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Via FedEx

June 2, 2017
In reply, refer to SHEA-115691

Mr. Mark Malinowski, P.G.
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Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 95826-3200

Dear Mr. Malinowski:

Subject: *Boeing Site-Wide Groundwater RCRA Facility Investigation (RFI) Report, Santa Susana Field Laboratory, Ventura County, California*

The Boeing Company (Boeing) is pleased to present the attached "*Boeing Site-wide Groundwater RFI Report, Santa Susana Field Laboratory, Ventura County, California*". This document is Boeing's portion of the site-wide groundwater investigation report, which will be incorporated with the DOE and NASA portions and submitted along with the over-arching site wide summary document under a separate cover. If you have any questions regarding this submittal, please contact Mike Bower at (818) 466-8776.

Sincerely,

Michael O. Bower, P.E.
Project Manager
Santa Susana Field Laboratory

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The attached document related to the Santa Susana Field Laboratory (SSFL) project is a DRAFT, submitted to the Department of Toxic Substances Control (DTSC) for review and comment.

DTSC's review of the document is currently in progress. DTSC has not approved the document and revisions may be required.

Currently, DTSC does not approve or endorse the content, conclusions, or proposals in this draft document, nor do we stand by the accuracy of any statements made in the document.

After review, DTSC will release our comments or recommendations in the form of an official letter, which will be posted to the DTSC SSFL website at: http://www.dtsc.ca.gov/SiteCleanup/Santa_Susana_Field_Lab/

If you have any questions related to this draft document, please contact DTSC's SSFL Public Participation Specialist Michelle Banks-Ordone at (818) 717-6573, or michelle.banks-ordone@dtsc.ca.gov.

Boeing Site-wide Groundwater RCRA Facility Investigation Report

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Santa Susana Field Laboratory

Ventura County, CA

June 2017

Prepared for:

THE BOEING COMPANY

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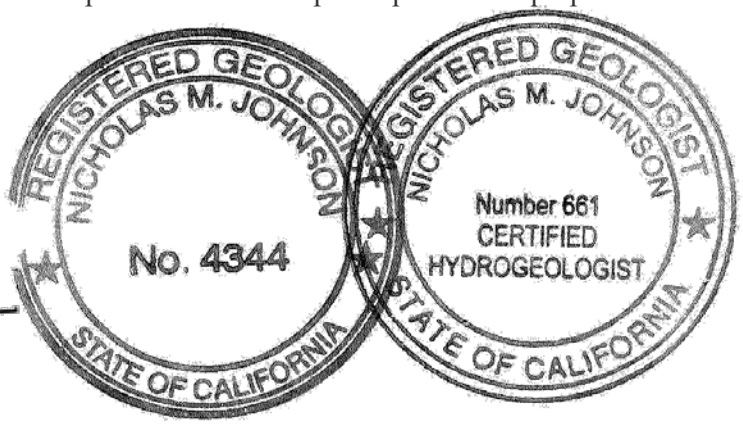


PROFESSIONAL CERTIFICATION

Boeing Site-wide Groundwater RCRA Facility Investigation Report
June 2017
Santa Susana Field Laboratory

This report has been prepared by a team of qualified professionals under the supervision of the senior staff whose seal and signature appears below. The findings, interpretations of data, specifications or professional opinions are presented within the limits of available information at the time the report was prepared, in accordance with generally-accepted professional geology, hydrogeology, and engineering practices and within the requirements of the client. There is no other warranty, either expressed or implied.

Information included in this report is based on available data obtained from public and prívate sources. Additional studies may or may not disclose information that may modify the findings of this report. In the event that there are appreciable changes in the nature and/or design of the project, or if additional subsurface data are obtained, the conclusions and recommendations in the report may require further evaluation by the qualified professionals who participated in its preparation



Nicholas M. Johnson, Ph.D., P.G., C.Hg

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichlorothene
1,2,3-TCP	1,2,3-trichloropropane
1,2-DCA	1,1-dichlorothane

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

2-D	two-dimensional
3-D	three-dimensional
AILF	Area I Landfill
AOC	Administrative Order on Consent
APTF	Advanced Propulsion Test Facility
Area	Administrative Area
B359	Building 1359
bgs	below ground surface
Boeing	The Boeing Company
cDCE	cis-1,2-dichloroethene
CMS	corrective measures study
COC	chemical of concern
CTL	Components Test Laboratory
CUA	chemical use area
DNAPL	dense non-aqueous phase liquid
DOE	United States Department of Energy
DQO	data quality objective
DSFR	Data Summary and Findings Report
DTSC	Department of Toxic Substances Control
ECL	Engineering Chemistry Laboratory
EEL	Engineering Effects Laboratory
ESADA	Empire State Atomic Development Authority
ft	feet
FSDF	Former Sodium Disposal Facility
gpm	gallons per minute
GPS	global positioning system
GWIM	groundwater interim measure
H&A	Haley & Aldrich
HVN	Happy Valley North

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

HVS	Happy Valley South
IEL	Instrument and Equipment Laboratory
ISCO	in situ chemical oxidation
kg	kilogram
LETF	Laser Engineering Test Facility
LOX	Liquid Oxygen (Plant)
mg/l	milligrams per liter
msl	mean sea level
NASA	National Aeronautics and Space Administration
NDMA	n-nitrosodimethylamine
NPDES	National Pollutant Discharge Elimination System
OU	operable unit
PCE	tetrachloroethene
PDU	Process Development Unit (for Coal Gasification)
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	remedial investigation
Rocketdyne	Rocketdyne Propulsion and Power
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
STL	Systems Test Laboratory
STP-3	Sewage Treatment Plant in Area III
SUL	Southern Undeveloped Land
TCE	trichloroethene
tDCE	trans-1,2-dichloroethene
TPH	total petroleum hydrocarbons
UDMH	unsymmetrical-dimethyl-hydrazine
VOC	volatile organic compound

1.0 INTRODUCTION AND BACKGROUND

This site-wide groundwater Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report presents an assessment of the nature and extent chemical impacts to groundwater within The Boeing Company's (Boeing's) areas of responsibility at Santa Susana Field Laboratory (SSFL). Groundwater underlying SSFL has been impacted from historical chemical releases with the primary impacts at the Boeing sites from trichloroethene (TCE) releases. Environmental characterization and remedial activities are overseen by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). This groundwater RFI report is being submitted pursuant to the 2007 Consent Order for Corrective Action, Docket No. P3-08/003 and presents findings of work performed to address comments by DTSC to the previously submitted *Draft Site-Wide Groundwater Remedial Investigation (RI) Report* (*Draft Groundwater RI Report*, MWH, 2009b). As such, this RFI report presents additional groundwater characterization activities completed since the *Draft Groundwater RI Report* including investigations of geologic, hydrogeologic and contaminant conditions.

The SSFL property is located approximately 29 miles northwest of downtown Los Angeles, California, in the southeast corner of Ventura County (Figures 1-1 and 1-2). The SSFL property is owned by Boeing and the federal government (administered by the National Aeronautics and Space Administration [NASA]), and has been divided into four administrative areas that include Areas I through IV, and two undeveloped areas known as the Northern Undeveloped Land and the Southern Undeveloped Land (SUL). Areas I and III are operated by Boeing, which owns the majority of Area I and all of Area III, as well as the Northern and SULs. A portion of Area I (about 40 acres), and all of Area II are owned by the federal government (administered by NASA) and formerly operated by Boeing for NASA. The land within Area IV is owned by Boeing and the United States Department of Energy (DOE) leased about 90 acres. Developed areas of the facility include roads, buildings, and other infrastructure associated with its past use as a scientific research and test facility, which operated from the late 1940s until 2006. As industrial operations at SSFL have ceased, current activities at the site include environmental monitoring and sampling, storm water management, and remediation planning. Boeing's areas of responsibility for groundwater characterization have been agreed to amongst Boeing, NASA, and DOE, and are shown in Figure 1-3[1]. Groundwater conditions at SSFL related to contaminants have been investigated since about 1984 and are characterized

[1] Further references to characterization of environmental media throughout this report apply to the areas shown and identified in Figure 1-3.

through a series of more than 500 monitoring points, the locations of which are shown in Figure 1-4, along with the interpreted elevation of first groundwater from measurements collected in October 2016.

This RFI report has been prepared to present a complete characterization of findings in Boeing's areas with insight from the SSFL Groundwater Advisory Panel (Groundwater Panel) on behalf of Boeing. The Groundwater Panel was formed initially by Rocketdyne Propulsion and Power (Rocketdyne) in 1997 to provide advice and guidance concerning investigations of the distribution and transport and fate of chemicals in bedrock beneath SSFL. Since then, the Groundwater Panel has been intimately involved in the bedrock characterization program as evidenced through their involvement through field-based research and other characterization work plans and reports. The Groundwater Panel is currently comprised of Dr. John Cherry, Distinguished Professor Emeritus, Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Ontario and Dr. Beth Parker, Professor and Natural Sciences and Engineering Research Council Industrial Research Chair in Fractured Rock Contamination Hydrology, School of Engineering, University of Guelph, Guelph, Ontario and formerly of the University of Waterloo (1996-2006).

The following sections provide additional background related to groundwater characterization and describe the purpose and scope of work performed.

Regulatory Framework

The RCRA Corrective Action program at SSFL began with the *RCRA Facility Assessment (RFA)* in 1989. The RFA was completed in 1994 (Science Applications International Corporation, 1994) and was followed by the RFI, which commenced in 1996 with oversight by DTSC. In 2007, DTSC issued a *Consent Order* that identified the RCRA corrective action requirements for SSFL to be implemented by Boeing, DOE, and NASA. For corrective action, the *Consent Order* (DTSC, 2007) identifies two Operable Units (OUs) for investigation purposes. The OUs at SSFL are schematically depicted in Figure 1-5 and described as follows:

- The Surficial Media OU comprises saturated and unsaturated soil, sediment, surface water, near-surface groundwater, air, biota, and weathered bedrock[2]. Near-surface groundwater is groundwater that occurs within the alluvium or weathered bedrock.

- The Chatsworth formation OU comprises the Chatsworth formation aquifer, and both saturated and unsaturated unweathered (competent) bedrock.

In 2010, DOE and NASA signed Administrative Orders on Consent for Remedial Action (AOCs) with DTSC that govern characterization and remedial action activities for soil in portions of SSFL in which their operations occurred (DTSC, 2010a and 2010b, respectively). The DOE AOC includes Area IV and the Northern Undeveloped Land (also known as the Northern Buffer Zone), and the NASA AOC includes Area II and a 40-acre parcel of Area I, where the Liquid Oxygen (LOX) Plant was formerly located. The characterization and cleanup of soil in these areas are regulated by the AOCs. Characterization and clean-up of affected environmental media not subject to the AOCs (e.g., groundwater, air, biota) are regulated by the 2007 Consent Order.

Boeing is completing the RCRA Corrective Action Program, including preparing this *Site-Wide Groundwater RFI Report*, in accordance with the 2007 *Consent Order*. Due to the 2010 DOE and NASA AOCs, and with DTSC concurrence, Boeing is completing the Corrective Action Program using 'subarea' designations. The portions of land that are not subject to the DOE or NASA AOCs (that is, Areas I and III and the SUL) were reorganized into nine Boeing RFI subareas in 2013. Each Boeing Subarea comprises two to four RFI sites, with the exception of Boeing RFI subarea 10, As presented on Figure 1-3, the nine Boeing subareas include: 1A North, 1A Central, 1A South, 1B North, 1B Southeast, 1B Southwest, 5/9 North, 5/9 South, and 10. Additionally, Boeing has agreed to complete groundwater characterization at eight RFI Sites within Area IV per the Consent Order designations. Table 1-1 provides a summary of Boeing subareas and RFI sites.

Recent data gap analysis and investigations have been performed for the RFI at each of these Boeing subareas and at Boeing Area IV RFI sites in accordance with the *Master RFI Data Gap Work Plan* (CH2M HILL, 2013a), the *Master Data Gap Work Plan Addendum* and *Amendment for Boeing Area IV Groundwater Evaluation* (MWH, 2015d and 2016a), and the *Comprehensive Data Quality Objectives*

[2] Weathered bedrock at the SSFL is considered the lithological profile of rock that meets the definition of W7 through W8, as described in Table 4-4 of the United States Bureau of Reclamation Engineering Geology Field Manual (1998), and is above the first-encountered saturated zone.

(DQO) Report (CH2M HILL, 2013b). As required by the 2007 *Consent Order*, Boeing is preparing RFI reports for DTSC's review and approval to present the results of the RFI for all media. These documents, called *RFI Data Summary and Findings Reports* (DSFRs), provide RFI sampling results and recommendations for further evaluation in the RCRA corrective measures study (CMS) for the vadose zone (i.e., unsaturated soil and bedrock of both operable units) and groundwater. The DSFRs, in conjunction with future risk assessment reports and this *Boeing Site-Wide Groundwater RFI Report*, will represent the completion of the RFI in accordance with the 2007 *Consent Order* once approved by DTSC.

1.1 HISTORY OF GROUNDWATER CHARACTERIZATION AND REPORTING ACTIVITIES

A *Draft Groundwater RI Report* (MWH, 2009b) was previously prepared and submitted to complete an assessment of the nature and extent of site-related chemicals and radionuclides in groundwater and the unsaturated bedrock and to forecast both their short- and long-term transport and fate in these media. The *Draft Groundwater RI Report* used data collected throughout SSFL's characterization history and was supplemented by work performed in accordance with a *Site-Wide Groundwater Characterization Work Plan* (MWH, 2008) and additional work to fill data gaps identified during review of available data or to further reduce uncertainties related to the characterization of groundwater underlying SSFL. A *Data Gap Sampling and Analysis Plan (Data Gap SAP, MWH, 2010)* was prepared and submitted to address data gaps identified during preparation of the *Draft Groundwater RI Report*.

DTSC submitted comments to the *Draft Groundwater RI Report* in a letter dated December 21, 2011 and an appendix subsequently submitted on January 3, 2012 (DTSC, 2011b). A total of 122 comments were provided. Following receipt of DTSC comments, a meeting was held on January 17, 2012 with DTSC and SSFL representatives. During this meeting, it was agreed that a series of technical meetings would be held to address six broad categories of comments. The six categories of comments received are provided below and detailed in a March 19, 2012 letter from Boeing (Boeing, 2012).

- Contaminant Source Area and Plume Characterization
- Work that was already underway, i.e., work identified in the *2010 Data Gap SAP*
- Ongoing seep evaluations
- Fault studies

- Groundwater flow model revisions
- Plume visualization/contaminant transport modeling

DTSC approved the above proposed framework in an email dated March 22, 2012. Numerous studies and evaluations have been prepared in accordance with the above framework to support groundwater characterization, monitoring, and treatability/ remediation activities. Groundwater characterization work performed to address DTSC's comments on the *Draft Groundwater RI Report* are fully described in Section 3 of this report. Since 2013, NASA, DOE, and Boeing have been implementing separate groundwater characterization activities within their areas of responsibility.

1.2 SCOPE, PURPOSE, AND CONTENT

The general scope of this report is to supplement the RFI site *DSFRs* by presenting a summary of chemical impacts to groundwater along with a description of the extent of groundwater impacts at concentrations above characterization levels. Its general purpose is to fulfill additional requirements established by DTSC (2014).

1.2.1 Scope

This groundwater *RFI report* includes results for groundwater present in both the Surficial OU (i.e., that present in the alluvium/colluvium and/or weathered bedrock) and the Chatsworth formation (i.e., that present within the unweathered bedrock). Groundwater present within both OUs has been combined in this report since the groundwater present within the alluvium and/or weathered bedrock flows into, or is continuous with (i.e., not separated by a vadose zone) groundwater in the unweathered bedrock. This report includes both historical results and results of data collected since the *Draft Groundwater RI Report* and presents findings from studies and activities completed by Boeing as described in Section 3. This report carries forward work performed as part of an additional comprehensive effort to identify old releases of chemicals from historical facilities/operations or sources in soil and bedrock that are interpreted to have impacted groundwater based on evaluations of environmental media sampling results (see methods presented in *Comprehensive Data Quality Objectives Report*, CH2M Hill, 2013b). This report summarizes results of detailed evaluations of groundwater impacts conducted at various geographic scales within and beyond Boeing's RFI sites at SSFL. Detailed groundwater evaluations are presented in *DSFRs* for each RFI site, most of which are being prepared as of the date of this report.

1.2.2 Purpose

The purpose of this *site-wide groundwater RFI report* is to provide a summary assessment of the nature and extent of site-related impacts to groundwater. The vast majority of the characterization work conducted at SSFL has been performed under the RCRA Corrective Action program, as implemented in the 2007 Consent Order for Corrective Action, Docket No. P3-08/003. This *RFI report* was prepared to fulfill the requirements established in the Consent Order (DTSC, 2007) and in accordance with DTSC's comments on the *Draft Groundwater RI Report* and its 2014 letter regarding groundwater characterization (DTSC, 2014).

1.2.3 Content

This report includes seven additional sections, with a summary of each provided below.

- Section 1 Introduction – describes the content of the report and its principal bases.
- Section 2 Site Setting and History – provides general background information at SSFL and within Boeing's areas of responsibility. It also includes a chronological overview of the history of the groundwater characterization program at SSFL conducted by Boeing.
- Section 3 Description of Work Performed – provides a description of work performed by Boeing to characterize geology, hydrogeology, sources, and groundwater impacts in association with various work plans since issuance of the *Draft Groundwater RI Report*.
- Section 4 Geologic Setting – presents a summary of the geology of SSFL. Both regional and site-specific information are included with updated information gathered during fault mapping and reporting conducted since the *Draft Groundwater RI Report*.
- Section 5 Hydrogeology – presents a summary of the hydrogeology of SSFL, with a specific focus on Boeing's areas. Both regional and site-specific information are included with updated interpretations based on data collected since the *Draft Groundwater RI Report*.
- Section 6 Nature and Extent of Chemicals in Groundwater – presents a summary of chemical use areas and summarizes the approach used to identify sources in soil and bedrock that have

impacted groundwater. This section describes the areal extent of chemical impacts to groundwater.

- Section 7 Summary and Conclusions – presents a brief summary of the groundwater RFI along with key conclusions.
- Section 8 References – presents a list of the supporting documents referred to in this report.

2.0 SITE SETTING AND HISTORY

Sandstone rock outcrops of the Chatsworth formation form a prominent and visually stunning setting at SSFL. The site also has a long and storied history, playing a featured role in the development of America's space program as relates to propulsion systems.

2.1 SETTING

The SSFL occupies approximately 2,850 acres of hilly terrain that expresses approximately 1,100 feet of topographic relief near the crest of Simi Hills. The highest surface elevation at SSFL occurs near the center of the property within Boeing Subarea IB North at an approximate elevation of 2,245 feet above mean sea level (msl), along two ridges that trend northeast-southwest. The lowest elevation occurs at the eastern property boundary in Dayton Canyon within Boeing Subarea 10 and has an elevation of approximately 1,175 feet above msl. The lower elevations at SSFL occur primarily along the eastern, southern, and north-central to northwestern perimeters of the property. A broad, relatively flat area of topography exists within the southern portion of Area IV and is referred to as Burro Flats. Figure 2-1 shows SSFL's topography.

The geologic units within SSFL are predominantly bedrock of the Chatsworth formation, with smaller areas of the Santa Susana, Simi Conglomerate, Las Virgenes, and Calabasas Formation sediments (Yerkes and Campbell, 2005). All are composed mostly of sandstone with some siltstone, shale, and conglomerate sections. The rocks at and in the vicinity of SSFL have undergone folding and faulting since deposition. Alluvial/colluvial sediments have accumulated over approximately 11 percent of SSFL, generally limited to topographic lows and ephemeral streams, and in Burro Flats. Information on the geology and groundwater at SSFL, including the occurrence of groundwater seeps[3], are described in later sections of this report (Sections 4.0 and 5.0, respectively).

Vegetation at SSFL is composed of various coastal sage scrub and chaparral plant communities, oak woodland, mulefat scrub, and annual grassland. Substantial portions of SSFL are located within areas of exposed bedrock or previously developed areas with little or no vegetation, in particular, where paved and

[3] Subsequent references to seeps in this report refer to locations where groundwater discharges at the ground surface within and beyond the perimeter of SSFL. The "seeps" term is used in this report because the actual discharge of groundwater at the ground surface at and in the vicinity of SSFL at most times is low. These discharges most visually appear to "seep" from the ground as opposed to higher rates of discharge that can more accurately be described as a spring. However, groundwater discharge at the ground surface seasonally varies based on rainfall, runoff, and evapotranspiration. As such, a single location can exhibit spring-like and seep-like discharge depending these variables.

unpaved roads are maintained or various structures are present. Other portions of SSFL have undergone demolition, interim cleanup actions, and restoration activities including hydroseeding, and in some locations, replanting with native species.

Numerous ephemeral stream channels and drainages are present at SSFL. Most surface water is intermittently present only during the winter rainy season and is conveyed offsite via one of four natural drainage areas: Northwestern, Northern, Happy Valley, and South. Precipitation averages over 18 inches per year and nearly all is rainfall. The majority of the rainfall runoff from SSFL flows across the southern property boundary through drainages into what ultimately becomes the headwaters of the Los Angeles River. As such, most surface water that flows through Boeing's RFI sites within Areas I, III, and IV drain to the south, with a small portion in Areas I and IV draining to the north. Operational water from cooling and rinsing during historical rocket engine testing and extracted groundwater was historically discharged to the southern drainages (Figure 2-1), which are monitored as required by a *National Pollutant Discharge Elimination System (NPDES) permit*. Boeing has implemented storm water management systems to capture storm water runoff for onsite treatment using both active and passive/natural treatment systems, prior to discharge through NPDES monitoring locations.

There are seven surface water ponds within SSFL, as shown on Figure 2-1. These ponds are identified as the R-1 Pond, Perimeter Pond, two R-2 Ponds (R-2A and R-2B), Silvernale Reservoir, Sodium Reactor Experiment (SRE) Pond, and Coca Pond. In addition to these ponds, there is surface water contained within the Building 4056 excavation feature. Of these surface water bodies, the R-1 Pond, Perimeter Pond, Silvernale Reservoir, and SRE Pond are located within Boeing's areas. Except for Silvernale Reservoir these ponds are typically dry most of the year, but can contain surface water for short periods during the winter rainy season. Silvernale Reservoir is also largely dry through much of the year, although surface water can sometimes persist in a small portion of the pond year-round.

2.2 HISTORY

The primary site activities at SSFL since its opening in 1948 have been research, development, and testing of liquid-fueled rocket engines and associated components, and small nuclear reactor research within a 90-acre portion of Area IV. The vast majority of rocket engine testing and ancillary support operations occurred from the 1950s through the early 1970s for the federal government. Boeing acquired land at SSFL

in 1996 through its acquisition of Rocketdyne, which it has subsequently divested. A summary of key events in SSFL's history is presented in Table 2-1.

2.2.1 Site History Relative to Groundwater Characterization

Boeing's areas for groundwater characterization include 29 RFI sites: 21 RFI sites in nine subareas in Areas I and III, and eight RFI sites in parts of Area IV as shown in Figure 1-3. Operations included primarily liquid-fueled rocket engine and component testing with various support facilities including testing or production laboratories, storage areas, surface water ponds, maintenance areas, and waste disposal or treatment locations. Review of available records indicates that there were no operational or waste disposal activities conducted in Subarea 10 (SUL). Historical operations at each RFI site are summarized in Table 2-2. Numerous sampling programs and investigations of environmental media have been conducted at SSFL to determine the nature and extent of chemicals of concern (COCs). A visual chronology of the groundwater characterization program is shown in Plate 2-1 and a written description of the groundwater characterization chronology as of 2009 is provided in Appendix 2-A of the *Daft Groundwater RI Report*. Groundwater characterization work performed since 2009 is discussed in the following section.

3.0 WORK PERFORMED TO COMPLETE GROUNDWATER RFI

As summarized in Section 1.1, work performed to supplement the body of knowledge that existed at the end of 2009 regarding groundwater characterization included two primary efforts: implementation of the 2010 *Data Gap SAP* and implementation of plans developed in response to DTSC's comments on the *Draft Groundwater RI Report*. Furthermore, remediation technology field experiments (e.g., in situ chemical oxidation) and groundwater interim measure activities provide insight regarding groundwater characterization and contaminant transport. Groundwater characterization has also been supported by various community outreach events. Summary descriptions of work performed for each effort are provided in the following sections.

3.1 2010 DATA GAP CHARACTERIZATION

The *Draft Groundwater RI Report* presented data gaps across all SSFL. The *Data Gap SAP* presented a specific plan for conducting field investigations to fill identified data gaps related to the Happy Valley and Burro Flats Faults, potential groundwater impacts from releases at a few RFI sites, and collection and analysis of samples from existing monitoring wells and groundwater seeps. The following work was performed in for Boeing in accordance with the *Data Gap SAP*:

Area I

- Trenches were excavated across segments of the Happy Valley Fault (MWH, 2011a).
- A corehole was drilled along the Happy Valley Fault and rock core samples were collected and analyzed for 11 VOCs. A Westbay multi-level monitoring system was installed (RD-103).
- An aquifer test was completed along the Happy Valley Fault, using RD-10 as an extraction well (MWH, 2014c).
- Source zone characterization wells RD-99 (at Components Test Laboratory-V [CTL-V] RFI site) and RD-100 (at Area I Burn Pit RFI Site) were drilled and rock core was collected and analyzed for 11 VOCs.
- Although not associated with the *Data Gap SAP*, two wells were installed in early 2010 in response to DTSC requirements for further evaluation of groundwater conditions as part of the regulated-unit monitoring program. RS-33 and RS-35 were installed near the surface

impoundments under post-closure care at the Systems Test Laboratory (STL)-IV and Advanced Propulsion Test Facility (APTF) RFI sites, respectively.

Area III and Southern Undeveloped Land

- Trenches were excavated across segments of the Burro Flats Fault (MWH, 2011b).
- Four sets of vertically-discrete seep cluster wells were installed on-site in the southwest drainage (Pierce et al., 2015).

Area IV

- A pair of coreholes were drilled at the Sodium Reactor Experiment (SRE) RFI site (RS-36/RD-102). Rock core samples were collected and analyzed for 11 VOCs. The two coreholes were completed as monitoring wells.

All Areas Above

- Samples were collected from more than 50 groundwater monitoring wells to fill data gaps targeting a focused set of analytes. This work supplemented sampling and analysis conducted under the regulated-unit and site-wide groundwater sampling and analysis programs (Haley & Aldrich [H&A], 2010a and b).

Locations of wells installed as described above are shown in Figure 3-1 and drilling logs and well completion diagrams are provided in Appendix 3-A. Trenching logs were provided in the referenced deliverables previously transmitted to DTSC. Reports of rock core sampling and analysis are provided in Appendix 3-B. Borehole geophysical logs were collected from select wells and are provided in Appendix 3-C.

3.2 CHARACTERIZATION TO ADDRESS DRAFT GROUNDWATER RI REPORT COMMENTS

Data gap analysis and investigations to address DTSC's comments (DTSC, 2011b; 2012a) on the *Draft Groundwater RI Report* were completed in accordance with various work plans that were reviewed and approved by DTSC; the general approach for work plan development is shown in Figure 3-2. Work plans were prepared to address the groupings of DTSC's comments, which included:

- Contaminant source zones and plumes,
- Seeps and springs,
- Faults,
- Three-dimensional groundwater flow model, and
- Plume Visualization/Contaminant transport.

Descriptions of the work performed for each major heading are summarized in subsections that follow.

3.2.1 Source Zone and Plume Characterization

Characterization of potential sources in soil and major inputs that have impacted bedrock and groundwater were performed at various RFI sites in accordance with the *Master RCRA Facility Investigation Data Gap Work Plan, Santa Susana Field Laboratory, Ventura County, California* (Master RFI Data Gap Work Plan) (CH2M HILL, 2013a) and the *Comprehensive Data Quality Objectives Report, RCRA Facility Investigation, Santa Susana Field Laboratory, Ventura County, California* (DQO Report) (CH2M HILL, 2013b) for Areas I and III and in the Southern Undeveloped Land. Characterization work for Boeing in Area IV were performed in accordance with *Master RCRA Facility Investigation Data Gap Work Plan Addendum, Boeing Area IV Groundwater Evaluation* (MWH, 2015d) and *Amendment* (MWH, 2016a) and *Field Sampling Plan Boeing, Area IV Groundwater Evaluation* (MWH, 2016b). Completion of the RFI for each Boeing subarea is documented in separate *Data Summary and Findings Reports* that include investigations of all environmental media at the RFI site. A subarea typically includes a grouping of two to four RFI sites and adjacent unaffiliated areas. A summary of the work performed to characterize sources and plumes for each administrative area follows.

Area I

- Six source zone wells were installed between 2013 and 2015 at various RFI sites: RD-109 and C-19 at APTF, RD-110 at Happy Valley North (HVN), RD-119 at CTL-III, RD-129 at Area I Landfill, RD-130 at B-1, and RD-131 at Instrument and Equipment Laboratory (IEL). RD-109 and C-19 were drilled and rock core was collected and analyzed at approximately one-foot intervals for VOCs to evaluate potential dense non-aqueous phase liquid (DNAPL) inputs at

APTF. C-19 was drilled in close proximity to RD-109 using an experimental hydra-core drilling method.

- Three plume characterization wells were installed in 2013/14 to characterize contaminant transport from the Happy Valley North (RD-121) and from Canyon (RD-108 and RD-120) RFI sites, the latter two were positioned further east along the Happy Valley Fault.

- Four additional plume characterization wells were installed in 2016 (RD-146 through RD-149) to evaluate potential preferential contaminant transport along faults; these are further described below in section 3.2.3.

Area III

- Five source zone wells were installed between 2013 and 2015 at various RFI sites as follows: RS-37 at Engineering Effects Laboratory (EEL), RS-38 and RS-41 at Compound A Facility, RS-39 at Silvernale, and RS-40 at STL-IV.

Area IV

- Six source zone wells were installed in 2016 at various RFI sites as follows: RD-150 at Empire State Atomic Development Authority (ESADA), RD-151 at Pond Dredge, RD-152 at Boeing Area IV Leachfields, RD-153 at EEL, and RD-154 and RD-155 at New Conservation Yard (EEL).

- One plume characterization well (RD-156) was installed near Building 100 in Area IV.

Well locations are shown in Figure 3-1. Drilling logs and well completion diagrams are provided in Appendix 3-A. Reports of rock core sampling and analysis are provided in Appendix 3-B. Borehole geophysical logs were collected from select wells and are provided in Appendix 3-C.

All Areas Above

- Samples were collected from a number of groundwater monitoring wells to fill data gaps targeting a focused set of analytes. This work supplemented sampling and analysis conducted under the regulated-unit and site-wide groundwater sampling and analysis programs (H&A, 2010a and b).

3.2.2 Seep Investigations

Beginning in 2011, two types of portable continuous core drilling equipment were used to drill coreholes and install clusters of small-diameter monitoring wells near 16 seep locations and one phreatophyte location. Up to five wells per cluster were advanced to a maximum depth of 55 feet below ground surface (bgs); a total of 53 seep cluster wells were installed. Forty-two of these seep cluster wells were sampled and analyzed for volatile organic compounds (VOCs), perchlorate, inorganics, metals, and stable and radioactive isotopes. The other 11 seep cluster wells were dry or yielded insufficient water for sampling (Pierce et al., 2015). In a subsequent study led by California State University, East Bay, 19 seep cluster wells and 22 conventional SSFL monitoring wells were further sampled using specialized methods. Samples were analyzed at the Environmental Radiochemistry Laboratory at Lawrence Livermore National Laboratory for groundwater age tracers including tritium, dissolved helium isotope ratio, and dissolved noble gases, to provide insight into the age, source, and recharge conditions of SSFL groundwater (Lawrence Livermore National Laboratory, 2014).

A field effort undertaken in summer and fall of 2013 involved revisiting groundwater seeps previously identified to note changes in conditions since the prior visit, and reconnaissance of areas not previously examined. Additional reconnaissance was performed in December 2013 and fall 2014. The mapped seep locations were refined using a combination of global positioning system (GPS) technology and aerial photographs. Twelve new seeps were identified, bringing the total number of verified seep locations at and surrounding SSFL to 165. Seep fact sheets were created for the twelve newly identified seeps, and existing seep fact sheets were updated based upon observations made during the 2013-2014 reconnaissance work (Pierce et al., 2015). Water samples were collected from eight seeps during this field effort and analyzed for various combinations of VOCs, perchlorate, inorganics, metals, dissolved gases, and stable and radioactive isotopes.

3.2.3 Fault Characterization

Additional field mapping and shallow trenching (also mentioned in 3.1 above) were performed to further characterize certain fault strands, and to allow inspection of the bedrock for characteristics providing insight into the nature of fault structures. Between two and five trenches were excavated across the: 1) southern branch of the Happy Valley Fault in Area I near well RD-103, 2) Burro Flats Fault in the Southern Undeveloped Land southeast of well WS-9A, and 3) Former Sodium Disposal Facility structures (photo lineaments not classified as faults) in Area IV north and northwest of Building 100 (MWH, 2011a, 2011b,

2013). The trenches were up to 119 feet in length and extended to a depth of up to 18 feet. Further field mapping and interpretation of faults and fractures with a focus on Area I were performed by a team from Stanford University (Aydin & Cilona, 2015; Cilona et al., 2015; Cilona et al., 2016).

Personnel from the University of Kansas and Kansas Geological Survey performed an active-source, two-dimensional (2-D) pilot seismic study to assess the effectiveness of high-resolution seismic methods for imaging faults, fractures, complex subsurface structures, and stratigraphy at SSFL (Tsoflias, 2014, 2015). 2-D seismic data were acquired along three profiles with a total length of approximately 7,200 feet, with complementary ultra-shallow ground-penetrating radar acquired along the same profiles. Two of the profiles were along strike to the Shear Zone Fault (northeast-southwest), and the third profile was oblique to the Shear Zone Fault (east-west). The survey lines crossed four additional faults: the Woolsey Canyon, IEL, North, and CTL Faults.

A 31-day pumping test was conducted in the vicinity of the Happy Valley Fault in Area I to evaluate the potential hydrogeologic influence of the fault zone on groundwater movement across and along its strike (MWH, 2014c). Groundwater from RD-10 was withdrawn at a rate of nearly 30 gallons per minute while water levels were monitored using data logging pressure transducers in 28 discrete monitoring intervals in 14 observation wells within approximately 2,400 feet of the pumping well. Water levels were monitored for more than nine months spanning a timeframe before, during, and after the test.

The University of California Santa Cruz further investigated the hydrogeologic architecture of SSFL fault zones using water level tidal response (Xue and Brodsky, 2016). Water level data were collected from 35 monitoring wells over a period of about 7 months using high-frequency, high-precision data logging pressure transducers, and evaluated for responses to earth tides. The data from wells found to exhibit a large tidal signal were further evaluated using a cross-spectrum analysis method, and by applying a tidal response model to quantify hydrogeologic properties. Earth tide analysis methods were also applied to transducer data collected before, during and after the RD-10 pumping test described above, and using data collected from a 2003 pumping test where groundwater was withdrawn from C-1 (Allegre et al., 2016).

High resolution straddle packer testing methods were used to evaluate hydraulic properties within six SSFL coreholes located within or near fault zones (Quinn et al., 2016a, 2016b). A total of 255 discrete vertical intervals were tested using a variety of methods including rising and falling head slug tests, constant head

step tests, and pumping/recovery tests, with multiple test trials and methods applied at many of the test intervals.

Four groundwater monitoring wells were installed in SSFL Area I at locations specified by DTSC to further investigate the effect of faults on groundwater flow and contaminant transport. These well installations are documented in a technical memorandum presented in Appendix 3-D. Appendix 3-E contains a separate technical memorandum describing drilling details during the installation of RD-146. Westbay multilevel systems were designed and installed in three wells (RD-103, RD-108 and RD-120) within or near the Happy Valley Fault to further assess its nature, as documented in a technical memorandum presented in Appendix 3-F.

Preliminary interpretations of permeability structures for segments of faults and fault zones that cut through Areas I and III, and the Southern Undeveloped Land, were presented in a technical memorandum (MWH, 2014b). All of the above work that provided data or interpretations relevant to the hydrogeologic assessment of SSFL faults were integrated in a comprehensive report characterizing fault hydrogeology (MWH, 2016c).

3.2.4 Groundwater Flow Model Updates

In August 2016, work on three-dimensional (3-D) groundwater flow model was initiated to: address DTSC's comments on the *Draft Groundwater RI Report*, incorporate additional SSFL data collected since 2009, and employ advancements in the modeling software's capabilities. Flow model updates are in progress as of the date of this report and are not required to complete the RFI (DTSC, 2014), so are not discussed further in this report.

3.2.5 Plume Visualization and Transport Assessments

In 2015, work was performed to develop 3-D interpolations of the lateral and vertical extent of TCE and its biological transformation products (MWH, 2015a, 2015b). These 3-D plume visualizations were completed using groundwater data representing two distinct points in time so as to also provide insight into contaminant transport.

3.3 GROUNDWATER GAUGING AND SAMPLING

Water level measurements have been collected at 3-month intervals (quarterly) from monitoring locations identified in the *regulated-unit and site-wide groundwater sampling and analysis plans* (Haley & Aldrich, 2010a and b) since submittal of the *Draft Groundwater RI Report*. Samples from wells have typically been collected semi-annually during the first and third calendar quarters of each year. Samples have been submitted for chemical analysis as specified in the regulated-unit and site-wide groundwater sampling and analysis plans, and supplemented with additional chemical analysis and/or samples from additional wells based on data reviews performed during preparation of the *Draft Groundwater RI Report* and during the source zone and plume evaluations conducted to fulfill data quality objectives. Since 2009, these events have yielded 28 additional comprehensive measurements of groundwater depth and 14 additional sets of groundwater quality measurements related to chemical impacts.

3.4 TREATABILITY STUDIES AND FIELD EXPERIMENTS

Groundwater and bedrock technology treatability studies were performed to provide information during development of the groundwater corrective measures study, which will be initiated after approval of this report. Two field and one laboratory experiments were conducted. The two field experiments include in situ chemical oxidation (conducted by Boeing) and bedrock vapor extraction (conducted by NASA). Boeing's in situ chemical oxidation field experiment was conducted at the IEL RFI site and included installation of two coreholes (C-18 and C-20), drilling of three new wells (RD-105, 106, and -107), and retrofitting of C-10, C-18, RD-105, -106 and -107 with FLUTe or Solinst multi-level monitoring systems (CH2M, 2016). Locations are shown in Figure 3-1. The laboratory field experiment evaluated enhanced biological reduction and was funded by Boeing. Results from these experiments provide insight into groundwater flow and contaminant transport conditions at various scales under closely monitored conditions.

3.4.1 In Situ Chemical Oxidation Field Experiment

An in-situ chemical oxidation (ISCO) field experiment was performed in the northeastern portion of SSFL (Area I), with field work and data acquisition occurring between October 2012 and January 2016 (CH2M, 2016). Well RD-35A was deepened and modified for use as an injection well. Four coreholes and five new multilevel monitoring systems were installed nearby to facilitate monitoring during the experiment.

During the course of the ISCO field experiment monitoring, a total of 75 wells or discrete-interval multilevel system ports were sampled at frequencies that generally ranged from weekly to bimonthly, yielding over 4,000 groundwater samples that were analyzed in the field or laboratory for various combinations of VOCs, permanganate, fluorescein, dissolved metals (potassium and manganese), dissolved boron, anions (bromide, chloride, nitrate, sulfate and bicarbonate), dissolved organic carbon, total organic carbon, total dissolved solids, dissolved oxygen, oxidation-reduction potential, specific conductivity, pH, and temperature.

Before oxidant injection began, a sodium fluorescein dye tracer test was performed to evaluate fracture network connectivity between injection well RD-35A and the surrounding monitoring wells and multilevel system intervals. Injection of fluorescein dye solution was conducted over a 96-hour period from March 5 to 9, 2014, and monitoring for fluorescein was performed periodically through June 4, 2014. The first injection of potassium permanganate solution (oxidant) was initiated on June 9, 2014; this first oxidant injection event also included the addition of potassium bromide to the injected solution to serve as a conservative, non-reactive tracer. A total of seven oxidant injection events were performed, each approximately one week in duration, between June 2014 and February 2015. A total of 6,171 pounds of potassium permanganate in 36,787 gallons of solution were injected during the ISCO field experiment. A post-injection corehole was installed from August 26 to September 2, 2015, to look for evidence of potassium permanganate presence and diffusion into the rock matrix.

3.4.2 Bedrock Vapor Extraction Field Experiment

A bedrock vapor extraction field experiment was conducted by NASA in Area II at the Bravo Test Area RFI Site (CH2M Hill, 2015).

3.4.3 Biostimulation Laboratory Experiment

A laboratory study of enhanced biological reduction (i.e., biostimulation) was conducted at Clemson University with Dr. David Freedman as the principal investigator. The purpose of the laboratory study was to provide information needed to evaluate enhanced biological reduction in the corrective measures study for groundwater. The study was conducted in two phases. Phase I used microcosms prepared with samples of crushed rock and groundwater from Area II of SSFL. Phase II of the study used novel intact rock core microcosms prepared with rock and groundwater from the same area of SSFL. Study objectives included: 1) determining the effect of biostimulation on the rate of TCE reduction; 2) determining if biostimulation

enhances transformation of TCE and *cis*-1,2-dichloroethene (cDCE) via pathways other than reductive dechlorination by quantifying the products formed from carbon-14-labeled (^{14}C) TCE and cDCE, and the extent of $\delta^{13}C$ enrichment; and 3) assessing the effect of biostimulation on transformation of TCE and cDCE within the rock matrix. Objectives 1 and 2 were evaluated during Phase I using crushed rock while objective 3 was evaluated using Phase II intact rock core.

3.5 INTERIM MEASURES

The initial construction of a new groundwater treatment plant was completed in December, 2010. Groundwater interim measure (GWIM) pumps and conveyance piping were installed during May through October, 2015. Well and wellhead modifications at WS-5, for potential use as a treated water injection well, were ongoing as of first quarter 2017.

A series of three potable-water injection tests were conducted during April and May 2014 at SSFL to evaluate the feasibility of injecting treated groundwater as an alternative to surface discharge. Nearly 60,000 gallons of potable water were injected into existing well RD-45C over 19 hours at rates up to 66 gallons per minute (gpm), while water levels were monitored with data logging pressure transducers in the injection well and four nearby wells (MWH, 2015c).

A *Report of Waste Discharge for treated groundwater injection* was prepared and submitted to the Los Angeles Regional Water Quality Control Board in early 2016.

3.6 COMMUNITY OUTREACH

A seven-session community outreach educational series called *SSFL Groundwater University*, or "Groundwater U," was conducted during March through June, 2011. This outreach program consisted of classroom sessions and field trips. The classroom sessions were held at public venues proximal to SSFL, during which experts presented various elements of fundamental hydrogeologic and contaminant transport principles and their application at SSFL. Field trips were conducted where specialized equipment and investigation techniques were presented and discussed at locations where these studies were actually performed. Groundwater U was followed by a series of six periodic public meetings in 2012 through 2014 at both public venues near and at SSFL, during which key work plans and updates on work performed were

presented and discussed. Three "Public Open House" events were conducted at approximately quarterly intervals during 2015.

4.0 GEOLOGY

The Simi Hills and SSFL are located within the eastern-most portion of the Western Transverse Ranges, a southern California physiographic province that extends east-west across the San Andreas Fault zone (Figure 4-1). This province has undergone intense deformation as a result of tens of million years of uplift, folding, and faulting, including about 90 degrees of clockwise rotation approximately 20 million years ago, followed by periods of extension and ongoing north-south compression (Nicholson et al., 1994; Langenheim et al., 2011). For further reference, MWH (2014a) prepared an extensive and illustrated review of the geotectonic setting and evolution of the Simi Hills that is appended to its report on SSFL fault hydrogeology (MWH, 2016c).

4.1 CHATSWORTH FORMATION

The Cretaceous Chatsworth formation is one of the oldest and most extensively exposed units in the Simi Hills and directly underlies most of SSFL (Figure 4-1). It is a roughly 70-million-year-old and greater than 2,000-foot thick composite turbidite sequence of arkosic sandstone interbedded with shale, siltstone, and conglomerate deposited in a mid-submarine-fan, sand-rich environment at water depths between 600 and 3,000 feet (Link et. al., 1984). Fine-grained intervals within the formation represent periods of turbidite fan inactivity.

The boundaries between predominantly coarse- and fine-grained intervals within the Chatsworth formation are diffuse and interbedded, such that defined subunits are generally heterogeneous lithologic packages. In the vicinity of SSFL, defined coarse-grained units are typically several hundred feet thick with discontinuous fine-grained interbeds 5 to 20 feet thick. Named fine-grained units generally contain 50 percent or more interbedded siltstone and shale and range between 20 and 300 feet thick.

The Chatsworth formation contains features typical of turbidite deposition, including thick sediment sequences, soft-sediment deformation, graded and cross bedding, variations in bedding dip and grain size, poor sorting, bioturbation, and scour at the base of beds. Individual sandstone beds range in thickness from roughly an inch to 30 feet or more, but are typically 1 to 5 feet thick. Intervals of stacked sandstone beds with few or no fine grained interbeds typically reach tens of feet thick and may extend laterally for several thousand feet. Coarse-grained beds also include thinner and less extensive lenses of conglomerate that generally are less than several feet thick. Individual fine-grained beds are generally less than 3 feet thick

and usually less than 1 foot thick. Sandstone beds within fine-grained units may be laterally extensive and more than 10 feet thick.

Analysis of core samples indicates that the average mineralogical composition of Chatsworth formation sandstone is 33 percent quartz, 33 percent plagioclase, 20 percent feldspar, and 10 percent phyllosilicate minerals, with about 5 percent lithic fragments. Whereas, fine-grained units average 23 percent quartz, 30 percent plagioclase, 22 percent feldspar, and 18 percent phyllosilicate minerals, with rare lithic fragments. The predominant phyllosilicate minerals are biotite and chlorite (Loomer, 2009). The predominant cementing agents within all bedding types are calcite (calcium carbonate), dolomite (magnesium carbonate), and clay.

Where unexposed, the Chatsworth formation is unconformably overlain by a thick sequence of Tertiary (i.e., about 65 to 5 million years before present) sedimentary and volcanic formations. These include the Simi Conglomerate, Las Virgenes, and Santa Susana formations exposed in the southwest corner of SSFL and to the northwest of SSFL. The Simi and Las Virgenes formations were deposited primarily in fluvial and alluvial environments, whereas the Santa Susana and Llajas formations are of marine origin. Southeast of SSFL, the Chatsworth formation is unconformably overlain by marine sandstone and conglomerate referred to here as the Lindero formation[4].

The Chatsworth formation and several of the formations overlying it are folded along the west-plunging Simi Valley syncline. The northern edge of the Simi Hills is on the southern limb of the syncline, such that the Chatsworth formation dips 20 to 35 degrees to the northwest at SSFL.

4.2 STRATIGRAPHIC MODEL

Figure 4-2 presents a site-wide SSFL map of exposed geologic units and faults. Based largely on previous work (Dibblee, 1992; Yerkes and Campbell, 2005; MWH, 2007 and 2009b), this map has been revised to incorporate more recent geologic mapping (Aydin and Cilona, 2015; Cilona et al., 2016; NASA, 2017). Appendix 4-A (MWH, 2017b) is a compilation of various selected past and recent SSFL geologic maps that provide additional detail and illustrate site characterization over time. Figures 4-3, 4-4, and 4-5 provide geologic cross sections for section lines A-A′, B-B′, C-C′, and D-D′ shown on Figure 4-2.

[4] The "detrital sediments of Lindero Canyon" is a prominent local member of the Calabasas Formation.

Local to SSFL, the Chatsworth formation is informally subdivided into upper and lower units (Montgomery Watson, 2000; MWH, 2007). The upper Chatsworth formation is further subdivided into two sandstone-dominated packages, Sandstones 1 and 2, which are separated and bounded above and below by fine-grained packages referred to as Shales 1, 2, and 3. An approximately 500-foot thick interval of lower Chatsworth formation also lies above Shale 1 (cross section B-B′, Figure 4-3).

As summarized in the table below, locally defined individual lithofacies within Sandstones 1 and 2 include named members and beds (MWH, 2007). From older to younger, Sandstone 1 consists of the Bowl, Canyon, and Sage sandstone members respectively separated by the Woolsey and Happy Valley fine-grained members. The Sage sandstone member contains the upper and lower Line beds and the upper and lower Bravo beds, and the Bowl sandstone member contains the upper and lower Bowl beds. Sandstone 2 consists of the Silvernale and upper and lower Burro Flats members separated by the SPA and ELV fine-grained members, respectively. The upper Burro Flats member contains the Lot bed. Although defined by their predominant texture, these units are generally heterogeneous packages of interbedded sandstone, siltstone, mudstone, and shale. The lower Chatsworth formation is equally or more interbedded and heterogeneous.

			Unit	Relative Texture		Thickness (feet)	
				Coarse	Fine	Unit	Sum
↑	Upper Chatsworth formation		Shale 3		●	75 - 125	
		Sandstone 2	Upper Burro Flats[a]	●		500	900 - 1,100
			ELV		●	15 - 40	
			Lower Burro Flats	●		300 - 370	
			SPA		●	15 - 30	
			Silvernale	●		110 - 160	
			Shale 2		●	150 - 175	
		Sandstone 1	Sage[b]	●		~700	1,800 - 2,300
			Woolsey		●	100 - 300	
			Canyon	●		500 - 600	
			Happy Valley		●	70 - 110	
			Bowl[c]	●		400 - 600	
			Top of lower Chatsworth formation	●	●	~500	
			Shale 1		●	~200	
Older ↓	Lower Chatsworth formation		interbedded sandstone, siltstone, and shale	●	●	~1,000	

Fine-grained interbeds (~5 – 20 feet thick):
[a] Lot Bed
[b] Upper and lower Line and Bravo Beds
[c] Upper and lower Bowl Beds

Members of the Chatsworth formation are exposed along banded outcrops striking northeast and decreasing in geologic age from southeast to northwest as a result of the formation's 20- to 35-degree northwest dip in the vicinity of SSFL. Exposures of resistant and massive upturned sandstone form topographic ridges, whereas exposures with a higher proportion of fine-grained material erode to more planar features including Burro Flats. Relatively flat-lying areas typically are covered by 1 to 30 feet of unconsolidated material, including soils, colluvium, alluvium, highly weathered bedrock, and placed fill in developed areas (Figures 4-2 through 4-5).

4.3 GEOLOGIC STRUCTURES

As a result of its long geotectonic history of folding, rotation, extension, and compression, the Chatsworth formation is pervasively fractured and faulted. The nature and extent of fracturing and faulting at SSFL has been studied and reported on extensively, given the relevance of fracturing to the permeability and transport characteristics of the Chatsworth formation and its component members. These assessments have relied on field mapping, aerial and satellite imagery, oriented rock core, and various types of geophysical logging (Cherry et al., 2009; MWH, 2009b, 2016c).

The mechanical properties of the Chatsworth formation vary as a function of mineral composition, compaction, cementation, and sedimentary architecture, which in turn contribute to local variations in fracture and fault character and density.

Recently, Cilona et al. (2016) performed an outcrop-based structural and statistical characterization of fractures and faults exposed at SSFL. They showed that the Chatsworth formation's multi-scale hierarchies of fractures and faults reflect the response of the formation's stratigraphic architecture to its long geotectonic history. The lengths and spacings of individual fractures and faults are related linearly to bed and unit thicknesses, and fault length and width are related logarithmically to estimated fault displacement. Nevertheless, the extent, propagation, and termination of fractures and faults are strongly influenced by multi-scale lithologic and structural heterogeneities that are difficult to fully characterize.

Additional data and studies conducted since 2009 that have contributed to the understanding of SSFL structural geology include approximately 60 relatively deep borings for new monitoring wells site wide; trenching across three interpreted faults; a surface seismic study; and a literature review and analysis of the regional geotectonic setting and history (MWH, 2016c).

4.3.1 Fractures

The Chatsworth formation fracture network consists of multiple sets of bedding-parallel and bedding-perpendicular fractures of highly variable orientation, density, and aperture. Two primary orthogonal sets of bedding-perpendicular fractures (i.e., joints) have orientations approximately northeast-southwest and northwest-southeast, roughly parallel and sub-perpendicular to bedding, and generally dipping 65 to 90 degrees (Cilona et al., 2016). These joint sets exhibit mutual abutting relationships, suggesting they formed contemporaneously.

The length and spacing of fractures and faults are strongly controlled by the thickness of the host beds, as illustrated schematically in Figure 4-6a (Aydin and Cilona, 2015). A correlation between joint spacing and bed thickness suggests that fractures within beds 1, 10, and 20 feet thick are spaced on average roughly 0.5, 1.5, and 3 feet apart, respectively. Sandstone joints generally terminate at the boundaries of fine-grained layers with thicknesses greater than several inches, and instead transition into relatively non-transmissive bedding-plane fractures within bounding fine-grained layers. Joint zones are spaced about 50 feet apart, on average, and generally terminate at shale-rich layers with thicknesses greater than about 4 inches. Shear joints and small faults may cut across mechanical interfaces and thicker fine-grained layers. Splay joints are common in the extensional quadrants of shear joints and joint zones, potentially linking neighboring joints, and locally increasing their connectivity and effective length. Less than about 5 percent of observed joints have vein fillings.

Appendix 4-A provides several examples of detailed fracture mapping at SSFL. Additional work characterizing the deterministic and stochastic nature and distribution of SSFL fractures is ongoing by the Groundwater Panel.

4.3.2 Faults

Subregional faults encompassing SSFL include the Simi, Santa Susana, Chatsworth Reservoir, and Burro Flats faults (Figure 4-1). More distant regional faults include the San Andreas and Malibu Coast faults located approximately 34 and 14 miles to the north and south of SSFL, respectively.

SSFL joints and joint zones have been subjected to progressive shearing over geologic time, inducing the formation of various generations of splay joints, the linkage of neighboring sheared structures, and the eventual development of a conjugate fault system consisting of two main populations of faults oriented

generally northeast-southwest and roughly east-west. The development and architecture of these faults was strongly influenced by the distribution and geometry of pre-existing joints and joint zones (Aydin and Cilona, 2015; Cilona et al., 2016).

Of the two main populations of conjugate, sub-vertical faults cutting the Chatsworth formation at SSFL, one is oriented roughly east-west with apparent right-lateral strike slip, and is one oriented northeast-southwest with generally apparent left-lateral strike slip. Of these, the Burro Flats fault is the dominant east-west fault and the Shear Zone is the dominant northeast-southwest fault (Figure 4-2). The apparently dominant left-lateral deformation is consistent with the stress field currently affecting the Western Transverse Ranges province (Cilona et al., 2016).

Cilona et al. (2016) divide SSFL faults into three groups as a function of estimated total displacement:

- Small faults form from single or linked joints, have displacements up to 3 feet, are segmented and discontinuous, and terminate in fine-grained beds. On average, small faults are spaced about 200 to 400 feet apart at SSFL.

- Intermediate faults form by linking small faults, have displacements between 3 and 30 feet, and have more developed fault core and damage zone features. Such faults have sufficient displacement to offset thin fine-grained intervals and may cut entire fining-upward cycles of roughly 100 feet. On average, intermediate east-west faults are spaced roughly 600 feet apart, whereas intermediate northeast-southwest faults are spaced about 1,500 feet apart.

- Large faults created by continued displacement and the linkage of smaller faults have displacements greater than 30 feet, ranging up to more than one mile in the case of the Burro Flats fault. Large faults have numerous strands that overlap, link, and cut through entire sedimentary sequences. Faults with displacements of about 500 feet or less are typically segmented with a thin, discontinuous fault core. Large faults bound large rock volumes containing smaller and more numerous faults. On average, large east-west and northeast-southwest faults are spaced roughly 3,600 and 2,000 feet, respectively. The boundaries of large fault zones may be estimated from geomorphological features where otherwise obscured as a result of erosion and deposition in low-relief faulted areas.

The following table presents estimated lengths, widths (fault core plus damage zone), and displacements for several large faults identified in Figure 4-2:

Fault	General Orientation	Length (feet)*	Width (feet)*	Apparent Offset (feet)*
Woolsey Canyon (N. trace)	E-W	784	52	33 - 50
unnamed (S. of HVF)	E-W	1,800	65	75 - 100
Coca (spur)	E-W	2,300	33	131
IEL	E-W	4,270	82	115 - 260
Woolsey Canyon	E-W	4,920	245	195 - 395
Happy Valley (N. trace)	E-W	6,070	185	102 - 245
Happy Valley (S. trace)	E-W	6,560	213	233 - 550
North	E-W	~8,000	200+	?
Skyline	NE-SW	9,840	165	165 - 230
Coca	E-W	12,500	312	1,500
Bell Canyon	E-W	~15,000	-	?
Santa Susana Pass	E-W	15,400	100	490 - 755
Shear Zone	NE-SW	18,000	295	560 - 755
Burro Flats	E-W	32,800	~300	5,250 - 6,600
*Converted from meters; adopted from Cilona, 2015, written communication.				

The Coca fault roughly parallels the Burro Flats fault within about 2,000 feet to the north, and spans nearly the entire site from east to west (Figure 4-2). The Bell Canyon fault is subparallel to the Burro Flats fault to the south and extends partially offsite. Exposures of the Simi, Santa Susana, and Las Virgenes formations are faulted against the Chatsworth formation southwest of the intersection of the Burro Flats and Bell Canyon faults.

The Shear Zone cuts northeast-southwest through SSFL Area I and separates two sets of generally east-west faults. The set west of the Shear Zone includes the North, DTSC 2, Ridge, and Tank faults, and east of the Shear Zone are the Woolsey Canyon, DTSC 3, IEL, Happy Valley, and Bowl faults.

Faults oriented northeast-southwest other than the Shear Zone are, from west to east, the Skyline, CTL, Box Canyon, and Dayton faults, the latter two of which are offsite. This group may include the inferred southwest extension of the North fault. Evidence of faulting has not been established or confirmed for several relatively minor features identified as geologic structures, including the Alfa, and Bravo structures within SSFL Area II and the DTSC 1 and FSDF structures in Area IV.

The faults depicted in Figure 4-2 are highly generalized representations of complex fault zones, as illustrated in comparison to a detailed field map (see Attachment 7, Appendix 4-A). The observed segmented and en-echelon patterns of faulting are inferred to continue into the subsurface (Cilona, et. al., 2016). Subsurface fault orientations are uncertain but generally interpreted to be effectively near vertical.

SSFL faults formed and propagated within the moderately porous, brittle sandstone of the Chatsworth formation by shearing and linking pre-existing joints and other discontinuities while undergoing lateral to oblique slip, with more ductile deformation occurring in shale units (Cilona, et. al., 2016). Brittle faults form zones of deformed rock with complex three-dimensional structures and geometries, and are seldom discrete planar structures. Fault zone architecture typically consists of two primary elements: a fault core of altered and deformed fault rock, including gouge and cataclasite, formed as the result of highly localized strain and intense shearing; and an enveloping damage zone of bedrock with enhanced fracturing (Figure 4-6b). Slip surfaces may bound, split, and/or cross-cut the fault core. The fault core is surrounded by an irregularly shaped damage zone consisting of shear joints, splay fractures, deformation bands, and other small faults. The occurrence of these features and their influence on groundwater are discussed in Section 5.

Within the broad envelopes encompassing mapped faults, the distribution of apparent subsurface faulting is complex. Indications of apparent faulting in borehole logs are fairly ubiquitous within broad areas up to several hundred feet across encompassing mapped faults. For example, 85 percent of Area I corehole logs note evidence of faulting (e.g., offset, gouge, slickensides), and several are relatively far from the nearest mapped fault. In most cases, it remains uncertain whether encountered evidence of faulting represents the same fault trace as the one mapped. Faulting may be expected to some degree throughout the subsurface as a three-dimensional repetition of the segmented and en-echelon pattern of faulting observed at multiple scales near ground surface (MWH, 2016c).

4.4 BOEING AREAS OF GROUNDWATER CHARACTERIZATION

Boeing is responsible for groundwater characterization at SSFL in nearly all of Area I, all of Area III, and portions of Area IV. Figure 4-7 provides a map of these areas and their respective RFI sites relative to the geology. Cross sections A-A´ through D-D´ (Figures 4-3, 4-4, and 4-5) illustrate the subsurface geology in these areas.

4.4.1 Area I

SSFL Area I is underlain predominantly by the Sandstone 1 sedimentary package, which consists of the Sage, Canyon, and Bowl sandstone members separated by the Woolsey and Happy Valley fine-grained members. The Sandstone 1 package is overlain by the fine-grained Shale 2 member and underlain by sandstone and fine-grained units near the top of the lower Chatsworth formation. As across most of SSFL, the Chatsworth formation generally dips 20 to 35 degrees to the northwest, such that most members are exposed along banded outcrops striking northeast. Relatively flat-lying areas typically are covered by 1 to 30 feet of unconsolidated deposits, including fill in developed areas.

Within the boundaries of Area I, offset along the Shear Zone has juxtaposed the Sage member on the west side of the fault with the Canyon and Bowl members on the east side (cross section B-B´, Figure 4-3). East of the Shear Zone, the intersection of northwest-dipping, fine-grained units with the Shear Zone forms a set of stacked northeast-plunging structural troughs.

For each Area I RFI site, the following table identifies the underlying geologic units and location relative to mapped faults:

Area I RFI Sites (listed NE to SW)	Site directly overlies:				Location relative to:				Underlying fine-grained unit:					Other underlying faults:				
		Upper Chatsworth members			Shear Zone fault		Coca fault											
	Lower Chatsworth Formation	Bowl	Canyon	Sage	west side	east side	south side	north side	Lower Chatsworth	Bowl Beds	Happy Valley	Woolsey	Bravo & Line Beds	Bowl	Happy Valley	IEL	North	Woolsey Canyon
1 B-1			●	●		●		●				●	?					●
2 IEL			●		○	●		●			●					●	○	
3 AILF			●	○	○	●		●			●							
4 B359			●			●		●			●							
5 APTF			●	○	○	●		●			●							
6 HVN			●			●		●			●							
7 LETF/ CTL-I			●	●	●	●		●			●	●	?		○			
8 HVS		●	○			●		●		●	●				●			
9 Canyon		●	◉			●		●		●	●				●			
10 R-1 Pond		●				●		●		●	●							
11 Bowl		●				●		●	●	●	?			●				
12 CTL-III	●	●				●	●	●	●									
13 CTL-V				●	●			●				●	?					
14 Area I Burn Pit	●	○		○	●	○	●	○	●									
15 Perimeter Pond	●					●	●		●									

● majority of site footprint ○ minor amount of site footprint ◉ locally unsaturated

4.4.1.1 Shear Zone

Cilona et al. (2015) identified nine en-echelon segments of the Shear Zone within a fault zone 100 to 500 feet wide and about 3.5 miles long (Figure 4-2). The segments are generally about 0.5 to 1 mile long and overlap about half their length. Fault width, including damage zones, averages approximately 300 feet. Fifteen boreholes along the Shear Zone have encountered one or more indications of potential faulting (e.g., slickensides, gouge, offset) at depths 30 to 700 ft bgs and distances up to 400 feet from the nearest mapped trace of the Shear Zone. Logged indications of faulting encountered in some coreholes suggest that the mapped trace of the Shear Zone dips approximately 70 to 80 degrees to the southeast in northeastern Area I. Other encountered faults appear more likely to be splays or separate fault traces not apparent at the ground surface.

