prior site activities also involved interviews of workers, both former and current, that were engaged either in operations within Area IV (until 1988) or the decommissioning and demolition of facilities. The most recent interviews took place in 2011 and 2012 by DOE and EPA. EPA's interviews are published in their Historic Site Assessment Report (HGL, 2011). DOE's interviews are published in a report developed by P2 Solutions (P2 Solutions, 2011). The interviews were conducted to obtain details on historic operations, the handling of chemicals and radioactive materials, waste disposition, and building decommissioning and demolition activities.

2.4 Aerial Photograph Reviews

There have been several incidences of aerial photograph review. The purpose of the aerial photograph reviews were to identify timing of activities (e.g., building construction, demolition), land surface disturbances, road development, land staining, impoundments, storage of materials and drums, and other features (tanks) that could indicate presence of contamination. The first documented review of aerial photos was performed by EPA Region IX as part of the RFA (EPA, 1997). EPA used aerial photographs covering the years of 1952-53, 1957, 1965, 1978, 1988, and 1995. The review addressed the entirety of the SSFL. Types of features identified included engine test stands, landfills, burn pits, ponds, pits, impoundments, tanks, and open storage areas. The RFI sampling programs for Area IV used the EPA reviews plus additional aerial photograph reviews to identify locations for sampling. EPA conducted a second aerial photograph review starting in 2009 as part of its soils radiological investigation of Area IV (EPA, 2010). EPA's 2009 photo reviewed addressed aerial photos specific to Area IV covering the years 1952 through 2005 (1952, 1957, 1959, 1962/63, 1965, 1967, 1972, 1978, 1980, 1983, 1988, 1995, and 2005). The effort focused on SWMUs and Areas of Concern documented through the RFA, checking the photos for evidence of waste disposal areas, impoundments, processing areas, fill areas, and open storage areas. The results of these reviews were incorporated into the design of the Phase 1 soil sampling efforts led by EPA.

2.5 Geophysical Investigations

The records reviews, interviews, and aerial photograph reviews identified the potential for buried materials or utilities, historic leach fields, or ground disturbances requiring further investigation. Geophysical investigations, typically electro-magnetic and/or ground penetrating radar surveys were conducted. Locations exhibiting subsurface anomalies were subject to further investigation either through digging test pits or trenches using a backhoe, or using a drill rig or geoprobe rig to collect subsurface soil samples.

2.6 Soil Gas Sampling

Soil gas sampling was performed throughout Area IV to locate sources of volatile organic contamination (solvents and fuels). Because volatile chemicals can move in subsurface soils, sampling of soil gas can be used to identify locations for subsequent soil sample collection. The soil gas sample locations are shown on Figure 2-1. Each of the RFI soils reports (Group 5 – CH2MHill, 2008; Group 6 – MWH, 2006; Group 7 – MWH, 2009; and Group 8 – MWH, 2007) provided the results of the earliest soil gas investigations. More recently, MWH completed a soil gas data gap program and collected additional soil gas samples throughout Area IV (MWH, 2014a and b). Because volatile chemicals are typically mobile and soluble, they threaten groundwater quality and can be observed as a groundwater contaminant. The soil gas data were also evaluated for locations of groundwater impact and are being investigated under the Area IV groundwater RI (CDM Smith, 2015c)

2.7 Soil Sampling

Over the past 20 years more than 8,100 soil samples have been collected across Area IV from the surface to the interface with bedrock. The work plans and sampling plans (field planning documents) under which samples were collected by DOE consultants are listed in Table 2-1.Soil samples were collected in accordance with work plans and standard operating procedures (SOPs) describing sampling processes and the recording of field data. Samples have been analyzed for an extensive list of chemicals including metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons, volatile organic chemicals, pesticides, herbicides, energetics, n-nitrosodimethylamine (NDMA), perchlorate, and petroleum hydrocarbons. Table 2-2 provides the number of analyses performed for each group. For some analytical groups, such as metals, individual metals were sometimes analyzed in a sample (such as lead or mercury) and not the entire group. In addition, not all samples were analyzed for the all chemical groups, with knowledge of chemical use and spills being used to identify which chemical group was relevant for each sample location.

Table 2-2
Number of Samples Analyzed by Chemical Group.

Chemical Group	Number of Samples Analyzed[1]
Metals	5901
Chromium VI	3423
Lead	5909
Mercury	6005
Methyl Mercury	11
Fluoride	3037
Perchlorate	3543
PAHs	5738
SVOCs	4620
PCBs	5590
Pesticides	1428
Herbicides	1282
Dioxins/Furans	4687
Phthalates	4451
Alcohols	1335

Table 2-2 Number of Samples Analyzed by Chemical Group.	
Terphenyls	1582
Glycols	1475
Total Petroleum Hydrocarbons	7934
Formaldehyde	1424
n-Nitrosodimethylamine	6617
Energetics	1013
Nitrate	1053
Cyanide	3037

[1] Maximum number of analyses for each chemical group are shown. Specific number of analyses by each chemical are provided in the tables in Chapter 3.

2.8 Data Quality Reviews

All soil samples were collected under the guidance of Field Sampling and Analysis Plans (SAPs) and Quality Assurance Project Plans (QAPPs). All data have been subject to data quality reviews per the QAPP guidelines. Data that have been found to meet data quality parameters are addressed in the nature and extent discussions in the following sections. Additional details are provided in Section 5.

2.9 Previous Removal Actions

Throughout site operations and afterward, DOE implemented a number of removal actions to remediate soil, bedrock, and structures (e.g., buildings, transformers, and parking lots) with concentrations of radionuclides or chemicals that exceeded the cleanup standards used at the time. The most notable of these removal actions were as follows:

The FSDF was used for cleaning sodium and other alkali metals from metal components. The process resulted in the discharge of mercury, PCBs, cesium-137, and solvents into two ponds and the contamination of a concrete pad. In 1980, approximately 20 cubic yards of soil were excavated from the Lower Pond to remove cesium-137. In 1992 and 1993, soil was excavated to the bedrock interface, and all debris found within the excavation was removed. Soil was also removed from two drainages north of the FSDF. Limited excavation of buried objects occurred in August 1996. Soil sampling conducted in 1995 identified mercury, total petroleum hydrocarbons (TPHs), PCBs, and dioxins in soil; additional soil and debris removal continued until 2000. In all, 14,000 cubic yards of soil were removed from FSDF. Ultimately, the excavated ponds were backfilled with soil from the Area IV borrow pit.

The SRE engineering test building (Building 4003) was used to test SNAP reactor burnup samples and evaluate irradiation experiments. Interior structures and components exposed to radioactive materials were removed from the building in 1975. Interior sewer lines suspected of contamination were removed in 1982, and the building was demolished in 1999.

The former SRE Reactor Building (Building 4143) was demolished in 1999, including the removal of surrounding soils and underground structures (Sapere, 2005; Rockwell, 1976). In 1979, the SRE retention pond was allowed to dry out. Soil exceeding the standards at that time was removed. Mercury was released to the soil during decommissioning of the steam generation plant. Contaminated buildings, soil, and bedrock were removed. Unconsolidated materials in the former SRE area include both native soil and fill placed in various building excavations during demolition. Native soils are estimated to be up to 10 feet thick at some locations, with bedrock surface expressions in others. The basement excavation of the former SRE Reactor Building contains approximately 30 feet of fill material. In 2000, the former septic tank, leach field and associated drain lines were removed. Levels of radioactivity were below the soil cleanup levels of the time.

Building 4059 was used for testing small nuclear reactors under vacuum conditions and, later, for the Large Leak Test Rig Sodium Test Program. A French drain was installed adjacent to the building to lower the water table and prevent water from entering the building. In 1969, a leak was detected in the reactor core, and the reactor was shut down. Removal of activated concrete and debris started in 1991 and continued through 1992. Some of the concrete and metal debris was placed at the RMHF (Sapere, 2005). Decontamination began again in 1994, and equipment was dismantled in 1997. Building 4059, the French drain, and storage tanks were removed in 2003 and 2004. The resulting excavation was backfilled with approximately 5,000 to 8,000 cubic yards of material from an Area IV borrow pit (CH2M Hill, 2008).

Building 4010 was used to test the SNAP 8 Experimental Reactor. Although there are no known releases, Building 4010 was considered a possible source of tritium contamination in groundwater. The building was decommissioned and decontaminated in 1978, and approximately 7,150 cubic yards of radioactive waste were removed. DOE released the building for unrestricted use in 1982, and the building was subsequently demolished (Rockwell International, 1989).

Radioactive contamination at the RMHF leach field site was discovered in 1975 during routine monitoring. The source of the contamination is thought to have been an inadvertent release of radioactive liquid in 1962 or 1963. In 1978, contaminated soil from the leach field was removed down to bedrock, and radioactivity in accessible bedrock was removed by hydraulic hammering. The environmental report on the removal of the leach field (Rockwell 1982a, 1982b) states that, after excavation, on average 300 picocuries per gram (pCi/g) of strontium-90 and traces of cesium-137 remained in bedrock cracks. Following removal of the bedrock that could be excavated, the bedrock was sealed with a bituminous asphalt mastic material, and the site was backfilled with 10 feet of soil. In 2006, about 50 cubic yards of soil were removed from the slope north of the RMHF buildings because there were elevated levels of cesium-137. A sump pump at the canopy-covered drum storage area was excavated in 2007 (Hydrogeologic, 2012a).

The former 17th Street Pond was a man-made pond that received drainage from the Process Development Unit (PDU). By 1997, the pond had filled in with silt and, in 1997 and 1998, this former pond was screened for radionuclides. Radioactive isotopes of thorium, uranium, and cesium were detected. Radioactivity in most of the samples was less than the cleanup criteria used at that time (CH2M Hill, 2008). However, cesium-137 exceeded its cleanup level of 9.2 pCi/g and some locations and portions of the former 17th Street Pond were excavated in 1998, when approximately 2,100 cubic feet of soil were removed (Boeing, 1999). A final survey was performed in 1999, and the site was released for unrestricted use in 2004 (Sapere, 2005).

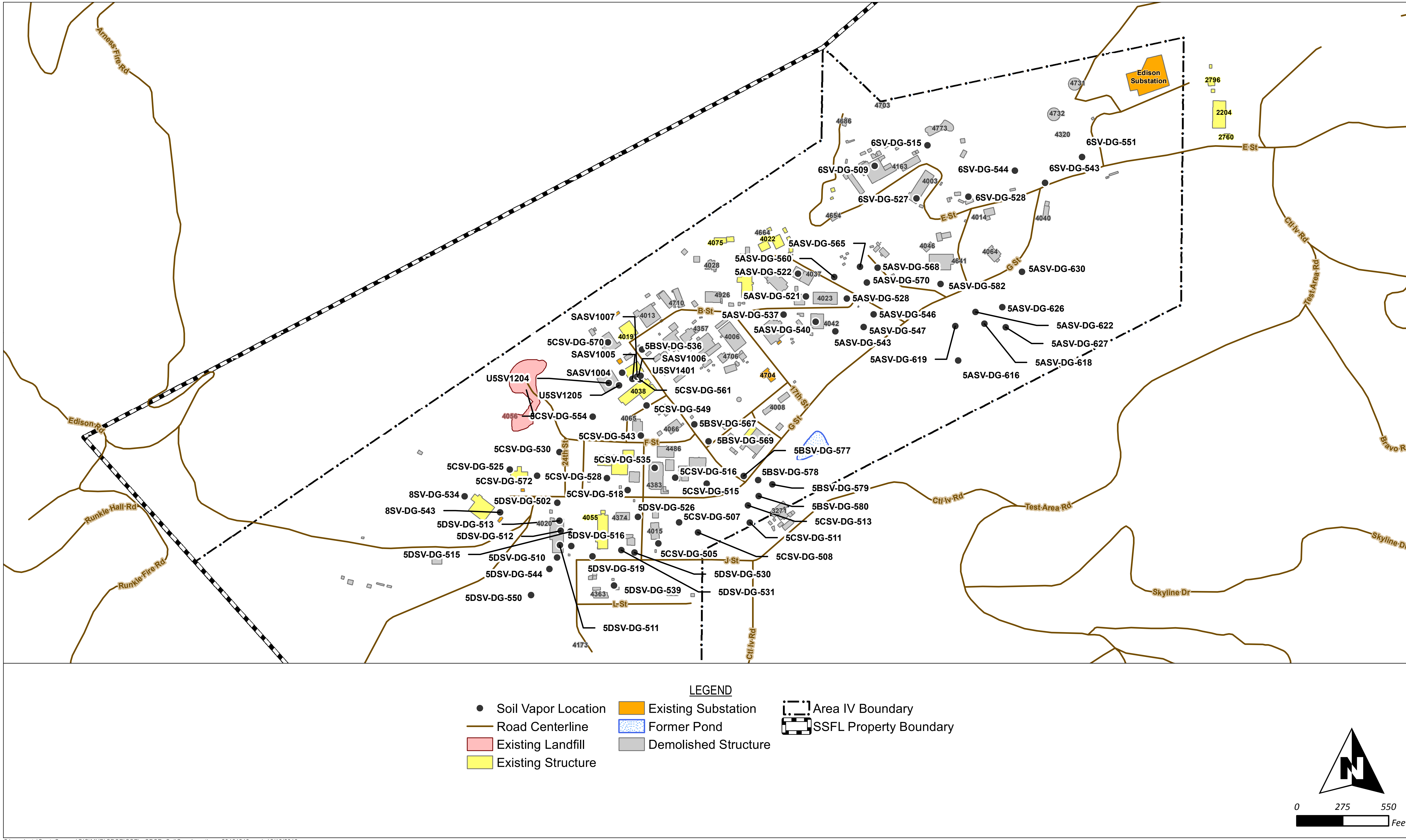
The Old Conservation Yard was used for storage of materials used in other areas of Area IV. Soil containing cesium-137 was found in a 400-square-foot area in the southwest corner of the Old Conservation Yard (known as the Rocketdyne Conservation Yard at that time) in 1988 (Rockwell 1990); the contamination was remediated in 1989.

Other, less extensive removals or removals of unknown quantities of soil and debris were documented in the Historical Site Assessment (HSA) (Hydrogeologic 2012a), including the following:

- Building 4024 was a SNAP Reactor building where unknown quantities of soil and debris were removed when underground liquid and gas holdup tanks were removed.
- Building 4073 was a kinetics experiment water boiler where underground lines and tanks were removed.
- Building 4029 was a radiation measurement facility. Three radioactive source storage wells were excavated in 1989. The total volume of soil and debris was about 100 cubic feet (about 3.7 cubic yards).
- The Sodium Component Test Installation complex comprised 11 numbered structures. Demolition of the complex was completed in 2002 and included extensive excavation of underground concrete pits. No radiological contamination was found in the debris.
- Building 4020 was the Rockwell International hot laboratory ("Hot Lab"), which was used for remote handling of highly radioactive materials. Basement demolition was conducted in 1997. Three areas of soil contamination were identified during demolition; a total of 34 cubic yards of contaminated soil were removed from two of the locations. The volume of contaminated soil in the third location was not stated in the HSA. Uncontaminated soil excavated during demolition was stockpiled and used to backfill the excavation.
- Building 4654 was an interim storage facility in the SRE complex consisting of eight 20-inch-diameter galvanized steel storage tubes anchored into bedrock. The tubes were excavated in 1984 and 1985, and the excavation was backfilled with clean concrete rubble and local soil; 220 cubic yards of low-activity waste were excavated.
- Building 4028 was a shield test reactor located in the RMHF area. The building included a 200-square-foot, 20-foot-high concrete vault that was built into a slope, and so was not entirely underground). In 1975, 30 cubic yards of contaminated soil were removed from the slope north and west of Building 4028. In 1988, 55 cubic yards of radioactive debris from reactor demolition were removed off site. About 130 cubic yards of soil, primarily contaminated with cesium-137, were excavated and removed from the south perimeter fence area sometime between 2003 and 2009. In 2006, about 10 cubic yards of cesium-137 impacted soil were removed from the RMHF holdup pond area located northwest of Building 4028.
- Building 4009 was a sodium graphite reactor. When a 1,500-gallon underground diesel fuel tank was removed in 1987, 24 tons of petroleum-contaminated soil was also removed. EPA

found little additional information concerning other excavation work at Building 4009 that was related to removal of septic tanks, holdup tanks and leach fields.

EPA's HSA documents many cases where there is evidence or an indication of soil excavation, but where there are few details about the amount of soil removed or even the purpose of the excavation. In several cases, structures (e.g., buildings, parking lots, concrete pads, and storage areas) were demolished and removed, and the size of the excavation is not known. Other excavations are observed on aerial photographs or mentioned in historical documentation with few details. Additional excavations documented in the HSA include Buildings 4027, 4023, 4036/4037, 4093, 4633, 4643, 4793, 4030, 4046, 4641, 4005, 4042, 4048, 4049, the 4012 complex, 4013, 4025, 4228, 4355, 4478, 4402, 4606, 4607, 4615, 4026, 4226, 4358, 4826, 4334/4335, 4293, 4354, 4502, 4714, 4735, 4007, 4008, 4171, 4172, 4500, 4521, 4611, 4612, 4459, 4626, 4662, 4383, 4487, 4468, 4520, 4173, 4353, 4041, 4153, 4163, 4183, 4184, 4185, 4653, 4689, 4695, 4753, 4064, 4622, 4664, and 4317/4730.



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CDM Smith

FIGURE 2-1
Locations of Data Gap Soil Gas Samples

Section 3

Identification of Chemicals of Concern

3.1 Soil Chemical Database

As was indicated in Section 2, the characterization of soil within Area IV was performed through multiple investigations over time. During the RFI 2,259 surface and subsurface samples were collected. During the AOC Phases 1, 2, and 3 sampling, 5,854 surface and subsurface samples were collected. The plates presented in Exhibit A illustrate the locations of these samples.

Soil samples were analyzed for chemical constituents based on the history of chemical uses at the location and for those constituents that prior soil data indicated what the chemicals of interest were identified for the location. For locations with unknown historical chemical usage, a broader range of chemicals were included in the analytical suite. For example, at transformer locations, soil sampling would focus on PCBs, polycyclic aromatic hydrocarbons (PAHs), and TPH. Locations where wastes were stored were subject to a larger suite of possible chemicals defined as the 'default' group. The default group normally included metals, PCBs, PAHs, and dioxins. The chemical groups and analytical methods used to identify respective chemicals are listed in Table 3-1.

Table 3-1
Chemical Groups and Respective Analytical Methods

Chemical Group	Analytical Methods
Metals	EPA 6010B/6020
Chromium VI	EPA 7199
Mercury	EPA 7174A
Methyl Mercury	EPA 1630
Fluoride	EPA 300.0
Perchlorate	EPA 6850/EPA 314.0
PAHs	EPA 8270 SIM
SVOCs	EPA 8270
PCBs/PCTs	EPA 8082
Pesticides	EPA 8081A
Herbicides	EPA 8151
Dioxins/Furans	EPA 1613B
Alcohols	EPA 8015B
Terphenyls	EPA 8015B
Glycols	EPA 8015M
TPH	EPA 8015M
Formaldehyde	EPA 8315A
n-Nitrosodimethylamine	EPA 1625C
Energetics	EPA 8330A
Nitrate	EPA 300.0
Cyanide	EPA 9012B

[1] Analytical methods from USEPA Test Methods for Evaluating Solid Waste (SW-846)

3.2 COC Criteria and Identification Process

The soils investigation effort involved the collection of over 8,100 soil samples and the analysis for up to 290 individual chemicals in some soil samples. To effectively present the results of the studies for this number of samples and analysis requires a methodology to identify which of those chemicals are of interest for soil cleanup (i.e., which soil chemical results truly identify contamination above a LUT value). Therefore, the first step in the data evaluation process is to identify the chemicals of potential concern (COPCs), meaning chemicals detected in samples, and then evaluate the list of COPCs for chemicals of concern (COCs) that may require a cleanup action. The steps taken in this evaluation process, used to identify CPOCs and then the COCs through comparison with site-specific criteria, is similar to the process used for the evaluation of soil data at chemically impacted sites all across the United States. Meaning the process was not created specifically for application at SSFL.

The determination of COCs is an iterative process involving step-wise data assessments. These assessments start with a compilation of all analytical data for soils obtained through all sampling events as described in Section 2 and maintained in the site-wide Environmental Quality Information System (EQuIS) database. This database was subject to a series of queries to determine which of the 290 chemicals subject to laboratory analyses were detected in any sample. Those analytes that were detected are considered COPCs for Area IV and the NBZ, and are further evaluated to determine if they are COCs. Any chemical that was never detected was eliminated from any future review.

The Importance in Managing Uncertainty for Cleanup Decisions

The Administrative Order on Consent established soil cleanup criteria for Area IV, but it did not change the process under which cleanup decisions are to be made by DOE and DTSC. Decision makers need at least a 95% confidence in identifying what is being cleaned up is actually real contamination. However, making point-by-point decisions involving up to 290 chemicals (i.e., 290 independent decisions for each point) greatly decreases confidence in cleanup decisions (i.e., data indicating false presence of a chemical), increasing the uncertainty for the decision and resulting in the possibility of removal of uncontaminated soil. The identification of true contamination is even more important when cleanup standards are set based on laboratory reporting limits because labs are more likely to falsely report the presence of a chemical at the reporting limit concentration. The process described in this section on the identification of chemicals of concern that reflect true soil contamination is one used for cleanup decisions nationwide, and was not developed specifically for evaluating Area IV data.

After determining which of the chemicals were reported to be present in a laboratory sample, the next step in COC determination process was calculation of the frequency of detection for each COPC (i.e., the number of detected results divided by the total number of analyses). For a database that is as large as the one maintained for Area IV, the normal practice is to consider 5% detections and greater as a threshold criterion to identify a COC. The 5% criterion considers the potential for a laboratory to falsely report the presence of a chemical. A chemical may be retained as a COPC event though the detection frequency was less than 5% pending additional screening, described in the following paragraphs. Typically, 5% is a threshold for allowing identification of false positives (i.e., a detection frequency of <5% can be attributed to a false positive rate, a frequency greater than 5% indicates that the chemical is present at the site). However to be conservative, a 2.5% frequency of detection criterion was applied for the identification of COCs for the Area IV database. If an analyte was detected in less than 2.5 percent of the samples collected, the chemical is recommended to be screened from further COC consideration, pending a "hot spot" analysis as presented in Section 3.16. If the frequency of detection exceeds 2.5 percent, the COPC evaluation proceeds to the second step.

The next assessment step involves an evaluation of the COPC concentrations against their respective soil LUT (background) values. This step honors the AOC requirement to address chemicals that are above the AOC Look-up Table (LUT)[3] values. Background concentrations for all chemicals were determined by the DTSC through a sampling program as described in "Final Chemical Soil Background Study Report" (URS, 2012). DTSC provided background concentrations for all chemicals in LUTs (DTSC 2013b) to DOE for use as cleanup levels in site remedial designs and remedial actions. Using the database, each individual sample chemical concentration was compared with its respective soil LUT value and the number of samples with values exceeding the LUT values was calculated. If the percentage of detections exceeding the LUT value was greater than 2.5 percent, that COPC was considered a COC and further evaluation is not necessary. If the LUT exceedance percentage was less than 2.5 percent or no LUT exists for the chemical, the chemical proceeds to the third step described in the next paragraph. Because the LUT value reflects background for many COPCs, exceedence of the LUT value is possible due to analytical error or background variability. (For example, chemicals within 61 of the 268 background samples collected by DTSC exceeded a LUT value, demonstrating background variability). The 2.5 percent exceedence of a LUT value criterion addresses this concern. Because any COPC with a natural occurrence (e.g., metals, PAHs, dioxins) are expected to be present in more than 2.5 percent of samples, this criterion primarily addresses man-made chemicals (e.g., PCBs).

The third data assessment step for COC determination involves an evaluation of the COPC concentrations against the human health risk based screening levels (RBSL[4]) values (set for the suburban resident scenario). Risk based chemical concentrations in soil were determined through a risk assessment evaluation presented in the Final Standardized Risk Assessment Methodology (SRAM) Revision 2 Addendum (MWH Americas, Inc., 2014c). The SRAM publishes a list of RBSL based on a suburban residential soil exposure scenario. Each COPC concentration was compared against its respective RBSL value. The number of samples with values exceeding the RBSL values is calculated. Then this total is compared to the number of samples that had detections of that COPC. If the percentage of detections exceeding the RBSL value is greater than 5 percent, that COPC was retained as a COC. If the RBSL exceedence percentage is below 5 percent, the chemical was considered for a “hot spot” determination prior to making the recommendation to be screened from COC consideration.

The comparison of individual chemicals and their RBSL values also addresses a community request for DOE to present the relative risk for chemicals in soils within Area IV.

Minerals and essential nutrients (e.g., calcium, iron, phosphorous) were screened from COPC consideration.

For those COPCs recommended not be included as a COC, a final assessment was made based on the distribution of the chemical within known operational areas and non-operational areas. A chemical observed primarily in operational areas and co-located with other COCs was still considered to be a COC even if observed in less than 2.5% of samples. Chemicals randomly

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[3] DTSC established LUT values for 116 of the most frequently observed chemicals throughout SSFL. Many of the chemicals on the LUT were not used in Area IV. However, the data assessment in this report addresses all 290 chemical subject to laboratory analysis, not just the LUT listed chemicals.
[4] An RBSL value was not established for all the 290 chemicals.

distributed and not co-located with COCs may not be considered a COC as there was no evidence of them being site-related. The presence of those chemicals may be related to background variability or influenced by bedrock outcrops.

3.3 Metals Evaluation

Table 3-2 provides the COPC evaluation for metals analyzed in soil samples. Because metals are naturally occurring the 'frequency of detection' criterion does not apply and the percentage of sample exceeding the LUT background value was used as the primary criterion to identify the metals COCs. A review of Table 3-2 shows that antimony, cadmium, mercury and methyl mercury, selenium, and silver exceed the 2.5 percent LUT CPOC criterion and are COCs for Area IV. The distributions of these metals are presented in Section 4 of this CDSR.

Chromium VI (1.58 percent exceedence of LUT value), lead (1.98% exceedence), and zinc (2.2% exceedence) are being retained for “hot spot” analysis (see Section 3.16). Three other metals, arsenic, thallium, and zirconium had less than 1 percent exceedence of LUT values and their background LUT values are greater than the RBSL values. Due to the low LUT exceedence rate of 0.14 percent for arsenic, 0.2 percent for thallium, and 0.02 percent for zirconium, the conclusion can be made that these metals are naturally occurring at these concentrations and should not be considered site COCs.

3.4 Polychlorinated Biphenyls (Aroclors)

PCBs (Aroclor is a brand name for PCBs) are man-made for industrial uses and do not have a natural origin. Therefore, the frequency of detection is the appropriate criterion for COC identification. Table 3-3 provides a summary of the PCB data. Aroclors 1254, 1260, and 5460 exceed the 2.5 percent frequency of detection criterion and are considered COCs. Aroclor 1248 exceeded its LUT in 1.35% of samples. Exceedences of LUT values for Aroclors 1242 and 1268 were less than 0.2%. Results for Aroclors 1262 and 5422 did not exceed their LUT values. Section 4 presents the distribution of the results for the PCB analyses. The PCB Aroclors were typically found co-located in soil in Area IV. This means if the primary COC Aroclors (1254, 1260, and 5460) are subject to soil cleanup, other Aroclors (1248, 1262 and 1268) are likely to be excavated and removed at the same time.

3.5 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs) are a group of similar chemicals that can be created naturally from brush and forest fires, or created during the manufacturing of chemicals containing chlorine, or the burning of chemicals containing chlorine. For SSFL PCDDs and PCDFs occur naturally resulting from brush fires and from site activities such as burning of wastes. No chemical manufacturing occurred within Area IV.

PCDDs and PCDFs exist as groups of similar bi-ringed compounds termed congeners that differ in the number of chlorine atoms. The text box below provides a listing of the congeners. The most toxic of the congeners is 2,3,7,8-tetrachloro dibenzo-p-dioxin (2,3,7,8-TCDD). The World Health Organization (WHO) has established an approach that provides for an evaluation of the collective group of dioxins and furans based on the toxicity of 2,3,7,8-TCDD (DTSC, 2013a). WHO has recommended a toxicity evaluation be applied to the common PCDDs and PCDFs observed in site data resulting in a toxicity equivalency quotient (TEQ) for the data set. The 2,3,7,8-TCDD equivalency factors used in this analysis are those presented in DTSC (2013) and shown in the text box below. DTSC in its background study developed TEQs for dioxins and furans for use in evaluating site data.

Dioxins-Furans World Health Organization (WHO) Toxicity- Equivalency Factors

Dioxin-Furan	Name	WHO TEF
1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.01
1,2,3,4,6,7,8-HpCDF	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8,9-HpCDF	1,2,3,4,,7,8,9-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8-HxCDD	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,4,7,8-HxCDF	1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-HxCDD	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,6,7,8-HxCDF	1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-HxCDD	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,7,8,9-HxCDF	1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
1,2,3,7,8-PeCDD	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1.0
1,2,3,7,8-PeCDF	1,2,3,7,8-Pentachlorodibenzofuran	0.03
2,3,4,6,7,8-HxCDF	2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
2,3,4,7,8-PeCDF	2,3,4,7,8-Pentachlorodibenzofuran	0.3
2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.0
2,3,7,8-TCDF	2,3,7,8-Tetrachlorodibenzofuran	0.1
OCDD	Octachlorodibenzo-p-dioxin	0.0003
OCDF	Octachlorodibenzofuran	0.0003

Table 3-4 provides the dioxin and furan data summary for Area IV. Because dioxins and furans have a natural origin, the frequency of detection criterion does not apply. The percentage of detections above the LUT value does apply and dioxins and furans are considered COCs for Area IV. The distribution of dioxins/furans using the TEQ result is presented in Section 4.0.

3.6 Polycyclic Aromatic Hydrocarbons

PAHs have a natural origin, particularly as a result of natural brush fires experienced by arid coastal climate of southern California. Thus PAHs would be expected to be found in shallow, undisturbed soils at SSFL. PAHs are also a result of burning of waste materials and are components of heavier petroleum fuels and products. PAHs also exist as a mixture of complex organic molecules and are normally found in soil as a mixture. PAHs are separated into two classes: Non-Carcinogenic and Carcinogenic PAHs. Table 3-5 presents a summary of the results for the PAH classes. With the exception of 1,1'-Biphenyl (1 detection) and Azobenzene (no detections) all of the PAHs are considered COCs for Area IV. Section 4.0 presents the results.

Similar to the manner in which dioxins are evaluated against the most toxic congener, the carcinogenic PAHs are evaluated against a toxicity equivalency factor based on Benzo(a)pyrene (BaP). Calculation of BaP equivalent concentrations was performed in accordance with State of California Guidance (DTSC, 2011). The text box below provides the equivalency factors for BaP published by DTSC. Table 3-5 provides the results of the toxicity evaluation for BaP. Carcinogenic PAHs are COCs for Area IV.

Cal/EPA Polycyclic Aromatic Hydrocarbon (PAH) Cancer Potency Equivalency Factors

PAH or Derivative	Cal/EPA Cancer Potency Equivalency Factor
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(j)fluoranthene	0.1
Benzo(k)fluoranthene	0.1 (0.01)
Indeno(1,2,3-cd)pyrene	0.1
Chrysene	0.01 (0.001)

3.7 Pesticides

Chlorinated pesticides were once used extensively throughout the U.S. via aerial application and as a result are detected in surface soils as part of atmospheric deposition (e.g., dispersal from airplane applications). As a result, 'background' values exist for many of the chlorinated pesticides. It is assumed that some pesticides were applied near former buildings within Area IV, but records of pesticide type, application rates, and locations are not available. Table 3-6 provides a summary of the pesticide results. A total of 21 chlorinated pesticides were detected, 15 of which exceeded the 2.5 percent frequency of detection criterion, but only 7 exceed the 2.5 percent LUT criterion. Because the LUT value was set to reflect 'background' for the pesticides, it is the best comparative criterion for COC identification. Therefore the pesticides 4,4'DDD, 4,4'-DDE, 4,4'-DDT, Beta-Benzene Hexachloride, Chlordane, Delta-Benzene Hexachloride, and Dieldrin are considered chlorinated pesticide COCs for Area IV. Section 4.0 presents the results.

3.8 Herbicides

A number of herbicide chemical products were in use during the 1960s and 1970s for control of weeds and agricultural fields and grass and brush near buildings. Airplane applications of herbicides may have resulted in atmospheric deposition remote from the application sites. There are no records of herbicide usage in Area IV but it is assumed some herbicides were applied to control weeds and brush near roadways and buildings as a fire-control measure.

Table 3-7 provides the summary of results for herbicides in Area IV soils. Because the presence of herbicides can be from atmospheric deposition (meaning presence in soil not resulting from operations in Area) the frequency of detection criterion does not apply. For the 10 herbicide chemicals that were analyzed in soil samples, three herbicide chemicals – 2,4-DB, MCPA, and MCPP – exceeded the 2.5 percent exceedence of LUT value criterion. These three herbicides are considered COCs for Area IV. The distribution of herbicides in Area IV is discussed in Section 4.

Pentachlorophenol is a wood treatment chemical used to preserve wood that comes in contact with soil to prevent attack by fungus and insects (e.g., termites). It is commonly used for telephone poles and wooden fence posts. Pentachlorophenol is not applied using airplanes and is not expected to have a background value. However, it was only observed above the LUT value in 7 of 3104 samples (0.23 percent) and thus did not exceed the 2.5 percent exceedence of LUT value criterion.

3.9 Phthalates

Phthalates are a group of similar chemicals used in industry for the manufacturing of plastics. They are used in plastics and vinyl to increase flexibility of the materials. Although not manufactured at Area IV, phthalates could have been present in plastic materials, such as PVC pipe. Other potential uses of phthalates at SSFL could be a result of their possible presence in paints and propellants (EPA, 2012). Table 3-8 provides the summary of the phthalate data. Four phthalates, Bis(2-ethylhexly)phthalate, Butylbenzylphthalate, Di-n-butylphthalate, and Di-n-octylphthalate exceed the 2.5 percent frequency of detection criterion. However, only Bis(2-ethylhexly)phthalate and Di-n-octylphthalate exceed the LUT value criteria and are considered COCs. Further discussion on the presence of phthalates is provided in Section 4.