Cilona et al. (2015) noted the occurrence of shale smearing in Shear Zone fault rock, both in outcrop and at a depth of approximately 620 feet in an optical televiewer corehole log. Shale smearing occurs when shale or other sufficiently plastic fine-grained units become incorporated into extensional stepovers between vertically discontinuous fault segments (Aydin and Eyal, 2002). In the case of the Shear Zone, the incorporation of multiple fine-grained units into the fault core has produced a plastic shale bent against fractured sandstone and shale-rich fault rock, forming an effectively continuous fault core between discontinuous fault segments. The 3-foot thick fault core observed at depth consists of highly folded and brecciated shaley fault rock with a locally complex cataclastic texture. X-ray diffraction indicates a composition of half or more plagioclase, half or less clay minerals, and minor quartz. An intensely fractured 25- to 50-foot wide damage zone was observed along the Shear Zone near its intersection with the Coca Fault.

4.4.1.2 Other Faults

The Woolsey Canyon fault extends from the Shear Zone nearly one mile east to Box Canyon fault (Figures 4-3). Its mapped northern and southern branches are 200 to 300 feet apart. En-echelon fault segments comprising the DTSC 3 fault are subparallel to the Woolsey Canyon fault roughly 100 to 500 feet to the south. Indications of faulting in corehole logs suggest that the Woolsey Canyon fault dips 60 to 80 degrees south-southwest, the IEL fault dips 75 degrees south, and the Coca fault dips 70 degrees south-southwest (MWH, 2016c).

Gouge up to 5 inches thick and damage zones up to 10 feet wide have been noted along the Woolsey fault. Slip surfaces, gouge, and deformation bands have been observed in coreholes along the IEL fault (MWH, 2007). Trenching across the southern trace of the Happy Valley fault revealed a broad zone of distributed deformation and intervals of fault gouge several inches wide (MWH, 2011a).

4.4.2 Area III

SSFL Area III overlies both Sandstones 1 and 2 and is cut across its southern portion by the Coca, Burro Flats, and Bell Canyon faults (Figure 4-7). The Compound A, ECL, Silvernale, and STP-3 RFI sites straddle the outcrop of Shale 2 that separates Sandstones 1 and 2. The STL-IV RFI Site overlies an undifferentiated sandstone unit of Sandstone 1 between the Coca and Burro Flats faults. The EEL RFI Site straddles the Area III-IV boundary and overlies the Silvernale, SPA, and lower Burro Flats members. The Santa Susana, Las Virgenes, and Simi formations are juxtaposed against the Chatsworth formation along the Burro Flats fault west of the Bell Canyon fault.

The Burro Flats fault zone is up to 200 feet wide and has an inferred dip about 70 degrees to the northeast. Trenches excavated across the Burro Flats and Bell Canyon faults observed multiple traces, fault offset, a gouge zone up to 1 foot wide, and high intensity fracturing (MWH, 2011b).

4.4.3 Area IV

SSFL Area IV is underlain by alluvium, fill, and upturned sandstone and fine-grained members of Sandstone 2 between the outcrops of Shale 2 to the southeast and Shale 3 to the northwest (Appendix 5-A; MWH, 2017a). Among the Boeing Area IV RFI sites: the ESADA and Pond Dredge sites overlie the lower Burro Flats member abutted against the north side of the Burro Flats fault; the Boeing Leachfields, Southeast Drum Storage Yard, and northern half of the EEL site also overlie the lower Burro Flats member; the New Conservation Yard and Process Development Unit (PDU) sites straddle the ELV member outcrop; and the SRE site overlies the upper Burro Flats member near the inferred western extension of the Burro Flats fault (Figure 4-7). Similar to southern Area III, younger Tertiary formations are juxtaposed against the Chatsworth formation along the Burro Flats fault in southern Area IV. The Burro Flats and Coca faults are mostly covered by unconsolidated materials where they cut across southwestern Area IV (MWH, 2017a).

A broad zone of deformation bands and minor faults extends from the west end of the North fault north of Area III, partially underlies the SRE RFI Site, and follows the northwest boundary of Area IV toward the Burro Flats fault (MWH, 2007). Wells with logged indications of potential faulting are located within this zone (MWH, 2017a). An unconfirmed apparent bedding-plane fault referred to as DTSC 1 lies mostly within this zone. Trenches excavated across two short north-south lineaments referred to as the FSDF structures did not find evidence of faulting along these features (MWH, 2013).

5.0 HYDROGEOLOGY

Groundwater in the Simi Hills occurs in fractured and porous rock at elevations as much as 1,000 feet above the adjacent Simi and San Fernando Valley floors. The "mountain-scale" groundwater flow system encompassing SSFL is bounded by the valley-hill margins to the north and east, and canyons deeply incised into bedrock to the south and west (Figure 5-1). Groundwater inflow occurs as recharge from precipitation and applied water within these boundaries, whereas groundwater outflow occurs primarily as discharge to canyon and hillslope seeps and phreatophytes; wells if pumping; and subsurface flow into the adjoining alluvial basins.

Section 5.1 provides a summary of the site-wide SSFL hydrogeologic conceptual model. Section 5.2 provides more in-depth hydrogeologic summaries for Boeing areas of responsibility in SSFL Areas I, III, and IV. These summaries are based on information and analysis adopted from the *Draft Groundwater RI Report* (MWH, 2009b), its companion compendium of research documents (Cherry et al., 2009), more recent work (e.g., MWH, 2016c; Aydin and Cilona, 2015; Cilona et al., 2015 and 2016; Manna et al., 2016), and materials appended to this report (Appendices 5-A and 5-B; MWH, 2017a and 2017c).

5.1 SSFL AND VICINITY

The hydrogeology of SSFL and adjacent areas is described below in terms of the boundaries of the encompassing mountain-scale groundwater flow system (Section 5.1.1); the site's hydrogeologic units (Section 5.1.2) and permeability structures (Section 5.1.3); and the occurrence and movement of groundwater within these units under the influence of these structural and boundary conditions (Section 5.1.4). Section 5.2 provides more in-depth descriptions of the occurrence and movement of groundwater in Boeing areas.

5.1.1 Mountain-Scale Groundwater Flow System Boundaries

As delineated in Figure 5-1, the groundwater flow system encompassing SSFL is approximately 20 square miles of elevated terrain bounded by Simi Valley to the north, San Fernando Valley to the southeast, Box Canyon to the northeast, Bell Canyon and Las Virgenes Canyon to the south, and Runkle Canyon to the west. Ground surface elevations range from just under 1,000 feet above mean sea level (ft msl) at the valley floors to ridge crests above 2,000 ft msl. Groundwater originates as recharge from precipitation and applied

water within this area, then discharges to canyon seeps, phreatophytes, and pumping wells, in addition to moving outward into adjoining areas as groundwater flow. The potential for outward subsurface flow exists along the entire boundary, but is highly influenced by local geology and hydraulic gradients. The delineated area corresponds approximately with the domain of the SSFL mountain-scale numerical groundwater flow model (AquaResource, 2009).

Figure 5-1 shows the distribution of mapped groundwater seeps and areas of potential phreatophyte evapotranspiration along canyon bottoms and hillslopes within and along the mountain-scale groundwater flow system boundaries. The flow system boundaries along the margin of Simi and San Fernando valleys have a combined length of about 6.5 miles, a little more than a third of the mountain-scale flow system perimeter. The basin alluvial fill is generally thin and fine-grained along these valley margins.

Conceptually, the base of the active groundwater flow system occurs at the boundary between fresh and connate groundwater. This boundary remains undefined, however, because pore-water samples from the deepest coreholes at SSFL have not revealed increasing concentrations of chloride with depth (maximum depth of 1,400 feet below ground surface [ft bgs] at an elevation of about 300 ft msl). Exploratory oil and gas wells in the region have encountered connate water between -300 and 900 ft msl in bedrock other than the Chatsworth formation (Appendix D in AquaResource & MWH, 2007).

5.1.2 Hydrogeologic Units and Hydraulic Properties

The stratigraphic and structural model presented in Section 4 provides a framework for defining the hydrogeologic units of the groundwater flow system and how they are structured. Figure 5-2 is a map of the generalized geology within the mountain-scale flow system area.

The alternating coarse- and fine-grained sedimentary rock units of the SSFL stratigraphic model described in Section 4.2 form a sequence of alternating moderate- and low-permeability zones. Differences in the mechanical strength of these units—as a function of lithology, bed thickness, and cementation—affect the nature and extent of fracturing in response to the local stress history. Bulk permeability is largely determined by the degree to which these fractures remain open under current conditions. Although defined by overall texture, these units are typically heterogeneous packages of interbedded sandstone, siltstone, mudstone, and shale.

As summarized in the table below, the bulk hydraulic conductivity of thick, fractured sandstone units of the Chatsworth formation is generally one to three orders of magnitude greater than unfractured sandstone and estimated values for fine-grained units.

Hydrogeologic Unit (equated to stratigraphic units)			Thick-ness* (feet)	Characteristic Permeability		Hydraulic Conductivity* (centimeters/second)		Low-Permeability Interbeds (~5-20 feet thick)
				Low to Mod.	Low	Un-fractured Rock Core	Bulk	
surficial deposits and fill			<30	●		-	-	
Lindero formation			100s	●		-	-	
Santa Susana, Llajas, and Las Virgenes formations			100s to 1,000s		●	-	-	
Simi formation			~200	●		-	-	
upper Chatsworth formation	Shale 3		100		●	-	$\sim 1\times10^{-7}$	Lot bed
	Sand-stone 2	Upper Burro Flats	500	●		5×10^{-7}	4×10^{-6}	
		ELV	30		●		$\leq 5\times10^{-7}$	
		lower Burro Flats	300	●			4×10^{-6}	
		SPA	25		●		$\leq 5\times10^{-7}$	
		Silvernale	130	●			4×10^{-6}	
	Shale 2		160		●	2×10^{-8}	$\leq 1\times10^{-7}$	
	Sand-stone 1	Sage	700	●		7×10^{-7}	1×10^{-4}	upper & lower Line & Bravo beds
		Woolsey	200		●	-	$\leq 1\times10^{-7}$	
		Canyon	500	●		2×10^{-7}	2×10^{-4}	
		Happy Valley	100		●	-	$\leq 1\times10^{-7}$	
		Bowl	500	●		4×10^{-7}	9×10^{-5}	upper & lower Bowl beds
top of lower Chatsworth formation				●	●	3×10^{-6}	6×10^{-5}	
	Shale 1		~200		●	-	$\leq 1\times10^{-7}$	
lower Chatsworth formation	interbedded sandstone, siltstone, and shale		~1,000	●	●	-	-	
*Estimated approximate average.								

In relatively flat-lying areas the Chatsworth formation is overlain by discontinuous, unconsolidated surficial deposits 1 to 30 feet thick consisting of soils, colluvium, alluvium, highly weathered bedrock, and placed

fill. The hydraulic properties of these zones is highly variable given their heterogeneity. These zones capture and convey recharge; contain perched and shallow water tables; and interface with surface water and the underlying bedrock.

The Simi formation abuts the Chatsworth formation along the Burro Flats fault in southwestern SSFL and overlies the Chatsworth formation to the immediate northwest of SSFL. The Lindero formation overlies the Chatsworth formation along the southeastern corner of SSFL. Both of these units are coarse-grained with the potential to be in hydraulic communication with the Chatsworth formation.

The remainder of this section summarizes measurements and estimates of porosity, hydraulic conductivity, specific storage, and hydraulic diffusivity for SSFL hydrologic units. Several previous works have presented analyses of these data (e.g., Cherry et al., 2009; MWH, 2009b, 2016c). The synthesis, interpretation, and interpolation of these data is complicated by differences in methodology, scale, and local conditions. Nevertheless, statistical summaries of these data provide representative central values for the local occurrence of individual hydrogeologic units. The relevant occurrence of each unit is limited in area and depth as a result of the dipping stratigraphy, such that statistical summaries of the collected data are representative of local stress histories. Limited additional insight is provided by mapping the spatial distribution of measured and estimated values given the inherent variability of the data and data-reduction issues related to methodology, scale, and the three-dimensional geologic framework.

5.1.2.1 Porosity

Relatively unweathered Chatsworth formation is characterized by dual porosity[5] as a result of open interstices in the sandstone matrix (primary porosity) and open fractures (secondary porosity). The porosity of the rock matrix is about 14 percent, whereas the bulk fracture porosity is about 0.01 percent or less. The dual porosity of the Chatsworth formation sandstone contributes to a distinct subsurface environment with regard to groundwater flow and storage, solute transport, and various hydrogeochemical processes important to the attenuation of contaminant concentrations. Groundwater storage occurs primarily within the low-permeability sandstone matrix, whereas groundwater flow occurs predominantly within high permeability fractures despite their small contribution to porosity.

Gravimetric measurements of the matrix porosity of unweathered Chatsworth formation sandstone range between 3 and 20 percent, averaging about 14 percent, whereas unweathered siltstone and shale average

[5] Porosity is the ratio of void space (i.e., open pores and fractures filled with air and/or water) to the total volume of the media.

about 7 percent, ranging from 2 to 14 percent. The available data do not exhibit any trend with depth to about 1,000 ft bgs. Measurements using a backscatter electron microscope method indicate a high degree of interconnection among the pore spaces. The porosities of weathered sandstone and surficial deposits range between about 10 and 50 percent (Cherry et al., 2009).

The bulk fracture porosity of unweathered Chatsworth formation sandstone is small (~0.01 percent) and contributes little to total porosity. Nevertheless, a high degree of fracture interconnectivity is indicated by several lines of evidence, including: the ubiquity of fracturing observed in outcrop and various types of borehole logs; observed water-level responses to pumping; and hydraulic head profiles from multi-level monitoring wells showing nearly uniform heads from top to bottom within a sandstone unit. Other than variations coinciding with lithology, no consistent or statistically significant vertical trend in fracture frequency has been observed within 500 ft bgs.

5.1.2.2 Hydraulic Conductivity

The following is summarized from a recent and updated assessment of available measurements and estimates of SSFL hydraulic conductivity[6] provided by laboratory analyses of rock core; single-well pumping and slug tests; discrete interval tests using packers and/or multi-level ports; analysis of groundwater hydraulic head responses to Earth tides; and multi-well pumping and injection tests (MWH, 2016c). Subsequent subsections summarize insights provided by multi-well pumping tests regarding the occurrence and movement of groundwater and the influence of geologic structures.

The results of various types and scales of laboratory and field tests for estimating hydraulic conductivity exhibit significant variability. Estimates associated with a single sandstone member vary up to five orders of magnitude, including within single boreholes tested at discrete intervals. However, the log-averages (i.e., geometric means) of these data demonstrate consistent differences among lithologic units and measurement methods and scales of measurement.

Laboratory tests performed on unfractured core samples provide estimates of the rock-matrix permeability. As presented in the above table, the geometric mean of matrix hydraulic conductivity ranges between 1×10^{-7} to 1×10^{-6} centimeters per second (cm/s) for sandstone members of the Chatsworth formation exposed and

[6] Hydraulic conductivity is the proportionality constant between the hydraulic gradient and the rate of groundwater flow through a saturated media, and is equivalent to transmissivity normalized for unit thickness.

underlying SSFL, and about an order of magnitude lower for fine-grained units. Other than variations coinciding with lithology, the data to not exhibit an apparent trend within 600 ft bgs.

The bulk permeability of the Chatsworth formation derives primarily from the density, interconnectedness, and aperture of the fracture network. Fracture length and spacing are strongly controlled by lithology and bed thickness. Joints generally terminate at sandstone boundaries where strain transitions into relatively non-transmissive bedding-plane fractures within bounding fine-grained layers. Shear joints and small faults cut across mechanical interfaces and fine-grained layers, providing hydraulic connections across vertical dimensions in the range of 50 to 200 feet. Linkages among various scales of strata-bound joints and small faults contribute to a highly interconnected fracture network with pronounced vertical connectivity within sandstone units. As a result, bulk hydraulic conductivity appears to be relatively isotropic within sandstone units, but highly anisotropic for sedimentary packages of coarse- and fine-grained units.

The geometric mean bulk hydraulic conductivity of fractured Chatsworth formation sandstone at SSFL is approximately 5×10^{-5} cm/s and is generally one to three orders of magnitude greater than the unfractured sandstone. Sandstone members of the Sandstone 1 sedimentary package have a geometric mean bulk hydraulic conductivity of approximately 1×10^{-4} cm/s, whereas sandstone members of the Sandstone 2 package have a lower geometric mean bulk hydraulic conductivity of 4×10^{-6} cm/s as a result of lower fracture density, a greater proportion of fine-grained interbeds, and possible local stress conditions. Among all sandstone members, roughly 10 to 20 percent of hydraulic conductivity estimates exceed 1×10^{-3} cm/s. A trend of decreasing hydraulic conductivity with depth as a result of fracture closing under overburden pressure is not evident within the studied depths of SSFL.

The hydraulic conductivity of fine-grained units is more difficult to measure due to sample recovery limitations and the lower limits of practical field tests. A reasonable upper limit of approximately 1×10^{-7} cm/s may be assumed based on laboratory tests of Shale 2 rock core and field-test limitations. The low permeability of these units is demonstrated by zones of saturated sandstone bounded by fine-grained units that exhibit distinct piezometric surfaces and pumping-test responses.

5.1.2.3 Storage Properties

The storage properties of SSFL hydrogeologic units are estimated in terms of storativity (or storage coefficient), specific storage, and specific yield.[7] Fractured Chatsworth formation sandstone is characterized by relatively low storage properties as a result of the low fracture porosity and the tortuous flow paths within pores of the sandstone matrix. Packer tests, multi-well pumping tests, and hydraulic head responses to Earth tides indicate that the specific storage of upper Chatsworth formation sandstone members generally ranges from 1×10^{-6} to 1×10^{-5} ft^{-1} (MWH, 2016c).

Storativities estimated for the Canyon member from the results of a 2003-04 multi-well pumping test have a geometric mean of approximately 2×10^{-3}, corresponding to a specific storage of 5×10^{-6} ft^{-1}. Storativities estimated for the Bowl sandstone member from the results of a 2013 pumping test have a geometric mean of approximately 1×10^{-2}, corresponding to a value of specific storage of 4×10^{-5} ft^{-1}, with values as much as an order of magnitude higher for observation wells located in the same fault zone as the pumping well. A storativity of 1×10^{-4} was estimated from a 2014 injection test into a deep portion of the Sage and/or Canyon members west of the Shear Zone (MWH, 2016c). A storativity of 1×10^{-5} was estimated from the results of a 2004 pumping test performed in the upper Burro Flats member. The specific yield of weathered sandstone and surficial deposits is variable and may range up to 45 percent.

5.1.2.4 Hydraulic Diffusivity

Hydraulic diffusivity is the ratio of hydraulic conductivity to specific storage, which is equivalent to the ratio of transmissivity to storativity. Hydraulic stresses propagate laterally and quickly through confined saturated media as a result of high hydraulic diffusivity, regardless of the actual values of transmissivity and storativity. However, such rapid pressure responses (i.e., apparent hydraulic "interconnectivity") do not reflect the actual movement of groundwater, which is generally much slower. High hydraulic diffusivity is responsible for relatively flat piezometric surfaces as a result of the rapid, distant, and efficient responses to changes in hydraulic pressure.

[7] Storage properties characterize the capacity of saturated media to release groundwater. Storativity represents the volume of water released from storage per unit decline in hydraulic head for a vertical prism of confined saturated media of unit surface area. Specific storage is equivalent to storativity divided by the thickness of the saturated media. Specific yield represents the volume of water that drains by gravity from a unit volume of saturated, unconfined media. Storativity and specific yield are dimensionless whereas specific storage has units of inverse length.

Fractured rock is characterized by relatively high hydraulic diffusivity as a result of highly transmissive fractures conveying relatively small amounts of groundwater released from storage in a low-permeability matrix. Additional confinement by fine-grained aquitards further lowers storativity and increases hydraulic diffusivity. The following examples illustrate the high hydraulic diffusivity of fractured Chatsworth formation sandstone at SSFL (MWH, 2016c):

- An ongoing groundwater level recovery that extends as a nearly flat piezometric surface across approximately 800 acres of exposed Sage member west of the Shear Zone and north of the Coca fault in SSFL Areas I and II over the past 17 years. The smooth recovery lacks the influence of variable recharge, indicating confined or semi-confined conditions.

- Several stacked, nearly flat piezometric surfaces exist in the Canyon and Sage members confined or semi-confined between the Line Beds and Woolsey member across a wide area north of the Woolsey Canyon fault (Appendix 5-B; MWH, 2017c).

- Rapid and widespread responses to pumping tests in the Bowl, Canyon, and Sage members, including strong responses in observation wells as distant as 2,400 feet away where confined or semi-confined between fine-grained units; and, nearly identical responses as the pumping well in observation wells as much as 300 feet away within fault zones.

These observations reflect the special circumstances of high hydraulic diffusivity (i.e., lateral flow under essentially confined conditions with a high ratio of transmissivity to storativity) and do not necessarily indicate zones of significantly elevated hydraulic conductivity, or provide an indication of potential transport.

5.1.3 Permeability Structures

The occurrence and movement of SSFL groundwater is potentially influenced by permeability structures that include fine-grained units serving as competent aquitards and the high- and low-permeability features of fault zones.

5.1.3.1 Fine-Grained Units

The SSFL groundwater flow system is dominated structurally by the dipping stratigraphy of alternating sandstone and fine-grained units. Compared to the relatively isotropic fracture network within sandstone units, the overall system is highly anisotropic in three dimensions as a result of dipping fine-grained units

serving as competent, yet leaky, aquitards. The dipping, low-permeability, fine-grained units contribute to the partial vertical as well as lateral compartmentalization of the groundwater flow system. Groundwater movement downward and to the east and southeast against stratigraphic dip is particularly impeded. Examples of the influence of fine-grained aquitards at SSFL include the following:

- As much as a 200-foot difference between Sandstone 1 and Sandstone 2 piezometric heads above and below Shale 2.
- Flowing artesian conditions in wells penetrating Shale 3 immediately north of SSFL.
- The occurrence of multiple piezometric surfaces in northeastern SSFL as a result of the fine-grained Woolsey and Happy Valley members and Line beds, as demonstrated by multi-level and cluster wells (Appendix 5-B; MWH, 2017c).
- Little-to-no hydraulic response across the fine-grained Happy Valley member during pumping tests conducted in either the underlying Bowl sandstone member or overlying Canyon sandstone member.
- A steep eastern gradient along the eastern margin of SSFL, against stratigraphic dip.

Vertical profiles of hydraulic head provided by wells equipped with multi-level systems exhibit relatively uniform heads within sandstone units, and relatively sudden changes in hydraulic head within fine-grained units that sometimes occur within intervals of 15 feet or less. This suggests that joints and small faults within sandstone units partially penetrate into fine-grained units, distributing the heads of overlying and underlying sandstone units into the top and bottom of the fine-grained units, perhaps as a function of heterogeneities and sandstone interbeds within the fine-grained units. Steep head drops also may result from thin, low-permeability mechanical layers, such as resulting from cementation (MWH, 2016c).

5.1.3.2 Fault Zones

Much of the information presented in this and following Sections 5.1.3.3 through 5.1.3.7 are addressed in greater detail in a more fully referenced report on SSFL fault hydrogeology (MWH, 2016c).

Faults commonly are segmented along both dip and strike, have multiple slip surfaces, and involve varying degrees of ductile deformation. The mechanics of faulting account for a wide range of failure-plane orientations within a fault zone, as well as the overall sub-vertical orientation of the fault zone. Three-dimensional patterns and distributions of segmented en-echelon faults evolve as a function of the geometry

and mechanical properties of the stratigraphy in relation to the stress field. Strain may be homogeneously distributed across the fault core or may be highly localized onto discrete slip surfaces. A weakened fault core further localizes strain and limits damage-zone growth.

Faults in the immediate vicinity of SSFL formed and propagated by shearing and linking pre-existing joints and other discontinuities within moderately porous, brittle sandstone undergoing lateral to oblique slip, with more ductile deformation in fine-grained units (Cilona et al., 2016). Faults in brittle sandstone form zones of deformed rock with complex, three-dimensional structures and geometries unlike discrete planar structures.

Groundwater flow may be influenced by faults as a result of juxtaposed lithologies and complex permeability structures within the fault zone. The standard conceptual model of fault zone architecture may be described to consist of three primary elements (Figure 4-6b):

- A fault core of deformed, altered, and typically low-permeability fault rock, including gouge and cataclasite, formed as the result of highly localized strain and intense shearing.
- Fault slip surfaces may bound, split, and/or cross-cut the fault core.
- An enveloping, irregularly shaped damage zone of enhanced fracturing, including shear joints, splay fractures, deformation bands, and small faults. Damage zone effective permeability may be high, low, or strongly anisotropic.

These elements tend to repeat and overlap along multiple fault strands that segment, branch, braid, anastomose, and link. The configuration, properties, and continuity of these elements determine the potential for a fault zone to act as either a partial hydraulic barrier to cross-fault flow, a preferential flow pathway parallel to the fault, or some combination thereof. Fault cores may have similar or enhanced permeability compared to the host rock as the result of recent rupturing or in the case of some sandstones with very low clay content (MWH, 2016c).

5.1.3.3 Partial Hydraulic Barriers Along Faults

Where sufficiently continuous along some fault zones, low-permeability fault rock forms partial hydraulic barriers responsible for observed fault-perpendicular changes in piezometric head and the emergence of groundwater seeps. The hydraulic properties of fault rock depend on host-rock lithology, fault mechanics, stress history, and whether ductile material is incorporated into the fault core.

Fault rock may be relatively permeable under some conditions (e.g., incipient faulting, extensional stresses, low-clay content, recent rupture). Typically, however, the permeability of fault rock is lower than that of the host rock. Low-permeability components of a fault core include fine-grained cataclasite (e.g., gouge), other deformed fault rock, shear joints, and deformation bands. Fault slip surfaces may enhance fault-parallel permeability, but tend to be discontinuous as a result of segmentation, cross faulting, and changes in lithology.

The permeability of shale-rich fault gouge in sandstone is reported in the literature to be up to three orders of magnitude lower than for the host rock. Additional deformation by compaction, folding, and alteration may lower the permeability several additional orders of magnitude. The potential for fault gouge to act as an effective partial hydraulic barrier depends on its continuity, thickness, and extent. Clay or shale smearing occurs when sufficiently plastic material within fine-grained units becomes incorporated into the fault core. This process contributes to the low permeability and continuity of the fault core, although is likely limited by depth and distance away from the intercepted fine-grained unit.

Examples of partial hydraulic barriers along SSFL faults include the following:

- The Shear Zone forms an effective low-permeability hydraulic barrier as a result of fault gouge and shale smearing (Cilona et al., 2015), resulting historically in as much as a 400-foot difference in hydraulic heads across the fault and a lack of cross-fault responses from pumping.
- A partial hydraulic barrier along the Burro Flats fault is evidenced by the emergence of groundwater seeps where the southwest drainage crosses the fault.
- A groundwater level difference of up to 200 feet occurs across the southern branch of the Woolsey Canyon fault east of the Shear Zone.
- Portions of the North fault appear partially sealed hydraulically from the Burro Flats sandstone member, but not the Sage member at depth below Shale 2.
- Along portions of the Coca fault both east and west of the Shear Zone, mounded groundwater and groundwater level differences across the fault suggest a zone of relatively low permeability.

5.1.3.4 Fault Slip Surfaces

Slip surfaces are discrete failure planes with potential openings on the order of several millimeters that bound, split, and possibly cross-cut the fault core. The potential for enhanced lateral flow along open slip surfaces is limited by the surrounding envelope of low-permeability fault rock, limited hydraulic connectivity between fault segments, and relatively gentle hydraulic gradients compared to potential vertical gradients. Open slip surfaces bounded by low-permeability fault rock most likely represent potential vertical hydraulic connectivity based on examples in the literature (e.g., adjacent hot and cold springs; patterns of mineralization; brackish water and petroleum migration; geothermal anomalies), whereas published examples of enhanced lateral flow along faults are limited. Such structures may help explain complex conditions where artesian heads within the fault zone are bounded by water table conditions offset along the fault. Potential vertical pathways also may occur where the damage zones of segmented faults overlap.

Examples of vertical hydraulic connectivity along SSFL faults include:

- A closed depression in the groundwater surface immediately west of the intersection of the North fault with the Shear Zone suggests locally enhanced downward leakage through vertical pathways within the fault zone and/or through a deep inactive water supply well that may encounter either or both faults at depth.

- All but the shallowest wells within the North fault zone correlate nearly one-to-one (1:1) with the long-term groundwater level recovery of the Sage member, including wells located more than 5,000 feet west of the Shale 2 outcrop where the Sage member occurs far below the bottom of the well at depths greater than 1,200 ft bgs. And, all but the shallowest wells along the fault zone appear uninfluenced by shallower zones in Sandstone 2 members with higher hydraulic heads south of the fault and lower hydraulic heads north of the fault.

The hydraulic properties of slip surfaces and fault zones in general may be altered during and following seismic events. Fault zone permeability may increase by several orders of magnitude as a result of an earthquake, then heal over a period of months to years as a function of the time needed to mechanically block or geochemically seal the fault, resulting in overall cumulative reductions in permeability. A literature review did not identify examples of groundwater contaminant mobilization along faults following an earthquake.

5.1.3.5 Fault Damage Zones

Damage zones envelope fault segments in three dimensions and may contain enhanced fracturing, shear joints, splay fractures, deformation bands, folds, and small faults. An inner damage zone of high-fracture frequency tends to flank the fault core, whereas an irregularly shaped outer damage zone may contain long splays and subsidiary faults that link to other fault segments.

Damage-zone permeability results from the distribution, orientation, and continuity of both high- and low-permeability elements within the damage zone. Permeability within a damage zone may be enhanced by patterns of fracturing that intersect and connect oriented but discontinuous minor fault slip surfaces within the damage zone. However, competing factors and processes contribute to the effective hydraulic continuity of these zones. Damage zone effective permeability may be high, low, or strongly anisotropic.

Potential permeable pathways comprised of damage zone features depend on their continuity, connectivity, and ability to cross-cut lower permeability structures. Damage zone continuity may be limited by fault zone heterogeneity, fault segmentation, intersecting faults, and changes in lithology and weathering that limit the continuity of individual structures. Heterogeneities inherent to fault zones increase the likelihood that permeable pathways are blocked, discontinuous, or truncated.

Damage-zone fractures that extend beyond the tips of faults increase the likelihood of hydraulic connection along segmented faults. Additionally, potential vertical pathways may occur where the damage zones of segmented faults overlap. Deformation bands and clay-filled or cemented fractures that extend away from the fault core may impede fault-parallel flow.

The effects of high hydraulic diffusivity described in Section 5.1.2.4 are apparent within various areas of SSFL, both near and away from faults. High hydraulic diffusivity is not in and of itself an indicator of elevated hydraulic conductivity or preferential pathways within and between fault damage zones.

SSFL damage zones have not been exhaustively mapped or characterized. Site examples of the potential hydraulic influence of damage zones include the following:

- Along the Shear Zone, patterns of fault-related sandstone fractures within adjacent damage zones appear highly interconnected, with the potential to contribute to enhanced damage-zone

permeability (Cilona et al., 2015). Responses to a 2003-04 pumping test in the Canyon member east of the Shear Zone indicated high hydraulic diffusivity within several hundred feet of the Shear Zone. In the same area, a reactive-tracer study encountered subsurface faults and demonstrated strong hydraulic communication between some monitoring wells. A packer test of one well provided a relatively high hydraulic conductivity estimate of 6×10^{-3} cm/s.

- Analysis of drawdown observed during the 2003-04 pumping test in the Canyon member east of the Shear Zone suggests a narrow zone along the IEL fault with up to an order of magnitude greater hydraulic conductivity than the host rock, which may be attributable to linked damage zones and/or slip surfaces that do not appear to extend east beyond the outcrop of the Happy Valley member.

- A sharp groundwater-level decline across the southern branch of the Woolsey Canyon fault may indicate enhanced downward leakage within the fault zone as well as the effects of a partial hydraulic barrier along the fault. Enhanced leakage may occur as a result of a permeable damage zone or slip surface, and/or the absence of an effective shallow aquitard between the northern and southern branches of the fault.

- A 1994-95 salt-tracer test conducted under an induced gradient along the southern trace of the Happy Valley fault zone exhibited hydraulic connectivity over a distance of 600 feet in a zone confined or semi-confined between the upper and lower Bowl beds (Groundwater Resources Consultants, 1996). A short-duration pulse of elevated groundwater electrical conductivity arrived five months after the introduction of the tracer, indicating an average transport velocity of approximately 4 feet per day. Because of uncertainty over the initial conditions, the amount of solute lost to matrix diffusion and lateral dispersion is unclear. However, the apparent plug flow indicated by limited longitudinal dispersion upon arrival of the salt pulse may be explained by two factors: one, that the hydraulic gradient induced by the pumping well helped to counter the dispersive effects of the fracture network; and two, the induced gradient may have been effectively very gentle as a result of high hydraulic diffusivity in this fractured sandstone zone confined between two fine-grained beds. For these reasons, these observations do not in and of themselves suggest the existence of preferential pathways under ambient hydraulic head conditions, especially as faults extend into and across differing lithologies and groundwater conditions.

- A 2013 pumping test of the Bowl member along the Happy Valley fault demonstrated good hydraulic responses along the fault zone, including beyond where the fault crosses the fine-grained Happy Valley member and Bowl beds. Drawdown analysis suggests a narrow zone with a higher storage coefficient and two- to ten-times greater hydraulic conductivity along the fault. Limited responses in the lower Chatsworth formation suggest limited fault hydraulic continuity across the upper-lower Chatsworth formation contact.

- Hydraulic enhancement within a damage zone along the north side of the Burro Flats fault in southwestern SSFL may help partially explain distant responses to pumping wells along the fault zone and an apparent inflection in the groundwater surface, although other contributing factors potentially include a hydraulic barrier along the south side of the fault zone and high hydraulic diffusivity not necessarily related to faulting.

5.1.3.6 Deformation Bands

Small-displacement deformation bands form and amalgamate as a result of strain localized along pre-existing shear joints in relatively coarse-grained, high-porosity rocks. The sandstone porosity threshold for deformation-band formation is approximately 10 to 15 percent, although rock properties, burial depth, fluid pressure, and local and remote stress fields contribute to this threshold. The Chatsworth formation is close to this threshold with an average porosity of approximately 14 percent.

Compared to other fracture types, deformation bands have enhanced cohesion and reduced permeability as a result of processes that include compaction, cataclasis, phyllosilicate smearing, and mineral precipitation, such that they contribute to a reduction in bulk permeability. Deformation bands may indicate proximity to larger faults and may occur within the core and damage zones of developed faults. Their potential to act as an effective partial hydraulic barrier depends on their continuity, extent, and variation in thickness. Dense regions of deformation bands at fault-segment stepovers may contribute to the continuity of segmented, low-permeability fault cores.

Deformation bands have been mapped across SSFL, typically in proximity to fault zones and along incipient faults extending beyond the end of mapped fault traces. Mapped deformation bands occur in proximity to the Happy Valley and Bowl faults east of the Shear Zone, the Alpha and Bravo structures west of the Shear Zone, and the Burro Flats fault and its associated secondary faults. A large and dense cluster of deformation bands is mapped within a broad zone along, and extending beyond, the western end of the North fault immediately north of SSFL Area IV (MWH, 2009b).

5.1.3.7 Interpolated and Extrapolated SSFL Fault Permeability Structures

Where supported by the interpretation of available information, MWH (2016c) categorized particular SSFL fault segments and damage zones among the following types:

- No apparent effect on flow perpendicular to fault (enhanced permeability along fault possible but not evident).
- Some basis for inferring a partial, possibly leaky, hydraulic barrier.
- Strongly apparent low-permeability hydraulic effect.
- Apparent enhanced permeability and/or hydraulic diffusivity along the fault.
- Apparent damage zones with altered hydraulic properties.

MWH interpolated and extrapolated these interpretations along all SSFL faults relevant to Boeing's areas of responsibility, including identification of intersections between faults and fine-grained units where hydraulic features associated with faulting may be enhanced (e.g., reductions in fault core permeability as a result of shale smearing) and/or interrupted (e.g., discontinuous damage zones and slip surfaces). Other conceptualizations are possible and may be evaluated through three-dimensional groundwater flow model calibration and optimization (AquaResource, 2013).

5.1.4 Groundwater Occurrence and Movement

Groundwater occurs under unconfined conditions in perched and non-perched zones within unconsolidated deposits, fill, and shallow weathered and fractured portions of the Chatsworth formation beneath SSFL. Confinement increases with depth as a result of fine-grained units, well-cemented sandstone intervals, and the influence of the low-permeability sandstone matrix. Depths to non-perched groundwater vary from less than 50 ft bgs in some low-lying areas to several hundreds of feet beneath elevated terrain.

Nearly all groundwater flow originates locally as recharge to the water table. Estimated site-wide average rates of precipitation recharge range from 0.33 to 1.75 inches per year (Manna et al., 2016). Groundwater discharge to canyon and hillslope seeps and phreatophytes is estimated to account for about half of site recharge under non-pumping conditions, with the remaining amount moving along deep flow paths ultimately toward the adjoining alluvial basins (AquaResource, 2009).

Dominant influences on the occurrence and movement of groundwater in the immediate vicinity of SSFL include: (1) the generally well-interconnected sandstone fracture network; (2) the distribution and continuity of low-permeability fine-grained units; (3) partial hydraulic barriers along the Shear Zone, Burro Flats fault, and other fault segments; and (4) subsurface dewatering as a result of wells pumping in excess of potential inflow and recharge, and the ensuing long periods of recovery.

Groundwater hydraulic heads fluctuate in response to variable seasonal and climatic conditions. Where sufficiently unconfined, groundwater levels respond strongly to years of above average precipitation recharge, and little to none during years of average to below-average precipitation. Vertical hydraulic gradients tend to be downward across much of SSFL, except where influenced by low-permeability boundaries perpendicular to the hydraulic gradient, and at lower elevations on the hillslopes surrounding portions of SSFL.

Evidence of groundwater movement throughout the sandstone fracture network includes little variation in ionic hydrochemistry to the 1,500-foot depth of the site's deepest corehole, and indications from high-resolution temperature profiling of numerous hydraulically active discreet fractures to depths in excess of 500 feet.

Figure 5-3 presents a contour map of interpolated non-perched groundwater surface elevations representative of 2015 and 2016 autumn conditions for SSFL and vicinity. Groundwater surface elevations generally range from 1,200 to 1,800 ft msl. The groundwater surface shown in Figure 5-3 is represented on the geologic cross sections provided in Section 4 and Appendices 5-A and 5-B (MWH, 2017a and 2017c).

Perched groundwater conditions occur within various portions of SSFL, but are highly variable over time in thickness and extent as a result of recharge conditions during current and preceding years. The *Draft Groundwater RI Report* provided a map of perched zones representative of 2001-2009 conditions (MWH, 2009b). Appendix 5-B includes a map showing the extent and elevation of perched zones along the Shear Zone in SSFL Area I updated through 2014 (MWH, 2017c, Figure 3). Some perched zones have dissipated and some saturated zones have become perched as a result of the 2012-2016 drought.

The occurrence and movement of SSFL groundwater is further described by SSFL administrative area in Section 5.2.

5.2 GROUNDWATER OCCURRENCE AND MOVEMENT IN BOEING AREAS

Boeing is responsible for groundwater characterization in SSFL Areas I, II, and portions of IV. Figure 4-7 provides a map of these areas and their respective RFI sites relative to the near-surface geology. Subsurface geology and groundwater levels in these areas are illustrated by cross sections provided in Figures 4-3, 4-4, and 4-5 and Appendices 5-A and 5-B (MWH, 2017a and 2017c). Figures 5-4, 5-5, and 5-6 provide more detailed maps of each area with labeled monitoring well and seep locations.

5.2.1 SSFL Area I

The occurrence and movement of groundwater in SSFL Area I is discussed separately in the sections below for areas east and west of the Shear Zone, and south of the Coca fault. Descriptions provided below represent current conditions and do not consider changes in the groundwater flow system throughout its operating history associated with historic groundwater withdrawals, and the import and use of municipal water. Historical influences on the groundwater flow system associated with pumping can be found in the *Draft Groundwater RI Report* (see section 6.3.1.3 of MWH, 2009b). Furthermore, implementation of pending groundwater interim measures will alter the flow system locally at designated extraction wells.

5.2.1.1 East of the Shear Zone

In Area I east of the Shear Zone (Figure 5-4), the groundwater surface is mounded above 1,800 ft msl at the top of a stacked series of structural northeast-plunging troughs formed by northwest dipping fine-grained units and the northeast striking low-permeability Shear Zone. The fine-grained Happy Valley and Woolsey members, and Bowl and Line beds, serve as dipping aquitards that, along with the Shear Zone, partially constrain groundwater movement. These conditions result in strong downward hydraulic gradients and multiple piezometric zones. Groundwater flow appears to be preferentially northeast through these stacked troughs, despite crossing several faults and an overall eastward hydraulic gradient. The structural troughs are most open to groundwater movement northeast in the general direction of stratigraphic strike and the plunge of the stacked troughs, as well as toward the edge of the Simi Hills. The downward movement of groundwater is facilitated where fine-grained units are discontinuous, and possibly along some fault segments.

Cross sections and data analysis presented in Appendix 5-B identify as many as eight separate piezometric zones common to two or more wells in Area I north of the Happy Valley fault. The piezometric surfaces are relatively flat as a function of the high hydraulic diffusivity of the fractured sandstone confined between fine-grained units. This results in rapid, efficient, and distant responses to changes in hydraulic pressure,

which tend to normalize hydraulic heads within each piezometric zone. The higher-elevation piezometric zones become perched and discontinuous northeast of the Woolsey Canyon fault as groundwater migrates downward along the edge of the Simi Hills. The steep hydraulic gradient east from Area I reflects the topography and hydraulic resistance of the northwest dipping stratigraphy to groundwater flow. Appendix 5-B presents a map similar to Figure 5-4 that illustrates how the interpolated groundwater surface contours are shaped by the edges of the stacked piezometric surfaces.

5.2.1.2 West of the Shear Zone

Groundwater occurs in a large, thick contiguous block of the Sage and deeper sandstone members across a broad area west of the Shear Zone, north of the Coca fault, and confined to the northwest beneath the Shale 2 outcrop (Figure 5-4). The piezometric surface has remained relatively flat in this area during the long-term recovery of groundwater levels following the discontinuation of remedial groundwater pumping in 2000, and is currently about 1,620 ft msl, roughly 200 feet lower than east of the Shear Zone. Perched zones east of the Shear Zone extend a short distance west across the Shear Zone in some areas. The Shear Zone forms an effectively continuous partial hydraulic barrier over a distance of at least 1.5 miles as a result of the incorporation of a portion of the fine-grained Woolsey member into the fault zone (Cilona and others, 2015).

The recovering piezometric surface is confined beneath Shale 2 northwest of the Shale 2 outcrop, and expressed in both shallow and deep wells along the North fault zone, which appears to hydraulically connect with the Sage member at depth. The North fault does not appear to impede groundwater flow where the Sage member is exposed between the Shear Zone and Shale 2 outcrop. Groundwater level recoveries that trend above or below the recovery curve common to most wells in this area suggest that (a) groundwater leaks into the recovering Sage member from across the Coca fault and downward from Sandstone 2, and (b) groundwater in this zone flows away from SSFL to the north and northeast.

An apparent groundwater surface depression on the west side of the Shear Zone near its intersection with the North fault (Figure 5-4) suggests a location of enhanced downward leakage, possibly as a result of fault-related permeability structures and/or downward flow under ambient gradients through a deep former water supply well (WS-14, Figure 5-4).

West and northwest of the Shale 2 outcrop in northwest Area I, groundwater in the upper and lower Burro Flats members forms a large mound above Shale 2, resulting in a piezometric surface as much as 200 feet higher than groundwater levels in the Sage member below Shale 2. This mound extends across the Burro

Flats area of SSFL Areas II, III, and IV. The overall lower bulk permeability and frequency of fine-grained beds in the sandstone units above Shale 2 contribute to the occurrence of this mound.

5.2.1.3 Along and South of the Coca Fault

Groundwater is mounded along portions of the Coca fault as an apparent response to low-permeability structures within the fault zone combined with a generally southward hydraulic gradient against stratigraphic dip (Figure 5-4). As a result, portions of the Coca fault coincide with an apparent north-south groundwater surface divide that may become less significant with depth. A 30-foot groundwater level difference occurs across the Coca fault west of its intersection with the Shear Zone where the piezometric surface is otherwise relatively flat (between RD-99 and RD-100; Figure 5-4). Along the Coca fault east of the Shear Zone, the results of a 1998 multi-well pumping test indicated limited hydraulic communication as a result of generally low permeability conditions.

5.2.2 SSFL Area III

Boeing's Area III RFI sites straddle the Shale 2 outcrop and extend from there south toward the Burro Flats fault zone (Figure 5-5). In this area, the groundwater surface descends generally south from the Burro Flats groundwater mound above Shale 2, following beneath the southwest drainage relatively unimpeded by upturned fine-grained units. A component of groundwater flow appears to be diverted southeast along the Burro Flats fault damage zone, much of which discharges to ephemeral seeps and phreatophytes along the damage zone and southwest drainage where it crosses the fault zone, suggesting a partial hydraulic barrier along this segment of the fault. The remaining groundwater flow gradually passes through the fault zone under non-pumping conditions. Hydraulic effects associated with the Coca fault are difficult to distinguish where the fault crosses Area III.

5.2.3 SSFL Area IV

Groundwater is mounded to relatively shallow depths below ground surface across Burro Flats within most of Area IV as a function of precipitation recharge over the relatively low permeability Burro Flats sandstone members and several upturned fine-grained units (Figure 5-6). This elongated mound forms an east-west groundwater divide between a hydraulic gradient south toward Area III and a gradient north toward the northern undeveloped lands. Hillslopes and groundwater levels descend steeply to the north and northwest across the northern undeveloped land, roughly parallel to stratigraphic dip. The vertical hydraulic gradient is generally downward beneath Burro Flats as a function of the recharge mound, but becomes upward at

lower elevations to the northwest as groundwater becomes confined beneath Shale 3, resulting in groundwater seeps and artesian monitoring wells along incised drainages.

The Coca and Burro Flats faults and the inferred western extension of the North fault are each roughly perpendicular to local hydraulic gradients and do not appear to significantly influence overall groundwater flow. A damage zone with enhanced hydraulic characteristics along the Burro Flats fault may provide a preferential pathway across a portion of the southeastern Area IV boundary.

A more detailed description of Area IV hydrogeology is provided in Appendix 5-A.

6.0 NATURE AND EXTENT OF GROUNDWATER IMPACTS

The general process used to define the nature and extent of groundwater impacted by chemicals released from historical site operations included:

- **Identify Chemical Use Areas** - Chemical use areas (CUAs) were comprehensively identified.
- **Characterize Nature and Extent of Chemical Releases in the Vadose Zone** - Samples of environmental media were systematically collected and submitted for analysis based on chemical use. Sample results were further evaluated to define the nature and extent of chemical distributions in vadose zone soil and soil vapor at concentrations that exceed screening values[8] and represent a source of groundwater contamination. Bedrock was also characterized to evaluate impacts to groundwater underlying CUAs where DNAPL was known or suspected to have entered the ground.
- **Identify Locations Where Chemicals in the Vadose Zone Have Impacted Groundwater** - Further evaluations were performed to identify and define vadose zone sources responsible for chemical impacts to the underlying groundwater.
- **Characterize Nature and Extent of Chemicals in Groundwater** – Hydrogeologic conditions, groundwater sampling and analysis, and bedrock porewater results were evaluated to define the nature and extent of chemical impacts in groundwater.

Each process element is described further below.

6.1 CHEMICAL USE AREAS

The identification of chemical use areas was preliminarily documented in RFI Group Reports issued in 2008 and 2009 (e.g., see MWH, 2009a). Additional work to identify and confirm chemical use areas was performed consistent with the Comprehensive DQO Report, which was prepared in response to DTSC comments on both the 2008/09 RFI Group Reports and the Draft Groundwater RI Report. These additional evaluations have resulted in the final identification and description of chemical use areas for each RFI site

[8] Soil/soil vapor screening values for groundwater protection were defined in Appendix D of the *Comprehensive DQO Report.*

as presented in Table 6-1, with chemical use area locations shown in Figure 6-1. These areas[9] represent the universe of locations/conditions that could result in releases to soil, bedrock and groundwater.

6.2 NATURE AND EXTENT OF CHEMICALS IN THE VADOSE ZONE

The vadose zone at SSFL includes unsaturated portions of both the surficial media and Chatsworth formation operable units. Analytical laboratory results of soil vapor, and unsaturated soil matrix and bedrock have been used to evaluate potential impacts to groundwater from the vadose zone. Sampling results were used guide determining the lateral and vertical extent of vadose zone chemical impacts and are summarized below and comprehensively evaluated in the RFI site *DSFRs*.

6.2.1 Soil and Soil Vapor

Starting in 2013, additional samples of soil and soil vapor, as well as other environmental media, were collected using an iterative approach to characterize potential releases from each chemical use area in accordance with the methods described in Table 2 of the *Comprehensive DQO Report* (CH2M Hill, 2013b). Samples were also collected as outlined in the *Comprehensive DQO Report* to support answering vadose zone and groundwater study questions, which are provided in Table 6-2. Sampling was supplemented during iterative field sampling events as necessary to fulfill any additional requests by DTSC. DTSC confirmed characterization completeness (i.e., sampling and analysis of surficial media sufficient to complete the RFI) at Boeing's RFI sites in Areas I and III and the Southern Undeveloped Land, starting in November 2014 with Subarea 5/9 South and ending in August 2016 with Subarea 1A North (email correspondence from DTSC to Boeing). Similarly, DTSC confirmed that sampling and analysis of soil within Area IV was sufficient for purposes of site characterization (DTSC, 2015). Soil, soil vapor, and vadose zone bedrock sample locations are shown in Figure 6-2.

As of the date of this report, Boeing is in the process of preparing reports for each RFI site that summarize data collected, evaluations performed, and present overall findings related to the RFI for all environmental media and transport pathways. These *Data Summary and Findings Reports* include detailed evaluations of the transport of chemicals in unsaturated soil and/or bedrock (i.e., vadose zone) to groundwater and

[9] Evaluations of groundwater impacts potentially related to the presence of chemicals in soil within CUA cluster 14 at the Instrument and Equipment Laboratory RFI site have not been evaluated as part of this report since active sampling is on-going and additional measures are anticipated.

chemical impacts within groundwater. Detailed tables that provide answers to each study question by chemical group for the vadose zone and groundwater at the CUA cluster scale are prepared and included in each RFI site *DSFR*. This Boeing site-wide groundwater RFI report does not repeat information included in the RFI site *DSFRs*, as most remain a work in progress as of the date of this report. However, tables that describe findings for the vadose zone and groundwater study questions for four RFI sites in Subarea 5/9 South (EEL, STP-3, Compound A, and STL-IV) and three RFI sites in Subarea 1A Central (B359, APTF and Happy Valley North) are provided in Appendix 6-A for ease of reference, since these DSFRs have been submitted to DTSC for review (CH2M, 2017a, b, c and d; MWH, 2017d, e and f).

6.2.2 Bedrock

Bedrock samples were collected and analyzed from known or likely areas where rocket engines or associated equipment were tested and typically cleaned using chlorinated solvents (DNAPL). Bedrock sampling included the collection of vadose zone rock core and analysis for VOCs at 12 Boeing RFI sites in Areas I and III: B-1, IEL, APTF, LETF/CTL-I, Canyon, Bowl, CTL-III, CTL-V, Area I Burn Pit, ECL, Compound A Facility, and STL-IV. Similarly, vadose zone rock core samples were collected and analyzed for VOCs at the SRE RFI site in Area IV. Vadose zone rock core samples were also collected and analyzed for perchlorate from the Building 359 and Happy Valley South RFI sites. Rock core sample identifiers for each RFI site are shown in Table 6-3. Descriptions of results from each location are presented in Table 4-1 of each RFI site's DSFR.

6.3 LOCATIONS OF VADOSE ZONE SOURCES THAT IMPACTED GROUNDWATER

Information on chemical use areas and vadose zone sampling results were integrated to identify areas and locations that have resulted in impacts to groundwater. Methods used to identify these areas based on sampling results are described below.

6.3.1 Soil and Soil Vapor

Soil sources defined as having impacted groundwater have been identified at Boeing RFI sites in Areas I, III, and IV. Chemical impacts are defined when a chemical exceeds both its screening value in soil or soil vapor samples and in groundwater samples from wells interpreted to intercept flow from the chemical use

area cluster where the soil or soil vapor exceedances occur. Concentrations that can remain without further impacting groundwater are based on best professional judgment and supported by vadose zone to groundwater transport simulations. The approach used to evaluate soil and soil vapor sampling results and to support application of professional judgment is shown in Figure 6-3. Areas where soil sources to groundwater have been identified are shown in Figure 6-4 and can include a single chemical (e.g., perchlorate) or a combination of chemicals (e.g., TCE and perchlorate) within the boundary of the areas shown. Other information used to identify the footprint of these areas in soil include historical activities and site features such as ponds, drainages, bedrock outcrops, and fault locations.

6.3.2 Bedrock

Areas of impacted vadose zone bedrock have been estimated using multiple lines of evidence as existing data yield greater sampling densities in the vertical direction (about every 1 to 1.5 feet) than laterally. Chemicals judged to have impacted vadose zone bedrock are those that have relatively high mobility in the subsurface and for which transport through the alluvium to bedrock is suggested based on both site data and professional judgment informed by vadose zone to groundwater transport simulations. The criteria used to identify the footprint of impacted vadose zone bedrock include:

- Bedrock vadose zone sampling results
- Soil and soil vapor sampling results with VOC concentrations about ten times or more above screening values (this guideline was chosen considering the time of chemical releases relative to time of sampling [typically decades], VOC mass transfer including volatilization to the atmosphere, imbibition of immiscible phase solvents into the bedrock matrix, and dissolution into groundwater through recharge), and soil sampling results with perchlorate concentrations greater than its screening value (given its extremely high solubility),
- Areas where previous soil interim measures or soil closure excavations were conducted that likely reduced or removed higher concentrations of chemicals in soil than those detected after such work was completed
- Historical site features used to collect, convey or store chemicals used in former operations at the RFI site, including collection trenches or drains, ponds, tanks, and other locations. Many of these features are identified as chemical use areas within the summary provided in Tables 6-1a through 6-1m.

The footprint of impacted vadose zone bedrock has been estimated for TCE (largest and most prolific chemical used at SSFL and relatively mobile) and perchlorate (high solubility with similar mobility as TCE). The footprint of impacted vadose zone bedrock is shown on Figure 6-5 and the rationale for each location's selection is summarized in Table 6-4.

6.4 NATURE AND EXTENT OF CHEMICALS IN GROUNDWATER

Historical evaluations of chemical impacts to groundwater as outlined in the *Draft Groundwater RI Report* and annual tracking of 16 key chemicals in groundwater over the ensuing 7 years serve as a basis for further describing the nature and extent of chemical impacts to groundwater. Of these 16 chemicals, TCE and perchlorate generally identify the outer limits of the extent of impacted groundwater in Boeing's areas. The 16 key chemicals and their parent chemical groupings are:

1. Chlorinated ethenes: PCE, TCE, cis-1,2-dichloroethene (c-DCE), trans-1,2-dichloroethene (tDCE), vinyl chloride and 1,1-DCE;

2. Chlorinated ethanes and by-products: 1,2-DCA, 1,1-DCA and 1,4-dioxane;

3. Other chlorinated compounds: carbon tetrachloride and 1,2,3-trichloropropane;

4. Non-chlorinated chemicals: n-nitrosodimethylamine, perchlorate, nitrate, and fluoride; and

5. Petroleum hydrocarbons: as gasoline and/or diesel/kerosene range.

The nature and extent of each of these 16 chemicals in groundwater are described in the subsections that follow. Chemical extents are estimated based on comparing sampling results to groundwater characterization levels, which are presented in Table 6-5. Groundwater impacts from all other chemicals are evaluated by carbocomparing sampling results to the GCLs listed in Table 6-5. Figures from the 2016 Annual Groundwater Monitoring and Sampling Report are used as a baseline in presenting groundwater impacts and interpretations of the lateral extent for each chemical. Baseline map information is supplemented with: 1) soil and/or soil vapor sample locations that are estimated to present current impacts to groundwater, and 2) plan view configurations of areas in soil and/or bedrock interpreted as requiring further evaluation in the RCRA corrective measures study for groundwater protection. Minor adjustments

to soil/bedrock configurations may be made in RFI site *Data Summary and Findings Reports* that have not been completed as of the date of this report. Frequent references are made in the following sub-sections to RFI sites, and when made, report consumers should reference Figure 1-3 for locations.

A separate digital deliverable is provided to supplement this report that includes: 1) soil and bedrock CMS areas that have been interpreted to have impacted groundwater 2) soil and/or soil vapor sample locations that are indicative of current impacts to groundwater, and 3) groundwater chemical extents. The digital deliverable is provided as an *.gdb and layer files executable using ArcGIS.

6.4.1 Tetrachloroethene

Figure 6-6 illustrates the interpreted areal extent of PCE in Areas I and III as there are none in Area IV for which Boeing has responsibility. Figure 6-6 also illustrates the areas and locations where PCE has been detected in soil (and vadose zone bedrock where applicable) above concentrations considered to be a source to groundwater based on professional judgment and supported by site data and vadose zone to groundwater transport simulations. Sources of PCE to groundwater have been confirmed at three RFI sites in Area I (from north to south): B-1, IEL, and APTF, and the ECL RFI site in Area III. Sources were confirmed through comprehensive data reviews of chemical use areas and operations during preparation of Data Summary and Findings Reports for these RFI Sites. Locations of PCE in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Impacts to underlying bedrock were interpreted from operational information and interim measure (or other) excavations that would have removed elevated concentrations of PCE in soil or sediment, and by applying professional judgment. Sources of PCE to groundwater at the APTF and ECL RFI sites are attributable to historic releases at the former surface impoundments that are under post-closure care as no soil or soil vapor samples at these locations showed results with concentrations presenting impacts to groundwater.

Impacted groundwater above the 5 micrograms per liter (µg/L) characterization level for PCE is found in three separate areas within Boeing's Area I: one around well HAR-16 at the APTF RFI Site, one around well C-1 at the IEL RFI Site, and one around well RD-84 at the B-1 RFI Site. Impacted groundwater above the 5 µg/L characterization level for PCE is also found around well SH-04 at the ECL RFI Site in Area III. Historical sampling results showed a one-time detection of PCE at PZ-037 at the STL-IV RFI Site.

However, groundwater depths in this area are below the screened interval of this piezometer and no soil sources have been identified. As such, this area has been eliminated from the 2016 PCE base map.

The estimated areas of PCE impacts in groundwater at the four RFI sites are small relative to TCE (described below) and are contained within the footprint of TCE-impacted groundwater. Site data indicates no evidence of substantial transport, likely because releases were small, as there was no reported appreciable use of PCE identified in historical records. Additionally, analysis of thousands of bedrock samples for PCE from the vadose and saturated zones show periodic detections in discrete samples at concentrations above its 5 µg/L characterization level. As examples, locations where this occurs include rock core collected from C-2 and PZ-12 at Canyon, C-4 at Bowl, RD-46B at CTL-III, and RD-100 at Area I Burn Pit RFI sites. However, groundwater samples collected from these locations do not show PCE at concentrations above the 5 µg/L characterization level. The infrequent detections in discrete rock core samples are surmised to result from the presence of PCE as an impurity in neat, technical, or commercial grade TCE (Morrison and Murphy, 2015), the latter of which is reported to have been used in appreciable quantities at SSFL (CH2M Hill, 1993).

6.4.2 Trichloroethene

Figure 6-7 illustrates the interpreted areal extent of TCE in groundwater (along with iso-concentration contours of equivalent TCE, described further in section 6.4.2.1 below) within Areas I and III. Figure 6-7 also illustrates the areas and locations where TCE and its biological transformation products have been detected in soil (and/or vadose zone bedrock where applicable) above concentrations considered to be a source to groundwater based on professional judgment and supported by site data and vadose zone to groundwater transport simulations. Sources of TCE to groundwater have been confirmed at 12 of 15 RFI sites in Area I (from north to south): B-1, IEL, Area I Landfill, B359, APTF, Happy Valley North, LETF/CTL-I, Canyon, R-1 Pond, Bowl, CTL-III, and Area l Burn Pit. In Area III, sources of TCE to groundwater have been confirmed at four of six Boeing RFI sites (from northeast to southwest): ECL, Compound A, EEL, and STL-IV. Sources were confirmed through comprehensive data reviews of chemical use areas and operations during preparation of Data Summary and Findings Reports for these RFI Sites. Locations of TCE and biological transformation products in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Impacts to underlying bedrock were

interpreted from operational information and interim measure (or other) excavations that would have removed elevated concentrations of TCE in soil or sediment, and by applying professional judgment.