3.10 n-Nitrosodimethylamine and Perchlorate

NDMA and perchlorate are two compounds of interest for SSFL overall as they were components of rocket fuels and propellants. According to EPA (2014), NDMA was once used in liquid rocket fuel, antioxidants, additives for lubricants, and softeners for copolymers. EPA (2014) also reports that NDMA can be created in natural and water treatment processes. Although no rocket engine testing occurred in Area IV, preparation of some rocket fuels was conducted in Area IV. And NDMA may have been used in steam boilers and water coolant systems. NDMA was observed in 5.38 percent of samples, but only 11 of 6609 samples exceeded (0.17 percent) the LUT value. Therefore, NDMA is a SSFL overall contamination is retained as an Area IV COC (Table 3-9).

According to EPA (2015), perchlorate has both natural and man-made origins. The majority of the use of perchlorate is rocket engine propellants, pyrotechnics, and fireworks, but it also has industrial applications. Perchlorate was observed in 3.50 percent of samples and was above the LUT value in 2.27 percent of samples, exceeding the 2.5 percent criterion. Perchlorate is considered an Area IV COC. Its presence is discussed further in Section 4.

3.11 Miscellaneous Chemicals

For purposes of data presentation in this report, alcohols, formaldehyde, glycols, and terphenyls have been grouped in this subsection. Table 3-9 provides the data summary for these chemical groups. 2-Propanol was detected only 1.88 percent of the time, does not have a LUT value, and is not considered a COC. Ethanol and Methanol exceeded the 2.5 percent frequency of detection but not the 2.5 percent exceedence of LUT value criterion and are not considered COCs. Formaldehyde exceeded both criteria and is considered a COC. This chemical is discussed further in Section 4.

Of the four glycols analyzed for, only Triethylene Glycol exceeded the 2.5 percent frequency of detection criterion. However, this glycol does not have a LUT value and was not detected above its RBSL value. It is not considered an Area IV COC.

None of the three terphenyls was detected in more than 2.5 percent of samples and o-Terphenyl was not detected above its LUT value. Terphenyls are not considered a COC for Area IV.

Cyanide did not exceed the frequency of detection or LUT criteria and is not considered a COC for Area IV.

3.12 Total Petroleum Hydrocarbons

Petroleum fuels, particularly diesel, were widely used in Area IV to power vehicles, construction equipment, and back-up generators. TPH represent the straight and branched alkane fraction of fuels (e.g., kerosene, gasoline, diesel). The analytical results for TPH are typically reported by the range of carbon atoms (C) contained in a sample (e.g., <C12, C10 to C15, C15 to C20, >C20). The lighter chemicals typically degrade or volatize (are lost from the impacted soil) faster than the heavier molecules. This fact is illustrated in Table 3-10 and is supported by the results of the soil treatability studies. The reporting of the presence of low gasoline compounds with carbons ranges of <12 carbons atoms and 10 to 15 carbon atoms was 4.5% and 2.72%, respectively. These are carbon ranges of typical organic molecules in the soil environment and may not reflect hydrocarbon presence at all. The higher carbon ranges of 15 to 20 and greater than 20 carbon molecules were observed in 23.26% and 69.55% of the samples, respectively. Some of these samples may also have contained naturally occurring organic matter.

DTSC selected 5 milligrams per kilogram (mg/kg)[5] as the interim LUT value for TPH pending the outcome of the soil treatability studies. The analytical method used to test for TPH (EPA Method 8015M) is non-specific as to the type of organic matter it reports, and the method primarily is used to identify the carbon size fraction (i.e., number of carbon atoms) of organic molecules in the sample. The soil treatability studies were instrumental in determining that some of organic molecules reported by Method 8015M are not petroleum related at all, but are of natural origin (Nelson et. al, 2015). Therefore, the 5 mg/kg value is not an indicator of the presence of petroleum-related chemicals.

A review of Table 3-10 shows that the lower range carbon containing compounds do not exceed the LUT criterion and are not COCs. The heavier range compounds do exceed the criterion, but there remains uncertainty as to whether all of the exceedences are petroleum related (Nelson et al, 2015; Burgesser, 2015). This issue is discussed further in Section 4.

3.13 Energetic Compounds

Energetic compounds are of interest for SSFL overall as they are components of rocket engine fuels and igniters. Although no rocket engine testing was performed in Area IV, some fuels were formulated in Area IV and contaminated soil from Areas II and III was placed in Area IV (e.g., Dredge Spoils Area). Table 3-11 presents the results for energetic compounds. None of the

[5] The AOC Look-up Table published by DTSC in June 2013 includes a footnote a cleanup strategy for TPH would be considered upon completion of the soil treatability studies.

compounds detected exceeded their respective RBSLs and energetic compounds are not considered COCs for Area IV.

3.14 Semivolatile Organic Compounds

The semivolatile organic compounds (SVOCs) represent a group of chemical compounds typically liquids or waxes at room temperature of differing origins and structures. They share a common physical nature in that they can be lost to the atmosphere through volatilization although at much slower rates that volatile compounds. SVOCs are used as part of chemical manufacturing and processing and are typically part of the suite of analytical methods used for characterization of soil at most industrial facilities. Most are manufactured and do not have a natural origin in the environment. Morpholine (4 detections) was used as a corrosion inhibitor in steam pipes that were used during energy transfer research.

Table 3-12 presents the soil sampling data for SVOCs. None of the SVOCs analyzed for in Area IV soils exceeded the 2.5 percent frequency of detection criterion, 2.5 percent LUT value exceedence criterion, or RBSL criterion. None of the SVOCs are COCs for Area IV.

3.15 Volatile Organic Compounds

Volatile organic compounds (VOCs) like SVOCs are a group of chemicals used in industrial processes, but differ in that they are much more volatile. VOCs exist as liquids or gases at room temperatures. VOCs are much more mobile (volatile and soluble) and are lost from soils much more rapidly. These physical properties of VOCs mean that their concentrations would be expected to decrease quickly in the sandy, arid, and aerated soils present at Area IV.

Table 3-13 presents the soil sampling data for VOCs. With the exception of common laboratory chemicals, methylene chloride, acetone, toluene, and methyl ethyl ketone (MEK), all VOCs detections were below the 2.5 percent frequency of detection criterion. Methylene chloride is present in the laboratory environment as it is commonly used as a sample extractant to remove chemicals from soil for analysis. Acetone and toluene are used for the cleaning of laboratory glassware. MEK is used for the construction of laboratory apparatus. As a result, these chemicals are reported in analytical results although they were not present in the original sample.

The solvents trichloroethylene (TCE), 1,1,1-Trichloroethane, and perchloroethylene (PCE) were used in Area IV to clean metallic objects. These VOCs and their common breakdown products 1,1-Dichloroethene (1,1-DCE) and 1,2-Dichloroethene (1,2-DCE) are COCs for groundwater in Area IV. Analysis of soil gas is a more appropriate method for analyzing for these VOCs. MWH conducted soil gas sampling within Area IV that identifies where TCE, PCE, and 1,1-DCE are present in soil gas (MWH, 2014b). This data set is being used as part of the groundwater remedial investigation to assess potential sources for groundwater contamination. The groundwater remedial investigation will assess the need for VOC remediation and no further evaluation of VOCs in made in this CDSR.

3.16 Hot Spot Evaluation

"Hot spots" reflect limited locations with elevated concentrations of a chemical. Although the chemical may not be widespread in Area IV, the localized elevated concentrations are of concern.

Hot spots typically are found in chemical process areas and are co-located with other chemicals, but a hot spot analysis ensures that the chemicals are addressed as part of cleanup. The metals chromium VI, lead, and zinc were subject to a "hot spot" analysis to determine whether the presence was random (possibly of natural origin) or related to site activities, such as localized spills. The results were plotted for this evaluation. Section 4.0 presents the plots. A review of the plots indicates that these metals should be considered COCs for Area IV.

3.17 Chemicals of Concern Summary

The assessment of COCs in this chapter is not the final assessment of chemicals within Area IV. During the planning, design, and implementation of the soil remediation action, (as introduced in the SRAIP), it may be determined additional samples, either laterally or at depth, may be needed at a proposed remediation areas to refine excavation volumes, for example. However, DOE believes that the current database is sufficiently robust to allow soil remediation planning to start.

Table 3-14 presents a summary of the results of the COC analysis of Area IV soil data. The primary COCs for Area IV are:

Metals

Antimony	Cadmium	Chromium VI	Lead
Mercury	Methyl Mercury	Selenium	Silver
Zinc			

PCBs

Arochlor 1254	Arochlor 1260	Arochlor 5460

Dioxins and Furans

All dioxin and furan compounds

PAHs

1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Anthracene
(Benzo(g,h,i)Perylene	Fluoranthene	Fluorene	Naphthalene
Phenathrene	Pyrene	Benzo(e)pyrene	Benzo(a)anthracene
Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(K)fluoranthene	Chrysene
Dibenzo(a,h)anthracene		Indeno(1,2,3-cd)pyrene	

Pesticides

4,4'-DDD	4,4'-DDE	4,4'-DDT	Beta-BHC
Chlordane	Delta-BHC	Dieldrin	

Herbicides

2,4-DB	MCPA	MCPP

Phthalates

Bis(2-ethylhexyl)phthalate	Di-n-octylphthalate

Miscellaneous Chemicals

N-Nitrosodimethylamine

Perchlorate
Formaldehyde
Fluoride
Total Petroleum Hydrocarbons

Table 3-2 Metals Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# Samples Above LUT	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
Aluminum	5852	5851	99.98%	58600	mg/kg	0	0.00%	75300	mg/kg	0	0.00%
Antimony	**5706**	**3135**	**54.94%**	**0.86**	**mg/kg**	**208**	**3.65%**	**26.4**	**mg/kg**	**7**	**0.12%**
Arsenic	5901	5807	98.41%	46	mg/kg	8	0.14%	0.0658	mg/kg	5807	98.41%
Barium	5885	5883	99.97%	371	mg/kg	12	0.20%	11000	mg/kg	0	0.00%
Beryllium	5880	5769	98.11%	2.2	mg/kg	1	0.02%	31.2	mg/kg	0	0.00%
Boron	5804	2978	51.31%	34	mg/kg	5	0.09%	15200	mg/kg	0	0.00%
Cadmium	**5884**	**5248**	**89.19%**	**0.7**	**mg/kg**	**299**	**5.08%**	**4.6**	**mg/kg**	**13**	**0.22%**
Calcium	4804	4801	99.94%	NE			0.00%	NE			0.00%
Chromium	5883	5881	99.97%	94	mg/kg	12	0.20%	37200	mg/kg	0	0.00%
Chromium VI	3423	1754	51.24%	2	mg/kg	54	1.58%	1.29	mg/kg	119	**3.48%**
Cobalt	5869	5866	99.95%	44	mg/kg	8	0.14%	22.8	mg/kg	22	0.37%
Copper	5880	5871	99.85%	119	mg/kg	22	0.37%	3040	mg/kg	1	0.02%
Iron	4804	4802	99.96%	NE			0.00%	NE			0.00%
Lead	5909	5890	99.68%	49	mg/kg	117	1.98%	80	mg/kg	56	**0.95%**
Lithium	5570	5561	99.84%	91	mg/kg	1	0.02%	152	mg/kg	0	0.00%
Magnesium	4804	4796	99.83%	NE				NE			
Manganese	4804	4804	100%	1120	mg/kg	9	0.19%	6130	mg/kg	0	0.00%
Mercury	**6005**	**3152**	**52.49%**	**0.13**	**mg/kg**	**304**	**5.06%**	**16.8**	**mg/kg**	**10**	**0.17%**
Methyl Mercury	**11**	**5**	**45.45%**	**0.05**	**µg/kg**	**5**	**45.45%**	**7610**	**µg/kg**	**0**	**0.00%**
Molybdenum	5866	4770	81.32%	3.2	mg/kg	46	0.78%	380	mg/kg	1	0.02%
Nickel	5881	5865	99.73%	132	mg/kg	7	0.12%	908	mg/kg	2	0.03%
Organic Lead	5	0	0%	NE				NE			
Phosphorus	4736	4735	99.98%	NE				NE			
Potassium	5672	5670	99.96%	14400	mg/kg	0	0.00%	NE			
Selenium	**5894**	**3846**	**65.25%**	**1**	**mg/kg**	**231**	**3.92%**	**380**	**mg/kg**	**0**	**0.00%**
Silver	**5913**	**4185**	**70.78%**	**0.2**	**mg/kg**	**405**	**6.85%**	**230**	**mg/kg**	**4**	**0.07%**
Sodium	5748	5104	88.80%	1780	mg/kg	15	0.26%	NE			
Strontium	4735	4733	99.96%	163	mg/kg	38	0.80%	45600	mg/kg	0	0.00%
Thallium	5882	5452	92.69%	1.2	mg/kg	12	0.20%	0.761	mg/kg	20	0.34%
Tin	4738	569	12.01%	NE				45600	mg/kg	0	0.00%
Tributyl Tin	22	0	0.00%	NE				NE			
Titanium	4736	4735	99.98%	NE				NE			
Vanadium	5875	5874	99.98%	175	mg/kg	1	0.02%	188	mg/kg	1	0.02%
Zinc	**5901**	**5900**	**99.98%**	**215**	**mg/kg**	**130**	**2.20%**	**22800**	**mg/kg**	0	0.00%
Zirconium	5576	3967	71.14%	19	mg/kg	1	0.02%	6.09	mg/kg	276	4.95%

Notes:
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - none established for chemical, no value developed for LUT and/or RBSL
Chemicals of concern are indicated in **bold**

Table 3-3 Polychlorinated Biphenyl (Aroclors) Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Detections above LUT Value	Percentage Samples above LUT	RBSL Value	RBSL Unit	# Detections above RBSL	Percentage Samples Above RBSL
Aroclor 1016	5560	0	0.0%	17	µg/kg	0		3860	µg/kg	0	0.00%
Aroclor 1221	5590	0	0.0%	33	µg/kg	0		NE			
Aroclor 1232	5560	0	0.0%	17	µg/kg	0		NE			
Aroclor 1242	5559	28	0.5%	17	µg/kg	10	0.18%	232	µg/kg	1	0.02%
Aroclor 1248	5558	175	3.1%	17	µg/kg	75	1.35%	232	µg/kg	21	0.38%
Aroclor 1254	**5567**	**1449**	**26.0%**	**17**	**µg/kg**	**520**	**9.34%**	**232**	**µg/kg**	**68**	**1.22%**
Aroclor 1260	**5567**	**1348**	**24.2%**	**17**	**µg/kg**	**335**	**6.02%**	**232**	**µg/kg**	**30**	**0.54%**
Aroclor 1262	4732	2	0.0%	33	µg/kg	0		NE			
Aroclor 1268	4732	20	0.4%	33	µg/kg	1	0.02%	NE			
Aroclor 5432	4875	0	0.0%	50	µg/kg	0		NE			
Aroclor 5442	4875	2	0.0%	50	µg/kg	0		NE			
Aroclor 5460	**4872**	**1006**	**20.6%**	**50**	**µg/kg**	**132**	**2.71%**	**232**	**µg/kg**	**29**	**0.60%**

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
ECO - ecological screening level
NE - none established for chemical, LUT and/or RBSL value not developed
Chemicals of concern are indicated in **bold**

Table 3-4 Dioxin Congeners and TCDD-TEQ Chemical of Concern Evaluation

Dioxin TCDD-TEQ Calculations	# of Samples Evaluated for TEQ Calculations	# of TEQ Calculations	Percentage of Samples Subject to TEQ Calculation	LUT Value	LUT Unit	# of TEQ Calculations Above LUT	Percentage of TEQ Calculations Above LUT	RBSL Value	RBSL Unit	# of TEQ Calculations Above RBSL	Percentage of TEQ Calculations Above RBSL
Total TEQ_Dioxin	**4687**	**3979**	**84.89%**	**0.912**	**ng/kg**	**1324**	**33.27%**	**4.81**	**ng/kg**	**488**	**10.41%**

Dioxin Congeners	# of Samples Collected	# of Detections	Frequency of Analyte Detection
1,2,3,4,6,7,8-HPCDD	4687	3134	66.87%
1,2,3,4,6,7,8-HPCDF	4687	2614	55.77%
1,2,3,4,7,8,9-HPCDF	4687	1568	33.45%
1,2,3,4,7,8-HXCDD	4687	2249	47.98%
1,2,3,4,7,8-HXCDF	4687	1936	41.31%
1,2,3,6,7,8-HXCDD	4687	2952	62.98%
1,2,3,6,7,8-HXCDF	4687	1948	41.56%
1,2,3,7,8,9-HXCDD	4687	2823	60.23%
1,2,3,7,8,9-HXCDF	4687	1660	35.42%
1,2,3,7,8-PECDD	4687	2006	42.80%
1,2,3,7,8-PECDF	4687	2034	43.40%
2,3,4,6,7,8-HXCDF	4687	1681	35.87%
2,3,4,7,8-PECDF	4687	1598	34.09%
2,3,7,8-TCDD	4687	1462	31.19%
2,3,7,8-TCDF	4687	2328	49.67%
OCDD	4687	3613	77.09%
OCDF	4687	2731	58.27%

TCDD TEQ calculations performed on all samples with at least 1 detected congener.
708 samples had no detections

Notes:
ng/kg - nanograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
LUT and RBSL values established for TCDD TEQ comparison only

Table 3-5 Polycyclic Aromatic Hydrocarbon Chemical of Concern Summary

Non-Carcinogenic PAHs	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Detections above LUT Value	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
1,1'-Biphenyl	617	1	0.16%	NE							0.00%
1-Methylnaphthalene	**5557**	**528**	**9.50%**	**2.5**	**µg/kg**	**144**	**2.6%**	7290	µg/kg	1	0.02%
2-Methylnaphthalene	**5677**	**707**	**12.45%**	**2.5**	**µg/kg**	**199**	**3.5%**	162000	µg/kg	0	0.00%
Acenaphthene	**5741**	**348**	**6.06%**	**2.5**	**µg/kg**	**158**	**2.8%**	3230000	µg/kg	0	0.00%
Acenaphthylene	5738	422	7.35%	2.5	µg/kg	96	1.7%	2980000	µg/kg	0	0.00%
Anthracene	**5739**	**1020**	**17.77%**	**2.5**	**µg/kg**	**409**	**7.1%**	16400000	µg/kg	0	0.00%
Benzo(g,h,i)perylene	**5733**	**1903**	**33.19%**	**2.5**	**µg/kg**	**1085**	**18.9%**	1650000	µg/kg	0	0.00%
Fluoranthene	**5744**	**2385**	**41.52%**	**5.2**	**µg/kg**	**1120**	**19.5%**	2200000	µg/kg	0	0.00%
Fluorene	**5749**	**450**	**7.83%**	**3.8**	**µg/kg**	**142**	**2.5%**	2180000	µg/kg	0	0.00%
Naphthalene	**5896**	**1041**	**17.66%**	**3.6**	**µg/kg**	**232**	**3.9%**	14600	µg/kg	1	0.02%
Phenanthrene	**5737**	**2373**	**41.36%**	**3.9**	**µg/kg**	**914**	**15.9%**	16400000	µg/kg	0	0.00%
Pyrene	**5750**	**2381**	**41.41%**	**5.6**	**µg/kg**	**1100**	**19.1%**	1650000	µg/kg	0	0.00%
Benzo(e)pyrene	**1387**	**243**	**17.52%**	NE			**--**	1650000	µg/kg	0	0.00%

Carcinogenic PAHs	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Detections above LUT Value	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
Benzo(a)anthracene	5727	1752	30.59%	NE				387	µg/kg	59	1.03%
Benzo(a)pyrene	5734	1911	33.33%	4.47	µg/kg	913	15.9%	38.7	µg/kg	273	4.76%
Benzo(b)fluoranthene	5734	2540	44.30%	NE				387	µg/kg	77	1.34%
Benzo(k)fluoranthene	5588	1386	24.80%	NE				387	µg/kg	33	0.59%
Chrysene	5738	2661	46.38%	NE				3870	µg/kg	10	0.17%
Dibenzo(a,h)anthracene	5737	737	12.85%	NE				113	µg/kg	32	0.56%
Indeno(1,2,3-cd)pyrene	5737	1379	24.04%	NE				387	µg/kg	38	0.66%

BaP TEQ Calculations	# of Data Sets Considered	# of BaP TEQ Calculations	Percentage of Data sets subject to BaP TEQ Calculations	LUT Value	LUT Unit	# of TEQ Calculations above LUT	Percentage BaP TEQ Calculations above LUT	RBSL Value	RBSL Unit	# of BaP Calcuations above RBSL	Percentage of BaP TEQ Calcluations Above RBSL
Total TEQ_BAP	**5651**	**2938**	**51.99%**	**4.47**	**µg/kg**	**1065**	**18.8%**	**38.7**	**µg/kg**	**362**	**6.41%**

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - LUT value not established for this chemical
Chemicals of concern are indicated in **bold**

Table 3-6 Pesticides Data Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# Detections Above LUT Value	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
4,4'-DDD	**1416**	**67**	**4.73%**	**0.48**	**µg/kg**	**33**	**2.33%**	**2460**	**µg/kg**	**0**	**0.00%**
4,4'-DDE	**1424**	**521**	**36.59%**	**8.6**	**µg/kg**	**44**	**3.09%**	**1740**	**µg/kg**	**0**	**0.00%**
4,4'-DDT	**1428**	**687**	**48.11%**	**13**	**µg/kg**	**49**	**3.43%**	**1740**	**µg/kg**	**0**	**0.00%**
Aldrin	1416	7	0.49%	0.24	µg/kg	1	0.07%	34.8	µg/kg	0	0.00%
Alpha-BHC	1421	44	3.10%	0.24	µg/kg	11	0.77%	219	µg/kg	0	0.00%
Beta-BHC	**1416**	**109**	**7.70%**	**0.23**	**µg/kg**	**56**	**3.95%**	**394**	**µg/kg**	**0**	**0.00%**
Chlordane (Technical)	**1421**	**295**	**20.76%**	**7**	**µg/kg**	**46**	**3.24%**	**1690**	**µg/kg**	**0**	**0.00%**
Delta-BHC	**1421**	**151**	**10.63%**	**0.22**	**µg/kg**	**38**	**2.67%**	**328**	**µg/kg**	**0**	**0.00%**
Dieldrin	**1417**	**120**	**8.47%**	**0.48**	**µg/kg**	**74**	**5.22%**	**36.9**	**µg/kg**	**3**	**0.21%**
Endosulfan I	1400	20	1.43%	0.24	µg/kg	8	0.57%	412000	µg/kg	0	0.00%
Endosulfan II	1411	47	3.33%	0.48	µg/kg	15	1.06%	412000	µg/kg	0	0.00%
Endosulfan Sulfate	1415	27	1.91%	0.48	µg/kg	13	0.92%	412000	µg/kg	0	0.00%
Endrin	1408	14	0.99%	0.48	µg/kg	3	0.21%	20600	µg/kg	0	0.00%
Endrin Aldehyde	1409	107	7.59%	0.7	µg/kg	28	1.99%	20600	µg/kg	0	0.00%
Endrin Ketone	1407	51	3.62%	0.7	µg/kg	8	0.57%	20600	µg/kg	0	0.00%
Gamma-BHC (Lindane)	1422	90	6.33%	0.24	µg/kg	10	0.70%	537	µg/kg	0	0.00%
Heptachlor	1419	68	4.79%	0.24	µg/kg	29	2.04%	144	µg/kg	0	0.00%
Heptachlor Epoxide	1418	79	5.57%	0.24	µg/kg	24	1.69%	107	µg/kg	0	0.00%
Methoxychlor	1411	21	1.49%	2.4	µg/kg	7	0.50%	343000	µg/kg	0	0.00%
Mirex	1393	82	5.89%	0.5	µg/kg	28	2.01%	32.8	µg/kg	0	0.00%
Technical Toxaphene	1410	16	1.13%	8.8	µg/kg	8	0.57%	493	µg/kg	0	0.00%

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
Chemicals of concern are indicated in **bold**

Table 3-7 Herbicide Data Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detections	LUT Value	LUT Unit	# Detections Above LUT	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Detections Above RBSL	Percentage Detections Above RBSL
2,2-Dichlor-Propionic Acid	1256	0	0%	12.5	µg/kg	0	0.00%	2060000	µg/kg	0	
2,4,5-T	1282	102	7.96%	1.2	µg/kg	11	0.86%	686000	µg/kg	0	0%
2,4-D	1279	45	3.52%	5.8	µg/kg	10	0.78%	686000	µg/kg	0	0%
2,4-DB	**1269**	**265**	**20.88%**	**2.4**	**µg/kg**	**184**	**14.50%**	**549000**	**µg/kg**	**0**	**0%**
Dicamba	1265	110	8.70%	1.3	µg/kg	9	0.71%	2060000	µg/kg	0	0%
Dichlorprop	1271	43	3.38%	2.4	µg/kg	14	1.10%	686000	µg/kg	0	0%
Dinitrobutyl Phenol	689	12	1.74%	3.3	µg/kg	3	0.44%	68600	µg/kg	0	0%
MCPA	**1273**	**302**	**23.72%**	**761**	**µg/kg**	**75**	**5.89%**	**34300**	**µg/kg**	**0**	**0%**
MCPP	**1270**	**127**	**10%**	**377**	**µg/kg**	**43**	**3.39%**	**68600**	**µg/kg**	**0**	**0%**
Silvex (2,4,5-TP)	1278	143	11.19%	0.63	µg/kg	18	1.41%	549000	µg/kg	0	0%
Pentachlorophenol	3104	7	0.23%	170	µg/kg	6	0.19%	21200	µg/kg	0	0%

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
Chemicals of concern are indicated in **bold**

Table 3-8 Phthalate Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Detections above LUT Value	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
Bis(2-ethylhexyl)phthalate	**4451**	**1955**	**43.92%**	**61**	**µg/kg**	**300**	**6.7%**	**173000**	**µg/kg**	**0**	**0.00%**
Butylbenzylphthalate	4383	436	9.95%	100	µg/kg	31	0.7%	274000	µg/kg	0	**0.00%**
Diethylphthalate	4449	79	1.78%	27	µg/kg	1	0.0%	48900000	µg/kg	0	0.00%
Dimethylphthalate	4402	44	1%	27	µg/kg	15	0.3%	48900000	µg/kg	0	0.00%
Di-n-butylphthalate	4450	544	12.22%	27	µg/kg	72	1.6%	NE			
Di-n-octylphthalate	**4400**	**405**	**9.20%**	**27**	**µg/kg**	**122**	**2.8%**	**611000**	**µg/kg**	**0**	**0.00%**

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - RBSL value not established for this chemical
Chemicals of concern are indicated in **bold**

Table 3-9 Miscellaneous Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# Samples Above LUT	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
N-Nitrosodimethylamine	6617	356	5.38%	10	µg/kg	11	0.17%	32.5	µg/kg	2	0.03%
Perchlorate	**3543**	**124**	**3.50%**	**1.63**	**µg/kg**	**76**	**2.15%**	**53300**	**µg/kg**	**0**	**0.00%**
2-Propanol	1328	25	1.88%	NE							
Ethanol	1335	45	3.37%	700	µg/kg	1	0.07%	NE			
Methanol	1326	163	12.29%	700	µg/kg	23	1.73%	NE			
Formaldehyde	**1424**	**199**	**13.97%**	**1870**	**µg/kg**	**114**	**8.01%**	**12200000**	**µg/kg**	**0**	**0%**
Diethylene Glycol	1472	7	0.48%	NE				6110	mg/kg	0	0%
Ethylene Glycol	1475	2	0.14%	NE				NE			
Propylene Glycol	1474	1	0.07%	NE				NE			
Triethylene Glycol	139	5	3.60%	NE				2750	mg/kg	0	0%
m-Terphenyl	1582	8	0.51%	NE				65	mg/kg	0	0%
o-Terphenyl	1548	8	0.52%	7	mg/kg	0	0.0%	65	mg/kg	0	0%
p-Terphenyl	1547	19	1.23%	NE				65	mg/kg	0	0%
Cyanide	1309	27	2.06%	0.6	mg/kg	6	0.46%	45.6	mg/kg	0	0.0%
Fluoride	**3037**	**2539**	**83.60%**	**10.2**	**mg/kg**	**115**	**3.79%**	**3040**	**mg/kg**	**0**	**0.0%**
Nitrate	1053	937	88.98%	22.3	mg/kg	14	1.33%	NE			

Notes:
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - none established, LUT and/or RBSL value not established for this chemica
Chemicals of concern are indicated in **bold**

Table 3-10 Total Petroleum Hydrocarbon (TPH) Contaminant of Concern Evaluation

Total Petroleum Hydrocarbons	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# Samples Above LUT	Percentage Samples Above LUT
Low Gasoline Range Organics - Approximately <C12	6083	275	4.52%	5	mg/kg	30	0.49%
Low Diesel Range Organics - Approximately C10-C15	4009	109	2.72%	5	mg/kg	23	0.57%
Medium Diesel Range Organics - Approximately C15-C20	4497	1046	23.26%	5	mg/kg	256	5.69%
High Diesel Range Organics - Approximately >C20	7934	5518	69.55%	5	mg/kg	4256	53.64%

Notes:
mg/kg - milligrams per kilogram
LUT - look-up table value
No RBSL established for TPH

Table 3-11 Energetic Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Detection	LUT Value	LUT Unit	# Samples Above LUT	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage Samples Above RBSL
1,2-Dinitrobenzene	3	3	100%	NE				6110	µg/kg	0	0%
1,3,5-Trinitrobenzene	1013	0	0%	NE				NE			
2,4,6-Trinitrotoluene	1013	0	0%	NE				20700	µg/kg	0	0%
2,4-Diamino-6-nitrotoluene	991	1	0.10%	NE				NE			
2,6-Diamino-4-nitrotoluene	992	0	0%	NE				NE			
2-Amino-4,6-Dinitrotoluene	1013	0	0%	NE				154000	µg/kg	0	0%
2-Nitrotoluene	1013	0	0%	NE				NE			
3-Nitrotoluene	1013	0	0%	NE				NE			
4-Amino-2,6-Dinitrotoluene	1013	0	0%	NE				NE			
4-Nitrotoluene	1013	0	0%	NE				NE			
HMX	1013	1	0.10%	NE				3850000	µg/kg	0	0%
Hydrazine	26	1	3.85%	NE				173	µg/kg	0	0%
M-Dinitrobenzene	1013	17	1.68%	NE				6110	µg/kg	0	0%
Nitroglycerin	1009	1	0.10%	NE				NE			
PETN	1009	0	0%	NE				NE			
RDX	1013	4	0.39%	300	µg/kg	0	0%	5940	µg/kg	0	0%
Tetryl	1013	0	0%	NE				NE			

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - none established, LUT and/or RBSL not established for this chemical

Table 3-12 Semivolatile Organic Compound Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# Samples Above LUT	Percentage Samples Above LUT	RBSL Value	RBSL Unit	# Samples Above RBSL	Percentage of Samples Above RBSL
1,2,4-Trichlorobenzene	4526	8	0.18%	NE				29200	µg/kg	0	0%
1,2-Dichlorobenzene	4621	0	0%	NE				1700000	µg/kg	0	0%
1,2-Diphenylhydrazine	3062	0	0%	NE				NE			
1,3-Dichlorobenzene	4620	0	0%	NE				915000	µg/kg	0	0%
1,4-Dichlorobenzene	4620	2	0.04%	NE				1330	µg/kg	0	0%
1,4-Dioxane	925	2	0.22%	10	µg/kg	0	0%	19300	µg/kg	0	0%
2,4,5-Trichlorophenol	3090	1	0.03%	NE				6110000	µg/kg	0	0%
2,4,6-Trichlorophenol	3105	1	0.03%	NE				7430	µg/kg	0	0%
2,4-Dichlorophenol	3075	0	0%	NE				NE			
2,4-Dimethylphenol	3105	0	0%	NE				1220000	µg/kg	0	0%
2,4-Dinitrophenol	3073	0	0%	NE				NE			
2,4-Dinitrotoluene	4076	4	0.10%	NE				NE			
2,6-Dichlorophenol	64	0	0%	NE				NE			
2,6-Dinitrotoluene	4077	0	0%	NE				NE			
2-butoxyethanol	291	0	0%	NE				NE			
2-Chloronaphthalene	3105	1	0.03%	NE				NE			
2-Chlorophenol	3105	0	0%	NE				NE			
2-Methylphenol	3090	0	0%	NE				3060000	µg/kg	0	0%
2-Nitroaniline	3089	0	0%	NE				NE			
2-Nitrophenol	3105	0	0%	NE				NE			
2-phenoxyethanol	291	0	0%	NE				NE			
3,3'-Dichlorobenzidine	3101	0	0%	NE				NE			
3,5-Dimethylphenol	2817	1	0.04%	NE				440000	µg/kg	0	0%
3-Nitroaniline	3089	0	0%	NE				NE			
4,6-Dinitro-2-methylphenol	3099	0	0%	NE				NE			
4-Bromophenyl-phenylether	3105	0	0%	NE				NE			
4-Chloro-3-methylphenol	3104	0	0%	NE				6110000	µg/kg	0	
4-Chloroaniline	3090	0	0%	NE				NE			
4-Chlorophenyl-phenylether	3105	0	0%	NE				NE			
4-Methylphenol	3079	0	0%	NE				6110000	µg/kg	0	
4-Nitroaniline	3090	0	0%	NE				34200	µg/kg	0	
4-Nitrophenol	3104	0	0%	NE				NE			
Aniline	3057	0	0%	NE				NE			
Azobenzene	579	0	0%	NE				NE			
Benzidine	2986	0	0%	NE				NE			
Benzoic Acid	3072	12	0.39%	660	µg/kg	4	0.13%	244000000	µg/kg	0	0%
Benzyl Alcohol	3086	3	0.10%	NE				6110000	µg/kg	0	0%
bis(2-chloroethoxy)methane	3105	0	0%	NE				NE			
bis(2-chloroethyl) ether	3104	0	0%	NE				NE			
bis(2-chloroisopropyl) ether	3102	0	0%	NE				NE			
Carbazole	2831	59	2.08%	NE				26000	µg/kg	0	0%
Dibenzofuran	3089	31	1%	NE				54700	µg/kg	0	0%
Hexachlorobenzene	3104	5	0.16%	NE				NE			
Hexachlorobutadiene	4525	2	0.04%	5	µg/kg	1	0.02%	6670	µg/kg	0	0%
Hexachlorocyclopentadiene	3101	0	0%	NE				NE			
Hexachloroethane	3105	0	0%	NE				NE			
Isophorone	3105	0	0%	NE				NE			
Methylhydrazine	26	0	0%	NE				1.24	µg/kg	0	
Morpholine	337	4	1.19%	NE				NE			
Nitrobenzene	4118	0	0%	NE				NE			
N-Nitroso-di-n-propylamine	3105	0	0%	NE				NE			
n-Nitrosodiphenylamine as Diphenylamine	3210	1	0.03%	NE				57800	µg/kg	0	0%
Phenol	3104	13	0.42%	170	µg/kg	1	0.03%	18300000	µg/kg	0	0%
Pyridine	44	0	0%	NE				NE			
Tetralin	872	2	0%	NE				NE			