TCE groundwater impacts in Area I show an overall northeast to southwest distribution. Its distribution is consistent with transport by groundwater flow from source areas based on: 1) historical groundwater withdrawals from former water supply and interim measure wells that affected the groundwater flow patterns, and 2) anisotropy imparted by the northeast-to-southwest trending Shear Zone fault to the west of the impacted area and the relative low permeability, northeast to southwest striking geologic units (e.g., Happy Valley Member) to the east. The TCE impacted groundwater beneath the Happy Valley South RFI site may be, in part, from eastward transport along the east-west trending Happy Valley fault as shown on Figure 6-7. The TCE impact in groundwater northeast of Boeing's Area I likely originated from sources at the B-1 RFI Site. In Area III, TCE from source areas in the EEL, Compound A, and STL-IV RFI sites have been transported by groundwater flow to the south, in the general direction of the groundwater gradient, but also influenced by historical groundwater withdrawals from WS-9A. There is also a separate and distinct zone of impacted groundwater associated with historic releases at the ECL RFI Site.

Figure 6-8 shows the interpreted areal extent of TCE in groundwater in Area IV encompassing wells RD-91 and RD-7 and appearing to be sourced from the vicinity of Building 100, where Boeing has agreed to complete groundwater characterization. Evaluation of sampling results have not shown an appreciable source of TCE in soil or soil vapor at this site, with only a few detections in soil at estimated concentrations (j) below 1 microgram per kilogram and soil vapor below 0.005 micrograms per liter. The absence of a TCE source in soil is attributed to the relatively thin veneer of soil overlying bedrock, coupled with the decades that have passed since a suspected release would have occurred. Releases that are decades old allow sufficient time for mass loss to occur in soils by volatilization to the atmosphere, coupled with discharge to groundwater by both vapor-phase diffusion and partitioning into recharge waters.

6.4.2.1 TCE Iso-concentration Contours and Three-Dimensional Interpolations

Three-dimensional representations of the groundwater zone impacted by TCE and its chlorinated degradation products in Area I and Area III were previously prepared (MWH, 2015a and 2015b) and are included as part of this groundwater RFI report. The three-dimensional interpolations were made in context of: 1) local hydrogeologic conceptual models, 2) an evaluation of TCE sources, 3) historical groundwater levels, 4) groundwater pumping, 5) recharge related to precipitation, and 6) groundwater flow path lines

simulated by the SSFL mountain-scale numerical groundwater flow model (as presented in the *Draft Groundwater RI Report*).

In Area I, results from 2,735 laboratory analyses of primary groundwater samples collected from 196 unique locations from 1992 through 2014 were used to prepare a data set of equivalent TCE, defined here as the normalized sum of TCE and its chlorinated daughter product concentrations, which include cDCE, tDCE, 1,1-DCE, and vinyl chloride. In Area III, results from 2,220 laboratory analyses of primary groundwater samples from 95 unique locations from 1987 through 2013 were used.

The data were subdivided into early and late periods to allow an evaluation of temporal changes in the spatial distribution of equivalent TCE. The data set for the early period started in 1992 and extended through 2001; the late period started in 2003 extending through 2014 for the Area I data set. For Area III, the data set for the early period started in 1987 and extended through 2007; the late period started in 2008 extending through 2013. The data sets consist of maximum equivalent TCE concentrations for each sample location. In Area I, the early period was chosen by retaining maximum concentrations measured in 1993 or the closest year to 1993 with sample results, and the late period was chosen using maximum concentrations for 2014 or the next closest year with sample results if a location was not sampled in 2014. In Area III, the early period was chosen by retaining maximum concentrations measured primarily in two periods: 1987 (42 percent of values) and 2001/02 (36 percent of values). The late period was chosen using maximum concentrations for 2013 or the next closest year with sample results if a location was not sampled in 2013. The remainder of the discussion in this sub-section presents results from only the late period data sets (2003 through 2014 for Area I and 2008 through 2013 for Area III) as these are most representative of current conditions.

Iso-concentration contours of equivalent TCE were manually created in map view as shown in Figures 6-9 and 6-10 for Areas I and III, respectively. As shown in Figure 6-9 for Area I, the 1 µg/L iso-concentration contour encompasses an area approximately 290 acres. The TCE plume is elongated approximately 1.8 miles to the northeast, consistent with the structural influence of the dipping sandstone members and fine-grained aquitards; the partial hydraulic barrier perpendicular to strike of the Shear Zone; and a potential damage zone of enhanced hydraulic interconnectivity along strike of the Shear Zone. The delineated plumes encompass identified potential and known TCE source areas and most of the simulated groundwater path lines that originate from them. The interpolated mass of equivalent TCE above 1 µg/L in groundwater is estimated to range from about 11,000 to 12,000 kilograms (kg).

As shown in Figure 6-10 for Area III, the 10 µg/L iso-concentration contour encompasses an area of approximately 116 acres, about 48 percent of which is within Area II (subject to final interpretation by NASA). The groundwater zone impacted above 10 µg/L equivalent TCE appears impeded on the southwest by the Burro Flats fault, consistent with the interpretation that the fault zone acts as a partial, low-permeability hydraulic barrier to groundwater flow perpendicular to strike. The impacted zone above 100 µg/L appears to be elongated along strike of the fault, consistent with the potential for hydraulic enhancement along its strike, and the historical influence of WS-9A groundwater withdrawals. Detections of TCE and its degradation products in the vicinity of the ECL and Silvernale RFI sites within Area III Subarea 5/9 North, and within Area IV, are interpreted to represent separate zones of impacted groundwater, and thus are not included within the contoured areas. The interpolated mass of equivalent TCE above 10 µg/L in groundwater is estimated to be about 5,100 kg with about 70 to 75 percent of the total within Area III (i.e., excluding Area II).

The map view iso-concentration contours were used to help locate a series of cross-sections sufficient to capture the three-dimensional concentration structure of maximum equivalent TCE. Seventeen (17) cross-sections were created to a depth of mean sea level in Area I and six were created to a depth of 300 feet above mean sea level in Area III. Equivalent TCE iso-concentration contours were then manually created on each cross-section based on: 1) depth-discrete sample results, 2) the intersection of simulated groundwater flow paths with each cross-section, 3) a conceptual model of the hydrogeology, and 4) pumping and contaminant histories. Results are presented in Figures 6-11 and 6-12 for Areas I and III, respectively. In Area I, interpretations of the vertical extent of TCE impacts reach 1,000 feet or so near the central and northern segments of the zone of impacted groundwater as can be seen in cross-sections A-A´ and G-G´ in Figure 6-11, with some of the vertical extent having been influenced by historical groundwater withdrawals from WS-5. In Area III, vertical extents are less data constrained and are estimated to also reach 1,00 feet or so as shown in cross-section A-A´ of Figure 6-12, with the vertical distribution being influenced from historical groundwater withdrawals from WS-9A.

Cross-section iso-concentration contours were also digitized and converted into a three-dimensional data set in site coordinates. Using spatial analysis software, the data sets derived from the cross-sections for each period were interpolated into a three-dimensional block of nodes spaced 50 feet horizontally and 25 feet vertically to a minimum elevation of mean sea level in Area I and 300 feet above mean sea level in Area III. The interpolated blocks were contoured and can be viewed in three dimensions, including along

cut faces. Static images of the 3-D interpolations are shown in Figures 6-13 and 6-14 for Areas I and III, respectively. A greater appreciation of the interpolated concentration structures can be achieved by manipulating these images in three-dimensional space using *RockWorks*™ software in which they were created.

6.4.3 Cis-1,2-Dichloroethene

Figure 6-15 illustrates the interpreted areal extent of cDCE in groundwater in Areas I and III at SSFL. There are no current or historic primary sources of cDCE at SSFL, as it is an anaerobic, biologically-mediated, transformation product of TCE (Vogel et al., 1987). Section 6.4.2 above describes sources of its parent compound, TCE, in Areas I, III, and IV. The extent of the cDCE groundwater impacts in Areas I, III, and IV are within the footprint of TCE impacts.

Figure 6-15 also illustrates locations where cDCE has been detected in soil and/or soil vapor at concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Sources of cDCE in the vadose zone are most likely attributable to TCE transformation to cDCE from the aerobic cometabolic biological degradation, or in some cases may be from vapor migration from underlying groundwater. Locations of cDCE in soil from RFI sampling results (i.e., sources to groundwater) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. cDCE in soil, soil vapor and/or vadose zone bedrock has been confirmed at seven of 15 RFI sites in Area I (from north to south): B-1, IEL, APTF, LETF/CTL-I, R-1 Pond, Bowl, and CTL-III. In Area III, sources of cDCE to groundwater have been confirmed at three of six Boeing RFI sites (from northeast to southwest): ECL, Compound A, and STL-IV. Each of these locations also contained TCE (the parent compound for cDCE) except for chemical use area cluster R1-CC-1-2 at the R1 Pond RFI Site, and is likely present from localized aerobic cometabolic TCE degradation that has since attenuated to below screening levels in soil or soil vapor samples.

The extent of cDCE impacts to vadose zone bedrock are expected to lie within the estimated footprint of TCE bedrock impacts, the latter extents of which are shown in Figure 6-5. The extent of cDCE vadose zone bedrock impacts are expected to be limited due to aerobic conditions reflected in oxidized bedrock core samples as revealed by their brown coloration.

The configuration of the interpreted areal extent of cDCE in Area I approximates, but is slightly smaller than, the interpreted areal extent of TCE-impacted groundwater. This is expected as it is derived from anaerobic biological transformation of TCE and their transport is diffusion-controlled, leading to stable plume configuration. The areal extent of cDCE in Area III is similar to TCE's configuration at the ECL RFI Site. As illustrated in Figure 6-15, two separate areas of cDCE-impacted groundwater occur within the four RFI sites in Subarea 5/9 South, with the interpreted extent falling within the overall footprint of TCE-impacted groundwater shown in Figure 6-8.

Figure 6-16 illustrates the interpreted areal extent of cDCE in groundwater in Area IV encompassing wells RD-91 and RD-7 and appearing to be sourced from the vicinity of Building 100, where Boeing has agreed to complete groundwater characterization. The interpreted areal extent is similar to the TCE footprint presented earlier in Figure 6-8, although cDCE concentrations are about 1/12 of TCE's values. A similar footprint is expected since cDCE is derived from TCE and their transport is diffusion-controlled, leading to stable plume configuration.

6.4.4 Trans-1, 2-Dichloroethene

Figure 6-17 illustrates the extent of tDCE in groundwater in Areas I and III at SSFL. In Boeing's Area IV, there are no groundwater sampling results of tDCE above its 10 µg/L characterization level. No primary sources of tDCE use have been identified at SSFL; however, tDCE is an anaerobic, biologically mediated, break-down product of TCE (Vogel et al., 1987). Section 6.4.2 above describes TCE sources that generate tDCE, although at a much lower molar ratio than cDCE production from TCE. The areal extent of tDCE groundwater impacts in Areas I and III are within the footprint of TCE impacts in both areas.

As illustrated in Figure 6-17, there are no soil or soil vapor sample locations where tDCE has been detected in soil above concentrations considered to be yield groundwater impacts and is not considered to be a source to groundwater.

Impacted groundwater above the 10 µg/L characterization level for tDCE is found at isolated wells or locations relative to TCE and cDCE at the following RFI sites within Boeing's Area I: IEL, APTF, Canyon, and Bowl; and at two RFI sites in Area III: Compound A and STL-IV. Maximum concentrations detected are all within an order of magnitude of the 10 µg/L characterization level. The areas of tDCE impact are

defined by sampling results from monitoring locations that do not contain tDCE concentrations above the characterization level.

6.4.5 Vinyl Chloride

Figure 6-18 illustrates the extent of vinyl chloride in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results of vinyl chloride above its 0.5 µg/L characterization level. No primary sources of vinyl chloride use have been identified at SSFL; however, vinyl chloride is an anaerobic, biologically mediated, break-down product of TCE, primarily via reductive dechlorination of cDCE (Freedman and Gossett, 1989). Section 6.4.2 above describes the sources of TCE to groundwater and section 6.4.3 describes the primary intermediate parent constituent (cDCE) for vinyl chloride in Areas I and III. The areal extent of vinyl chloride groundwater impacts in Areas I and III lie within the footprint of TCE impacts in both areas.

Figure 6-18 also illustrates the areas and locations where vinyl chloride has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. With no known primary source of vinyl chloride at the surface, sources of vinyl chloride in the vadose zone may be from diffusive vapor transport from underlying groundwater or, in some areas, localized aerobic cometabolic degradation of cDCE. Locations of vinyl chloride in soil from RFI sampling results (i.e., sources to groundwater) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment.

In Area I, vinyl chloride sample results in soil or soil vapor show singular locations at the B359, LEFT/CTL-I, Canyon, and Bowl sites where concentrations could impact groundwater. In Area III, results from a few soil or soil vapor sample locations at the ECL and STL-IV RFI sites are at concentrations that could impact groundwater. Soil and/or soil vapor results from each of these RFI sites also contain TCE (the parent compound for cDCE and vinyl chloride) concentrations in the vadose zone determined to be potential sources to groundwater.

Impacts of vinyl chloride to underlying bedrock are expected to be limited and lie within the estimated extent of TCE bedrock impacts. Limited impacts are expected due to aerobic conditions reflected in oxidized bedrock core samples as revealed by their brown coloration.

Impacted groundwater above the 0.5 µg/L characterization level for vinyl chloride is found in two separate lobes within Area I: one centered at the IEL RFI Site and the other encompassing the Canyon and Bowl RFI sites. Sample results at RD-100, which monitors groundwater at the Area I Burn Pit RFI Site contains vinyl chloride slightly above its characterization level. In Area III, groundwater impacted by vinyl chloride is found beneath the ECL, Compound A, and STL-IV RFI sites.

6.4.6 1,1-Dichloroethene

Figure 6-19 illustrates the extent of 1,1-DCE in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results of 1,1-DCE above its 6 µg/L characterization level. 1,1-DCE is an anaerobic, biologically-mediated, transformation product of TCE (Vogel et al., 1987). Additionally, 1,1-DCE is also an abiotic transformation product of 1,1,1-trichloroethane (TCA) (Vogel and McCarty, 1987a). 1,1,1-TCA is known to have been used at the IEL RFI Site and may have been used in small quantities elsewhere.

Figure 6-19 illustrates the areas and locations where 1,1-DCE has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Locations of 1,1,1- and 1,1,2-TCA soil or soil vapor sample results indicative of impacts to groundwater at concentrations above their comparison thresholds have been added to this figure to indicate potential sources of 1,1-DCE to groundwater. Locations of 1,1-DCE, 1,1,1-TCA, and 1,1,2-TCA in soil from RFI sampling results (i.e., sources to groundwater) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Impacts of 1,1-DCE to underlying bedrock are expected to be limited and lie within the estimated extent of TCE bedrock impacts. Limited impacts are expected due to the general aerobic conditions in the vadose zone bedrock and the limited use of 1,1,1-TCA.

RFI sites where 1,1-DCE and/or 1,1,1- and 1,1,2-TCA were identified in the vadose zone at concentrations determined to be a potential source to groundwater in Area I include IEL, APTF, and Area I Burn Pit, and in Area III at ECL. Each of these RFI sites also contain TCE in the vadose zone (an alternate potential parent compound for 1,1-DCE) at concentrations determined to be potential sources to groundwater.

In Area I, impacted groundwater above the 6 µg/L characterization level for 1,1-DCE is found centered around historic releases from the IEL RFI Site. Its distribution in groundwater is consistent with transport from the source zone based on gradients and anisotropic conditions imparted by the northeast to southwest striking Shear Zone fault to the west and the relative low permeability, northeast to southwest striking geologic units to the east of the impacted area. Sample results at RD-100, which monitors groundwater at the Area I Burn Pit RFI Site contains 1,1-DCE slightly above its characterization level. In Area III, 1,1-DCE in groundwater above its characterization level is found beneath the ECL, Compound A, and STL-IV RFI sites. The estimated areas of 1,1-DCE impacts in groundwater at the STL-IV, Compound A, and ECL RFI sites are small relative to TCE. Sources at STL-IV and Compound A are suspected to be related to small historic releases at the post-closed impoundments and former pond #3, respectively.

6.4.7 1,2-Dichloroethane

Figure 6-20 illustrates the extent of 1,2-dichloroethane (1,2-DCA) in groundwater in Areas I and III at SSFL. 1,2-DCA 1) is an anaerobic biologic transformation product from 1,1,2-TCA (minor) or its parent 1,1,2,2-tetrachloroehane (Lorah and Olsen, 1999), 2) is a stabilizer in 1,1,1-TCA (Morrison and Murphy, 2015), and 3) was added to leaded gasoline as a lead scavenger (Falta, 2004). In Area IV within Boeing's area, there are no groundwater sampling results of 1,2-DCA above its 0.5 µg/L characterization level. Figure 6-20 also shows the few locations where 1,2-DCA has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Locations of 1,2-DCA in soil from RFI sampling results (i.e., sources to groundwater) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. RFI sites where 1,2-DCA was identified in the vadose zone at concentrations determined to be a potential source to groundwater are IEL and ECL in Areas I and III, respectively.

Impacted groundwater above the 0.5 µg/L characterization level for 1,2-DCA is found beneath two Boeing RFI sites in Areas I and II: IEL and ECL, respectively. The interpreted area of groundwater impact beneath the IEL RFI site is small relative to the distribution of other chemicals discussed above. The interpreted lateral extent of 1,2-DCA in groundwater beneath the ECL RFI Site is similar to the extent of TCE in groundwater at this location.

6.4.8 1,1-Dichloroethane

Figure 6-21 illustrates the extent of 1,1-dichloroethane (1,1-DCA) in groundwater in Areas I and III at SSFL. 1,1-DCA is an anaerobic, biologically-mediated, transformation product of 1,1,1-TCA (Vogel and McCarty, 1987b). 1,1,1-TCA is known to have been used at the IEL RFI site and may have been used in small quantities elsewhere.

Figure 6-21 illustrates the areas and locations where 1,1-DCA has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. In addition to historic releases from primary sources of 1,1,1-TCA at and below ground surface, sources of 1,1-DCA in the vadose zone may be from diffusive vapor transport from underlying groundwater or, in some areas, localized aerobic cometabolic or anaerobic degradation of 1,1,1-TCA. Locations of 1,1-DCA in soil from RFI sampling results (i.e., sources to groundwater) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. RFI sites where 1,1-DCA was identified in the vadose zone at concentrations determined to be a potential source to groundwater in Area I include IEL and Area I Burn Pit, and in Area III at ECL and STL-IV.

Impacts of 1,1-DCA to underlying vadose zone bedrock are expected to be limited due to its general aerobic conditions and is expected to lie within the interpreted footprint of bedrock impacts from historical releases of TCE or other VOCs.

Impacted groundwater above the 5 µg/L characterization level for 1,1-DCA is sourced from two RFI sites within Boeing's Area I: IEL and AI Burn Pit and from three RFI sites within Area III: ECL, Compound A, and STL-IV. In Boeing's area of responsibility at SRE in Area IV, there is a single monitoring location (PZ-161) with a historical sample result (March 2010) with a concentration (8.1 µg/L) above 1,1-DCA's characterization level of 5 µg/L.

The distribution of 1,1-DCA impacts from its known 1,1,1-TCA parent source area at IEL is consistent with the advanced groundwater flow system understanding of this area as presented in Appendix 5-B The local occurrence of 1,1-DCA in groundwater at Area I Burn Pit is also consistent with the presence of lower permeability lithologies local to this area. The estimated areas of 1,1-DCA impacts in groundwater at the ECL, Compound A, and STL-IV RFI sites are relatively small. Although a source in soil has not been

identified at Compound A it is suspected that a small historic release of 1,1,1-TCA to former pond #3 is the source. The configuration of the interpreted areal extent of 1,1-DCA is most attributable to 1,1,1-TCA releases at the IEL RFI Site in Area I and a suspected 1,1,1-TCA release at the ECL and STL-IV RFI sites in Area III.

6.4.9 1,4-dioxane

Figure 6-22 illustrates the interpreted areal extent of 1,4-dioxane in groundwater in Areas I and III at SSFL. 1,4-dioxane was used as a chemical stabilizer in 1,1,1-TCA in the 2 to 4 percent range and reportedly in TCE and carbon tetrachloride (Morrison and Murphy, 2015). In Area IV within Boeing's area, there are no groundwater sampling results of 1,4-dioxane above its 1 µg/L characterization level.

Figure 6-22 also illustrates the few locations where 1,4-dioxane has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Soil sources of 1,4-dioxane to groundwater have been confirmed at two RFI sites in Area I: IEL and Area I Burn Pit. Locations of 1,4-dioxane in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Other sources of 1,4-dioxane in groundwater could include those shown in Figures 6-7 for TCE, Figure 6-19 for 1,1-DCE (which includes 1,1,1-TCA soil sources) and Figure 6-21 for 1,1-DCA (also an indicator of 1,1,1-TCA soil sources).

Impacts of 1,4-dioxane to underlying vadose zone bedrock are expected to lie within the interpreted footprint of bedrock impacts from historical releases of TCE or other VOCs locations, which are shown in Figure 6-5.

The interpreted extent of 1,4-dioxane impacted groundwater above the 1 µg/L characterization level in the northern part of Area I appears primarily sourced from 1,1,1-TCA releases at IEL, with the impacts extending both northeast and southwest along Shear Zone strike. Transport southwest from IEL is either related to historical groundwater withdrawals at WS-5 and/or from a small release(s) that may have occurred within the post-closed surface impoundments at APTF. 1,4-dioxane impacts to groundwater are somewhat unique in this area in that it is found in wells west of the Shear Zone while other more ubiquitous contaminants (e.g., TCE) are absent. The occurrence of 1,4-dioxane west of the Shear Zone is attributed to

the unknowable source architecture of historic 1,1,1-TCA release(s) coupled with the complex nature of the Shear Zone fault and the properties of 1,4-dioxane (low sorption capacity). 1,4-dioxane is also found at or near its characterization level in a few wells positioned along the Happy Valley fault where the suspected source would be from historic releases at the Canyon RFI Site. There are a few other isolated locations of 1,4-dioxane in the southern part of Area I at the Area I Burn Pit and near the Bowl and CTL-III RFI sites.

In Area III, the interpreted aerial extent of 1,4-dioxane impacted groundwater above the 1 µg/L characterization level is sourced from three RFI sites: ECL, Compound A, and STL-IV, with sources consistent with those described in previous section for 1,1-DCE and other chlorinated ethanes.

6.4.10 Carbon Tetrachloride

Figure 6-23 illustrates the interpreted areal extent of carbon tetrachloride in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results of carbon tetrachloride above its 0.5 µg/L characterization level.

Figure 6-23 also illustrates the few locations where carbon tetrachloride has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Carbon tetrachloride in soil or soil vapor as a source to groundwater has been confirmed at only the ECL RFI Site in Area III. Locations of carbon tetrachloride in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment.

Impacts to underlying vadose zone bedrock lie within the interpreted footprint of bedrock impacts from historical releases of TCE or other VOCs locations, which are shown in Figure 6-5.

The interpreted areal extent of impacted groundwater above the 0.5 µg/L characterization level for carbon tetrachloride is found within the IEL RFI Site in Area I and at the ECL RFI Site in Area III. The areas of carbon tetrachloride impact in groundwater at these RFI sites fall within the footprint of TCE impacts to groundwater described in Section 6.4.2. Two locations previously shown in the 2016 annual report have been removed from Figure 6-22: a location around HAR-16 at the APTF RFI Site and another around ES-

24 at the Compound A facility RFI Site. Both were removed, as carbon tetrachloride has not been detected in these wells and they were only previously retained due to elevated detection limits at these locations. Furthermore, both locations have been impacted by other chemicals (e.g., TCE) and lie within the interpreted extent of impacted groundwater.

6.4.11 1,2,3-Trichloropropane

Figure 6-24 illustrates the few locations where 1,2,3-trichloropropane (1,2,3-TCP) has been found in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results of 1,2,3-TCP above its 0.005 µg/L characterization level.

1,2,3-TCP has been found at concentrations above its characterization level in a few wells at the IEL RFI site, at HAR-16 at the APTF RFI site, at RD-46A at the CTL-III RFI site in Area I and at SH-3 at the ECL RFI site in Area III. 1,2,3-TCP was not found in soil or soil vapor samples at concentrations estimated to impact groundwater at these sites. Suspected sources at APTF, CTL-III and ECL are from small historical releases into the post-closed surface impoundments at APTF at ECL and the former pond at CTL-III. Areas of impacted bedrock from 1,2,3-TCP (if present) would lie beneath these former impoundments and ponds, both of which are identified in Figure 6-5.

One location of 1,2,3-TCP in groundwater noted as being present in the 2016 Annual Groundwater Monitoring and Sampling Report has been removed around the RD-36 well cluster north of the B-1 RFI site. This area was removed because 1,2,3-TCP was not detected or was detected at concentrations below characterization levels. Also, this location is impacted by other chemicals (e.g., TCE), thus already lies within the interpreted extent of impacted groundwater.

6.4.12 n-Nitrosodimethylamine

Figure 6-25 illustrates the interpreted areal extent of n-nitrosodimethylamine (NDMA) in groundwater in Areas I and III at SSFL. It is believed that the occurrence of NDMA in groundwater in these areas is a by-product of the historical neutralization of unused unsymmetrical di-methyl hydrazine (UDMH, a rocket fuel) with hypochlorite, which most likely occurred in impoundments or ponds that are now closed. NDMA formation from UDMH neutralization with hypochlorite has been reported by various researchers (Fine, 1976a and 1976b; Brubaker et al, 1985). In Area IV within Boeing's area, there are no groundwater sampling results of NDMA above its 0.01 µg/L characterization level.

Figure 6-25 also illustrates the few locations where NDMA has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Sources of NDMA in soil interpreted to impact groundwater have been confirmed at three RFI sites in Area I: APTF, Canyon, and Bowl. Locations of NDMA in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Areas of impacted bedrock from NDMA (if present) would lie beneath these soil locations as well as former impoundments and ponds, which are identified in Figure 6-5.

The estimated area of NDMA impacts in groundwater sourced from the former impoundments at the APTF RFI Site extends southwest and has likely been influenced by historical pumping from WS-5. Groundwater impacts at the Bowl RFI Site are local to historical sampling results from PZ-87. The configuration of NDMA impacts at the ECL, Compound A, and STL-IV RFI sites is related to likely sources from former surface impoundments or ponds at each. NDMA-impacted groundwater lies within the area of TCE-impacted groundwater beneath the Compound A and STL-IV RFI sites described earlier in section 6.4.2. The interpreted lateral extent at the ECL RFI Site is similar in extent to TCE.

The location of NDMA around OS-24 north of the B-1 RFI Site noted as being present in the 2016 Annual Groundwater Monitoring and Sampling Report has been removed from Figure 6-25 based on non-detect sampling results from RD-36C, which monitors the same groundwater zone as OS-24 and the aged results from OS-24 (2004). Samples from OS-24 cannot be collected because the well is obstructed with a FLUTe sampling device. Multiple efforts have been made to remove the sampling device from OS-24 without success.

6.4.13 Petroleum Hydrocarbons

Figure 6-26 illustrates the interpreted areal extent of total petroleum hydrocarbons (TPH, C4 to C30 range) in groundwater in Areas I and III and a part of Area IV at SSFL. Figure 6-27 illustrates the interpreted extent of an area of impacted groundwater underlying Boeing's and DOE's areas of responsibility within the northeastern part of Area IV.

Figure 6-26 also illustrates locations within Area I and III where TPH has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. *DSFRs* for individual RFI sites describe in detail the occurrence of individual TPH ranges in the vadose zone and in groundwater. In Area IV, evaluations of soil sampling results and other site data do not show locations of TPH in soil that could impact groundwater beneath Boeing's New Conservation Yard RFI Site, hence no locations are shown.

Sources of TPH in soil that have been interpreted to impact groundwater have been confirmed at four RFI sites in Area I: B-1, IEL, R-1 Pond, and Bowl; at three RFI sites in Area III: ECL, Compound A, and STL-IV; and at the Boeing Leachfield site in Area IV. Locations of TPH in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Any areas of impacted bedrock are expected to lie beneath areas identified for TCE and other VOCs as shown in Figure 6-5. In the northeastern part of Area IV, no TPH sources have been identified in either site data or in sampling results at Boeing's New Conservation Yard RFI Site. However, prior reports issued on the adjacent Old Conservation Yard RFI Site show the presence of both petroleum use areas and the occurrence of petroleum hydrocarbons in soil (see Appendix 2-A of MWH, 2006). Further evaluation as to a source of the petroleum hydrocarbon impacts to groundwater shown in Figure 6-27 are beyond the scope of this report.

In Area I, the interpreted area of TPH impacts to groundwater are consistent with the understanding of the local groundwater flow system is discussed in Section 5 of this report and remain local to where sources have been identified at the B1, IEL, Canyon, and R1 Pond/Bowl RFI sites. Although little soil exists at the Canyon RFI Site to allow for source identification, characterization work conducted in 2009 revealed the presence of a light, non-aqueous phase liquid for a brief time in corehole C-2 (MWH, 2009b). Laboratory analysis of the floating product showed hydrocarbons in the range of C10 to C16, consistent and characteristic of liquid rocket propellant RP-1 (essentially a high-grade kerosene that fueled rocket engines tested at the Canyon test stands). The estimated area of TPH impact extends from the Canyon RFI Site to the east toward the Happy Valley South RFI Site, along strike of the Happy Valley Fault that may enhance eastward transport. In Area III, the interpreted extent of TPH impacts to groundwater show local areas typically around a few wells at the ECL, Compound A, and STL-IV RFI sites. Similarly, TPH is present at concentrations above the characterization level in RD-152 at the Boeing Leachfield RFI Site in Area IV.

The location of TPH around PZ-50 at the EEL RFI Site noted as being present in the *2016 Annual Groundwater Monitoring and Sampling Report* has been removed from Figure 6-26, as the elevated DRO result at PZ-050 occurred during one sampling event in which there were deviations from the standard, approved sampling procedures, due to an insufficient water column within the screened interval.

6.4.14 Perchlorate

Figure 6-28 illustrates the interpreted areal extent of perchlorate in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results of perchlorate above its 6 µg/L characterization level.

Figure 6-28 also illustrates the areas and locations where perchlorate has been detected in soil (and vadose-zone bedrock where applicable) above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations.

Sources of perchlorate to groundwater have been confirmed at five RFI sites in Area I: Building 359, APTF, Happy Valley North, Happy Valley South, and LEFT/CTL-I. Locations of perchlorate in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment. Impacts to underlying bedrock were interpreted from operational information and interim measure (or other) excavations that would have removed elevated concentrations of perchlorate, and by applying professional judgment.

Impacted groundwater above the 6 µg/L characterization level for perchlorate is sourced from releases associated with historic operations conducted at the Building 359, APTF, and Happy Valley North and South RFI sites where interim measures have been implemented to remediate perchlorate in soil (MWH, 2004a). The area of perchlorate-impacted groundwater centered around the Building 359/Happy Valley North RFI sites results from extension northeastward from groundwater withdrawals at C-1 during a pumping test initiated in 2003 (MWH, 2004b) and southwestward from historic surface water flow in the late 1950s that is suspected to have contained low concentrations of dissolved perchlorate that infiltrated the subsurface and entered the groundwater system. The southern plume extension also may have resulted from historic groundwater withdrawals from former water supply well WS-5. The estimated area of perchlorate impacts to groundwater at the Happy Valley South RFI Site is localized at well RD-10 with

historic detections in nearby piezometer PZ-117, which has not been sampled for over a decade as the drought has prevented shallow groundwater from accumulating within its monitored zone.

6.4.15 Nitrate as NO_3

Figure 6-29 illustrates the occurrence and distribution of nitrate as NO_3 (further referred to below as nitrate) in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results with nitrate above its 45 mg/L characterization level.

Figure 6-23 also illustrates the few locations where nitrate has been detected in soil above concentrations considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations. Nitrate in soil as a source to groundwater has been confirmed at only the ECL RFI Site in Area III. Locations of nitrate in soil from RFI sampling results (i.e., sources) were identified by evaluating and noting those locations with concentrations above comparison thresholds, which were used as a basis for professional judgment.

Impacted groundwater at or above the 45 mg/L characterization level for nitrate is found in two separate wells within Boeing's Area I: RD-106 at the IEL RFI Site and HAR-16 at the APTF RFI Site, the latter of which is suspected to be sourced from historic release(s) into the former surface impoundments. Nitrate is also found above its characterization level in well SH-9 at the ECL RFI Site in Area III, where the suspected source would have been from historic releases into the ECL pond that is under post-closure care. All three locations are local occurrences, impacting a single well at concentrations above the characterization level. The location of nitrate around RS-3 from over 30 years ago at the LETF/CTL-I RFI Site noted as being present in the 2016 Annual Groundwater Monitoring and Sampling Report has been removed from Figure 6-29 based on its age, the detected concentration relative to the characterization level (45.2 to 45 mg/L), and its position over groundwater impacted by other chemicals (e.g., TCE or perchlorate).

6.4.16 Fluoride

Figure 6-30 illustrates the extent of fluoride in groundwater in Areas I and III at SSFL. In Area IV within Boeing's area, there are no groundwater sampling results with fluoride above its 0.8 mg/L characterization level.

Interpretations of fluoride soil sampling results indicates that there are no locations where fluoride can be directly considered to be a source to groundwater based on professional judgment supported by site data and vadose zone to groundwater transport simulations.

Impacted groundwater above the 0.8 mg/L characterization level for fluoride is found in two separate areas within Boeing's Area I: one within the APTF RFI Site, and around PZ-91 along the southern extent of Area I Road, and at the ECL and STL-IV RFI sites within Area III. Suspected sources at the APTF, ECL and STL-IV RFI sites are likely associated with historic release(s) at the former surface impoundments or ponds. At PZ-91, it is likely that recent results from this location are within the natural variability of measurement considering the methods used to establish the characterization level and the lack of an identified source. The areas of fluoride-impacted groundwater at the three RFI sites fall within the footprint of TCE impacts to groundwater except for the southern portion of the fluoride area of impact at the ECL RFI Site.

The location of fluoride above its characterization level around the RD-36 well cluster noted as being present in the 2016 Annual Groundwater Monitoring and Sampling Report has been removed from Figure 6-30 based on recent sampling results at concentrations below fluoride's characterization level of 0.8 milligrams per liter (mg/L). Additionally, the location of fluoride around RS-3 at the LETF/CTL-I RFI Site noted as being present in the 2016 Annual Groundwater Monitoring and Sampling Report has been removed from Figure 6-30 based on dated sampling results (greater than 30 years), the detected concentration relative to the characterization level (1.5 to 0.8 mg/L), and its position over groundwater impacted by other chemicals (e.g., TCE or perchlorate).

6.4.17 Other Chemicals in Groundwater

Comprehensive evaluations of chemical use areas and sampling results from soil, soil vapor, bedrock and groundwater show limited impacts to groundwater beyond the 16 chemicals characterized above. These evaluations have characterized potential impacts of the following chemical groups: VOCs; semi-volatile organic compounds; polychlorinated-biphenyls, -terphenyls, -dioxins and –furans; pesticides and herbicides; metals and other inorganics; petroleum hydrocarbons; energetics; and radionuclides. These evaluations show that few other chemicals have impacted groundwater at concentrations above characterization levels from sources associated with Boeing's areas; those that have are described below.

Freon-113 (1,1,2-trichloro-1,2,2-trifluoroethane) has been found in groundwater at concentrations above its characterization level of 1,200 µg/L within four wells at the STL-IV RFI site: ES-17 and -27, HAR-32 and RS-33. The suspected source is from small historic releases into the former surface impoundments that are under post-closure care.

Benzene, toluene, methyl tertiary butyl alcohol and tert butyl alcohol have been found in groundwater samples collected from a few wells at the IEL RFI site (RD-73 and -35B) and it is most probable that their occurrence is related to a historic gasoline release.

Methylchlorophenoxypropionic acid, a chemical used as a herbicide, has been in groundwater samples collected from a few wells at the IEL and CTL-III RFI sites.

Samples from wells containing these chemicals at concentrations above characterization levels are also impacted by other chemicals (e.g., see Figure 6-7).

There are no confirmed results of radionuclides above characterization levels in wells monitoring known or potential sources from Boeing's areas of responsibility in Areas I, III and IV.

6.5 SUMMARY

Defining the nature and extent of chemical impacts to groundwater within Boeing's areas at SSFL was initiated with issuance of the Draft Site-wide Groundwater RI Report. Since then, additional field investigations were conducted and samples of various environmental media were collected to refine the nature and extent of chemical impacts to groundwater. Evaluations and analysis of: 1) data reviews to identify chemical use areas, 2) soil, soil vapor, bedrock and groundwater sampling results, and 3) predictive tools to estimate impacts to groundwater from chemicals in the vadose zone coupled with applying professional judgment, have facilitated the identification of chemical sources in soil and bedrock to the groundwater system.

Updates to or differences from groundwater chemical characterization work presented in the Draft Site-wide Groundwater RI Report include:

1. Chemical sources in soil and bedrock within various RFI sites have been identified.

2. Groundwater chemical impacts at concentrations above characterization levels have been confirmed beneath the Area I Burn Pit RFI Site in Area I, but not at the CTL-V and SRE RFI sites in Areas I and IV, respectively.

3. The lateral and vertical extent of TCE and daughter product groundwater impacts eastward along the Happy Valley fault in Area I and south across the Burro Flats fault in Area III have been updated by extension.

4. Additional insight has been gained as to the complexities of fault zones and their influence on: a) source zone architecture, b) the groundwater flow system, and c) chemical contaminant occurrence and distribution.

5. Groundwater chemical sampling results for TCE and its daughter products spanning a period of 30 years have been used to characterize and predict their transport.

7.0 SUMMARY AND CONCLUSIONS

A Draft Site-wide Groundwater RI Report was submitted to DTSC for review in December 2009. The report included a list of data gaps to support characterization completeness. A Data Gap Sampling and Analysis Plan was submitted in March 2010 to fill the identified data gaps. The Data Gap SAP was approved by DTSC (2011a) and field implementation commenced in summer 2011.

DTSC issued comments to the Draft Groundwater RI Report in December 2011. In March 2012, Boeing issued a plan for completing its groundwater characterization program in response to DTSC's comments on the Draft Groundwater RI Report. Boeing's groundwater characterization completion plan was organized to address six general groupings of DTSC's comments to the Draft Groundwater RI Report. Boeing's groundwater characterization completion plan was approved by DTSC (2012b). One of the six comment groupings was being addressed by Boeing's Data Gap SAP. Boeing submitted additional detailed groundwater characterization plans to address general Draft Groundwater RI Report comment groupings on: 1) source zones and plumes, 2) groundwater seeps, 3) faults, and 4) the groundwater flow model. Preparation of a detailed work plan to address contaminant transport evaluations, the sixth comment category, is being deferred with concurrence from DTSC (2014).

Concurrent with work plans to address data gaps in the Draft Groundwater RI Report, a series of four work plans were submitted to evaluate technologies potentially applicable for the vadose zone and groundwater as pre-cursors to the groundwater Corrective Measures Study. Results of implementation of two technology field experiments (in situ chemical oxidation and bedrock vapor extraction) and one laboratory study experiment (biostimulation) provide insight as to local hydrogeologic and chemical contaminant conditions and reactions.

Work performed to complete Boeing's groundwater characterization program since the Draft Groundwater RI Report started in 2010 and includes sample results collected through 2016. Additional work performed to support Boeing's groundwater RFI included:

1. Installation of 35 monitoring wells in source zones and plumes
2. Collection of rock core samples at 13 locations in source zones and plumes and analysis of more than 1,000 rock core samples for 11 VOCs
3. Installation of three Westbay and five FLUTe multi-level monitoring systems
4. Installation of 11 sets and 2 individual seep piezometers to evaluate plume extents or potential off-site transport of site-related chemical impacts
5. Field observations and measurements of fractures and faults and finalization of site geologic map
6. A 2-D seismic survey along about 7,200 feet of fault zones in Area I
7. A pumping test at RD-10 and interpretation of interim measures pumping influences at WS-9A
8. Hydrogeologic characterization of fault zones and detailed potentiometric surface evaluations
9. Collection and analysis of soil, soil vapor, vadose zone bedrock and groundwater samples
10. Community outreach to inform project stakeholders at Groundwater U and periodic public briefings

Use of existing comprehensive hydrogeologic, geochemical, and contaminant data sets coupled with additional geologic characterization work has helped refine the hydrogeologic character of faults. Results and interpretations of pumping and other hydraulic tests and treatment technology field experiments have

yielded additional insights into hydraulic parameters and groundwater flow conditions. This information will be used to update the 3-D groundwater flow model that is a work in progress as of the date of this report.

Identification of chemical use areas and sampling and analysis of potential releases from CUAs yielded an extensive data set that was used to identify and define sources in soil, soil vapor, and vadose zone bedrock that have impacted groundwater. The chemical sampling data set was also used to define and estimate the lateral and vertical extent of impacted groundwater, with a primary focus around TCE in groundwater because of its appreciable use at SSFL and its chemical character. In summary, TCE-impacted groundwater in Area I extends to depths of about 1,000 feet and spans a length of about 1.8 miles, primarily east and along strike of the Shear Zone fault, owing its length to multiple source areas and influences from historic groundwater withdrawals. In Area III, TCE-impacted groundwater encompasses an area of approximately 60 acres. Its transport appears impeded on the southwest by the Burro Flats fault, consistent with the interpretation that the fault zone acts as a partial, low-permeability hydraulic barrier to groundwater flow perpendicular to strike. Within Boeing's areas of responsibility in Area IV, TCE-impacted groundwater apparently sourced from the vicinity of Building 100 extends over an area slightly less than 4 acres. Evaluations of soil and soil vapor sampling results at this RFI site did not identify a source, with its absence attributable to the relatively thin veneer of soil overlying bedrock, coupled with the decades that have passed since a suspected release would have occurred.

All other chemicals that were professionally judged to have also impacted groundwater in Boeing's SSFL geography were evaluated for their nature and extent. Locations where the occurrence and distribution of other chemicals extend beyond the interpreted area of TCE-impacted groundwater are noted in this report and include:

1) 1,4-dioxane sampling results from wells RD-37 and RD-78 west and north of the IEL RFI Site and west of the Shear Zone fault,

2) fluoride south of the ECL RFI Site, and

3) TPH impacts to groundwater at RD-152 and RD-154 at the Boeing Area IV Leachfields and New Conservation Yard RFI sites, respectively.

A transport evaluation of TCE was conducted in Areas I and III by comparing plume extents and mass estimates between two reference time periods as further described in section 6.4.2.1. In summary, little

change in both plume extent and TCE mass estimates was noted for both locations, yielding a strong data-driven field-indicator of stable plumes.

Key Conclusions

- Evaluations of site data and sampling results have identified sources in soil and bedrock that have impacted underlying groundwater, the locations and chemical composition of which should be further evaluated in the corrective measures studies for the surficial media and Chatsworth formation operable units.

- The occurrence and distribution of chemical impacts to groundwater has been adequately characterized to support development and preparation of the CMS for both operable units from the groundwater-as-a-receptor perspective.

- No new off-site impacts to groundwater have been identified as a result of investigations completed since the *Draft Groundwater RI Report*. Available data confirm that impacted groundwater extends off-site to the north of the entry to SSFL at the intersection of Woolsey Canyon and Black Canyon Roads.

8.0 REFERENCES

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Table 1-1

List of Boeing SSFL RFI Sites Included for Groundwater Characterization

Administrative Area	Subarea	RFI Sites (and abbreviation, if applicable)
I	1A North	B-1 Engine Test (B-1) Instrument & Equipment Laboratory (IEL) Area I Landfill (AILF)
	1A Central	Building 1359 (B359) Advanced Propulsion Test Facility (APTF) Happy Valley North (HVN)
	1A South	Laser Engineering Test Facility/Components Test Laboratory I Canyon Engine Test Area (LETF/CTLI) Happy Valley South (HVS)
	1B North	R-1 Pond (R-1 Pond) Bowl Engine Test Area (Bowl)
	1B Southeast	Components Test Laboratory III (CTL-III) Perimeter Pond
	1B Southwest	Components Test Laboratory V (CTL-V) Area I Burn Pit (AIBP)
III	5/9 North	Silvernale Reservoir (Silvernale) Engineering Chemistry Laboratory (ECL)
	5/9 South	Engineering Effects Laboratory, South Section (EEL) Sewage Treatment Plant-3 (STP-3) Compound A Facility Systems Test Laboratory IV STL-IV)
IV	AIV North	Sodium Reactor Experiment (SRE)
	AIV East	New Construction Yard (NCY) Southeast Drum Storage Yard (SE Drum Yard)
	AIV Central	Coal Gasification Process Development Unit (PDU) Boeing Area IV Leach Fields (BIV LF) Engineering Effects Laboratory, North Section (EEL)

Table 2-1
Summary of Key Events in SSFL History

Year	Event
500 A.D.	Chumash, Tongva and Tataviam cultures inhabit the area and leave native pictographs and other sites with significant archeological resources.
1939	The site provides the backdrop for several movies and television shows from 1939 through 1996. Some movies include "Stagecoach," "The Lone Ranger," "Telefon," "Star Trek Deep Space Nine," "I Spy" and "Escape from Witch Mountain."
1947	North American Aviation (NAA) acquires property from the Dundas and Silvernale families and establishes the Aerophysics Laboratory to meet the requirements to static-fire large rocket engines for the U.S. Army Air Corp. The site is later renamed the Santa Susana Field Laboratory.
1948	NAA creates the Atomic Energy Research Department (AERD) to manage its government and commercial nuclear research and development activities.
1949	The first rocket engine test stand, Vertical Test Stand-1, is constructed in "The Bowl" area. It is modeled after a similar structure built at the German Lehesten rock quarries during World War II. The test stands and the control center create the first rocket engine test complex in the nation.
1950	The first rocket engine test – on a Navaho rocket engine – is conducted on Vertical Test Stand-1. It lasts 11 seconds.
1953	The rocket development group conducts operations in Area I, II and III. The nuclear research group conducts operations in Area IV, which becomes a center of excellence for research, development and testing of nuclear, non-nuclear liquid metals and alternative energy sources, including solar.
1954	Canyon Test Area is activated and supports Atlas, Thor and Jupiter rocket engines.
1955	1) NAA creates two separate divisions: Atomics International (AI) and Rocketdyne. 2) Alfa Test Area, located on federal government property and administered by NASA, is activated and supports the Navaho, Thor, Delta and Atlas engines. Two test stands remain as of the date of this report.
1956	1) Bravo Test Area, located on federal government property and administered by NACA is activated. The test stands are used first for combustor research and later for turbo pump development for the F-1 engine, the world's largest single rocket engine. One test stand remains as of the date of this report. 2) Coca Test Area, located on federal government property and administered by NASA, is activated to support the Navaho and Atlas programs.
1957	Delta Test Area, located on federal government property and administered by NASA, is activated to support the Thor program. The linear-aerospike, Lance and J-2 engines are also tested at the stand.
1958	1) The National Aeronautics and Space Act is passed, disestablishing NASA's predecessor, the National Advisory Committee for Aeronautics (NACA). 2) The Canyon Test Area supports testing of the Jupiter C- Redstone engine, which is used to launch the first U.S satellite, Explorer.
1960	Systems Test Lab IV (STL-IV) supports thousands of component and systems test for the Apollo Lunar Module ascent engine and small reaction control engines to maneuver the Gemini and Apollo spacecrafts in flight.
1962	Alfa Test Area supports the first manned orbital flight of an Atlas-powered Mercury rocket engine.
1963	The three Coca test stands are demolished and replaced by two large test stands which are used to test the second stage of the Saturn V launch vehicle. The stands are later

Table 2-1
Summary of Key Events in SSFL History

Year	Event
	modified to test the Space Shuttle Main Engine (SSME) engine system. Two test stands remain as of the date of this report.
1965	The System for Nuclear Auxiliary Power (SNAP) 10A is the first U.S. nuclear reactor to orbit space when it is launched from Vandenberg Air Force Base.
1967	North American Aviation merges with Rockwell Standard to become North American Rockwell.
1973	1) The corporate name changes to Rockwell International. Throughout this period AI and Rocketdyne continue to exist as independent divisions within NAA. 2) NASA acquires 451 acres, formerly known as Air Force Plant 57, from the U.S. Air Force.
1974	Last onsite research nuclear reactor is shut down.
1976	1) The Burro Flats Painted Cave, a prehistoric archaeological site located on federal government property, is listed on the National Registry of Historic Places (NRHP) and the California Register of Historic Places (CRHP). 2) Stormwater at Santa Susana is monitored at drainage locations before it leaves the site.
1977	President Jimmy Carter signs into law The Department of Energy Organization Act of 1977 and creates the U.S. Department of Energy.
1983	The Delta Test Area is modified to support the Propellant Load Facility (PLT), the last manufacturing operation for the Peacekeeper Missile.
1984	1) Atomics International merges with Rocketdyne. 2) Trichloroethylene (TCE) is discovered in water supply wells from historic releases during rocket engine testing. Environmental media characterization work begins.
1987	With oversight by the California Department of Toxic Substances Control (DTSC), groundwater investigations begin and involve installing and analyzing groundwater from wells, investigating the nature of the groundwater system through a series of aquifer tests, mapping of the geology of Simi Hills, and identifying and sampling of seeps and springs.
1988	Nuclear research activities cease.
1990	1) Activities in Area IV focus on decontamination and decommissioning (D&D) of former nuclear facilities. 2) Rocketdyne starts public bus tours.
1992	With approval and oversight by DTSC, more than 16 interim, or temporary, cleanups are completed from 1992 – 2013, amounting to the removal of 50,000 cubic yards of contaminated soil and debris as well as in situ, “in place,” bioremediation.
1996	The Boeing Company acquires the aerospace divisions of Rockwell International, which includes Rocketdyne.
1997	Rocketdyne commissions SSFL’s Groundwater Advisory Panel including world’s leading experts on contaminant transport in fractured sedimentary rock.
2001	The Santa Susana Field Laboratory is named a national historic aerospace site by the American Institute of Aeronautics and Astronautics (AIAA).
2004	Boeing receives a permit under a National Pollutant Discharge Elimination System (NPDES) from the Los Angeles Regional Water Quality Control Board that imposes stringent monitoring and discharge limits on stormwater running off the site.
2005	Boeing sells Rocketdyne to Pratt Whitney yet retains ownership of the Santa Susana Field Laboratory.
2006	Rocket engine testing programs cease. The last rocket engine test is conducted at the Alfa test site in March of 2006.

Table 2-1
Summary of Key Events in SSFL History

Year	Event
2007	1) Boeing, NASA and DOE sign a Consent Order, a comprehensive cleanup agreement, with the DTSC. This enforceable Order provides for a comprehensive investigation and public participation process to ensure that the final cleanup is protective. 2) Boeing commits to preserve Santa Susana as undeveloped open space.
2008	1) The Los Angeles Regional Water Quality Control Board issues an Interim Source Removal Action (ISRA) order to Boeing and NASA to remove contaminated soil at two stormwater catchments. 2) Santa Susana Stormwater Expert Panel, an independent committee of five internationally recognized experts who provide guidance to Boeing and the Regional Board, is created. 3) According to a South Coast Wildlands 2008 report, the Santa Susana Field Laboratory lies within the 125,000-acre Santa Monica-Sierra Madre Connection, one of the few coastal-to inland linkages remaining in California's South Coast Ecoregion.
2009	Boeing designs and constructs advanced stormwater treatment systems at Outfalls 011 and 018 to employ water treatment processes similar to those used by city and county municipalities to make drinking water.
2010	1) In order to remove contaminants from groundwater in source zones, Boeing constructs a groundwater extraction treatment system. 2) NASA and the U.S. Department of Energy sign Administrative Orders on Consent (AOCs) with DTSC committing to the federal agencies to a pre-defined "background" cleanup for portions of Santa Susana.
2012	1) U.S. Environmental Protection Agency (EPA) completes $42 million radiation survey of Area IV. The survey found that low levels of residual contamination from past nuclear energy research affects approximately 40 acres in Area IV. 2) Boeing receives Wildlife Habitat Council's prestigious Corporate Lands for Learning certification for providing public wildlife habitat preservation and restoration education programs.
2013	1) Boeing works with the Santa Susana Stormwater Expert Panel, Pollinator Partnership and the Los Angeles Conservation Corps to design a biofilter as part stormwater treatment, part wildlife habitat. 2) The California Stormwater Quality Association recognizes the Santa Susana biofilter with an Outstanding BMP Implementation Award for providing a creative stormwater solution. 3) Boeing completes its Interim Source Removal Actions to improve water quality in two drainage locations by removing soil to remove constituents that affect stormwater; 25,000 cubic yards of soil is removed.
2016	DTSC is set to release their Environmental Impact Report (EIR), the final cleanup plan for Santa Susana, in the fall of 2016.

Table 2-2
Summary of Operational Activities at RFI Sites
Santa Susana Field Laboratory

Administrative Area or Boeing RFI Subarea	RCRA Facility Investigation (RFI) Site	Summary of Operations and Use
1A North	B-1 Test Area	The B-1 Test Area was used for prototype jet engine testing from the early-1950s to the mid-1970s. Jet engine testing using Jet Propulsion 4 (JP-4) fuels (a mixture of gasoline and diesel) was performed at three test stands, and "exotic" fuels (not defined in records) were tested at a fourth test stand. Solvents were used for cleaning engines at all test stands. Wastes generated at the fourth test stand were conveyed to a 1,000-gallon AST located in the drainage west of the former operational area. Following test operations, the site was used for general equipment storage. Excavation interim measures were performed in 2010 to remove soils with elevated concentrations of dioxins/furans and some metals as part of the Interim Source Removal Action (ISRA). Currently, the site is inactive with most buildings and structures demolished.
	Instrument and Equipment Laboratories (IEL)	The IEL RFI Site was primarily used for the service, repair, assembly, cleaning, and testing of engine valves, manifolds, and instruments since the late 1940s. The primary facilities included various types of laboratories (chemical, instrument, photographic, and propellant testing), an acid wash bay (for cleaning and etching of metallic instruments), a valve test area, machine shops, and other support and storage structures. Other key features at the site included solvent tanks and pipelines, the AI Tower, and fuel storage tanks. Currently, the site is mostly inactive with some offices and storage areas in use.
	Area I Landfill (AILF)	The AILF RFI Site was used from the late 1950s to the early 1970s for disposal of materials generated during construction activities in Area I, including excess fill soils, bedrock, and construction debris, such as asphalt, concrete, timber, scrap metal, and occasional pieces of operational equipment. The area on top of the landfill was also used for fuel truck staging and included various storage buildings, and tank and equipment storage. Currently the site is mostly inactive with only minor equipment storage.
1A Central	Advanced Propulsion Test Facility (APTF)	The APTF RFI Site was used for research and testing of propellants, small rocket engines, and rocket engine components at test stands located in five different test pits from 1953 to 2005. Laser research and testing was also conducted at the site. Primary chemicals used included petroleum fuels, hydrazine, nitrogen tetroxide (NTO), liquid oxygen, liquid hydrogen, fluorine, and other propellants. Discharge from the operational area was directed into two former (excavated, backfilled, and clean closed) surface impoundments for retention and treatment before being released to a drainage leading to R-1 Pond. Currently, the site is inactive and all structures have been removed.
	Building 359 (B359)	The B359 RFI Site was used for energetic testing, research, and storage of solid propellants between 1952 and 1994. Tests were conducted at test cells along the north side of Building 1359 as well as at smaller test structures and areas surrounding Building 1359. Additionally, saltwater conversion experiments were conducted at the Neptune Test Area/Potassium Loop Facility during the 1960s in the northeastern portion of the site. Excavation interim measures (IM) to remove soils with metals/perchlorate impacts were performed in 2003, and biotreatment of perchlorate-impacted soils transported from the HVS RFI Site was performed during 2004-2006, as part of the Happy Valley Interim Measures (HVIM). Currently the site is inactive with structures demolished.
	Happy Valley North (HVN)	The HVN RFI Site area was used to test rocket and gun propellants at the Tunnel Facility and conduct chemical, energetic, and leaser research and testing in the Building 1315 Area from the mid-1950s to the mid-1990s. An excavation IM to remove soils with metals/perchlorate impacts were performed in 2003, and biotreatment of perchlorate-impacted soils transported from the HVS RFI Site was performed during 2004-2006, as part of the HVIM. Currently the site is inactive with structures demolished.
1A South	Happy Valley South (HVS)	The HVS RFI Site was primarily used as a solid propellants test and research facility. From the mid-1950s to 1965, the site was used primarily in support of flare research, development, and production for the military. Between 1965 and 1993, the site was used for rocket propellant research and testing activities. In addition, motor testing was performed at the Motor Test Area and gun propellants were tested the Gun Propellant Test Area. Interim measures for debris and suspect ordnance removal was performed in 1999 (excavation/screening), and for biotreatment of perchlorate in 2003/2004 for the HVIM (excavation and transportation to the B359 and HVN RFI Sites). Currently the site is inactive with structures demolished.
	Laser Engineering Test Facility (LETF)/Component Test Laboratory I (CTL-I)	The CTL-I portion of this site, located northwest of the Area I Road, was primarily used for engine component testing (1950s - 1960s), laser diagnostic studies (1970s to 1995), and as a maintenance facility (since 1996). Cooling water and other liquids generated during testing were diverted into concrete-lined channels which discharged into a steel-lined burn off pit. Pumps and flow meters were also tested in subsurface water vaults at the site. Primary supporting facilities included: test cells, storage tanks, discharge structures (ditches, sumps, burn-off pits), fuel and oxidizer tanks and pipelines, and various machine shops, workshops, and storage areas. • The LETF portion of the site, located southeast of the Area I Road, was primarily used (1950s - 1970) for jet engine testing and combustion heat transfer research, using petroleum fuels, liquid oxygen, and nitrogen tetroxide. Chemical laser component research and development testing using fluorine was also conducted (1970s - 1985). Currently the area is inactive with buildings and structures demolished. Primary supporting facilities included: the LETF Pond, a high vacuum mechanical pumping system, a fluorine scrubber system, test cells, test pads, and associated storage tanks and discharge structures.
	Canyon Area	The Canyon Area was used for testing large, liquid-fueled rocket engines at three engine test stands from the mid-1950s to 1968. Support facilities included: the test stand drainages, Canyon Skim and Retention Ponds, solvent and fuel tanks and pipelines, instrumentation buildings and workshops, and a neutralizing pit. Primary chemical use was petroleum fuels and liquid oxygen (LOX) for testing, and solvents for cleaning purposes. Hydyne, a hydrazine fuel, was used at one test stand. Currently the site is inactive, with above ground test structures demolished.

Table 2-2
Summary of Operational Activities at RFI Sites
Santa Susana Field Laboratory

Administrative Area or Boeing RFI Subarea	RCRA Facility Investigation (RFI) Site	Summary of Operations and Use
1B North	Bowl	The Bowl Area was used for engine testing which supported several programs including the Navaho, Reston, Jupiter, Thor, Atlas, and Saturn programs. The Bowl Area includes the Bowl Skim/Retention Pond, which was an unlined earthen pond with a capacity of approximately 200,000 gallons that was used to collect runoff from the test stand. Other features that supported the Bowl Area operations included the Flame Test Area and the Reclaimed Water Tank Area.
	R-1 Pond	The R-1 Pond is an unlined, approximately 3-million-gallon-capacity pond. R-1 Pond received effluent from STP-1, stormwater runoff, drainage from upgradient areas in Groups 1A and 1B, and wastewater discharge from APTF-1, APTF-2, Canyon Retention and Skim Ponds, LETF Pond, and Bowl Skim/Retention Pond until closure/inactivity of these ponds. The R-1 Pond also received water pumped from Perimeter Pond for reuse in the water reclamation system.
1B Southeast	Component Test Laboratory III (CTL-III)	CTL-III was used for testing gas generators, high-energy, chemical laser testing, hypergol loading and igniter testing, rocket engine testing, and water jet propulsion testing within four buildings, known as modules. Other features supporting the CTL-III operations included the CTL-III spillway and pond, former lube-oil area, laser test facility, high-energy particle optical laboratory, solvent storage area, and underground tunnels.
	Perimeter Pond	The Perimeter Pond is a 0.6-acre, unlined earthen pond with approximately 2 million gallons of storage capacity. Historically, Perimeter Pond received industrial wastewater and stormwater runoff from R-1 Pond, which in turn received wastewater from areas farther upgradient within Administrative Area I. Perimeter Pond also received water from the Property Line Pond, CTL-III, and CTL-V, and AIBP RFI sites.
1B Southwest	Component Test Laboratory V (CTL-V)	CTL-V was used to test rocket engine turbo pumps and turbines. Some of the tests involved using hydrogen to evaluate rocket engine turbines. An oil pump station and associated piping provided oil for lubrication of electric motors during pump test operations. A cooling tower controlled the temperature of the electric motors. CTL-V also included a pretest storage and workshop and a control room. Other features within the CTL-V include aboveground tanks, leach fields, substations and transformers.
	Area I Burn Pit (AIBP)	AIBP was used for the destruction of chemicals by combustion and detonation and operated until 1971. Other disposal activities continued at the AIBP until 1990.
5/9 North	ECL	The ECL RFI Site activities over time included research and development of rocket and gun propellants and new fuel additives, a general chemistry laboratory, and the Continuous Wave Laser Laboratory. The ECL Pond as used to store hazardous wastes, rainfall runoff, and spill runoff from nearby buildings. Various buildings were used for chemical, equipment, and/or drum storage to support ECL operations.
	Silvernale	The Silvernale Reservoir is a 6-million-gallon unlined reservoir used to collect surface runoff since the 1950s. Historically, Silvernale Reservoir received discharge water and surface water runoff either directly or indirectly (via pumping from the R-2 Ponds) from the following: operational areas in Administrative Area II, Administrative Area III, and Administrative Area IV. Dredge material from Silvernale Reservoir may have been deposited north of the reservoir. The Silvernale RFI site reporting area also include an explosives storage magazine, aboveground storage tanks, a nitrogen facility and a former cooling tower.
5/9 South	Compound A Facility	The Compound A Facility RFI site was used in support of Rocketdyne Propulsion and Power operations. It was used for manufacturing of chlorine pentafluoride (Compound A) and also manufactured laser chemicals (nitrogen, fluoride, and antimony compounds). Additionally, the Compound A Facility generated fluorine gas used at Engineering Chemistry Laboratory (ECL).
	Environmental Effects Laboratory (EEL)	The EEL RFI Site within Boeing RFI Subarea 5/9 South encompasses the portion of the RFI site within Area III. Activities over time included a Cryogenic Laboratory and its associated test cells. Activities also included testing various materials under high-pressure hydrogen conditions. Other structures associated with the testing operations included an equipment and material storage building, a mechanics workshop, a hazardous material storage pad, transformers, and aboveground storage tanks.
	Area 3 Sewage Treatment Plan (STP-3)	STP-3 RFI Site was used as a sanitary sewage treatment plant. In addition to sanitary wastes, the treatment plant received cooling tower discharges from non-chromated cooling tower systems and treated groundwater from the site groundwater treatment and recovery system.
	Systems Test Laboratory (STL-IV)	STL-IV RFI Site was used for testing small engines, including the Apollo engines and the axial engines for the Peacekeeper missiles. Various fuels and oxidizers, including monomethyl hydrazine (MMH), nitrogen tetroxide (NTO), and inhibited red-fuming nitric acid (IRFNA), among others, were used over time at different test stands.
Area IV[1]	Sodium Reactor Experiment (SRE)	The SRE RFI Site was used for the operation of a high-temperature, sodium-cooled, graphite-moderated nuclear reactor which operated from 1957 through 1964. Primary support features included the Sodium Reactor Building (B4143), the Southern California Edison (SCE) Steam Power Plant, a Toluene Process Area and Tetralin Heat Exchanger located north of B4143, a Sodium Components Cleaning Area, several ASTs and USTs, and the SRE Pond. The reactor building and associated structures were deactivated in 1968 and decontamination and decommissioning activities took place from 1974 through 1983. The SRE facility was released for unrestricted use in 1985. The site was then used for hazardous waste storage up through 1998. The site is currently inactive and all aboveground structures have been removed.
	New Conservation Yard (NCY)	The NCY RFI Site was used for the temporary storage of equipment and salvageable non-radioactive materials from construction, refurbishing, and dismantling activities at various Area IV facilities between approximately 1977 and the 1990s. In addition, a protective services control building, fire truck canopy, and ash pile were present in the western portion of the site. The site has been inactive since 1997, and all structures have been removed, with the exception of asphalt lining in a portion of a drainage.