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - none established, LUT and/or RBSL not established for this chemical

Table 3-13 Volatile Organic Compounds (VOCs) Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Samples Above LUT	Percentage of Samples Above LUT	RBSL Value	RBSL Unit	# of Samples Above RBSL	Percentage of Samples Above RBSL
1,1,1,2-Tetrachloroethane	1536	0	0.0%	NE				2870	µg/kg	0	0%
1,1,1-Trichloroethane	1605	1	0.1%	NE				5740000	µg/kg	0	0%
1,1,2,2-Tetrachloroethane	1606	1	0.1%	NE				288	µg/kg	0	0%
1,1,2-Trichloro-1,2,2-trifluoroethane	1547	1	0.1%	NE				28800000	µg/kg	0	0%
1,1,2-Trichloroethane	1605	0	0.0%	NE				533	µg/kg	0	0%
1,1-Dichloroethane	1605	1	0.1%	NE				1890	µg/kg	1	0.1%
1,1-Dichloroethene	1605	36	2.2%	5	µg/kg	2	0.12%	55800	µg/kg	0	0%
1,1-Dichloropropene	1477	0	0.0%	NE				NE			
1,1-Dimethylhydrazine	26	0	0.0%	NE				7800	µg/kg	0	0%
1,2,3-Trichlorobenzene	1475	5	0.3%	NE				39000	µg/kg	0	0%
1,2,3-Trichloropropane	1476	0	0.0%	NE				NE			
1,2,4-Trimethylbenzene	1530	8	0.5%	NE				39700	µg/kg	0	0%
1,2-Dibromo-3-chloropropane	1536	0	0.0%	NE				97.8	µg/kg	0	0%
1,2-Dibromoethane	1476	1	0.1%	NE				104	µg/kg	0	0%
1,2-Dichloroethane	1605	4	0.2%	NE				261	µg/kg	0	0%
1,2-Dichloropropane	1599	0	0.0%	NE				439	µg/kg	0	0%
1,3,5-Trimethylbenzene	1535	3	0.2%	NE				175000	µg/kg	0	0%
1,3-Dichloropropane	1476	0	0.0%	NE				NE			
1,3-Dichloropropylene	49	0	0.0%	NE				NE			
1-Chlorohexane	132	2	1.5%	NE				NE			
2,2-Dichloropropane	1476	0	0.0%	NE				NE			
2-Butanone (MEK)	1582	108	6.8%	NE				23300000	µg/kg	0	0%
2-Chloro-1,1,1-trifluoroethane	1323	0	0.0%	NE				NE			
2-Chloroethyl Vinyl Ether	1549	0	0.0%	NE				4.2	µg/kg	0	0%
2-Chlorotoluene	1475	0	0.0%	NE				337000	µg/kg	0	0%
2-Hexanone	1517	1	0.1%	10	µg/kg	0	0%	170000	µg/kg	0	0%
2-Phenylbutane	1475	7	0.5%	NE				1730000	µg/kg	0	0%
4-Chlorotoluene	1475	0	0.0%	NE				310000	µg/kg	0	0%
4-Methyl-2-pentanone (MIBK)	1517	7	0.5%	NE				496000	µg/kg	0	0%
Acetone	1587	226	14.2%	20	µg/kg	80	5.04%	60100000	µg/kg	0	0%
Acrolein	131	0	0.0%	NE				NE			
Acrylonitrile	131	0	0.0%	NE				NE			
Benzene	1610	17	1.1%	5	µg/kg	1	0.06%	115	µg/kg	0	0%
Bromobenzene	1476	0	0.0%	NE				236000	µg/kg	0	0%
Bromochloromethane	1473	0	0.0%	NE				NE			
Bromodichloromethane	1605	1	0.1%	NE				195	µg/kg	0	0%
Bromoform	1605	0	0.0%	NE				62200	µg/kg	0	0%
Bromomethane	1605	0	0.0%	NE				5160	µg/kg	0	0%
Carbon Disulfide	183	1	0.5%	NE				542000	µg/kg	0	0%
Carbon Tetrachloride	1605	0	0.0%	NE				71	µg/kg	0	0%
Chlorobenzene	1605	0	0.0%	NE				135000	µg/kg	0	0%
Chloroethane	1605	1	0.1%	NE				NE			
Chloroform	1605	35	2.2%	NE				733	µg/kg	0	0%
Chloromethane	1605	0	0.0%	NE				45100	µg/kg	0	0%
Chlorotrifluoroethylene	1327	0	0.0%	NE				NE			
cis-1,2-Dichloroethene	1571	2	0.1%	5	µg/kg	2	0.1%	9220	µg/kg	0	0%
cis-1,3-Dichloropropene	1584	0	0.0%	NE				NE			
Cymene	1475	27	1.8%	NE				1940000	µg/kg	0	0%
Di isopropyl Ether	129	0	0.0%	NE				NE			
Dibromochloromethane	1545	0	0.0%	NE				7280	µg/kg	0	0%
Dibromomethane	1476	0	0.0%	NE				22300	µg/kg	0	0%
Dichlorodifluoromethane	1551	0	0.0%	NE				66200	µg/kg	0	0%
Ethylbenzene	1610	70	4.3%	5	µg/kg	8	0.50%	2310	µg/kg	0	0%
Hexachloro-1,3-butadiene	4525	2	0.0%	5	µg/kg	1	0.02%	6670	µg/kg	0	0%
Isopropylbenzene	1475	10	0.7%	NE				1510000	µg/kg	0	0%
m,p-Xylene	1545	77	5.0%	NE				NE			
Methyl Iodide	132	0	0.0%	NE				428000	µg/kg	0	0%
Methyl Tert-Butyl Ether	1439	0	0.0%	NE				NE			
Methylene Chloride	1603	189	11.8%	10	µg/kg	71	4.43%	2970	µg/kg	0	0%
n-Butylbenzene	1475	5	0.3%	NE				845000	µg/kg	0	0%
n-Propylbenzene	1475	6	0.4%	NE				3160000	µg/kg	0	0%
o-Xylene	1545	7	0.5%	NE				286000	µg/kg	0	0%
Styrene	1520	66	4.3%	NE				11400000	µg/kg	0	0%

Table 3-13 Volatile Organic Compounds (VOCs) Chemical of Concern Evaluation

Chemical Name	# of Samples Collected	# of Detections	Frequency of Analyte Detection	LUT Value	LUT Unit	# of Samples Above LUT	Percentage of Samples Above LUT	RBSL Value	RBSL Unit	# of Samples Above RBSL	Percentage of Samples Above RBSL
tert-Butyl ethyl ether	129	0	0.0%	NE				NE			
tert-Butylbenzene	1475	1	0.1%	NE				1730000	µg/kg	0	0%
Tertiary amyl methyl ether	129	0	0.0%	NE				NE			
Tertiary butyl alcohol	129	0	0.0%	NE				NE			
Tetrachloroethene	1605	11	0.7%	5	µg/kg	3	0.19%	416	µg/kg	0	0%
Toluene	1610	183	11.4%	5	µg/kg	10	0.62%	3740000	µg/kg	0	0%
trans-1,2-Dichloroethene	1600	0	0.0%	NE				85300	µg/kg	0	0%
trans-1,3-Dichloropropene	1590	0	0.0%	NE				NE			
Trichloroethene	1607	15	0.9%	5	µg/kg	6	0.4%	797	µg/kg	1	0.1%
Trichlorofluoromethane	1571	2	0.1%	NE				530000	µg/kg	0	0.0%
Vinyl Acetate	149	0	0.0%	NE				NE			
Vinyl Chloride	1605	2	0.1%	5	µg/kg	1	0.1%	20.4	µg/kg	1	0.1%
Xylene (Total)	42	4	9.5%	NE				428000	µg/kg	0	0.0%

Notes:
µg/kg - micrograms per kilogram
LUT - look-up table value
RBSL - human health risk-based screening level
NE - none established, LUT and/or RBSL not developed for this chemical

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Metals

Metal	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Aluminum	5852	5851	0.00%	N	N	N
Antimony	5706	3135	3.65%	Y	N	Y
Arsenic	5901	5807	0.14%	N	Y	N
Barium	5885	5883	0.20%	N	N	N
Beryllium	5880	5769	0.02%	N	N	N
Boron	5804	2978	0.09%	N	N	N
Cadmium	5884	5248	5.08%	Y	N	Y
Calcium	4804	4801	0.00%	N	N	N
Chromium	5883	5881	0.20%	N	N	N
Chromium (Hexavalent Compounds)	3423	1754	1.58%	N	Y	Y1
Cobalt	5869	5866	0.14%	N	N	N
Copper	5880	5871	0.37%	N	N	N
Iron	4804	4802	--	--	--	N
Lead	5909	5890	1.98%	N	N	Y[1]
Lithium	5570	5561	0.02%	N	N	N
Magnesium	4804	4796	--	--	--	N
Manganese	4804	4804	0.19%	N	N	N
Mercury	6005	3152	5.06%	Y	N	Y
Methyl Mercury	11	5	45.45%	Y	N	Y
Molybdenum	5866	4770	0.78%	N	N	N
Nickel	5881	5865	0.12%	N	N	N
Organic Lead	5	0	--	--	N	N
Phosphorus	4736	4735	--	--	N	N
Potassium	5672	5670	0.00%	N	N	N
Selenium	5894	3846	3.92%	Y	N	Y
Silver	5913	4185	6.85%	Y	N	Y
Sodium	5748	5104	0.26%	N	N	N
Strontium	4735	4733	0.80%	N	N	N
Thallium	5882	5452	0.20%	N	N	N
Tin	4738	569	--	--	--	N
Titanium	4736	4735	--	--	--	N
Vanadium	5875	5874	0.02%	N	N	N
Zinc	5901	5900	2.20%	N	N	N
Zirconium	5576	3967	0.02%	N	Y	N

[1]Hot spot consideration

Polychlorinated Biphenyls (PCBs)

Aroclor	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Aroclor 1016	5560	0	0%	N	N	N
Aroclor 1221	5590	0	0%	N	N	N
Aroclor 1232	5560	0	0%	N	N	N
Aroclor 1242	5559	28	0.18%	N	N	N
Aroclor 1248	5558	175	1.35%	N	N	N
Aroclor 1254	5567	1449	9.34%	Y	N	Y
Aroclor 1260	5567	1348	6.02%	Y	N	Y
Aroclor 1262	4732	2	0.00%	N	N	N
Aroclor 1268	4732	20	0.02%	N	N	N
Aroclor 5432	4875	0	0%	N	N	N
Aroclor 5442	4875	2	0.00%	N	N	N
Aroclor 5460	4872	1006	2.71%	Y	N	Y

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Dioxins/Furans

Dioxin/Furan Congener	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	4687	3134	--	Note: The dioxin toxic equivalency quotient (TEQ) is used for the evaluation of dioxins/furans being a COC		
1,2,3,4,6,7,8-HPCDF	4687	2614	--			
1,2,3,4,7,8,9-HPCDF	4687	1568	--			
1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	4687	2249	--			
1,2,3,4,7,8-HXCDF	4687	1936	--			
1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	4687	2952	--			
1,2,3,6,7,8-HXCDF	4687	1948	--			
1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	4687	2823	--			
1,2,3,7,8,9-HXCDF	4687	1660	--			
1,2,3,7,8-Pentachlorodibenzofuran	4687	2006	--			
1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	4687	2034	--			
2,3,4,6,7,8-HXCDF	4687	1681	--			
2,3,4,7,8-PECDF	4687	1598	--			
2,3,7,8-TCDD	4687	1462	--			
2,3,7,8-Tetrachlorodibenzofuran	4687	2328	--			
OCDD	4687	3613	--			
OCDF	4687	2731	--			
Dioxin TEQ		No of TEQ Calculations		**Exceed LUT Criterion**	**Exceed RBSL Criterion**	**COC**
Dioxin TEQ	4687	3979	33.27%	Y	Y	Y

Polycyclic Aromatic Hydrocarbons (PAHs)

Non-Carcinogenic PAHs	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
1,1'-Biphenyl	617	1	0.00%	N	N	N
1-Methylnaphthalene	5557	528	2.60%	Y	N	Y
2-Methylnaphthalene	5677	707	3.50%	Y	N	Y
Acenaphthene	5741	348	2.80%	Y	N	Y
Acenaphthylene	5738	422	1.70%	N	N	N
Anthracene	5739	1020	7.10%	Y	N	Y
Benzo(e)pyrene	1387	243	--	--	--	--
Benzo(g,h,i)perylene	5733	1903	18.90%	Y	N	Y
Fluoranthene	5744	2385	19.50%	Y	N	Y
Fluorene	5749	450	2.50%	Y	N	Y
Naphthalene	5896	1041	3.90%	Y	N	Y
Phenanthrene	5737	2373	15.90%	Y	N	Y
Pyrene	5750	2381	19.10%	Y	N	Y
Carcinogenic PAHs						
Benzo(a)anthracene	5727	1752	--	Note: The Benzo(a)Pyrene (BaP) TEQ is used for the evaluation of carcinogenic PAHs being a COC		
Benzo(a)pyrene	5734	1912	--			
Benzo(b)fluoranthene	5734	2541	--			
Benzo(k)fluoranthene	5588	1385	--			
Chrysene	5738	2660	--			
Dibenzo(a,h)anthracene	5737	741	--			
Indeno(1,2,3-cd)pyrene	5737	1381	--			
BaP TEQ		# of TEQ Calculations		**Exceed LUT Criterion**	**Exceed RBSL Criterion**	**COC**
BaP TEQ	5651	2938	18.80%	Y	Y	Y

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Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Pesticides

Chlorinated Pesticides	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
4,4'-DDD	1416	67	2.33%	N	N	Y
4,4'-DDE	1424	521	3.09%	Y	N	Y
4,4'-DDT	1428	687	3.43%	Y	N	Y
Aldrin	1416	7	0.07%	N	N	N
Alpha-BHC	1421	44	0.77%	N	N	N
Beta-BHC	1416	109	3.95%	Y	N	Y
Chlordane	1421	295	3.24%	Y	N	Y
Delta-BHC	1421	151	2.67%	Y	N	Y
Dieldrin	1417	120	5.22%	Y	N	Y
Endosulfan I	1400	20	0.57%	N	N	N
Endosulfan II	1411	47	1.06%	N	N	N
Endosulfan Sulfate	1415	27	0.92%	N	N	N
Endrin	1408	14	0.21%	N	N	N
Endrin Aldehyde	1409	107	1.99%	N	N	N
Endrin Ketone	1407	51	0.57%	N	N	N
Gamma-BHC (Lindane)	1422	90	0.70%	N	N	N
Heptachlor	1419	68	2.04%	N	N	N
Heptachlor Epoxide	1418	79	1.69%	N	N	N
Methoxychlor	1411	21	0.50%	N	N	N
Mirex	1393	82	2.01%	N	N	N
Technical Toxaphene	1410	16	0.57%	N	N	N

Herbicides

Herbicides	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
2,2-Dichlor-Propionic Acid	1256	0	0.00%	N	N	N
2,4,5-T	1282	102	0.86%	N	N	N
2,4-D	1279	45	0.78%	N	N	N
2,4-DB	1269	265	14.50%	Y	N	Y
Dicamba	1265	110	0.71%	N	N	N
Dichloroprop	1271	43	1.10%	N	N	N
Dinitrobutyl Phenol	689	12	0.44%	N	N	N
MCPA	1273	302	5.89%	Y	N	Y
MCPP	1270	127	3.39%	Y	N	Y
Silvex (2,4,5-TP)	1278	143	1.41%	N	N	N
Pentachlorophenol	3104	7	0.19%	N	N	N

Phthalates

Phthalates	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Bis(2-ethylhexyl)phthalate	4451	1955	6.70%	Y	N	Y
Butylbenzylphthalate	4383	436	0.70%	N	N	N
Diethylphthalate	4449	79	0.02%	N	N	N
Dimethylphthalate	4402	44	0.30%	N	N	N
Di-n-butylphthalate	4450	544	1.60%	N	N	N
Di-n-octylphthalate	4400	405	2.80%	Y	N	Y

NDMA (Nitrosodimethylamine)

NDMA (Nitrosodimethylamine)	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
N-Nitrosodimethylamine	6617	356	0.17%	N	N	N

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Perchlorate

Perchlorate	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Perchlorate	3543	124	2.15%	N	N	Y

Alcohols

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
2-Propanol	1328	25	--	N	--	N
Ethanol	1335	45	0.07%	N	--	N
Methanol	1326	163	1.73%	N	--	N

Formaldehyde

Formaldehyde	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Formaldehyde	1424	199	13.97%	Y	N	Y

Glycols

Gyclols	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Diethylene Glycol	1472	7	--	--	N	N
Ethylene Glycol	1475	2	--	--	--	--
Propylene Glycol	1474	1	--	--	--	--
Triethylene Glycol	139	5	--	--	--	--

Terphenyls (o, m and p)

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
m-Terphenyl	1582	8	--	--	N	N
o-Terphenyl	1548	8	0.00%	N	N	N
p-Terphenyl	1547	19	--	--	N	N

Cyanide

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Cyanide	1039	27	0.46%	N	N	N

TPH

TPH Carbon Range	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Low gasoline C<12	6083	275	0.49%	N	--	N
Low Diesel C10-C15	4009	109	0.57%	N	--	N
Medium Diesel C15-C20	4497	1046	5.69%	Y	--	Y
High Diesel >C20	7934	5518	53.64%	Y	--	Y

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Energetic Chemicals

Energetic Chemicals	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
1,2-Dinitrobenzene	3	3	--	--	N	N
1,3,5-Trinitrobenzene	1013	0	--	--	--	N
2,4,6-Trinitrobenzene	1013	0	--	--	N	N
2,4-Diamino-6-nitrotoluene	991	1	--	--	--	N
2,6-Diamino-4-nitrotoluene	992	0	--	--	--	N
2-Amino-4,4-Dinitorotoluene	1013	0	--	--	N	N
2-Nitrotoluene	1013	0	--	--	--	N
3-Nitrotoluene	1013	0	--	--	--	N
4-Amino-2,6-Dinitorotoluene	1013	0	--	--	--	N
4-Nitrotoluene	1013	0	--	--	--	N
HMX	1013	1	--	--	N	N
Hydrazine	26	1	--	--	N	N
M-Dinitrobenzene	1013	17	--	--	N	N
Nitroglycerine	1009	1	--	--	--	N
PETN	1009	0	0.00%	--	--	N
RDX	1013	4	0.00%	N	N	N
Tetryl	1013	0	0.00%	--	--	N

Semi-volatile Organic Compounds (SVOCs)

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Benzoic Acid	3072	12	0.13%	N	N	N
Benzyl Alcohol	3086	3	--	--	N	N
bis(2-chloroethoxy)methane	3105	0	--	--	--	N
bis(2-chloroethyl) ether	3104	0	--	--	--	N
bis(2-chloroisopropyl) ether	3102	0	--	--	N	N
Carbazole	2831	59	--	--	--	N
Dibenzofuran	3089	31	--	--	N	N
Diphenylamine	116	0	--	--	--	N
Hexachlorobenzene	3104	5	--	--	--	N
Hexachlorobutadiene	4525	2	0.02%	N	N	N
Hexachlorocyclopentadiene	3101	0	--	--	--	N
Hexachloroethane	3105	0	--	--	--	N
Isophorone	3105	0	--	--	--	N
Methylhydrazine	26	0	--	--	--	N
Morpholine	337	4	--	--	--	N
Nitrobenzene	4118	0	--	--	--	N
N-Nitroso-di-n-propylamine	3105	0	--	--	--	N
n-Nitrosodiphenylamine as Diphenylamine	3210	1	--	--	--	N
Phenol	3104	13	0.03%	N	N	N
Pyridine	44	0	--	--	N	N
Tetralin	872	2	--			
1,1'-Biphenyl	630	3	--			
1,2,4-Trichlorobenzene	4526	8	--	--	N	N
1,2-Dichlorobenzene	4621	0	--	--	N	N
1,2-Diphenylhydrazine	3062	0	--	--	--	N
1,3-Dichlorobenzene	4620	0	--	--	N	N
1,4-Dichlorobenzene	4620	2	--	--	N	N
1,4-Dioxane	925	2	0%	N	N	N
2,4,5-Trichlorophenol	3090	1	--	--	N	N
2,4,6-Trichlorophenol	3105	1	--	--	--	N
2,4-Dichlorophenol	3075	0	--	--	--	N
2,4-Dimethylphenol	3105	0	--	--	N	N
2,4-Dinitrophenol	3073	0	--	--	--	N
2,4-Dinitrotoluene	4076	4	--	--	--	N
2,6-Dichlorophenol	64	0	--	--	--	N
2,6-Dinitrotoluene	4077	0	--	--	--	N
2-butoxyethanol	291	0	--	--	--	N
2-Chloronaphthalene	3105	1	--	--	--	N
2-Chlorophenol	3105	0	--	--	--	N

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Semi-volatile Organic Compounds (SVOCs)

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
2-Methylphenol	3090	0	--	--	N	N
2-Nitroaniline	3089	0	--	--	--	N
2-Nitrophenol	3105	0	--	--	--	N
2-phenoxyethanol	291	0	--	--	--	N
3,3'-Dichlorobenzidine	3101	0	--	--	--	N
3,5-Dimethylphenol	2817	1	--	--	N	N
3-Nitroaniline	3089	0	--	--	--	N
4,6-Dinitro-2-methylphenol	3099	0	--	--	--	N
4-Bromophenyl-phenylether	3105	0	--	--	--	N
4-Chloro-3-methylphenol	3104	0	--	--	N	N
4-Chloroaniline	3090	0	--	--	--	N
4-Chlorophenyl-phenylether	3105	0	--	--	--	N
4-Methylphenol	3079	0	--	--	N	N
4-Nitroaniline	3090	0	--	--	N	N
4-Nitrophenol	3104	0	--	--	--	N
Aniline	3057	0	--	--	--	N
Benzidine	2986	0	--	--	--	N

Volatile Organic Compounds (VOCs)

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
1,1,1,2-Tetrachloroethane	1536	0	--	--	N	N
1,1,1-Trichloroethane	1605	1	--	--	N	N
1,1,2,2-Tetrachloroethane	1606	1	--	--	N	N
1,1,2-Trichloro-1,2,2-trifluoroethane	1547	1	--	--	N	N
1,1,2-Trichloroethane	1605	0	--	--	N	N
1,1-Dichloroethane	1605	1	--	--	N	N
1,1-Dichloroethene	1605	36	0.12%	N	N	N
1,1-Dichloropropene	1477	0	--	--	--	N
1,1-Dimethylhydrazine	26	0	--	--	N	N
1,2,3-Trichlorobenzene	1475	5	--	--	N	N
1,2,3-Trichloropropane	1476	0	--	--	--	N
1,2,4-Trimethylbenzene	1530	8	--	--	N	N
1,2-Dibromo-3-chloropropane	1536	0	--	--	N	N
1,2-Dibromoethane	1476	1	--	--	N	N
1,2-Dichloroethane	1605	4	--	--	N	N
1,2-Dichloropropane	1599	0	--	--	N	N
1,3,5-Trimethylbenzene	1535	3	--	--	N	N
1,3-Dichloropropane	1476	0	--	--	N	N
1,3-Dichloropropylene	49	0	--	--	N	N
1-Chlorohexane	132	2	--	--	--	N
2,2-Dichloropropane	1476	0	--	--	--	N
2-Butanone (MEK)	1582	108	--	--	N	N
2-Chloro-1,1,1-trifluoroethane	1323	0	--	--	--	N
2-Chloroethyl Vinyl Ether	1549	0	--	--	N	N
2-Chlorotoluene	1475	0	--	--	N	N
2-Hexanone	1517	1	0.00%	N	NN	N
2-Phenylbutane	1475	7	--	--	N	N
4-Chlorotoluene	1475	0	--	--	N	N
4-Methyl-2-pentanone (MIBK)	1517	7	--	--	N	N
Acetone	1587	226	5.04%	Y	N	N[2]
Acrolein	131	0	--	--	--	N
Acrylonitrile	131	0	--	--	--	N
Benzene	1610	17	0.06%	N	N	N
Bromobenzene	1476	0	--	--	N	N
Bromochloromethane	1473	0	--	--	--	N
Bromodichloromethane	1605	1	--	--	N	N
Bromoform	1605	0	--	--	N	N
Bromomethane	1605	0	--	--	N	N
Carbon Disulfide	183	1	--	--	N	N
Carbon Tetrachloride	1605	0	--	--	N	N

Table 3-14 Area IV and NBZ Potential Chemicals of Concern Summary

Volatile Organic Compounds (VOCs)

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Chlorobenzene	1605	0	--	--	N	N
Chloroethane	1605	1	--	--	--	N
Chloroform	1605	35	--	--	N	N
Chloromethane	1605	0	--	--	N	N
Chlorotrifluoroethylene	1327	0	--	--	--	N
cis-1,2-Dichloroethene	1571	2	0.10%	N	N	N
cis-1,3-Dichloropropene	1584	0	--	--	--	N
Cymene	1475	27	--	--	N	N
Di isopropyl Ether	129	0	--	--	--	N
Dibromochloromethane	1545	0	--	--	N	N
Dibromomethane	1476	0	--	--	N	N
Dichlorodifluoromethane	1551	0	--	--	N	N
Ethylbenzene	1610	70	0.50%	N	N	N
Hexachloro-1,3-butadiene	4525	2	0.02%	N	N	N
Isopropylbenzene	1475	10	--	--	N	N
m,p-Xylene	1545	60	--	--	--	N
Methyl Iodide	132	0	--	--	N	N
Methyl Tert-Butyl Ether	1439	0	--	--	--	N
Methylene Chloride	1603	189	4.43%	Y	N	N[2]
n-Butylbenzene	1475	5	--	--	N	N
n-Propylbenzene	1475	6	--	--	N	N
o-Xylene	1545	7	--	--	N	N
Styrene	1520	66	--	--	N	N
tert-Butyl ethyl ether	129	0	--	--		N
tert-Butylbenzene	1475	1	--	--	N	N
Tertiary amyl methyl ether	129	0	--	--	--	N
Tertiary butyl alcohol	129	0	--	--	--	N
Tetrachloroethene	1605	11	0.19%	N	N	N
Toluene	1610	183	0.62%	N	N	N
trans-1,2-Dichloroethene	1600	0	--	--	N	N
trans-1,3-Dichloropropene	1590	0	--	--	--	N
Trichloroethene	1607	15	0.40%	N	N	N
Trichlorofluoromethane	1571	2	--	--	N	N
Vinyl Acetate	149	0	--	--	--	N
Vinyl Chloride	1605	2	0.10%	N	N	N
Xylene (Total)	42	4	--	--	N	N

[2]Common laboratory contaminant

Wet Chemistry

Chemical Name	# of Samples	# of Detects	Frequency Above LUT Value	Exceed LUT Criterion	Exceed RBSL Criterion	COC
Bromide	89	1	--			
Chloride	73	62	--			
Fluoride	3037	2539	--	--	--	--
Nitrate	1053	937	--	--	--	--
Nitrite-NO2	99	10	--			
Sulfate	91	82	--			
Sulfite	2	0	--			

Notes:
LUT - look-up table value
RBSL - human health risk-based screening level
COC - chemical of concern

Section 4

Area IV and NBZ Soil Characterization Data Presentation

This section presents the discussion of the extent of contamination for the COCs identified in Section 3. Included in this section are data plots illustrating the horizontal and vertical extent of contamination of soils within Area IV and the NBZ. The Area IV soil chemical database coupled with the geographic information system (GIS) are being used to display the results. The sample locations are represented by a color unique to each chemical group used in the COC screening.

4.1 Metals

Based on the review of the metals data presented in Section 3.2, antimony, cadmium, mercury, selenium, and silver are COCs for Area IV. Lead and chromium VI are also considered COCs based on the 'hot spot' analysis. Figure 4-1 illustrates the distribution of antimony above background within Area IV. Antimony presence is primarily in former operational areas[6], and not within areas remote from Area IV research activities. Figure 4-2 illustrates the depths where antimony was observed in soil in Area IV. The majority of results are at the surface and 5 feet below ground surface.

Figure 4-3 illustrates the distribution of cadmium above background within Area IV. Cadmium presence is more widespread in operational areas than that of antimony. Figure 4-4 illustrates the depths were cadmium was observed in soil in Area IV. The majority of results are at the surface and 5-feet below ground surface.

Figure 4-5 illustrates the distribution of mercury above background within Area IV. Mercury distribution is more concentrated than other metals, with the releases at the SRE, within the OCY, 17th Street Drainage, and near Buildings 4363 and 4373 evident. Figure 4-6 illustrates the depths where mercury was observed in soil in Area IV. Mercury was used as part of energy transfer testing and in electrical components.

Figure 4-7 illustrates the distribution of selenium above background within Area IV. Selenium distribution is highly focused on the central part of Area IV and at the B56 landfill site. Selenium is also observed at the OCY. Figure 4-8 illustrates the depths where selenium was observed in soil in Area IV. Many of the deeper concentrations were found in the B56 landfill area.

Figure 4-9 illustrates the distribution of silver above background within Area IV. Silver is assumed present in soils from photographic wastes. Researchers photographed their activities within Area IV with development of the negatives and pictures performed on site. There are a number of apparent localized areas impacted in Area IV including the OCY/NCY, PDU, 17th Street

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[6] Operational areas reflect locations where research was conducted, chemicals may have been used or stored, or locations where wastes were stored, treated, or released.

Pond, and Dredge Spoils area. Figure 4-10 illustrates the depth of observed silver soil contamination, with the majority of results above background to be at the surface.

Figure 4-11 provides the results of the "hot spot" review for chromium VI and lead. Lead and chromium VI are a COC for Area IV based on its distribution.

Figure 4-12 illustrates the distributions of arsenic, thallium, zinc, and zirconium above background. A review of the figure indicates that with the exception of zinc, the distribution of arsenic, thallium, and zirconium are random, and not related to specific releases.

4.2 PCBs (Aroclors)

Figure 4-13 illustrates the distribution of Aroclors 1254, 1260, and 5460 above their LUT values. Figure 4-14 illustrates the distribution of Aroclors 1254, 1260, and 5460 at depth. PCBs were detected in most operational areas and drainages extending from them. Figure 4-15 illustrates the distribution of Aroclors 1242, 1248, and 1268 in surface soil and Figure 4-15b their distribution in subsurface soil. The locations of these less frequently observed PCBs overlaps with that of Aroclors 1254, 1260, and 5460 in most cases.

4.3 Dioxin TEQ

Figure 4-16 illustrates the distribution of dioxins that exceed the TEQ LUT value. Dioxins have a natural origin from brush fires and their distribution can be partially attributed to that factor. They are also created from the burning of chemicals and other wastes, and along with PAHs, are the most widespread of the COCs in Area IV. Figure 4-17 illustrates the distribution of Dioxin TEQ values at depth.

4.4 Polycyclic Aromatic Hydrocarbons

PAHs are a mixture of multi-ring organic molecules found in petroleum and are created naturally by brush fires and by man through the burning of organic wastes. PAHs are divided into two classes; carcinogenic and non-carcinogenic. Similar to dioxins, carcinogenic PAHs are evaluated using a toxicity equivalency quotient based on the toxicity of Benzo(a)Pyrene (BaP). Figure 4-18 illustrates the distribution of carcinogenic PAHs based on the BaP TEQ LUT value. Like dioxins, the distribution of PAHs is throughout the operational areas of Area IV. Figure 4-19 illustrates carcinogenic PAHs at depth

Figure 4-20 illustrates the distribution of three non-carcinogenic PAHs anthracene, fluoranthene, and pyrene detections above their respective LUT values. The distributions of these PAHs are similar to the carcinogenic PAH distribution as PAHs are typically found as a group of chemicals, not as individual chemicals. Figure 4-21 illustrates the maximum observed depths of either anthracene, fluoranthene, or pyrene (depending on which PAH was observed deepest.

4.5 Chlorinated Pesticides

Figure 4-22 illustrates the distribution of 4,4'DDE, 4,4-DDT, Chlordane, and Toxaphene in soil above their respective LUT values. The pesticides are primarily found at localized hot-spots in operational areas of Area IV. Figure 4-23 illustrates their presence at depth.

4.6 Herbicides

Figure 4-24 illustrates the distribution of the herbicides 2,4-DB, MCPA, and MCPP in soils exceeding their respective LUT values. The distribution of herbicides is more widespread than the chlorinated pesticides indicating a different usage pattern. Figure 4-25 illustrates their presence at depth.

4.7 Phthalates

Figure 4-26 illustrates Bis(2-ethylhexyl)phthalate, Butylbenzylphthalate, and Di-n-octylphthalate above their respective LUT values. There is very little overlap in their distributions indicating differing sources and activities have led to their presence in Area IV. Figure 4-27 illustrates the distribution of these phthalates at depth.