Table 2-2
Summary of Operational Activities at RFI Sites
Santa Susana Field Laboratory

Administrative Area or Boeing RFI Subarea	RCRA Facility Investigation (RFI) Site	Summary of Operations and Use
Area IV[1]	Southeast Drum Storage Yard	The Southeast Drum Storage Yard RFI Site was used to store approximately 50 to 100 drums with unknown contents in the early 1960s. The drums were used in forklift exercises and all of the drums have been removed from this area. In addition, a soil disturbance area that has been present intermittently between 1965 and the mid-1990s is located southeast of the SED Storage Yard. The site is inactive and all structures have been removed.
	Coal Gasification Process Development Unit (PDU)	The PDU RFI Site area was in operation from 1958 through 1986 and was primarily used for coal gasification process development, testing of coolants for organic moderated reactors, the production of enriched uranium carbide fuel for the Heavy Water Organic Cooled Reactor, and as a molten salt combustion pilot plant. Except for the Building 4005 concrete building foundation pad, all structures have been removed and the site is inactive.
	Boeing Area IV Leach Field (BLF)	The BLF RFI Site area was in operation primarily from 1958 to 1996 and was primarily used for aerospace assembly and component manufacturing; x-ray development in support of various non-nuclear programs; radiation instrumentation calibration and maintenance; electrical laser laboratory and machine shop operations; and the storage of equipment, radiological sources, and hazardous waste. All structures have been removed from the site except for the northern portion of B4011.
	Environmental Effects Laboratory, Area IV (EEL-AIV)	The EEL RFI Site operated from 1968 through 2008 and primary operations included the testing of the properties of various materials, including carbon and stainless steel under high-pressure hydrogen conditions in B3271. EEL-AIV encompasses the northern portion of B3271, the Cryogenic Test Cells, within Area IV. Structures at the site have been demolished, and tanks have been removed. Paved areas surrounding buildings were removed during 2012 demolition activities.
	Pond Dredge Area	The Pond Dredge Area was potentially used for disposal of dredge materials from Silvernale Reservoir and R-2 Ponds during the 1960s, although documentation of this practice is not available in historical records. In addition to dredge materials, drill cuttings and construction debris were also likely disposed of at the site; during the 2008 RFI investigation concrete, asphalt, and metal debris was found corresponding to known hummocky areas.
	Empire State Atomic Development Authority (ESADA)	The ESADA RFI Site operated from approximately 1960 through 1995. The site was primarily used during the 1960s for testing of sodium-water reaction rates on a modular steam generator mockup. After the late 1960s, the ESADA area was used for drum storage, testing of zirconium hydride (ZrH2) fuel, and the eastern portion of the site was used as a pistol range.
	Southern Undeveloped Land (SUL)	The SUL includes the hillside area south of the ESADA, Pond Dredge, and DOE Leach Field 3 RFI Sites. The SUL includes the Area IV Soil Borrow Area and was mostly non-operational with the exception of a sodium storage pad that was later converted to the Gammagraph X-Ray Building (Building 4865, also known as Building 4173) and the presence of three debris areas and a portion of the STL-IV spray field.
10	N/A	No industrial operations have occurred in Group 10 and no RI Sites are located in Group 10. However, there are six general features of areas with previous chemical detections above background levels or RBSLs and areas where chemicals might have been used or released. These six features included a volatile organic compound (VOC) detection area (north-central portion), drainage channels (east, central, and west drainages), group-wide surface soil (for potential of airborne migration of site contaminants), debris areas, a Department of Toxic Substance Control (DTSC)/public interest area (potential disposal area), and an antenna station area.

Table 2-2
Summary of Operational Activities at RFI Sites
Santa Susana Field Laboratory

Acronyms:
AILF: Area I Landfill
AIV: Area IV
APTF: Advanced Propulsion Test Facility
AST: aboveground storage tank
B359: Building 1359
bgs: below ground surface
BLF: Boeing Leach Field
CTL: Component Test Laboratory
DOE: Department of Energy
DTSC Department of Toxic Substance Control
ECL: Engineering Chemistry Laboratory
EDTA: Nu-Vertan
EEL Environmental Effects Laboratory
EPA: Environmental Protection Agency
ESADA: Empire State Atomic Development Authority
GWTS: Groundwater Treatment System
HVN: Happy Valley North
HVS: Happy Valley South
IEL: Instrument and Equipment Laboratories
IM: interim measures
IRFNA: inhibited red-fuming nitric acid
JP-4: Jet Propulsion 4
LETF: Laser Engineering Test Facility
MMH: monomethyl hydrazine
NTO nitrogen tetroxide
N/A: not applicable
NCY: New Conservation Yard
NOx: Nitrogen oxides
OCY: Old Conservation Yard
PCB: polychlorinated biphenyls
PD: Pond Dredge
PDU: Coal Gasification Process Development Unit
PM: propylene glycol methyl ether
PVC: Polyvinyl chloride
RCRA: The Resource Conservation and Recovery Act
RFI: RCRA Facility Investigation
SCE: Southern California Edison
SCTI: Sodium Component Test Installation
SED: Southeast Drum
SOx: Sulfur oxides
SRE: Sodium Reactor Experiment
STL-IV: Systems Test Laboratory IV
STP-3: Area 3 Sewage Treatment Plan
SUL: Southern Undeveloped Land
SVOC: semivolatile organic compound
SWMU: solid waste management unit
TCA: 1,1,1-Trichloroethane
TCE: Trichloroethene
UST: underground storage tank
VOC volatile organic compound
ZrH2: zirconium hydride

Note:

[1] RFI sites listed within Administrative Area IV in this summary table are included in the DOE Administrative Order on Consent to address soil contamination. Boeing has agreed to complete groundwater characterization for these RFI sites.

Table 2-2
Summary of Operations at RCRA Facility Investigation Sites
Santa Susana Field Laboratory

Area IV	Boeing Area IV Leach Field (BLF)	• The Electric Laser Lab (B4008) • The Sodium Storage Building (B4008) Additional support facilities and operations included: • The B4011 Leach Field • Transformer 4711 • The spray paint room (B4611) • Electronic equipment storage (B4171) • A 1,000-gallon oil and diesel fuel UST (UT-06) • X-ray room and radiological source storage (B4172) • A pipeline extended from OCY and terminating at AST 4735 • Several tanks and one pump station
	Environmental Effects Laboratory RFI Site, Area IV (EEL-AIV)	The EEL-AIV Groundwater Characterization Subarea encompasses approximately 1.5 acres located in the south-central portion of Area IV within the Group 5 Reporting Area boundary. The southern portion of the EEL RFI Site, located in Administrative Area III, is not described in this summary. The EEL RFI Site operated from 1968 through 2008 and primary operations included the testing of the properties of various materials, including carbon and stainless steel under high-pressure hydrogen conditions in B3271. EEL-AIV encompasses the northern portion of B3271, the Cryogenic Test Cells, which was the only SWMU (6.9) or Area of Concern identified in the RFI site. Primary chemicals used or stored included solvents, metals, and oils at B3271; hydraulic oil, and compressed gasses (hydrogen and helium) in various tanks; unspecified hazardous wastes (VOCs, metals, and oil) at the storage pad; and PCBs at the transformer. Structures at the site have been demolished, and tanks have been removed. Paved areas surrounding buildings were removed during 2012 demolition activities. Additional supporting features and operations included: • A hazardous material storage pad • Various ASTs • A transformer pad north of B3271 • Two reclaimed water sprayfields • A storage debris area north of B3271 • A potential fill area identified in aerial photographs
	Pond Dredge (PD) Area	The PD Area RFI Site is approximately 3.6 acres located in the western portion of SSFL in Area IV within the Group 5 Reporting Area boundary. The PD Area was potentially used for disposal of dredge materials from Silvernale Reservoir and R-2 Ponds during the 1960s, although documentation of this practice is not available in historical records. In addition to dredge materials, drill cuttings and construction debris were also likely disposed of at the site; during the 2008 RFI investigation concrete, asphalt, and metal debris was found corresponding to known hummocky areas. Historical documents also indicate that the site may contain a spent-uranium slug dropped from a helicopter during a test that was not recovered during the 1960s, and that there was a release of 1,500 gallons of Nu-Vertan (EDTA) from a tanker truck disposing the material in the field south of the Building 4020 parking lot, which occurred in 1982. During an Environmental Protection Agency (EPA) geophysical survey, several terrain conductivity, magnetometer, and fill areas were identified, and included features such as mounded soil with buried metal and non-metal debris, soil disturbance areas, and one area east of the water pipeline where a debris field and fill area was identified.
	Empire State Atomic Development Authority (ESADA)	The ESADA RFI Site is approximately 2.6 acres located in the western portion of SSFL in Area IV within the Group 8 Reporting Area boundary. The ESADA RFI Site operated from approximately 1960 through 1995. Documentation indicated that chemicals used or stored at ESADA included solvents (Dowanol™ glycol ethers, denatured ethanol, Dowanol PM [propylene glycol methyl ether]); byproducts from sodium-water reactions; wastes associated with PDU containing sulfur, ash, organic compounds; lead shot; zirconium hydride; and radionuclides. The site is inactive and all structures have been removed. Primary operations included: • Testing of sodium-water reaction rates on a modular steam generator mockup • Testing of zirconium hydride (ZrH2) fuel • Drum storage of glycol-based solvents saturated with sodium • Practice Shooting Range

Table 2-2
Summary of Operations at RCRA Facility Investigation Sites
Santa Susana Field Laboratory

Area IV	Empire State Atomic Development Authority (ESADA)	Additional support features and operations included: • Steam supply boiler • High-pressure water storage tank • Sodium storage tank • Reaction products relief tank • A PDU AST area with two horizontal tanks • Three pole-mounted transformers at Pole X-35 • Portions of the disturbed soil area and debris area southwest of the Solar Concentrator Facility • An extensive road grid pattern that appears to have been developed on level areas near ESADA, then extended south to the hillside • An approximately 5,500 square foot hummocky area with soil piles, metals, PVC, and asphalt
	Building 4100 (B4100) Trench[1]	The B4100 RFI Site area is approximately 5.3 acres located in the western portion of SSFL in Area IV, primarily within the Group 5 Reporting Area boundary. Small sections in the northern and western edges of the B4100 Area fall within the Group 8 Reporting Area. The B4100 RFI Site area operated approximately from 1960 through 2008 and primary operations included the testing of 20 different reactor core configurations in B4100 between 1960 and 1974, using thorium, uranium, and high-energy neutron fuels. In additional, documentation indicates that VOCs, SVOCs, petroleum hydrocarbons, metals, inorganics, energetics, perchlorate, herbicides, and pesticides were associated with B4100 and the associated leach field; and PCBs with the transformer substations. The site is currently inactive and Building 4100 (B4100) and, except for a sanitary leach field, the surrounding infrastructure remain in place. Additional supporting features and operations included: • The western half of the distribution line to the B4100 Leach Field • Parking Lot 4509 • Transformer Substations 709 (formerly associated with the B009 RFI Site) and 710 • The northeast portion of a large grid-patterned, cleared vegetation area located south of Parking Lot 4509
	Southern Undeveloped Land (SUL)	The SUL is approximately 71 acres located in the southwestern portion of the SSFL in Area IV within the Group 5 and 8 Reporting Area boundaries. The SUL boundary includes the mostly non-operational hillside south of the ESADA, Pond Dredge, and DOE Leach Field 3 RFI Sites. No SWMUs or Areas of Concern were identified in the SUL. Primary constituents used include oils, alcohols, hydrazine-related compounds, metals, petroleum fuels, and radionuclides. Primary features include: • Three debris areas • A road-grid pattern soil disturbance area • A hilltop soil disturbance and mineralization area • A sodium storage pad that was later converted into the Gammagraph X-Ray Building (B4865, also known as B4173) • Two large water tanks (Tanks 701 and 702) • The western portion of the STL-IV Spray Field • The Area IV Soil Borrow Area located south of the Pond Dredge and DOE Leach Field 3 RFI Sites
10	N/A	No industrial operations have occurred in Group 10 and no RI Sites are located in Group 10. However, there are six general features of areas with previous chemical detections above background levels or RBSLs and areas where chemicals might have been used or released. These six features included a volatile organic compound (VOC) detection area (north-central portion), drainage channels (east, central, and west drainages), group-wide surface soil (for potential of airborne migration of site contaminants), debris areas, a Department of Toxic Substance Control (DTSC)/public interest area (potential disposal area), and an antenna station area.

Table 2-2
Summary of Operations at RCRA Facility Investigation Sites
Santa Susana Field Laboratory

Acronyms:
AILF: Area I Landfill
AIV: Area IV
APTF: Advanced Propulsion Test Facility
AST: aboveground storage tank
B359: Building 1359
bgs: below ground surface
BLF: Boeing Leach Field
CTL: Component Test Laboratory
DOE: Department of Energy
DTSC Department of Toxic Substance Control
ECL: Engineering Chemistry Laboratory
EDTA: Nu-Vertan
EEL Environmental Effects Laboratory
EPA: Environmental Protection Agency
ESADA: Empire State Atomic Development Authority
GWTS: Groundwater Treatment System
HVN: Happy Valley North
HVS: Happy Valley South
IEL: Instrument and Equipment Laboratories
IM: interim measures
IRFNA: inhibited red-fuming nitric acid
JP-4: Jet Propulsion 4
LETF: Laser Engineering Test Facility
MMH: monomethyl hydrazine
NTO nitrogen tetroxide
N/A: not applicable
NCY: New Conservation Yard
NOx: Nitrogen oxides
OCY: Old Conservation Yard
PCB: polychlorinated biphenyls
PD: Pond Dredge
PDU: Coal Gasification Process Development Unit
PM: propylene glycol methyl ether
PVC: Polyvinyl chloride
RCRA: The Resource Conservation and Recovery Act
RFI: RCRA Facility Investigation
SCE: Southern California Edison
SCTI: Sodium Component Test Installation
SED: Southeast Drum
SOx: Sulfur oxides
SRE: Sodium Reactor Experiment
STL-IV: Systems Test Laboratory IV
STP-3: Area 3 Sewage Treatment Plan
SUL: Southern Undeveloped Land
SVOC: semivolatile organic compound
SWMU: solid waste management unit
TCA: 1,1,1-Trichloroethane
TCE: Trichloroethene
UST: underground storage tank
VOC volatile organic compound
ZrH2: zirconium hydride

Note: [1]RFI site is listed as a Department of Energy Site in the Administrative Order on Consent. Boeing has agreed to complete groundwater characterization at this RFI site.

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
AILF	1	1, 2a, 2b, 2c, 2d, 3, 4a, 4b, 5, 6a, 6b, 6c, 6d, 6e, 6f, 6g, 7	**CUA 1:** The Area I Landfill (AILF) (SWMU 4.2) was active from 1949 to the early 1970s. The primary landfill activity occurred from 1953 to 1965, coinciding with the construction of many buildings in Area I. The 2.4 acre landfill was primarily used for disposal of excess soil; however disposal also included construction debris such as asphalt, concrete, timber, scrap metal, and occasional pieces of operational equipment. Historical aerial photos show the natural drainage north of Area I Road as being in filled over time due to landfill activities, forming the flat platform of the AILF site. Facility records do not indicate spills or hazardous chemical disposal. After 1972 up to present, the landfill was used as temporary storage for tanks, site related equipment, soil bins, and storage containers. Based on historical aerial photographs, multiple buildings, tanks, and other features have been present on the landfill; use and identity of most are unknown. **CUA 2a – 2d**: The former Fuel Truck Staging Area was located in the western portion of AILF and was used between 1953 and 1972 for temporary parking of fuel trucks. This area includes the staging area (2c), former Building 1403 south of the staging area (2d), one unidentified tank VXXX-1 (2a) and one unidentified building 1XXX-1 (2b), and both north of the staging area. The staging area is a dirt parking area first observed in aerial photographs in 1953. It was used to stage various fuel trucks which contained multiple types of fuel. After 1972, the area was left unused until the late 1970s when it became used for temporary storage of drums, storage containers, soil bins, and occasionally operational equipment. To the south, Building 1403 is first seen in aerial photographs from 1957. It is unknown if the structure supported truck staging operations; the only known use was as storage for the Advanced Propulsion Test Facility (APTF) RFI Site. It was removed by 1992. The unknown tank VXXX-1 is first observed in aerial photographs from 1957 and was removed by 1964. Its contents, use and size are unknown. The unknown building 1XXX-1 existed between the late 1970s and mid-1980s. Its use and construction material are unknown. **CUA 3**: A potential leach field was identified in the east-central portion of the landfill during the 2003 landfill investigation. No information is known regarding use or dates. Leach field gravels and distribution pipes were observed at depths ranging from 2 to 9.5 feet bgs in several trenches excavated, and were oriented generally in an east-west direction. Given the proximity and orientation of the leach lines, the leach field was likely in use during the 1950s in association with a building at the Instrument and Equipment Laboratory (IEL) RFI Site. The use of leach fields ceased at the SSFL in 1961. **CUAs 4a, 4b:** Building 1765 (4a) and Building 1327 (4b) were present from 1961 to the mid 1970's, and were used for canteen storage and paint storage. The buildings were located in the northeastern portion of the landfill, at the top of the landfill slope. Both buildings were covered structures and have been removed. **CUA 5**: A pad mounted transformer (Tag #259) was located on the eastern portion of the landfill. The period of use of this transformer is unknown and it has been removed. **CUA 6a – 6g:** This CUA includes the unidentified tanks and buildings in the central and eastern portions of the landfill. Unknown buildings 1XXX-2 (6d), 1XXX-3 (6e), 1XXX-4 (6f) and 1XXX-5 (6b) were present at various times from 1957 to 1966, and were covered structures. No information regarding building use is available in historical records. Above ground tanks VXXX-2 (6a), VXXX-3 (6c) and VXXX-4 (6g) were present at varying times between 1977 and 1997, based on aerial photographs. No information is available regarding tank construction, use, or contents. **CUA 7**: In 2001/2002, an investigation was performed at the landfill which identified a subsurface network (10 feet below grade) of storm drain pipeline (MWH, 2004). Then during 2003 and 2004, sections of the pipeline were investigated via exploratory trenches and a video camera to inspect inside parts of the pipeline (MWH, 2003). The main storm drain pipeline trended northwest-southeast through the landfill and conveyed runoff from an inlet within the concrete-lined drainage on the south side of Area I Road at the Building 359 (B359) RFI Site. Runoff from both the B359 and IEL RFI Sites was conveyed by this storm drain pipeline and discharged into the natural drainage north of the landfill. A second pipeline was identified intersecting the main line trending southwest-northeast; the southwestern terminus of this pipeline was not be identified during the field investigation. Subsequent to the investigation, some sections of the pipeline were removed and the southern end of the main line (at the inlet in the B359 RFI Site) was sealed shut at the request of Ventura County Environmental Health Division in 2002.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides • Glycols • Organic tin
AILF	2	8	**CUA 8:** The culvert modification (CM-8) area includes the culvert modification and sediment basin constructed at the storm drain culvert located downstream of a tributary drainage to the Northern Drainage. There are no known or potential operational areas, debris areas, or other features present upstream along this drainage, however the culvert receives road runoff from Service Area Road (Test Area Road).	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
B-1	1	1a, 1b, 1c, 2a, 2b, 3, 4b, 4c, 4d, 4g, 5a, 5b, 8, 9, 10, 11, 12, 14	**CUA 1a, 1b, 1c:** Engine Test Stands 1, 2, and 3 (SWMU 4.1) were used for large jet engine testing between early-1950s and mid-1970s. Engine testing used JP-4, a mixture of gasoline and kerosene fuels. Following engine test firings, engines were flushed with organic solvents including TCE, PCE, MEK, and acetone. Locations of solvent storage are not documented for the site. Facility drawings (1950s) indicate slosh, leakage, and pressure tests at former Test Stands 1 through 3. B-1 Test Stands were inactive after the late-1970s. After testing operations ceased and until 1999, the former test stands and surrounding area were used for equipment storage and as part of the Old Property Yard (CUA 12). The site became inactive in 1999. During subsurface pipeline removal activities in 2011, a small release of hydrocarbon/water mixture occurred during removal of an abandoned fuel pipeline on the west end of CUA 1a. Visibly impacted soil was removed and confirmation samples collected. **CUA 2a, 2b:** Engine Test Stand 4 (SWMU 4.1) was used for large engine testing activities from the mid-1950s until the mid-1970s, utilizing JP-4 and other "exotic" non-petroleum fuels. "Exotic" fuels are not specified, but may include hydrazine and pentaborane based on historical SSFL operations. Following engine test firings, engines were flushed with organic solvents including TCE, PCE, MEK, and acetone. Locations of solvent storage are not documented for the site. Test Stand 4 waste flowed northwest from a drain on the pad, through a pipeline to a 1,000 gallon AST (CUA 2b). The AST and test stands were removed around 1999. During ISRA data gap sampling in 2010, green subsurface staining was observed between 7.5 to 12.5 feet bgs (bedrock) in the western drainage near the former waste AST location. **CUA 3**: Fuel (JP-4) for engine tests was stored in three USTs located between Test Stands 2 and 3. Tanks UT-39 and UT-40 each had a 10,000-gallon capacity and Tank UT-41 had a 20,000-gallon capacity. The tanks were removed under VCEHD oversight in 1984. Soil was excavated to the bottom depth of the USTs and the area backfilled with imported soil. Fuel contamination in soil was observed during the tank removal. In 2010, during ISRA excavation activities, several subsurface pipelines were uncovered, some with mastic wrapping. At this time, an abandoned fuel line extending southwest from the UST area was identified. In 2011, small release of hydrocarbon/water mixture occurred during pipeline removal; visibly impacted soil was removed and confirmation soil samples collected. **CUAs 4b, 4c, 4d, and 4g**: One pole-mounted transformer (CUA 4b) is located northwest of Building 1445 in an area sloping southwest towards the B-1 drainage. Three pole-mounted transformers (CUA 4c) are located south of Building 1351 in a southwest-sloping area. One pad-mounted transformer (CUA 4g) and four pole-mounted transformers (CUA 4d) were formerly located west of Test Stand 1. The transformers and pad were removed prior to the July 2005 Transformer Survey. **CUA 5a, 5b**: Building 1312 (CUA 5a) was primarily a workshop and engine test shop during the mid-1950s to mid-1970s, although igniter storage and propellant processing were also performed at this building. From the mid-1970s to late-1990s, the building was used as an office space and storage facility, with equipment stored around the building. The building was removed in early 2000. The Building 1312 Leach Field (CUA 5b) was constructed in 1948 to treat sanitary waste water from the Engine Test Shop (Building 1312) and the Facility Control Center (Building 1351). The area above the leach field was paved in the 1950s and served as a parking lot. Sanitary waste water was conveyed from Buildings 1312 and 1351 to a 750-gallon septic tank that drained to an 85 feet by 30 feet area containing four gravel-lined trenches, each 7.5 feet wide. The leach field trenches are approximately 3 feet to 4 feet bgs based on soil borings. The leach field was active until late 1990 when the B-1 Test Stand buildings were removed. The leach field and septic tank are currently in place. **CUA 8**: Building 1444 was a Jet Weld and Workshop that supported B-1 Test Stand activities during jet engine testing conducted between 1957 and mid-1970s. Details regarding activities and chemicals used are not available. Once engine testing was terminated, Building 1444 was used as storage for non-hazardous materials. **CUA 9**: A water pumping station (Building 1778) is adjacent to V-814, a 100,000-gallon water AST that supplies water to Santa Susana. Pump station equipment includes two 200 hp pump motors, two 1200 GPM pumps, and two motor starters. The pump station structure consists of a concrete pad and awning that contain all equipment. **CUA 10:** Building 1445 acted as a B-1 support structure when testing was active. Once testing operations ceased, Building 1445 was used as a Class C Explosives storage area. **CUA 11**: Building 1357 was used as an instrument and jet engine storage building in support of testing activities. **CUA 14**: A buried layer of burnt debris was uncovered during ISRA excavation activities within the western drainage in 2010. Approximately 10 cubic yards of material was removed, with portions under Coast Live Oak trees left in place at depth due to the protected species status of these trees.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides • Asbestos • Radionuclides

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
B-1	2	15a, 15b	**CUA 15a:** Dioxin Release Area along the V-808 Access Road connecting the B-1 operational area with water tank V-808 on the hillside east of the B-1 test stands. Source of dioxin impacts is unknown and currently under investigation. **CUA 15b:** During 2009 B-1/OPY demolition activities, a mercury release occurred when a pipeline switch was broken. The spill area was approximately 200 square feet and visually impacted soil was excavated after the spill occurred. Confirmation soil samples were collected following soil removal.	• VOCs • SVOCs • TPH • Metals and inorganics • Dioxins/furans • Energetics • Radionuclides
B-1	3	4e, 7a, 7b, 16	**CUA 4e:** Three pole-mounted transformers (tag numbers not known) mounted on power pole SCE at the southwest corner of Building 1N. **CUAs 7a and 7b:** The GN_2 Pump House (Building 1N, CUA 7a) transferred gases from offsite via a pipeline along Black Canyon Road and distributed them for site operations. The Pump House was constructed in 1964 and remained in operation until the late 1990s. Pump house equipment included compressors and two cooling towers. A small shed (Building 1XXX-002) was located adjacent to the former pump house. An unidentified structure (CUA 7b) was documented approximately 60 feet west of the GN_2 Pump House (CUA 7a) in an aerial photograph dated 1967. **CUA 16 (previously potential CUA A):** A large cleared area northwest of the B-1 parking and storage areas (CUAs 6c and 6d) was identified in aerial photographs from 1959 to 1972. Screening sampling was conducted at this parking/storage area, and based on detection of lead, PCBs, and BaP, the westernmost portion of the potential CUA was carried forward as CUA 16.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Energetics • Herbicides and pesticides • Asbestos
B-1	4	4f, 6a, 6b, 6c, 6d	**CUA 4f:** Three pole-mounted transformers (Tags 250, 251, 252) on power pole B172B. During the July 2005 Transformer Survey, no staining, rusting, or leaking was observed. **CUA 6a:** Former Building 1435 was used as a shipping and receiving warehouse from approximately 1964 through early 1980. The shipping dock was located on the northeastern face of the building; the dock was covered by an awning and contained four grate-lined trenches used to drain water to the paved area north of the building. In the mid-1980s, Building 1435 was converted to a machine and weld shop. An awning-covered support area (Building 1XXX-001) was located approximately 10 feet west. Building 1XXX-001 housed an air compressor, press brake, bending roll, and hydraulic shear. Both buildings were removed in 2008 along with surrounding asphalt paving. **CUA 6b:** Several former concrete structures located in the northern section of the fenced B1435 operational area were identified during site visits. The use of these structures is unknown. One appears to be a concrete containment structure that contained three concrete risers with ½ inch steel pipe exiting the west side of the structure. Nine other structures, formerly located along the northwest fence that surrounds the B1435 operational area, are believed to be pipe supports for the nitrogen gas pipeline from the former GN2 Pump House (CUA 7a). These features and surrounding asphalt paving were removed in 2008. **CUA 6c and 6d:** Storage areas identified during aerial photograph review located at the Lower Parking Lot west of B1435 (6c) and adjacent west and north of B1435 (6d). A portion of the B1300 leach field (IEL CUA 10d) lies within the southwestern part of CUA 6c; this feature is discussed as a part of the IEL Reporting Area.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics • Pesticides • Glycols • Terphenyls • Radionuclides
B-1	5	4a	**CUA 4a:** One transformer (Tag #241) is mounted on power pole B65 just outside the Santa Susana entrance.	• VOCs • TPH • Metals • PCBs • Dioxins/furans
B-1	6	13	**CUA 13:** The Woolsey Canyon Water Tank drum staging area is a former unpaved storage/staging area identified in an aerial photograph dated January 1981. Storage was not observed after 1981 and the full operational use period or materials stored are unknown.	• VOCs • SVOCs • TPH • Metals

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	1	1a, 1b, 1c, 1d, 1e, 1f, 1g, 2a, 2e, 3b, 6d, 16f, 16g, 16n, 19b	**CUA 1a:** From the late 1940s until 2006 when operations ceased, Building 1301 was used as an Equipment Laboratory for servicing and testing engine valves and manifolds. A distillation unit was installed in 1975 outside the northwestern portion of the building for recycling TCA; two, 1,500-gallon TCA tanks were located outside the distillation unit in a containment berm. In 1987, 175 to 200 gallons of TCA spilled from the distillation unit across the Area I Road into the drainage ditch. New information during the 2010-2011 historical document review identified a 15-gallon TCE spill at the bermed cleaning pad (near CUA 1d) which occurred in 1983. Historical documents also identify a 1-ton and a 2-ton cooling tower at Building 1301 with exact locations unknown. In 2009, staining was observed at the former distillation unit and paved area west of Building 1301. **CUA 1b:** Acid Bay used for cleaning and etching metallic instruments using acids and solvents from the 1950s until 2006. Acids were reportedly neutralized with caustics prior to disposal. The area contained a degreaser, oil drum and clarifier, and several dip tanks containing acids, solvents, and petroleum-based cleaners. During 2008 demolition activities, the Tank Containment Sump was discovered to be corroded and exposed to soil, containing liquid waste and debris. **CUA 1c:** A pipeline reportedly drained wastewater from the Acid Bay Floor Sink (CUA 1b) to the Northern Drainage from the 1950s to the 1980s. The pipeline reportedly ran northeast from the Acid Bay to the Northern Drainage. A storm drain line, located east of the Acid Bay, runs north along Building 1436, turns northeast running along the Area I Road, turns northwest down into the Lower Parking Lot, and into the Northern Drainage. **CUA 1d:** A 3,000-gallon solvent waste UST associated with Building 1301 and was removed in 1987. In 1983, a 15-gallon TCE spill occurred and is described in CUA 1a. **CUA 1e:** V-401 was a 3,000 gallon TCA tank located to the south of B1301 (CUA 1a) and the Acid Bay (CUA 1b) in concrete secondary containment and was connected with B1301 via an overhead pipeline hanging over the generally flat, asphalt-lined Valve Test Area (CUA 1b). **CUA 1f:** A TCA supply pipeline ran from the Building 1301 TCA ASTs to Building 1324 Instrument Laboratory. The pipeline ran below grade along Building 1301, across the Area I Road (placed in a grated trench), to the west side of Building 1324. **CUA 1g:** A cooling tower was located within the secondary containment concrete berm around the TCA ASTs at Building 1301 Equipment Laboratory (CUA 1a). **CUA 2a:** Beginning in the 1950s, the Valve Test Area was used to support Building 1301 Equipment Laboratory (CUA 1a) operations. Hydraulic fluid was used to test valves. A former test stand exists between Buildings 1443 and 1791, which were used as hydraulic valve test cells. Building 1982 was noted as an Explosion Chamber in facility drawings. The area was demolished in 2008. **CUA 2e:** A 1,000-gallon AST was located to the east of the Building 1266). North of the building were several hydraulic pumps, an actuator, a 60-gallon hydraulic oil tank (V-474), and hydraulic oil pipelines. Above-grade features and the concrete foundation were demolished in 2008. During 2011 ISRA activities, stained soil was removed. **CUA 3b:** Facility diagrams showed a waste collector drum to the northeast of the GN2 Compressor Area, but was removed prior to facility inspections. **CUA 6d:** UT-44 was used to store diesel fuel oil next to Building 1301, was removed in 1987, and clean-closed by VCEHD. **CUAs 16f, 16g, and 16n:** Transformers: one pad-mounted (Tag #11) located at Substation 521; one pole-mounted (Tag#12) located southwest of Building 1791; and one pad-mounted transformer located on the northwest side of Building 1443. **CUA 19b:** An unidentified vertical structure was identified in a 1950's historical photo. The structure was adjacent to known waste storage areas identified in aerial photos dated 1959 through 2005.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Glycols • Radionuclides
IEL	2	10d, 12, 23a, 23b, 23c, 24	**CUA 10d:** Building 1300 Leach Field received wastewater generated at the Building 1300 Chemistry Laboratory and Warehouse (CUAs 10a and 10b). The leach field consisted of a 3,000-gallon septic tank draining to 17 leach lines each 100 feet long, 4 feet deep, and spaced 3 feet apart. The leach field was operational from the 1940s through 1961 when it was abandoned in-place. **CUA 12:** The Safety Demonstration Area was reportedly used during the early/mid-1950s for demonstrations using mixtures of liquid oxygen and alcohols or fuels.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and inorganics

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	2	10d, 12, 23a, 23b, 23c, 24	**CUAs 23a, 23b, and 23c:** The Lower Parking Lot Subsurface Staining (CUA 23a) was uncovered while investigative trenching during asphalt removal activities. At the two locations chosen within the planned BMP footprint, stained soil was encountered at 3.5 feet to 7 feet bgs and in the second location from 1 foot to 10 feet bgs, with staining observed in weathered bedrock from 10 feet to 12 feet bgs. During Lower Parking Subsurface soil staining was also observed within the sidewalls and floor of trench and cistern area excavations (CUAs 23b and 23c) during Lower Parking Lot BMP construction in 2012. Stained soil was observed ranging between one foot bgs up to 14 feet bgs. **CUA 24:** During 2012 asphalt removal activities at the Lower Parking Lot, waste characterization sampling conducted by Boeing revealed lead-impacted road base gravel present beneath the asphalt on Sage Ranch property. The impacted road base has been removed.	• Dioxins/furans • Energetics and perchlorate • Pesticides • Alcohols and glycols • Terphenyls • Radionuclides
IEL	3	6f, 6g, 7a, 10a, 10b, 10c, 10e, 10f, 16j, 22g	**CUA 6f:** This fuel tank was identified in facility drawings located along the north wall of Building 1304. The size, specific contents, and tank number are unknown. **CUA 6g:** UT-4 was a 1000-gallon diesel fuel oil UST located south of Building 1300. The tank was removed in 1987 and clean-closed by VCEHD. **CUA 7a:** Building 1304 Photographic Laboratory was used as a cafeteria, classroom, and a dark room from the 1950s through 1998 when the building was demolished. Building 1304 contained a 5-ton AC unit that was noted to be corroded and leaking. **CUA 10a, 10b, 10c, and 10f:** Building 1300 Chemistry Laboratory, Warehouse, and Clarifier. The western portion of Building 1300 was used as a chemistry laboratory (CUA 10a). The eastern portion of the building was engineering offices and a logistics warehouse (CUA 10b). Chemistry laboratory operations were conducted from the 1950s until 2003 and included fuel technology, combustion, acoustics, spectrograph analysis, instrument analysis, physics, environmental media, and general chemistry laboratories. Building 1300 contained two 50-ton cooling towers that were noted as corroded and leaking; the building was demolished in 2012. Wastewater generated in the laboratory collected in lab sinks and floor drains was routed, via underground piping, to a 6 x 10 x 6 foot concrete clarifier (CUA 10c) located west of the warehouse. The clarifier discharged to the B1300 Leach Field (CUA 10d) while it was operational, and to the sewer system after the leach field was abandoned. Three concrete secondary containment structures (CUA 10f) were noted west of the clarifier during the 2008 Debris Survey. Specific use and history of these structures was not documented. An unknown vertical, corrugated metal pipe was located west of B1300 during the July 2012 building demolition. The exact use of this pipe is not documented; however, it is believed to be the cleanout associated with the B1300 septic tank. **CUA 10e:** Building 1386 was used storage for the Building 1300 Chemistry Laboratory. This building was a small metal shed approximately 16 x 12 feet and 8 feet high, sitting on a compressed wood foundation. A Toxics Shack was located south of Building 1386. The specific use of the Toxics Shack was not documented. **CUA 16j:** Transformer pole was identified on a facility drawing north of Building 1304. The ID and number of transformers are unknown. Transformer is removed. No staining was observed during a 2008 inspection. **CUA 22g:** Debris Area MWH-G1A-3017 is an approximately 2,450 square foot debris area discovered on 2/8/2008 containing disturbed soil, rusted metal pipe, fencing, and a rusted metal locker. The debris has been removed; the soil piles remain in-place.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Pesticides • Glycols • Terphenyls • Asbestos • Radionuclides
IEL	4	4a, 4b, 5a, 5b, 5c, 6e, 15a, 16c, 16e, 22k	**CUAs 4a and 4b:** Building 1324 (CUA 4a) was used as a machine shop from the 1940s to 1950s. Building 1322 (CUA 4b) was also used as a machine shop, likely after the Building 1324 machine shop operations discontinued. Building 1322 contained several lathes, grinders, and a weld booth. Building 1324 was used as an Engineering Building and Library between 1958 and 1968. In 1972, the building was converted from offices to the Instrument Laboratory and Test Operations Recording Center. The eastern half of the building was used as a computer recording center, and the western half was used to calibrate, service, clean, and disassemble engine instruments such as pressure transducers, thermocouples, and flowmeters. Calibration machines in the north portion of the building utilized small amounts (few gallons) of hydraulic oils. Waste generated at the laboratory was storage on the platform outside (west) of the building (CUAs 5a and 5b). Operations continued in Building 1322 until the mid-1990s and in 1324 until 2006. Building 1322 was demolished in the mid-1990s and remaining aboveground structures removed in 2008. Building 1324 was removed, along with all aboveground structures and surrounding pavement, in 2009. **CUAs 5a, 5b and 5c:** Tank V-269 (CUA 5c) was a 500-gallon polyethylene AST located on an elevated concrete platform outside (west) of Building 1324. The tank was used for storage of hazardous waste generated at the Instrument Laboratory. Secondary containment was placed around the tank in the early 1970s. Wastes stored in the tank consisted of approximately 80 percent water, 5 percent Freon 113, 5 percent isopropyl alcohol, and 5 percent oxalate. Waste was transferred via subsurface pipeline (CUA 1f) to Building 1301 distillation unit (CUA 1a) for recycling. In 1993, the waste pipelines were disconnected, and wastes were stored in a 55-gallon stainless steel drum (CUA 5a) north of V-269. Directly east of CUAs 5a	• VOCs • SVOCs • TPH • PCBs • Metals • Organotins

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	4	4a, 4b, 5a, 5b, 5c, 6e, 15a, 16c, 16e, 22k	and 5c, inside Building 1324, was a spray paint booth (CUA 5b) which was connected to the V-269 hazardous waste tank. All features associated with CUAs 5a, 5b, and 5c have been removed. **CUA 6e:** UT-47, located at the southwest side of Building 1324, was used for diesel fuel oil storage to operate backup power generators at Building 1324. The tank was buried approximately 7 to 10 feet bgs. UT-47 was reportedly installed in 1959 and removed in 1987. Tank closure was approved by VCEHD in 1994. **CUA 15a:** Location was identified as an equipment storage station, north of Building 1324. **CUA 16c:** Capacitor Pole B163, located outside the northwest corner of Building 1324, consisted of 6 pole-mounted capacitors. The capacitors were removed sometime prior to 2005. In 1982, the capacitors were documented to have been leaking for two hours with PCB-containing liquid falling onto sandbags surrounding the pole. **CUA 16e:** Three pad-mounted transformers (Tag #s 5, 6, and7) located outside the northeast corner of Building 1324. The transformers are in-place, but are inactive. No staining was observed during a 2003 inspection. **CUA 22k:** ISRA 2010 excavation area IEL-1 uncovered a buried debris layer containing metal shavings, asphalt, and concrete. Debris within the excavation boundary was removed; however, debris was left in-place along the western sidewall of the excavation.	
IEL	5	6a, 6b, 6c, 7b, 8a, 8b, 9a, 15h, 16b, 21	**CUA 6a:** A gasoline station for onsite vehicles (Building 1321) was located in the parking lot west of Building 1324. UT-38, a metal UST, was located beneath the gas station and likely installed (unknown) and used during the 1950s to 1970s. UT-38 was removed in 1986 and replaced in 1987 with UT-37, a double-walled UST. Both tanks were 10,000-gallon capacity. In May 1987, a gasoline spill of 800 gallons occurred at UT-37; the tank was removed and 400 cubic yards of soil was excavated to bedrock (23 ft bgs). UT-37 was reinstalled in September 1988 and used until removal in 1993. **CUA 6b:** UT-67 was a 4,000-gallon diesel storage UST used for vehicle fuel. Removed in 1986, the tank was located in the asphalt-paved parking lot west of Building 1324. **CUA 6c:** The fueling station was located in the asphalt-paved parking lot west of Building 1324, near the driveway into the parking lot. **CUA 7b:** Building 1361 was identified as a photographic laboratory in facility drawings. The former location of the building is located in the parking lot area west of Building 1324. **CUA 8a:** Building 1377, which operated as a paint shop; removed in the late 1980s based on review of aerial photographs. **CUA 8b:** Building 1748, which operated as a paint storage shed; removed in the 1960s based on review of aerial photographs. **CUA 9a:** Several unknown buildings were located in the paved area west of Building 1324. Based on aerial photos and facility diagrams, the buildings were built throughout the late 1950s to 1970s. The buildings in this area included Building 1976 and two unidentified buildings. Operational history at these buildings is unknown, and all were removed by the 1970s. **CUA 15h:** Storage yard and unidentified structure noted west of B1324 in aerial photos dated 1953 through 1988. This area includes B1712 and previously unknown B1743, identified as storage docks for the Instrumentation Lab in historical documentation. **CUA 16b:** Three pole-mounted capacitors were located on power pole B155 and were removed prior to 2005. **CUA 16d:** Three concrete pad-mounted transformers (Tag #: 2, 3, 4) were located adjacent to Building 1324. **CUA 21:** A cooling tower was located on the southeast side of Building 1436.	• VOCs • SVOCs • TPH • PCBs • Metals • Organotins • Asbestos

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	6	9b, 15d, 15e, 15f, 15j, 16h, 16i, 16q, 17, 18, 19a, 27	**CUA 9b:** Small (approximately 20 square feet) unidentified structure noted south of Building 1436 in aerial photo dated 1957. **CUA 15d:** Building 1408 and surrounding storage area. B1408 was built in the 1970s and was used as a material shipping and receiving warehouse. Historical documents show that pipe bombs containing RDX were stored at Building 1408. **CUA 15e:** Building 1407 and the adjacent fenced-in yard were used for engine, equipment, parts storage, and raw stock storage. **CUA 15f:** Buildings 1992 and 1993, located northwest of the storage yard and in the north corner of the storage yard, respectively, was used for acceptance engine storage. The buildings were demolished in the early 1990s. **CUA 15j (previously PCUA A):** A storage yard noted east of Building 1436 at the location of former Building 1XXX-14 in aerial photos dated 1990 through 2005. **CUA 16h:** Three pad-mounted transformers (Tag #: 8, 9, 10) were located at substation 1-B-180. Transformers are in-place, but are inactive. **CUA 16i:** One pole-mounted transformer (Tag #: 449) as located on a hill slope southeast of the former Building 1993. The transformer is removed. **CUA 16q:** A fenced-in concrete pad was observed on a building inspection in July 2008. The pad appeared similar to other transformer pad, but there were no existing transformers. **CUA 17:** Building 1303 was a propellant laboratory in the early to mid-1950s. The lab contained a Control and General Analytical Chemistry Lab room, a Solid Propellants and Components Lab room, and a Physical Properties of Propellants Lab room. A drain line ran from the southeast corner of the propellant laboratory to an industrial dry well to the east of the building (CUA 18). **CUA 18:** An industrial dry well was located east of the Building 1303 in a former topographic low spot. The well was found on a facility drawing, which indicated a drain line ran from the building into the well. **CUA 19a:** An unknown vertical structure was identified in a historical photo from the mid-1950s in this area. Exact location of the vertical structure was difficult to pinpoint due to the perspective of the photograph, but is likely located east of Building 1744. **CUA 27 (previously PCUA H):** A potentially mastic-wrapped natural gas pipeline system.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Energetics and perchlorate • Glycols • Asbestos
IEL	7	1h, 2b, 3a, 15b, 15i	**CUA 1h:** Storage yard and unidentified structure noted west of Building 1301 and adjacent to known waste storage areas in aerial photos dated 1959 through 2005. **CUA 2b:** Facility diagrams show a hydraulic pump unit located next to Building 1986 on an approx. 10’ x 10’ concrete pad. The pump unit is no longer in place. In 2009, potential staining was observed during demo activities. **CUA 3a:** This is a waste storage area noted west of Building 1301 and adjacent to known waste storage areas. Specific wastes stored were not identified in reviewed documentation. **CUA 15b:** Building 1986 was a thrust chamber storage area from the late 1950s to the mid-1970s. Building 1987 was a small building identified as storage. The yard surrounding the buildings was also used for storage. In 2009, potential staining was observed during demo activities. **CUA 15i:** Storage yard and unidentified structure noted west of Building 1301 and adjacent to known waste storage areas in aerial photos dated 1959 through 2005. During 2009 demolition work, soil staining was observed at one location at the corner of the concrete paved area west of B1301.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Perchlorate • Glycols
IEL	8	2c, 2d, 14, 15c, 15g, 16o	**CUA 2c:** Facility drawings show this concrete pad may have been used as storage for hydraulic oil drums. **CUA 2d:** Two GN2 compressors, removed in 2008, had been mounted on a concrete pad on a bedrock outcrop. The compressors contained small tanks of a few gallons each to store hydraulic oil. During demo activities, oil staining was observed beneath the pad. **CUA 14:** Building 1396 was used as an igniter and explosives storage building.	• VOCs • SVOCs • TPH • PCBs • Metals

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	8	2c, 2d, 14, 15c, 15g, 16o	**CUA 15c:** The storage area included three storage buildings or canopies (Building 1989, Building 1991, and Building 1303). Building 1989 (canopy) was used as a TSC (unknown acronym) and valve storage area. Building 1991 was a portable canopy chamber storage area that was in place from the late 1950s to the 1990s. Building 1303 was used as a fire storage building or security building in the late 1950s. Another previous building, the Propellant Laboratory (CUA 17), was also identified as Building 1303 prior to this building. **CUA 15g:** During a building inspection of Building 1386 in 2008, a suspected storage area was identified. Historical photographs confirmed storage in this graded area. Storage contents are unknown. **CUA 16o:** One transformer was located on the south corner of the Building 1744 concrete pad. The transformer was removed at an unknown date.	• Dioxins/furans • Energetics and perchlorate
IEL	9	13, 16m	**CUA 13**: The AI Tower was a former oil derrick located on a concrete pad northeast of B1436 used in support of Sodium Reactor Experiment development in Area IV. The tower was used as a mockup facility to test for problems arising from changing long vertical fuel elements under an inert atmosphere. In the 1960s the AI Tower area was used for igniter development; several small trailers, buildings, and a cooling tower were located in the area at this time. Structures were largely removed from the area in the 1970s and early-1980s; concrete pads were removed and the area was demolished in 2008. **CUA 16m**: Substation 1-B-240, located north of the AI Tower area, consisted of three pad-mounted transformers. Transformers have been removed.	• VOCs • SVOCs • TPH • PCBs • Metals • Energetics and perchlorate
IEL	10	16l, 16p, 20a, 20b	**CUA 16l:** One pad-mounted transformer (Tag #: 448) was located on the northeast side of Building 1436, in the SHEA Parking Lot. **CUA 16p:** One transformer was located on the southeast side of Building 1436. Transformer pad is located next to a steep gunite slope to the north. **CUA 20a:** Building 1436 Cooling Tower **CUA 20b:** In 1995, the bellows in the air conditioning (A/C) unit in Building 1436 ruptured, causing 200 pounds of oil and Freon to spill. The A/C unit was located on the southeast side of Building 1436.	• SVOCs • TPH • PCBs • Metals
IEL	11	11, 16a, 22h, 22l, 22m	**CUA 11:** During the 1940s - 1960s, a leach field connected to the Building 1324 (CUA 4a) sanitary system was installed. The leach field comprised a 3,000-gallon septic tank and eight leach lines. It was abandoned-in-place and replaced by a sanitary sewer system in 1961. **CUA 16a:** Three pole-mounted transformers (Tag # 256, 257, 258) were located on power pole 167. Transformers were removed prior to 2005. **CUA 22h:** Debris Area MWH-G1A-3005 is an approximately 450 square foot debris area discovered on 2/7/2008 containing broken pieces of clay pipe, asphalt, and concrete. Clay pipe was removed on 2/11/2010. **CUA 22l:** Debris Area MWH-G1A-1010 is an approximately 450 square foot debris area discovered on 2/8/2008 containing soil, a concrete slab, and clay pipe fragments. Concrete slab was removed on 2/10/2010. **CUA 22m (previously PCUA I):** An approximately 400 square foot debris area (MWH-G1A-3000) discovered on 2/7/2008 containing soil, asphalt, and road debris. Asphalt was removed in 2/10/2010.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Pesticides • Alcohols and glycols • Organotins • Radionuclides
IEL	12	22a, 22b	**CUA 22a:** A partially exposed, rusted metal cylinder (18" diameter, 4" tall) and an exposed pipe (1/2" diameter, 2' long) were discovered during the 2008 Waste Debris Survey. The debris was located along a hill slope to the east of the IEL RFI Site. **CUA 22b:** A metal pipe was found lying on the ground on the top of a hill during a site walk in 2008. The pipe was approximately 10 feet long and 6 inches in diameter. The debris was located at the top of a hill to the east of the IEL RFI Site.	• VOCs • SVOCs • TPH • Metals and inorganics • Dioxins/furans • Perchlorate

Table 6-1a – Subarea 1A North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
IEL	13	22c, 22d, 22e, 22f	**CUA 22c – 22f:** A transite pipe was discovered during the 2008 Waste Debris Survey. The pipe was likely used as a conduit for telephone wires. The pipe ran along a blind drainage to the east of the IEL RFI Site; the drainage does not receive surface water from an operational area of the IEL RFI Site. The area has broken, scattered pipe fragments along this transite pipeline.	• SVOCs • TPH • Metals and inorganics • Asbestos
IEL	14	22i, 22j, 22k, 22l, 22n, 22o, 22p, 22q, 22r, 22s, 22t, 24, 25, 26	**CUA 22i:** Debris Area MWH-G1A-3059 is an approximately 9,400 square foot debris area identified on 10/30/2009 containing broken pieces of concrete and asphalt. Debris was partially removed November 2009. **CUA 22j:** LOX Debris Removal Area Debris Area ND-6, discovered during the July 2007 Leased Area Survey, is a large debris area containing construction debris including insulation, drywall, and metal. **CUA 22k:** Debris Area ND-18, discovered during the July 2007 Leased Area Survey, contains four rusted canisters, noted as possibly being paint thinner. **CUA 22l:** Debris Area ND-32, discovered during the July 2007 Leased Area Survey, contains a sheet of black felt material, with noted clay pigeon debris. **CUA 22n and CUA 22o (previously PCUA D):** Two debris areas (ND-12 and ND-20) were identified during the July 2007 Leased Area Survey. The debris areas contain metal, lead shot, electrical conduit, scattered trash and other miscellaneous debris. Debris at ND-20 was noted as being possibly burned. **CUA 22p (previously PCUA E):** Debris Area ND-69, discovered during the July 2007 Leased Area Survey and noted as containing lead shot. **CUA 22q (previously 1A North Unaffiliated Area PCUA A):** Debris pile MWH-G1A-3006 less than 100 square feet identified during the 2009 Debris Survey. The debris pile, which is located off on the north shoulder of Service Area Road, consists of soil intermixed with asphalt. A portion of the asphalt was removed on 2/10/10; the remainder is still in place. **CUA 22r (previously PCUA C):** Two debris areas, MWH-G1A-3072 and ND-9, were identified during surveys in February 2010 and July 2007, respectively. These areas cover a combined area of approximately 4,500 square feet and contain soil, asphalt, concrete, pipe insulation, metal, glass and cable. Debris was partially removed from MWH-G1A-3072 in February 2010. **CUA 22s (previously PCU J):** Debris area ND-32 was identified during the July 2007 Leased Area Survey. The debris area contains a sheet of black felt material, with noted clay pigeon debris. **CUA 22t (previously PCUA B):** A debris area (MWH-G1A-3071) containing soil and asphalt was identified on February 8, 2010. The debris area covered approximately 1,100 square feet, and surface asphalt was removed on February 9, 2010. **CUA 24:** During 2012 asphalt removal activities at the Lower Parking Lot, waste characterization sampling conducted by Boeing revealed lead-impacted road base gravel present beneath the asphalt on Sage Ranch property. The impacted road base has been removed. **CUA 25:** CUA 25 consists of an ephemeral streambed (the Northern Drainage), and adjacent areas, from west of the Former Rockwell Employee Shooting Range (CUA 26) east to the LOX RFI site. This section of the Northern Drainage receives surface water discharge from large portions of the B-1, IEL, and AILF RFI Sites, and the water tanks area north of the LETF/CTL-I RFI Site. In 2007 as part of the LOX RFI Site debris removal action, approximately 2,500 cubic yards of debris and soil were removed from the Northern Drainage east of the LOX RFI site. This removal was due to noted debris containing antimony and asbestos (MWH, 2008). **CUA 26:** The former Rocketdyne-Atomics International Rifle and Pistol Club shooting range area, or Former Rockwell Employee Shooting Range, (former shooting range) was located on the Mountains Recreation Conservancy Authority Sage Range property, immediately north of Santa Susana. The range was a trap/skeet shooting range operated from 1972 to 1991. Interim Removal Action activities were performed in the Northern Drainage Leased Area between 2007 and 2011, including the shooting range, to remove soil and debris (asbestos-containing material, lead shot, and clay pigeon) from impacted areas with elevated concentrations of PAHs, asbestos, and antimony. Four locations containing igniter debris were discovered in the Clay Target debris area during 2009 activities. Between 2007 and 2010, approximately 7,400 cubic yards of debris and soil were removed from the shooting range area (Haley & Aldrich, 2010).	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics • Herbicides and pesticides • Glycols • Asbestos
IEL	15	16k	**CUA 16k:** One pole-mounted transformer (Tag #: 337) was located on power pole C220. Transformer is in-place, but is inactive.	• PCBs

Table 6-1a – Subarea 1A North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
IEL	16	N/A	No CUAs, features, or evidence of historical operations were identified at this CUA Cluster in previous reporting or in documentation reviewed during the DQO evaluation.	• VOCs • SVOCs • Metals • Energetics • Pesticides • Radionuclides
Unaffiliated Areas	N/A	N/A	N/A	• VOCs • SVOCs • TPH • Metals • Dioxins/furans

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
APTF	1	1a, 1b, 1c, 1d, 2a, 2b, 2c, 4e, 9b, 10, 12	**CUA 1a:** Test Pits 1 and 2 (B1786), the Lower Research Workshop (B1342), and B1446. Test Pits 1 and 2 were test bays that housed smaller test stands, aboveground tanks, and associated piping. Test Pit 1, at the northwest end of B1786, contained the Lima, Nan, and Mike Test Stands; Test Pit 2, at the southwest end of B1786, contained the Peter, Roger, and Sugar Test Stands. B1342, a workshop within B1786, contained the Perchlor Flushing System, where PCE was used to clean engines, components and associated test piping after testing. Activities supporting research programs were conducted at Test Pits 1 and 2 and B1342 periodically from 1953 to 2005. Operations consisted primarily of engine component, turbopump, and small rocket engine testing. Primary propellants included RP/JP fuels, hydrazine-based fuels, NTO, LH_2, and LOX. Perchlorate was used for ignition. TEA/TEB were used in some testing at the Mike Stand and beryllium was used in some testing at the Sugar Test Stand. During some test stand activities, flames were directed into a pipe running west from B1786 that vented south of former impoundment APTF-2. B1446 was constructed in the 1980s to support APTF laser research, and contained a subsurface hydraulic dampening system in a vault at the building center. The primary chemicals used during laser testing included potassium hydroxide, chlorine, fluorine, argon, and hydraulic oil (used in dampening system). After completion of laser testing in the 1990s, B1446 was used as a workshop for Test Pits 1 and 2 operations. **CUAs 1b and 1c:** Test Pit 3 (B1764) and Test Pit 4 (B1767) were test bays that housed smaller test stands, aboveground tanks, and associated piping. Test Pit 3 contained the Uncle, Victor, Yoke, and Willie Test Stands; Test Pit 4 contained the Zebra, X-Ray, and Tare Test Stands. Research support program activities were conducted at Test Pits 3 and 4 periodically from 1953 to 2005. Operations consisted primarily of engine component, turbopump, and small rocket engine testing. Primary propellants used included: RP/JP fuels, hydrazine-based fuels, NTO, LOX, and fluorine (Test Pit 3). Tanks containing these constituents and GN2, IRFNA, and diborane were noted at Test Pit 3. Additionally, B1767 housed a transformer (CUA 4e). A sump identified in facility drawings was located northwest of Test Pit 3. The surface was graded to direct surface water into the sump, which discharged to the APTF Drainage Channels (CUA 2c) and then the APTF surface impoundments (CUAs 2a and 2b). Additionally, a subsurface 50-gallon drum filled with granitic gravel, fed from the top through a sealed lid by a 3-inch pipe (suspected French drain) was noted north of former B1764 during site demolition activities. **CUA 1d:** Test Pits 5 and 5J, and the Ozonator Wastewater Tank. Test Pits 5 and 5J, located east and south of former impoundment APTF-1 (CUA 2a), were active periodically from 1953 through 2005. No test stands or structures were located in these pits; however, a number of tanks were present: a 1,500-gallon RP-1 AST, a 35-gallon lube oil AST in Pit 5, and a MMH AST. The Ozonator Wastewater Tank was a 1,000-gallon, polypropylene AST within secondary containment, south of impoundment APTF-1. After surface impoundment (CUAs 2a and 2b) closure in 1985, wastewater containing hydrazines generated during APTF testing was treated in the ozonator tank. Treated water was either discharged to the R-1 Pond or pumped to another tank up-gradient from APTF for use as engine cooling water at the APTF RFI Site. The ozonator tank was removed in 1996. **CUAs 2a and 2b:** APTF-1 (CUA 2a) was a gunite-lined, 40,600-gallon surface impoundment northwest of the APTF testing area. CUA 2A contained operational water overflow, surface runoff from the APTF testing area, and aspirated water contaminated with fuels from Test Pit piping. Surface water was directed to APTF-1 via the APTF channels (CUA 2c) and oxidized with hydrogen peroxide or calcium hypochlorite. Treated water was discharged to APTF-2 for possible further treatment, then discharged to the R-1 Pond. APTF-2 (CUA 2b) was a gunite-lined, 131,000-gallon surface impoundment approximately 30 feet west of APTF-1. The former surface impoundments were active from 1960 to 1985. In 1985, APTF-1 and APTF-2 impoundment closure was conducted under California Dept. of Health Services oversight. Gunite liners were removed, soil was excavated, and backfilled with soil from an unspecified Area IV borrow source. A concrete slab was constructed over APTF-1 and a 6-inch layer of vegetated topsoil placed over APTF-2. Concrete-lined surface water diversion ditches were constructed around former impoundment APTF-2. Closure activities were completed in December 1988. **CUA 2c:** The APTF channels were a series of concrete-lined drainages that conveyed surface water and operational wastewater from the APTF testing area to the former surface impoundments (and later the ozonator tank) and Area I Road Drainage. The channels were approximately 18 inches deep and 18 inches wide.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides • Terphenyls • Alcohols and glycols