4.8 Perchlorate and NDMA

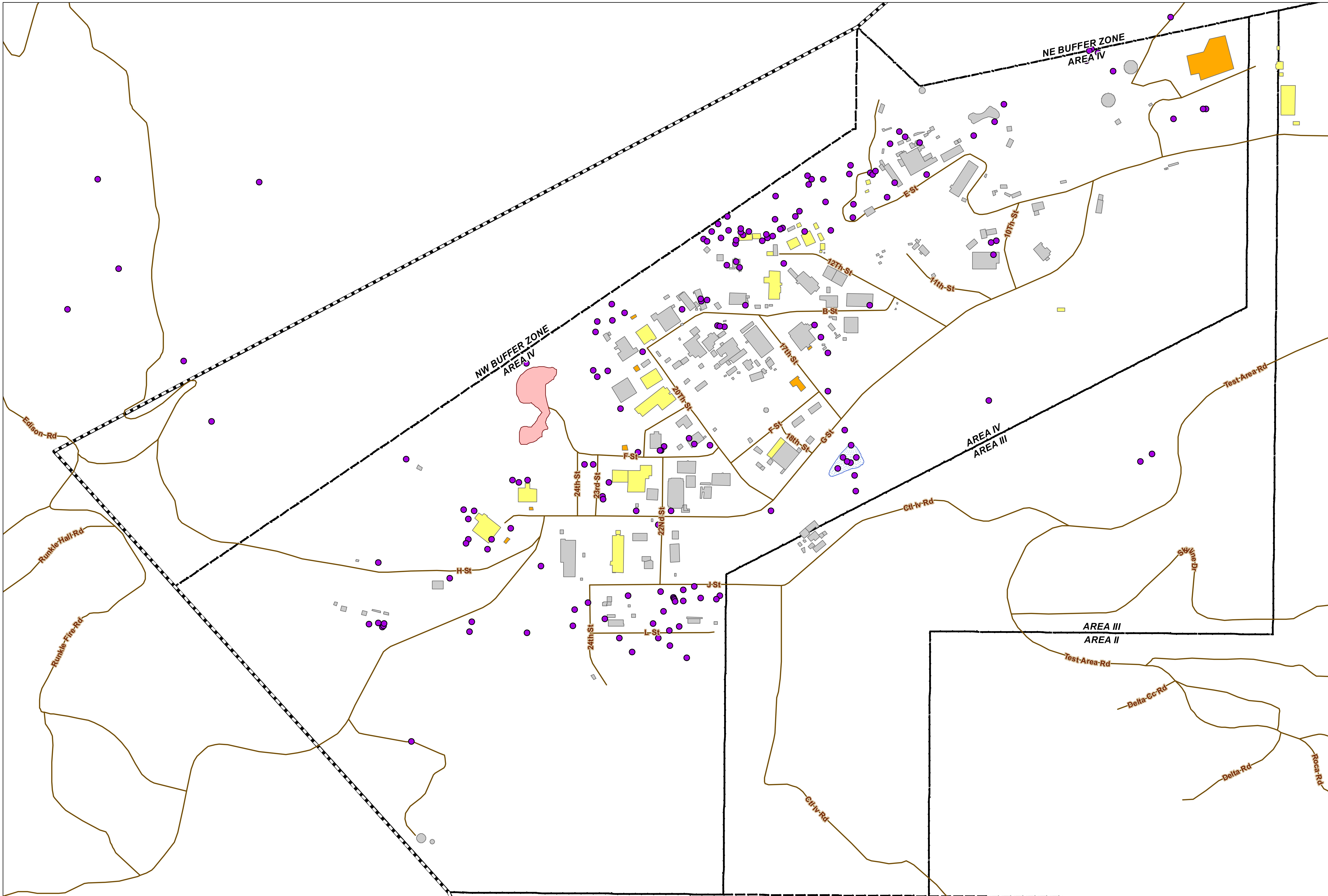
Figure 4-28 illustrates distribution of perchlorate and NDMA above their LUT values in Area IV. The chemicals are observed in operational and non-operational areas. NDMA is primarily located in the Dredge Spoils area (where sediments from Area II and III ponds were placed). Figure 4-29 illustrates their distribution by depth.

4.9 Formaldehyde

Figure 4-30 illustrates the distribution of Formaldehyde above its LUT value. Formaldehyde is primarily located in the vicinity of former reactor buildings in the northern section of Area IV.

4.10 Total Petroleum Hydrocarbons

Figure 4-31 illustrates the distribution of medium carbon range TPH (C15-C20) above the LUT value of 5 milligrams per kilogram (mg/kg). There were very few exceedences above 500 mg/kg. Figure 4-32 illustrates the distribution of heavier carbon range TPH (>C20) above the LUT value of 5 mg/kg.



Legend

- Antimony Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Antimony Exceeding LUT Values
Surface Soils

0 160 320 640 960 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-1

CDM Smith

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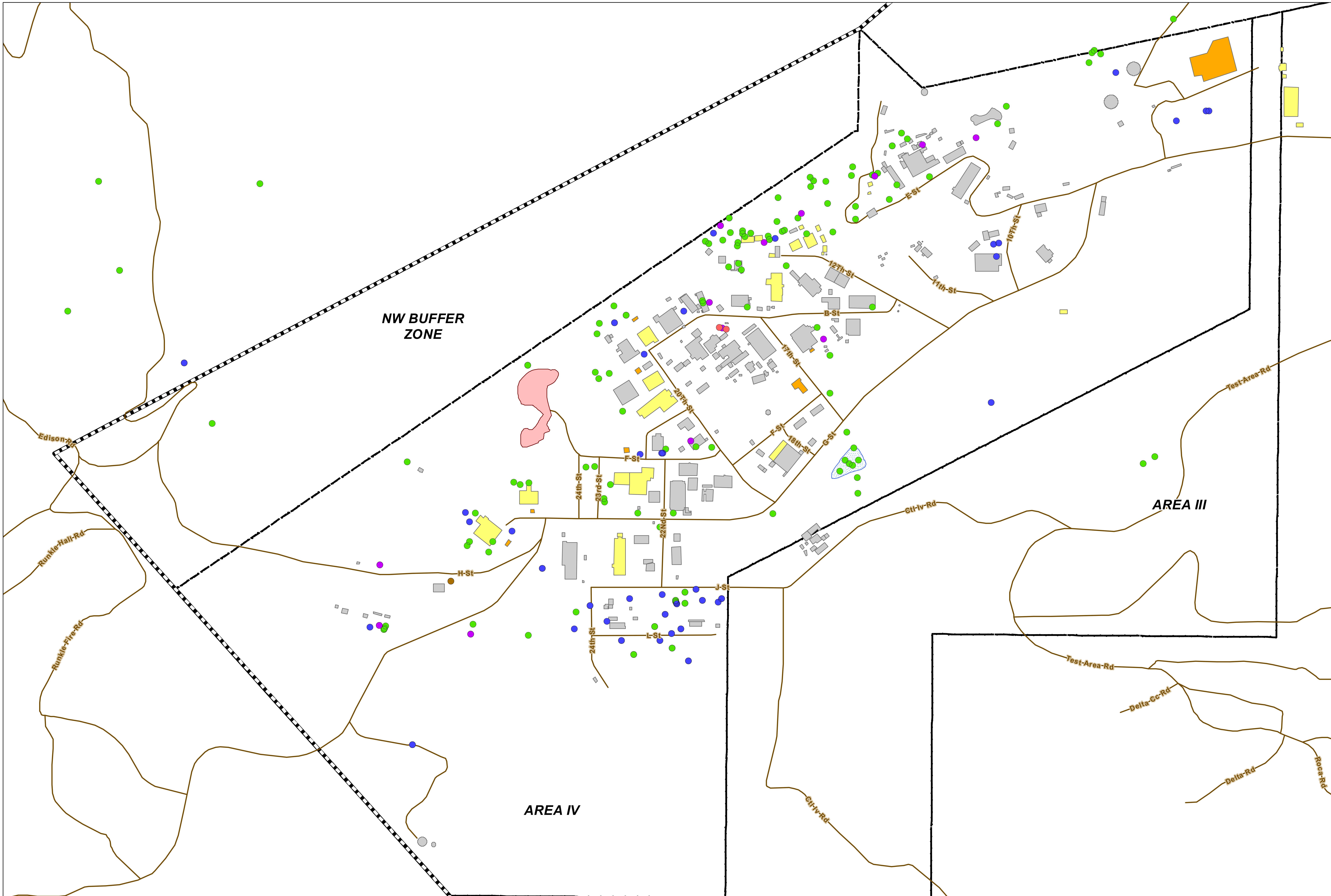

Antimony LUT Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure

- Area Boundary
- SSFL Property Boundary

Metals: Antimony Exceeding LUT Values by Depth

N

0 200 400 800 1,200 Feet

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Ventura County, California
Figure 4-2

CDM Smith

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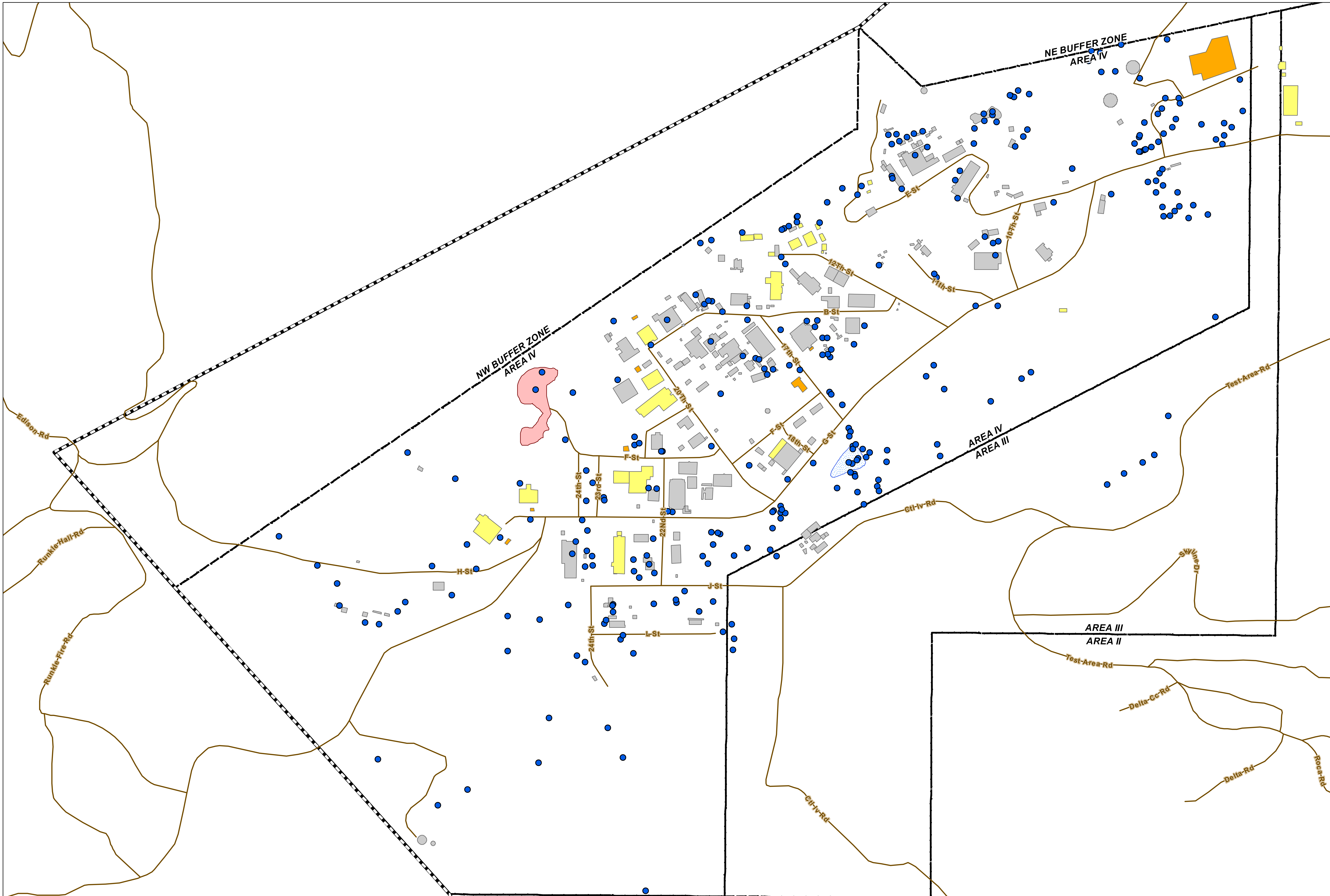

Legend

- Cadmium Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Cadmium Exceeding LUT Values
Surface

0 160 320 640 960 Feet

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Ventura County, California
Figure 4-3

CDM Smith

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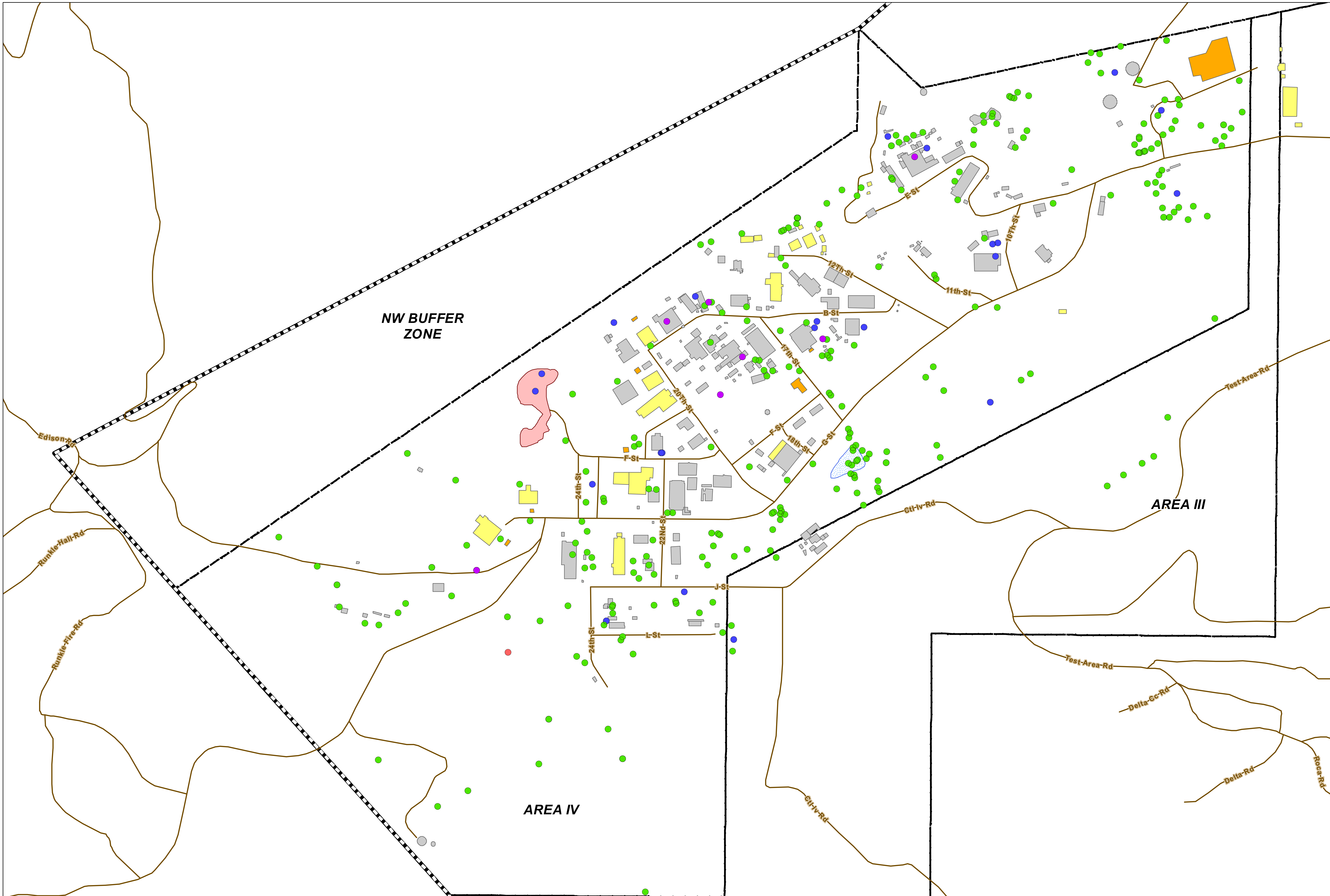

Cadmium LUT Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Cadmium Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

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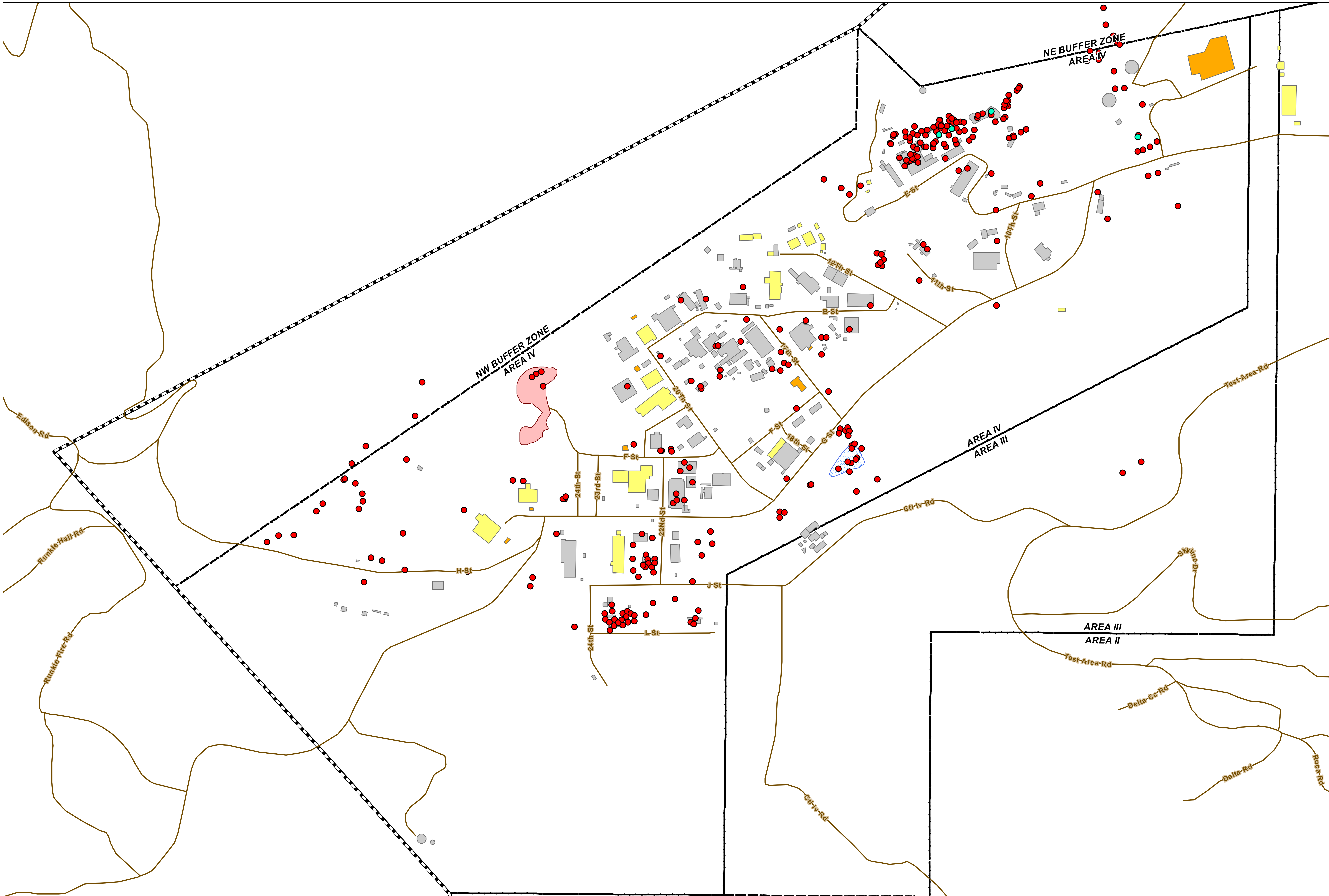
Ventura County, California
Figure 4-4

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_Cadmium_LUTEXC_NoAP_18x24_20160504.mxd 5/4/2016



Legend

- Methyl Mercury Exceedance Location
- Mercury Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Mercury and Methyl Mercury Exceeding LUT Values Surface

0 200 400 800 1,200 Feet

N

Santa Susana Field Laboratory
Ventura County, California
Figure 4-5

CDM Smith

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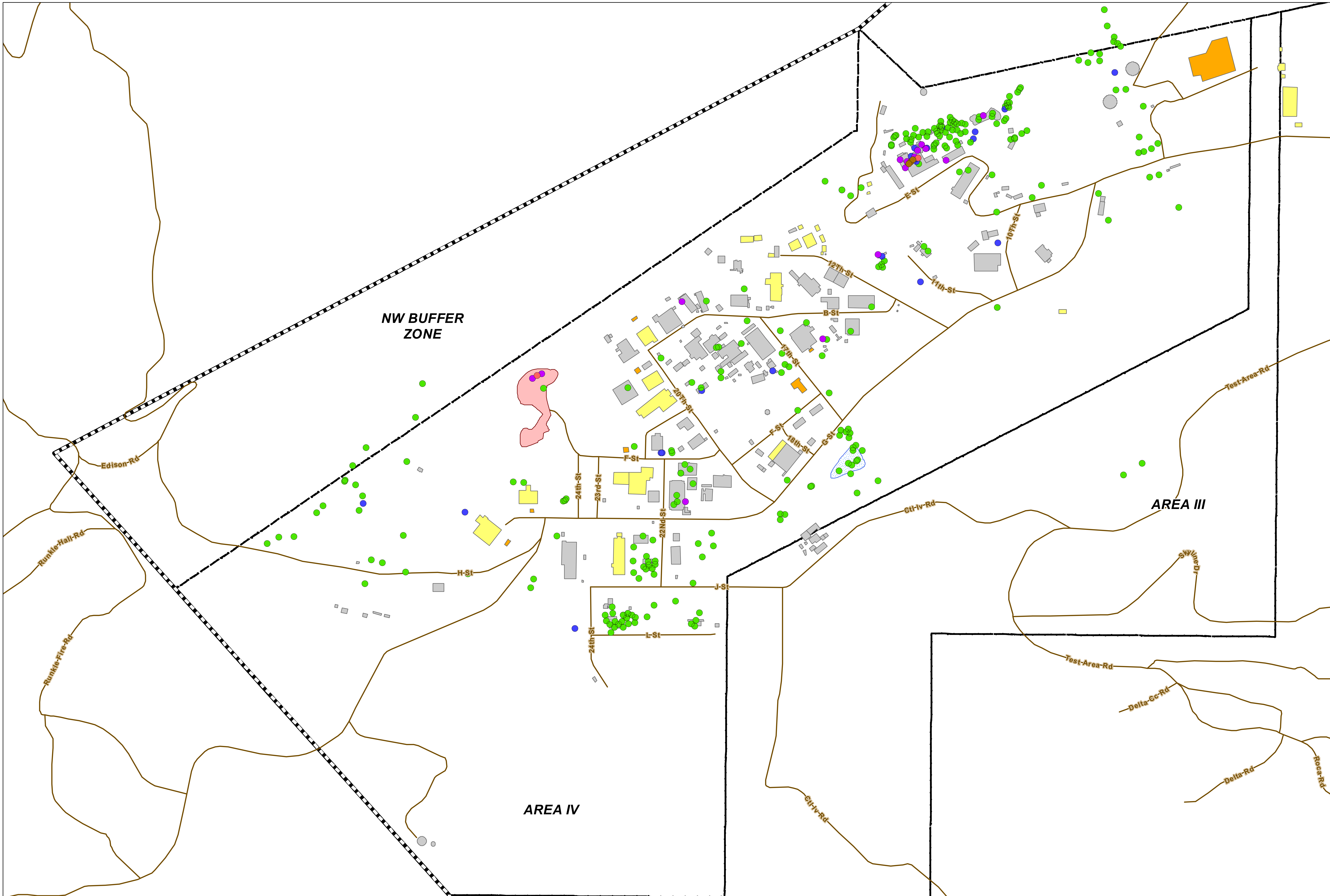

Mercury LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Mercury Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

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Ventura County, California
Figure 4-6

CDM Smith

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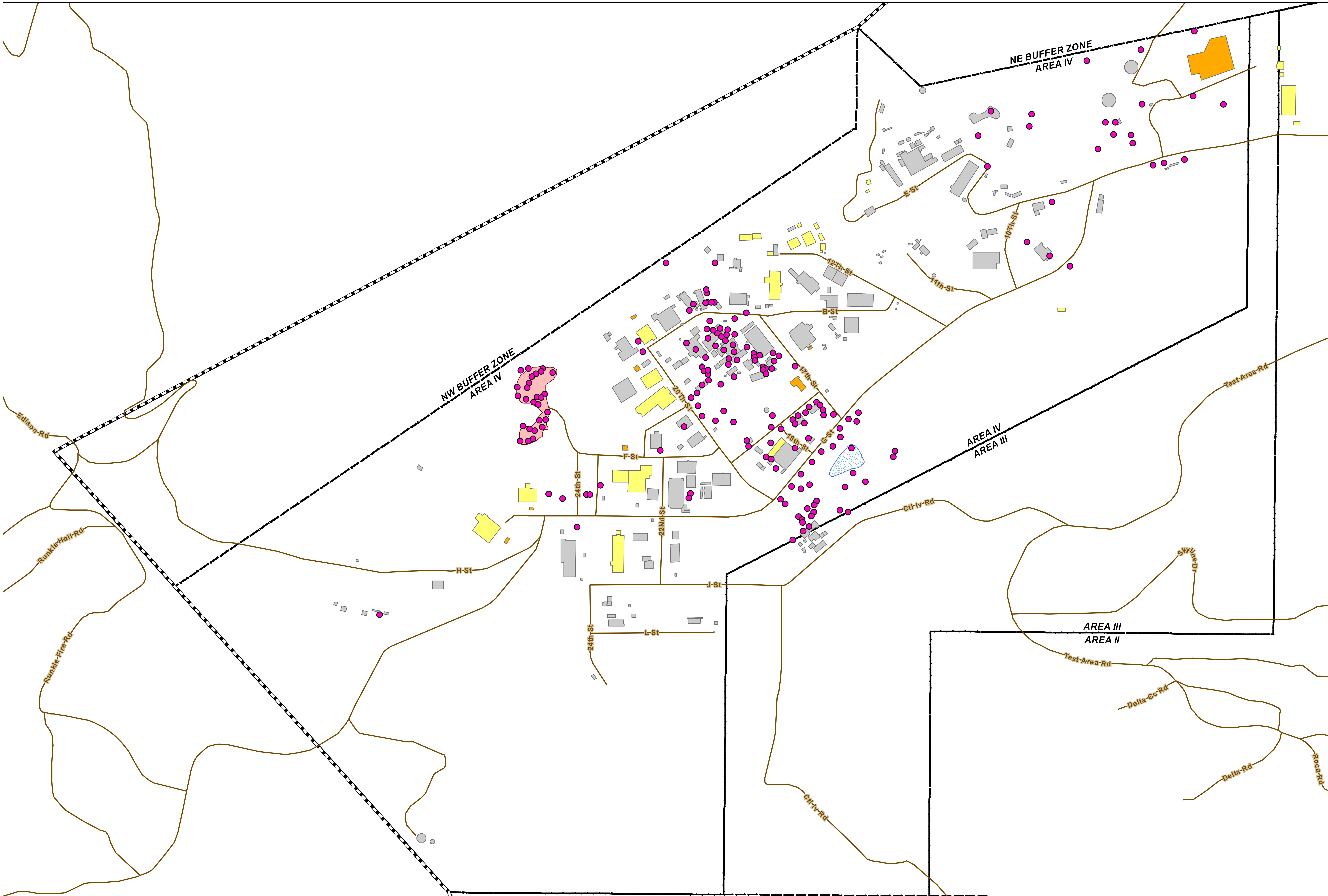

Legend

- Selenium Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Selenium Exceeding LUT Values
Surface

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-7

CDM Smith

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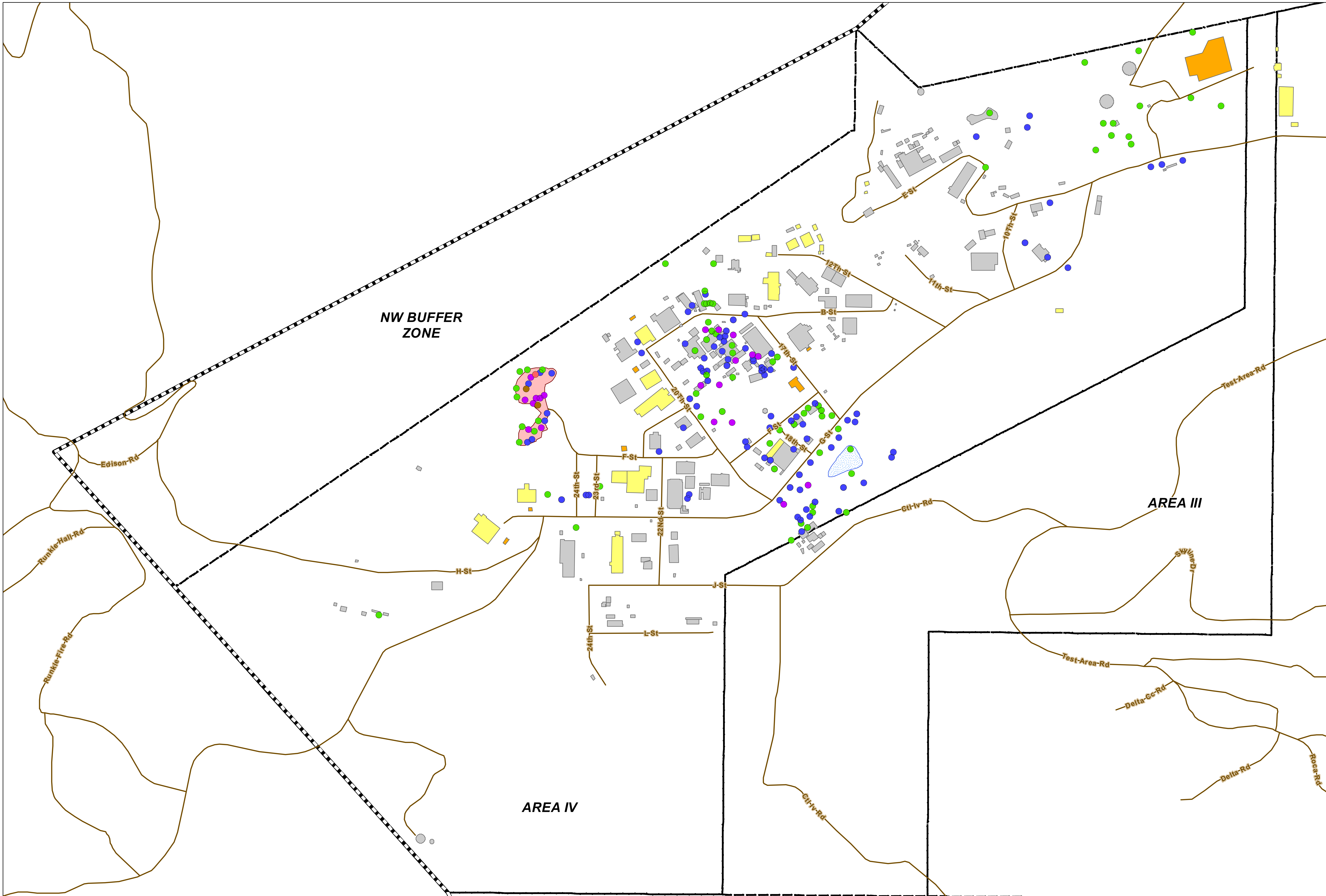

Selenium LUT Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure

- Area Boundary
- SSFL Property Boundary

Metals: Selenium Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

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Ventura County, California
Figure 4-8

CDM Smith

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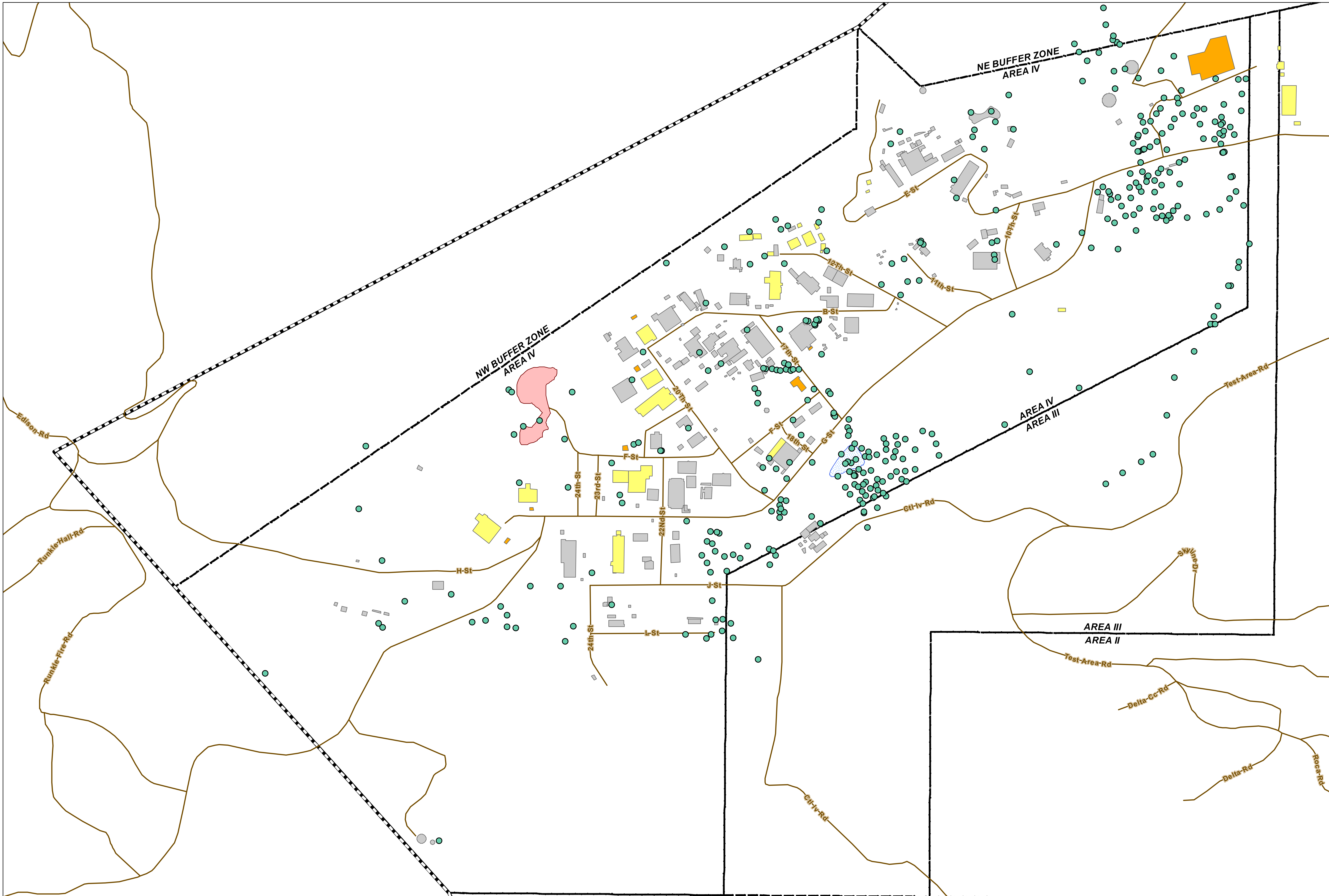


Legend

- Silver Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

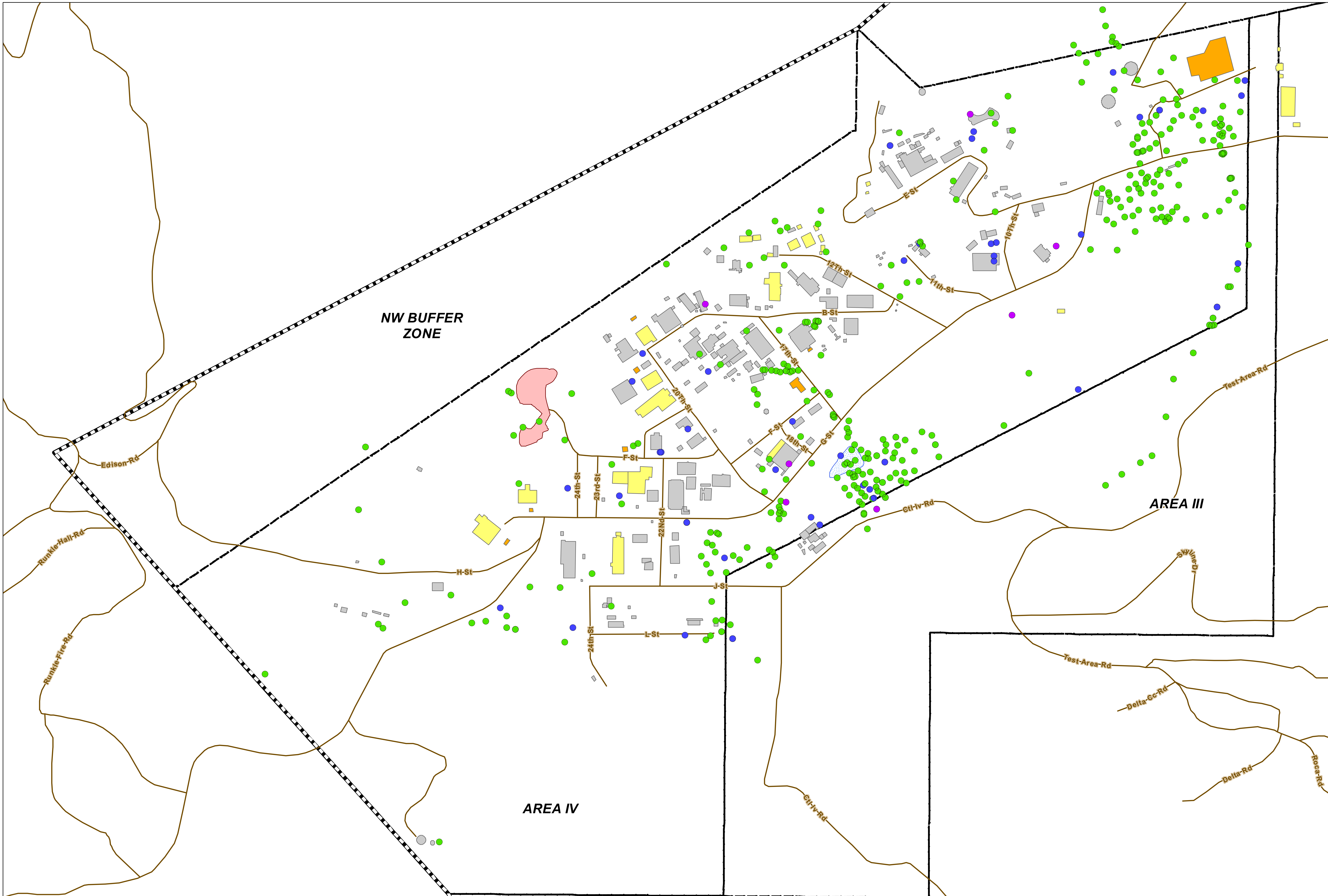
Metals: Silver Exceeding LUT Values
Surface

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-9

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Metals\SSFL_CDSR_Metals_Silver_LUT_NoAP_18x24_20160504.mxd 5/4/2016



Silver LUT Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Silver Exceeding LUT Values by Depth

N

0 200 400 800 1,200 Feet

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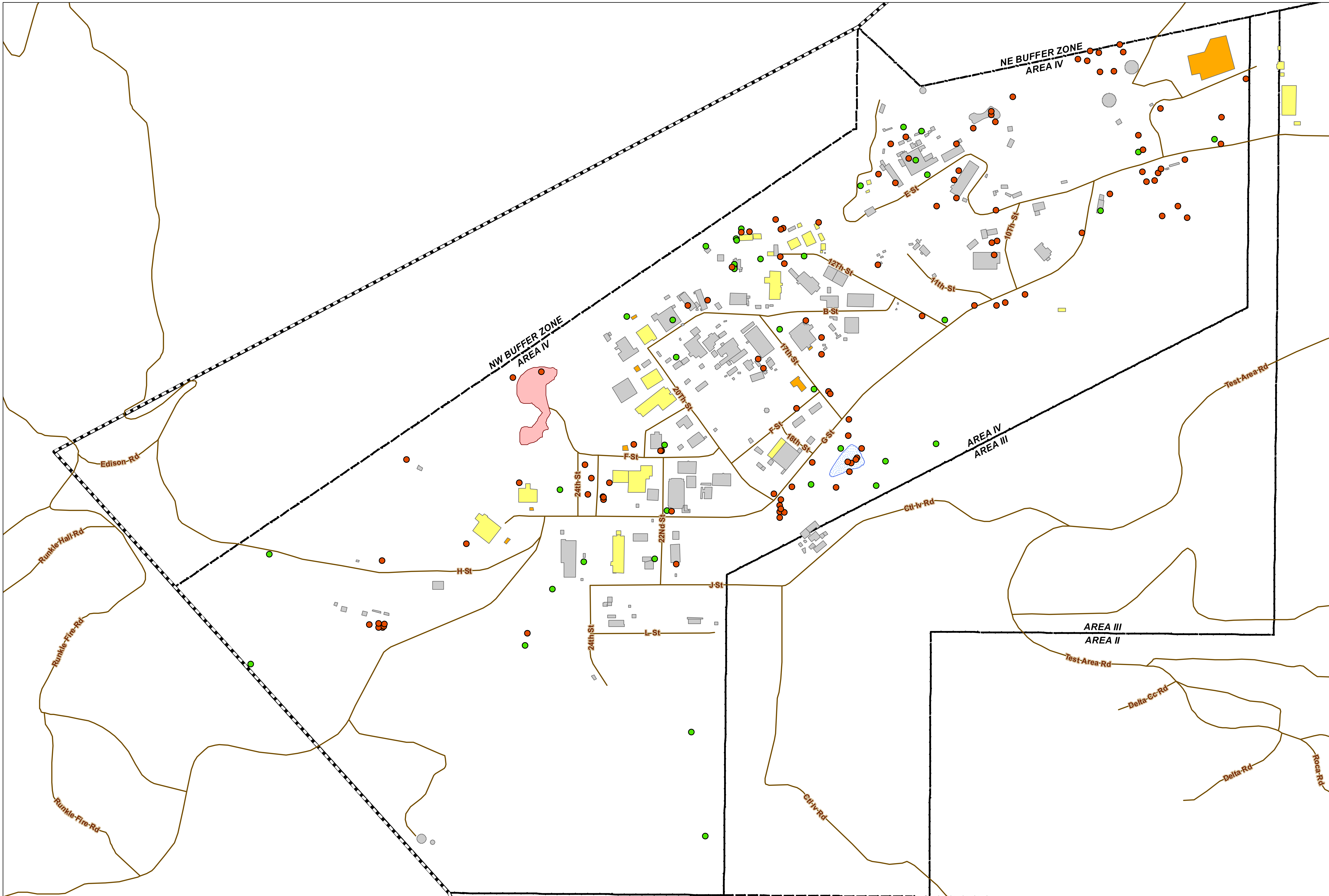
Ventura County, California
Figure 4-10

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSSFL_Silver_LUTEXC_NoAP_18x24_20160504.mxd 5/4/2016



Legend

- Lead Exceedance Location
- Hexavalent Chromium Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Metals: Hexavalent Chromium and Lead Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-11

CDM Smith

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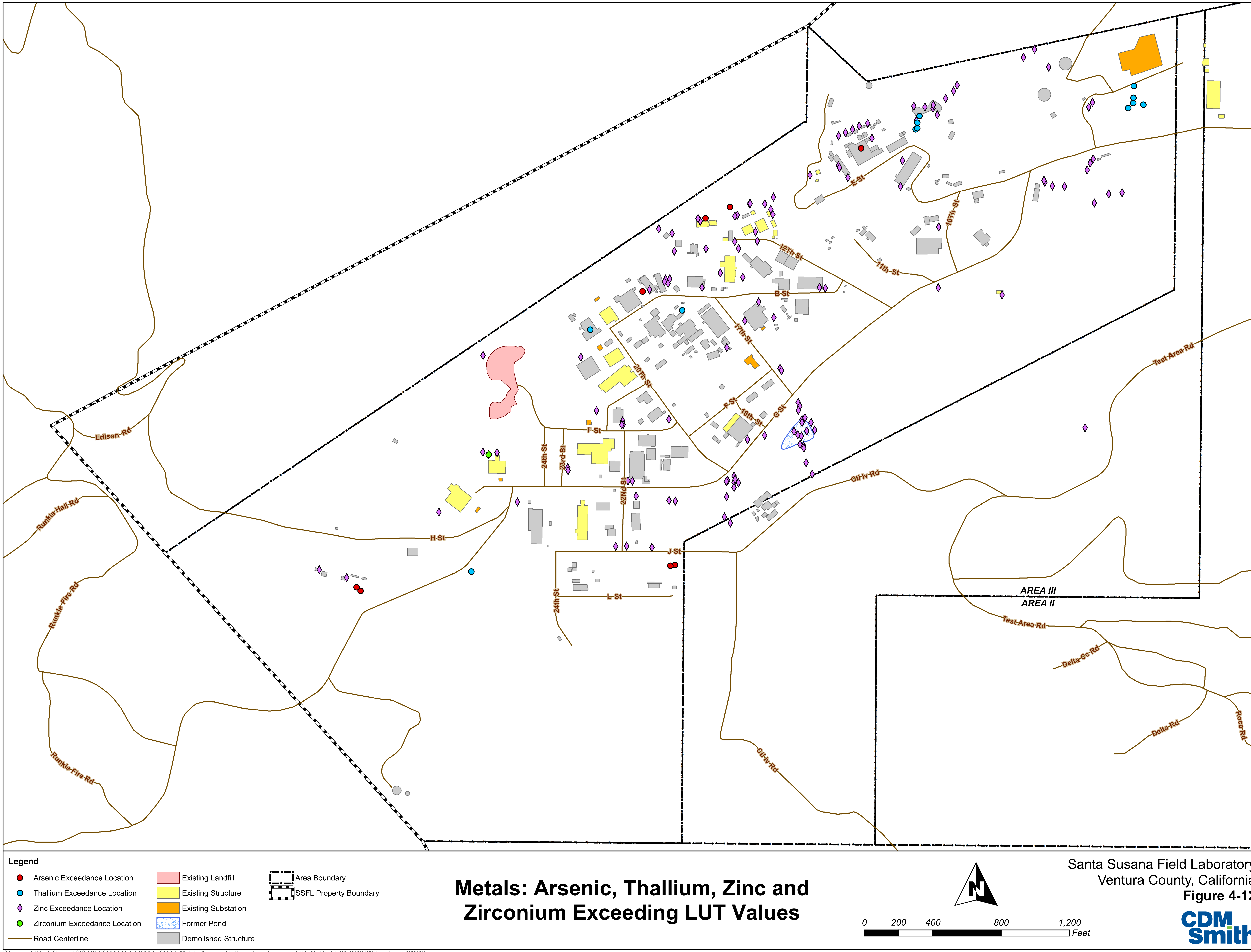

Metals: Arsenic, Thallium, Zinc and Zirconium Exceeding LUT Values

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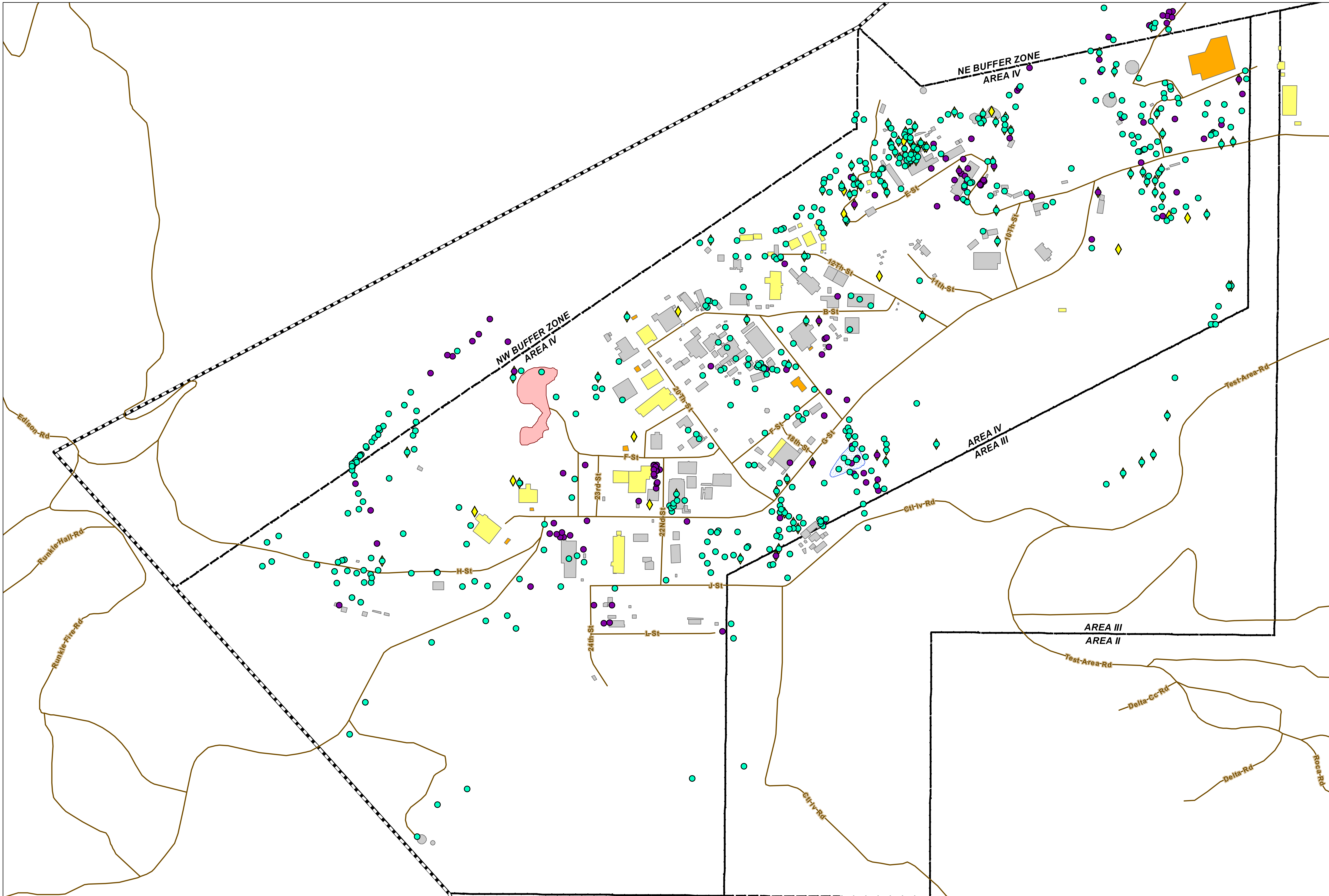

Legend

- Aroclor 1254 Exceedance Location
- Aroclor 1260 Exceedance Location
- Aroclor 5460 Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

PCBs: Aroclors 1254, 1260 and 5460 Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-13

CDM Smith

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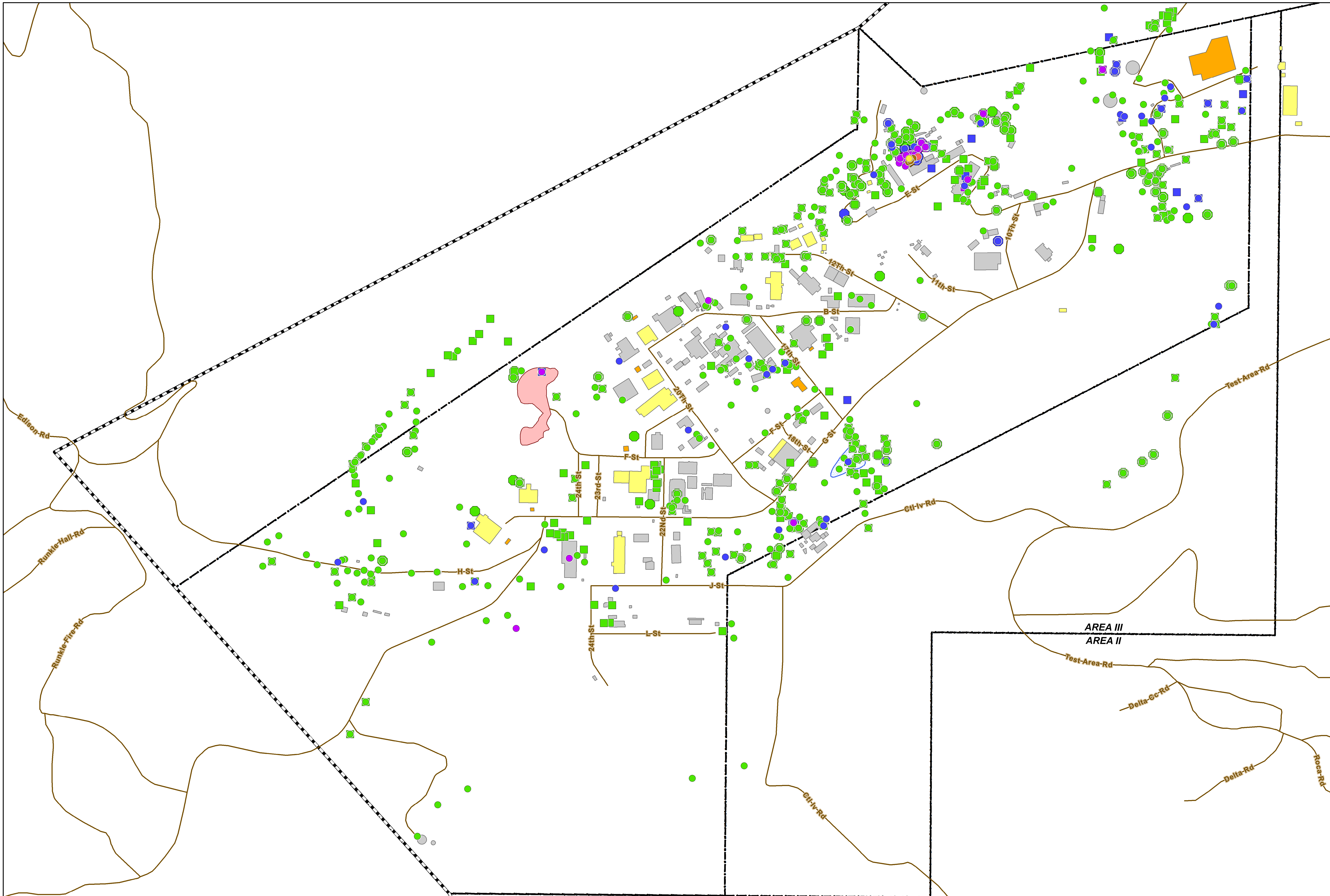


Aroclor 1254 Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet
- 25 Feet

Aroclor 5460 Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet

Aroclor 1260 Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet

Road Centerline
Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
Area Boundary
SSFL Property Boundary

PCBs: Aroclors 1254, 1260, and 5460 - Exceeding LUT Values by Depth

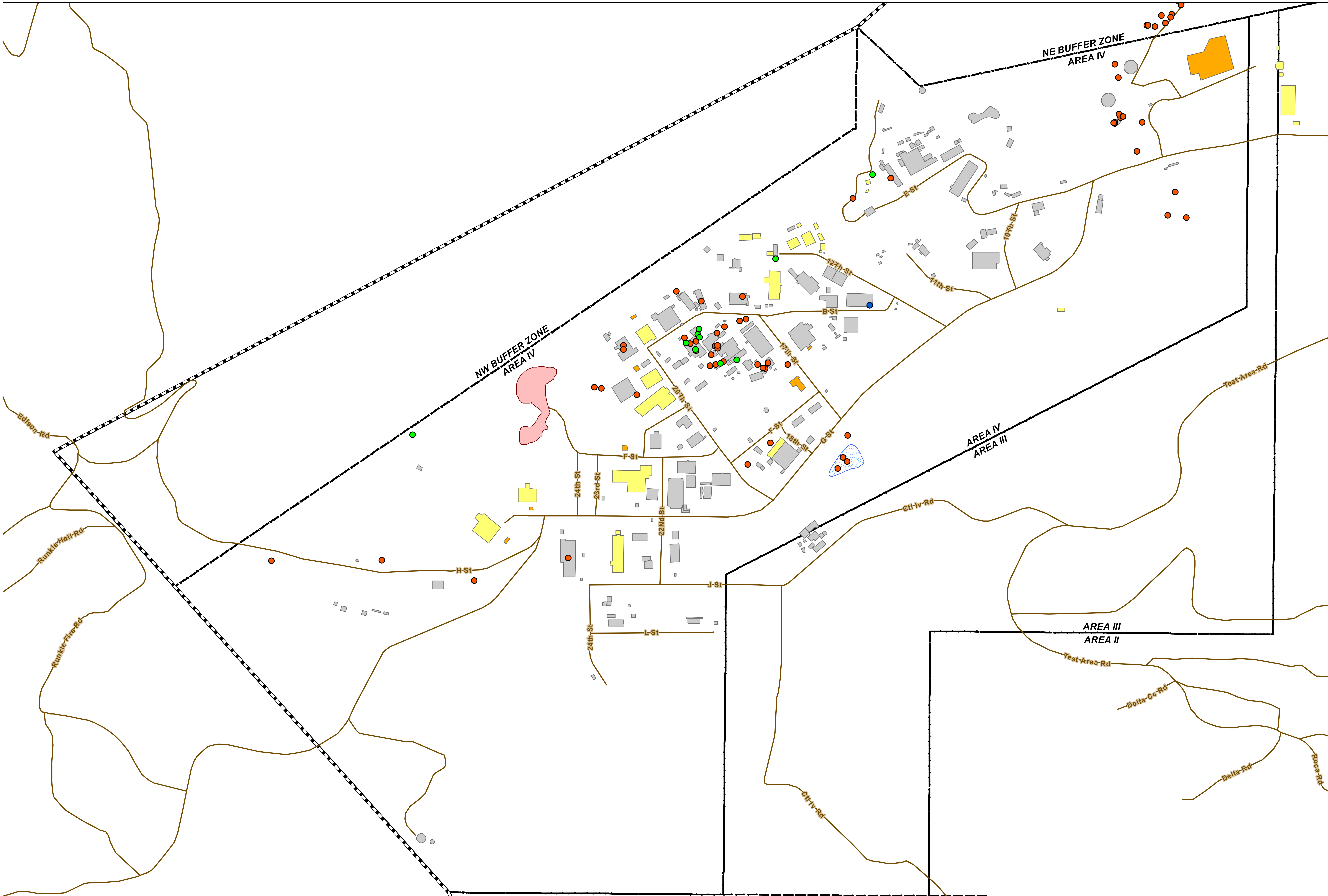
N

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-14

CDM Smith

C:_projects\SantaSusana\GIS\MXD\CDSR\Depths\MXD\SSFL_Aroclor_1254_1260_5460_LUTEXC_NoAP_18x24_20160613.mxd 6/13/2016



Legend

- Aroclor 1242 Exceedance Location
- Aroclor 1248 Exceedance Location
- Aroclor 1268 Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

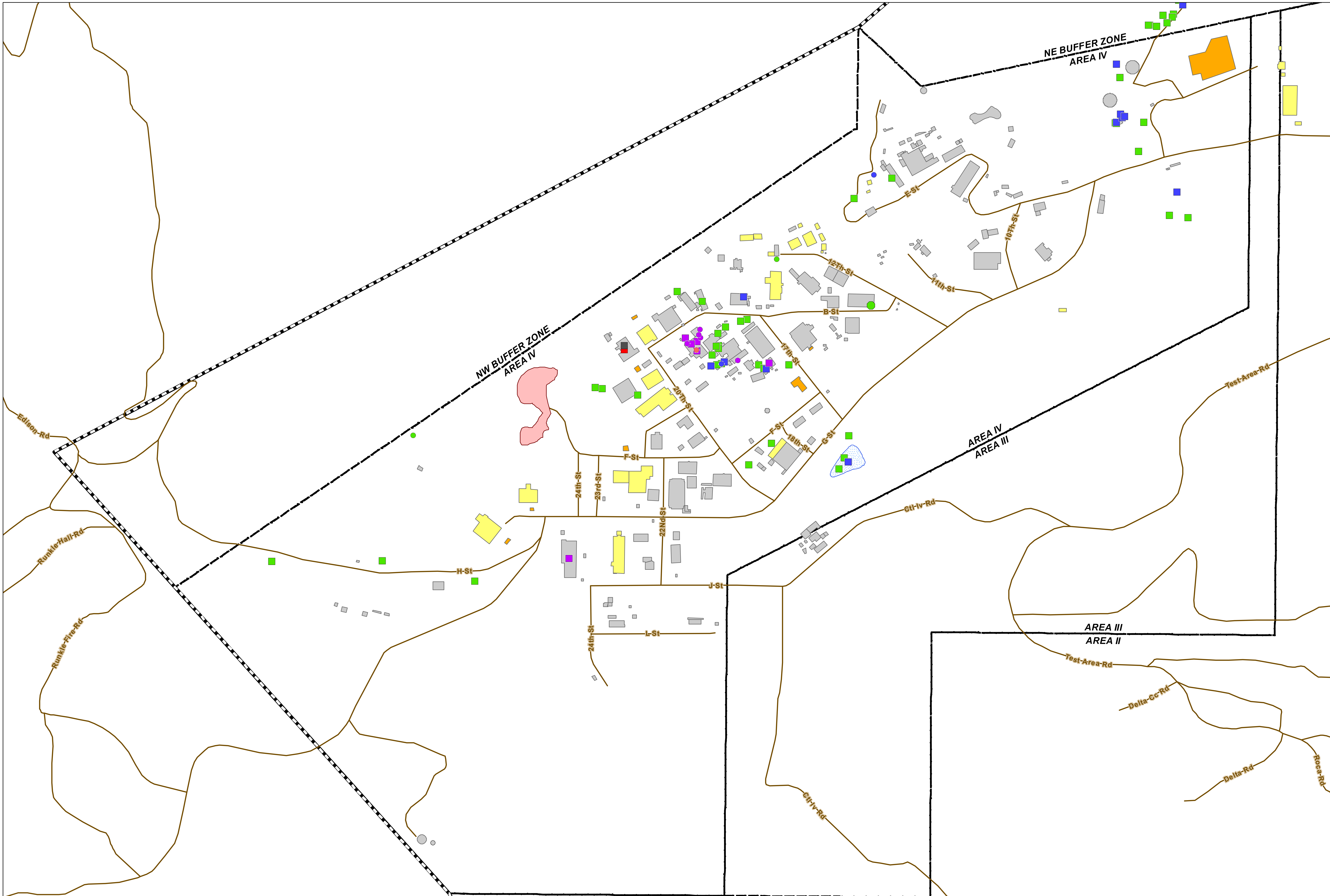
PCBs: Aroclors 1242, 1248 and 1268 Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-15

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\PCBs\SSFL_CDSR_PCBs_1242_1248_1268_LUT_NoAP_18x24_20160504.mxd 5/4/2016



Aroclor 1242 Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet

Aroclor 1248 Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 40 Feet
- 55 Feet

Aroclor 1268 Exceedance by Depth

- Surface

Road Centerline

Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
Area Boundary
SSFL Property Boundary

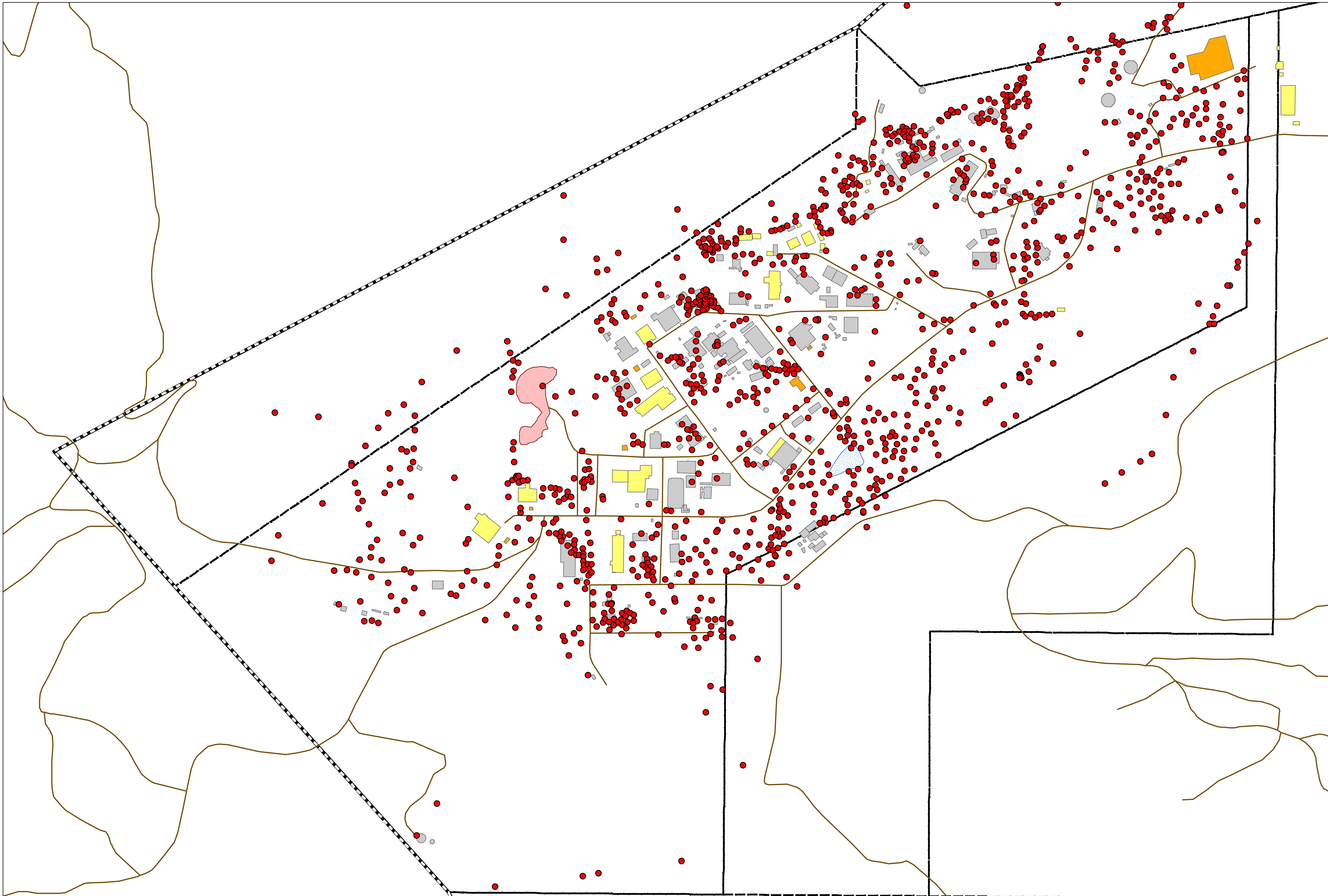
PCBs: Aroclors 1242, 1248, and 1268 - Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-15b

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_Aroclor_1242_1248_1268_LUTEXC_NoAP_18x24_20160505.mxd 5/5/2016



Legend

- Dioxin TEQ Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

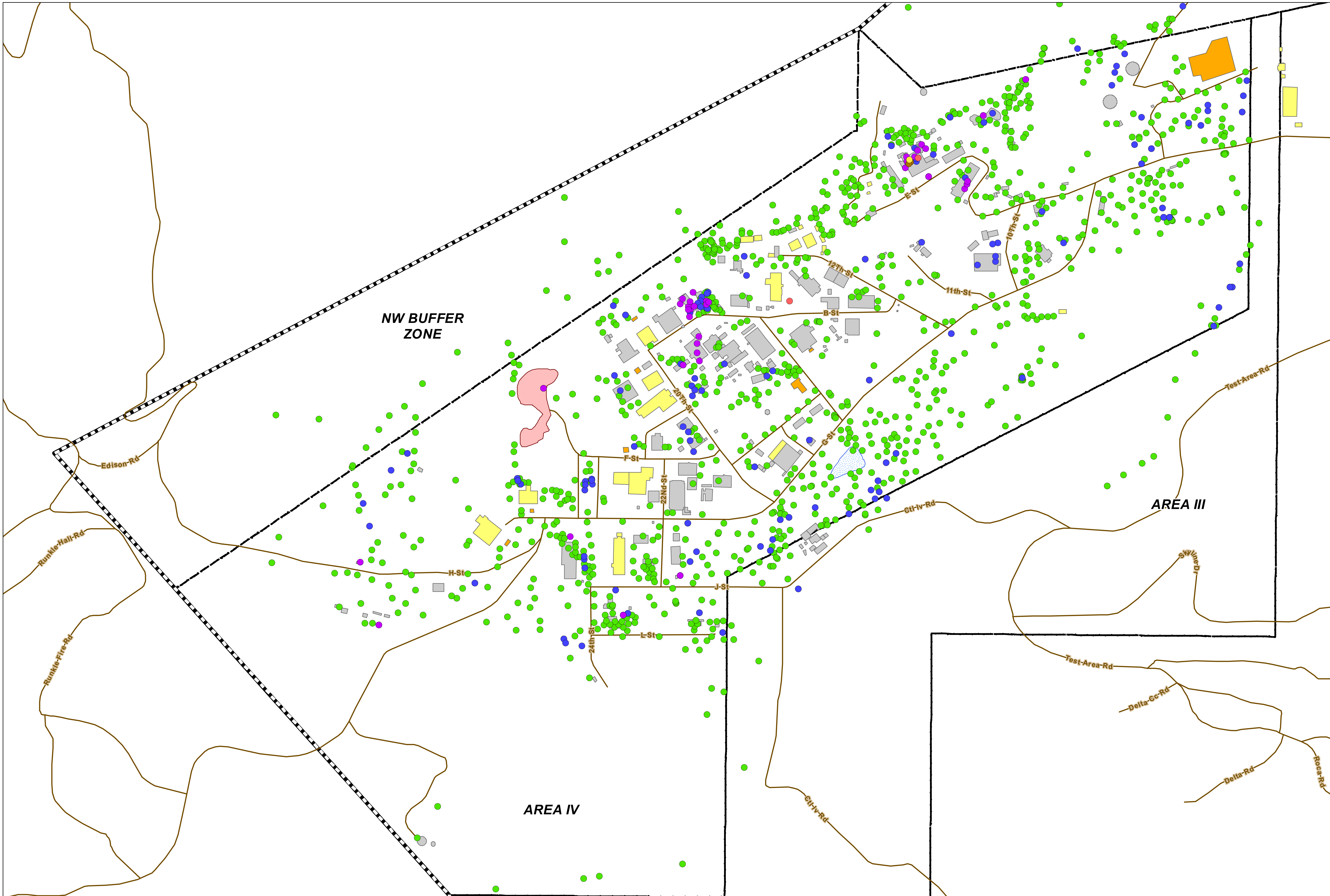
Dioxin TEQ Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-16