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
APTF	1	1a, 1b, 1c, 1d, 2a, 2b, 2c, 4e, 9b, 10, 12	**CUA 4e:** Former pad-mounted transformer located on a concrete surface in Test Pit 4 (B1767). **CUA 9b:** The Fluorine Pad consisted of a concrete pad, a bank of fluorine gas cylinders, and a liquid impinging scrubber (Tank V-650) that supported B1446 laser testing during the 1980s and 1990s. The fluorine bank consisted of 26 3-pound fluorine cylinders and two 3-pound nitrogen cylinders (identified in historical documents and during a 2008 site walk). Documentation also indicated that V-650 contained LH2 in support of testing at Test Pits 1 and 2. **CUA 10:** The Alta Test Stand and hydraulic mule were used in APTF testing operations from the 1960s through the 1980s. The test stand occupied a 40- by 20-foot area south of Test Pit 3. The Alta Test Stand was referred to as the Hi Altitude Vacuum Facility in the 1960s and 1970s and had a vacuum chamber for testing operations. In the 1980s, the Alta Stand was used for testing engines and components. Documented chemical use includes MMH, NTO, and hydraulic fluid. A 10-gpm hydraulic mule northeast of the Alta Test Stand supported activities at the Alta Test Stand and Pit 3. **CUA 12**: A drum storage area south of B1446 was in use beginning in the 1950s. Rock outcrop was removed in the mid-1980s to create a larger storage area. Stored chemicals were not documented; materials may have included fuels, acids, and oils. The storage area was potentially used to oxidize spent fluorine-containing liquids after use in testing.	
APTF	2	3a, 3b, 3c, 4a, 4d, 5, 6, 7, 8, 9a	**CUAs 3a, 3b, and 5:** Operations Workshop, Machine Shop, and Instrumentation Shop (B1338), and Control Center (B1314). B1338 was constructed in the 1950s and used as the main workshop in support of APTF until approximately 2000, when it was demolished. The B1338 configuration changed throughout site history; facility drawings show it contained the operations workshop, a machine shop, an instrumentation shop, a storage room, and a tool crib. The operations workshop and machine shop contained workbenches where engines, components, and test-related equipment were assembled, disassembled, cleaned, and repaired. The machine shop contained lathes, saws, drills, and other equipment and tools for use in repair and fabrication activities. The instrumentation shop was used to assemble, calibrate, clean, and repair instrumentation (pressure gauges, flow meters, temperature gauges, valves, etc.). Chemical usage and storage associated with B1338 and associated storage areas include solvents, CTF, 1,4-dioxane, oils, lubricants, alcohols, hydrazines, insecticide, hydraulic fluids, naphthalene, pentaborane, hydrocarbon fuels, and IRFNA. B1314 (CUA 5) contained the control center, conference room, and an electrical equipment room. The control center consisted of control panels and instrumentation wired remotely to test stands in Test Pits 1, 2, 3, and 4. Additionally, one cooling tower was noted at B1314 in historical documentation. B1338 had two associated concrete drum storage areas (CUAs 3a and 3b) on the north and east sides of the building. Both drum storage areas were covered, used throughout the B1338 operational history, and removed with the building in 2000. Specific materials stored at these areas were not documented; however, storage could include materials associated with B1338. **CUA 3c:** B1540 is a 30- by 40-foot concrete pad with 4-foot concrete walls. The pad was constructed in the 1950s and was used until the early 2000s for drum storage and housed a liquid fluorine trailer that supported Test Pit 3 (CUA 1b) and RASL (CUA 7) activities. Facility drawings indicate four tanks southeast of B1540, which at different times contained LF_2, CTF, NTO, JP-4, LOX, and LN_2. Leaking oil was noted from tank V-12 in 1988. **CUA 4a:** Secondary Substation 1-B-20 consisted of three pad-mounted transformers (Tag #s 16, 17, and 18), on the eastern boundary of the site, adjacent to the Research Road, north of B1383. No staining was observed during site walks. **CUA 4d:** One pad-mounted transformer on the southwest side of B1370. **CUA 6:** The Mixing Pad (B1440) consisted of a 20- by 40-foot concrete pad with a 3-inch containment berm. The pad was used in the 1950s to early 1960s for drum storage and mixing various chemicals used in site operations. In 1964, the pad was enclosed and covered with a storage shed. The shed was removed in the 1970s and four horizontal tanks (contents not documented) were installed on the pad.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Pesticides • Terphenyls • Alcohols

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
APTF	2	3a, 3b, 3c, 4a, 4d, 5, 6, 7, 8, 9a	**CUA 7:** The RASL (B1370) was a 40- by 40-foot building constructed in the 1980s southeast of B1338 and northeast of Test Pit 3. RASL was used for laser research in the 1980s and 1990s. Specific chemical use is not documented, but chemicals used in similar facilities typically included iodine, potassium hydroxide, chlorine, fluorine, and argon. Laser testing concluded in the 1990s and B1370 was used for storage of charts, gauges, and miscellaneous instrumentation. **CUA 8:** The Engineering and Administration Office (B1383) and former Barrel Storage Area. B1383 was constructed between 1985 and 1988 and included an office, a small equipment workshop, a break room, and a restroom. The area was previously occupied by the Lower Research Decontamination and Shower Facility (B1378), Lower Research Sanitary Facility (B1374), and the Barrel Storage Area. Activities at the decontamination facility are not documented, but likely involved removal of protective clothing potentially contaminated with residual fuels and site-associated chemicals. The Barrel Storage Area was located east of former B1378. Chemicals used and stored at B1338, B1383, and associated storage areas included solvents, 1,4-dioxane, CTF, oils, lubricants, alcohols, hydraulic fluids, hydrazines, naphthalene, pentaborane, hydrocarbon fuels, insecticide, and IRFNA. **CUA 9a:** Four 370-gallon horizontal fluorine ASTs were located west of B1764. They were likely installed in 1970 or 1971 based on documented fluorine testing at Test Pit 3, and were removed in the 1990s. Fluorine was mixed with LOX during propellant testing. These tanks potentially supported operations at B1446 as well.	
APTF	3	4b, 4c, 11, 13, 14, 15, 16, 17	**CUA 4b:** The Big Rock Substation, owned by Southern California Edison, is a transformer substation installed in the 1950s which is still operational. The substation consists of three pad-mounted transformers, northwest of B1512 and across the Area I Road from the APTF RFI Site. Some suspected oil staining and leakage has been observed on the concrete pad during site walks. **CUA 4c:** Consisted of three pole-mounted transformers northwest of the APTF testing area, along the north side of Area I Road. **CUA 11:** The Acid and Fuel Storage Area (B1501) was a 60- by 90-foot concrete pad constructed in the 1950s, approximately 4 feet above ground surface. The west end of the structure was covered (former B1740). Documented chemicals stored on the pad included acids, solvents, fuels, and oils. A storage area attendant occupied B1740, which was also used to store safety gear. **CUA 13:** An incinerator was identified on facility drawings from the 1950s. The period of use and materials burned are not documented. This feature has been removed (date unknown). **CUA 14:** The Research Equipment Storage Shelter consisted of a 20- by 30-foot concrete pad used for miscellaneous equipment storage. Historical photographs show the shelter was covered. **CUA 15:** Former B1329 was identified as chemical storage in a 1961 facility drawing. No documents indicate specific chemicals stored. The building has been demolished (date unknown). **CUA 16:** The Equipment Storage Yard was an approximately 200- by 350-foot area used for storage of tanks, piping, and miscellaneous equipment. The storage yard was located north of Area I Road, across from the APTF testing area. No specific chemical use was documented at this area. **CUA 17 (Previously Potential CUA A):** A dirt road leading from The Big Rock Substation/Acid and Fuel storage area to the AILF was identified in aerial photos dated 1959 through 1990.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Terphenyls
APTF	4	4f	**CUA 4f:** One pole-mounted transformer (unknown ID) located on the slope, south the APTF testing area. No staining was observed during site walks.	• PCBs
APTF	5	4g	**CUA 4g:** Three pole-mounted transformers (Pole C-10) northwest of the APTF testing area on the south side of Area I Road. No staining was observed during site walks.	• PCBs

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
B359	1	1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 3a, 3b, 3d, 12, 13, 14b, 14c, 14d, 14e, 16a, 16b, 18	**CUAs 1a-e:** Former B1359 (CUA 1a) was the primary energetic material test area at the B359 RFI Site, and contained four test cells along the northern side that drained into a covered concrete-lined sump (CUA 1b). The test cells faced an approximately 20-foot high soil berm. B1359 contained two cooling towers (potentially associated with the B1359 cooling system [CUA 1e]); one was reportedly corroded and leaking. The building was used from 1963 to the 1990s, and removed in 2002. The B1359 sump discharge channel (CUA 1c) connected the B1359 sump (CUA 1b) to the Research Road drainage just south of Area I Road. B1353, B1343, B1363, B1348, and B1354 (CUA 1d) were used as storage sheds, workshops, and assembly rooms. They were built in 1957 and removed in 1993. In 2003, as part of the HVIM, the sump was removed during excavation of a larger area present north and west of former B1359; soil was excavated to 5 feet bgs (Figure 3-1) to remove elevated arsenic, hexavalent chromium, and mercury concentrations in soil prior to biotreatment activities for perchlorate impacts. **CUA 2a-c:** B1325 and B1344 (CUA 2a) were built in 1957. Perchlorate was milled and mixed with other compounds for solid rocket propellant development; B1325 also contained a press room and was also used for energetics storage. A cooling tower was located on the west side; 30-ton and 1-ton cooling towers were located at unspecified locations. Vacuum pumps were located west and south (CUAs 2b and 2c, respectively) of B1325. Wastewater was conveyed to the sanitary sewer system via a pipe from the northwest corner of B1325 to the Research Road trunk line. B1325 was also connected to the natural gas line that ran beneath Area I Road and Research Road (PCUA A). B1325 and B1344 were removed in the late 1990s. **CUA 3a:** Former B1741 (Firing Pits and Igniter Testing) was used for igniter testing in a series of small, east-facing test cells. Unlabeled solvent drums and a Conex box containing acetone, methylene chloride, glycols, and vacuum pump oil were noted at, and adjacent to, this building. The estimated use period was from 1963 to 1981 (removed in 1981). **CUAs 3b, 3d:** At former B1328 (CUA 3b), solid rocket propellant was pressed into appropriate shapes. The building was also used as dry inorganic materials storage. East of B1328 was a series of three igniter test stands (B1XXX-3, B1XXX-4, and B1XXX-5) (CUA 3d). **CUA 12:** The Building 1374 Leach Field (formerly the "Building 1359 Leach Field") is associated with B1374 at the APTF. B1374 (removed in the 1980s) was the shower facility for the Lower Research Area. The associated leach field is still in place. Adjacent to B1374 were the Decontamination Facility (former B1378) and the Barrel Storage Area. There is no documentation regarding specific activities at the Decontamination Facility. Activities likely involved cleaning and decontaminating small parts and equipment after use in testing operations and removing protective clothing potentially contaminated with residual fuels and chemicals associated with site activities. The Barrel Storage Area (drum storage) was located south of former B1378. The approximately 3,400 square foot leach field gravel pack depth varies from approximately 1 foot bgs to 3.5 to 5 feet bgs, with the distribution lines running between 1.5 to 4 feet bgs. **CUA 13:** The aboveground B359 Southwest Fueling Tank was located on a concrete pad at the southwest corner of the B359 RFI Site, approximately 40 feet south of former B1325. The tank was used for vehicle refueling; tank size and contents are not documented. The tank was also connected to the natural gas line that ran beneath Area I Road and Research Road (PCUA A). The estimated use period was in the 1960s (removed in the 1960s). **CUA 14b:** Single, wall-mounted, 5 kVA transformer located on the southern wall of former B1741. The estimated use period was from 1963 to 1981 (removed in 1981). **CUA 14c:** Single, wall-mounted, 7.5 kVA transformer located on the southern wall of former B1328. The estimated use period was from 1950 to 1989 (removed in 1989). **CUA 14d:** Single, wall-mounted, 3 kVA transformer located on the northern wall of former B1359. The estimated use period was from 1963 to 2002 (removed in 2002). **CUA 14e:** Single, wall-mounted, 2 kVA transformer located on the southern wall of former B1359. The estimated use period was from 1963 to 2002 (removed in 2002). **CUA 16a (previously PCUA F):** Unknown structure 1XXX-6 identified west of B1359 in aerial photos dated 1959 through 1962. **CUA 16b (previously PCUA I):** Unknown structure 1XXX-12 observed adjacent to Area I Road in aerial photo dated 1962. **CUA 18 (previously PCUA M):** Possible location of the B1315 Leach Field. Geophysical surveying and trenching activities were performed during 2013 data gap activities, but could not verify the exact location of this feature.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics • Herbicides and pesticides • Organotins • Terphenyls • Alcohols and glycols

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
B359	2	3c, 3e, 3f, 3g, 4a, 4b, 4c, 5, 14f, 15a	**CUA 3c:** Former B1362, B1404, and B1404a (CUA 3c), all located south of B1328, served as storage areas for site activities. In 2003, as part of the HVIM program, 1 to 2 feet of soil was excavated east of B1404 (CUA 3c) to remove elevated concentrations of mercury. **CUA 3e:** Former Building 1XXX-2 was an ordnance storage bunker located north of former B1400. Building use period and removal date were not documented. **CUAs 3f and 3g (previously PCUA H):** Unknown structures 1XXX-8 and 1XXX-9 identified north of B1723 in an aerial photo dated 1960. One of these structures may be B1424, Propellant Hardware Storage, identified as west of B1404 in historical documentation. **CUA 4a-4c:** Former B1723 (CUA 4a) was used for storage for site activities. Former B1400 (CUA 4b) was used as a peroxide storage and activate building. The estimated use period for the building is from 1957 to 1994 (removed in 1994). The B1400 sump (CUA 4c) is located approximately 15 feet north of the building. In 2003, as part of the HVIM program, 1 to 2 feet of soil was excavated from beneath B1723 (CUA 4a) and beneath and north of the B1400 sump (CUA 4c) to remove elevated concentrations of mercury. **CUA 5:** Former B1373 was used as an H_2O_2 passivation and test facility, as well as for general H_2O_2 storage. B1373 was used beginning in 1957 and was removed in 1994. Sediment from a grated trench at this structure was collected as a contained unit sample. **CUA 14f:** Single, floor-mounted, 15kVA transformer located at the western wall of former Building 1400. The transformer was contained in a weather-proof container. **CUA 15a:** During removal of the paved access road in the southern B359 RFI Site in 2012, an area of stained soil was observed along the west end near a former subsurface utility pipe being removed. Sampling was performed at the area of staining and along the road following removal.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics
B359	3	9, 10, 11, 14a, 16c, 16d, 16e, 16f, 16g	**CUA 9:** The former Neptune Test Stand / Potassium Loop Facility area was used for naval experiments during the 1960s. All above grade features were removed when operations ceased. Two gasoline ASTs were located in an earthen dike on the north end of the area, just outside of the B1790 footprint. A butane tank was located just outside of the southeast corner of B1790, and two tanks (unknown contents) were located within the B1790 footprint. A 48 cubic foot dirt sump was located northeast of B1790. In addition, former B1341, an instrumentation shack, and former B1380, the Potassium Loop Facility Office, supported operations in the area. **CUA 10:** The B359 former debris area was identified during HVIM activities. The area was found to contain scattered metallic debris, burned debris, ash, and wiring. The debris extended between 1 to 2 feet bgs and covered an area approximately 900 square feet. In 2003, as part of HVIM activities, soil was excavated (and backfilled) down to 2 feet bgs to remove elevated concentrations of barium, chromium, copper, lead, silver, and zinc in the former debris area. **CUA 11:** The Northeast Leach Field is associated with former B1301 in the IEL RFI Site. Operations at B1301 consisted of service, cleaning, maintenance, repair, and testing of engine valves and manifolds. Chemicals used for valve repair include acids (nitric, phosphoric, hydrofluoric) and solvents (TCE, TCA). The septic tank (removed) was located approximately 60 feet west of former B1301. The leach field covers an area approximately 10, 600 square feet. The leach field gravel pack is located between 2 and 6 feet bgs, with the distribution lines between 3.5 to 5 feet bgs. **CUA 14a:** Transformer substation located at the former Neptune Test Stand / Potassium Loop Facility area in the northeastern portion of the B359 RFI Site. This substation formerly provided power to the northeastern portion of Area I. The transformer and substation pad were removed in 2012; no soil staining was observed. **CUA 16c (previously PCUA B):** Unknown structure 1XXX-14 identified east of B1359 in aerial photos dated 1972 and 1980 through 1988.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics • Glycols • Asbestos • Radionuclides

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
B359	3	9, 10, 11, 14a, 16c, 16d, 16e, 16f, 16g	**CUA 16d (previously PCUA C):** Unknown structures 1XXX-16, 1XXX-17, and 1XXX-18 identified west of B1380 in aerial photos dated 1967, 1980, and 1990 through 1995. One of these structures may be the Power Controller Building (B1703) identified as west of the Neptune Test Stand/Potassium Loop Facility area in historical documentation. **CUA 16e (previously PCUA J):** Support structure 1XXX-31 south and adjacent to B1380 (Potassium Loop Facility office) observed in aerial photos dated 1966 through 1967. **CUA 16f (previously PCUA K):** Unknown structure 1XXX-19 identified northwest of the Neptune Test Stand/Potassium Loop Facility in an aerial photo dated 1967. **CUA 16g (previously PCUA L):** Five trailers (1XXX-20 through 1XXX-24) identified in the northeast portion of B359 site in aerial photos dated 1959 through 1962.	
B359	4	7a, 7b, 8, 15b	**CUAs 7a and 7b:** Former B1376 (CUA 7a) and B1743 (CUA 7b) were used as perchlorate storage areas for operations in Happy Valley. B1376 was used beginning in 1957 for oxidizer preparation and storage. B1743 was used beginning in 1963 as an oxidizer and chemical drum storage dock and shelter. Both buildings were removed in 1998. In 2005, as part of HVIM activities, an area northwest of B1376 was excavated down to bedrock for treatment in the Consolidated Biotreatment Area; the area was backfilled with successfully biotreated soils from the B1359 area. **CUA 8:** Former B1702 was used for perchlorate storage for operations in Happy Valley, as well as for fluoride and acid storage in support of NAKA operations. The building use period is unknown, but the operational period is believed to range from the 1950s to mid-1960s, based on review of aerial photographs. **CUA 15b:** During removal of the paved access road in 2012, an area of stained soil was observed along the west end near a former subsurface utility pipe being removed (CUA 15a). Sampling was performed at the area of staining and along the road following removal.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics
B359	5	6a	**CUA 6a:** Former B1997 was a storage (perchlorate and energetics) building located in the southeastern portion of the B359 RFI Site, along the southern access road leading to former B1358. Building use began in 1963, and the building was removed in 1980.	• Metals • Perchlorate • Energetics
B359	6	6b, 17	**CUA 6b:** Former B1358 area, located approximately 460 feet southeast of main B359 site operational areas, was used for igniter bunker storage beginning in 1965 and removed in 2008 (structure was closed/inactive at time of removal). Additionally, an unknown structure (1XXX-30) was identified in the future B1358 footprint in a 1959 aerial photograph. **CUA 17 (previously downstream of PCUA E):** Portion of the former B1358 access road.	• VOCs • SVOCs • TPH • Metals • Perchlorate • Energetics
HVN	1	1a, 1b, 2, 3, 4a, 4b, 4c, 4d, 4e, 5a, 5b, 5c, 5d, 6, 7, 8a, 8b, 8c, 8d, 8e, 9, 10, 11	**CUA 1a:** Building 1316, the Propellant Control Center, was used for burn testing and igniter testing, as well as experiments to pressurize and rupture diaphragms, from the mid-1950s until the mid-1990s. The building footprint included two test cells along the east side of the building where propellant waste disposal and static hot fire testing was conducted. Building 1316 was removed in 2003 prior to perchlorate biotreatment at the site as a part of the Happy Valley Interim Measures (HVIM), as described below. **CUA 1b:** Building 1773, the Tunnel Facility, was an enclosed, cylindrical steel structure used from the early to mid-1950s to the mid-1990s to test gun and rocket propellants, solid pyrotechnics, and detonation devices. The Tunnel Facility was removed in 2000. The area surrounding the Tunnel Facility and adjacent Building 1316 were subject to two phases of Interim Measures (IMs). From 1999 to 2000, IM activities removed suspect ordnance and energetic items, and metal debris. In 2003, HVIM activities were implemented to remove 800 cubic yards of metals-impacted soil (primarily arsenic). The excavation was backfilled with perchlorate-impacted soil from the Happy Valley South RFI Site and this soil was recontoured and biotreated onsite from 2004 to 2006.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics • Herbicides and pesticides

Table 6-1b – Subarea 1A Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
HVN	1	1a, 1b, 2, 3, 4a, 4b, 4c, 4d, 4e, 5a, 5b, 5c, 5d, 6, 7, 8a, 8b, 8c, 8d, 8e, 9, 10, 11	**CUA 2:** The former incinerator was used for burning trash and paper, rags and paper towels used to apply solvents, and propellant wastes (McClaren/Hart, 1991). The incinerator was used from 1957 to 1990, and was demolished in 2003. During HVIM and subsequent biotreatment activities from 2004 to 2006, the western portion of the former incinerator area, along with area surrounding Building 1316 and the Tunnel Facility, was excavated, backfilled, treated, and recontoured, as described in the discussion of CUA 1b above. **CUA 3:** Building 1346 contained the Environmental Conditions Testing Facility from 1957 to 1968, during which time humidity and low temperature tests were performed on propellants inside various chambers. From the 1950s to the 1980s, live rounds for the gun tunnel were also stored in Building 1346. The building was demolished in 2003. **CUA 4a:** Buildings 1337 and 1347 were separate free-standing buildings until the late 1950s when the buildings were incorporated into a single structure. Building 1337/1347 was used from the mid-1950s to the early 1980s as an instrumentation shop and a mechanics workshop **CUA 4b:** The vacuum pump, located west of the Building 1337/1347 Workshop, was believed to have been used in support of the testing done at the Tunnel Facility. Documentation of known or potential chemicals used in this building have not been found in available records. **CUA 4c:** Building 1726 was a high altitude chamber used for testing. An email from 1999 suggests that the structure consisted of a 200-gallon steel tank used to test ammonium perchlorate engines, and the document goes on to request that the tank be removed during upcoming demolition activities. **CUAs 4d and 4e:** Buildings 1-XXX-1 and 1-XXX-2 were two small buildings that stood in the early 1950s until the mid to late 1970s. These structures were identified in an aerial photograph from 1953 and an oblique photograph from 1954 (HDMSe00397797). No additional documentation for these buildings are available. **CUA 5a:** Building 1315 was also known as the Propellant Engineering Lab and the Chemical Physicals Laboratory. This structure was the original chemical laboratory used in support of engine testing at sites in Area I, explosive compacting testing, small-scale ignition testing of basic hydrogen peroxide, flash lamp-initiated impulse testing, and was later used as a diagnostic optics laser laboratory. The Molten Salt Oven/Oxidation Unit was moved from Building 4006 in Area IV to Building 1315 in 1993 and set up for use in 1994. Historical site plans indicate that Building 1315 was connected to a leach field located in the southern part of the B359 RFI Site. Geophysical surveys, including ground-penetrating radar, were performed as part of the Master RFI Data Gap Work Plan Addendum sampling activities at the B359 RFI Site (MWH, 2013 and 2014), however the surveys did not identify subsurface anomalies consistent with a pipeline or leach field. The boundaries of CUA 5a were extended north along the road to include potential CUA A and any subsurface pipelines that might have served Building 1315. Six test cells on the west side of Building 1315 were used for static motor testing. The structure was demolished in 2008. **CUA 5b:** The concrete-lined Detonation Sump west of Building 1315 was used to conduct static explosives tests. The detonation sump was removed in October 2008. **CUA 5c:** The energetics sump was a double-walled cylindrical steel sump used in support of propellant and static explosives testing at the Building 1315 chemistry laboratory. The energetics sump was removed in October 2008. **CUA 5d:** Building 1339 was a workshop used in support of the Building 1315 chemistry laboratory. Documentation of known or potential chemicals used in this building have not been found in available records. **CUA 6:** Two ASTs (V-386 and V-387) were located northwest of Building 1315. The larger AST, which had a capacity of 1,600 gallons, was located in a vegetated area north of the concrete pad. The smaller AST had a capacity of 150-gallons and was located within a concrete bermed structure. Documents from 1965 indicated that the tanks contained water, and no other chemical uses were documented. The tanks were removed during October 2008 demolition activities. **CUA 7:** CUA 7 consists of a transformer pole that was located at the top of the gunite slope, north of Building 1337/1347. **CUA 8a:** Building 1364 was the Vibration Analysis Building; available documentation does not indicate known or potential chemicals used. **CUA 8b:** Building 1367 was a chemical lab workshop used in support of the Building 1315 laboratory. Documentation of known or potential chemicals used in this building have not been found in available records.	

Table 6-1b – Subarea 1A Central				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
HVN	1	1a, 1b, 2, 3, 4a, 4b, 4c, 4d, 4e, 5a, 5b, 5c, 5d, 6, 7, 8a, 8b, 8c, 8d, 8e, 9, 10, 11	**CUA 8c and 8d:** Building 1345 was the Peroxide Catalyst Production Building prior to being relocated from west of Building 1315. Following the relocation, the building was referred to as the Chemical Lab Shop. Documentation of known or potential chemicals used in this building have not been found in available records. **CUA 8e:** Building 1329 was used for chemical storage in support of Building 1315. Documentation of known or potential chemicals used in this building have not been found in available records. **CUA 9:** The cooling tower was used to cool ethylene glycol for operations at the APTF RFI Site from approximately 2003 to 2005. A former drain was located within a concrete berm near the northern edge of the site, downslope from the cooling tower. The drain pipe fed into a concrete channel that ran northeast to join with the drainage trench along Research Road. The cooling tower and drain were removed in October 2008. **CUA 10:** A former hydrazine tank was relocated from the Storable Propellant Area RFI Site in Area II to the west side of Building 1315 where it was used to contain gaseous nitrogen. The 3,800-gallon tank was removed in October 2008. **CUA 11 (previously PCUA B):** A dirt road leading west from the main road south of the HVN RFI site extended over the saddle of the ridge and connected to the southern B359 RFI Site. This feature was identified in aerial photographs from 1953 to 1972.	
Unaffiliated Areas	N/A	N/A	N/A	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Canyon	1	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 8, 11a, 11i, 15, 16, 18	**CUA 1a:** Canyon Test Stand 1, also known as TRE-1, was used for large rocket engine testing in support of the Redstone, Jupiter, and Thor programs from 1954 to 1963. The test stand were reconfigured for the Transition Reliability Experiment (TRE), to test engine performance at high altitude. The engines tested at TRE-1 used hydrocarbon fuels (JP-4, RP 1, and kerosene) in combination with liquid oxygen (LOX). During the engine tests, the flame deflector buckets were deluged with non-contact cooling water. After testing, TCE was used to flush the hardware and engine thrust chambers. The cooling water and wasted solvents were discharged to concrete-lined spillway that directed flow northward to an unlined channel (CUA 2a) leading to the Canyon Skim Pond (CUA 2e). TRE-1 was dismantled in 1974, and the foundations, retaining wall and concrete spillways were removed in 2011. **CUA 1b:** Canyon Test Stand 2 (TRE-2) was the easternmost test stand and used to test large rocket engines in support of the Redstone and Jupiter programs between 1955 and 1960. These engines used hydrocarbon fuels (JP-4, RP-1, and kerosene) in combination with LOX. Historical documentation suggests that hydyne, a mixture of 60% unsymmetrical dimethylhydrazine (UDMH) and 40% diethylenetriamine (DETA), may have also been used at TRE-2. During the engine tests, the engine exhaust was deluged with water. After testing, TCE was used to flush the hardware and engine thrust chambers. The cooling water and wasted solvents were discharged to concrete-lined spillway that directed flow northward to an unlined channel (CUA 2b) leading to the Canyon Skim Pond (CUA 2e). TRE-2 was dismantled in 1974, and the foundations, retaining wall and concrete spillways were removed in 2011. **CUA 1c:** Canyon Test Stand 2 (TRE-2) was the easternmost test stand and used to test large rocket engines in support of the Redstone and Jupiter programs between 1955 and 1960. These engines used hydrocarbon fuels (JP-4, RP-1, and kerosene) in combination with LOX. Historical documentation suggests that hydyne, a mixture of 60% unsymmetrical dimethylhydrazine (UDMH) and 40% diethylenetriamine (DETA), may have also been used at TRE-2. During the engine tests, the engine exhaust was deluged with water. After testing, TCE was used to flush the hardware and engine thrust chambers. The cooling water and wasted solvents were discharged to concrete-lined spillway that directed flow northward to an unlined channel (CUA 2b) leading to the Canyon Skim Pond (CUA 2e). TRE-2 was dismantled in 1974, and the foundations, retaining wall and concrete spillways were removed in 2011. **CUA 2a, 2b, and 2c:** Cooling water and wasted solvents were discharged to concrete spillways, which drained via unlined channels (CUAs 2a, 2b, and 2c) to the Canyon Skim Pond (2e) and the Canyon Retention Pond (2f). The channels were constructed in bedrock or within topographic lows. A small natural drainage is located east of the TRE-3 channel (CUA 2c), and flows northeast to the Canyon Skim Pond. CUA 2a, associated with TRE-1, was active during testing operations from 1954 to 1963. CUA 2b, which served TRE-2 was active from 1955-1960, and CUA 2c, which received runoff from TRE-3, was active from 1957-1968. **CUAs 2d:** CUA 2d is a 265-foot channel with a 70-foot gunite spillway that extended west from the Canyon Skim Pond (CUA 2e) to the Canyon Retention Pond (CUA2f). Overflow from the Canyon Skim Pond, and cooling water and wasted solvent from TRE-3 collected in this channel and flowed westwards. The channel has been inactive since testing operations at TRE-3 ceased in 1968. Concrete from a 200-foot section of the channel west of Canyon Skim Pond was removed during 2011 demolition activities. **CUA 2e:** The Canyon Skim Pond is an unlined pond that received cooling water and wasted solvents from TRE-1 and TRE-2. After burning or "skimming" the fuel floating on the surface, water was released via a culvert and gunite-spillway to the Canyon Retention Pond (CUA 2f). The Canyon Skim Pond has been inactive since engine testing operations ceased in 1968. **CUA 2f:** The Canyon Retention Pond is a gunite-lined pond that received discharges from the Canyon Skim Pond and the test stands. Water from the Canyon Retention Pond, was discharged to R-1 Pond (SWMU 4.16) via a drainage channel on the west side of the pond. The Canyon Retention Pond was a natural depression that was excavated and dammed to increase capacity. The pond has been inactive since engine testing operations ceased in 1968. **CUA 8:** The Canyon Instrumentation Shop (Building 1368) was located at the end of Canyon Road southwest of TRE-3. Building 1368 was likely a support building for rocket engine testing and possibly repair of instruments used at the test stands. The Building 1368 concrete pad and drainage grate were removed in 2011. **CUA 11a:** The debris area east of the Canyon Skim Pond consisted of scrap metal, a 55-gallon drum, and asbestos pipe, identified in 2006.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides • Alcohols

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Canyon	1	1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 2f, 8, 11a, 11i, 15, 16, 18	**CUA 11i:** CUA 11i is a debris area where sections and fragments of transite pipe were identified in the wiring tray northwest of TRE-1 and on the underlying soil during demolition in 2011. **CUA 15:** CUA 15 comprises an area where diesel and water was spilled from a truck during 2011 demolition activities. Visibly stained soil was excavated, and a confirmation sample was collected to test for TPH. **CUA 16:** The WS-05 Area UV/Peroxide water treatment system was brought online in 1991 to treat groundwater extracted from supply well WS-05. Treated water was ultimately released to R-1 Pond. Production from WS-05 ceased in mid-2001 and the system has been dismantled. **CUA 18 (previously PCUA B):** CUA 18 encompasses the dirt road that extends from Area I Road eastwards along the Canyon Drainage, as well as an area of cleared vegetation southwest of the Retention Pond.	
Canyon	2	3, 6a, 6f, 7, 11d, 11e, 14, 17	**CUA 3:** CUA 3 includes the former Canyon Pad and the gunite-lined Neutralizing Pit. The pit may have been used for neutralizing hydrazine compounds in runoff. The former Canyon Pad housed the Canyon Groundwater Treatment System (GWTS) which consisted of two air stripping towers and two carbon canisters within a concrete bermed area. The GWTS removed VOCs from well water pumped from RD-01 in Happy Valley. The Canyon GWTS was placed on standby operational status on October 20, 1998. In 2001, the air stripping towers were deactivated, and in 2011 the towers, concrete pad, and the gunite Neutralizing Pit were removed. **CUA 6a:** CUA 6a comprises three former transformers located near Building 1370 (CUA 7), identified as Pole C35, tag numbers 266, 267 268. The transformers have been removed. **CUA 6f:** Based on historical facility drawings, a transformer pad was potentially located on the northwest corner of Building 1375. No structure was in place as of 2011 demolition activities. **CUA 7:** Building 1370, 1he Canyon Control Center Workshop, was located northeast of Building 1375. Historical use is not specified in available historical documents, but it is likely that Building 1370 was a support building for operations conducted in the Building 1375, which may have included observation of rocket engine tests and monitoring of fuel intake during the tests. The B1370 concrete pad was removed in 2011. **CUA 11d:** This 700 square-foot debris area is located in the north portion of the Canyon RFI Site, on the slope north of Building 1375, and consists of broken, exposed, concrete debris mixed in soil piles. This debris area was identified in the 2008 Waste Debris Survey. **CUA 11e:** This debris area, less than 100 square feet in size, is located southwest and downslope of the Neutralizing Pit and consists of exposed, ripped graphite-like metal fibrous sheets. This debris area was identified in the 2008 Waste Debris Survey. **CUA 14:** The Building 1375 Leach Field is located north of Canyon Control Center (Building 1375), and served the sanitary restrooms in the north part of Building 1375. Drawings indicate that the restrooms were connected to a septic tank via 4-inch cast iron pipe, transitioning to vitreous clay pipe; metal pipe conforming to this description and pieces of ceramic material were observed during field activities. Drawings indicate that the 700-gallon septic tank discharged into two 20-foot gravity-fed distribution leach lines in 2 foot trenches spaced 6 feet apart. B1375 had no documented chemical use. Dates of operation are uncertain but likely occurred in the mid-1950s to 1974, the time period when the Canyon RFI Site was active. **CUA 17 (previously PCUA A):** The Canyon Control Center (Building 1375) was used to observe engine testing at the test stands from the 19450s to 1968. Historical documentation indicates that the structure was used for storage after testing operations at Canyon ceased. Building 1375 also housed sanitary restrooms on the north side of the building. CUA 17 also includes a mastic-wrapped subsurface pipeline that was identified along the south face of Building 1375 during demolition activities in 2011.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans
Canyon	3	10a, 10b	**CUA 10a:** CUA 10a includes the Pretest, Instrumentation, and Stores/Tool Crib Buildings between TRE-1 and TRE-3, north of Canyon Road. Building 1382 was the Instrumentation/Data Collection Center; Building 1383 was the restroom for the support buildings; Building 1384 served as storage and the tool crib; and Building 1369 was the Pretest Building. Additionally, a 1,500-gallon septic tank was located west of former Building 1383 sanitary facilities. CUA 10a also includes the slope north of the buildings to include a mastic-wrapped conduit that extended below the gunite. Use of these buildings likely stopped in 1968, when engine testing ceased. Building 1382, the concrete foundations for Buildings 1383, 1384, and 1369, the septic tank, and all surrounding asphalt and gunite were removed in 2011. **CUA 10b:** The B1382 Leach Field was associated with support buildings (CUA 10a) located between TRE-1 and TRE-3, and consisted of two 7-foot diameter septic leach pits approximately 100 feet west of former B1383. The leach pits were removed to a depth of 4 feet during 2011 demolition activities and backfilled with clean gravel.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Canyon	4	4a, 4b, 5a, 5c, 5d, 5e, 5f, 5g, 5h 6b, 6c, 6d, 6e, 6g, 9, 11b, 11g, 11h, 12, 13, 19 21	**CUA 4a and 4b:** Aboveground TCE pipelines (CUA 4a) and former AST H-155 (CUA 4b) located on the south side of the Canyon RFI site were used to convey TCE to the test stands for cleaning after rocket engine tests. H-155 was located south of TRE-1 in an asphalted area. Use of the tank and pipelines were likely discontinued in 1968, after engine testing ceased. H-155 was removed prior to 2005, and the concrete foundation, asphalt, and pipelines were removed during 2011 demo activities. **CUA 5a:** CUA 5a comprises the fuel pipelines that supply petroleum fuel from storage tanks to the three test stands. See Cluster 7 for additional description of this feature. **CUA 5c:** Historical facility drawings indicate the possible existence of a gasoline underground storage tank, designated as V-XXX-3, located adjacent to the Pump House on the south side of Canyon. All pipelines and concrete structures in the area were removed during 2011 demo activities, and no tank was uncovered. **CUA 5d:** A fuel pump was located west of AST H-155 (CUA 4b). The former fuel pump was located on the south side of Canyon Road an asphalted area across from B1382. A concrete pad in the former location of the pump was removed during 2011 demo activities. **CUA 5e:** CUA 5e is a former AST, designated V-XXX-4. The AST was used to store RP-1/JP-4 fuel and was located south of TRE-1 and west of the Staging Area. The tank was removed prior to 2005. **CUA 5f:** One 7,000 gallon AST containing RP-1 fuel was located south of TRE-1, in the Staging Area (CUA 13). The AST, H-58, and surrounding asphalt was removed prior to 2005. **CUA 5g:** CUA 5g consists of one 10,000 gallon former AST (H-16) containing fuel located south of TRE-2. A retaining wall and bermed concrete pad that supported the tank were removed in 2011, along with subsurface pipelines that extended beneath the road north to TRE-2. **CUA 5h:** Two former 6,500-gallon ASTs, V-431 and V-432, were located along the ridge south of TRE-2. The ASTs contained RP-1/JP-4 fuel to supply the test stands. **CUA 6b:** Three transformers were located east of TRE-3 and north of Pump House. These former transformers were associated with Pole C80, (Tag # not identified) and were removed prior to demo activities in 2011, when the utility poles and wooden supports were removed. **CUA 6c:** CUA 6c includes transformers that were associated with Pole C75, Tag # 272, 273, 274 east of TRE-3. Transformers have been removed. **CUA 6d:** Former pad-mounted transformers located south of TRE-2 on the hillside, associated with substation 1DA-C240, Tag # 253, 254, 255. Transformers have been removed. **CUA 6e:** These former transformers were associated with Pole C65, Tag # 269, 270, 271 and were located in a flat area nearby former fuel tank H-16 south of TRE-2. Transformers have been removed. **CUA 6g:** The Jeffries Transformer was associated with a Los Angeles Conditioning water tank (V-XXX-1) located approximately 40 feet east of TRE-3. The concrete pad and tank were removed in 2011. **CUA 9:** B1763, the Canyon Pump House, was located south of Canyon Road and east of TRE-3. There is no documentation of operations at the Pump House in available historical documentation, but B1763 likely served as a support building for the rocket engine tests. Abandoned pumps, pipes, and concrete at CUA 9 and the adjacent pad to the east were removed during 2011 demolition activities. **CUA 11b:** This debris area located south of the Staging Area (CUA 13) consisted of three 55-gallon drums, metal wiring, glass, and an empty NTO cylinder. Asphalt and concrete mixed with rock was also located in this area. It appeared that the debris was pushed over the side of the hill. This debris area was identified in 2006.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Canyon	4	4a, 4b, 5a, 5c, 5d, 5e, 5f, 5g, 5h 6b, 6c, 6d, 6e, 6g, 9, 11b, 11g, 11h, 12, 13, 19 21	**CUA 11g:** This 1,993 square foot debris area adjacent to the Staging Area on south side of Canyon consists of partially exposed and scattered broken asphalt and concrete. This area exists downslope of TRE-3, adjacent to the former fuel pipelines leading to the LETF and Bowl RFI sites (CUA 5A). This debris area was identified in the 2008 Waste Debris Survey. **CUA 11h:** This debris area, less than 100 square feet in size, was located along the edge of Canyon Road at the top of the hillside, and includes broken sheet metal, rusted metal fasteners, and rope. This debris area was identified in the 2008 Waste Debris Survey. **CUA 12:** Based on historical facility diagrams, a temporary office and workshop building may have existed east of TRE-2 along Canyon Road in 1954. Exact operations in this area are unknown, but the building may have been utilized as a temporary support building for engine testing operations. During 2011 demolition activities, a 6-foot square concrete pad with an embedded section of a fuel pipeline were removed from the area. **CUA 13:** The Staging Area is a generally flat region located upslope of the test stands, on the southeast fork of Canyon Road. Based on historical photographs, it appears that materials were stored in this formerly asphalted area. Helium and GN2 tanks (V-XXX-5 to V-XXX-9) were located north of this area. A former road (PCUA F) that connected the Canyon RFI Site to the Happy Valley South RFI Site to the east existed on the north end of this area. **CUA 19 (previously PCUA G):** CUA 19 is the area immediately surrounding a mastic-wrapped subsurface pipeline removed during 2011 demolition activities. This 12-inch diameter water pipeline extended approximately 125 feet northeast from the concrete pad that housed pump equipment and valves to a grated vault at TRE-1. The pipeline was removed in 2011. **CUA 21 (previously PCUA C):** CUA 21 is a portion of a dirt road extending west from TRE-3 towards the Bowl RFI Site, identified in historical aerial photographs from 1959 through 1960.	
Canyon	5	11f	**CUA 11f:** This 1,394 square foot debris area west of TRE-3 consists of exposed, ripped metal-fiber sheeting and a rusted 5-gallon bucket. This debris area was identified in the 2008 Waste Debris Survey.	• VOCs • SVOCs • TPH • Metals
Canyon	6	11c	**CUA 11c:** A debris area is located on top of the hillside east of B1375, and consists of fibrous material containing metal shavings on a telephone pole and scattered along the ground. This debris area was identified in the 2008 Waste Debris Survey.	• VOCs • SVOCs • TPH • Metals • Dioxins/furans
Canyon	7	5a, 5b	**CUA 5a:** CUA 5a comprises fuel pipelines that conveyed RP-1 and JP-4 from former aboveground storage tanks located on the south side of Canyon to the test stands. Additionally, CUA 5 also includes a fuel pipeline extended from the Bowl RFI site, through the west portion of Canyon where it connected a fuel tank west of TRE-3 (CUA 5b), and north to CTL-I. Use of the tanks and pipelines were likely discontinued in 1968, after engine testing ceased at TRE-3 and pipelines were removed as of demolition activities in 2011. **CUA 5b:** One former 10,000 gallon AST containing RP-1 fuel was located west of TRE-3A and TRE-3B. The AST, designated H-17, has been removed.	• VOCs • SVOCs • TPH

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Canyon	8	20	**CUA 20:** Tank H-813 was a 100,000-gallon tank used to supply cooling water to the Canyon test stands. Records indicate that this water tank may have received reclaimed water from R-1 pond via pipes extending through the Bowl RFI Site. The tank was operational from 1954 to 1974, and was removed prior to 2011 demolition activities.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides
HVS	1	7a, 11a, 11b, 13a, 13b, 15a, 15b, 17a, 17b	**CUA 1c:** The B1372 sump discharge pipeline originated in HZ-CC-8 at B1372 which crossed through the southern portion of HZ-CC-1 as a subsurface pipeline south of the access road and discharged onto a hillslope in the Canyon RFI Site to the west. **CUA 7a:** A curing oven and associated fuel oil tank were located directly west of B1399. The fuel oil tank was gravity fed along a pipeline leading east to supply the curing oven. The former curing oven and associated fuel oil tank were demolished in 2003. **CUAs 11a, 11b:** B1365 was used as a propellant magazine, igniter storage, and ordnance storage building (CUA 11a). B1365 was demolished in 2003. Surrounding former B1365 was a small debris area (MWH-G1A-3053) measuring approximately 788 square feet (CUA 11b). It was composed of stockpiled soil containing partially exposed concrete and asphalt. This debris area was removed in 2009. **CUA 13a:** Three former pad-mounted transformers located northwest of former B1399. **CUA 13b:** One wall-mounted transformer northwest of former B1399. **CUA 15a, 15b**: During 2008 ISRA implementation activities, dioxin-impacted soil was removed from ISRA areas HVS-3 (15a) and HVS-4 (15b). At ISRA area HVS-3, a septic tank measuring approximately 6 feet in diameter and 6 feet deep was discovered in the southeast portion of the excavation area and was subsequently removed under Ventura County oversight. This septic tank previously connected with the B1399 Leach Pit (CUA 3b in HZ-CC-2). **CUAs 17a, 17b (previously PCUA B)**: Two unknown structures, 1XXX-13 and 1XXX-14, identified south-southwest of B1399 in an aerial photo dated 1967.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics
HVS	2	1c, 3a, 3b, 4, 8a, 8b, 15c, 18, 19	**CUA 1c:** The B1372 sump discharge pipeline originated in HZ-CC-8 at B1372 and crossed through the central portion of HZ-CC-2 as a subsurface pipeline. This CUA is further discussed below in HZ-CC-8. **CUA 3a:** B1406 was the Propellant Grain Fabrication Laboratory and machine shop. Propellant support buildings were involved with using and/or storing energetics, perchlorate, metals, and fuels. **CUA 3b:** The B1399 Leach Pit (previously described as a leach field) was discovered south of former B1406 during 1999 interim measures activities. The leach pit was associated with domestic sanitary waste of B1399, the former change house, and the Happy Valley shower facility. The leach pit was approximately 4 feet deep and 3 feet wide. This area was excavated to bedrock during the 2003 HVIM. **CUA 4:** A concrete pit was located southeast of B1390. It measured approximately 2 feet by 2 feet in area and was topped by a steel grating. The concrete pit received storm water from upslope areas, including B1390 (Control Center) and B1745 (Solid Propellant Test Lab). The concrete pit was demolished during the 2003 HVIM, and was excavated to bedrock. **CUA 8a:** B1387 was in operation between the early 1960s through 1980s and was described as the Hybrid Development Building/ Propellant Press Building and Laboratory. Propellants were pressed into shapes for use in later testing. In addition, two 500-gallon tanks containing beryllium fuel were located within this building. The building was demolished in 2003.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Perchlorate • Energetics

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
HVS	2	1c, 3a, 3b, 4, 8a, 8b, 15c, 18, 19	**CUA 8b:** The B1387 Leach Field was shown in facility drawings to be located north of former B1387. Exploratory trenches were dug in the area identified in drawings; however, leach field materials were not observed in these trenches. The estimated location of this leach field is shown on figures included in this DSFR. **CUA 15c:** During 2008 ISRA implementation activities, dioxin and lead-impacted soils were removed from ISRA area HVS-1. **CUA 18 (previously PCUA E)**: Unknown structure 1XXX-16 was identified southeast of B1406 in an aerial photo dated 1980. In addition, unknown structure 1XXX-17 was included with PCUA E but could not be evaluated (see discussion below for PCUA E). **CUA 19 (previously PCUA H)**: Two unidentified features were identified west of and adjacent to B1390 in an aerial photo dated 1999.	
HVS	3	9a, 9b, 10, 14a, 20	**CUA 9a and 9b:** B1988 (CUA 9a) was described as the Beer Butte Shelter/Solid Propellant Curing Oven and was used for curing and hardening of propellants from 1960 through the late 1980s. B1340 (CUA 9b) was used for chemical storage and small chemical processing operations between 1959 and early 1990s. To the south of B1340 was a support structure (B1333). All buildings were demolished in 2003 prior to HVIM activities. **CUA 10:** B1385 was used for ordnance storage (including energetic and perchlorate materials) from 1960 through early 1990s. B1385 was demolished in 2003. **CUA 14a:** The central debris area (MWH-G1A-3048) was observed in February 2008 during the SSFL waste debris survey. The debris area was identified southeast of the former B1340, and in-between former B1385 and B1988. The central debris area consists of partially exposed, broken concrete and road asphalt debris mixed in soil piles with areas of approximately 650 square feet each. Debris is likely from demolition of former B1340, B1385, and B1988. In 2009, debris removal was performed and the soil pile was left in place. **CUA 20 (previously 1A South Unaffiliated Areas PCUA E):** Dirt road between the canyon and HVS RFI Sites observed in aerial photos dated 1957 through 1967.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics • Alcohols
HVS	4	6a, 6b, 13c	**CUA 6a:** B1745 (Solid Propellant Test Area) was the primary energetic test facility in this portion of the site. B1XXX-3 located south of B1745 is described in historical documents as the Polymer Flow Bench/Propellant Laboratory. Small motor engines were tested at a small vertical stand using high energy propellants. These tests typically involved igniting the test propellant in a fixed mounted motor; engine exhaust was directed out the north side of the building toward the hillside. Initially, the Solid Propellant Test Area at B1745 and the Motor Test Facility at B1706 (CUA 6b, described below) were part of the Beryllium Metal Program (1962-1967), which tested beryllium as a rocket fuel. Following decommissioning of the beryllium processing activities in 1967, the area was renovated for subsequent use for pilot scale synthesis and testing of propellants. **CUA 6b:** The Motor Test Facility at B1706 contained an 11,000-gallon, beryllium-fuel testing tank. This tank was used during the testing of rocket motors that used solid propellants containing beryllium. The exhaust from these motors was conveyed into the tank, which contained a water-spray system to capture the exhaust materials. B1706 was demolished in 2003. In 2009, lead-impacted soil was removed from the area surrounding former B1706 as part of ISRA activities. Details related to this soil removal are provided below under the Existing Conditions section. **CUA 13c:** Former wall-mounted transformer west of former B1706.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Energetics
HVS	5	5a, 5b, 7b, 7c, 13d, 14b, 15e, 16	**CUA 5a:** The gun range area includes B1447 (gun propellant building), B1917 (gun propellant storage), B1477 (shelter), and unknown structures 1XXX-4 and 1XXX-5. Gun propellant tests were conducted at a gun range adjacent to former B1447. These tests involved firing 20-40 millimeter (mm) target projectiles into a “sand catcher” backstop in front of an earthen berm located northeast of B1447. Facility drawings indicate B1477 housed a steam generator and an air compressor tank was located directly to the south of B1477. B1447, B1477, and B1917 were all demolished in 2003. In 2009, copper- and lead-impacted soils were removed from two areas within CUA 5a as part of ISRA activities (HVS-2B-1 and HVS-2D). **CUA 5b:** The gun range backstop area is located east of the gun range buildings and across the road. This area was used as a direct fire target backstop for gun propellant testing. In 1999, an interim measure to identify and remove suspected ordnance and other energetic materials was performed at the gun range backstop area. Soil was excavated (in some areas to bedrock) and processed using a mechanical sifter. Debris and possible unexploded ordnance (UXO) were segregated from the soil and removed for disposition by UXO technicians. In 2009, lead-impacted soil was removed from one area within CUA 5b as part of ISRA activities, in the former gun range backstop area (HVS-2A). Details regarding soil removal activities and other features found during ISRA are described below in the Existing Conditions section.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Perchlorate • Energetics

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
HVS	5	5a, 5b, 7b, 7c, 13d, 14b, 15e, 16	**CUA 7b and 7c:** B1917 (CUA 7b) and B1749 (CUA 7c) each housed a curing oven and associated fuel oil tank. The former curing ovens and associated fuel oil tanks were demolished in 2003. **CUA 13d:** Former wall-mounted transformer west of B1749. **CUA 14b:** A debris area (MWH-G1A-3039) was discovered in February 2008 during the SSFL waste debris survey. The debris area consisted of rusted, partially exposed metal piping protruding from the ground approximately 100 sq. ft. in size. The debris was removed during the demolition of B1358 during October 2008. **CUA 15e:** During 2009 ISRA implementation activities, copper- and lead-impacted soils were removed from ISRA area HVS-2B-2. **CUA 16:** During 2009 ISRA activities, a natural gas pipeline was identified just west of ISRA area HVS-2A. This pipeline is a portion of the natural gas pipeline that connects with B1408 in the IEL RFI Site. The pipeline was removed and sampling was performed along the former pipeline trace for PCBs and asbestos. Soil was found to be impacted by PCBs and additional soil removal was conducted.	
HVS	6	14c	**CUA 14c:** The northern debris area (MWH-G1A-3040) was discovered in February 2008 during the SSFL waste debris survey (MWH/CH2M HILL, 2008a). The northern debris area consists of partially exposed piping (insulated and uninsulated), cable, and metal debris; all broken and rusted, approximately 2,945 sq. ft. in size. The northern debris area was removed during the demolition of B1358 in October 2008.	• VOCs • SVOCs • TPH • PCBs • Metals • Perchlorate • Asbestos
HVS	7	12a, 12b, 12c	**CUA 12a, 12b, and 12c:** B1395 (CUA 12a), B1394 (CUA 12b), and B1616 (CUA 12c) were used for energetics material storage. These buildings were demolished in 2003.	• VOCs • SVOCs • TPH • Metals • Perchlorate • Energetics • Glycols
HVS	8	1a, 1b, 1c, 2, 13e, 21	**CUAs 1a, 1b, and 1c:** B1372 (CUA 1a) was used for chemical storage in the late 1950s, as a flare research, development, and production facility during the 1960s, and for gun propellant, solid propellant, and small rocket motor research and development from the 1970s through 1993. It was formerly known as B1751 up until the mid-1960s, when the building was reconfigured. Discharge from operations flowed southward along a grate-covered, concrete-lined drainage trench and collected into two sumps located on the southwest and southeast corners of the building (CUA 1b). Each sump discharged through 3-inch cast iron pipelines that led to a sump pump located south of the building, adjacent to the Happy Valley drainage. A final discharge pipeline (CUA 1c) led westward through the HVS RFI site and discharged onto a hillslope above the ponds at the Canyon RFI site. Pipelines were buried approximately 2 feet bgs. In 1999, an interim measure (IM) to identify and remove metallic anomalies potentially associated with suspect energetic and/or ordnance items was performed in the B1372 area. The primary soil/debris removal area was south of B1372, within the upper reach of the Happy Valley drainage. Approximately 1,800 cy of soil/debris were removed. Soil was excavated to bedrock. During 2002,	• VOCs • SVOCs • TPH • Metals • Dioxins/furans • Perchlorate • Energetics • Herbicides and pesticides

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
HVS	8	1a, 1b, 1c, 2, 13e, 21	the B1372 foundation was removed along with associated sumps and pipelines (CUAs 1b and 1c) and approximately 2 feet of underlying soil as a control measure to address potential perchlorate migration via surface water. **CUA 2:** The former metallic debris area is located to the south and down slope of B1372. It was bound to the north by an unpaved road and to the east, south and west by rock outcrops. During the 1999 IM a small amount of suspect unexploded ordnance (UXO), UXO scrap, and non-UXO debris was discovered in this area. The non-UXO debris was primarily large construction debris, such as asphalt and concrete. The northern portion of the debris area was excavated to bedrock and the southern portion of the debris area was excavated, sifted, and backfilled as part of the 1999 IM. During the 2003 HVIM the remaining portions of the debris area were excavated to bedrock and backfilled with clean soil from the onsite borrow source. **CUA 13e:** Former pad-mounted transformer located south of B1372. The area was excavated to bedrock during the 2003 HVIM. **CUA 21 (previously 1A South Unaffiliated Area PCUA A):** Cleared vegetation area identified in non-operational area south of the HVS RFI Site during review of historical aerial photographs dated 1953 through 2010. This area is a topographic low upslope of a tributary drainage that connects with the Happy Valley drainage to the east.	
HVS	9	N/A	A portion of a soil disturbance area (previously part of 1A South Unaffiliated Areas PCUA F) identified in aerial photos dated 1988 through 1999 is present in the northwestern portion of HZ-CC-9. Other than this feature, no source or potential sources were identified along the tributary drainage within HZ-CC-9. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• VOCs • SVOCs • TPH • Metals • Dioxins/furans • Perchlorate
HVS	10	N/A	No source or potential sources were identified along the headwaters of the tributary drainage within HZ-CC-10. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• SVOCs • TPH • Metals • Perchlorate
HVS	11	N/A	No source or potential sources were identified along the headwaters of the tributary drainage within HZ-CC-11. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• SVOCs • TPH • Metals • Perchlorate
HVS	12	15d	**CUA 15d:** During 2009 ISRA implementation activities, dioxin-impacted soils were removed from ISRA area DRG-1.	• Metals • Dioxins/furans
HVS	13	N/A	No source or potential sources were identified along the hill slope area within HZ-CC-13. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• Metals and inorganics
HVS	14	22	**CUA 22**: A cleared vegetation area that was observed in aerial photos dated 1960 through 1967 and previously identified as 1AS Unaffiliated Area PCUA B.	• VOCs • SVOCs • TPH • Metals and inorganics • Dioxins/furans • Ammonia

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
HVS	15	14d, 14e, 14f, 23, 24	**CUA 14d:** One of three southern debris areas discovered in 2008 during the SSFL waste debris survey. The debris area consists of broken, scattered, partially exposed rusted metal, glass, roof shingles, and a white chalky material. The area is approximately 228 sq. ft. in size. **CUA 14e:** The second of three southern debris areas discovered in 2008 during the SSFL waste debris survey. The debris area consists of a soil pile mixed with broken, scattered concrete road debris and culvert pieces; and rusted metal pipe and fence posts. The area is approximately 13,266 sq. ft. in size. **CUA 14f:** The third of three southern debris areas discovered in 2008 during the SSFL waste debris survey. The debris area consists of exposed, rusted 2000-31gallon tank and 55-gallon drum, both empty. The area is approximately 100 sq. ft. in size. **CUA 23:** A portion of a vegetation clearance area observed in aerial photos dated 1953 through 1965 and 1972 through 1988 that was previously identified as 1AS Unaffiliated Area PCUA C. **CUA 24**: A vegetation clearance area observed in an aerial photo dated 1978 that was previously identified as 1AS Unaffiliated Area PCUA D.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans • Perchlorate
HVS	16	N/A	HZ-CC-16 includes a portion of a soil disturbance area (previously part of 1A South Unaffiliated Areas PCUA F) identified in aerial photos dated 1988 through 1999. Other than this, no source or potential sources were identified within HZ-CC-16. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• SVOCs • TPH • Metals
HVS	17	N/A	HZ-CC-17 includes a portion of a soil disturbance area (previously part of 1A South Unaffiliated Areas PCUA F) identified in aerial photos dated 1988 through 1999. Other than this, no source or potential sources were identified within HZ-CC-17. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• VOCs • SVOCs • TPH • Metals
HVS	18	N/A	HZ-CC-18 includes a portion of a soil disturbance area (previously part of 1A South Unaffiliated Areas PCUA F) identified in aerial photos dated 1988 through 1999. Other than this, no source or potential sources were identified within HZ-CC-18. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• VOCs • SVOCs • TPH • Metals
HVS	19	N/A	A portion of a soil disturbance area (previously part of 1A South Unaffiliated Areas PCUA F) identified in aerial photos dated 1988 through 1999 is present in the northwestern portion of HZ-CC-9. Other than this feature, no source or potential sources were identified within HZ-CC-19. No CUAs, features, or evidence of historical operations were identified at this CUA cluster in previous reporting or in documentation reviewed during the DQO Figure 2 process.	• VOCs • SVOCs • TPH • Metals
LETF/CTL-I	1	1f, 13a, 13b, 13c, 13d, 13e, 13f, 13g, 13h, 14a, 14f, 14g, 15a, 15b, 15c, 16a, 16b, 16c, 16d, 17a, 17b, 17c, 18b, 20b	**CUA 1f:** Former pad-mounted transformer (Tag #25) located approximately 30 feet west of former B1381. The transformer was identified on facility drawings, and based on historical documents, was installed in the early 1950s and removed in the 1960s. **CUAs 13a and 14a:** Former B1317 consisted of two parts: six test cells in the southeastern portion of the building (CUA 13a) used for jet engine testing with kerosene-based fuels and LOX, and the support building (CUA 14a). B1317 was commissioned in the early 1950s as the Hot Fuels Laboratory (HFL). In 1964, the HFL was renamed the Combustion Heat Transfer Laboratory (CHTL) and test cells were modified for J-series engine testing. Associated chemicals included NTO, petroleum-based fuels, and TCE. TCE was supplied to the test cells in 55-gallon drums for engine cleaning. In 1970, the facility was renamed the Laser Engineering Test Facility (LETF) and rebuilt for fluoride laser testing using nitrogen-based high energy compounds. Operational areas at the support building included: a turbojet workshop in the northwest, the control center in the northeast,	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
LETF/CTL-I	1	1f, 13a, 13b, 13c, 13d, 13e, 13f, 13g, 13h, 14a, 14f, 14g, 15a, 15b, 15c, 16a, 16b, 16c, 16d, 17a, 17b, 17c, 18b, 20b	a turbojet workshop extension in the southwest which later became the Laser Operations Room, and equipment storage in the southeast which was replaced by additional test cells in 1958. B1317 was inactivated in 1985 and demolished between 1999 and 2000. **CUA 13b:** LETF Former Test Pad 3 was a partially covered concrete pad with a backstop against a rock outcrop to the south. The test pad, also known as the Test Firing Stand, was used for jet engine and J-series engine testing during HFL and CHTL operations from the early 1950s to 1970. **CUAs 13c and 13d:** The former LETF drainage system consisted of concrete-lined channels that captured operational wastewater from Buildings 1317, 1381, and Test Pad 3 (CUA 13c), leading to a concrete wastewater collection sump (CUA 13d) that discharged to the LETF Pond via a 1-foot corrugated drainpipe. Operational discharge to the channels potentially contained compounds associated with LETF testing, primarily residual fuels, solvents, and fluorine-containing compounds. **CUAs 13e and 13h:** The LETF former B1381 (CUA 13e) was used as a support building for historical operations conducted at HFL, CHTL, and LETF. From the early 1950s to 1964, B1381 was known as the Heat Transfer Lab (HTL). The HTL contained twelve welding machines and a positive displacement high pressure pump, used to study the buildup of carbon in electrically heated tubes cooled by fuel. B1381 was later expanded to sixteen welding machines and high pressure tanks to study heat transfer effects on tubes with various propellants, including liquid hydrogen. A fuel pump, 400-gallon RP-1 tank (H-332), and concrete tank pad (CUA 13h) located at the southeastern corner of former B1381 supported HFL, HTL, CHTL, and LETF operations. **CUAs 13f and 13g:** The former B1317/1381 sumps and western portion of the LETF drainage system consisted of two sumps located along the western and southern sides of B1381 (CUA 13f), which discharged to a network of concrete-lined drainage channels converging at a central sump (CUA 13g) that discharged to the former LETF Pond. **CUAs 14f and 14g:** The LETF former Freon system consisted of a 5-horsepower pump (CUA 14f) used to move Freon 113 from Tank V-12 (CUA 14g) to B1317 for use as a coolant during laser operations. The pump and tank at the northeast portion of former B1381 were in use from 1972 to 1979. **CUAs 15a-c:** Former B1725 (CUA 15a) was known as Hot Fuels Test Pad 2 and the Wax Processing Building. In the 1950s, this building was equipped with a large cylindrical tank used to simulate the aerodynamic heating of a cruise missile full of kerosene-based fuel. The actuator-mounted tank simulated sloshing in flight. RP-1 used in testing was stored in AST V-371 (CUA 15c). After LETF site reconfiguration in 1970, B1725 became the Wax Processing Building and contained two wax tanks (V-286 and V-1001). Northwest of former B1725 was a concrete-lined catchment basin/fuel sump (CUA 15b). This sump was 12 feet long by 12 feet wide, and 12 feet deep at its deepest point. B1725 operational wastewater was contained in the sump prior to discharge to the LETF Pond via a 4-inch drain line. **CUAs 16a-c:** The former LETF Pond (CUA 16a) was a 50,000-gallon pond used for storage and treatment of HFL and CHTL operational wastewater. The LETF Pond was first used in 1950 and was originally gunite-lined before being relined in 1978 with reinforced steel mesh and an additional 4 inches of gunite. The pond had a spillway to the south where it discharged to a concrete-lined drainage leading to the Area I Road Drainage, and the R-1 Pond. During later operations, the LETF Pond was used in DF laser testing. The pond was treated with caustics and used as the water supply for the scrubber tower (CUA 16c). Water in the pond was pumped annually and disposed offsite by a hazardous waste transporter. The former aqueous alkaline fluorine gas scrubber (CUA 16c), north of the LETF Pond, was operational from the early 1970s to the early 1980s. A 20-inch steel exhaust pipe from B1317 connected to the scrubber on the north side of the system. The LETF Pond was inactivated in 1984 and impoundment closure activities began. The gunite liner and reinforced steel were removed and soil was excavated and disposed of at a Class I disposal facility. Excavation areas were backfilled but not paved. The pond was clean-closed in November 1984 (DHS, 1984). In 1993, an accelerated cleanup soil removal action excavated 2-3 cubic yards of fluorine-impacted soil downslope from the LETF Pond (ICF, 1993). In 1985, the LETF Pond was replaced by 15,000-gallon underground holding tank UT-66 (CUA 16b). UT-66 was designed to contain fluorine and caustic solutions to form sodium fluoride. The tank was removed under oversight of the VCEHD in October 1994. No evidence of impacted soil was observed during tank removal; the site was closed by VCEHD in November 1994 (VCEHD, 1994). **CUA 16d:** Former B1789 was identified as the Molybdenum/Fluorine System. This building and an associated concrete-lined drainage were located southwest of former B1725.	• Tritium

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
LETF/CTL-I	1	1f, 13a, 13b, 13c, 13d, 13e, 13f, 13g, 13h, 14a, 14f, 14g, 15a, 15b, 15c, 16a, 16b, 16c, 16d, 17a, 17b, 17c, 18b, 20b	**CUAs 17a and 17c:** Two storage buildings were associated with former B1725. Former B1771 (CUA 17a) was located south of B1725; specific storage was not documented. Former B1406, located northwest of the B1725 Fuel Sump, was known as the Hot Fuels Storage Building. Facility drawings indicate this building was used to store waste fluids from B1725 operations; however, specific chemicals were not documented. **CUA 17b:** CUA 17b is a topographic low downslope, southwest of the LETF Pond. Stormwater runoff and accidental releases from the LETF Pond could have collected in this area. **CUA 18b:** The former LETF LN_2/Hydrazine Bottle Storage Area consisted of a bottle bank with 24 bottles (totaling 600 cubic feet) used at different times for the storage of hydrazine and LN_2. **CUA 20b:** Debris Area MWH-G1A-3019 is an approximately 7,200 square foot debris area west of former B1381, documented during a 2008 debris survey. The area contained scattered metal, asphalt, and concrete.	
LETF/CTL-I	2	14d, 14e, 18a, 18c, 19, 20c	**CUA 14d:** Former B1379 was an office building south of Area I Road, west of B1317. Additionally, B1379 contained a "Jet-O-Mizer" to grind TAGN for use in gun propellants, a test cell for J-series engines during CHTL operations, and six tanks containing LOX, fluorine, CTF, and RP-1. Former B1379 used, generated, or stored hydrazines, antimony grain propellant, and triethylaluminum. **CUA 14e:** The LETF former storage area was located south of B1379. Based on facility drawings and aerial photographs, the storage area was used from 1978 to 1983. Specific chemicals and materials stored were not documented. **CUA 15d:** Former fuel (JP-5) tanks V-7 and V-8, a fuel pit, and associated piping were located west of B1317. The fuel supported operations at the Hot Fuel Test Pad (CUA 15a). **CUA 18a:** The LETF former Drum Storage Area was located west of B1379. Based on operational history, petroleum fuels and solvents were likely stored in this area; specific chemicals were not documented. **CUA 18c:** Two hydrazine storage tanks were located north of the former LN_2/hydrazine bottle bank (CUA 18b). The size and use period of these tanks were not available in reviewed documentation. **CUA 19:** The B1317/1423 Leach Field was a 65 foot by 48 foot leach field, located approximately 130 feet west of former B1317 (based on facility drawings), and had an associated 1,000-gallon septic tank (unknown location). The leach field became inactive in the early 1960s with the installation of the SSFL central sanitary sewer system. Removal status of this leach field is unknown; investigative trenching and geophysical surveying have been performed, but the leach field and septic tank were not located. **CUA 20c:** Debris Area MWH-G1A-3018 was documented during a 2008 debris survey at the same location as the former hydrazine tanks (CUA 18c). The debris area contained a rusted, exposed gate valve and piping and was less than 100 square feet in size.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics
LETF/CTL-I	3	1e, 13i, 14b, 14c	**CUA 1e:** The LETF Substation east of B1318 consisted of one pad-mounted transformer (Tag # 347). The substation was removed between 1999 and 2003 based on aerial photograph review. **CUA 13i:** Former fuel tanks H-11 (11,500-gallon) and AT-52 (4,000-gallon) provided JP-5 and RP-1 fuel for LETF testing operations. Fuel was pumped to two catch tanks west of B1317 via a 3-inch fuel line. These tanks also provided RP-1 to the APTF operational area via a 1.5-inch fuel line. **CUA 14b:** Former B1972 was a storage building and drum storage pad east of B1317. Specific materials and chemicals stored were not documented. **CUA 14c:** Former B1318 was a workshop and storage building north of B1317. Historical documentation identified that copper oxide, Freon, mercury, and oils were used, generated, or stored at B1318.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
LETF/CTL-I	4	20a, 20d, 20e, 20f, 20g	**CUA 20a:** Debris Area MWH-G1A-3031, at the hillside southeast of the former LETF operational area, was documented during a 2008 debris survey. The area contained a broken, rusted metal table and table hardware. Based on a site interview, the debris was determined to be a fluorine burn box to dispose of fluorine bottles used in support of LETF laser operations. **CUA 20d:** Debris Area MWH-G1A-3032, located southeast of the former Test Pad 3, was documented during a 2008 debris survey. The area contained partially exposed, intact metal sheeting and was located along the drainage pathway that flows between the Canyon and APTF RFI Sites to the former LETF operational area. **CUA 20e:** The debris area south of the former LETF operational area consisted of approximately 175 feet of 2-inch metal pipe. Historical documents and a site interview indicated the pipe may have conveyed fuel, water, or inert gas. **CUA 20f**: Debris Area MWH-G1A-3074 consists of four pipe supports on bedrock discovered in 2010. The pipe supports indicate a removed pipeline approximately 270 feet in length; what the pipe conveyed and what locations it connected were not documented. The pipe supports have been removed. **CUA 20g**: Debris Area MWH-G1A-3075 consists of a 3-inch pipeline running from B1375 (Canyon RFI Site) northwest to the former LETF operational area. Specific materials the pipe conveyed and what location within LETF it connected to were not documented. Aboveground portions of the pipe have been removed.	• VOCs • SVOCs • TPH • Metals and inorganics • Dioxins/furans
LETF/CTL-I	5	2a, 2b, 2c, 2d, 2e, 2g, 2h, 2i, 2j, 4a, 4b, 7b, 7c, 7d, 8d	**CUA 2a:** The northern portion of former B1309 consisted of Test Cells 1 through 7 that contained smaller test stands, tanks, process piping, and drainage trenches. The concrete-paved area tested small rocket engines and engine components between 1953 and 1995. From 1977 to 1991, the test cells supported development testing for the SSME program using LOX. Other facility equipment included motor drives, dynamometers, and propellant tanks. Operations at the CTL-I Test Cells used LOX, JP fuels, TCE, and exotic propellants such as pentaborane. **CUAs 2b-e**: Operational wastewater generated at the CTL-I Test Cells discharged via pipelines and trenches to a concrete-lined drainage ditch (CUA 2b) north of the test cells. This drainage ditch directed water to a steel-bottom concrete burn-off pit (CUA 2e). Dimensions of this burn-off pit were 35 feet by 20 feet by 8 feet. The area also includes two other burn-off pits located west of the test cells. A gunite-lined burn-off pit (CUA 2c) with dimensions of 9 feet by 9 feet by 9 feet. The other (CUA 2d) was identified in facility drawings as a burn-off pit and is located west of the steel-bottom burn-off pit. This second area was observed to be unpaved, and dimensions of this pit are unknown. **CUAs 2g and 2h:** Fuel AST H-4 (10,000-gallons) (CUA 2g) west of the CTL-I Test Cells contained JP-1 and RP-1 fuels. Fuel from this AST was transported via subsurface pipeline to the first of two fuel pumping stations (CUA 2h). This fuel pumping station consisted of five below-grade fuel pumps used to transport fuel from the AST to both the CTL-I Test Cells and the second fuel pumping station (CUA 2k, LF-CC-7) located downslope near Area I Road. **CUA 2i:** A fuel tank was located adjacent (north) to Test Cell 5. Specific size and contents of this tank were not available in reviewed documentation. **CUA 2j:** The Central Fuel Farm Switchboard controlled a series of pumps which supplied fuel for CTL-I Test Cell operations. This feature was located west of the test cells. **CUAs 4a and 4b**: Two cooling towers (CUA 4a), approximately 50 feet northeast of B1309 supplied and circulated cooling water in support of test cell operations. Facility drawings indicate cooling water from the towers discharged via pipeline to the gunite-lined drainage channel (CUA 4b) north of the test cells. The drainage channel discharged into the gunite-lined burn-off pit (CUA 2c) and former burn-off pit (CUA 2d). **CUAs 7b-d:** Three drum storage areas were identified in and around the former CTL-I Test Cells. One drum storage area was south of the steel-bottom burn-off pit (CUA 7b); another northwest of Test Cell 7 (CUA 7c); and the third north of Test Cell 4 (CUA 7d). Specific chemicals are not documented; however, these areas likely stored fuels, solvents, and/or other chemicals associated with CTL-I operations. **CUA 8d:** Debris Area MWH-G1A-3030, north of the CTL-I Test Cells, is an approximately 2,100 square foot area documented in a 2008 debris survey. The debris area was noted as containing metal, glass, and stainless steel tubing.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Alcohols

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
LETF/CTL-I	6	1a, 1b, 3a, 3v, 3c, 3d, 3e, 5a, 5b, 7e	**CUAs 1a and 1b:** The CTL-I Transformer Substation Area consisted of five pad-mounted transformers (CUA 1a), a switching station in a fenced area to the southwest, and three pole-mounted transformers located to the northeast (CUA1b). Slight staining was observed at the bottom of the pole-mounted transformers. **CUA 3a:** The CTL-I Support Building consisted of Buildings (within the overall B1309 footprint) 1309, 1310, 1311, 1323, and 1330. The building was constructed in 1949 to perform turbopump testing and maintenance, flow meter calibration, and bearing and seal testing. Support operations performed at B1309 include: • B1309: Weld and fabrication shop, machine shop, and laser chiller; • B1310: High flow testing and turbopump testing; • B1330: Stock room and storage; and • B1311: contained the Excimer Laser Lab in the western portion, and the Low Flow test area in the eastern portion. **CUAs 3b-e:** The B1309 sanitary sewer system had two septic tanks. The 1000-gallon northern septic tank and gravity fed distribution line (CUA 3b) was tied to the northern leach field located east of B1309 (CUAs 3c and 3d). The northern leach field served the northern portion of B1309 prior to the workshop building addition in 1956. The western portion of the northern leach field (CUA 3c) contained 100 feet of perforated pipe that was abandoned due to the addition. The eastern portion of the northern leach field (CUA 3d) contained 150 feet of perforated pipe located in two 2-foot deep trenches. The 2,250-gallon southern septic tank and gravity fed distribution line (CUA 3e) was tied to the southern leach field (CUA 3f, LF-CC-7), also known as the B1309 Leach Field, south of B1309. It is not documented when leach fields 3d and 3f became inactive, but it was likely in the early 1960s, with the installation of the SSFL central sanitary sewer system. **CUA 5a:** The former Vacuum Pump House east of B1309, identified in facility drawings and aerial photographs, supported CTL-I operations and potentially used cleaning solvents and oils. **CUA 5b:** A compressor was identified in facility drawings east of B1309. The compressor supported testing operations at CTL-I, and potentially used cleaning solvents and oils. **CUA 7e:** Historical photographs show a row of seven drums/barrels located east of B1330, potentially used in support of early CTL-I operations. Specific chemicals are not documented; however, this area likely stored fuels, solvents, and/or other chemicals associated with CTL-I operations.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Perchlorate • Alcohols • Asbestos
LETF/CTL-I	7	2f, 2k, 3f, 6, 7a, 8b, 8c, 9	**CUA 2f:** Effluent from the steel-bottom burn-off pit (CUA 2e; LF-CC-5) discharged via a 16-inch corrugated metal pipe and concrete trench (CUA 2f) to the concrete drainage channel along the north side of Area I Road. Additionally, facility drawings show a planned burn-off pit/known discharge sump (southern portion of CUA 2f) north of the B1309 Leach Field. **CUA 2k:** The former fuel pumping station and associated fuel pipelines were located southwest of B1309, near Area I Road. This system is the second set of pumps used to transport fuel from Tank H-4 (CUA 2g). Fuel at this pumping station was transported to the former fueling station (CUA 9). **CUA 3f:** The B1309 Leach Field, south of B1309, contained 900 feet of perforated pipe located in two 4-6 foot deep trenches running roughly parallel approximately 15 to 25 apart. Leach lines and gravels were removed during 2009 demolition activities, and the area was graded. It is not documented when the B1309 Leach Field was inactive, but it was likely in the early 1960s, with the installation of the SSFL central sanitary sewer system. **CUA 6:** A welding shop and storage shed were identified west of B1309 during review of facility drawings. Operational history and specific chemical usage at these locations were not documented. **CUA 7a:** A drum storage area and concrete cradles were located west of B1309. The drum storage area was 65 feet by 50 feet. Specific contents of the drums were not documented, but potentially included fuels and solvents based on CTL-I operational history.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Pesticides • Alcohols • Radionuclides

Table 6-1c – Subarea 1A South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
LETF/CTL-I	7	2f, 2k, 3f, 6, 7a, 8b, 8c, 9	**CUA 8b:** Debris Area MWH-G1A-3028, west of the former B1309 Leach Field footprint, was identified during a 2008 debris survey. The debris area consisted of partially exposed, broken concrete rubble mixed with disturbed soil. **CUA 8c:** A debris pile (soil or fill) was identified southwest of B1309 during review of historical photos (unknown photograph date). **CUA 9:** The former fueling station consisted of a concrete pad with two fuel pumps that received fuel from the secondary pumping system (CUA 2k). The eastern portion of the fuel station was utilized by CTL-I; the western portion transported fuel to the Canyon RFI Site.	
LETF/CTL-I	8	1c, 1d, 11a, 11b, 12	**CUA 1c:** One pole-mounted transformer (Pole #1-A-50) was located north of Area I Road, southeast of B1306. No staining or leakage were observed during a 2005 site inspection. **CUA 1d:** The transformer substation east of former B1423 consisted of two sets of pad-mounted transformers, including three 300-KVA transformers and three 167-KVA transformers. No staining or leakage were documented at this substation. **CUA 11a:** The former Fire Pump House (B1306) was located north of Area I Road, east of the CTL-I operational area. This structure was identified in facility drawings and aerial photographs. Specific activities and chemical use information were not documented. **CUA 11b:** Former Tank UT-46 was a 650-gallon diesel/fuel oil UST at the east side of B1306. UT-46 was removed under oversight of the VCEHD in August 1988 as a part of Rockwell's tank removal program. No evidence of impacted soil was observed during tank removal. **CUA 12:** The former Ion Research Facility (B1423) was located north of Area I Road, east of the former CTL-I operational area. The facility contained a dark room in the southeastern corner, and historical documentation indicated that copper oxide, Freon, mercury, and oils were used, stored, or generated at B1423. This building was also identified as an instrumentation lab. Storage of two drums was noted outside the northeast corner of the building; drum contents were not documented.	• VOCs • SVOCs • TPH • PCBs • Metals • Dioxins/furans
LETF/CTL-I	9	8a	**CUA 8a:** Debris Area MWH-G1A-3025, southwest of the former LETF operational area east of Area I Road, was an approximate 630 square foot area containing broken, scattered concrete, a rusted metal pipe, and miscellaneous construction debris.	• SVOCs • TPH • Metals and inorganics
LETF/CTL-I	10	10	**CUA 10:** Former B1786 was an igniter storage building south of Area I Road, southwest of the LETF and CTL-I operational areas. Based on aerial photos, this building was constructed in the early to mid-1950s and removed in the late 1950s or early 1960s.	• Metals • Energetics and perchlorate
LETF/CTL-I	11	8e, 8f, 8g	**CUA 8e:** Debris Area MWH-G1A-3008, immediately north of former Water Tanks 801, 802, and 803, was an approximately 7,200 square foot area containing exposed, scattered metal debris, a 5-gallon bucket, an open and rusted 55-gallon drum, and concrete. In 2010 as part of the ISRA program, approximately 1,200 cubic yards of soil were excavated from the CUA 8e area and drainage downstream to the north (ISRA Area CTLI-1). This removal action was conducted to address elevated copper, lead, and dioxin/furan concentrations in soil. **CUA 8f:** Debris Area MWH-G1A-3009, adjacent to the surface water drainage pathway north of former Water Tanks 801, 802, and 803, consists of a length of rusty pipe, with portions both exposed and buried, running the length of the hillside from the water tanks to Test Area Road. Exposed portions of the pipe have been removed. Specific pipe contents (likely water) were not documented. **CUA 8g:** Debris Area MWH-G1A-3011, northwest of former Water Tanks 801, 802, and 803, consists of approximately 10 feet of rusted metal pipe and supports.	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans

Table 6-1c – Subarea 1A South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
Unaffiliated Areas	N/A	N/A	N/A	• VOCs • SVOCs • TPH • PCBs • Metals and inorganics • Dioxins/furans • Energetics and perchlorate • Herbicides and pesticides

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
R-1 Pond	1	1, ,2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	**CUA 1: The Building 1543/1964 STP** is a package-type sludge-activated STP. The sewage waste from Administrative Area I and from the southern portion of Administrative Area II were treated at STP-1. STP-1 includes Building 1964, an influent sump, a concrete berm, an air compressor, an air dryer, a gas chlorinator, and two aboveground storage tanks (one containing domestic sewage and one with unknown contents). Operations at STP-1 began in 1958 and ceased in December 2001. The STP-1 basins are currently used as collection points for wastewater generated onsite. This CUA also includes a tank that was formerly located at the location of STP-1 prior to the construction of the STP. The tank was installed in 1956 and was presumably removed when the STP was constructed. The contents of the tank are not known. **CUA 2: Building 1424** was used as a propellant hardware storage building in 1967 and as a blower house for STP-1 in 1966. The building was demolished in 2012. **CUA 3: The Former Fuel Transfer Area** contained former structures 1XXX-017 observation post, a former aboveground storage tank with an approximate size of 60 by 10 feet with unknown contents, an aboveground LOX tank, and a former station for rocket-fuel storage (kerosene-based fuels, TCE, hydrazine, and fuel oil). The fuel lines from this transfer station conveyed fuel to the Bowl Fuel Farm, which supplied fuel for the testing operations conducted at VTS-1, VTS-2, and VTS-3. Two fuel-oil pipelines were located in CUA 3; Fuel Pipeline 1 ran from the Tank H-17 in the Canyon RFI site to former Personnel Shelter (Building 1768), which is located just south of the CUA. Fuel Pipeline 2 ran from CUA 3 to the Bowl Area RFI site. **CUA 4: Air stripping towers (SWMU 4.18), also known as the Area I Road groundwater treatment unit**, were located north of R‑1 Pond and east of Area I Road in a concrete bermed area 20 feet wide by 30 feet long. These towers were part of a facility-wide groundwater reclamation system constructed in 1987 to remove VOCs from SSFL groundwater. The CUA also includes two aboveground tanks with unknown contents and use periods. This groundwater treatment unit was placed on operational standby status on December 31, 2001 and decommissioned and removed from the site in 2011 (Haley & Aldrich, 2012). While the Area I Road groundwater treatment unit was active, it operated under the Hazardous Waste Facility Post-Closure Permit for Areas I and III at the SSFL for U.S. Environmental Protection Agency (EPA) ID CAD093365435 (DTSC, 2001), and under the Ventura County Air Pollution Control District (VCAPCD) Permit No. 1344. The system consisted of two air stripping towers connected to activated carbon absorbers. While operational, the system received water from wells RD-2, ES-1, ES-3, ES-4, ES-5, ES-6, ES-7, ES‑11, HAR-4, and HAR‑16. This system was designed to handle a 40-gallon-per-minute flow. Groundwater was pumped through the first tower and passed downward through the tower as air passed upward. VOCs were volatilized from the water and entered the air stream. The effluent air stream from the tower then entered the activated carbon absorbers, where VOCs were removed from the air. The effluent groundwater from the first tower would then go through a second tower for further stripping. Air from the second tower was released without carbon filtration. The effluent from the second tower was discharged to the adjacent drainage. **CUA 5: R‑1 Pond (SWMU 4.16) (Area I Reservoir)** is an unlined, approximately 3 million-gallon-capacity pond constructed in the mid-1950s. R‑1 Pond received effluent from the STP-1, storm water runoff, drainage from upgradient areas in Administrative Area I, and industrial wastewater discharge from the Advanced Propulsion Test Facility-1 and -2, the Canyon Retention and Skim Ponds, the Laser Engineering Test Facility Pond, and the Bowl Skim/Retention Pond until closure/inactivity of these ponds. The R-1 Pond also received wastewater pumped via a pipeline from Perimeter Pond for reuse in the water reclamation system. There are no longer any operational discharges being released to the R-1 and Perimeter Ponds. Currently, the ponds receive storm water runoff only. Water in R-1 Pond was historically pumped uphill to the west to supply reclaimed water storage tanks on Skyline Drive for subsequent use in the cooling and fire suppression systems at various test areas throughout the SSFL and to the reclaimed water tanks in the Bowl and Canyon test areas, which supplied water by gravity feed to rocket test stands in the respective areas. Excess water in R‑1 Pond was discharged to the Upper and Lower Perimeter Pond spray fields, which are located in R-1 Pond CC 2, for subsequent evaporation or infiltration. Water from R-1 Pond was also conveyed to the Alfa spray field (R-1 Pond CC 3) via the reclaimed water storage tanks on Skyline Drive. Features associated with R-1 Pond include the north sump, south sump, a former dam, a storm drain, and three spillways. **CUA 6: R‑1 Pond Transformers/A166 Transformers** were located near the southeast side of R‑1 Pond and used from 1963 until 2011. The three transformers are located on concrete and labeled “150 KVA.” Building 1XXX-021 is an electrical pump control platform adjacent to the R‑1 Pond transformers that was demolished in 2011. The transformers are still present onsite.	• VOCs • SVOCs (including NDMA and Formaldehyde) • TPH • PCBs and PCTs • Dioxins and Furans • Pesticides and Herbicides • Energetics and Perchlorate • • Metals (including Hexavalent Chromium) • • Inorganics (including Cyanide) • • Terphenyls

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
R-1 Pond	1	1, ,2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	**CUA 7: Debris was observed during excavation at R‑1 Pond Spillway**-1 (the spillway in the southwestern part of the pond) in September 1998 (Shea, 1998). The excavation was expanded, and an area of approximately 80 feet by 40 feet was excavated to remove debris. Debris observed in the excavation included metal, asbestos, wire, and pipes. The debris was disposed offsite in October 1998. **CUA 8: Concrete Pad 3** Area consists of a 2 by 3-foot concrete pad located southwest of R‑1 Pond. The concrete pad was removed in the late 2000s and replaced with surface water treatment system equipment. **CUA 9: The Former Air-stripping Tower Transformer 1** was a pole-mounted transformer approximately 50 feet northeast of the air-stripping towers and used in 1987. **CUA 10: The Former Transformer Pad/Former Air-stripping Tower Transformer 2** is the location of two to three former transformers east of the observation post. It is not known when they were installed or removed. **CUA 11: The Former Area 1 Road Transformers** were located approximately 100 feet west of Area I Road across from the air-stripping towers and were used in 1959. **CUA 12: The Building 1543/STP-I Transformers** are three pole-mounted transformers north of the STP. The installation date is unknown, but the transformers are still currently in use. **R-1 Pond CC 1** is located in the eastern portion of the R-1 Pond RFI site reporting area in Administrative Area I. Area I Road runs along the western side of R-1 Pond, through the western side of R-1 Pond CC 1. Structures at the site have been demolished (except for Building 1543/1964), and tanks have been removed. Topography at R-1 Pond CC 1 generally slopes to the south toward R-1 Pond. Throughout most of R-1 Pond CC 1, soil is generally thin, typically ranging from less than 1 foot to up to 5 feet, but can be up to 30 feet thick within the pond footprint. Soil in the undisturbed areas of the site consists of weathered Chatsworth Formation materials, which are primarily fine-grained, silty sands and clayey silts. Surface water exists intermittently in ephemeral drainages that drain from the north (from upstream areas in Administrative Area I), west, and east (from the Bowl Area RFI site) into R‑1 Pond as the result of seasonal precipitation events. R-1 Pond is typically dry and temporarily stores water during heavy or long‑term precipitation. Surface water collected in the Pond is treated by the Storm Water Treatment System located next to the pond before the water is conveyed to Outfall 011, which is located downstream of Perimeter Pond (although the system has not been run and no discharges have occurred at Outfall 011 because of dry weather). **Other features within R-1 Pond CC 1** that are not associated with a CUA include Buildings 1768, 1790, 1XXX-018, 1XXX-019, 1XXX-20 (Two Personnel Shelters and three Spillway trailers, respectively; these structures were constructed in 1959 and were demolished at an unknown date), an aboveground LOX tank (and associated concrete tank pad) southwest of R-1 Pond that was used in 1964 and was subsequently removed, two aboveground tanks with unknown contents and use period east of Building 1790, and an aboveground hydrogen storage tank southwest of R-1 Pond that was in use from 1964 to 2009. The following debris locations are also located in R-1 Pond CC 1, but are not associated with a CUA: Debris points CH2-G1B-2084 (empty metal box, removed in 2010), CH2-G1B-2085 (several large pieces of concrete, removed in 2010), CH2-G1B-3052 (concrete bags, removed in 2009), and CH2-G1B-3053 (metal pipes, removed in 2009).	
R-1 Pond	2	13, 14	**CUA 13: The Lower Perimeter Pond spray field** was built in 1981 in response to high fluoride concentrations in R‑1 Pond. Water was pumped via an aboveground pipeline from R-1 Pond to the spray field for subsequent evaporation or infiltration, thereby reducing the volume of reclaimed water that required storage. The Lower Perimeter Pond spray field was a 2-acre spray field with a capacity of 45,000 gpd (9 sprayheads, each 1 inch in diameter, which operated 5 hours per day). The spray field is no longer used, and the pipelines and spray nozzles were removed in the early 2010s. **CUA 14: The Upper Perimeter Pond spray field** was constructed in 1968. Water was pumped via an aboveground pipeline from R-1 Pond to the spray field for subsequent evaporation or infiltration, thereby reducing the volume of reclaimed water that required storage. The Upper Perimeter Pond spray field was a 1.5-acre spray field with a capacity of 10,000 gallons per day (gpd; 11 sprayheads, each 0.5-inch in diameter, which operated for 5 hours per day). The spray field is no longer used, and the pipelines and spray nozzles were removed in the early 2010s. This CUA also includes Debris Areas CH2-G1B-3046 (soil pile intermixed with concrete, removed in 2009 and 2010) and CH2-G1B-3055 (asphalt and concrete pieces, metal filter, and metal box, removed in 2009), a soil disturbance area, Buildings 1XXX-03 and 1XXX-04 (a Radio Signal Boost Station constructed in 1997 and demolished in 2005), and an aboveground diesel storage tank associated with the radio signal boost station. **R‑1 Pond CC 2** is located in the western-central area of R‑1 Pond RFI site reporting area, west of the R‑1 Pond. There are no perennial bodies of surface water at R‑1 Pond CC 2. The topography at R‑1 Pond CC 2 slopes to the southeast at CUA 13 and towards the northeast at CUA 14. Bedrock	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
R-1 Pond	2	13, 14	outcrops exist to the north, south, east, and west of CUAs 13 and 14. Soil thickness throughout most of R‑1 Pond CC 2 ranges from less than 1 foot to approximately 5 feet thick. Surface water in R-1 Pond CC 2 flows to the east and southeast throughout the cluster; surface water drainage from R-1 Pond CC 2 eventually collects in Perimeter Pond. **Other features within R-1 Pond CC 2** that are not associated with a CUA include Debris Area CH2-G1B-2080 (several large pieces of concrete which remain in place) and Debris Point CH2-G1B-3047 (metal pipe, removed in 2009)	• • Metals (including hexavalent chromium) • • Inorganics (including asbestos)
R-1 Pond	3	15	**CUA 15 (previously Potential CUA A)**: The Alfa spray field was constructed in 1968. The Alfa spray field received water indirectly from R-1 Pond via the reclaimed water storage tanks on Skyline Drive (that is, water was pumped from R-1 Pond to the water storage tanks via aboveground pipelines, and was then pumped from the tanks to the spray field via aboveground pipelines) and reclaimed water tanks in the Alfa area. Water was pumped to the spray field via an aboveground pipeline. The Alfa spray field was a 3.5-acre spray field with a capacity of 21,000 gpd (20 sprayheads, each 0.5-inch in diameter, which operated up to 5 hours per day [Rockwell, 1985]). The spray field is no longer used, and the pipelines and spray nozzles have been removed. **R‑1 Pond CC 3** is located in the northwestern area of the R‑1 Pond RFI site reporting area, northwest of the R‑1 Pond. There are no perennial bodies of surface water at R‑1 Pond CC 3. The topography at R‑1 Pond CC 3 slopes to the northwest. Bedrock outcrops exist to the east, west, and northeast. Soil thickness throughout most of R‑1 Pond CC 3 ranges from less than 1 foot to approximately 11 feet thick. Surface water runoff at R-1 Pond CC 3 tends to flow to the northwest toward the Alfa RFI site; drainage basin divides surrounding R-1 Pond CC 3 hydrologically separate this CC from other R-1 Pond CCs.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Radionuclides
R-1 Pond	4	16	**CUA 16**: Several drainages in the northern portion of Boeing RFI Subarea 1B North traverse R-1 Pond CC 4. Surface water in these drainages drains north towards Test Area Road and subsequently into the Northern Drainage within and downgradient of the LOX plant. There are no historical operations that are known to have occurred in CUA 16. An active natural gas pipeline and a domestic water pipeline run through CUA 16 along Test Area Road. **R‑1 Pond CC 4** is located in the northern portion of R‑1 Pond RFI site reporting area, north of the R‑1 Pond and immediately south of the LOX area. The area is separated hydrologically from other portions of the R-1 Pond reporting area by drainage divides to the south. There are no perennial bodies of surface water at R‑1 Pond CC 4. The topography at R‑1 Pond CC 4 slopes to the north. Soil thickness throughout most of R‑1 Pond CC 4 ranges from less than 1 foot to approximately 10 feet thick. As presented in Data Summary Report for Santa Susana Field Laboratory, Ventura County, California (NASA, 2015), there is one NASA remediation area located, at least partially, in the R-1 Pond CC 4. This area is south of the Liquid Oxygen Plant, which includes a portion of the Northern Drainage and Culvert Modification 2. The NASA remediation areas are shown on Figure 3-1.	• VOCs • SVOCs (including NDMA) • TPH • PCBs • Dioxins and furans • Metals • Energetics

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
R-1 Pond	Boeing RFI Subarea 1B North Unaffiliated Areas		**The Unaffiliated Areas** consist of open space located outside the RFI site reporting area boundaries within Boeing RFI Subarea 1B North. Historical operations that occurred in the Unaffiliated Areas were related to operations at NASA RFI sites and are being addressed by NASA; these NASA RFI sites consist of the Area II Landfill and Alfa Area. A portion of the Area II Landfill extends into the Unaffiliated Areas. The Area II Landfill was active from approximately 1955 to 1980, but was primarily used between 1965 and 1978 (NASA, 2008). The Area II Landfill received unused fill materials, vegetation, some drums of unknown content, and construction debris (NASA, 2008). Based on historical documents and aerial photographs, there were four structures associated with the Alfa Area that were located in the Unaffiliated Areas. One of the structures was part of the Alfa groundwater treatment unit; however, the operations performed at the other three structures is not known. Three of the structures were removed and one remains. Outside of the historical operations performed as part of the Areas II Landfill and Alfa Area, there is no documentation of historical operations occurring within the Unaffiliated Areas. As presented in Data Summary Report for Santa Susana Field Laboratory, Ventura County, California (NASA, 2015), there are three NASA remediation areas located, at least partially, in the Unaffiliated Areas. These areas include an area south of the Liquid Oxygen Plant, which includes a portion of the Northern Drainage, the eastern portion of the Area II Landfill, which includes a portion of the Northern Drainage, and an area east of the Alfa Area, which includes debris area CH2-G02-1085. In addition, there are two areas of contamination, which are contiguous to and emanating from NASA sources of contamination in Administrative Area II that are associated with NASA responsibility and located within the Unaffiliated Areas. These areas include an area south of the Area II Landfill and an area east of the Alfa Area. The results from samples collected in NASA remediation areas and areas associated with NASA responsibility are presented in this table for completeness, but are further evaluated separately by NASA. The NASA remediation areas and areas associated with NASA responsibility are shown on Figure 3-1. The topographic relief of the Unaffiliated Areas is approximately 500 feet. Bedrock covers greater than 50 percent of the Unaffiliated Areas. Based on available boring logs for borings advanced to bedrock, the depth to bedrock in areas with soil cover is generally less than 5 feet. Surface water runoff at the site is regularly monitored as part of the NPDES monitoring program under the oversight of the Los Angeles RWQCB. Surface water in the northern portion of the Unaffiliated Areas flows north into drainages that lead into the Northern Drainage and discharge from the SSFL through NPDES Outfall 009. Surface water in the southern portion of the Unaffiliated Areas generally flows south, into Perimeter Pond. One monitoring location, Outfall 011, is located at the discharge of the Perimeter Pond. Discharge from Perimeter Pond flows south via drainages into Boeing RFI Subarea 10 and eventually drains to NPDES Outfall 001 at the southern end of Boeing RFI Subarea 10.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Pesticides • Radionuclides
		Potential CUA A	**Potential CUA A** was identified in the October 2013 Addendum to the Master RFI Data Gap Work Plan for the Areas Unaffiliated with RFI Sites (CH2M, 2013) to evaluate a sprayfield that was identified during the 2010/2011 reclaimed water system inventory activities. Some of the samples collected in Potential CUA A had chemicals that exceeded the corresponding SCLs, therefore, the entire Potential CUA A was added to and evaluated with the R-1 Pond RFI site as CUA 15. The evaluation for CUA 15 is presented in RCRA Facility Investigation Data Summary and Findings Report, R-1 Pond RFI Site, Boeing RFI Subarea 1B North, Santa Susana Field Laboratory, Ventura County, California (R-1 Pond RFI Site DSFR) (CH2M, 2017).	• See R-1 Pond RFI Site DSFR (CH2M, 2017).
		Potential CUA B	**Potential CUA B** was identified in the October 2013 Addendum to the Master RFI Data Gap Work Plan for the Areas Unaffiliated with RFI Sites (CH2M, 2013) to evaluate two vegetation clearance areas that were identified during the 2010/2011 aerial photograph review. The results for samples collected to evaluate Potential CUA B are summarized in this table.	• VOCs • SVOCs • Inorganics • Metals • TPH
Bowl Engine Test Area	1	1 through 10, 12 through 20	**CUA 1: Building 1900 Bowl Control Center and Leach Field**: Identified as an Area of Concern in the RFA. Building 1900 contained a machine workshop, two test bays, and fuel and drum storage areas. The two test bays, which were located on the southeastern side of the building, tested various generators, motors, combustors, and igniters before their use at the Bowl Test Area. In the 1980s, the test bays, several tanks, and an adjacent structure (Building 1905) were used for coal gasification studies. Chemicals used include VOCs, SVOCs, metals, small amounts of energetics, PCB ballasts, and petroleum hydrocarbons. The Building 1900 Leach Field received sanitary waste via a septic tank from Buildings 1900 and 1905 until the early 1960s when the sanitary sewer system was installed at the site. The exact location of the Leach Field is unknown. Additional features at	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Bowl Engine Test Area	1	1 through 10, 12 through 20	CUA 1 include an undefined feature and Building 1313. Building 1313 was located in the center of CUA 1, between R-1 Pond and Building 1900. There are no documented chemical uses for the undefined feature or Building 1313. **CUA 2: Building 1906**: Employee Locker Room north of the Bowl Control Center. Also used for storage of asbestos abatement materials and PCB ballasts. **CUA 3: Building 1907**: Electrical substation supporting Bowl Control Center and adjacent structures. **CUA 4: Building 1900** Drum Storage: Concrete pad for centralized storage of waste product drums from test activities. Potential chemicals are assumed to be the same as Building 1900. **CUA 5: Building 1908 Fuel Storage Area**: Storage shelter for various portable fuel tanks that was piped or offloaded to other areas. Area also includes concrete pad east of Building 1908 used for fuel transfer and storage. **CUA 6: Lower Bowl Drainage Area**, including a Portion of Debris Location CH2-G1B-1030: Includes Bowl Skim/Retention Pond, associated drains and weirs, spillways, pipelines, a portion of a storage yard near the Bowl Skim/Retention Pond, and a portion of debris location CH2-G1B-1030. The Bowl Skim/Retention Pond was an unlined pond that received spillway wastewater discharge from Test Stands 1, 2, and 3. Influent to the pond through surface runoff included TCE, hydrocarbons/kerosene, liquid oxygen, NTO, and gasoline (used to ignite fuels in the pond). The eastern half of the Pond was paved over with asphalt in the early 1980s. Debris location CH2-G1B-1030 consisted of a soil pile intermixed with concrete. The soil pile was too small to warrant sampling and no evidence of releases were observed. The concrete was removed in 2009. **CUA 7: Building 1921 (Test Stand 1, also known as Vertical Test Stand 1 [VTS-1]) and Related Buildings**: Used for rocket testing and coal gasification studies. Test stand 1 was constructed in 1950 and was the first permanent test stand at the SSFL. Horizontal test stand was constructed in 1951 and was located just east of Test Stand 1. Rocket engine testing was performed from the early 1950s until the early 1960s. The test stands at the Bowl Area RFI site supported several programs including the Navaho, Redstone, Jupiter, Thor, Atlas, and Saturn programs. The coal gasification program occurred in the 1980s. Surrounded by tanks and piping containing various substances, including kerosene-based fuels, TCE, fluorine, lube oil, hydrazine, and chlorine trifluoride. Area also includes Buildings 1320 (Power Control), 1903 (Instrumentation Repair Shop), 1904 (Power Control), 1931 (Electrical Control Station), a portion of a storage yard located at Buildings 1901 and 1904, and two unidentified structures. Sanitary waste from Building 1904 was released to the Building 1901/1904 leach field (CUA 13). **CUA 8: Building 1922 (Test Stand 2, also known as VTS-2) and Related Buildings**: Used for rocket testing and coal gasification studies. Test stand 2 was constructed in 1953 and rocket engine testing continued until around 1970. The coal gasification program occurred in the 1980s. Surrounded by tanks and piping containing various substances, including kerosene-based fuels, TCE, and lube oil. Building 1922 included PCB ballasts and asbestos use. Area also includes Building 1901 (Test Stand 2 Workshop and Control Center and former Pretest Storage Shed), 1932 (Electrical Control Station), a portion of a storage yard located at Buildings 1901 and 1904, and two unknown buildings east of the test stand. Building 1901 and associated leach field (CUA 13) were identified as part of an Area of Concern in the RFA. Additional features at CUA 8 includes several tanks and portions of Buildings 1332, Building 1334 and a portion of the Test Stand 2 spillway. Buildings 1332 and 1334 were associated with Bowl Area Instrumentation. **CUA 9: Building 1923 (Test Stand 3, also known as VTS-3) and Related Buildings**: Used for solar thermal testing and Steam Accumulator Blowdown Evaluation Rig (SABER) studies. Test stand 3 was constructed in 1955 and rocket engine testing continued until around 1970. SABER studies were performed by the Department of Energy between 1976 and 1986. Surrounded by tanks and piping containing various substances, including kerosene-based fuels, TCE, and lube oil. Area also includes Building 1924 (SABER Facility and Test Stand), 1933 (Unknown, near vault to spillway), 1934 (Mechanical Workshop and Test Stand 3 Control Room, including transformer to the west), 1935 (SABER Control Center and former substation/workshop), 1962 (Electrical Control Station), and approximately 16 aboveground storage tanks. **CUA 10: Bowl Fuel Farm Catch Basin, including a small portion of Debris Location CH2-G1B-1030**: Tanks at the Bowl Fuel Farm supplied fuels to Bowl Area test stands via pipelines across the site. The adjacent catch basin, an unlined earthen pond, accumulated spillage from the overhead tank(s) at the former Bowl Fuel Farm. Debris location CH2-G1B-1030 was located in CUA 6 with a small portion in CUA 10. The description of the debris location is presented with CUA 6. CUA 10 also includes a portion of the SABER storage area, a portion of a storage yard located at Buildings 1901 and 1904, and concrete pads. **CUA 12: Compressed Gas Storage Area**: Includes many compressed gas cylinders, related piping to test stands, and a building to the north (Reclaimed Water Control Building) with an unknown building number.	• Dioxins and furans • Energetics and perchlorate • Metals • Inorganics • Pesticides and herbicides • Radionuclides

Table 6-1d – Subarea 1B North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Bowl Engine Test Area	1	1 through 10, 12 through 20	**CUA 13: Building 1901 and Buildings 1901/1904 Leach Field**: Identified as a part of an Area of Concern in the RFA. The leach field received sanitary waste via a septic tank from Buildings 1901 and 1904 until the early 1960s, when the sanitary sewer system was installed at the site. The Buildings 1901/1904 Leach Field was removed in 2000. The area includes associated piping from Building 1904 that carried waste to the Lower Bowl Area, concrete pads, and a portion of the SABER storage area. **CUA 14: Transformers**: Two transformers located on a concrete pad east and west of Building 1934 (Vertical Test Stand 3 Control Room). **CUA 15: Transformer: Pole-mounted transformer and substation** located on concrete pad north of Building 1902A. **CUA 16: Transformer**: A pole-mounted transformer located on a concrete pad east of Building 1904. **CUA 17: Transformers**: Two pole-mounted transformers located on concrete pads north of Building 1900. **CUA 18: Debris Location CH2-G1B-1031**: Consisted of a soil pile intermixed with concrete. The soil pile was too small to warrant sampling and no evidence of releases were observed. The concrete was removed in 2009. **CUA 19: Debris Location CH2-G1B-1035**: Consisted of an empty 2.5-gallon metal container and was removed in 2009. **CUA 20: Debris Location CH2-G1B-3050**: Consisted of an empty 5‑gallon metal bucket with no lid, a 2-foot length of 3‑inch-diameter metal pipe, a 1-foot length of 4‑inch‑diameter metal pipe, and an 8-inch length of 3‑inch-diameter metal pipe and was removed in 2009. Bowl CC1 includes the entire Lower Bowl Area, which is the valley resulting from natural bowl-shaped bedrock outcrops where the former Bowl Skim/Retention Pond was located, as well as a portion of the Upper Bowl Area, where the test stands were located. There is up to 80 feet of topographic relief between the Upper and Lower Bowl areas of Bowl CC1. All structures at the site have been demolished, and the Buildings 1901/1904 Leach Field, most pipelines, and all tanks have been removed. Three pipelines remain in place; sanitary sewer segment 1B-2, a reclaimed water pipeline extending from the R-1 Pond RFI site to the Canyon RFI site, and a reclaimed water pipeline extending from R-1 Pond RFI site to Groundwater extraction well RD-02. Paved portions of the Bowl Skim/Retention Pond and concrete pads surrounding the test stands have also been removed. Soil thickness ranges from approximately 0.5 to 26 feet, with exposed bedrock surrounding the Bowl main operational area. Surface water exists intermittently at the site as the result of seasonal precipitation events. Surface water runoff flows generally towards the center of the site, then northwest into the Bowl Skim/Retention Pond, and eventually northwest to the R-1 Pond.	
Bowl Engine Test Area	2	11	**CUA 11: Plume Study/Flame Test Area (Buildings 1902A, 1902B, and 1902E):** The area consisted of three structures 1902A (Propellant Pretest), 1902B (Propellant Shelter), and 1902E (Concrete Slabs and Berm), concrete pads, an AST, and debris locations CH2-G1B-1028 and CH2-G1B-3057. The area was active from approximately 1959 to the mid-1960s. Observation pillboxes 1902C and 1902D have no documented releases and are not included in Bowl CC2 boundary. Debris location CH2-G1B-1028 consisted of an empty partially rusted 1-gallon metal bucket and was removed in 2009. Debris location CH2-G1B-3057 consisted of a soil pile intermixed with concrete and was not removed. Bowl CC2 is located in the southern portion of the Bowl RFI site at an elevation approximately 100 feet higher than that of the Bowl test stands. Historically, Buildings 1902A (Pretest) and 1902B (Shelter) were surrounded by concrete pads and accessed via a paved road to the south. Structures, concrete pads, and paved roads have been demolished. There is approximately 70 feet of topographic relief across Bowl CC2, but topography in the central portion of this area is relatively flat, along a dirt road running east to west. The area slopes to the north toward the Bowl Test Area and to the south toward the Component Test Laboratory III RFI site. Soil thickness ranges from approximately 0.5 to 5 feet, with exposed bedrock surrounding the main road in this CUA. Surface water exists intermittently at the site as the result of seasonal precipitation events. Surface water runoff flows generally north into the Lower Bowl Area, then northwest to the R-1 Pond.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Metals • Inorganics

Table 6-1d – Subarea 1B North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
Bowl Engine Test Area	3	21	**CUA 21: Upper Bowl/Reclaimed Water Storage Tank Area, including Debris Locations CH2-G1B-1025, CH2-G1B-1026, and CH2-G1B-1027:** The area includes reclaimed water storage tanks, associated pipelines, Building 1925 (Reclaimed Water or "Firex" Pump House), and debris locations CH2-G1B-1025, CH2-G1B-1026, and CH2-G1B-1027. Five reclaimed water storage tanks were located south of Building 1925, which stored reclaimed water from Test Stands 1, 2, and 3. Debris location CH2-G1B-1025 consisted of soil piles intermixed with asphalt, concrete, an empty partially rusted 5‑gallon metal container, and a metal stand. The metal container and metal stand were removed in 2009, the remaining material remains in place. Debris location CH2-G1B-1026 consisted of two empty rusted square metal containers with dimensions of approximately 2 feet by 1 foot and was removed in 2009. Debris location CH2-G1B-1027 consisted of 19 empty 5-gallon drums, lids, and several pieces of scrap metal and was removed in 2009. Bowl CC3 is located in the Upper Bowl Area, southeast and upslope of the Bowl main operational area, at an elevation approximately 100 feet higher than the test stands. All structures at the area have been demolished, and all tanks have been removed. Topography in the southeastern portion of the area slopes to the north and east, toward the pump house and Bowl main operational area. Soil thickness ranges from approximately 0.5 to 5 feet, with exposed bedrock to the north and south. Surface water exists intermittently at the site as the result of seasonal precipitation events. Surface water runoff from Bowl CC 3 operational area flows generally northwest into the Lower Bowl Area, then northwest to the R-1 Pond. Surface water runoff from the southern portion of Bowl CC3 flows to the southwest towards CTL-III.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Metals • Inorganics • Dioxins and furans • Pesticides and herbicides

Table 6-1e – Subarea 1B Southeast

RFI Site	CUA Cluster	CUAs	CUA Descriptions	• Chemical Groups Analyzed
CTL-III	1	1	**CUA 1: Weld Shop (Building 1412), Building 1412 Leach Field, and Unidentified Features (formerly Potential CUA A):** Used for welding and bulk iodine storage associated with CTL-III activities. Two tanks, with unknown contents, were located southwest of Building 1412. The leach field, identified as an Area of Concern in the RFA, received sanitary waste via a septic tank from Building 1412 until the early 1960s. Other features identified in CUA 1 include a large debris area (Debris Area 2064) consisting of concrete and asphalt pieces, scrap metal, broken glass, gravel, rebar, and pieces of "supersack" material partially located within CUA-1, an AST (Unknown-AT-CL-27) located within this debris area, three undefined features located southwest of Building 1412, and two undefined features (formerly Potential CUA A) located southwest of Building 1412, identified during the aerial photograph review. Based on detected analytes being similar to detected analytes in CUA 1, the boundary of CUA 1 were extended to include these two undefined features . Debris at the surface of the debris area (Debris Area 2064) was removed but the soil was not disturbed to see if more debris was below the surface, as directed by DTSC. CTL-III CC 1 is located on the northern boundary of the CTL-III RFI site. Structures within this cluster have been demolished, and tanks have been removed. The leach field was beneath a paved area southwest of Building 1412. The leach field remains in place, but has not been used in the 1960s when a site wide sanitary sewer system was installed. This cluster is currently unpaved due to demolition activities. Soil thickness ranges from approximately 0.5 to 18 feet, with minimal exposed bedrock in the northwest portion of the cluster. Topography at the site is relatively flat, with a general slope to the south. Surface water exists intermittently at the cluster as the result of seasonal precipitation events. Surface water flows east and then south, toward a drainage channel east of the CTL-III CC 1 (western drainage channel) or to the west towards a smaller drainage channel located along the western portion of CTL-III CC 1 (which drains into the western drainage channel in the southern portion of this CC), then ultimately to the Perimeter Pond. The western drainage channel conveys surface water run-off from R-1 Pond and upstream operational areas in Administrative Area I. The smaller drainage channel receives water for the R-1 pond RFI Site reporting area, including the R-1 Pond spray field located northwest of CTL-III RFI Site reporting area.	• VOCs • SVOCs • TPH • PCBs and PCTs • Inorganics • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium)
CTL-III	2	2 through 12, 14, 16, and 18	**CUA 2: Cascade Pump Shelter (Building 1441):** Liquid and gaseous nitrogen tanks surrounded Building 1441 to the east and south. The area also included a substation, located on a former concrete pad southwest of Building 1441; three additional tanks (AT-CL-9, AT-CL-10, and AT-CL-11), and one undefined feature, which were located south and west of Building 1441. **CUA 3: Building 1409 (Module 2), Pond, and Burn Pit**: Used for testing gas generators (late 1950s to mid-1970s), then converted for hypergol loading and igniter tests (1980s). Testing fuels and chemicals were stored in bunkers within Building 1409 and in tanks near the building. A concrete drainage channel north of Building 1409 conveyed surface water northwest towards the Building 1409 Pond. A second drainage channel or trench connected the Burn Pit to a gunite-lined pond north of Building 1409. Other features include an undefined feature within the pond and an unidentified structure east of Building 1409 that contained additional test cells. **CUA 4: Building 1411 (Module 3):** Used as a rocket engine test stand (late 1950s to mid-1970s), then converted for water jet propulsion testing (1975 to 1981). Testing fuels and chemicals were stored in tanks near the building. The building was used as a workshop and laboratory in the 1980s. Waste test chemicals and cleaning solvents were discharged via a spillway south of Module 3. A waste drum disposal area may have been located east of Module 3 in a runoff ditch. A locker room and workshop (Buildings 1313 and 1336) may have been located south of Module 3. **CUA 5: CTL-III Pond and Spillway**: Testing and cleaning wastes were discharged from Module 3 to the CTL-III Pond via a spillway southeast of Module 3. The spillway was used for Water Jet Propulsor testing from 1970 to approximately 1981. Discharge contained rocket fuel, JP-4, and RP-1, and TCE. Additionally, a concrete pad and transformer pole were located north of CTL-III Pond. **CUA 6: Former Lube-oil Area and Six Undefined Features (formerly Potential CUA F):** A UST stored fuel oil and diesel, which was conveyed via sitewide fuel pipelines (CUA 14) to Buildings 1409, 1410, and 1411. The UST was removed in 1987. Other features previously located at CUA 6 include: Two undefined features and two concrete equipment pads (for boiler and/or cooling tower), located south and west of the former UST, and six undefined features located south of Building 1411 (formerly Potential CUA F). Additionally, CUA 6 includes portions of the Lunar Excursion Module (LEM) testing area south of the CTL-III spillway.	• VOCs • SVOCs (Including formaldehyde, NDMA, and 1,4-dioxane) • TPH • PCBs and PCTs • Pesticides and herbicides • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including asbestos) • Radionuclides

Table 6-1e – Subarea 1B Southeast				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**• Chemical Groups Analyzed**
CTL-III	2	2 through 12, 14, 16, and 18	**CUA 7: Building 1415 (Module 4):** Used for testing gas generators (late 1950s to mid-1970s) and then as a workshop (1980s). Testing fuels and chemicals were stored in tanks that surrounded the building. Spare equipment and materials were also stored in the Proof Burst Facility (Building 1707) northwest of Module 4. **CUA 8: CTL-III Control Center (Building 1413), Building 1411/1413 Leach Field, and Two Storage Structures East of Building 1413 (formerly Potential CUA E):** Used to control testing conducted in Modules 1 through 4. Underground tunneling to the control center provided an evacuation route from the test modules. The leach field, identified as an Area of Concern in the RFA, received sanitary waste via a septic tank from Buildings 1411 and 1413 until the early 1960s. CUA also includes two structures (used for storage) east of Building 1413 (formerly Potential CUA E). **CUA 9: Laser Test Facility or 705 Facility (Building 1419):** Used for high-energy, chemical laser testing after 1974. Testing and cleaning chemicals were stored in tanks south of the building. A pressure recovery system that treated exhaust from laser testing was also located to the south of Building 1419. Other features at CUA 9 include a building with unknown contents, ASTs, and concrete pads. **CUA 10: High-energy Particle Optical Lab (Building 1414):** Used for high-energy, chemical laser testing after 1974. Cleaning fluids were stored in drums near the building in a hazardous materials storage area. Additionally, one tank (AT-CL-14), was located south and west of Building 1414 (partially within CUA 9). **CUA 11: Building 1410 (Module 1):** Used for testing gas generators (late 1950s to mid-1970s), then converted for high-energy, chemical laser testing in 1974. Testing fuels and chemicals were stored in tanks near the building. The building was used as a workshop in the 1980s. Other features at CUA 11 include ASTs. **CUA 12: Former Solvent Storage Area**: Located north of Module 1, ASTs were used to store solvents for test modules. CUA 12 also included a building with unknown contents. **CUA 14: Fuel and Gas Pipelines:** Supplied RP-1, JP-4, nitrogen, and helium to Buildings 1409, 1410, and 1411. **CUA 16: Former Tunnels: Connected CTL-III Control Center to Module 1, 2, 3, 4, and Laser Test Facility (Buildings 1410, 1409, 1411, 1415, and 1419, respectively).** The tunnels were approximately 2.5 feet bgs and were approximately 6 feet tall and 6 feet wide. During demolition activities in 2011, roof tar material and mastic-wrapped pipelines were found under and near these tunnels. **CUA 18 (formerly Potential CUA C)**: Two ASTs (tank IDs Unknown-AT-CL-7 and Unknown-AT-CL-8) north of Building 1441 and one undefined feature located northeast of Building 1441. CTL-III CC 2 encompasses the main testing areas of the CTL-III RFI site and includes a majority of Solid Waste Management Unit 4.7 identified in the RFA. Structures and tunnels in CTL-III CC2 have been demolished, and tanks have been removed, with the exception of the structure containing the Groundwater Extraction and Treatment System (Building 1449). CTL-III CC2 is currently unpaved due to demolition activities. Soil thickness ranges from approximately 0.5 to 31.5 feet, with minimal exposed bedrock in the northeast portion of the cluster. Topography at the site is relatively flat, with a general slope to the south and west. Surface water exists intermittently at the cluster as the result of seasonal precipitation events. Surface water flows west towards the CTL-III western drainage channel, then ultimately to the Perimeter Pond via the Property Line Pond.	
CTL-III	3	13, 17	**CUA 13: Western Drainage Channel and Property Line Pond**: The southern section of the western drainage channel, which receives surface water run-off from R-1 Pond and from former operational areas in upstream areas of Administrative Area I. Surface water from the CTL-III RFI site is directed towards this channel and may have collected into the Property Line Pond. Includes a transformer pole west of the channel. There were historically no structures in CUA 13. **CUA 17 (formerly Potential CUA B):** A vegetation clearance area located south of Building 1412 along Area I Road. CTL-III CC 3 also includes a vegetation clearance area and is located on the western boundary of the CTL-III RFI site. Soil thickness ranges from approximately 0.5 to 15 feet. Topography at this cluster is relatively flat, with increasing slopes to the east and west. Surface water exists intermittently at the cluster as the result of seasonal precipitation events. Surface water flows south, through the drainage channel, then ultimately to the Perimeter Pond.	• VOCs • SVOCs (including formaldehyde) • TPH • PCBs • Inorganics • Pesticides and herbicides • Dioxins and furans • Energetics and perchlorate • Metals • Radionuclides

Table 6-1e – Subarea 1B Southeast				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	• **Chemical Groups Analyzed**
CTL-III	4	15	**CUA 15: Perimeter Pond Spray Fields:** The Perimeter Pond Spray Fields consisted of 18 spray nozzles, each nozzle spray had a radius of approximately 65 feet. There is approximately 2,700 feet of aboveground pipeline that connected the spray field nozzles to Perimeter Pond. Discharged water from Perimeter Pond to avoid discharges to drainage channels. Perimeter Pond received water from the Property Line Pond and R-1 Pond from the northeast. Includes sections of Debris Area 1023. CTL-III CC 4 is located on the southern boundary of the CTL-III RFI site. Equipment and piping at CTL-III CC 4 have been removed. Soil thickness ranges from approximately 1 to 31 feet, with minimal exposed bedrock in the southeast portion of the cluster. Topography at this cluster is relatively flat surrounding spray nozzles and generally slopes from east to west. Surface water exists intermittently at the cluster as the result of seasonal precipitation events. Surface water flows west towards the Perimeter Pond via a surface water drainage channel.	• VOCs • SVOCs (including NDMA, formaldehyde, and 1,4-dioxane) • TPH • PCBs and PCTs • Inorganics (including cyanide) • Pesticides and herbicides • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium)
	2	Potential CUA D	One undefined feature northeast of Building 1413 was identified during the aerial photograph review.	• VOCs • SVOCs • TPH • PCBs • Inorganics • Energetics • Metals
Perimeter Pond	1	1, 2, and 4	**CUA 1: The Perimeter Pond** is a 0.6‑acre, unlined earthen pond with approximately 2 million gallons of storage capacity. Perimeter Pond received wastewater and stormwater from R-1 Pond, which in turn received wastewater and stormwater from areas farther upgradient in Administrative Area I. Thus, Perimeter Pond indirectly received flow via R-1 Pond from the Advanced Propulsion Test Facility‑1 and -2, from the Canyon Retention and Skim Ponds, from the Laser Engineering Test Facility Pond, and from the Bowl Retention and Skim ponds, which discharged into the R-1 Pond. In addition, Perimeter Pond received drainage from the Property Line Pond (in the CTL-III RFI site) and CTL-III, CTL-V, and Area I Burn Pit (AIBP) RFI sites. Most of the excess water in Perimeter Pond was pumped back to R-1 Pond for reuse in the water reclamation system, which was reportedly pumped uphill to tanks on Skyline Drive and conveyed by gravity flow downhill for use in the cooling systems and for fire suppression at various test areas. Wastewater from Perimeter Pond was also pumped to three spray fields— Perimeter Pond spray field located to the east near the southeast corner of CTL‑III RFI site and two spray fields located to the north and west of R-1 Pond RFI site, referred to as the Lower and Upper Perimeter Pond Spray Fields. **CUA 2: Pump Pad (1XXX):** This structure located east of Perimeter Pond was identified during historic document review. **CUA 4: Structure 1789:** This building located northeast of the Perimeter Pond was identified during historic document review. The site is located in Administrative Area I. The concrete-lined channel, spillway, and north dam have been removed. A T-shaped portion of the spillway and south dam remain in place southwest of the Perimeter Pond. The concrete-lined channel directed flow from R-1 Pond, surface water runoff from the AIBP RFI site, and overflow from Perimeter Pond to the south to Outfall 011. The majority of the concrete-lined channel and a portion of the T-shaped spillway are located in the AIBP RFI site reporting area and are evaluated in the DSFR for that site (CH2M, pending). The north dam was located north of Perimeter Pond and was constructed to limit water discharge from the Property Line Pond (in the CTL-III RFI site	• VOCs • SVOCs (including NDMA, formaldehyde, and isopropanol) • TPH • PCBs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Radionuclides