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Dioxins\SSFL_CDSR_DioxinTEQ_LUT_NoAP_18x24_20160504.mxd 5/4/2016



Dioxin TEQ LUT Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet
- 25 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

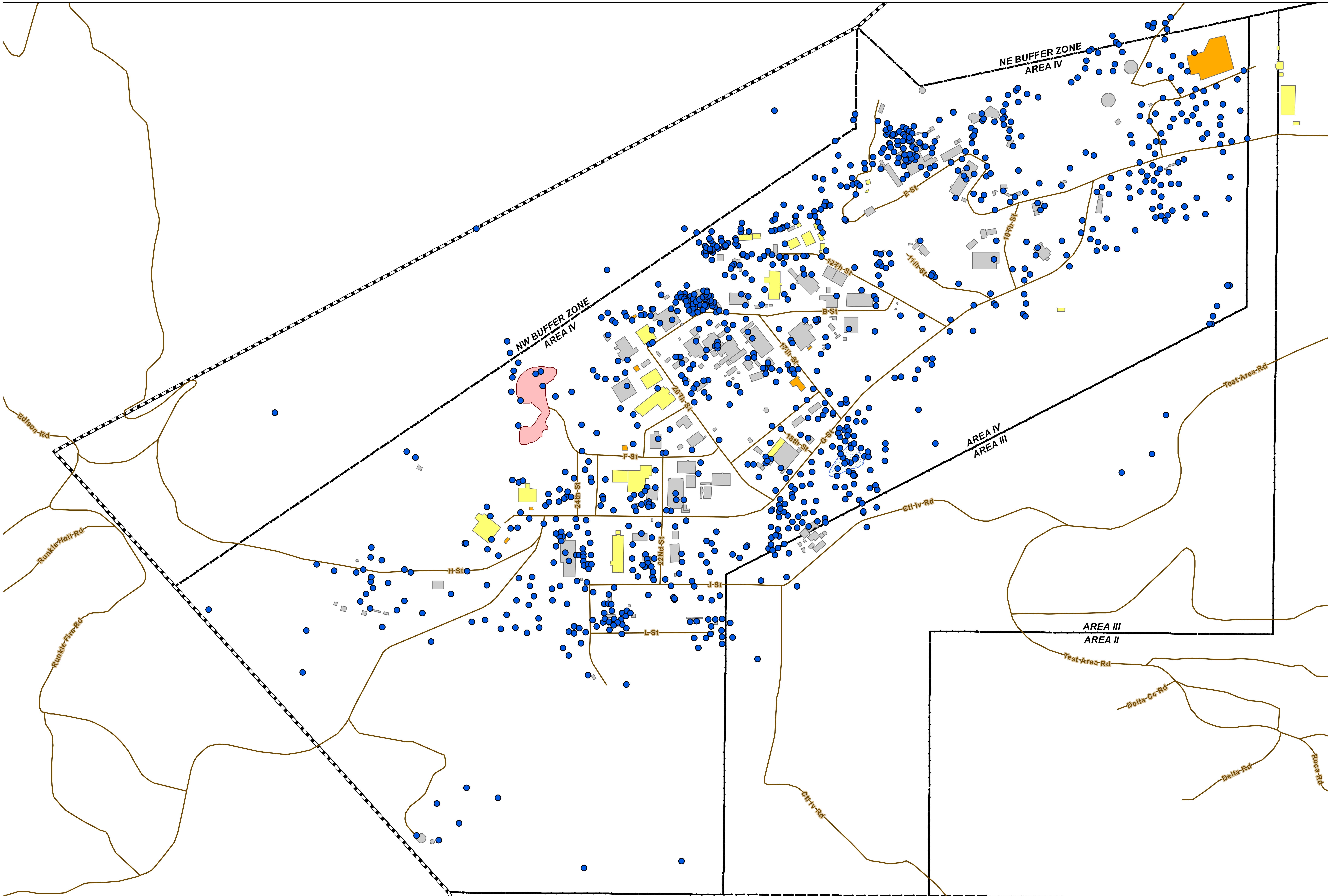
Dioxins: TEQ Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-17

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_Dioxin_TEQ_LUTEXC_NoAP_18x24_20160505.mxd 5/5/2016



Legend

- BaP TEQ Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

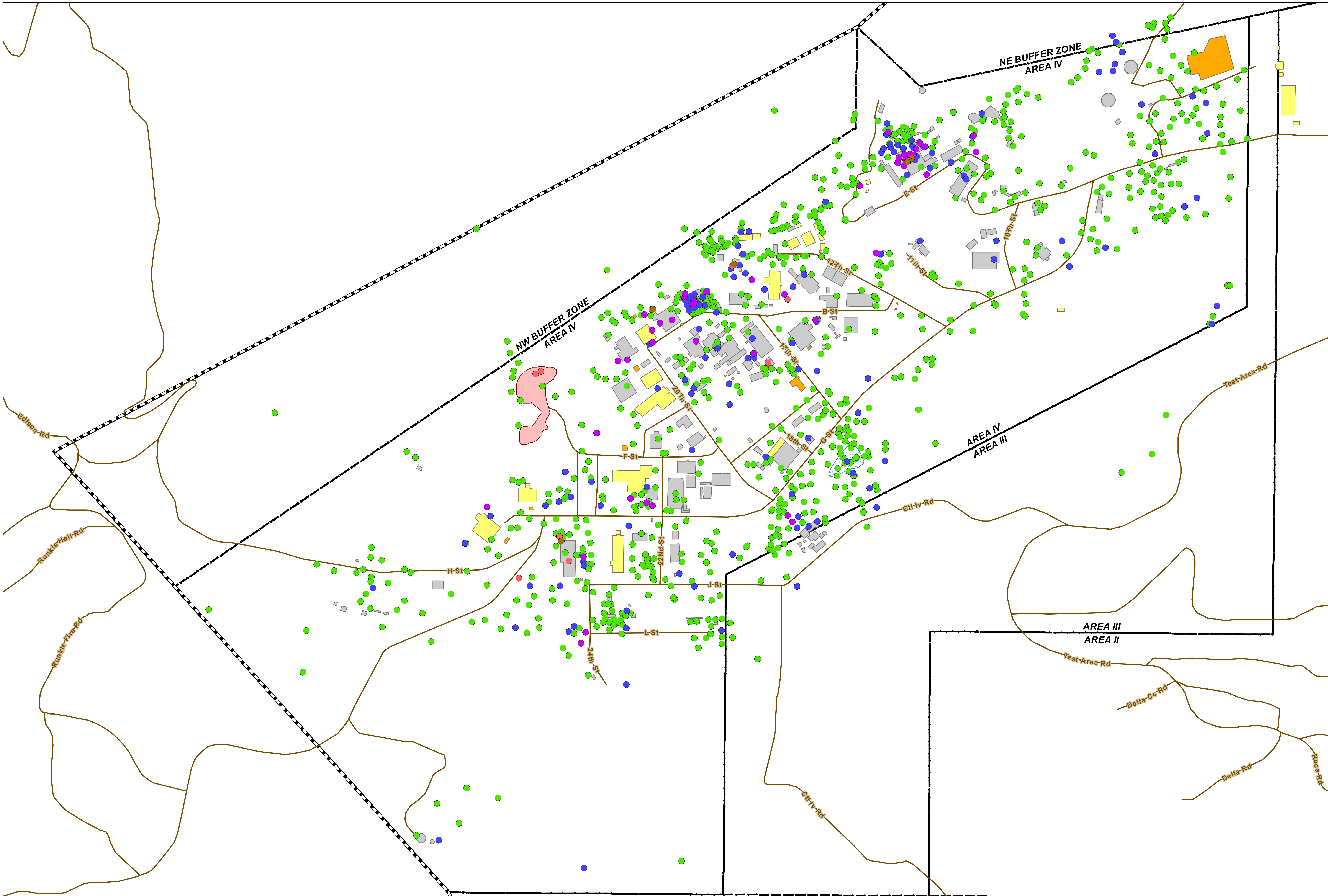
PAH Carcinogens: BaP TEQ Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-18

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\PAHs\SSFL_CDSR_PAH_Carcinogens_LUT_NoAP_18x24_20160504.mxd 5/4/2016



BaP TEQ Exceedance by Depth

- Surface
- 5 Feet
- 10 Feet
- 15 Feet
- 20 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

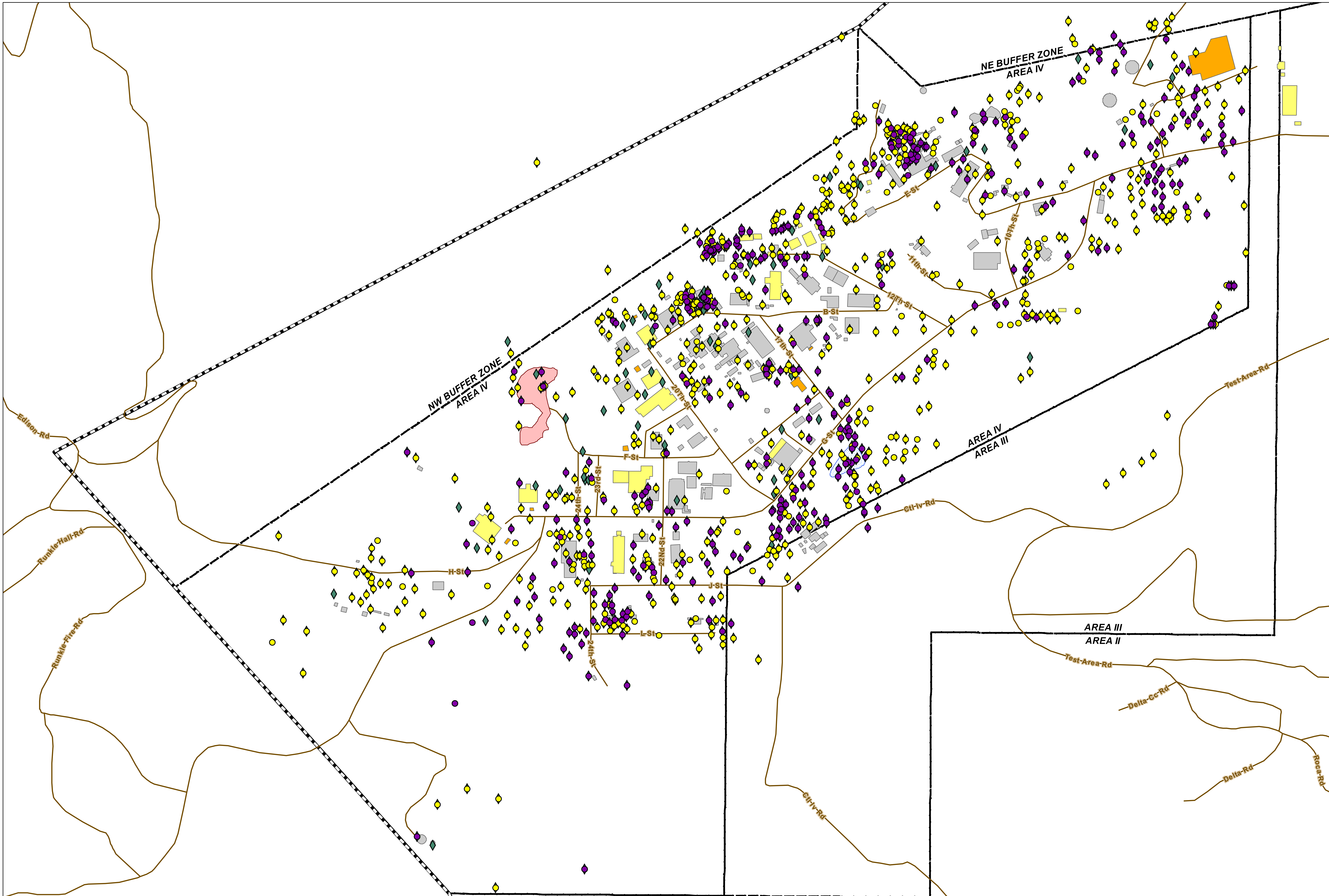
PAH Carcinogens: BaP TEQ Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-19

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_PAH_Carcinogens_LUTEXC_NoAP_18x24_20160505.mxd 5/5/2016



Legend

- Anthracene Exceedance Location
- Fluoranthene Exceedance Location
- Pyrene Exceedance Location
- Area Boundary
- SSFL Property Boundary

PAH Non-Carcinogens: Anthracene, Fluoranthene, and Pyrene Exceeding LUT Values - Surface Soils

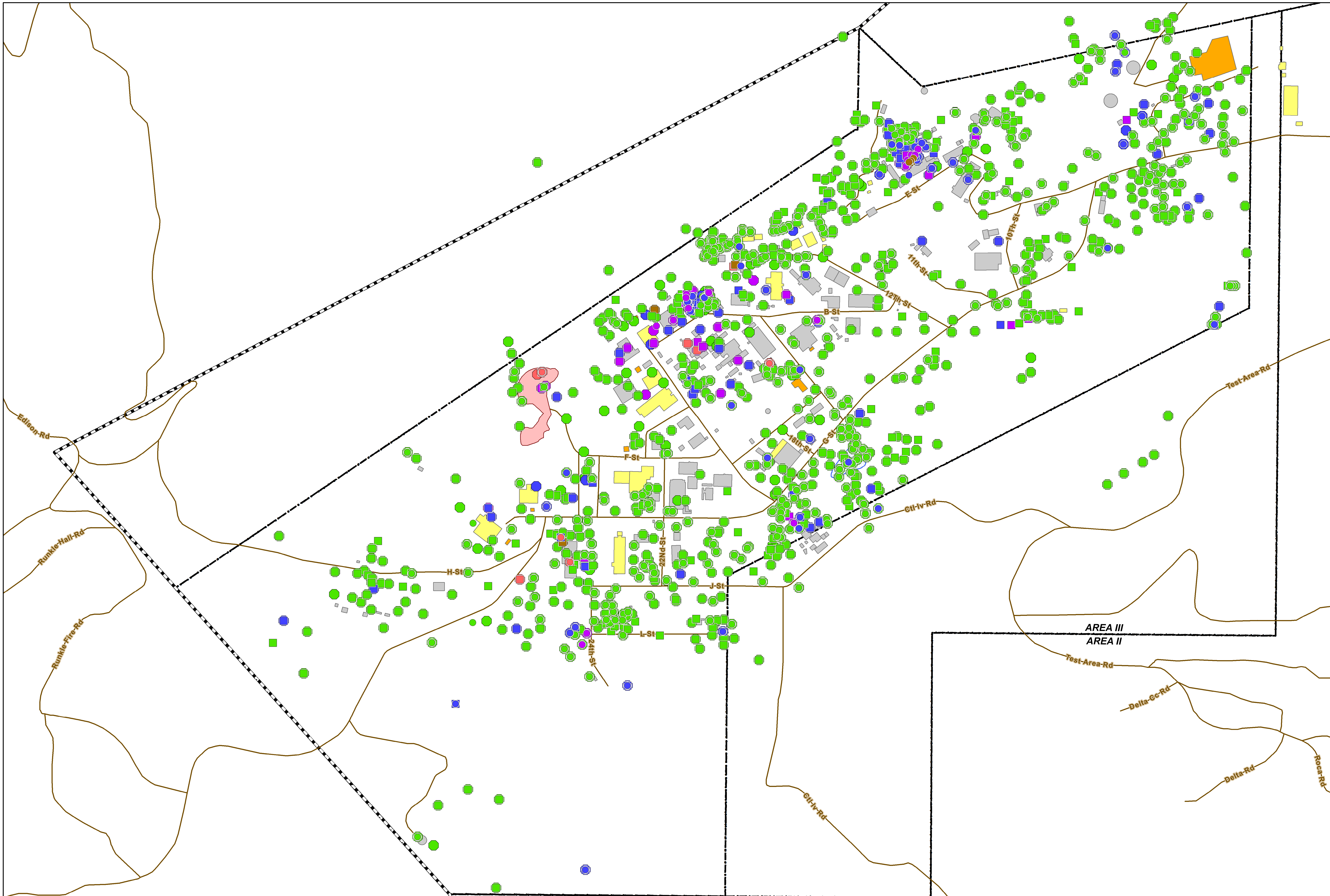
N

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-20

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\PAHs\SSFL_CDSR_PAH_NonCarcinogens_LUT_NoAP_18x24_20160504.mxd 5/4/2016



Anthracene LUT Exceedance by Depth	Fluoranthene LUT Exceedance by Depth	Pyrene LUT Exceedance by Depth
Surface	Surface	Surface
5 Feet	5 Feet	5 Feet
10 Feet	10 Feet	10 Feet
15 Feet	15 Feet	15 Feet
20 Feet	20 Feet	20 Feet

Road Centerline
Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
Area Boundary
SSFL Property Boundary

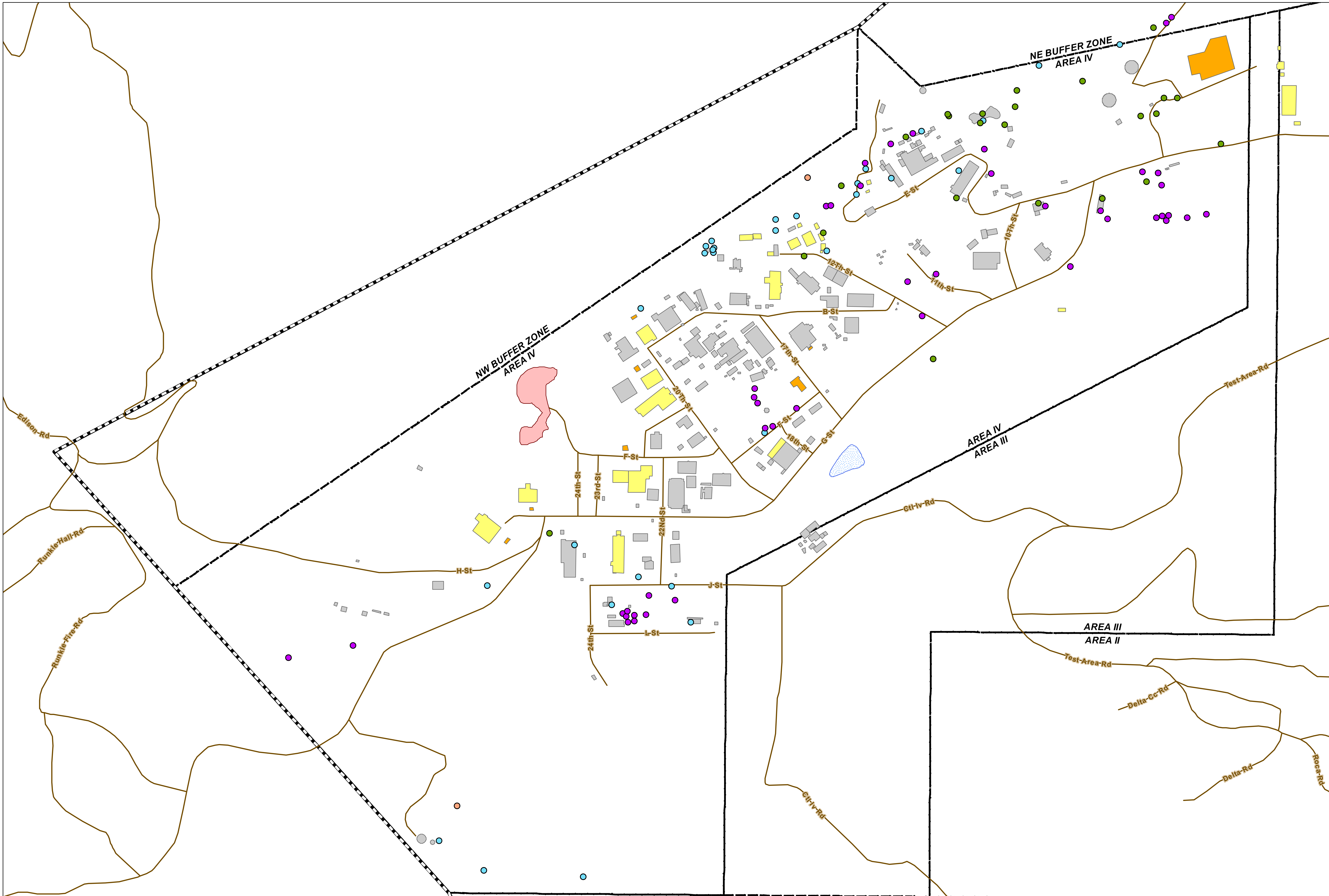
PAH Non-Carcinogens: Anthracene, Fluoranthene, and Pyrene Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-21

CDM Smith

C:_projects\SantaSusana\GIS\MXD\CDSR\Depths\MXD\SSFL_CDSR_PAH_NonCarcinogens_LUTEXC_NoAP_18x24_20160613.mxd 6/13/2016



Legend

- 4,4'-DDE Exceedance Location
- 4,4'-DDT Exceedance Location
- Chlordane Exceedance Location
- Toxaphene Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Pesticides: 4,4'-DDE, 4,4'-DDT, Chlordane, and Toxaphene Exceeding LUT Values Surface Soils

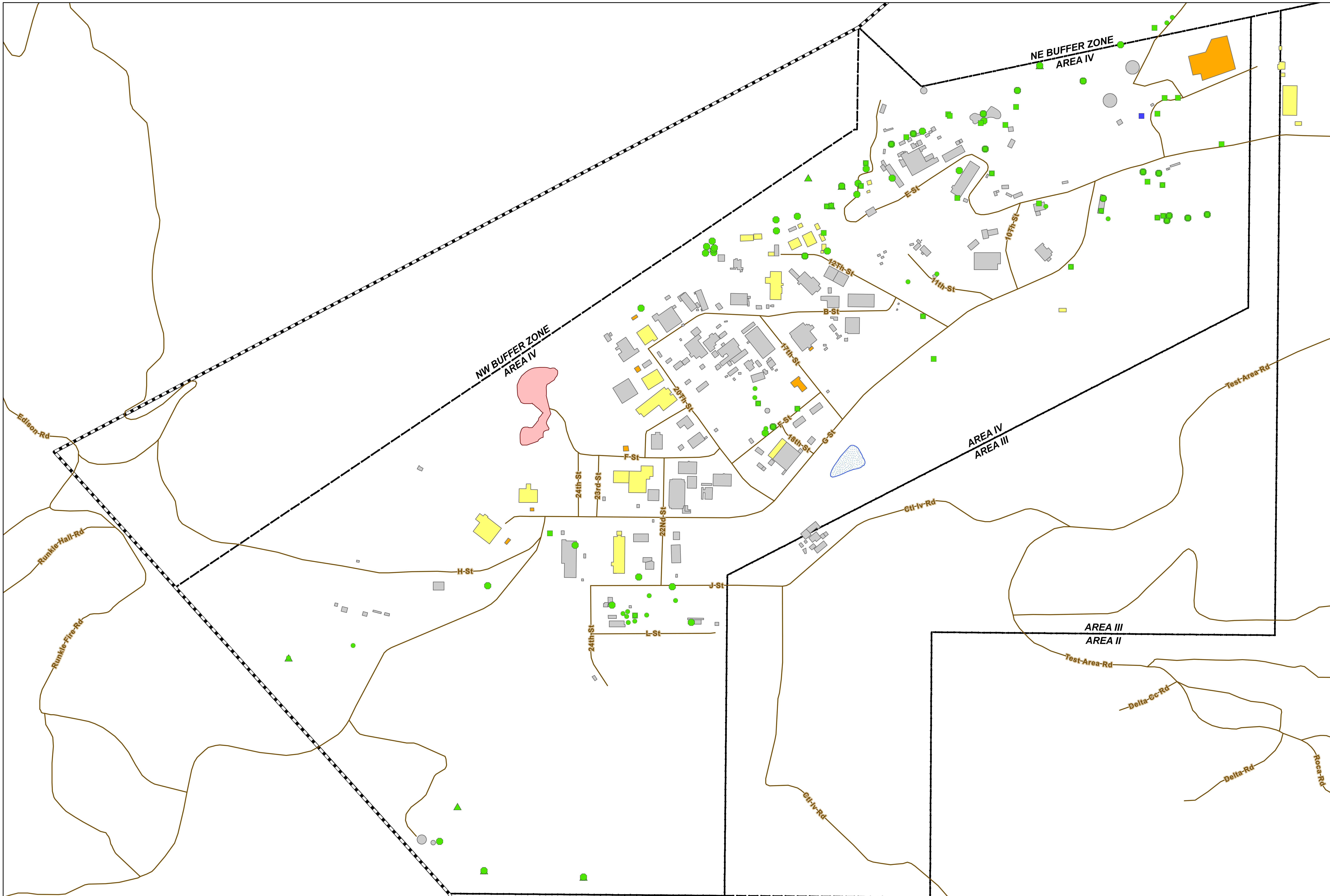
N

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-22

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Pesticides\SSFL_CDSR_Pesticides_LUT_NoAP_18x24_20160504.mxd 5/4/2016



4,4'-DDE LUT Exceedance by Depth
- Surface
- 5 Feet

4,4'-DDT LUT Exceedance by Depth
- Surface
- 5 Feet

Chlordane LUT Exceedance by Depth
- Surface

Toxaphene LUT Exceedance by Depth
- Surface

Road Centerline

Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
Area Boundary
SSFL Property Boundary

Pesticides: 4,4'-DDE, 4,4'-DDT, Chlordane, and Toxaphene Exceeding LUT Values by Depth

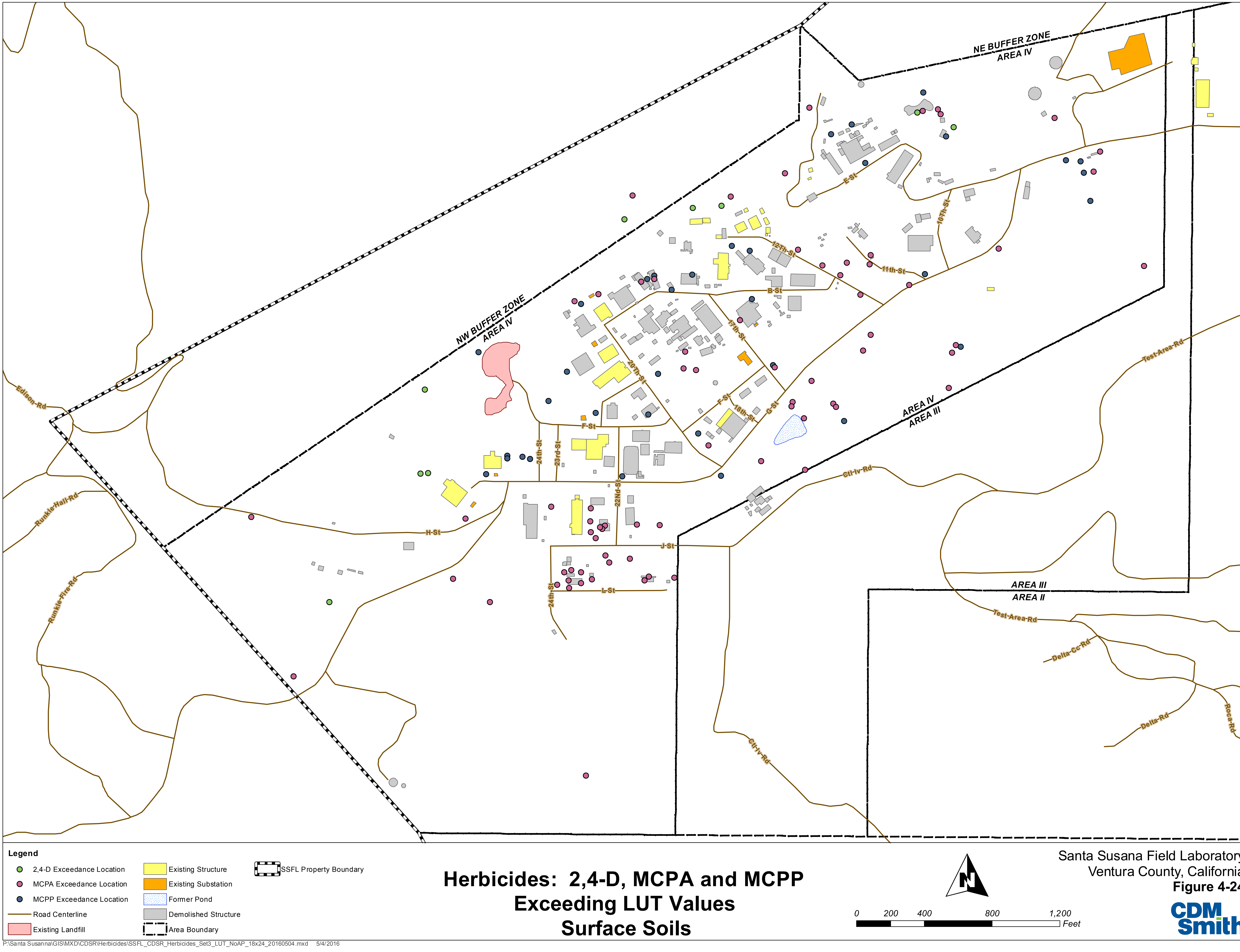
N

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-23

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSSFL_Pesticides_LUTEXC_NoAP_18x24_20160505.mxd 5/5/2016

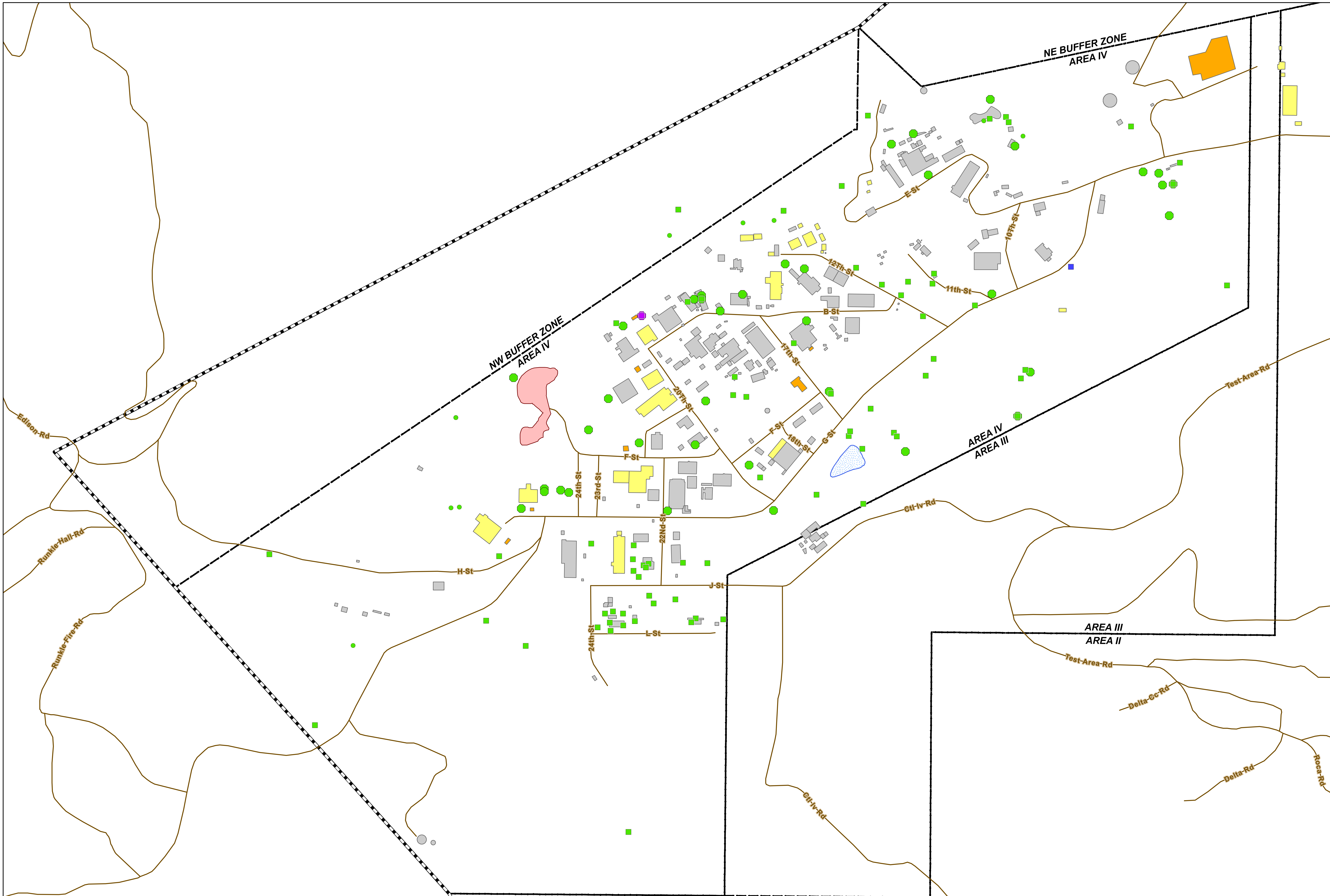


Herbicides: 2,4-D, MCPA and MCPP Exceeding LUT Values Surface Soils

Santa Susana Field Laboratory
Ventura County, California
Figure 4-24

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Herbicides\SSFL_CDSR_Herbicides_Set3_LUT_NoAP_18x24_20160504.mxd 5/4/2016



2,4-D LUT Exceedance by Depth
- Surface
- 5 Feet

MCPA LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet

MCPP LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet

- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Herbicides: 2,4-D, MCPA and MCPP Exceeding LUT Values by Depth