Table 6-1e – Subarea 1B Southeast				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**• Chemical Groups Analyzed**
Perimeter Pond	1	1, 2, and 4	reporting area) to Perimeter Pond. The south dam is located south of Perimeter Pond and was constructed to limit water discharge from the Perimeter Pond. Discharge through the dam historically flowed to Outfall 011. Pipelines at the Perimeter Pond RFI site have been removed, except two aboveground pipelines conveying surface water from Perimeter Pond to the Stormwater Treatment System near the R-1 Pond RFI site and back to Outfall 011. Perimeter Pond is typically dry (for example, it was dry during 2011 through 2015) and temporarily stores water during heavy and/or long-term precipitation only. Following construction of the Stormwater Treatment System in 2009, water that collects in the Perimeter Pond is pumped to the Stormwater Treatment System and then released through Outfall 011 via the aforementioned pipelines. The topography at Perimeter Pond CC 1 generally slopes towards the pond. The pond itself is relatively flat. The southwestern portion of Perimeter Pond CC 1 slopes to the south. Surface water runoff from portions outside of the pond within Perimeter Pond CC 1 flows to the Perimeter Pond. Surface water in the southwestern portion of the site flows towards the southwest. Throughout most of the site, soil is generally thin, typically ranging from 0.5 foot to 3.5 feet thick. There are a few locations scattered around Perimeter Pond CC 1 where soil is deeper, up to 10 feet bgs. Soil in the undisturbed areas of the site consists of weathered Chatsworth Formation materials, which are primarily fine-grained, silty sands and clayey silts. Soil in the pond consists of primarily silty sands. The majority of Perimeter Pond CC 1 is vegetated.	
Perimeter Pond	1	3	**CUA 3: An area of hummocky terrain** (CH2M, 2008). Other features associated with Perimeter Pond CC 2 include two pipelines and a drainage channel. Both pipelines (reclaimed water and water) extend from Perimeter Pond to the spray field at the CTL-III RFI site. The drainage channel drains surface water from the southern portion of the CTL-III RFI site to the Perimeter Pond. There are no structures and no perennial surface water bodies in Perimeter Pond CC 2. The topography in the Perimeter Pond CC 2 slopes towards the west. Surface water runoff from Perimeter Pond CC 2 flows towards the Perimeter Pond in the Perimeter Pond CC 1. Soil thickness at Perimeter Pond CC 2 is approximately 0.5 to 10 feet. Portions of Perimeter Pond CC 2 are vegetated.	• VOCs • SVOCs (including NDMA) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide)
Unaffiliated Area	Unaffiliated Areas	N/A	The Unaffiliated Areas consist of open space located outside the RFI site reporting area boundaries within Boeing RFI Subarea 1B Southeast. There are no CUAs or structures within the Unaffiliated Areas, and there is no documentation of historical operations in the Unaffiliated Areas. Bedrock outcrops cover approximately 50 percent of the Unaffiliated Areas. Surface water in the northern and eastern portions of the Unaffiliated Areas drains into drainages that ultimately lead into Perimeter Pond. Discharge from Perimeter Pond flows south into Boeing RFI Subarea 10. Surface water in the southern portion of the Unaffiliated Areas drains into either drainages that lead into Perimeter Pond or to a central drainage (discharges from Perimeter Pond) and flows into Boeing RFI Subarea 10. In some parts of the southern portion of the Unaffiliated Areas, surface water drains directly into Boeing RFI Subarea 10 but ultimately drains to the central drainage feature downstream from Perimeter Pond. Surface water from the Unaffiliated Areas eventually drains to the National Pollutant Discharge System Outfall 001 and Outfall 019 at the southern end of Boeing RFI Subarea 10. N/A	• Metals • Inorganics • Dioxins and furans • Radionuclides

Table 6-1f – Subarea 1B Southwest

RFI Site	CUA Cluster	CUAs	CUA Descriptions	• Chemical Groups Analyzed
CTL-V	1	1 - 8, 11, 13 - 16	**CUA 1, Building 1422 and Building 1627: Building 1422** was constructed between 1957 and 1959, and operations at Building 1422 occurred between the late 1950s and the 1980s. Building 1422 was used from the late 1950s and throughout the 1960s to test rocket engine pumps and turbines. The tests were conducted in outdoor test cells located along the western side of Building 1422. These test cells (Test Cells 1 through 4) were also referred to as Building 1627. Electric motor generator tests were conducted from 1963 to 1970 (gear oil was used during this period). Other tests involved using hydrogen to evaluate rocket engine turbines. Small-scale rocket engine component tests using hydrazine fuel were conducted in the test cell farthest south. Wastewater containing hydrazine was piped from the test cell to an aboveground steel retention container (CUA 13). The building was dormant in the 1970s, and in the 1980s, the space shuttle main engine fuel pump test was conducted there. Features associated with this building included a tool crib, hydraulic oil system, lubrication tanks, PCB-containing capacitors, and oil drums that stored PCB-containing lube oil. An L-shaped trench exists behind Cells 1A, 1B, 2A, and 2B, and Building 1422 and terminates into a lined concentration channel. An underground tunnel provided an evacuation route for personnel from Building 1422 and the test cell area to Building 1421. This building and associated structures were demolished in 2011. **CUA 2, Building 1420 and Building 1421: Building 1420** was used as an instrumentation workshop. It included a mechanical/electrical equipment room, control room, and workshop. Building 1421 was used as a recording and control center that supported engine and pump testing activities conducted in Building 1422. Based on review of aerial photographs, both buildings were constructed at some point between 1957 and 1959. The buildings were demolished in 2011. **CUA 3, Former Building 1950: Building 1950** was used as a storage shelter. This structure has been removed. Based on review of aerial photographs, Building 1950 was constructed at some point between 1960 and 1965 and demolished between 1978 and 1980. **CUA 4, Buildings 1439/1420 Leach Field:** The leach field received sanitary waste from a 750-gallon septic tank connected to Building 1439 and Building 1420. Six trenches were excavated to find the location and extent of the leach field. Soil samples were collected from two trench locations. The Building 1439/1420 leach field was located approximately 5.5 feet bgs. The leach field was made of two parallel terra cotta pipes approximately 60 feet long. The dates of construction and decommissioning are unknown. The leach field has not been removed. **CUA 5, Former Building 1439: Building 1439** was used as pre-test storage and workshop. Based on review of aerial photographs, Building 1439 was constructed between 1965 and 1967 and demolished between 1999 and 2003. **CUA 6, Building 1960:** This hydrogen gas compressor shelter constructed between 1960 and 1965 (based on aerial photographs) was used in association with the industrial waste conveyance system. An aqua tower was located immediately east of the building. Both structures were demolished in 2011. **CUA 7, Transformer Bank South of Building 1422**: This transformer bank was located along the southern wall of Building 1422. The operational years are unknown and the year of demolition is unknown. **CUA 8, CTL-V Substation:** This substation was located southeast of Building 1421. Operation began in 1958, and the substation was removed in 1996. **CUA 11, Oil Pump Station and Associated Pipelines:** The oil pump station supplied oil for lubrication of electric motors during pump test operations in Building 1422. **CUA 13, Steel Retention Container Southeast of Building 1421:** This 20,000-gallon wastewater tank containing hydrazine and TCE was used from approximately 1959 to 1960. This tank may have served as a neutralization tank for wastewater from rocket engine component testing containing hydrazine compounds. This tank may have also been used as a scrubber for hydrazine. The date this tank was removed is unknown. **CUA 14, Leach Field East of Building 1422:** The septic tank associated with this leach field was found during demolition activities in 2011. Information on the exact location of the leach field is not available, but results from samples collected during the septic tank removal and during subsequent characterization suggest that the leach field was located adjacent to the septic tank found in 2011. The leach field has not been removed. **CUA 15, Soil Staining East of Building 1422:** Soil staining was encountered during removal of the evacuation tunnel that connected Buildings 1422 and 1420. The soil was sampled and analyzed for TPH, SVOCs, and metals. **CUA 16 (formerly Potential CUA C), Debris Feature: Debris feature (ID CH2-G1B-3059)** was discovered during the 2009 debris removal activities. The feature consists of five 3-gallon rusty square cans and one 5-gallon rusty bucket. CTL-V CUA CC 1 is located in the northeastern, central, and western areas of the CTL-V RFI site reporting area. There are no surface water bodies in CTL-V CC 1. CTL-V CC 1 is currently unpaved (due to historical demolition activities) but historically, the central and northeastern portion of	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Energetics and perchlorate • Pesticides and herbicides • Terphenyls • Metals • Inorganics (including asbestos) • Radionuclides

Table 6-1f – Subarea 1B Southwest				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	• **Chemical Groups Analyzed**
CTL-V	1	1 - 8, 11, 13 - 16	the CC was paved. The topography of CTL-V CC 1 slopes toward the south and ranges from approximately 1,900 feet amsl in the former operations area to 1,800 feet amsl in the southern portion. Surface water runoff from the historical operational areas generally flows to drainage channels west and south of the site. Soil thickness at CTL-V CC 1 ranges from 0 to approximately 12 feet bgs. Bedrock is fairly shallow across most areas of the site and typically encountered within 3 feet bgs. There are significant bedrock outcroppings to the north, east, and within the southwestern portion of CTL-V CC1.	
CTL-V	2	9, 10, and 12	**CUA 9, Electrical Substation South of Building 1422:** This substation was located south of Building 1422. The operational years are unknown. Based on a review of aerial photographs, it was constructed between 1960 and 1965 and was demolished in October/November 2009. **CUA 10, Southern California Edison Substation:** The substation was located south of Building 1422 and was identified as Substation #5800 with a power rating of 15,000 kVA. Based on review of aerial photographs, the substation was constructed between 1960 and 1965 and was demolished in October/November 2009. The operational years are unknown. **CUA 12, Area Southwest of Pole-mounted Transformer:** The transformer pole was located in the southern portion of the RFI site, southeast of Building 1422. The operational years are unknown and the year of demolition is unknown. CTL-V CC 2 is located in the southeastern area of CTL-V. There are no surface water bodies in CTL-V CC 2. CTL-V CC 2 is currently unpaved. The topography at CTL-V CC 2 slopes toward the south and ranges from approximately 1,860 feet amsl in the northern portion to 1,780 feet amsl in the southern portion. Surface water runoff from CTL-V CC 2 flows south into the AIBP RFI site. CTL-V CC 2 is downslope from CTL-V CC 1 and could have received surface water runoff from that CC. Soil thickness at CTL-V CC 2 is approximately 0.5 to 4 feet. Bedrock in this area is shallow and typically encountered at approximately 1 foot bgs.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Pesticides and herbicides • Metals • Inorganics • Radionuclides
	1	Potential CUA A	Potential CUA A was identified in the December 2013 Addendum to the Master RFI Data Gap Work Plan for the CTL-V RFI site (CH2M, 2013) to evaluate an aboveground tank previously located south of Building 1422 and identified during the 2010/2011 tank inventory compilation activities.	• VOCs • SVOCs (including formaldehyde) • TPH • PCBs • Metals
	1	Potential CUA B	Potential CUA B was identified in the December 2013 Addendum to the Master RFI Data Gap Work Plan for the CTL-V RFI site (CH2M, 2013) to evaluate an undefined feature previously located between Buildings 1421 and 1422 and identified during the 2010/2011 review of aerial photographs.	• VOCs • SVOCs • TPH • Metals

Table 6-1f – Subarea 1B Southwest

RFI Site	CUA Cluster	CUAs	CUA Descriptions	• Chemical Groups Analyzed
Area 1 Burn Pit	1	1	**The AIBP RFI site is comprised of one CUA and one CC that extends across the entire AIBP RFI site reporting area.** The AIBP was established in 1958 for the destruction of chemicals by combustion and detonation. The AIBP was operated by Rocketdyne personnel until 1971. The area was granted interim status as a waste pile under RCRA Part A in 1980. A request to revise the RCRA Hazardous Waste Part A permit application from a waste pile to a thermal treatment facility (TTF) was submitted in 1985; the USEPA concurred with that request in 1988. The TTF was used for evacuation of pressurized cylinders and destruction of energetic wastes (nitroglycerin and ammonium perchlorate), plasticizers, and binders (EMCON, 1990). Operations at the TTF ceased in 1990. The TTF consisted of Concrete Pad 2 and Burn Pit 2. The TTF was historically identified as a separate administrative unit by regulating agencies (then the DHS, Toxic Substances Control Division). The draft document Closure Plan for Area I Thermal Treatment Facility (TTF Closure Plan) (CH2M, 2015e) was submitted to DTSC in order to achieve clean closure of the RCRA Part A-Permitted TTF by satisfying the Closure Performance Standards prescribed in 22 CCR, Section 66264.111. Operational features of the AIBP RFI site consisted of Burn Pits 1 & 2, three earthen ponds, three concrete-lined ponds including an acid pit, a Former Fire Department Demonstration Area, an entrance shack and related storage area, a control center, and two storage sheds for explosives. AIBP Burn Pits 1 and 2 also contained burn cages. The six ponds ranged from 200 to 10,000 gallons in capacity. Additional areas onsite might also be associated with burning, storage, and/or burial of wastes or other debris. Two hummocky areas were identified within the AIBP RFI site boundary. Aerial photographs dated from approximately 1959 to 1967 contain a graded area at the Western Hummocky Area, and several operational features (pits and roads) in the southern portion of the Eastern Hummocky Area. Historical photographs show a drum storage area, an aboveground tank, and several temporary structures in the Eastern Hummocky Area. In addition, Debris Location CH2-G1B-3037 (empty 30-gallon metal drum and file cabinet drawer located down slope of the Area I Road) was identified near the northern portion during the debris survey. The concrete-lined channel and spillway between Perimeter Pond and AIBP have been removed. A T-shaped portion of the spillway remains in place southwest of Perimeter Pond. The majority of the concrete-lined channel and portion of the T-shaped spillway are located in the AIBP RFI site and are evaluated in this report. In 1981-1982, approximately 1,600 cubic yards of debris (including empty cylinders and drums, concrete, rebar, ash, and steel fragments/pipes) and soil from six locations in the central portion of the AIBP RFI site were excavated where wastes and materials were buried or disposed of. The work was completed with supervision from the Los Angeles RWQCB and DHS. As part of the 2008 – 2009 field investigation at the AIBP RFI site, 22 exploratory trenches were advanced to bedrock to gain a better understanding of subsurface conditions. Topography of the AIBP site generally slopes to the southeast. Current surface elevations at the AIBP site range from a low of approximately 1718 feet above mean sea level (feet msl) in the southeastern portion of the AIBP site to a high of approximately 1820 feet msl at a rock outcrop in the northwestern portion of the AIBP site. Depth to bedrock ranges from less than 1 foot to approximately 25 feet. The thicker areas of soil above bedrock appear to be in areas of previous drainages that have been filled in. Although there are no perennial surface water bodies or sediment within the AIBP site, there are natural drainage patterns. Surface water run-off from the AIBP RFI site drains to southward-trending drainage channels located within and south (downgradient) of the AIBP RFI site.	• VOCs • SVOCs • TPH • PCBs and PCTs • Inorganics (including cyanide) • Dioxins and furans • Energetics and perchlorate • Pesticides and herbicides • Metals (including hexavalent chromium) • Radionuclides
		Boeing RFI Subarea 1B Southwest Unaffiliated Areas	The unaffiliated Areas consist of open space located outside the RFI site reporting area boundaries within Boeing RFI Subarea 1B Southwest. There are no CUAs or structures within the Unaffiliated Areas, and there is no documentation of historical operations in the Unaffiliated Areas. There is over 400 feet of topographic relief across the Unaffiliated Areas. Bedrock outcrops cover greater than 50 percent of the Unaffiliated Areas. Surface water runoff at the site is regularly monitored as part of the NPDES monitoring program under the oversight of the RWQCB. Surface water in the northern portions of the Unaffiliated Areas generally drains to the south (to the CTL-V RFI site) and to the southeast (to the CTL-III RFI site). Runoff collects in drainages that either lead into Perimeter Pond, downstream of Perimeter Pond on the eastern side of Boeing RFI Subarea 1B Southwest, or to the western side of Boeing RFI Subarea 1B Southwest. During heavy rain events, excess water that collects in Perimeter Pond can be pumped to the stormwater treatment system adjacent to the R-1 Pond for treatment before being released through NPDES Outfall 011, which is located at the southern end of Perimeter Pond. Discharge from Outfall 011 flows southwest into Boeing RFI Subarea 10. Surface water in the southern portion of the Unaffiliated Areas drains to a central drainage in Boeing RFI Subarea 10 that also receives discharges from Outfall 011, surface water run-off from upstream areas in CTL-V and the Area I Burn Pit RFI sites, the southern portion of Boeing RFI Subarea 1B Southeast, and Administrative Area II. Surface water from the Unaffiliated Areas eventually drains to the NPDES Outfall 001, which is located at the southern end of Boeing RFI Subarea 10.	• Metals • Inorganics • Radionuclides

Table 6-1g – Subarea 5/9 North

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Silvernale	1	1,4	**CUA 1: Silvernale Reservoir (SWMU 6.8):** The Silvernale Reservoir is a 6-million-gallon capacity unlined reservoir used to collect surface runoff since the 1950s (ICF, 1993). When filled to capacity, water from the Silvernale Reservoir flowed by gravity in lined and unlined drainage channels into the R-2A Pond via the R-2B Pond. Historically, Silvernale Reservoir received discharge water and surface water runoff either directly or indirectly (via pumping from the R-2 Ponds) from operational areas in: - Administrative Areas II - ELV and Building 515 Sewage Treatment Plant RFI sites in Group 2; the Alfa, Bravo, Building 204, and Storage Propellant Area RFI sites in Group 3; and the Coca, Delta, and PLF RFI sites in Group 4 - Administrative Area III - ECL, Environmental Effects Laboratory, Compound A Facility, and Area III Sewage Treatment Plant RFI sites in Group 5 - Administrative Area IV - all RFI sites in Group 5 except the Pond Dredge RFI site; the Old Conservation Yard, New Conservation Yard, Building 4064 Leach Field, and Sodium Reactor Experiment RFI sites in Group 6 Silvernale Reservoir is part of the reclaimed water system at SSFL. The Silvernale Reservoir effluent flows by gravity in lined and unlined drainage channels into the R-2A Pond via the R-2B Pond (Ogden Environmental, 1996; Water Board, 2007). Water from the R-2 ponds was either released to Bell Canyon, pumped back to Silvernale through aboveground pipelines, or redirected to tank reservoirs. The water in the Silvernale Reservoir is air-agitated to control algal blooms. A pump feeds a spray head with pond water and the spray heads disperse the water throughout the reservoir in order to control algal blooms. A surface water treatment system (the Outfall 018 Storm Water Treatment System) was installed on the southwest side of the Silvernale Reservoir in 2011 to treat storm water before it is discharged at Outfall 018 and eventually leaves SSFL via Outfall 002. In 2011, Boeing completed the installation of surface water conveyance pipelines that convey surface water from the R2 Ponds and Outfalls 003, 004, 005, 006, 007, 010, 012, and 013 to Silvernale Reservoir for treatment prior to discharge. There are a number of other active pipelines, tanks, and structures (Building numbers: 3XXX-03 through 3XXX-05) located in Silvernale CC 1 associated with the surface water management and treatment. The Silvernale Reservoir does not currently receive any operational discharges. Current inflow consists of stormwater runoff during heavy rainfall events only. Therefore, surface water is not consistently present within the entire footprint of the reservoir. For this reason, both soil and sediment samples have been collected within the footprint of the reservoir. A vegetation clearance area is located in CUA 1 northwest of the Silvernale Reservoir. **CUA 4: Former Nitrogen Facility (previously portion of Potential CUA A):** The former Nitrogen Facility included two structures (Building numbers: 3XXX-01 and 3XXX-02), a cooling tower, six ASTs (Unknown-AT-SN-1 through Unknown-AT-SN-6), and a septic tank (Tank ID: 3XXX-01 septic tank). CUA 4 also contains a portion of a soil disturbance area. The six ASTs had unknown capacities and most likely contained compressed or liquid nitrogen and were associated with the Nitrogen Facility. The septic tank was found and removed during demolition of the Nitrogen Facility in 2013 and its original intended purpose is unknown. The Nitrogen Facility was used continuously for gaseous nitrogen supply from before 1965 to 2012. There is an associated nitrogen conveyance pipeline near the Nitrogen Facility. Silvernale CC 1 is located in the southern portion of the Silvernale RFI site reporting area. CUA 1 and surrounding area was historically and is currently unpaved. CUA 4 was historically a partially paved parking area south of the former Nitrogen Facility, but is currently unpaved. The topography of Silvernale CC 1 is relatively flat with several areas of moderate topographic relief; the area immediately to the north of the reservoir has approximately 20 feet of topographic relief. Surface water run-off from Silvernale CC 1 generally flows to the southwest. Silvernale CC 1 includes the Silvernale Reservoir and the land surrounding the reservoir, including a vegetation clearance area. There is also a seasonal stream that leads into and out of the reservoir. Water levels in Silvernale Reservoir range from dry to approximately 8 to 10 feet above the bottom surface. The depth to bedrock beneath the Reservoir ranges from less than 1 foot to greater than 6 feet in some areas. The depth to bedrock in Silvernale CC 1, outside of Silvernale Reservoir, ranges from less than 1 foot to greater than 8 feet, but it is most frequently less than 5 feet. There are several other pipelines, other than those associated with the surface water treatment system, which include an inactive fresh/domestic water pipeline, aboveground reclaimed water pipelines, and an inactive sewer pipeline.	• VOCs • SVOCs (including NDMA isopropanol, and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide and asbestos) • Pesticides and herbicides • Chloramines • Radionuclides
Silvernale	1	Potential CUA A	Potential CUA A was identified in the July 2013 Addendum to the Master RFI Data Gap Work Plan for the Silvernale RFI site (CH2M HILL, 2013) to evaluate the soil disturbance area and the nitrogen facility. Although the nitrogen facility and northern portion of the soil disturbance area is being evaluated as CUA 4, the remaining portion of the soil disturbance area is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA A is located within Silvernale CC 1.	• VOCs • SVOC • TPH • Metals

Table 6-1g – Subarea 5/9 North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
Silvernale	2	2	**CUA 2: Dredge Deposition Area:** The Dredge Deposition Area is located north of the Silvernale Reservoir and east of ECL Building 3270. Dredge material from the Silvernale Reservoir may have been deposited here. Based on review of aerial photographs, it is estimated that deposition of dredge materials occurred between 1967 and 1983. The dredge area was identified based on observed site conditions and site inspections with the California Environmental Protection Agency, Department of Toxic Substances Control. No other features are located in Silvernale CC 2. CUA 2 and surrounding area was historically and is currently unpaved. The topography of Silvernale CC 2 is relatively flat. Surface water runoff from Silvernale CC 2 generally flows to the west and south. Soil thickness at Silvernale CC 2 ranges from 4 to approximately 12 feet.	• VOCs • SVOC (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics
Silvernale	2	2	**CUA 3: ECL Explosives Storage Magazine:** This CUA is located north of the Dredge Deposition Area and 180 feet east of ECL Building 3270 (at top of hill). This magazine was authorized to store up to 100 pounds of Class A explosives and was used until 1988. The ECL explosives storage magazine has been removed. A large rock outcrop encompasses approximately half of CUA 3. No other features are located in Silvernale CC 3. CUA 3 and surrounding area was historically and is currently unpaved. The topography of Silvernale CC 3 is relatively flat. Surface water runoff from Silvernale CC 3 generally flows to the south. The soil thickness at Silvernale CC 3 ranges from 2 to approximately 10 feet.	• VOCs • SVOC (including NDMA) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals • Inorganics
Silvernale	4	5	**CUA 5: Former Nitrogen Pipeline:** A high pressure pipeline that conveyed nitrogen passed through Silvernale CC 4. Portions of the pipeline were aboveground and portions of the pipeline were below ground, at a depth of approximately 4 feet bgs. The below ground portions of the pipeline were found to be wrapped with mastic-like tape. The portion of the pipeline in Silvernale CC 4 was removed in 2014. Portions of the NASA Building 204 Area and NASA SPA are within the Silvernale RFI site reporting area. The NASA Building 204 area was operated as a service area for equipment maintenance, automotive maintenance and repair, and building maintenance services. Several structures, or portions of structures, related to the Building 204 area operations are or were within the Silvernale RFI site reporting area: Building 2233, Building 2796, and a metal cutting equipment area are still in place and Buildings 2775 and 2757 have been removed. The NASA SPA was used to store bulk quantities of hazardous materials, mostly in connection with testing at the Alfa and Bravo testing facilities. Several structures or features related to past SPA operations, which have been removed, were within the Silvernale RFI site reporting area: 3 ASTs, 2 unidentified buildings, and one surface impoundment. The surface impoundment, solid waste management unit 5.16, was gunite lined and used to contain and treat hazardous waste. Additional details on the Building 204 Area and SPA can be found in the Data Summary Report for Santa Susana Field Laboratory, Ventura County, California (NASA, 2015). Silvernale CC 4 is located in the northeastern area of the Silvernale RFI site reporting area. There is approximately 80 feet of topographic relief across Silvernale CC 4. Surface water runoff from Silvernale CC 4 is generally to the south, with the exception of the northern most approximately 200 feet of Silvernale CC 4, where surface flow is to the north. Soil thickness at Silvernale CC 4 is approximately 1 to 5.5 feet bgs.B4865 (also known as B4173). A sodium storage pad, and later converted into the Gammagraph X-Ray Building. Based on aerial photographs, the building was present from the late-1950s to the mid-1990s. The building was identified as housing a 30 curie Ir-192 radiological source, and in 1978 a source projector containing 90 curies of Co-60 was dropped and damaged.	• VOCs • SVOC (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Energetics • Metals (including hexavalent chromium) • Inorganics • Pesticides and herbicides • Asbestos • Radionuclides

Table 6-1g – Subarea 5/9 North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
		Boeing RFI Subarea 5/9 North Unaffiliated Areas	The Unaffiliated Areas consist of open space located outside the RFI site reporting area boundaries within Boeing RFI Subarea 5/9 North. There are no CUAs or structures within the Unaffiliated Areas and there is no documentation of historical operations in the Unaffiliated Areas. During the 2008/2009 Debris Survey, a debris area containing a 5-foot section of a 6-inch-diameter metal pipe and an asphalt pile with soil, rebar, and metal was identified in the central portion of the Boeing RFI Subarea 5/9 North Unaffiliated Areas. The debris pile is still present. The depth to bedrock varies throughout the Unaffiliated Areas but is approximately 1 foot bgs to approximately 4 feet bgs. Bedrock outcrops cover most (approximately 90 percent) of the Unaffiliated Areas. Surface water in the northern portion of the Unaffiliated Areas drains to the north to northwest and west towards Silvernale Pond and in the southern portion it drains to the south to southwest, into the R2 Ponds in Administrative Area II.	• VOCs • PAHs • Other SVOCs • TPH • PCBs • Energetics • Metals • Dioxins and furans
ECL	1	9, 10, 11, 12, 14, and 15	**CUA 9: CUA 9 includes Building 3258, five aboveground tanks (unknown contents), five undetermined tanks (unknown contents), and an iodine generator.** Building 3258 was used for Chemical and Waste Storage (Hazardous Waste Storage Area). Chemicals stored included acid solutions, kerosene, paints, solvents, oil, and surfactants. Wastes stored included lead-, oil , solvent-, acid-, and caustic-contaminated debris; batteries; fluorescent tubes; PCB light ballasts; spent carbon canisters; friable asbestos debris; waste antifreeze; and waste-oil filters. Other chemical uses include ammonia, chlorine, non-radioactive rubidium (gaseous phase), and non-radioactive cesium (gaseous phase). Starting in 1991, Building 3258 served as the Continuous Wave Laser Laboratory for small-scale laser tests. **CUA 10: CUA 10 includes Building 3269. Before 1975**, Building 3269 was used as a general chemistry laboratory, where gaseous chemicals (chlorine, iodine, bromine, and fluorine) were used. It became the Continuous Wave Laser Laboratory in the late 1970s, using fluorine in the hydrogen fluorine laser and hydrogen peroxide, sodium hydroxide, iodine, and chlorine. Building 3269 was used for chemical laser research starting in 1985, and chemicals used included germanium, silicon, sodium, sodium azide, lithium iodide, lithium chloride, basic hydrogen peroxide, tetrafluorohydrazine, dichlorosilane, ammonia, non-radioactive rubidium, and non-radioactive cesium. Three spills (of trichloroethane, potassium hydroxide, and peroxide) are documented for CUA 10. **CUA 11: Transformer pad west of Building 3259.** Chemical use included PCBs. **CUA 12: Bunker located south of Building 3269**. This bunker was used for storage of explosives. **CUA 14: One septic tank (Building 3258 Septic Tank) and a Building 3258 Leach Field** located southwest of Building 3258. The Building 3258 Leach Field received waste from Building 3258 while it served as the Continuous Wave Laser Laboratory. **CUA 15: Stained soil area** discovered during the July 2010 demolition activities. ECL CC1 is located in the western area of the ECL RFI site reporting area. All structures in ECL CC1 have been demolished. There are no surface water bodies in ECL CC1. ECL CC1 is not currently paved; however, historically, the area was paved near the buildings. The topography at ECL CC1 is relatively flat. Surface water runoff from ECL CC1 flows via sheet flow to the east and ultimately flows south to the drainage channel that extends southwest from the Silvernale Reservoir into ECL. Soil thickness at ECL CC1 ranges from 1 to approximately 6.5 feet bgs.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals • Inorganics (including asbestos) • Radionuclides
ECL	2	1, 2, 3, 4, 5, 6, 7, and 8	**CUA 1: CUA 1 includes the following former features, as described herein: two structures, 31 aboveground tanks, nine undetermined tanks, two concrete pads, five undefined features, one stained soil area, and seven bottles.** Building 3270: Engineering Chemistry Laboratory (SWMU 6.1): Used for research and development of rocket and gun propellants, as well as exploratory chemical research to develop new fuel additives. Seven test bays were located along the northern and eastern sides of the building and were used for pilot-scale laboratory testing, production of energetic compounds, and solvent storage. In addition, three test bays previously located south of Building 3270 were used to produce elemental fluorine. Building 3270 contained two chemical reactors. These chemical reactors used unknown fuel. A machine shop was located on the southern side of the building. Historical uses of Building 3270 include: ~1963 to 1973: manufacturing of high-energy fluoride compounds, mixing of amine propellants through late 1960s ~1973 to 1980: manufacturing of nitric and sulfuric acid materials 1980 to 1996: manufacturing of glycidyl azide polymer consisting of polyepichlorohydrin, dimethyl sulfide, and sodium azide. Chemical uses include solvents, metals, hydrocarbons, propellants, energetics, perchlorate, hydrazine, formaldehyde, SVOCs, fluoride, chloride, nitrate and nitrile compounds, dimethyl sulfide, sodium azide, alcohols, ammonia, cyanide, asbestos, and cyanofuroxan. There was soil staining observed during demolition of a storm drain located west of Building 3270. Building 3367: Used for chemical and equipment storage to support operations at Building 3270.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides • Energetics and perchlorate • Metals • Inorganics (including asbestos and cyanide) • Radionuclides

Table 6-1g – Subarea 5/9 North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
ECL	2	1, 2, 3, 4, 5, 6, 7, and 8	The aboveground tanks in the container storage area at CUA 1 contained hazardous waste, nitric acid, methanol, isopropyl alcohol, caustic, acetone, sodium azide, nitrogen trifluoride, 3‑chlorosalicylaldehyde, 3-fluorosalicylaldehyde, 3‑nitrosalicylaldehyde, and unknown contents. Seven bottles contained nitrogen fluoride. Three undetermined tanks contained sulfuric acid, potassium fluoride, and potassium hydrogen fluoride. Five undefined features were located around Building 3270. Building 3270 Waste Tank was located south of Building 3270 and received liquid wastes from the building. Of the two concrete pads, one concrete pad that was immediately east of Building 3270 was used for recycling of methylene chloride. Methylene chloride was stored in 55-gallon drums next to the distillation unit. Approximately 5,000 to 6,000 pounds of methylene chloride were recycled annually during facility operation. The concrete pad south of Building 3270 contained an ECL scrubber system for fluoride gas. Eight spills (of hydrazine, nitric acid, firex, amyl acidate and pyridine, fluoride, fluorine and copper, acid and trichlorobenzene, and toluene) are documented for CUA 1. The Building 3260 ECL Runoff Tanks Area of Concern was used to collect surface water runoff and waste discharges from the Building 3270 concrete pad between 1989 and 1996, following removal of the ECL Pond. Surface water and other discharges were conveyed to the Runoff Tanks via a concrete-lined ditch extending from the southwestern corner of the Building 3270 concrete pad. Water collected in the Runoff Tanks was sent to STL-IV for groundwater treatment via vacuum truck. No releases from the ECL Runoff Tanks are documented. The Runoff Tanks were in use from 1989 through 1996. **CUA 2: CUA 2 includes former Building 3260, three drains, and a pipe**, as described further herein. Building 3260: Dry Chemical and Instrument Storage Facility. Used for storage of sodium salts, fluorides, aluminum chloride, oils, vermiculite, sodium azides, silica gel, potassium bifluoride, and potassium bisulfite. Building 3260 also included a 90-day hazardous waste storage yard. The area immediately west of Building 3260 was identified as “open storage” on a 1978 historical photograph and is likely associated with storage operations at Building 3260. Two drains were located west (storm drain) and north (floor drain) of Building 3260. A discharge point was located northeast of Building 3260. The storm drain at Building 3260 drained to the discharge point through a pipeline. A pipe draining to the south was located at the southwest end of the building. Five spills (of fluoride, fluoride & chromium, triaminonitrobenzene, and acetic acid) are documented for CUA 2. **CUA 3: Building 3798:** Former Drum and Bottle Storage Pad. Used for storage of solvents, fuel oil, and hydrazine. May have also used nitrogen tetraoxide in the 1960s. Other chemical uses include alcohols, inorganics, SVOCs, fluoride, and asbestos. No berm existed for spill containment, but drums and bottles were placed on top of pallets over a drainage trench that drained to the ECL Pond. A sump was located northeast of Building 3798. **CUA 4: ECL Pond (SWMU 6.2) and ECL Collection Tank (SWMU 6.3):** Gunite-lined pond received hazardous waste discharges from Building 3270 and surrounding areas from the late 1960s through 1984. The pond had a capacity of approximately 20,000 gallons with approximate dimensions of 50 feet by 25 feet by 5 feet deep. The pond was re-lined three times in the 1970s and in 1980, but releases from the pond resulted in contamination to surrounding soil and groundwater. In addition to receiving wastes from the ECL, a triaminoguanidine nitrate solution from Building 3270 was reportedly dumped into the ECL Pond, and 2,000 gallons of nitric acid was released to the ECL Pond in 1980. The pond was drained, backfilled with clean soil from the Burro Flats borrow area, and a concrete pad was placed over the former pond. During pond removal operations, 15,000 gallons of solvent-contaminated water were removed from the pond in 1987 and temporarily stored in an aboveground tank in the Tank Storage Area. After removal of the ECL Pond, a French Drain and a cut-off wall were installed to collect groundwater in the fill material. Groundwater that was recovered from the French Drain was stored in the 4,800-gallon ECL Collection Tank before undergoing treatment at STL-IV RFI site. The French Drain is no longer active. Closure activities associated with the ECL Pond were completed in 1989 and are documented in the Closure Report (EMCON, 1989). The ECL Pond is permitted in accordance with a RCRA Hazardous Waste Part B Permit (United States Environmental Protection Agency [USEPA] identification CAD093365435). A Post Closure Plan, including a permit application for the ECL Pond, was submitted to DTSC in 1990, and revisions to the permit application for post-closure care were submitted in 1993, 2004, 2006, and 2015 (Haley & Aldrich, Inc., 2015). The ECL Collection Tank was located at the former ECL Pond but was removed from the site during demolition activities in 2010.	• Terphenyls

Table 6-1g – Subarea 5/9 North				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
ECL	2	1, 2, 3, 4, 5, 6, 7, and 8	Two spills at the ECL Pond involved fluoride and solvents. The ECL Pond is currently a seasonal pond and is managed under the Areas I and III Surface Impoundments Post-Closure Plan (Emcon, 1993). **CUA 5: ECL Suspect Pond (SWMU 6.2):** This was a concrete-lined pond that received surface water runoff and discharges from Building 3260 and the Building 3270 concrete pad until 1989. A faulty liner may have caused releases to the environment. One spill at ECL suspect pond involved fluoride. The ECL Suspect Pond is not permitted under the RCRA Hazardous Waste Part B Permit referenced above for the ECL Pond. **CUA 6: Building 3270 Leach field (Area of Concern):** This leach field was located southeast of the ECL Pond and was used from 1976 to 1995. The leach field had a 750-gallon capacity and received sanitary wastes (nitric and sulfuric acids) from Building 3270. The leach field has been removed. **CUA 7: Transformer adjacent to Building 3367**. **CUA 8: Building 3799 (Drum Storage Area):** This area was used for storage of solvents and may have also used nitrogen tetraoxide or hydrazine in the 1960s. Other chemical uses include asbestos. A shed with four posts provided compressed air to Building 3270. ECL CC2 is located in the central and eastern portion of the ECL RFI site reporting area and comprises the majority of the historical operations that previously occurred at the ECL RFI site. All structures in ECL CC2 have been demolished. There are no perennial surface water bodies in ECL CC2. ECL CC2 is not currently paved; however, historically, the area was paved near buildings. The topography in the ECL CC2 slopes towards the south, which also represents the general direction of surface water flow. Surface water runoff from ECL CC2 flows via sheet flow towards the drainage channel that extends south from Administrative Area IV into ECL and ultimately flows south to the drainage channel that extends southwest from the Silvernale Reservoir into ECL. The southeast area of ECL CC2 is highly vegetated. Soil thickness at ECL CC2 is approximately 1 to 10 feet bgs. Bedrock outcrops are present west of Building 3799 (CUA 8) and northwest of Building 3270 leach field (CUA 6) in ECL CC2.	
ECL	3	13	**CUA 13: Bunker on the eastern side of the site.** This bunker was used for storage of explosives. There are no surface water bodies in ECL CC3. ECL CC3 is not currently paved. The topography at ECL CC3 is relatively flat. Surface water runoff from ECL CC3 flows via sheet flow towards the northwest and ultimately flows south to the drainage channel that extends southwest from the Silvernale Reservoir into ECL. Soil thickness at ECL CC3 is approximately 2 to 3.5 feet bgs.	• VOCs • SVOCs (including NDMA, Isopropanol, and formaldehyde) • Energetics and perchlorate • Metals
ECL	4	16	**CUA 16 (previously potential CUA A): Three ASTs (Unknown-AT-EC-1, Unknown-AT-EC-2, and Unknown-AT-EC-3) with unknown contents.** ECL CC4 is located in the northwestern area of the ECL RFI site reporting area. There are no surface water bodies in ECL CC4. ECL CC4 is not currently paved. The topography at ECL CC4 is relatively flat. Surface water runoff from ECL CC4 flows towards the south via sheet flow and ultimately flows south to the drainage channel that extends southwest from the Silvernale Reservoir into ECL. Soil thickness at ECL CC4 is approximately 1 to 5.5 feet bgs.	• VOCs • SVOCs (including NDMA) • TPH • Dioxins and furans • Energetics • Metals • Inorganics

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
EEL	1	2, 3, 8 - 16, and portions of 1 and 7a	**CUA 1: EEL Cryogenic Test Cell (Building 3271):** Identified as part of SWMU 6.9 in the RFA. Used for testing various materials, including carbon and stainless steel, under high-pressure hydrogen conditions from 1968 through 2008. One-ton and 20-ton metal cooling towers where KP-1 (a nonhazardous substance used to prevent buildup of scale and fouling deposits) was used were also located near or at Building 3271. **CUA 2: EEL Storage (Buildings 3109 and 3908):** EEL equipment and material storage. It also contained one structure feature near Building 3908. **CUA 3: EEL Mechanics Workshop (Buildings 3227 and 3264):** Mechanics workshop. It also contained one undefined feature south of Building 3264. **CUA 7: Hazardous Materials Storage Pad:** Hazardous materials were stored in drums on a concrete pad east of the cryogenic laboratory. **CUA 8: TPH Soil Excavation Area:** A removal action was conducted east of the cryogenic laboratory and south of the hazardous materials storage pad as part of the DTSC-approved 1993 Accelerated Corrective Action Work Plan (Appendix I of the Current Conditions Report; ICF, 1993). The removal action was based on TPH results at location D-3-02, and 2 to 3 cubic yards of soil were removed and disposed of offsite. **CUA 9: Transformers:** Located south of the hazardous materials storage pad and at Building 3268. **CUA 10: EEL Cryogenic Test Cell (Building 3108):** Contained a test cell associated with Building 3271. Used for testing various materials including carbon and stainless steel under high-pressure hydrogen conditions from 1968 through 2008. **CUA 11: Tanks: Small ASTs** primarily used to store hydraulic oil for the vacuum pumps and several hydrogen and helium gas tanks. **CUA 12: Tanks: Small ASTs** primarily used to store hydraulic oil for the vacuum pumps and several hydrogen and helium gas tanks. **CUA 13: Tanks: Small ASTs** primarily used to store hydraulic oil for the vacuum pumps and several hydrogen and helium gas tanks. **CUA 14: EEL Cryogenic Laboratory (Building 3268):** Identified as part of SWMU 6.9 in the RFA. Used for testing various materials including carbon and stainless steel under high-pressure hydrogen conditions from 1968 through 2008. Contained multiple transformers, one of which showed staining around the valve. There were 1‑ton and 30-ton metal cooling towers near Building 3268 that used KP-1 (a nonhazardous substance used to prevent buildup of scale and fouling deposits). Documented historical releases of 2.5 to 80 gallons of water paint, aluminum powder and water, coolant, and hydraulic fluid occurred between 1975 and 1996. **CUA 15 (previously portion of Potential CUA A): Western STL-IV Reclaimed Water Sprayfield:** A sprayfield located in western portion of the EEL RFI site reporting area that received reclaimed water from the STL-IV RFI site. **CUA 16 (previously portion of Potential CUA B): Eastern STL-IV Reclaimed Water Sprayfield:** A sprayfield located in eastern portion of the EEL RFI site reporting area that received reclaimed water from the STL-IV RFI site. The site is located on the border between Administrative Areas III and IV. Structures at the site have been demolished, and tanks have been removed. The site is currently unpaved due to demolition activities performed in 2012. Historically, areas near the buildings were paved. Topography in the central portion of the site slopes to the south and east. Topography in the western portion of the EEL RFI site reporting area slopes to the south and west. Throughout most of the site, soil is generally thin, typically ranging from less than 3 feet to 10.5 feet thick. Soil in the undisturbed areas of the site consists of weathered Chatsworth Formation materials, which are primarily fine-grained, silty sands and clayey silts. Surface water exists intermittently in ephemeral drainages at the western end of the EEL RFI site reporting area as the result of seasonal precipitation events. Surface water in the ephemeral drainages flows south through the Compound A Facility RFI site and ultimately to the R-2 Discharge Ponds in Administrative Area II. Surface water runoff in the other parts of the EEL RFI site reporting area flows via sheet flow generally south to the pond at the STP-3 RFI site.	• VOCs • SVOCs (SVOCs (including NDMA, Formaldehyde, and Isopropanol) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium • Inorganics (including cyanide) • Radionuclides
		Potential CUA A	Potential CUA A was identified in the May 2013 Addendum to the Master RFI Data Gap Work Plan for the EEL RFI site (CH2M, 2013) to evaluate the western sprayfield and one structure northwest of Building 3905. Although the sprayfield is being evaluated as CUA 15, the structure northwest of Building 3905 is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA A is located within EEL CC 1.	• VOC • SVOCs • TPH • PCBs • Metals

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
		Potential CUA B	Potential CUA B was identified in the May 2013 Addendum to the Master RFI Data Gap Work Plan (CH2M, 2013) to evaluate the eastern sprayfield. Although the sprayfield is being evaluated as CUA 16, a small stretch of pipeline that extended from the STP-3 RFI site to the STL-IV Reclaimed Water Sprayfield on the eastern portion of EEL RFI site reporting area that was also part of Potential CUA B is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA B is located within EEL CC 1.	• VOCs • SVOCs • TPH • PCBs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Cyanide • Inorganics
STP-3	1	1-4	**CUA 1: STP‑3:** STP‑3 was a small package activated sludge treatment plant that received sanitary sewage, groundwater treatment system effluent, and non-chromated cooling tower discharges from Administrative Areas II, III, and IV at an average flow rate of 20,000 gallons per day. The service connections in Administrative Area IV included buildings where radioactive materials may have been handled. Cooling tower discharges received by the plant were treated by a Dow biocide. Effluent from STP‑3 was discharged to an unlined creek that flowed to the R-2A Pond in Administrative Area II. The plant operated from the early 1950s to 2012, when the final remaining structures at the plant were demolished. The treatment plant consisted of a comminutor (for coarse solids reduction), two aeration tanks, a clarifier, an anthracite coal filter, and a chlorine contact tank and chamber. The aeration tanks extended to approximately 12 feet bgs. The system also included two concrete-lined holding pits intended to hold overflow if the treatment system backed up and a 20,000-gallon steel tank used to hold sewage while the treatment plant was being cleaned. Building 3600, part of the treatment plant, was used to store calcium hypochlorite and contained a sink. Releases of raw or partially treated wastewater occurred intermittently at the plant, the first of which was documented in 1989. Other features in CUA 1 include a sump northeast of Building 3600 and a portion of an underground reclaimed water pipeline in the southwestern portion of the CUA. **CUA 2: STP Pond:** The STP pond was an unlined pond intended to store wastewater containing significant amounts of radioactive material. According to site personnel, the pond was never used for this purpose, although the pond was used to contain accidental discharges of untreated or partially treated sewage from the sewage treatment plant. The pond also serves as a collection basin for stormwater runoff for areas upgradient of the pond. Other features in CUA 2 include a portion of an underground reclaimed water pipeline (Potential CUA A). **CUA 3 – STP Clarifier:** The clarifier was a component of the sewage treatment plant. A sump was located at the clarifier along with associated treatment plant piping. The layout of the piping connecting the clarifier to the treatment plant is not known. Other features in CUA 3 include a portion of an underground reclaimed water pipeline (Potential CUA A). **CUA 4: Former Ranch House:** The Former Ranch House area consisted of three buildings (3251, 3252, and 3267) that may have been used as a metallurgical laboratory, a machine shop, or both. Historical documentation shows that oil spills occurred in Buildings 3251 and 3252 and that Building 3267 was used for testing rocket propellant. Building 3251 contained a scrubber and air conditioning units. Building 3252 contained a pressure test fixture that used hydraulic oil. Aerial photographs show that the buildings were demolished in the late 1980s. All structures and tanks at STP‑3 CC 1 have been removed or demolished. Topography in the central portion of the STP‑3 RFI site reporting area slopes to the east toward the drainage channel located along the eastern portion of the reporting area. Topography within the western portion of the STP‑3 RFI site slopes from the north to the south. CUA 1 is currently unpaved but historically was paved; all other CUAs were historically unpaved. Soil thickness ranges from approximately 1 foot to greater than 10 feet. Soil in the undisturbed areas of the site consists of weathered Chatsworth Formation materials, which are primarily fine-grained, silty sands and clayey silts. There are no surface water bodies in CUAs 1, 2, 3, or 4, although CUA 2 is coincident with the location of the STP pond. Surface water exists intermittently in ephemeral drainages at the eastern end of the STP‑3 RFI site as the result of seasonal precipitation events. Surface water in the ephemeral drainages flows south through the Compound A Facility RFI site, and ultimately to the R-2 Ponds in Administrative Area II. Surface water runoff from the site's operational areas generally follows the topography of the site, with sheet flow generally occurring to the east toward the drainage in the eastern portion of the site, and to the south in the western portion of the site.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Radionuclides

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
	1	Potential CUA A	Potential CUA A was identified in the Addendum to the Master RFI Data Gap Work Plan for the STP-3 RFI site (CH2M, 2013) to evaluate 250 feet of underground reclaimed water pipeline that traversed the STP-3 RFI site (the pipeline ran from the STL-IV RFI site to the EEL RFI site). The pipeline is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA A is located within STP-3 CC 1.	• VOCs • SVOCs • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide)
Compound A	1	10	**CUA 10 is a large suspected dredge materials area north of the Compound A Facility RFI site.** CUA 10 includes only the portion of the suspected dredge materials area that is within Boeing RFI Subarea 5/9 South. The suspected dredge materials area is shown on figures as an area of disturbed soil in the southeast portion of CUA 10. A disturbed soil area is also located near that Area IV boundary and that area includes hummocks that appear to be related to site activities but how and when they were formed is not known. The disturbed soil areas contain fine grained soil that is unlike the native soil in the area. The northern portion of CUA 10 is not included in this evaluation because it is outside of Administrative Area III and Boeing RFI Subarea 5/9 South. (The northern portion of CUA 10 is located in Administrative Area IV, which is being evaluated by United States Department of Energy). There are no surface water bodies in CUA 10. CUA 10 is generally flat and vegetated. Surface water runoff from the western and southern portions of CUA 10 generally flows to the southwest into an unlined drainage channel that flows toward CUA 8. Surface water runoff in the eastern portion of the CUA 10 generally flows to the east and southeast. Soil thickness at CUA 10 ranges from 0 to 11.5 feet.	• VOCs • SVOCs (including NDMA) • TPH • PCBs and PCTs • Dioxins and furans • Energetics • Metals • Inorganics • Radionuclides
Compound A	2	8	CUA 8: Workshop (Building 3768) and bunkers for storage of energetics and explosive devices. CUA 8 includes two buildings identified as 3398 and Building 3397. Building 3768 is co-located with Building 3397. VOCs and TPH were stored in Building 3398. Two igniter storage features were identified as potential CUA B in the Compound A Work Plan Addendum. CUA 8 was expanded to include these igniter storage features based on screening-level sampling results. There are no surface water bodies in CUA 8. CUA 8 is generally flat, and all structures have been removed. Surface water runoff from CUA 8 generally flows southerly into an unlined drainage channel located on the west side of CUA 8. Soil thickness at CUA 8 is as shallow as 1.5 feet and depth to bedrock ranges from 9 feet on the west side to 5 feet on the east side.	• VOCs • SVOCs (including NDMA) • TPH • Energetics and perchlorate • Metals

Table 6-1h – Subarea 5/9 South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
Compound A	3	1,3,4, and 5	**CUA 1: Building 3418: Manufactured chlorine pentafluoride (Compound A) and laser chemicals from 1967 to 1969.** The building was not used after 1969 and was demolished in 2002. Operational history includes storage of chlorine pentafluoride (Compound A), fluorine production (trichloroethane, TCE, acetone, dowtherm, corrosives [iron fluorides], hydrofluoric acid, chloride, chlorine, fluorine, fluoride salts, trifluoride), and laser chemical manufacturing (hydrogen fluoride, nitrogen, antimony, antimony pentafluoride, nitrogen trifluoride, fluorine gas, sodium fluoride, chloride, fluoride and hydrofluoric acid). **CUA 3: Compound A Pond:** This unlined pond was used to control wastewater from material research or used as a holding pond for caustic solutions (sodium hydroxide and chloride). The pond was drained in 1980 and remaining pond sludge was excavated in 1984 (Ogden, 1996). The pond was backfilled in 1988. **CUA 4: Underground Fluorine Pipeline:** Likely used during the operation of Building 3418. A tank and an undefined structure were observed within CUA 4 during the 2010/2011 review of aerial photographs. The fluorine pipeline and other structures were demolished. **CUA 5: Storage Shed:** Includes a storage shed, three tanks and a structure with an unknown use. The storage shed was used for hazardous materials storage and this feature was demolished in 2002. Three tanks and a structure with an unknown use were observed during the 2010/2011 review of aerial photographs and were previously identified as Potential CUA C. There are no surface water bodies in CC 3 (other than the former Compound A Pond). CC 3 is generally flat, and all structures have been removed. Surface water runoff in CC 3 generally flows to the southeast into an unlined drainage channel what flows to the east. Soil thickness in CC 3 ranges from 0 to 12.5 feet in the central portion of the site.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics • Terphenyls
Compound A	4	2, 6, 7, and 9	**CUA 2: Forming Pits:** Used in the 1960s to shape metals through the use of explosives. Potential contaminants at this CUA are explosives (C-4, trinitrotoluene) and aluminum. The review of historical documents identified two tanks, three igniter and blasting cap storage features, and storage of energetics at CUA 2. The firing control building, enclosed furnace smelter, a built-up shelter, Building 916, and two structures with no documented use were observed during the 2010/2011 review of aerial photographs. CUA 2 also includes a portion of a reclaimed water pipeline that transported water from the STL-IV Impoundments located in the STL-IV RFI site to spray fields located at the EEL RFI site. **CUA 6: Suspect Pond:** There is speculation that an unlined surface water impoundment that might have received wastewater previously existed in this CC. **CUA 7: Debris Area:** Location of storage for various items including, scrap metal, drums, an empty 5,000-gallon aboveground storage tank, and other debris**.** **CUA 9: STL-IV Air-stripping Towers:** VOCs were removed from groundwater at the STL-IV air-stripping towers. A transformer was located at this facility. A tube-forming facility (Building 3430) was also in this area. Also within this CUA cluster is a power pole that contained three transformers. The transformers are located north of CUA 9. Samples collected from the base of the power pole did not have concentrations above SCLs and the power pole was subsequently not included as a CUA. There are no surface water bodies in CC 4 except for the suspect pond, which may have stored water occasionally. CC 4 is generally flat but does have some areas of topographic relief. Surface water runoff in CC 4 varies. Surface water runoff in the western portion of CUA 2 flows to the west or south into an unlined channel that flows to the east. Surface water runoff in the eastern portion of CUA 2 flows to the east or south into CUA 6 or into an unlined channel that flows to the east. Surface water runoff from CUA 9 flows to the south/southwest into CUA 6. Surface water runoff from CUA 6 flows to the south in an unlined channel that flows through CUA 7. Surface water runoff at CUA 7 flows into a central, unlined channel that flows to the south, into Administrative Area II. Soil thickness in CC 4 ranges from 0.5 foot to approximately 10 feet. All structures have been removed**.**	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics
Compound A	4	Potential CUA A	Potential CUA A was identified in the May 2013 Addendum to the Master RFI Data Gap Work Plan for the Compound A Facility RFI site (CH2M, 2013c) to evaluate one cap storage feature west of Building 3418 that was identified during the review of historical documents.	• VOCs • SVOCs (including NDMA and formaldehyde) • TPH • Energetics • Perchlorate • Inorganics • Metals

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
Compound A	4	Potential CUA D	Potential CUA D was identified in the May 2013 Addendum to the Master RFI Data Gap Work Plan for the Compound A Facility RFI site (CH2M, 2013c) to evaluate an aboveground reclaimed water pipeline extending from the STL-IV RFI site near STL-IV Impoundment 2 to the spray fields located in the EEL RFI site. The pipeline also ran through existing CUA 2. The pipeline has subsequently been removed.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • Energetics and perchlorate • Inorganics (including cyanide) • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Metals (including hexavalent chromium)
Compound A	4	Potential CUA E	Potential CUA E was identified in the April 2014 Addendum to the Master RFI Data Gap Work Plan Second Iteration for the Compound A Facility RFI site (CH2M, 2014a) to evaluate two spray heads and piping that were discovered in an area south of CUA 7 during the implementation of the Addendum to the Master RFI Data Gap Work Plan for the Compound A Facility RFI site (CH2M, 2013c). The nearest source of water for the piping and spray heads is STL-IV Impoundment 2. It is unknown if these spray heads were ever used.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • Energetics and perchlorate • Inorganics (including cyanide) • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Metals (including hexavalent chromium)

Table 6-1h – Subarea 5/9 South

RFI Site	CUA Cluster	CUAs	CUA Descriptions	Chemical Groups Analyzed
STL-IV	1	1, 2, 3, 4, 5, 9, 10, and 20	**CUA 1: Engine Test Stand Number 1 and Module 3: Module 3 (Buildings 3255) contained four test cells (25, 35, 37, and 38)** used to test small engines from the 1960s through the early 2000s. **CUA 2: Fuel Storage Area/MMH Vent Scrubber and Ozonator:** Contained two structures (one of which is partially located in CUA 2, the second structure is a canopy for the ozonator); a transformer pad; 21 ASTs; four undetermined tanks; a soil disturbance area; five pipelines ranging from approximately 10 to 125 feet long with unknown contents; one underground pipeline approximately 205 feet long that contained water (pipeline is partially located in CUA 2); and one aboveground pipeline approximately 22 feet long that contained water. **CUA 3: Fuel Storage Area:** Contained a portion of a structure; nine ASTs (including a second location for a tank located south of CUA 14); an undefined feature; and a firex system spill near the east side of Building 3263. **CUA 4: STL-IV Impoundments 1 and 2 and associated channels: STL-IV** Impoundments 1 and 2 were unlined until the late 1960s, at which time they were emptied and lined with gunite. Impoundment 1 received engine testing cooling water, aspiration water, wash water, site runoff, and emergency spill containment and treatment from 1958 through 1985. Impoundment 2 handled items similar to Impoundment 1 and also handled overflow from Impoundment 1 from 1960 to 1985. Excess water flowed to the spray fields at STL-IV or EEL RFI sites via the reclaimed water system. The two impoundments were closed in 1985. Impoundment 1 closure activities included excavating the liner and surrounding soil, backfilling with the pond with clean soil, and capping the area with concrete. Impoundment 2 closure activities included diversion channel construction, surface water removal, defoliation of the interior of the pond, backfilling with clean soil, construction of a gunite bypass channel, and installation of vegetated topsoil (Ogden, 1995). **CUA 5: Engine Test Stand Number 2 and Module 2: Buildings 3747 and** 3263 (used from the 1960s to 2000) supported/controlled test cells (24a, 24b, 25, 26a, 26b, 27, 28, and 29), which were used to test small engines from the mid-1950s through the early 2000s. **CUA 9: Building 3318 (Workshop, Instrumentation Shop, Tool Crib);** Contained Building 3210 (used as a lunch room in the 1960s to 1994); Buildings 3256 and 3331 (instrumentation shops, 1960s through the 2000s); Building 3261 (tool crib, 1960s through the 2000s); Unknown Building (unknown use, 1960s through the 2000s); Building 3750 (storage, 1960s through the 2000s); and Building 3262 (equipment storage, 1960s through the 2000s).. **CUA 10: Hazardous Waste Storage Locker,** VOC Storage and Use, General Storage and Use: Contained two structures, Test Cell 41, and a portion of a lined drainage channel. **CUA 20 (previously portion of Potential CUA A):** An undefined feature observed during the 2010/2011 aerial photograph review. STL-IV CUA Cluster (CC) 1 is located in the northeast area of STL-IV. There are no current surface water bodies in CUAs 1 through 5, 9, 10, or 20. Historically, CUA 1 contained two surface water impoundments. STL-IV Impoundment 1 was used for the collection of engine testing cooling water, aspiration water, area washdown water, and runoff, as well as emergency spill containment and treatment from 1958 to 1985. STL-IV Impoundment 2 was unlined and STL-IV Impoundment 1 was unlined until the late 1960s. A removal action was completed on these two impoundments in 1995. All of these CUAs are currently unpaved (due to demolition activities performed in 2008) but historically, most were paved. The topography of STL-IV CC 1 is relatively flat. Surface water runoff from CUA 1 generally flows to the west; surface water runoff from CUAs 2 and 9 generally flows to the north; surface water runoff from CUAs 3, 4, 5, and 20 generally flows to the northeast; and surface water runoff from CUA 10 generally flows to the northwest. Surface water runoff enters the drainage way in the northern portion of the site and then drains to Pond R-2B in Administrative Area II. Bedrock outcrops in places within STL-IV CC 1. Soil thickness at CUAs 1 through 5, 9, 10, and 20 range from 0 to approximately 16 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide)

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
STL-IV	2	6, 7, 8, and 16	**CUA 6: Hot Water Boiler Shelter (Building 3794), Assembly Decontamination (including Building 3780 and Cells 17 and 18):** Building 3794 was used as a hot water boiler shelter from the 1960s through the 2000s. Building 3780 was used for decontamination of engines/solvent uses from the 1960s through the 2000s. **CUA 7: Engine Test Stand Number 3 and Module 1: Module 1 (including Building 3253, an awning, and Cells 15 and 16)** produced hypergol igniters and tested Apollo engines. Engine testing was performed from the 1960s to 1979, after which time Building 3253 was used as an office building (from 1983 to 1993). **CUA 8: Control Center (Building 3254): Building 3254** operated as a Control Center from the 1960s through the 2000s. Other features include four ASTs, an awning, an undefined feature, a cooling tower, a sump, two underground pipelines, three transformers, and a transformer pad. **CUA 16: Leach Field:** Chemicals at the Leach Field are assumed to be the same as the chemicals stored/used at Buildings 3253 and 3254. STL-IV CC2 is located in the western-central area of STL-IV. There are no surface water bodies in STL-IV CC 2. STL-IV CC 2 is currently unpaved (due to demolition activities performed in 2008), but was historically paved. The topography at STL-IV CC 2 is relatively flat. Surface water runoff from CUAs 6, 7, and 16 generally flows to the east and surface water runoff from CUA 8 generally flows to the north. Soil thickness at CUAs 6, 7, 8, and 16 ranges from approximately 0.5 to 10 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals • Inorganics (including cyanide)
STL-IV	3	18, 21, and 27	**CUA 18: Debris Locations 3001 and 3002:** two small debris areas located on the south and north sides of a drainage channel. **CUA 21: Newly identified undefined feature** observed during the 2010/2011 aerial photograph review. **CUA 27: Newly identified undefined feature** observed during the 2010/2011 aerial photograph review. STL-IV CC 3 is located in the northwest area of STL‑IV. There are no surface water bodies in STL-IV CC 3. STL-IV CC 3 is currently and was historically unpaved. The topography at STL-IV CC 3 is relatively flat. Surface water runoff from STL-IV CC 3 flows to the southeast except along the road in the north section of the cluster. Surface water flows east in the swale next to the road. Bedrock outcrops in places within STL-IV CC 3. Soil thickness at STL-IV CC 3 is approximately 0 to 10 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Terphenyls • Radionuclides
STL-IV	4	14 and 24	**CUA 14: contained Operations Trailer/Office (Building 3265), Clean Room Trailer (Building 3274), Personnel Shelter (3777), a storage yard, and five ASTs. Buildings 3274 and 3265** were used from the 1960s through 2000s. **CUA 24: STL-IV spray field and three undefined features observed during the 2010/2011 aerial photograph review.** **STL-IV CC 4 is located in the western area of STL-IV. There are no surface water bodies in STL-IV CC 4.** STL-IV CC 4 is currently unpaved (due to demolition activities performed in 2008), but portions were historically paved. The topography at STL-IV CC 4 is relatively flat. Surface	• VOC • SVOCs (including NDMA and formaldehyde) • TPH