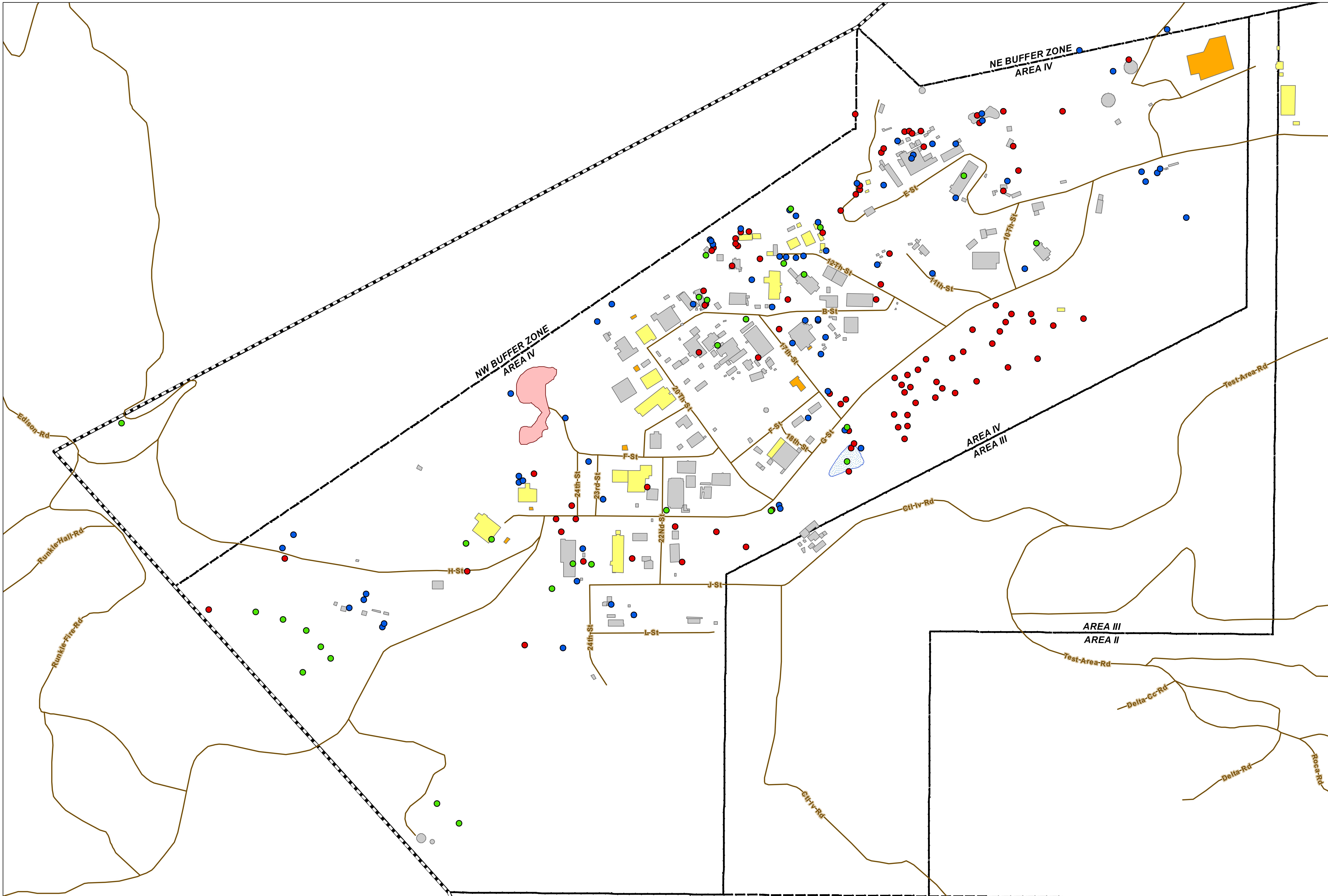
N

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-25

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_Herbicides_LUTEXC_NoAP_18x24_20160505.mxd 5/5/2016



Legend

- Butylbenzylphthalate Exceedance Location
- Di-n-butylphthalate Exceedance Location
- Di-n-octylphthalate Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

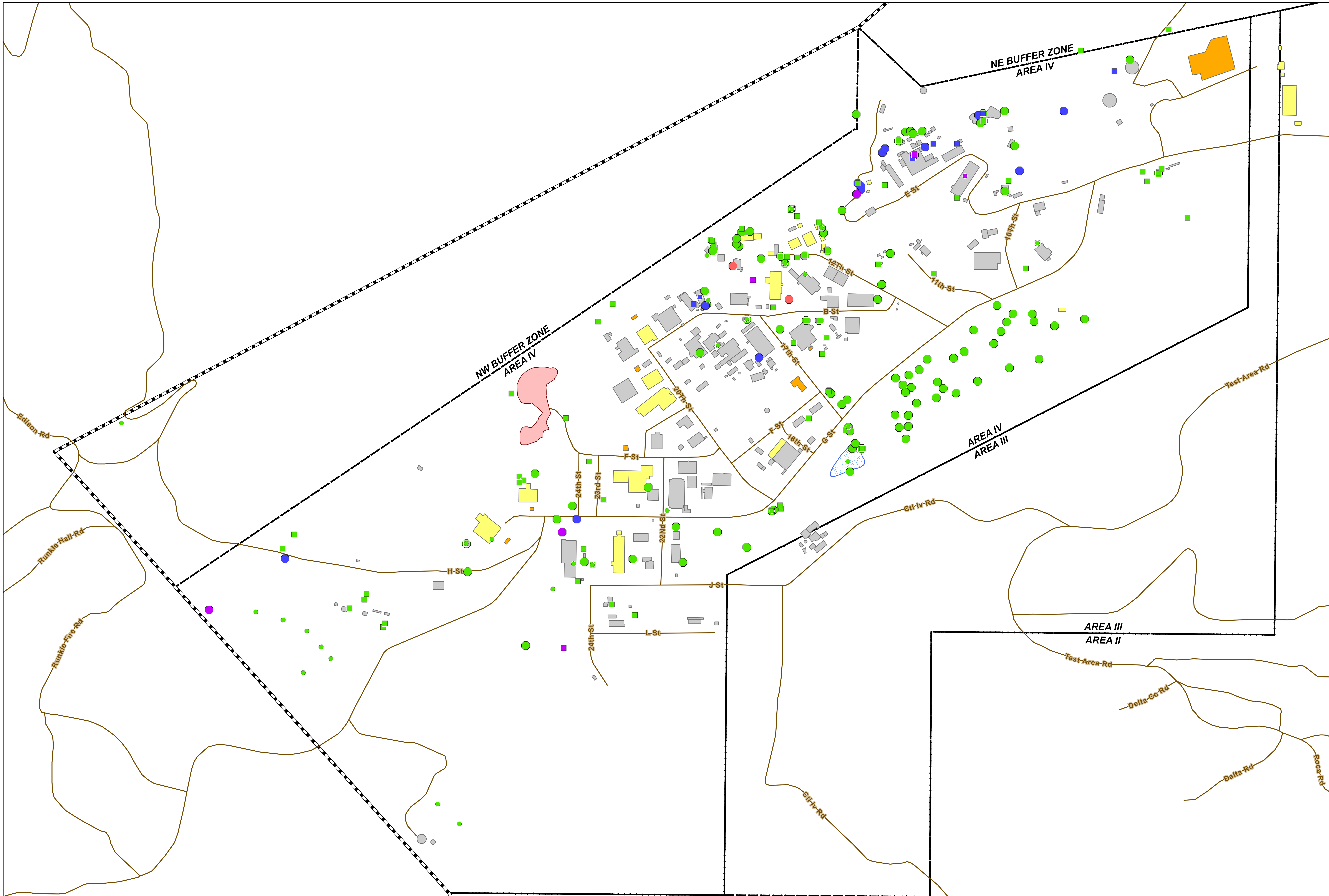
Phthalates: Butylbenzylphthalate, Di-n-butylphthalate and Di-n-octylphthalate Exceeding LUT Values Surface Soils

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-26

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\PAHs\SSFL_CDSR_PAH_Phthalates_Set2_LUT_NoAP_18x24_20160504.mxd 5/4/2016



Butylbenzylphthalate LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet

Di-n-butylphthalate LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 20 Feet

Di-n-octylphthalate LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 15 Feet

Road Centerline

Existing Landfill

Existing Structure

Existing Substation

Former Pond

Demolished Structure

Area Boundary

SSFL Property Boundary

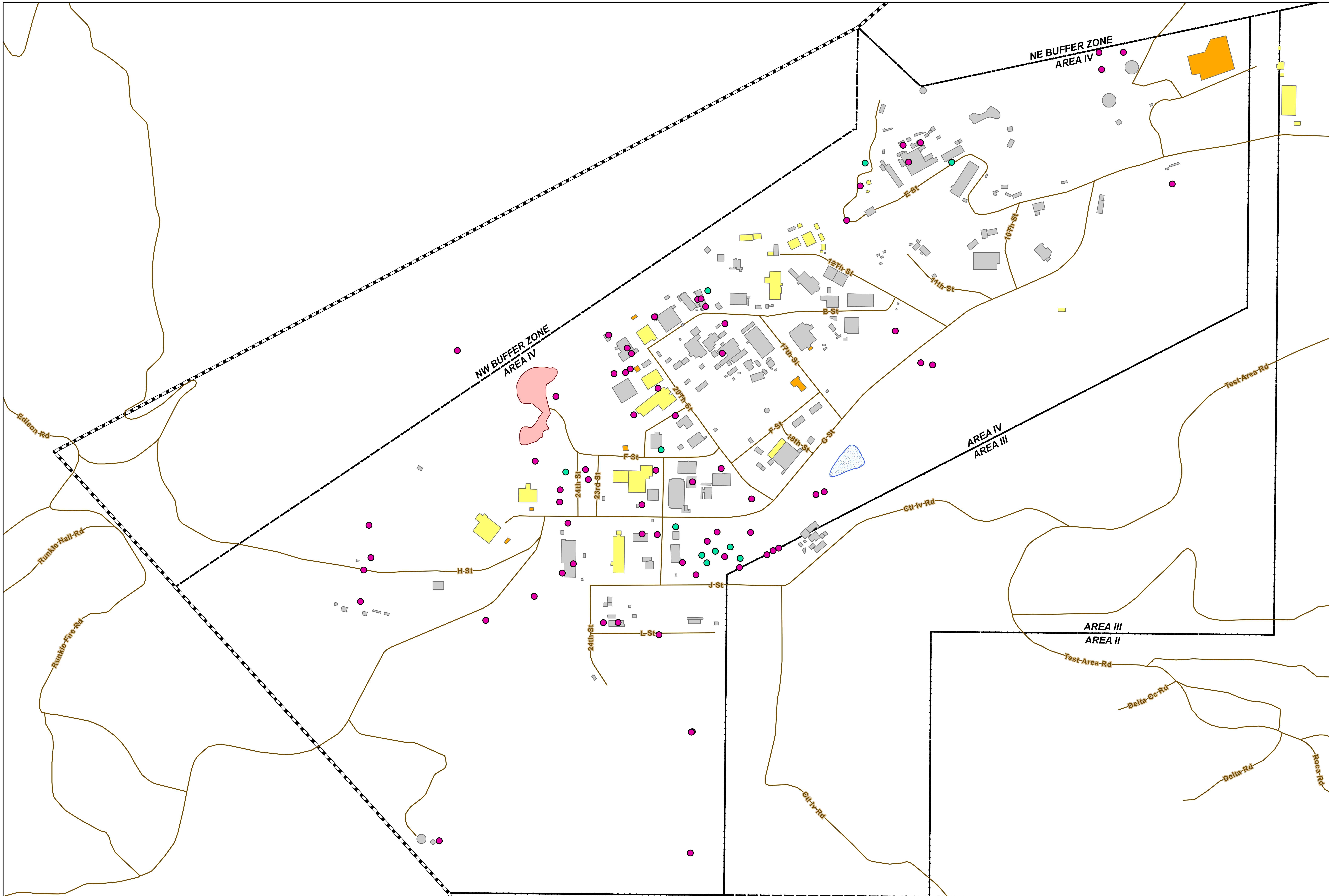
Phthalates: Butylbenzylphthalate, Di-n-butylphthalate and Di-n-octylphthalate Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-27

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_Phthalates_LUTEXC_NoAP_18x24_20160509.mxd 5/9/2016



Legend

- N-Nitrosodimethylamine Exceedance Location
- Perchlorate Exceedance Location
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

Perchlorate and NDMA Exceeding LUT Values Surface Soil

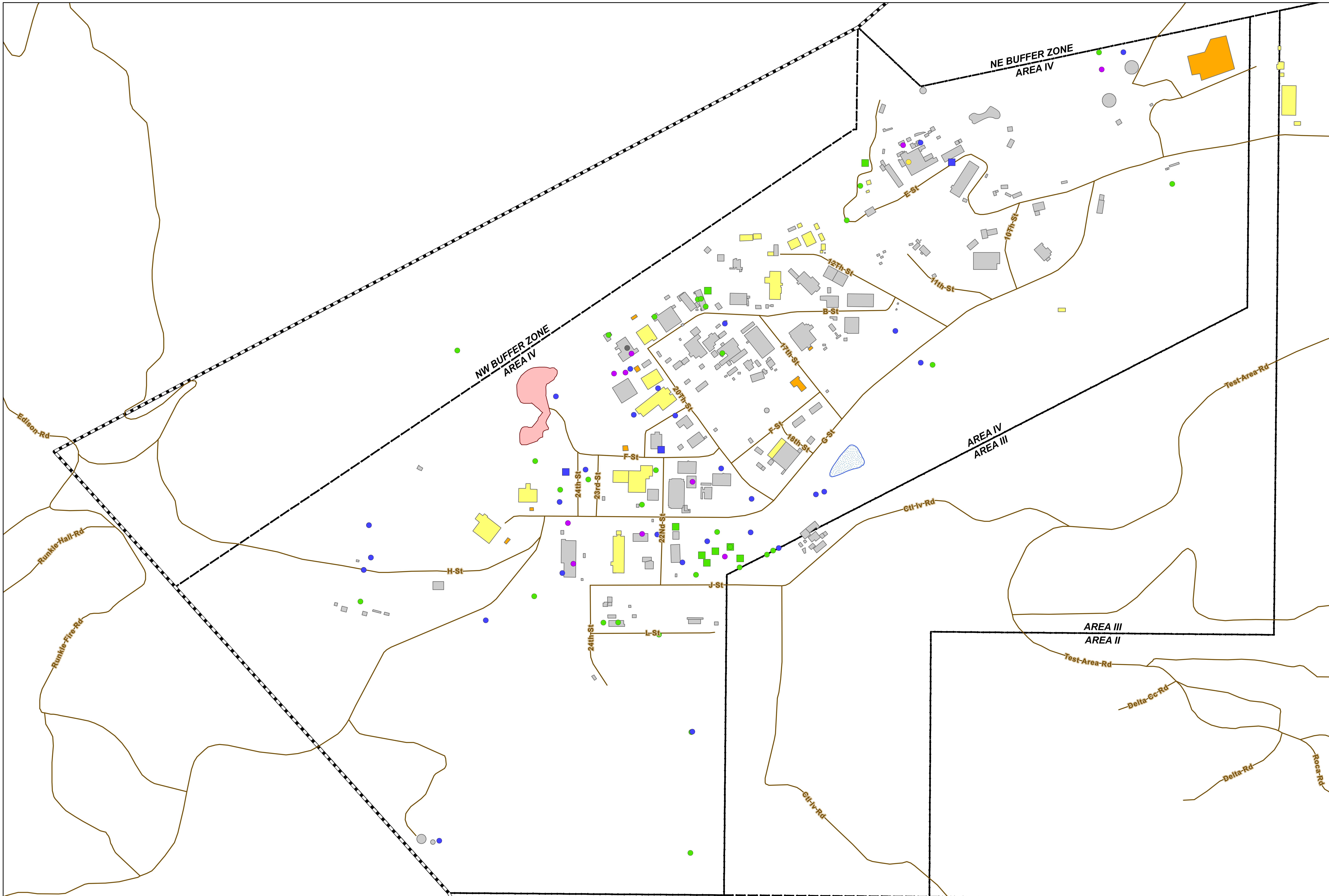
0 200 400 800 1,200 Feet

N

Santa Susana Field Laboratory
Ventura County, California
Figure 4-28

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Misc\SSFL_CDSR_PerchlorateNDMA_LUT_NoAP_18x24_20160509.mxd 5/9/2016



Perchlorate LUT Exceedance by Depth
- Surface
- 5 Feet
- 10 Feet
- 25 Feet
- 50 Feet

N-Nitrosodimethylamine LUT Exceedance by Depth
- Surface
- 5 Feet

Road Centerline
Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
Area Boundary
SSFL Property Boundary

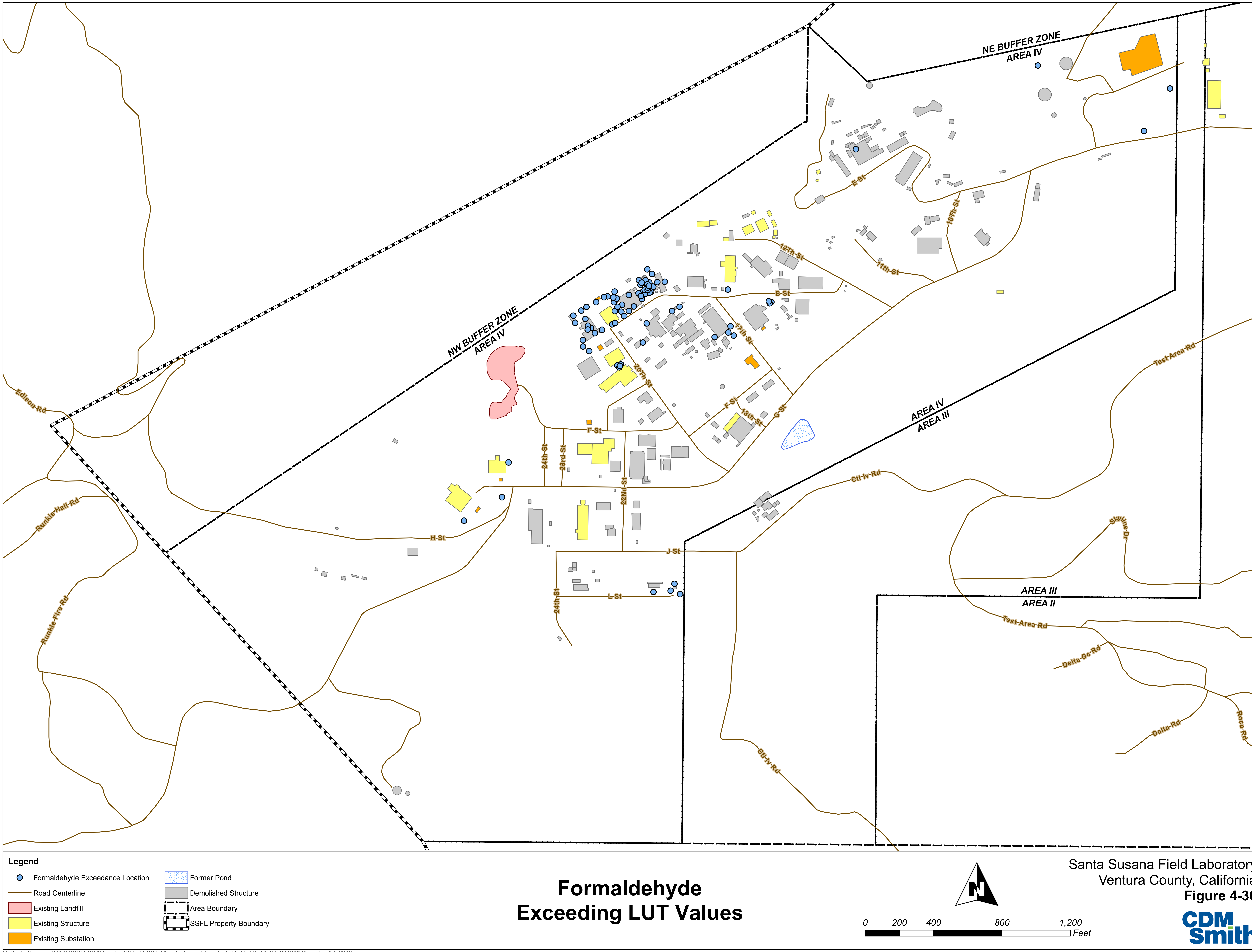
Perchlorate and N-Nitrosodimethylamine Exceeding LUT Values by Depth

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-29

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Depths\MXD\SSFL_PerchlorateNDMA_LUTEXC_NoAP_18x24_20160509.mxd 5/9/2016

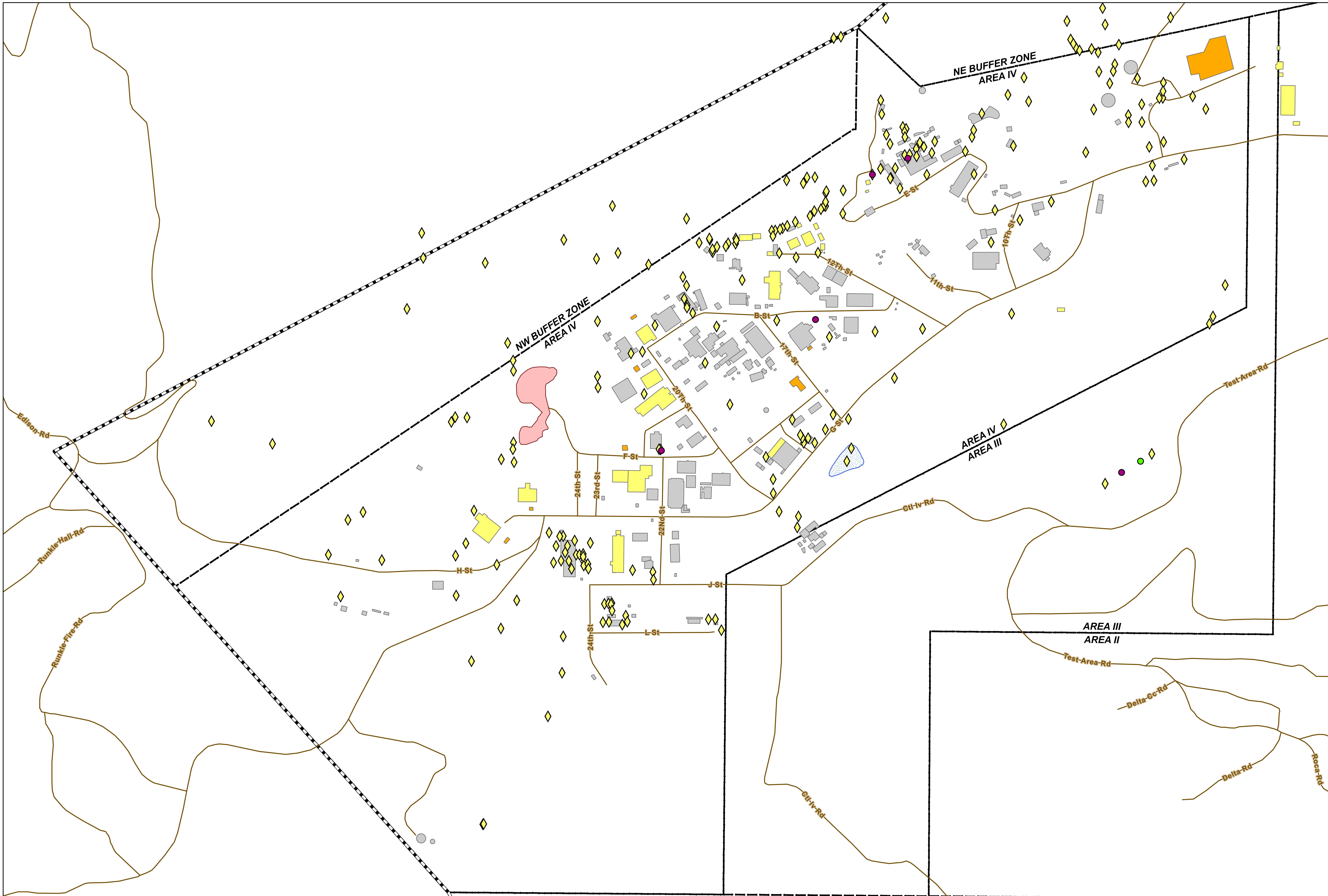


Formaldehyde Exceeding LUT Values

Santa Susana Field Laboratory
Ventura County, California
Figure 4-30

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\Glycols\SSFL_CDSR_Glycols_Formaldehyde_LUT_NoAP_18x24_20160509.mxd 5/9/2016



Legend

TPH EFH GRO Medium

- Greater Than 1000 mg/kg
- 500-1000 mg/kg
- 5 - 500 mg/kg
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

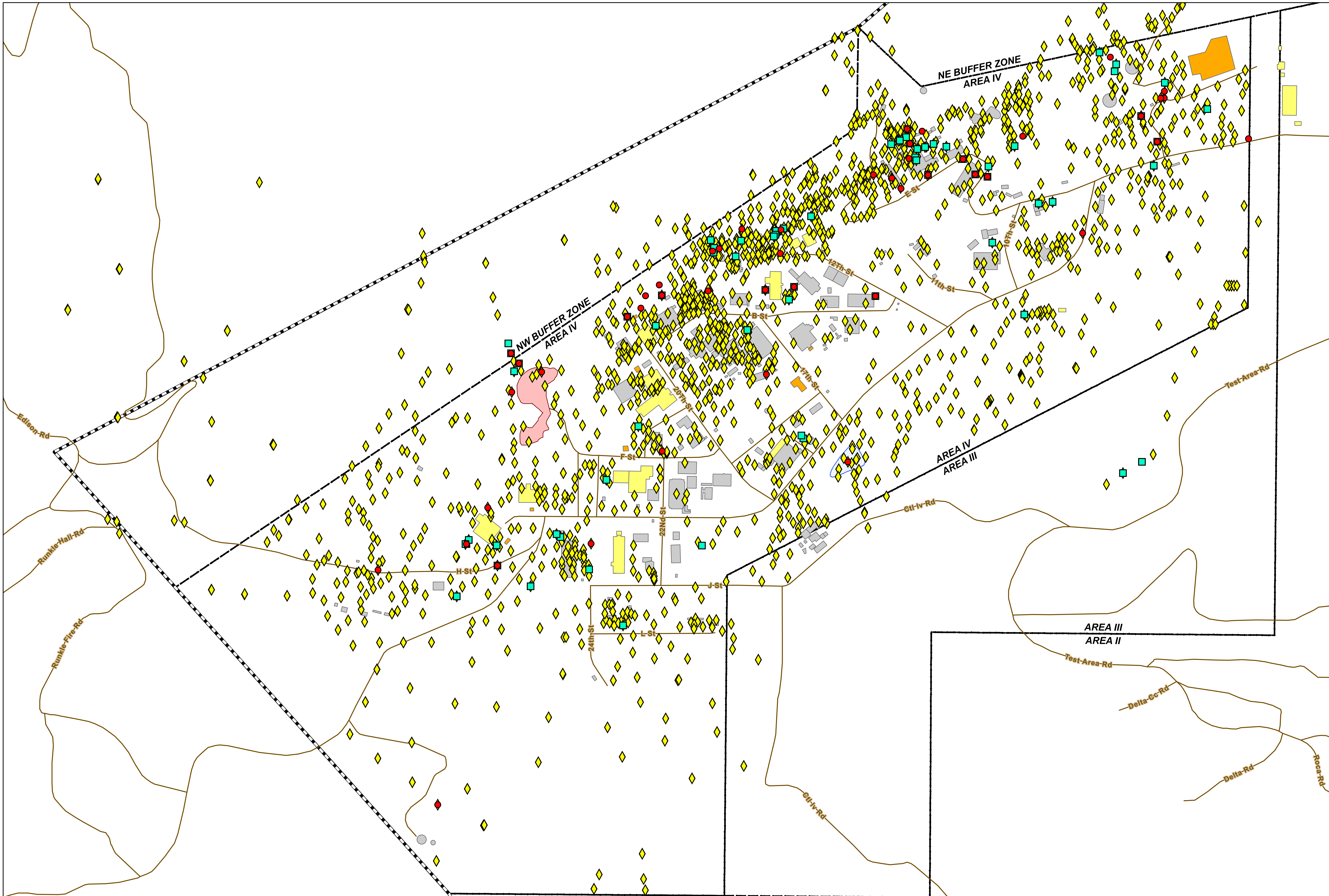
Medium Diesel Range Organics - Approximately C15-C20 Result Values

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-31

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\TPH\SSFL_EFH_GRO_Medium_NoAP_18x24_20160509.mxd 5/9/2016



Legend

TPH EFH DRO High

- Greater Than 1000 mg/kg
- 500-1000 mg/kg
- 5 - 500 mg/kg
- Road Centerline
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- Area Boundary
- SSFL Property Boundary

High Diesel Range Organics - Approximately >C20 Result Values

0 200 400 800 1,200 Feet

Santa Susana Field Laboratory
Ventura County, California
Figure 4-32

CDM Smith

P:\Santa Susanna\GIS\MXD\CDSR\TPH\SSFL_EFH_GRO_High_NoAP_18x24_20160509.mxd 5/9/2016

Section 5

Summary of Data Quality Review and Findings

5.1 CDM Smith Data Validation/Evaluation Process

A review of the collected data was necessary to determine if the data quality objectives (DQOs) established in the *Work Plan for Chemical Data Gap Investigation Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, California* (CDM Smith, 2012h) had been met. The following data measurement tasks were evaluated:

- Specification and adherence to analytical method and reporting limit (RL) requirements.
- Identification of the appropriate laboratory analytical quality control (QC) requirements and verification that QC requirements were met.
- Verification that measurement performance criteria (representativeness and completeness) for the data were met.
- Verification that field procedures were followed, deviations were documented, and a determination of impact on data quality as a result of these deviations.

Analytical data produced by the analytical laboratories were subject to multiple review steps to coincide with the start of distinct tasks. These steps were performed in a timely manner to ensure appropriate feedback and correction of errors. These steps included:

- Cross-reference check of sample chain of custody (CoC) documents against the laboratory acknowledgement of sample receipt form. The laboratory acknowledgement of sample receipt was typically transmitted to the data manager via e-mail 2 to 3 days after sample receipt and login, and includes a summary of the requested analyses to be performed per sample. Sample log-in errors were identified and corrected at this step.
- Tracking of sample collection, receipt, and laboratory sample delivery group (SDG) numbers on a sample tracking spreadsheet. This spreadsheet also includes field QC sample information, sample location coordinates, and required laboratory deliverables including reports, electronic data deliverables, raw data, and the status of validation.
- Laboratory consultation with the project chemists on data quality issues during sample analyses such as missed holding times, poor spike recoveries, etc. These issues are discussed between the project chemists and the laboratory and are resolved based on technical merit and determined if usable in the evaluation.

Upon receipt of the laboratory report (delivered via e-mail), a preliminary review of the data was performed. This review consisted of:

- Reconciliation of the reported analyses against the analyses that were requested on the CoCs.
- Review of the laboratory case narratives. The case narrative identifies and explains quality issues encountered during the analysis of the samples. Quality issues may include (but are not limited to) expired holding times, poor spike recoveries in matrix or batch-specific QC samples, instrument calibration exceedances, and blank contamination.
- Review of the laboratory-specific QC data. These data are provided by the laboratory in summary form. Any unanticipated deviations from the project or method-specific criteria are reconciled with the laboratory at this stage.

As part of the QC process, QC samples were collected in the field, which included field duplicates, matrix spike (MS)/matrix spike duplicate (MSD) samples, equipment rinsate blanks and field blanks. Trip blanks filled with laboratory analyte-free water were sent to the site from the laboratory and were submitted unopened with any samples to be analyzed for all applicable methods.

Both the field duplicates and MS/MSD samples were to be collected at a frequency of one per 20 (5 percent) parent soil samples collected. The field duplicate and MS/MSD samples were collected from the same location. The duplicate samples were submitted to the laboratory as separate (and blind) from the parent samples. The MS/MSD samples are additional volume of the parent samples collected in triple volume for the subsurface samples collected using the direct push technology (DPT) rig; a double volume of soil was sufficient for the surface and hand-augered MS/MSD samples.

Equipment rinsate blanks were collected weekly for both surface and subsurface soil samples regardless of the number of soil samples collected. Field blanks were collected once for each lot number of American Society for Testing and Materials (ASTM) International Type II water that was used for decontamination. Specific QC results are presented in individual data reports provided in Appendix B.

All sample data collected by CDM Smith were validated as required. The data validation review determined if the collected data are of sufficient quality to support their intended use. Data were validated by the independent data validation firm Laboratory Data Consultants, Inc. All data validation was conducted in accordance with the following guidance documents:

- *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004)
- *EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008)
- *EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* (EPA, 2005)

The data validation strategy was to validate ten percent of the data according to EPA Level IV protocols (all QC parameters and raw data) and the remaining 90 percent according to EPA Level III protocols (all QC parameters except calibrations and raw data). The Level IV determinations also included reviewing ten percent for each laboratory and each method. In order to achieve this, the validators chose appropriate samples in each laboratory SDG. Hence, not all samples in some of the SDGs were Level IV validated but they received a mix of Level IV and Level III review. Each of the specific Appendix B reports provide (in Table 4-1) the SDGs for all samples collected by CDM Smith and which SDG were validated as Level III or Level IV.

To evaluate the quality of the laboratory data and the validation process, CDM Smith's chemists reviewed over 10 percent of the soil sample SDGs. The SDGs reviewed were chosen based on methods and level of validation performed by the validation firm. The purpose of the review was to identify any laboratory QC issues not identified by the validation firm or any discrepancies in validation procedures by the validation firm. No additional qualifiers were applied to the data based on CDM Smith's review. Specific details are provided in Appendix B.

Qualifiers used during the validation process were as follows:

- **U –** The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- **J –** The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
- **R –** The data are unusable. The sample results are rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample.
- **UJ –** The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
- **Y –** Reporting Limits were adjusted for pesticides, herbicides, PCBs/polychlorinated triphenyls (PCTs). Affected sample results have been qualified with a "Y" qualifier.

5.2 CDM Smith Quality Procedures

A determination of quality involved evaluating quality assurance (QA) objectives for measurement data which are expressed in terms of precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS). The QA objectives provide a mechanism for evaluating and measuring data quality.

5.3 Laboratory QA/QC

Analytical QA/QC was assessed by laboratory QC checks, method blanks, sample custody tracking, sample preservation, adherence to holding times, laboratory control samples (LCSs), MSs, calibration recoveries, surrogates, tuning criteria, second column confirmations, internal standards, serial dilutions, laboratory duplicates, and interference check standards. The majority of the laboratory QC sample criteria met project requirements as indicated in the data validation reports in Appendix B. Outliers were appropriately qualified. Some sample results were rejected and are not usable for project decisions. Specific details are provided in the validation reports in Appendix B.

5.4 Data Quality Indicators

This section summarizes the validation performed. Individual SDG validation reports with specific sample detail are provided in Appendix B reports.

Achievement of the DQOs was determined in part by the use of data quality indicators (DQIs) described in the data usability assessment reports (DUARs) in Appendix B. These DQIs for measurement data are expressed in terms of PARCCS. The DQIs provide a mechanism for ongoing control to evaluate and measure data quality throughout the project. These criteria are defined in the sections below and described in detail in Appendix B reports.

5.4.1 Precision

Precision is the measurement of the ability to obtain the same value on re-analysis of a sample through the entire analytical process. The closer the measurement results, the greater the precision. Precision has nothing to do with accuracy or true values of the sample. Instead, it is focused on random errors inherent in the analysis that stem from the measurement process and are compounded by the non-homogeneous nature of some samples. Precision is measured by analyzing two portions of the sample (sample and duplicate) and then comparing the results. This comparison can be expressed in terms of relative percent difference (RPD). RPD is calculated as the absolute difference between the two measurements divided by the average of the two measurements.

$$\mathbf{RPD = \left[(A-B)/\frac{A+B}{2}\right] \times 100}$$

Qualifiers were applied to applicable sample analyte results during the validation process based on laboratory and field duplicate precision results. Details of the validation and the number of analytes qualified are provided in the DUARs and laboratory validation reports in Appendix B.

All field duplicate RPD results are presented in Appendix B. In summary, sample results that have been qualified as estimated "J/UJ" due to precision criteria are usable for project decisions with a degree of caution.

There was no discernible pattern or reason for the identified laboratory and field duplicate sample RPD exceedances. No field sampling issues were identified that would cause the RPD results that were outside of criteria. These exceedances are reasonable for this type of sampling activity.

5.4.2 Accuracy

Accuracy is a concept from quantitative analysis that attempts to address the question of how close the analytical result is to the true value of the analyte in the sample. Accuracy is determined through a spike procedure, where a known amount of the target analyte is added to a portion of the sample then the sample and the spiked sample are analyzed. The quantitative measure of accuracy is percent recovery (%R) calculated as follows:

$$\text{Percent Recovery} = \frac{(\text{Total Analyte Found} - \text{Analyte Originally Present})}{\text{Analyte Added}} \times 100$$

Qualifiers were applied to applicable sample results during the validation process based on laboratory accuracy results. Details of the validation and the number of analytes qualified are discussed in the DUARs and laboratory validation reports in Appendix B.

In summary, sample results that have been qualified as estimated "J/UJ" due to accuracy criteria are usable for project decisions. Results that have been rejected are not usable.

5.4.3 Laboratory and Field Blank Contamination

Blanks are used to determine the level of laboratory and field contamination introduced into the samples, independent of the level of target analytes found in the sample source. Field blanks, equipment blanks, trip blanks and laboratory method blanks are analyzed to identify possible sources of contamination. The DUARs and laboratory validation reports in Appendix B discuss the results that were qualified based on field and laboratory blank contamination.

For the dioxins, method detection limits (MDLs) for this analysis are very low, reported in nanogram per kilogram (ng/kg) or parts per trillion, resulting in numerous results qualified as estimated "J." Many of these estimated values have been subsequently qualified as non-detect "U" because the compound was detected in related laboratory blanks. In the laboratory blanks, low level detections of dioxin analytes are somewhat inevitable because of the nature and universal extent of the compounds. The dioxin levels found in the blanks are well below site-related action levels. Therefore, the resulting qualification of associated sample results as nondetect or "U" does not falsely diminish identification of site-related chemicals.

All equipment blanks were monitored to determine if the low level detections were consistent, thus indicating a possible deficiency in decontamination procedures and/or source water impacts that needed to be addressed and corrected.

In general all field blank results were considered acceptable the majority of the time. In a few instances analytes were detected that are not considered to be "normal" laboratory chemicals. In these cases a thorough review of the data, sampling collection procedures, and laboratory analyses was conducted. Qualification of the data based on field blank results was evaluated during the validation process and affected sample results were qualified accordingly. Specific details are provided in Appendix B.

5.4.4 Representativeness, Comparability, and Sensitivity

Representativeness, comparability, and sensitivity are achieved by using EPA-approved sampling procedures and analytical methodologies. By following the procedures described in the Master Field Sampling Plan (FSP) (CDM Smith, 2010b) for all sampling events, the sample analysis yielded results representative of environmental conditions at the time of sampling. Similarly, reasonable comparability of analytical results for this and future sampling events can be achieved if approved EPA analytical methods and standardized reporting units are employed.

5.4.4.1 Representativeness

Representativeness is a qualitative term that expresses the degree to which the sample data accurately and precisely represent the environmental conditions corresponding to the location and depth interval of sample collection. Requirements and procedures for sample collection are designed to maximize sample representativeness.

Representativeness has been achieved by the performed field work and laboratory analyses. The generated analytical data generated that have not been rejected are viewed to be a representative characterization of the project area.

5.4.4.2 Comparability

Comparability is a qualitative term that expresses the confidence with which a data set can be compared with another. Strict adherence to standard sample collection procedures, analytical detection limits, reporting units, and analytical methods assures that data from like samples and sample conditions are comparable. This comparability is independent of laboratory personnel, data reviewers, or sampling personnel. Comparability criteria are met for the project if, based on data review, the sample collection and analytical procedures are determined to have been followed, or defined to show that variations did not affect the values reported.

To ensure comparability of data generated for the site, standard sample collection procedures and DTSC-approved analytical methods were utilized. Utilizing such procedures and methods enables the current data to be comparable with previous and future data sets generated using similar methods.

5.4.4.3 Sensitivity

Sensitivity is related to the ability to compare analytical results with project-specific levels of interest, such as risk-based screening levels or action levels. Analytical detection limits for the various sample analytes should be below the level of interest to allow an effective comparison.

Qualifiers were applied to applicable sample results by the laboratory and identified during the validation process based on sample results being reported as detected below the RL/MDL. Appendix B provides the DUARs and laboratory validation reports including details of the validation findings and the number of results qualified.

5.5 Data Completeness

Completeness of the data collection program is defined as the percentage of samples planned for collection as listed in the Phase 3 Work Plan (CDM Smith, 2012h) versus the actual number of samples collected during the field program (see equation A).

Completeness for acceptable data is defined as the percentage of acceptable data obtained judged to be valid versus the total quantity of data generated (see equation B). Acceptable data include both data that pass all the QC criteria (unqualified data) and data that may not pass all the QC criteria but had appropriate corrective actions taken (qualified but usable data).

Equation A.

$$\%Completeness = C x \frac{100}{n}$$

Where:

C = actual number of samples collected
n = total number of samples planned

Equation B. $$\%Completeness = V x \frac{100}{n'}$$

Where:

V = number of measurements judged valid
n' = total number of measurements made

The overall completeness goal, as defined in the Master FSP (CDM Smith, 2010b) is 90 percent for each analytical test for all project data.

The completeness goals achieved for each of the sampled subareas were generally above 90 percent. Completeness tables are presented in the individual reports in Appendix B.

The completeness goals for both the locations sampled and the number of measurements judged to be valid were met the majority of the time for all collected data.

Sampling deviations from procedures described in the Master FSP (CDM Smith, 2010b) are discussed in Appendix B. Deviations did not impact DQOs for this sampling event. The data reported and not rejected are suitable for their intended use for characterization of Area IV of SSFL. The DQOs identified in the Master FSP met appropriate criteria. The achievement of the completeness goals for the data indicates a sufficient amount of usable data has been generated for project decisions.

5.6 Dioxin Details

Dioxins and furans are compounds created as by-products from several human activities as well as from natural causes such as forest fires. They are persistent environmental pollutants and have been shown to bioaccumulate in the environment. One objective of these analyses is to detect very low concentrations of dioxins and furans. To achieve this goal, all dioxin samples were analyzed by EPA Method 1613B. The laboratory was directed to report values that were determined to be Estimated Maximum Possible Concentration (EMPC) values. EMPC values are characterized by a response with a signal to noise ratio of at least 2.5:1 for both of the quantitation ions, but do not meet the ion abundance ratio criteria.

An EMPC result indicates that there is a detected presence of a compound above detection level. However, the detected concentration does not meet the appropriate QA/QC reporting level criteria to absolutely confirm whether it is a dioxin compound identified by the analytical system. What it does indicate is a possible low level dioxin peak has been identified but its concentration level is marginally above detection level.

For the dioxin analyses, the laboratories were directed to qualify any EMPC values with a "Q" qualifier for future evaluation. In the Appendix A tables, the "Q" qualified data will have the qualifier "J-EMPC" added to the final qualifier column to replace the laboratory "Q" qualifier. This is to aid the data user in identifying values that are EMPCs.

Another variable of dioxin analyses is the calculation of a dioxin toxicity equivalent (TEQ) for a sample. For a single dioxin congener, the TEQ is the product of the concentration of the dioxin congener in an environmental mixture and its corresponding toxicity equivalence factor (TEF). A TEF for a dioxin congener presents the congener's toxicological potency relative to that of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). The total TEQ for the mixture is the sum of the individual TCDD TEQs across the dioxin congeners. The TCDD TEQ provides a means for determining the toxicity of a mixture of dioxin compounds in the absence of toxicity values for these dioxin congeners.

The dioxin data review policy is presented in the USEPA *National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review* (EPA, 2011). These guidelines allow individual EPA regions flexibility in using criteria for calculating TEQ and how a data user can use EMPC results in this calculation.

For the calculation of the dioxin TEQ data for SSFL, all results that have been qualified with a "Q" qualifier by the laboratory, and then qualified as "J-EMPC" by CDM Smith, will be assigned a "0" value as the sample concentration. Any result that is non-detect has also been assigned a "0" value as the sample concentration. The TEF values used in the calculation are the World Health Organization 2005 Toxic Equivalency Factors (WHO: Van den Berg et al, 2006). The TEQ calculations and resulting sample values are summarized in Appendix A. Appendix C provides the documentation supporting the dioxin TEQ calculation procedures.

5.7 BaP TEQs

TEQs are also calculated for carcinogenic[7] PAHs results using an equivalency factor derived for BaP. The equivalency factors applied for the BaP equivalency analysis were derived from DTSC guidance (DTSC, 2015). Similar to dioxin TEQ calculations, a TEF value is assigned to individual PAH compounds to calculate their toxicity equivalence relative to BaP. In instances where the PAH result is produced by two different analytical methods, the greater value was used in the calculation. If one result was detect and one was non-detect the detected result was used; if both results were non-detect the lowest non-detect value was used. The seven carcinogenic PAH compounds in DTSC's LUT for chemicals were used when data existed for each. When 5 to 6 compounds and a benzo(a)pyrene result were measured, the TEQ was calculated with the 5 or 6 compounds and was called out as TEQ(6) or TEQ(5). If there were less than 5 compounds a TEQ was not calculated. Any result used for the BaP TEQ calculation that was non-detect (U qualified), a "0" value was assigned as the sample concentration. The BaP TEQ calculations and sample results are in Appendix A. Appendix D provides the documentation supporting the BaP calculation procedures.

[7] Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Dibenz(a,h)anthracene, Indeno(1,2,3-cd)pyrene

5.8 Low Level Method Reporting Limit Adjustments

During the Phase 1 co-located chemical soil sampling efforts for DOE, low-level analytical method reporting limits were utilized for some of the organic methods. For some of these methods, specifically pesticides, PCBs, PCTs and herbicides, a method modification was utilized for the preparation procedure that included an increase in mass of soil extracted, and a decrease in volume of the final extract. This modification was intended to allow for sample preparation that would result in MRLs approximately one order of magnitude less than the primary laboratories routine MRLs.

During the review of the Phase 1 sample results by CDM Smith and DTSC, concern over this method modification was raised. There is the possibility that this method modification resulted in retaining more of the target analyte in the final extract, as well as retaining other, interfering compounds in the final extract to the extent the analytical result data quality for the target analyte may be questionable and have a level of uncertainty that is not acceptable for the project's analytical program. By driving down the MRLs (and MDLs), the effect of site soil matrix interference becomes a bigger concern, because the matrix effect can potentially impact the confidence in identifying whether or not the analyte is actually present, and if it is the true target analyte. This concern is of upmost importance for these organic methods, as individual sample data generated under the AOC investigation is to be screened against values from the chemical look up table. The justification for addressing this concern is to ensure that data generated for this analytical program is defensible, with analytical uncertainty appropriately constrained such that the method can confidently detect an analyte and its concentration can be reported with a reasonable degree of accuracy and precision. Without this level of confidence, application of the sample results to the look up table process can be negatively affected.

To address this concern, the DTSC chemists suggested conducting an MDL study for herbicides, which allows one to evaluate the effect of the method preparation modification to a clean sand sample. The precision of the MDLs generated for some of the herbicide constituents was found to be unacceptable for the analytical program. The MDL study addressed the effects of the method modification on clean sand, yet the site soil can be a source of matrix interferences to the low level MDL. Certain quality control steps can be taken to demonstrate that site soil matrix is not impacting data quality results at these low levels, but these steps were not taken early in Phase 1 on a consistent, per sample batch basis. Thus, it was not demonstrated that the data generated at these low levels was not affected by site soil matrix, in terms of quality control. There is some concern over defensibility of data quality without this demonstration.

After a thorough review of the low-level MRL procedures and results, and in order to address the unacceptable analytical uncertainty associated with the method modification, Phase 1 MRLs will be adjusted to the laboratories standard routine MRLs. For Phase 1 existing data, non-detects will be adjusted (elevated) to the standard routine MRL and will continue to be considered as non-detect values. The detected results will not change, but will be qualified as estimated values if the result is between the laboratories standard routine MDL and MRL. Only MRL values have been changed. MDL values will remain the same. A "Y" qualifier will also be added to all data where the MRLs were adjusted. These adjustments have been made for purposes of generating a dataset to be used for screening against the look up table, and the adjustments will be documented and made available to the public (see Appendix E). For future characterization sampling, it was proposed (Appendix E) that analyses using these methods (pesticides, PCB/PCTs and herbicides) utilize standard analytical MRLs. Thus, the Phase 3 chemical data gap sampling utilized standard analytical MRLs, as recommended. If the low level MRLs are to be utilized in the future, a low level quality control program is recommended and should be utilized on a per sample batch basis to demonstrate that the data meet acceptable data quality criteria.

Appendix E provides the documentation supporting the low level reporting limit evaluation and reporting limit adjustment procedures.

5.9 Miscellaneous Data Revisions

Based on the high degree of quality of the analytical laboratories procured for the co-located sampling activities and the thoroughness of the evaluation/validation of the analyzed data, some data changes were required based on laboratory analytical activities. Often these changes were initiated by the laboratories (or the validation firm) as they had identified certain analytical instrument data reporting procedures that needed to be adjusted. The laboratories notified CDM Smith of the exact situation and provided adjusted results as required. All new updated results were validated and then integrated into the database system. Specific details of these adjustments are identified in Appendix B reports.

5.10 CH2MHill/MWH Data Validation/Evaluation Process

All data collected and analyzed by CH2MHill and MWH were validated. As documented in the RFI Site Reports Laboratory Data Quality documents, data was validated by qualified chemists following EPA guidelines as described in the RFI QAPPs and data validation standard operating procedures. The data validation procedures were based on EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA, 1998) and National Functional Guidelines for Inorganic Data Review (EPA, 1994).

Data were validated at either USEPA Level IV or V by MEC^X. Applicable qualifiers used during the validation process were as follows:

- U – nondetect
- J – estimated
- UJ – estimated nondetect
- N – tentative identification
- NJ – estimated and tentatively identified
- R – rejected

Data that was qualified with U, J, UJ, NJ, or N qualifiers are usable. Data that was rejected are not usable. This data was also additionally annotated with various codes indicating the reason for the validation qualifier. MEC^X reviewed the following items (when applicable) during the Level V validation process:

- Sample management (collection techniques, sample containers, preservation, handling transport, chain-of-custody, holding times)
- Method blank results
- Blank spike and laboratory control sample results

- Surrogate recoveries
- Matrix spike/matrix spike duplicate recoveries and precision
- Laboratory duplicate precision
- Serial dilution precision
- Field quality assurance/quality control sample results
- Other QC indicators as applicable

The following items (when applicable) were reviewed during the Level IV validation:

- Sample management
- Gas chromatography/mass spectroscopy (GC/MS) instrument performance
- Initial and continuing calibration
- Method blank results
- Continuing calibration blank results
- Matrix spike sample results
- Surrogate results
- Laboratory and field QC sample results
- Internal standard performance
- Target Compound identification
- Compound quantification
- Reported detection limits
- Definitive review of raw data

When appropriate, depending on the sampling activities and goals, precision, accuracy, representativeness, completeness, and comparability were also performed. Details of the specific validations performed and data quality of the CH2MHill/MWH data are provided in Appendix A.

Section 6

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Appendix A

Data Tables (on CD)

Appendix B

AOC Phase 1, 2 and 3 Reports, and RFI Reports (on CD)

CDM Smith

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Appendix C

Dioxin TEQ Documentation (on CD)

CDM Smith

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Appendix D

BaP Calculation Documentation (on CD)

Appendix E

Method Reporting Limit Documentation (on CD)

CDM Smith

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Legend

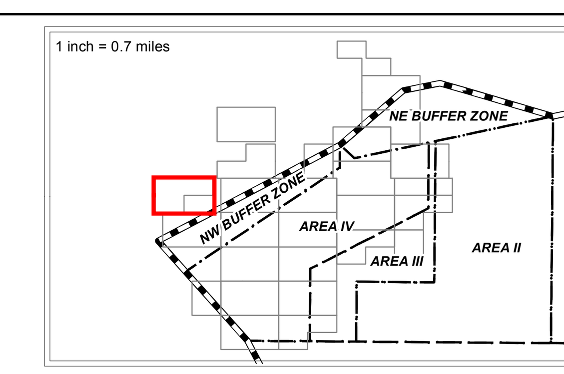
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-1

CDM Smith

Legend

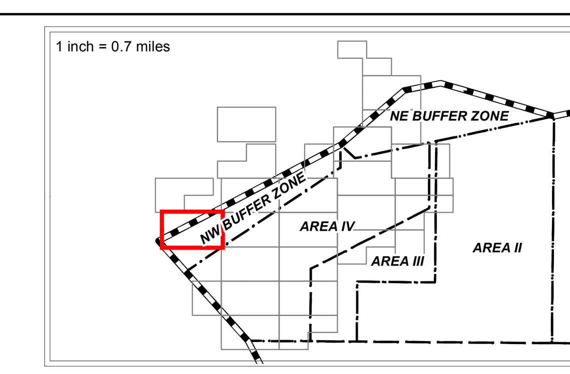
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-2

CDM Smith

N

Legend

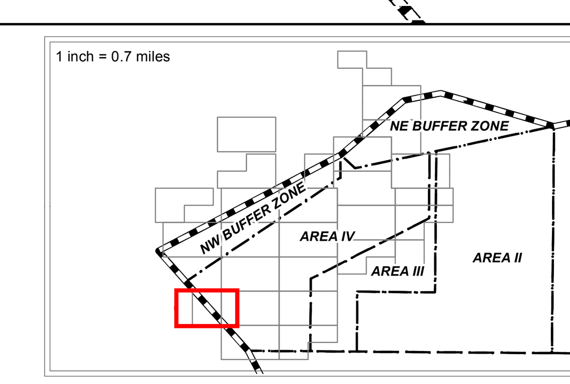
RFI Sample Location
Phased Sample Location
Road Centerline
Drainage
Existing Landfill
Existing Structure
Existing Substation
Former Pond
Demolished Structure
RI Site Boundary
Area Boundary
SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-3

CDM Smith

Legend

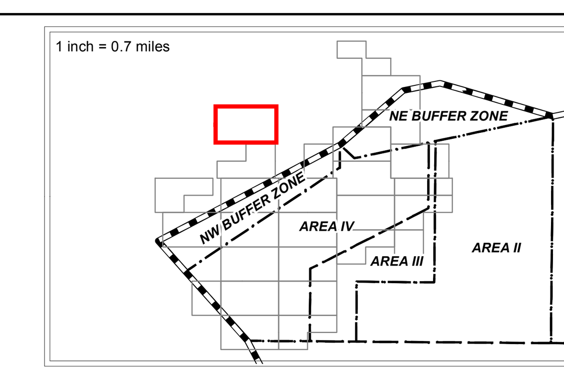
RFI Sample Location	Drainage	Existing Substation
Phased Sample Location	Existing Landfill	Former Pond
Road Centerline	Existing Structure	Demolished Structure
RI Site Boundary	Area Boundary	SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-4

CDM Smith

Legend

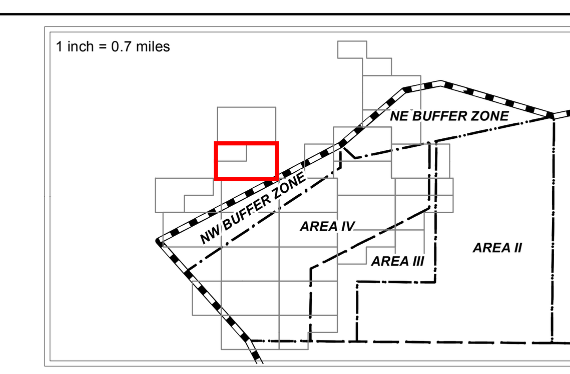
RFI Sample Location	Drainage
Phased Sample Location	Existing Landfill
Road Centerline	Existing Structure
Existing Substation	RI Site Boundary
Former Pond	Area Boundary
Demolished Structure	SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-5

CDM Smith

Legend

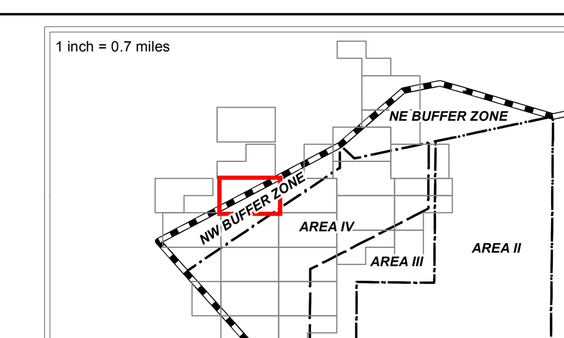
RFI Sample Location	Existing Landfill	Existing Substation
Phased Sample Location	Existing Structure	Former Pond
Road Centerline	Drainage	Demolished Structure
RI Site Boundary	Area Boundary	SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-6

CDM Smith

Legend

- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-7

CDM Smith

Legend

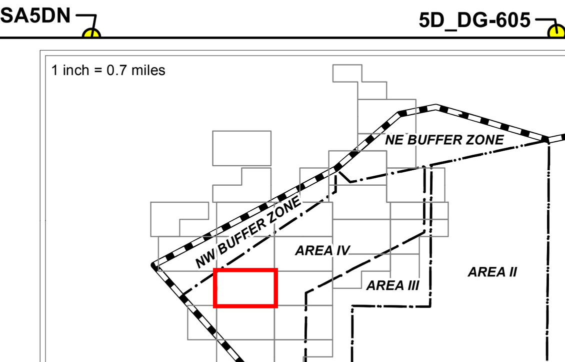
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-8

CDM Smith

Legend

- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-9

CDM Smith

Legend

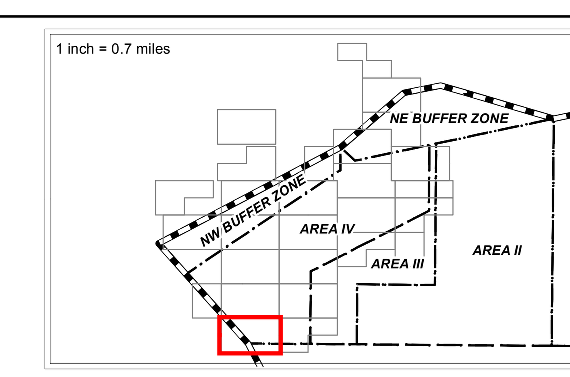
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42.25 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-10

CDM Smith

Legend

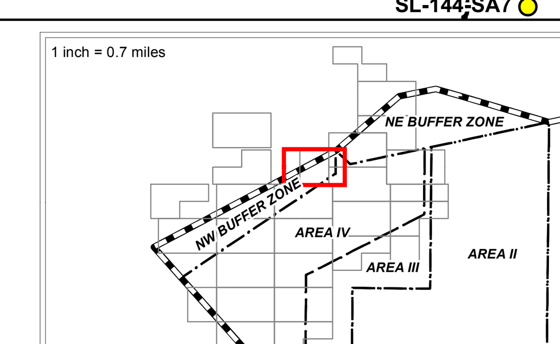
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-11

CDM Smith

Legend

- MWH RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-12

CDM Smith

Legend

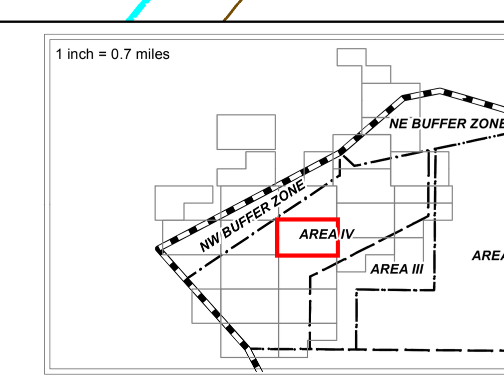
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-13

CDM Smith

Legend

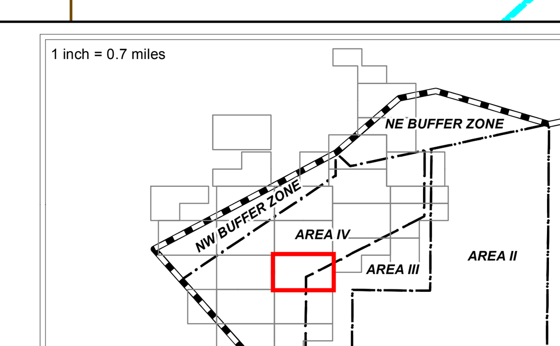
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-14

CDM Smith

N

Legend

- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-15

CDM Smith

Legend

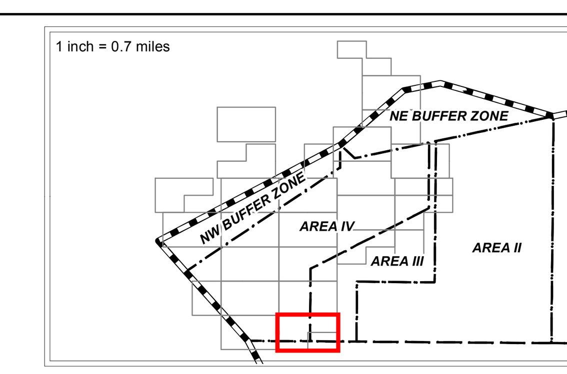
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-16

CDM Smith

Legend

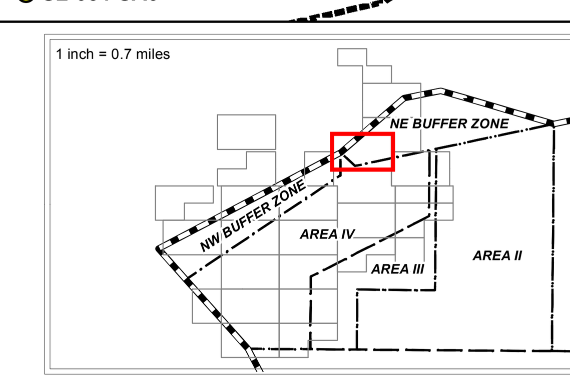
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-17

CDM Smith

Legend

- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-18

CDM Smith

Legend

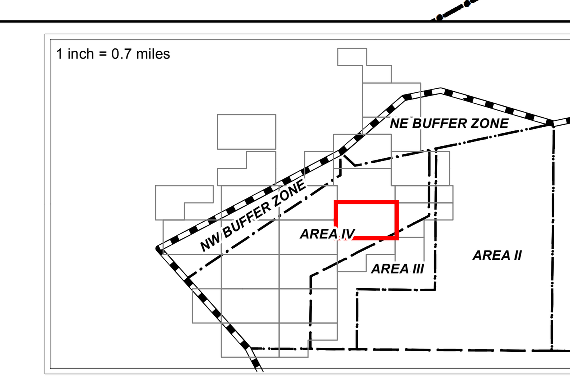
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-19

CDM Smith

Legend

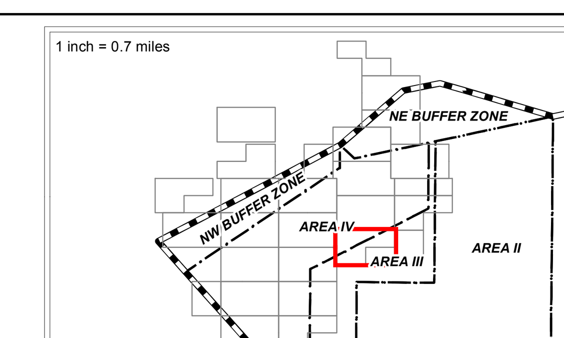
RFI Sample Location	Drainage	Existing Substation
Phased Sample Location	Existing Landfill	Former Pond
Road Centerline	Existing Structure	Demolished Structure
RI Site Boundary	Area Boundary	SSFL Property Boundary

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-20

CDM Smith

Legend

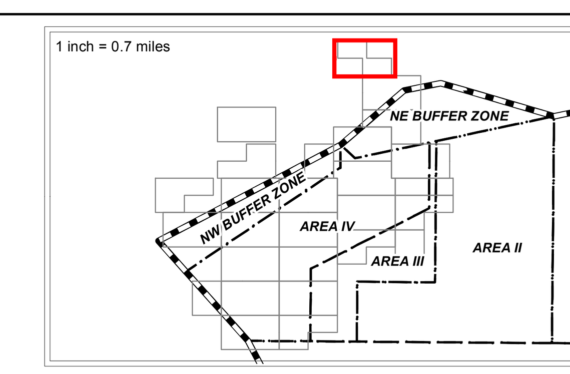
RFI Sample Location	Existing Substation	RI Site Boundary
Phased Sample Location	Existing Landfill	Area Boundary
Road Centerline	Former Pond	SSFL Property Boundary
Drainage	Existing Structure	
	Demolished Structure	

Santa Susana Field Laboratory
Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-21

CDM Smith

Legend

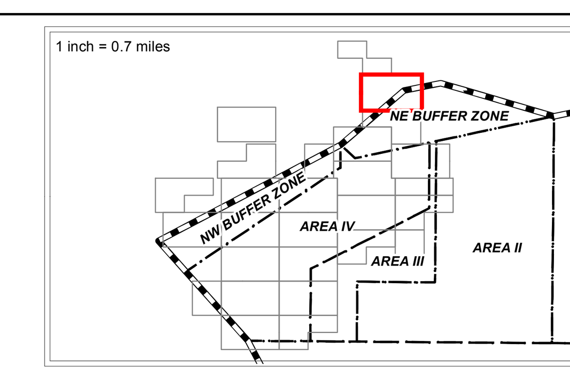
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-22

CDM Smith

Legend

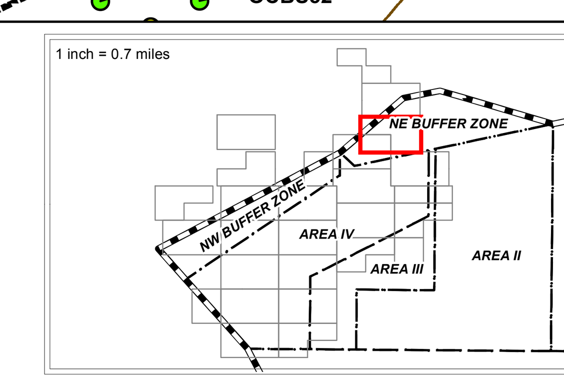
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-23

CDM Smith

Legend

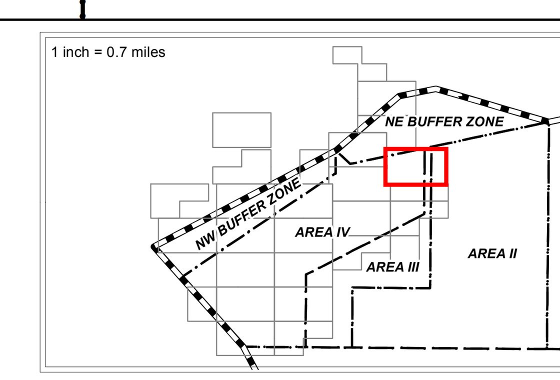
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-24

CDM Smith

Santa Susana Field Laboratory Sample Locations -

Santa Susana Field Laboratory
Ventura County, California

Exhibit A-25

CDM Smith

Legend

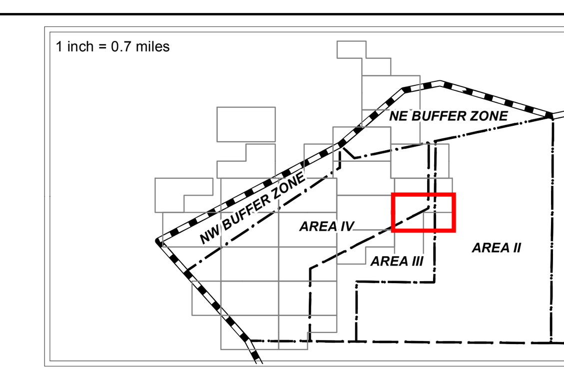
- RFI Sample Location
- Phased Sample Location
- Road Centerline
- Drainage
- Existing Landfill
- Existing Structure
- Existing Substation
- Former Pond
- Demolished Structure
- RI Site Boundary
- Area Boundary
- SSFL Property Boundary

Santa Susana Field Laboratory Sample Locations -

Notes:
- GIS Layers provided by MWH/Boeing.
- Road Centerline Source: Esri, TomTom.

1 inch = 42 feet

0 42 84 126 168 Feet



Santa Susana Field Laboratory
Ventura County, California

Exhibit A-26

CDM Smith