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
STL-IV	4	14 and 24	water runoff from STL-IV CC 4 flows to the east. Bedrock outcrops in places within STL-IV CC 4. Soil thickness at STL-IV CC 4 ranges from 0 to 16 feet.	• PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Terphenyls • Radionuclides
STL-IV	5	11	**CUA 11 operated as an explosives storage area (including Magazines 617 and 619) and stored Class 1.4 type explosives.** STL-IV CC 5 is located in the central area of STL-IV. There are no surface water bodies in STL-IV CC 5. STL-IV CC 5 is currently unpaved (due to demolition activities performed in 2008), but the storage area was historically paved. Surface water run off flows to the west and north. Soil thickness at STL-IV CC 5 is approximately 2.9 to 6 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • Energetics and perchlorate • Metals • Inorganics
STL-IV	6	12, 25, and 26	**CUA 12, Engine Test Stand Number 4**: Test Stand Number 4 also contained an unknown structure, a workshop (Building 3389), and a MMH/titanium compatibility testing storage area. **CUA 25, Newly identified undefined feature** observed during the 2010/2011 aerial photograph review. **CUA 26, Debris Location 3015: A large debris area.** The debris pile appeared to be construction debris materials (nails, bolts, pieces of clay and ceramic pipe, gas pipeline 1-inch approximately 15 feet long, and conduit) likely from demolition activities at STL-IV. STL-IV CC 6 is located in the south-central area of STL-IV. There are no surface water bodies in STL-IV CC 6. STL-IV CC 6 is currently unpaved (due to demolition activities performed in 2008) but portions were historically paved. The topography at STL-IV CC6 is relatively flat. STL-IV CC 6 is in a flat area north of which surface water clearly flows north and south of which surface water clearly flows south. Bedrock outcrops in places within STL-IV CC 6. Soil thickness at STL-IV CC 6 range from 0 to approximately 8.5 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals • Inorganics
STL-IV	7	15	**CUA 15: NTO Storage Area: Contained Test Cell Number 43 (Building 3766) from the 1960s through the 2000s.** STL-IV CC 7 is located in the southwestern area of STL-IV. There are no surface water bodies in STL-IV CC 7. In general, STL-IV CC 7 is and historically has been unpaved. However, CUA 15 was historically paved. The topography at STL-IV 7 is relatively flat. STL-IV CC 7 is in a flat area north of surface water that clearly flows north, and south of surface water that clearly flows south. Bedrock outcrops in places within STL-IV CC 7. Soil thickness at STL-IV CC 7 is approximately 0 to 7 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
STL-IV	7	15		• Dioxins and furans • Energetics and perchlorate • Metals • Inorganics • Radionuclides • •Terphenyls
STL-IV	8	19	**CUA 19, Debris Location 1000: Small debris area with a 3-foot metal cylinder.** STL-IV CC 8 is located in the southeastern area of STL-IV. There are no surface water bodies in STL-IV CC 8. STL-IV CC 8 is and was historically unpaved. The topography at STL-IV CC 8 is relatively flat. Surface water runoff from STL-IV CC 8 generally flows to the south. STL-IV CC 8 is on bedrock with soil thickness at a maximum of approximately 6.3 feet in some places.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • Dioxins and furans • Metals
STL-IV	9	13, 22, and 23	**CUA 13: Suspect pond.** **CUA 22: Soil Disturbance:** A portion of a soil disturbance area. **CUA 23: New Feature and Debris Location:** An undefined feature and Debris Location 1002 (a small soil pile intermixed with asphalt). STL-IV CC 9 is located in the southern area of STL-IV. There are no permanent surface water bodies in STL-IV CC 9. CUA 13 was a suspected pond, but proved to be a bedrock outcrop area. CUA 13 is intersected by a drainage way that originated at Pond R2-A in Administrative Area II. STL-IV CC 9 is currently and was historically unpaved. The topography at STL-IV CC 9 changes 110 feet dropping from the northwest to the southeast. Surface water runoff from STL-IV CC 9 flows to the southeast. Bedrock outcrops in places within STL-IV CC 9. Soil thickness at STL-IV CC 9 is approximately 0 to 9.5 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs and PCTs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics
STL-IV	10	17	**CUA 17, STL-IV explosive bunkers containing energetic constituents (Magazines 3618 and 3619) and a vegetation clearing area.** STL-IV CC 10 is located in the southern end of STL-IV. There are no surface water bodies in STL-IV CC 10. STL‑IV CC 10 is currently and was historically unpaved. The topography at STL-IV CC 10 is relatively flat. Surface water runoff from STL-IV CC 10 generally flows to the east. Soil thickness at STL-IV CC 10 is approximately 5.5 to 10 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals • Inorganics

Table 6-1h – Subarea 5/9 South				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
STL-IV	11	28	**CUA 28, Vegetation Clearance Area:** A vegetation clearance area was observed during the 2010/2011 aerial photograph review. STL-IV CC 11 is located southwest of the original STL-IV RFI site boundary south of Administrative Area IV. There are no surface water bodies in STL-IV CC 11. STL‑IV CC 11 is currently and was historically unpaved. The topography at STL-IV CC 11 is relatively flat with increasing elevation to the north and south. Surface water runoff from STL-IV CC 11 generally flows to the southeast. Soil thickness at STL-IV CC 11 is approximately 0 to 10.5 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • Metals • Inorganics
STL-IV	12	29 and 30	**CUA 29 and 30, Background Samples:** Two background samples that were previously evaluated with the Boeing RFI Subarea 5/9 South Unaffiliated Areas are now evaluated as part of the STL-IV RFI site. STL-IV CC 12 is located southeast of the original STL-IV RFI site boundary south of Administrative Area II. There are no surface water bodies in STL-IV CC 12. STL‑IV CC 12 is and was historically unpaved. The topography at STL-IV CC 12 is uneven and slopes to the north and east on the eastern side of the CC, the west in the central portion of the CC, and slopes to the east on the western side of the CC. Surface water runoff from STL-IV CC 12 generally flows to the north or east and eventually flows towards the south and through the CC. Soil thickness at STL-IV CC 12 is approximately 0 to 6 feet.	• VOC • SVOCs (including NDMA and formaldehyde) • TPH • PCBs • Dioxins and furans • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Radionuclides
STL-IV	13	31	**CUA 31, A drainage channel** STL-IV CC 13 is located southeast of the original STL-IV RFI site boundary south of Administrative Area II. There are no surface water bodies in STL-IV CC 13. STL‑IV CC 13 is and was historically unpaved. The topography at STL-IV CC 13 is relatively flat with increasing elevation to the east and west. Surface water runoff from STL-IV CC 13 generally flows to the southeast. Soil thickness at STL-IV CC 13 is approximately 0 to 0.3 feet.	• Dioxins and furans • Metals • PCBs
STL-IV	7	Potential CUA H	Potential CUA H was identified in the April 2013 Addendum to the Master RFI Data Gap Work Plan for the STL-IV RFI site (CH2M, 2013) to evaluate a new structure and undefined feature.	• Dioxins and furans • Metals • PCBs
STL-IV	9	Potential CUA I	Potential CUA I was identified in the April 2013 Addendum to the Master RFI Data Gap Work Plan for the STL-IV RFI site (CH2M, 2013) to evaluate the newly identified soil disturbance feature and an undefined feature.	• Metals
STL-IV	NA	Potential CUA J	Potential CUA J was identified in the April 2013 Addendum to the Master RFI Data Gap Work Plan for the STL-IV RFI site (CH2M, 2013) to evaluate the newly identified soil debris area.	• Dioxins and furans • VOCs • SVOCs • TPH • PCBs • Energetics • Perchlorate • Metals • • Inorganics

Table 6-1i – Subarea 10				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
Subarea 1B North Areas Unaffiliated with RFI Sites	1	Drainage Channels – Western Drainage (CUA 1)	**CUA 1 refers to the Subarea 10 Western Drainage channel**, which traverses roughly north-south through the western portion of Subarea 10. The Western Drainage channel receives drainage from primarily the western and central SSFL operational areas. Potential source areas include RFI sites and sources within Boeing RFI Subareas 5/9 South and 5/9 North (in Administrative Area III), including the Silvernale Pond; a large portion of Administrative Area II including the R2 Ponds and most former RFI Sites in RFI Groups 3 and 4; portions of Administrative Area IV associated with former RFI Group 5, Group 6, and Group 8; and a small unaffiliated portion of Boeing RFI Subarea 1B North (in Administrative Area I). Consequently, the Western Drainage channel has the potential for chemical impacts associated with migration of a variety of chemicals from various upgradient source areas via erosion and sediment mobilization along the drainage pathways. Due to the ephemeral nature of the drainages, sediment accumulated in the drainages is generally dry. No permanent surface water bodies exist in Subarea 10. Nearly all of Subarea 10 is unpaved and historically has been unpaved. The sediment thickness in the Subarea 10 drainages is typically about a few feet at most.	• VOCs • SVOCs • TPH • PCBs • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Dioxins and furans • Energetics • Pesticides and herbicides • Radionuclides
		Drainage Channels – Central Drainage (CUA 2)	Yes. A summary of releases, potential releases, and physical characteristics is provided below. During site reconnaissance activities performed in 2007 and 2008, a group of seven soil piles with intermixed debris were identified near the south-central Subarea 10 boundary, within an approximate 4,000-square-foot area adjacent to an unpaved access road (Debris Area 2006). Types of debris intermixed with the soil piles included concrete, metal, polyvinyl chloride pipes, wood, scrap metal, and plastic. The origin of the piles is not known. Some of the materials present appeared to be associated with roadway debris, possibly from the asphalt-paved access road to the water tanks. No soil staining was observed on or in the vicinity of the soil piles. Samples were collected from the soil piles for waste characterization purposes. The samples from two of the stockpiles contained metals above screening levels in use during the 2008 RFI. The soil stockpiles were removed from the site in 2008 as nonhazardous waste. After the soil piles were removed, a confirmation surface soil sample was collected beneath each of the two stockpiles; the samples contained metals above screening levels. Surface water runoff from Debris Area 2006 would flow to the north and eventually collect in the Central Drainage. The soil thickness at Debris Area 2006 ranges from 0.5 to 11 feet bgs.	• VOCs • SVOCs • TPH • PCBs • Metals (including hexavalent chromium) • Inorganics (including cyanide) • Dioxins and furans • Energetics • Pesticides and herbicides • Radionuclides
		Debris Area 2006 (CUA 3)	Potential CUA B was identified in the May 2013 Addendum to the Master RFI Data Gap Work Plan (CH2M, 2013) to evaluate the eastern sprayfield. Although the sprayfield is being evaluated as CUA 16, a small stretch of pipeline that extended from the STP-3 RFI site to the STL-IV Reclaimed Water Sprayfield on the eastern portion of EEL RFI site reporting area that was also part of Potential CUA B is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA B is located within EEL CC 1.	• VOCs • SVOCs • TPH • Metals (including hexavalent chromium)
		Subarea 10-Wide Surface Soil (CUA 4)	Yes. A summary of releases, potential releases, and physical characteristics is provided below. Numerous shallow or surface soil samples (up to 2 feet bgs) have been collected within the undeveloped land comprising Subarea 10—in most cases to evaluate background conditions for onsite studies—but also to assess potential air dispersion of contaminants from the onsite areas. For the 2008 Group 10 RFI, shallow soil sampling across the group area was performed on a grid to further assess whether impacts have occurred to Subarea 10 from potential historical air deposition of chemical constituents. The Subarea 10-Wide Surface Soil Investigation Area encompasses the entire area of Subarea 10.	• TPH • • PCBs • • Metals (including hexavalent chromium) • • Inorganics (including cyanide)

Table 6-1i – Subarea 10				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
		Subarea 10-Wide Surface Soil (CUA 4)	In 2014, a number of deeper samples were collected to delineate exceedances in surface soil samples. These deeper samples are included for characterization purposes in CUA 4. No permanent surface water bodies exist in Subarea 10. Groundwater beneath Subarea 10 is generally about more than 60 feet bgs. Surface water exists intermittently in ephemeral drainage channels as the result of seasonal precipitation events. Subarea 10 encompasses portions of three primary surface water drainage watersheds. Three NPDES outfalls exist in Subarea 10. Outfall 001 and Outfall 019 are located on the Central Drainage, whereas Outfall 002 is located on the Western Drainage. Several seeps and springs also exist within RFI Subarea 10. All of Subarea 10 is undeveloped and historically has been unpaved. Between 1999 and 2005, the road leading from Bell Canyon into Subarea 10 and terminating at the water tanks was paved. The soil thickness in Subarea 10 is typically on the order of a few feet at most. In many previous surface sampling locations there is only a thin veneer of soil on top of bedrock. Much of Subarea 10 is mountainous and difficult to access. There is no documentation of SSFL operations occurring within Subarea 10.	• Dioxins and furans • Energetics • Pesticides and herbicides • Radionuclides
	1	Potential CUA A	Potential CUA A was identified in the Addendum to the Master RFI Data Gap Work Plan for the STP‑3 RFI site (CH2M, 2013) to evaluate 250 feet of underground reclaimed water pipeline that traversed the STP‑3 RFI site (the pipeline ran from the STL-IV RFI site to the EEL RFI site). The pipeline is not being evaluated further as a CUA. However, the entire footprint of former Potential CUA A is located within STP‑3 CC 1.	• VOCs • SVOCs • TPH • PCBs and PCTs • Dioxins and furans • Pesticides and herbicides • Energetics and perchlorate • Metals (including hexavalent chromium) • Inorganics (including cyanide)
		Antenna Station (CUA 5; formerly Potential CUA H)	Yes. A summary of releases, potential releases, and physical characteristics is provided below. A radio frequency station currently exists in the southern portion of Subarea 10, on a small rocky plateau just south of two large domestic water tanks. Existing structures at the site include two radio frequency receivers and a small concrete pad containing equipment. Based on a review of historical aerial photographs, the existing radio frequency equipment was installed between 2003 and 2006. This location had been previously leased for a microwave receiver station by Adelphia (and its predecessors) from 1972 through 2003 for transmission of cable television signals. In 2002 and 2003, two property assessments were initiated by Boeing in response to requests from Adelphia to renew the lease. According to the 2003 Property Assessment Summary Report, previous equipment maintained by Adelphia at this location included a 25-foot by 25-foot perimeter fence, two pole-mounted satellite dishes, two pole-mounted television antennas, and a 10-foot by 10-foot metal shed on a concrete slab. Inside the shed were a microwave receiver, a power supply, an air compressor, an alarm box, a wall-mounted air conditioner, and a power amplifier (Boeing, 2003). During site investigations performed by Boeing environmental personnel in 2002 and 2003, no stains, discoloration, or storage of chemicals were observed. No indication of subsurface structures such as tanks, sumps, piping, etc. were observed. No transformers were observed. Chemicals potentially associated with former onsite equipment include petroleum hydrocarbons associated with the air compressor, Freon associated with the air conditioner, and PCBs associated with the power amplifier. There are no surface water bodies at the Antenna Station Investigation Area. The antenna station area is unpaved and historically was unpaved, with the exception of the concrete pad. The topography of the antenna station area is relatively flat, as the station is located on a plateau situated between two peaks. Surface water runoff from the antenna station area can flow in any direction to the west, north, or southeast. Soil thickness at the antenna station area is approximately 2.5 feet.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals
		Debris Area 1006 (Potential CUA A)	Yes. Potential CUA A was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate a crushed metal tank of unknown origin found in a drainage channel beneath some metal debris near the southwestern Subarea 10 boundary. The tank is not being evaluated further as a CUA.	• SVOCs • TPH • Metals

Table 6-1i – Subarea 10				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
		Crushed Steel Tank in Western Drainage (Potential CUA B)	Yes. Potential CUA B was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate an empty steel tank that had been placed on the ground surface on the bank of the Western Drainage in the northwestern portion of Subarea 10. The steel tank was located adjacent to the western drainage but was removed prior to 2008. The tank was initially investigated in 2008 as part of the Group 10 RFI. At that time it was thought to have been located within the Western Drainage channel, so characterization was accomplished using samples collected within the drainage channel. It was later clarified that the tank was found on the bank immediately south of the drainage channel, near historical sample location BCBS08. In 2013 a sample was collected at the former tank location, and another drainage sample was collected to assess potential impacts to the drainage. The tank is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals
		Debris Area 2026 (Potential CUA C)	Yes. Potential CUA C was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate Debris Area 2026 (a small area containing a soil pile with intermixed concrete and small, dark (possibly tar) surficial deposits) in the southern portion of Subarea 10. The debris area is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals • Dioxins and furnas
		Debris Area 2019 (Potential CUA D)	Yes. Potential CUA D was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate Debris Area 2019 (an area with two empty drums, metal pipe, scrap plastic, and broken concrete pipe pieces). The debris area was not accessible, precluding collection of samples at the debris location. Therefore, this feature was assessed by evaluating potential impacts in a minor ephemeral drainage leading away from the debris area. The debris was removed in 2010.The debris area is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals • Dioxins and furnas
		Northwestern Vegetation Clearance Area (Potential CUA E)	Yes. Potential CUA E was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate a vegetation clearance area in the northwestern part of Subarea 10 identified on the 1990 aerial photograph. The vegetation clearance area is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals
		Southwestern Soil Disturbance Area (Potential CUA F)	Yes. Potential CUA F was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate a soil disturbance area identified in the southwestern part of Subarea 10, identified on the 1967 aerial photograph. The soil disturbance area is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals
		DTSC/Public Interest Area (Potential CUA G)	Yes. Potential CUA G was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate a soil disturbance area identified in the east central part of Subarea 10, identified on aerial photographs by a member of the public in 2008 . The soil disturbance area is not being evaluated further as a CUA.	• VOCs • SVOCs • TPH • Metals
		Drainage Channels – Eastern Drainage (Potential CUA I)	Yes. Potential CUA I was identified in the August 2013 Addendum to the Master RFI Data Gap Work Plan for Subarea 10 (CH2M HILL, 2013a) to evaluate the eastern drainage channel for metals impacts. The eastern drainage channel is not being evaluated further as a CUA. The Subarea 10 eastern drainage receives drainage from a small area almost entirely within the southern buffer zone. It does not receive drainage from the SSFL operational areas. Because the eastern drainage channel does not receive surface water from SSFL operational areas, the eastern drainage channel is likely not a possible surface water migration pathway for onsite chemicals. However, metals exceeding SCLs in the Eastern Watershed may have been washed into the eastern drainage and accumulated in higher concentrations within the eastern drainage.	• Metals

Table 6-1i – Subarea 10				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions**	**Chemical Groups Analyzed**
		Debris Area 1005	Yes. A summary of releases, potential releases, and physical characteristics is provided below. During site reconnaissance activities performed in 2007 and 2008, an empty 55-gallon drum was found within the main central drainage channel in the central portion of Subarea 10 (Debris Area 1005). The lid and bottom of the drum were missing, and the drum appeared to have a white interior liner. No soil staining was observed at or in the vicinity of this area. The origin of the drum is not known. Surface water from Debris Area 1005 would flow to the south along the Central Drainage. The drum was located within a rock outcrop, where the soil thickness is approximately 0.5 foot. The drum was removed during the debris removal event in 2010. Debris Area 1005 is located within an ephemeral stream channel. There are no other surface water bodies near Debris Area 1005.	• VOCs • SVOCs • TPH • Metals • PCBs • Inorganics (including cyanide) • Dioxins and furans • Energetics • Pesticides
		Bricks	Yes. A summary of releases, potential releases, and physical characteristics is provided below. During an RFI site reconnaissance of the Subarea 10 Central Drainage in June 2008, 15 bricks were observed within an approximate 30-foot portion of the Central Drainage channel, south of Outfall 001. The bricks were lightweight with a pumice stone-type texture. Several of the bricks were lodged within boulders in the drainage channel. The source of bricks is unknown. However, based on the light weight and observed distribution of the bricks within the drainage channel, the bricks potentially could have been transported from a point upstream via stormwater flow. The bricks were collected and containerized for offsite disposal. For waste profiling purposes, a sample of one of the bricks was sent to an offsite laboratory for analysis of metals. Based on the laboratory analysis, the bricks were disposed at an appropriate offsite landfill as nonhazardous waste. The soil thickness near the bricks is approximately 0.5 foot.	• Metals
		Previous VOC Detection Area	Yes. A summary of releases, potential releases, and physical characteristics is provided below. VOCs have been detected in an area near the northern boundary of Subarea 10. No documented uses of VOC-containing chemicals have occurred in that area. There are no surface water bodies in the Previous VOC Detection Area. All of the Previous VOC Detection Area is unpaved and historically has been unpaved. The topography of the Previous VOC Detection Area is relatively flat. Surface water runoff from the Previous VOC Detection Area would flow to the south and collect in the Western Drainage. The soil thickness in the Previous VOC Detection Area is greater than 16 feet.	• VOCs • SVOCs • TPH • Metals • Inorganics (including cyanides)

Table 6-1j – Subarea SRE

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	Chemical Groups Analyzed
SRE	SRE-1	1, 3a, 3c, 4, 5, 8	**CUA 1: Toluene Process Unit and Tetralin Heat Exchanger** Facility drawings indicate these features were present from 1957 to 1973. **CUA 3a: SCE Steam Power Plant, Steam Generation Area** Supported SRE operations from 1957 – 1964 and included a steam generator building (B4185) and pad (Area 684), turbo generator, fire pump house (B4183), storage yard (Area 505), outdoor work area/shop (Area 714), and transformer area. An aboveground water tank and aboveground pipelines connected the power plant with B4143. Two small areas were excavated (totaling approximately 390 cubic yards) to remove soils with elevated levels of cesium-137 to the north and west of B4143. **CUA 3c: SCE Steam Power Plant, Mercury Release Area** Liquid mercury was reportedly released from a pipeline to the steam generator cut by a welding torch during post-closure SRE demolition activities unrelated to typical site operations (Rockwell, 1983; Lenox, 2000). In 2006, based on metals results which indicated mercury impacts were present in soils in the general area, a geomembrane was implemented as a best management practice (BMP) to prevent erosion and migration of mercury-impacted soils from the former SCE Power Plant Area. **CUA 4: UT-27** 1,000-gallon steel fuel tank located adjacent to southeast side of B4143 (SRE), which supplied diesel fuel for an emergency back-up generator. This tank was removed August 8, 1988 under Ventura County Environmental Health Division (VCEHD) oversight. **CUA 5: UT-71** 1,500-gallon steel gasoline fuel tank located adjacent to the east side of B4183 (Fire Pump House), which supplied fuel for the pumps. This tank was removed under VCEHD oversight on December 8, 1998. **CUA 8: Transformer Area 683** One concrete pad-mounted transformer adjacent to the east side of B4143. **Additional Features:** • **B4653 and SRE Radioactive (R/A) Waste Holdup Tanks** – The B4653 facility and associated tanks served as a radioactive gas and liquid waste holdup and decay system for wastes generated by activities at the SRE. It was located on the hill slope north of B4143 and included several concrete vaults that housed compressors and associated piping for four underground gas and two liquid waste holdup tanks buried on the hillside. Two auxiliary vaults also held ten 50-gallon holdup tanks. On November 14, 1977 one of two 500-gallon radioactive liquid waste transfer tanks was overfilled, resulting in approximately 25 gallons of water being released to the surrounding asphalt area. Absorbent material was placed over the spill and plastic and plywood was placed to help contain the release; records do not indicate whether potentially contaminated soil in the area was removed. The area was decontaminated during 1978 and included removal of all buried tanks, associated piping, and contaminated soil. The area was backfilled following these removals. • **B4143 SRE Reactor Vault** – The Sodium Reactor Building 4143 housed a high-temperature, sodium-cooled, graphite-moderated nuclear reactor which was in operation from 1957 through 1964. This facility provided power to the SCE Steam Power Plant located east of B4143 (CUA 3a). The reactor vault extended approximately 35 feet below ground surface. Chemicals known or potentially used in support of SRE operations included toluene, transformer oils (PCBs), diesel fuel, gasoline, kerosene, mercury, metallic sodium, irradiated beryllium, alcohols, tetralin, Freon-113, TCE, terphenyls, Dowanol™, and asbestos. B4143 was decommissioned and decontaminated between 1974 and 1983. Radiological surveys performed during this period also identified areas of residual contamination of soil and pond sediments, which were removed. Buildings and subsurface features, including the reactor vault, were removed and excavations were backfilled with clean soil and concrete rubble from demolition activities, or purchased from an offsite land development project. Structures associated with the SRE were removed as of 1983, although some building support structures were left embedded in bedrock east of B4143. **Cleared Vegetation Areas** – Areas of cleared vegetation were identified in the USEPA Historical Site Assessment (HSA) along the roadway leading to former B4686 and along the slope north and northwest of B4143 where B4653 and the former waste holdup tanks were located (MWH, 2012).	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Radionuclides

Table 6-1j – Subarea SRE

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	Chemical Groups Analyzed
SRE	SRE-2	3b, 7, 12, 13, 14, 15	**CUA 3b: SCE Steam Power Plant, Cooling Tower** The cooling tower was used to support power plant activities. Documented chemical use includes tri-butyl-tin and asbestos, and although specific algaecides or biocides that may have been used at the cooling towers is not documented, screening for metals, hexavalent chromium, anions (bromides and sulfates), glycols, Dowanol™ was conducted. Additionally hydrazine may have been used as an oxygen scavenger at the cooling tower, so formaldehyde (a breakdown product of hydrazine) was also included in screening sampling. **CUA 7: B4003 Leach Field** B4003 was initially connected to a sanitary leach field measures 600 linear feet with a 2,700-gallon septic tank. The leach field was in use up to 1961 when these features were discontinued and replaced by the existing sanitary sewer system. The septic tank and leach piping were removed in September 2000. For more information regarding B4003, see discussion below for "B4003 Hot Cave". **CUA 12: SRE Pond Influent Channels** Two concrete-lined channels, with one channel capturing runoff from the former SRE and SCE Stream Power Plant operational area (CUA Cluster SRE-1) and the second capturing runoff from former B4003 area (CUA Cluster SRE-2), that join further downstream of these respective areas and connects with the western end of SRE Pond. The channels are currently in place. **CUA 13: Former Industrial Dry Well** A septic sewer system received sanitary waste from B4143 and B4003 (see discussion above for CUA 7 - B4003 Leach Field). An industrial waste system paralleled this sewer system and terminated in a dry well adjacent to the leach field. Any overflow from the dry well was into the adjacent concrete channel leading to the sump and pond (CUA 12 - SRE Pond Influent Channels). Bedrock is shallow (less than 5 feet) in the area, so it is presumed the dry well was cased into Chatsworth formation bedrock. Cooling water biocides/algaecides may have been transported by the dry well (Rockwell, 1977). **CUA 14: SRE Pond** The SRE Pond was constructed in 1957 to capture waste water runoff from the SRE area. The pond is located along a natural drainage downslope of SRE operations and an earthen dam was constructed at the eastern end (Structure 773) equipped with a drainage control valve. In 1958, a 1.5-foot diameter valve-controlled outlet pipe was added and in 1959, a pump was added to transfer runoff from the SRE Pond to a drainage in the OCY RFI Site approximately 800 feet to the east; runoff eventually flows into Silvernale Reservoir. **CUA 15: SRE Pond Discharge Pipeline** A 4-inch diameter pipeline installed to divert SRE Pond water away from the SRE Pond and downstream drainage (see discussion above for CUA 14). Most of this pipeline was removed in 2002 during adjacent OCY RFI Site demolition activities.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Asbestos • Organic Tin • Radionuclides

Table 6-1j – Subarea SRE

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	Chemical Groups Analyzed
SRE	SRE-3	2, 6, 9, 10, 11, 12	**CUA 2: Sodium Components Cleaning Area** B4724 was a 10 feet x 22 feet x 12 feet high steel enclosure in which radioactive sodium components from SRE operations were cleaned in a hot oil bath, a concrete pit containing an oil heater and oil supply tank, and a concrete sump designed to hold effluent. Area 4723 was a 25 feet x 28 feet concrete pad on which sodium components were steam cleaned. B4688 was an auxiliary skid shack. Chemicals known or potentially used at this area include lubricant oils, alcohols, and solvents. These structures were in use between the 1960s and 1970s and were removed as of 1995. **CUA 6: UT-74** 1,500-gallon steel tank adjacent to the northeast corner of B4003, which supplied diesel fuel for an emergency back-up generator. This tank was removed March 28, 2001 under VCEHD oversight. **CUA 9: Transformer Area 693** A 40 feet x 10 feet pad that included two power poles with six transformers. Identified as Substation #1 on facility drawings. All features have been removed. **CUA 10: Transformer Area South of B4003** Three pad-mounted transformers. All features have been removed. **CUA 11: Oil Stain at B4003** Oil staining was observed on dirt surface at B4003 after demolition, during a DTSC site walk, but was not observed in historical aerial photos (USEPA, 1997). **CUA 12: SRE Pond Influent Channels** The inlet of one of two concrete-lined influent channels that drain into SRE Pond (see discussion above for CUA 12 at CUA Cluster SRE-2). **Additional Features:** • **B4003 Hot Cave** – B4003, also known as the Engineering Test Building, was used to assemble fuel elements for the SRE from 1957 through 1964. The building contained a Hot Cave, which was divided between and east and west set of cells, and other radioactive material handling equipment. It was also used for analysis of Systems for Nuclear Auxiliary Power (SNAP) fuel burn-up samples and evaluation of irradiation experiments up through 1973. Chemicals known or potentially used include lithium, sodium, solvents, petroleum products, and energetics. Initial decontamination activities were undertaken in 1975 and all materials and equipment associated with the Hot Cave were dismantled and removed. After the contents of the Hot Cave were removed, the floor was excavated to a depth of 35 feet bgs to create a mock-up construction of the SRE; a 31-foot deep tank representing the SRE core cavity and liner was used to simulate water shielding activities anticipated for dismantling of the SRE. Following this, the building was used as a non-radioactive storage area, and additional surveys and removal activities were undertaken to remove residual contamination. The structure was demolished in 1999. • **Debris area MWH-G06-2032.** The western portion of this debris area is located within CUA Cluster SRE-3; the eastern portion extends approximately 200 feet east along the northern border of E Street. This debris area consisted of a disturbed soil area (soil piles) with asphalt road debris, measuring approximately 21,000 square feet. In November 2009, debris south of the bedrock area was removed, including transite pipe. The soil piles, debris north of the bedrock outcrop, and two telephone poles cut at the ground surface were left in place. • **SRE Laundry Facility.** B4273 and B4283 were the protective clothing storage and radioactive laundry facilities where protective clothing worn at the operational facilities at the SRE RFI Site was cleaned and decontaminated. Other facilities in the area included a maintenance skid shack (B4316), an electronics shop and maintenance service building (B4063), and a substation (B4763).	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Radionuclides

Note:

[1] Information for this table is summarized from previous RFI reports, USEPA historical site assessments, and DOE data gap SAPs. USEPA and DOE have not specified 'chemical use area (CUA)' designations for some operational areas associated with this evaluation area; however, those operations and associated chemical uses are included above within the site CUA cluster.

Table 6-1k – Subarea Northeast

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	• Chemical Groups Analyzed
NCY	NCY-1	1, 2, OCY CUA 3	**CUA 1: New Conservation Yard (SWMU 7.8)** The NCY salvage yard was a 0.3-acre fenced-in yard that was used between approximately 1977 and the 1990s for temporary storage of equipment and salvageable non-radioactive materials from construction, refurbishing, and dismantling activities at various Area IV facilities. **CUA 2: B4040 Ash Pile** B4040 was constructed in 1960 and was used as initially used as a protective services control center building, and was later used for office supply storage. Adjacent to this building was Structure 624, a fire truck canopy. An ash pile was identified northwest of this building. The source was believed to be an incinerator located near the northwest corner of B4040, which was used to burn documents and photographs according to standard practices at the time. **OCY CUA 3: Fuel Pipeline** A pipeline originating in the OCY RFI Site traverses the west portion of the site, and may have carried petroleum.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols Radionuclides
SED	SED-1	1	**CUA 1:** The Southeast Drum Storage Yard was used to store approximately 50 to 100 drums with unknown contents in the early 1960s. The drums were used in forklift exercises. All of the drums have been removed from this area. In addition, a soil disturbance area that has been present intermittently between 1965 and the mid-1990s is located southeast of the Southeast Drum Storage Yard.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Radionuclides
Unaffiliated Area	Unaffiliated Area-1	N/A	N/A	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins /Furans • Energetics and Perchlorate • Herbicides and Pesticides • Radionuclides

Note:

[1] Information for this table is summarized from previous RFI reports, USEPA historical site assessments, and DOE data gap SAPs. USEPA and DOE have not specified 'chemical use area (CUA)' designations for some operational areas associated with this evaluation area; however, those operations and associated chemical uses are included above within the site CUA cluster.

Table 6-1l – Subarea Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	• Chemical Groups Analyzed
PDU	PDU-1	1, 7, 11, 13, 17, 21, 22, 23, BLF 6, BLF 11, BLF 12, OCY1d, HMSA 10	**CUA 1:** B4005 (SWMU 7.10) was built in 1958 to test coolants for organic moderated reactors, and operated until the 1980s. In the mid-1960s to 1967 the facility was used to make enriched uranium carbide fuel for the Heavy Water Organic Cooled Reactor. B4005 was decontaminated, and from 1972 through 1986, the building was operated as the Molten Salt Test Facility, a molten salt combustion pilot plant. B4005 was subdivided into a large high-bay area and portions that served as offices, control rooms, chemistry laboratories, and storage rooms. In addition to the B4005 structure, there were several concrete pads on the east side of the building that held equipment supporting the coal gasification PDU at adjacent CUA 7 and radioactive filter plenums. A sump was located at the southeast corner of the building, and a 1993 radiological survey identified it as a cooling tower sump. Two radioactive liquid holding tanks were located approximately 60 feet northeast of B4005, and connected to the labs and work areas within the building by underground drain lines. A low NOx-SOx burner was operated on the north side of B4005; test runs that investigated the burning of high-sulfur coal were conducted intermittently between 1982 and 1988 (HydroGeoLogic, 2012). In 1991, plant equipment was removed from B4005, and by 1993, the building was decontaminated, which included the removal of the radioactive waste tank, filter plenums, and exhaust ducting. (HydroGeoLogic, 2012). The upper structures of B4005 were demolished in 1997 (Rocketdyne, 1998). **CUA 7:** The former Coal Gasification PDU Area operated from 1977 through 1981, and used for experiments to convert low-BTU, low-sulfur coals to gas. The process created "green liquor" wastewater containing organics, sulfur and ash. **CUA 11:** B4402 was a small building adjacent to B4816 in the central part of the site. The structure was built prior to 1967, and used for sodium testing and solvent storage. B4402 housed a solvent fume hood and a solvent rack. **CUA 13:** B4616 was the cooling tower for B4006, which was located approximately 60 feet to the north. **CUA 17:** Transformer Substation 4706 served B4006, and was located approximately 25 feet southwest of B4006 in the central part of the site. **CUA 21:** The B4005/B4006 Leach Field received sanitary waste from B4005 and B4006, and operated from 1958 to 1961 when it was abandoned with the installation of the SSFL sitewide sanitary sewer system. Laboratories and work areas in B4005 also drained to the system. The leach field consisted of 480 linear feet of leach lines, and connected to two 2,340-gallon septic tanks. The leach field was removed in 2001. **CUA 22:** The Bag House was located approximately 85 feet northwest of B4005, and was a part of the Molten Salt Facility. **CUA 23:** CUA 23 was a catchment basin north of B4005 that was used as a part of the Molten Salt Facility. **BLF CUA 6:** AST 4735 was an 86,000 gallon tank that stored fuel oil. The tank was operational between 1977 to 1999. The pipeline that supplied this former tank is identified as OCY CUA 1d. **BLF CUA 11:** Sodium Component Test Installation (SCTI) Pump Station was located northwest of B4011 and supported operations in the Hazardous Materials Storage Area (HMSA) RFI Site. Chemical use at the pump station was petroleum fuel. **BLF CUA 12:** Parking Lot 4502 was located northwest of B4011. Coal drying was conducted at the parking lot. **HMSA CUA 10:** B4358 was initially used for chemical storage in support of the Small Component Test Loop area, and then in support of SCTI. The building was relocated south to its location on the border of PDU, northeast of the leach field, in 1978. In 1997, the building was used to store SSME stability bombs, ignitors, ammonium, magnesium, potassium perchlorate, and 55-gallon drums of lube oil. B4358 was removed in 2003. **OCY CUA 1d:** A pipeline extended from the Old Conservation Yard (OCY) RFI Site in Area 6, continued along F Street, and terminated at AST T-735 (BLF CUA 6) located in the south part of the PDU site. The pipeline transported petroleum fuel.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Organic tin • Radionuclides
BLF	BLF-1	1, 2, 3, 4, 5, 7, 8, 9, OCY 1d	**CUA 1: B4011** B4011 was constructed in 1958 and used for aerospace assembly and component manufacturing, administrative offices, as a machine shop, and as an x-ray development laboratory in support of various non-nuclear programs until 1984. From 1984 through 1996, portions of B4011 were used for non-nuclear programs support, and storage of communications equipment. The Low Bay in the northern portion of B4011 was used as a calibration laboratory for radiation instrumentation and as an equipment maintenance area in support of nuclear programs. The Low Bay portion of B4011 was released for unrestricted use by the California Department of Health in 1998 (Sapere, 2005). Between 2008 and 2011, B4011 was used to store	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans

Table 6-1l – Subarea Central

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	• Chemical Groups Analyzed
BLF	BLF-1	1, 2, 3, 4, 5, 7, 8, 9, OCY 1d	hazardous waste in support of environmental investigations. Documentation indicates that B4011 also housed a propane tank (AT-05) and a fuel-oil tank (AT-06). Sanitary facilities at B4011 were connected to a 2,340-gallon septic tank on the southwest side of the building (see CUA 9), and, after 1961, to the central sewer system. The southern portion of B4011 (the High Bay) was demolished in 2013. The northern portion of B4011 (the Low Bay) was prepared for demolition by the abatement of lead and asbestos in 2012, but the structure is still in place. **CUA 2: B4008 (Area of Concern) and B4007** B4007 and B4008 were constructed in 1958. B4008 was the Electric Laser Lab, and included a machine shop, a laboratory area, and an office area. Transformer 4XXX was also located at B4008 (location not specified). B4007 was used to store chemicals and flammable material. Chemicals stored and used at the buildings include lithium hydride, sodium hydride, denatured alcohol, salts, limestone, cement, amerzine, morpholine, hydrazine, flake caustic, acetone, sodium nitrite, and oils and lubricants. B4007 and B4008 were demolished in 1996. **CUA 3: Transformer 4711** Transformer 4711 was an electrical substation was located west of B4011. **CUA 4: B4611** B4611 was the spray paint room adjacent to the southwest corner of B4011. **CUA 5: B4171** B4171 was the used for electronic equipment storage. **CUA 7: UT-06** UT-06 was a 1000-gallon UST that stored fuel oil and diesel. The tank was adjacent to the northwest corner of B4011, and was removed in 1988. **CUA 8: B4011 Leach Field (Area of Concern)** The B4011 Leach Field was located approximately 120 feet south of B4011, and received sanitary waste from the septic tank on the west side of the building. The leach field consisted of 200 linear feet of 8-inch diameter clay pipes surrounded by gravel, and buried at depths of 2 to 7 feet bgs. The leach field was in use until 1961, and removed in 2000. **CUA 9: B4172** B4172 was the X-ray room and storage for sealed radiological sources. **OCY CUA 1d: Fuel Pipeline** A pipeline extended from the Old Conservation Yard (OCY) RFI Site in Area 6, continued along F Street, and terminated at AST T-735 (BLF CUA 6) located in the PDU groundwater evaluation area. The pipeline transported petroleum fuel. **Additional Feature:** A potential storage and stained soil area west of B4011 (OS-15) was identified in aerial photographs from 1962 to 1967.	• Energetics and Perchlorate • Herbicide and Pesticides • Terphenyls • Alcohol and Glycols • Radionuclides
EEL	EEL-1	1, 5, 6, 7, 15, 16	**CUA 1: B3271 Cryogenic Test Cells** The EEL Cryogenic Test Cells (B3271) were identified as SWMU 6.9 in the RFA (SAIC, 1994). The building was used for testing the properties of various materials, including carbon and stainless steel under high-pressure hydrogen conditions. The Test Cells were operated from 1968 through 2008. Metal cooling towers, 1-ton and 20-ton capacity, where KP-1 was used, were located near or at B3271. **CUA 5: ASTs** CUA 5 encompasses the various tanks in the EEL-AIV groundwater evaluation area. These tanks are documented as small ASTs primarily used to store hydraulic oil for the vacuum pumps and several hydrogen and helium gas tanks in support of operations at B3271. **CUA 6: Transformer Pad** A transformer pad (4XXX) located north of B3271. **CUA 7: Hazardous Materials Storage Pad** Hazardous materials were stored in drums on a concrete pad east of the cryogenic laboratory.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Radionuclides

Table 6-1l – Subarea Central				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions [1]**	**• Chemical Groups Analyzed**
EEL	EEL-1	1, 5, 6, 7, 15, 16	**CUA 15: Western STL-IV Reclaimed Water Sprayfield** A sprayfield located in western portion of the EEL RFI Site received reclaimed water from STL-IV RFI Site Impoundment 2. The sprayfield extends south into the Area III portion of the EEL RFI Site. **CUA 16: Eastern STL-IV Reclaimed Water Sprayfield** The sprayfield located in eastern portion of the EEL RFI Site received reclaimed water from the STL-IV RFI Site Impoundment 2. The sprayfield extends south into the Area III portion of the EEL RFI Site. **Additional Features** • **Storage/debris area north of B3271.** A debris area, described as a segment of pipeline, was identified in the northern portion of the EEL-AIV evaluation area north of B3271. DOE sample 5B_DG-826 targets this feature, and the Subarea 5B Phase 3 SAP (CDM Smith, 2012) refers to it as a storage area identified in aerial photographs. Potential fill area FA-11. A potential fill area extending over the south portion of the BLF RFI Site and the western portion of the EEL RFI Site was identified in aerial photographs from 1980 and 1983 (HydroGeoLogic, 2012). The area was described as vegetated, with mounded materials. Additionally, a potential underground anomaly was detected along the west edge of FA-11, in the undeveloped area between the two drainages.	

Note:

[1] Information for this table is summarized from previous RFI reports, USEPA historical site assessments, and DOE data gap SAPs. USEPA and DOE have not specified 'chemical use area (CUA)' designations for some operational areas associated with this evaluation area; however, those operations and associated chemical uses are included above within the site CUA cluster.

Table 6-1m – Area IV, Subarea Southwest

RFI Site	CUA Cluster	CUAs	CUA Descriptions [1]	Chemical Groups Analyzed
PD	PD-1	1	**CUA 1: Pond Dredge Area** The site was possibly used for disposal of dredge materials from Silvernale Reservoir and R-2 Ponds during the 1960s, although documentation of this practice is not available in historical records. In addition to dredge materials, drill cuttings and construction debris were also likely disposed at the site; during the 2008 RFI investigation concrete, asphalt, and metal debris was found corresponding to known hummocky areas. A dirt road borders the southern portion of the site and several dirt roads have been present crossing through and surrounding the site since the 1960s. No permanent structures have been present within the boundary of this site and a water pipeline runs through the eastern portion of the site. Historical documents also indicate that the site may contain a spent-uranium slug dropped from a helicopter during a test that was not recovered during the 1960s, and that there was a release of 1,500 gallons of Nu-Vertan (EDTA) from a tanker truck disposing the material in the field south of the Building 4020 parking lot, which occurred in 1982. **Additional Features** **EPA Geophysical Survey** – Geophysical surveying was performed at the Pond Dredge RFI Site to identify buried material and other potential subsurface features of interest. Several terrain conductivity, magnetometer, and fill areas were identified during the survey, and included features such as mounded soil with buried metal and non-metal debris, soil disturbance areas, and one area east of the water pipeline where a debris field and fill area was identified. Sampling was performed at these features during data gap sampling conducted in 2013/2014.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohols and Glycols • Radionuclides
ESADA	ESADA-1	1, 2a, 2b, 3, 4, 5, 6a, 7a, B009 6, B009 7b	**CUA 1:** The ESADA Former Storage Yard was a 0.6 acre, mostly unpaved area, divided horizontally by an asphalt road. In the 1970s, the area was used for storage of over 500 drums containing Dowanol™ glycol ethers and denatured ethanol; approximately 120 of these drums contained used Dowanol PM (propylene glycol methyl ether) "nearly saturated with sodium." Drums were removed in 1983. **CUAs 2a and 2b:** The ESADA Sodium Testing Area (CUA 2a) was used from 1964 to 1968 to study sodium-water reaction rates on a MSG mockup. The procedure consisted of admitting heated sodium and high-pressure water and steam into "test sections" (8 inch diameter schedule 304 stainless steel pipe) through mechanically punctured rupture discs. The test facility at B4814 consisted of a LLID; a 2 foot x 2 foot steam supply boiler (Tank B-1); a high-pressure water supply tank (T-2); a 220-gallon sodium storage tank (T-4); and a 6 foot x 14.5 foot reaction products relief tank (T-5). LLID electronic control panels and circuit breakers were located at B4514, east of the sodium test area. Sodium test control, observation, and recording were conducted at B4314, east of B4814. Underground piping (CUA 2b) connected B4814 to the western side of the FSDF Concrete Pool; specific materials transferred via this piping were not documented. **CUA 3:** The PDU AST area consisted of two horizontal tanks approximately 50 feet north of the Storage Yard. One tank was an 8,000-gallon stainless steel AST used at the PDU RFI Site to hold coal gasification process wastewater containing sulfur, ash, and organic compounds. The contents and size of the second tank are unknown. **CUA 4:** From 1966 to 1973, the ESADA Pistol Range area was used for testing of ZrH_2 fuel. Testing was conducted at the isotope impact system test device at B4820, while controls were housed at B4730. From 1980 to 1995, the area was used as a practice shooting range for security personnel. B4317 and B4318 were used as firing shelters. Targets, located at the southern end of the range, were backed by earthen berms to capture lead shot. **CUA 5:** Three transformers were mounted on Transformer Pole X-35, northwest of the former ESADA Pistol Range. The transformers and pole have been removed. **CUA 6a:** Debris Area MWH-G8-2048 comprised an approximately 5,500 square foot hummocky area with soil piles, metals, PVC, and asphalt. This debris area has been removed. **CUA 7a:** An extensive road grid pattern was observed near the ESADA RFI Site in a 1965 aerial photograph. The grid pattern appears to have been developed on level areas near ESADA, then extended south to the hillside. The purpose of this grid pattern is unknown and not documented in facility records. The ESADA evaluation area includes a small portion of the grid pattern area east of the operational area. The grid pattern extends northeast to the B009 RFI Site and south to the Area IV Southern Undeveloped Land.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Terphenyls • Alcohols and Glycols • Radionuclides

Table 6-1m – Area IV, Subarea Southwest				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions [1]**	**Chemical Groups Analyzed**
ESADA	ESADA-1	1, 2a, 2b, 3, 4, 5, 6a, 7a, B009 6, B009 7b	**B009 CUA 6:** The Solar Concentrator soil disturbance area was identified in historical photographs from the mid- to late-1970s and 1988. This feature was previously evaluated with the B009 RFI Site; the portion within the ESADA evaluation area consists of an arcuate soil escarpment that is still evident. The history and purpose of this escarpment are not documented in facility records. The escarpment is a potential low point and surface water collection area. **B009 CUA 7b:** Debris Area MWH-G8-2043 comprised an approximately 18,000 square foot soil pile area, some containing metal, concrete, and asphalt debris. Soil piles remain in place. This feature was previously evaluated with the B009 RFI Site; the ESADA evaluation area includes a portion of the debris area east of the operational area. The debris area extends north and east to the B009 RFI Site.	
SUL	SUL-1	6b, 6c, 6d, 7a, 7b	**CUA 6b:** Debris Area MWH-G08-2047 comprised stockpiled soil with metal debris. This debris area has been removed. **CUA 6c:** Debris Area MWH-G08-2046 comprised an approximately 710 square foot disturbed soil and stockpile area with metal debris. The metal debris has been removed; the soil remains in place. **CUA 6d:** Debris Area MWH-G08-2045 comprised an approximately 2,300 square foot disturbed soil area with small soil stockpiles and metal debris. The debris area remains in place. **CUA 7a:** An extensive road grid pattern was observed near the ESADA RFI Site in a 1965 aerial photograph. The grid pattern appears to have been developed on level areas near ESADA, then extended south to the hillside. The purpose of this grid pattern is unknown and not documented in facility records. The AIV SUL includes a small portion of the grid pattern area south of the Solar Concentrator Facility (B009 RFI Site), and the majority of the grid pattern on the hillside south of ESADA. The grid pattern extends north to the ESADA and B009 RFI Sites. **CUA 7b:** An approximate 300 by 100 foot vegetation clearance and disturbed soil area was noted on a hilltop south of ESADA in aerial photos. No operations are documented in this area, nor was debris observed in the 2008 debris survey. Significant mineralization has also been noted in this area. **Additional Features** • **Tanks 701 and 702**. Two water ASTs located on a hilltop in the southwestern corner of Area IV. The tank sizes are not documented; both tanks were removed in 2013.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohols and Glycols • Radionuclides
SUL	SUL-1	6b, 6c, 6d, 7a, 7b	• **B4865 (also known as B4173).** A sodium storage pad, and later converted into the Gammagraph X-Ray Building. Based on aerial photographs, the building was present from the late-1950s to the mid-1990s. The building was identified as housing a 30 curie Ir-192 radiological source, and in 1978 a source projector containing 90 curies of Co-60 was dropped and damaged. • **STL-IV Spray Field**. Spray fields which discharged excess operational wastewater from STL-IV Impoundment 2. This wastewater may have contained oils, alcohols, hydrazine-related compounds, metals, and petroleum fuels. Also within the spray field footprint was a potential storage/stockpile area identified in a 1988 aerial photo. **Area IV Soil Borrow Area**. A large soil disturbance and soil borrow source located south of the Pond Dredge and DOE Leach Field 3 RFI Sites. This disturbed area was visible in aerial photographs from the early-1950s to the early-2000s. Soil sampling was conducted throughout the borrow area in 1999, and DTSC approved the use of soils for onsite backfill locations in 2000. The area was a source of backfill materials for excavations across the SSFL.	

Table 6-1m – Area IV, Subarea Southwest				
RFI Site	**CUA Cluster**	**CUAs**	**CUA Descriptions [1]**	**Chemical Groups Analyzed**
None	B4100-1	2, 4 (western half), 6, B009 4a	**CUA 2:** Building 4100 (also known as the Advanced Epithermal Thorium Reactor [AETR] and Fast Critical Experiment Laboratory [FCEL]) was used to test 20 different reactor core configurations between 1960 and 1974, using thorium, uranium, and high-energy neutron fuels. Decommissioning and decontamination processes began in 1974, and the building was released for unrestricted use in 1980 by USNRC. After 1980, the B4100 High Bay was used for sodium suppression experiments and as a high-energy, computer-aided tomography facility. The B4100 Lab was used for radioactive sample counting and instrument calibration. In 2013, the CDPH released B4100 for unrestricted use. **CUA 4:** The Building 100 Leach Field, located approximately 30 feet east of B4100, received sanitary waste discharge from B4100. The exact usage period of this leach field was not available in reviewed documentation, but it is believed to have been in place from the beginning of B4100 operations (1960) and became inactive with the installation of the SSFL Sitewide Sanitary Sewer System (early 1960s). The leach field was removed in 2001. Only the western half of the distribution line from B4100 to the Building 100 Leach Field is within the B4100 Area. **CUA 6:** Transformer Substation 710 (also known as Transformer Substation 800) was installed in 1962. The substation powers B4100, and is currently in place and active. **B009 CUA 4a:** Transformer Substation 709 consisted of two transformers and concrete pads approximately 50 feet east of Building 4009. One transformer and pad have been removed; the other transformer powers Building 4009, and is currently in place and active.	• VOCs • SVOCs • TPH • PCBs and PCTs • Metals and Inorganics • Dioxins/Furans • Energetics and Perchlorate • Herbicides and Pesticides • Terphenyls • Alcohol and Glycols • Radionuclides

Note:

[1] Information for this table is summarized from previous RFI reports, USEPA historical site assessments, and DOE data gap SAPs. USEPA and DOE have not specified 'chemical use area (CUA)' designations for some operational areas associated with this evaluation area; however, those operations and associated chemical uses are included above within the site CUA cluster.

Table 6-2
Vadose Zone and Groundwater Study Questions from Comprehensive DQO Report
Boeing Areas of Responsibility in Areas I, III and IV

	Vadose Zone	Groundwater
Problem Statement	Chemicals identified in the vadose zone within CUAs or CUA clusters and above down-gradient groundwater plumes may represent unacceptable current or future risk to groundwater, human health or ecological receptors at SSFL.	Chemicals identified in groundwater beneath plumes beneath and/or down gradient of CUA clusters may represent unacceptable current or future risk to human health or ecological receptors at SSFL.
Study Question 1	Are all potential sources and chemicals identified in vadose zone soil, rock or soil vapor within CUAs?	Are all potential sources and chemicals identified in groundwater?
Study Question 2	Are the nature and extent of chemical distributions in vadose zone soil, rock and soil vapor characterized to required characterization levels, or are data adequate to recommend the CUA cluster or a portion of the CUA cluster for CMS?	Are the nature and extent of chemical distributions characterized to required characterization levels in groundwater, or are data adequate to recommend the CUA cluster or a portion of the CUA cluster for CMS?
Study Question 3	Are data adequate to evaluate the fate and transport of chemicals in the vadose zone, or are data adequate to recommend the CUA cluster or a portion of the CUA cluster for CMS?	Are data adequate to evaluate the fate and transport of chemicals in groundwater to the vadose zone and migration of chemicals to seeps and off-site wells, or are data adequate to recommend the CUA cluster or a portion of the CUA cluster for CMS?
Study Question 4	Do concentrations of chemicals in the vadose zone within CUA clusters and/or above down-gradient groundwater plumes exceed action levels?	Do concentrations of chemicals in groundwater exceed action levels and/or do concentrations of chemicals present significant risk to current or future receptors (indoor air, seeps or off-site wells)?
Study Question 5	Are existing data sufficient to perform remedial planning in vadose zone soils and/or soil vapor that exceed action levels?	Are existing data sufficient to perform remedial planning of groundwater with chemical concentrations above action levels?

Table 6-3
Vadose Zone Bedrock Sample Identifiers
Boeing Areas I and III, Santa Susana Field Laboratory

Subarea	RFI Site	Rock Core Locations with Vadose Zone Sampling Results	Chemical Use Area Cluster #
1A North	B-1	C-9 (RD-84)	1
	IEL	RD-35B	3
		C-1	6
1A Central	Bldg 1359	RD-77 (ClO_4)	4
	APTF	RD-109, C-19	1
1A South	LETF/CTL-I	C-3	6
		PZ-8	1
		PZ-12	7
	Canyon	C-2, PZ-16	1
	HV South	RD-76 (ClO_4)	8
1B North	Bowl	C-4	1
1B Southeast	CTL-III	RD-46B	2
1B Southwest	CTL-V	RD-99	1
	AI Burn Pit	RD-100	1
	ECL	PZ-6	2
	Compound A	PZ-13, PZ-14	4
		PZ-18	1
	STL-IV	PZ-15	1
Area IV	SRE	RD-102	2

Table 6-4
Basis for Bedrock CMS Area Selection
Boeing SSFL Groundwater RFI

RFI Site	Bedrock CMS Area Identifier	Basis for selection			
		Vadose zone porewater at concentrations above characterization level	Soil or soil vapor sample results at concentrations 10x or 1x of comparison values for volatile organics or perchlorate, respectively	Interim measure or other excavation area	Operational feature(s)
B-1	B1-BRCMS-V1	x	x		x
	B1-BRCMS-V2		x		x
	B1-BRCMS-V3		x		
IEL	IEL-BRCMS-V1	x			
	IEL-BRCMS-V2	x	x		x
B359	B359-BRCMS-P1	x	x	x	x
	B359-BRCMS-P2		x		
HVN	HVN-BRCMS-P1		x		x
	HVN-BRCMS-P2		x		x
	HVN-BRCMS-P3		x		
	HVN-BRCMS-P4		x		
	HVN-BRCMS-P5		x	x	x
APTF	APTF-BRCMS-V1		x		x
	APTF-BRCMS-V2	x	x	x	x
	APTF-BRCMS-V3		x	x	x
LETF	LETF/CTLI-BRCMS-V1	x	x		x
	LETF/CTLI-BRCMS-V2		x	x	x
	LETF/CTLI-BRCMS-V3	x		x	x
	LETF/CTLI-BRCMS-V4	x	x		
Canyon	CYN-BRCMS-V1	x	x		x
HVS	HVS-BRCMS-P1		x	x	x
	HVS-BRCMS-P2		x	x	x
	HVS-BRCMS-P3		x	x	x
	HVS-BRCMS-P4		x	x	x
R-1	R1-BRCMS-V1		x		
Bowl	Bowl-BRCMS-V1		x		x
	Bowl-BRCMS-V2		x	x	
	Bowl-BRCMS-V3		x	x	
	Bowl-BRCMS-V4	x	x		x
	Bowl-BRCMS-V5		x		x

Table 6-4
Basis for Bedrock CMS Area Selection
Boeing SSFL Groundwater RFI

RFI Site	Bedrock CMS Area Identifier	Basis for selection			
		Vadose zone porewater at concentrations above characterization level	Soil or soil vapor sample results at concentrations 10x or 1x of comparison values for volatile organics or perchlorate, respectively	Interim measure or other excavation area	Operational feature(s)
CTL-III	CTL3-BRCMS-V1		x		
	CTL3-BRCMS-V2		x		
	CTL3-BRCMS-V3		x		
	CTL3-BRCMS-V4		x		
	CTL3-BRCMS-V5		x		
	CTL3-BRCMS-V6		x		
	CTL3-BRCMS-V7		x		
	CTL3-BRCMS-V8	x	x		x
CTL-V	CTLV-BRCMS-V1	x	x		
AIBP	AIBP-BRCMS-V1		x	x	
	AIBP-BRCMS-V2	x	x	x	
ECL	ECL-BRCMS-V1		x		
	ECL-BRCMS-V2	x		x	x
EEL	EEL-BRCMS-V1		x		
Compound A	CMPNDA-BRCMS-V1	x			
	CMPNDA-BRCMS-V2	x			
	CMPNDA-BRCMS-V3		x	x	
	CMPNDA-BRCMS-V4	x			
STL-IV	STL4-BRCMS-V1	x	x	x	x
	STL4-BRCMS-V2		x		
	STL4-BRCMS-V3		x		

Abbreviations
BRCMS - bedrock corrective measures study
P - perchlorate V -volatiles
Other abbreviations provided on Table 1-1 and in list at beginning of report

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
Radiochemistry	Antimony-125	300	pCi/L	Primary MCL [a]
Radiochemistry	Barium-133	1520	pCi/L	Primary MCL [b]
Radiochemistry	Barium-137m	2150000	pCi/L	Primary MCL [b]
Radiochemistry	Carbon-14	2000	pCi/L	Primary MCL [a]
Radiochemistry	Cesium-134	80	pCi/L	Primary MCL [a]
Radiochemistry	Cesium-137	200	pCi/L	Primary MCL [a]
Radiochemistry	Cobalt-57	1000	pCi/L	Primary MCL [a]
Radiochemistry	Cobalt-60	100	pCi/L	Primary MCL [a]
Radiochemistry	Europium-152	200	pCi/L	Primary MCL [a]
Radiochemistry	Gross alpha	15	pCi/L	Primary MCL
Radiochemistry	Gross beta	50	pCi/L	Cal MCL
Radiochemistry	Gross beta	4	mrem/yr	Primary MCL
Radiochemistry	Iodine-129	1	pCi/L	Primary MCL [a]
Radiochemistry	Manganese-54	300	pCi/L	Primary MCL [a]
Radiochemistry	Neptunium-236	5960	pCi/L	Primary MCL [b]
Radiochemistry	Niobium-94	707	pCi/L	Primary MCL [b]
Radiochemistry	Radium-226/228	5	pCi/L	Primary MCL
Radiochemistry	Sodium-22	400	pCi/L	Primary MCL [a]
Radiochemistry	Strontium-90	8	pCi/L	Primary MCL
Radiochemistry	Thulium-171	1000	pCi/L	Primary MCL [a]
Radiochemistry	Tin-126	293	pCi/L	Primary MCL [b]
Radiochemistry	Tritium	20000	pCi/L	Primary MCL
Radiochemistry	Uranium-233/234	20	pCi/L	Cal MCL
Radiochemistry	Uranium-235	20	pCi/L	Cal MCL
Radiochemistry	Uranium-238	20	pCi/L	Cal MCL
Halogenated Ethenes	1,2-Dichloroethenes	130	ug/L	SWGW RBSL
Halogenated Ethenes	Tetrachloroethene	5	ug/L	Primary MCL
Halogenated Ethenes	Trichloroethene	5	ug/L	Primary MCL
Halogenated Ethenes	cis-1,2-Dichloroethene	6	ug/L	Cal MCL
Halogenated Ethenes	trans-1,2-Dichloroethene	10	ug/L	Cal MCL
Halogenated Ethenes	1,1-Dichloroethene	6	ug/L	Cal MCL
Halogenated Ethenes	Vinyl chloride	0.5	ug/L	Cal MCL
Halogenated Ethanes	1,1,2,2-Tetrachloroethane	1	ug/L	Cal MCL
Halogenated Ethanes	1,1,2-Trichloroethane	5	ug/L	Primary MCL
Halogenated Ethanes	1,1,1-Trichloroethane	200	ug/L	Primary MCL
Halogenated Ethanes	1,2-Dichloroethane	0.5	ug/L	Cal MCL
Halogenated Ethanes	1,1-Dichloroethane	5	ug/L	Cal MCL
Halogenated Ethanes	Chloroethane	16	ug/L	Taste/Odor
Halogenated Ethanes	1,2-Dibromoethane	0.05	ug/L	Primary MCL
Halogenated Ethanes	1,1,2-Trichloro-1,2,2-trifluoroethane	1200	ug/L	Cal MCL
Halogenated Ethanes	1,2-Dichloro-1,1,2-trifluoroethane	190000	ug/L	SWGW RBSL
Halogenated Ethanes	2,2-Dichloro-1,1,1-trifluoroethane	190000	ug/L	SWGW RBSL
Halogenated Methanes	Carbon Tetrachloride	0.5	ug/L	Cal MCL
Halogenated Methanes	Chloroform	80	ug/L	Primary MCL
Halogenated Methanes	Methylene chloride	5	ug/L	Primary MCL
Halogenated Methanes	Chloromethane	5.7	ug/L	SWGW RBSL
Halogenated Methanes	Trichlorofluoromethane	150	ug/L	Cal MCL
Halogenated Methanes	Dichlorodifluoromethane	1000	ug/L	Notification Level
Halogenated Methanes	Bromochloromethane	34000	ug/L	Taste/Odor
Halogenated Methanes	Bromodichloromethane	80	ug/L	Primary MCL
Halogenated Methanes	Bromoform	80	ug/L	Primary MCL
Halogenated Methanes	Bromomethane	8.8	ug/L	SWGW RBSL
Halogenated Methanes	Dibromochloromethane	80	ug/L	Primary MCL

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
Non-Halogenated VOCs	2-Heptanone	280	ug/L	Taste/Odor
Non-Halogenated VOCs	Benzyl chloride	12	ug/L	Taste/Odor
Non-Halogenated VOCs	Cumene (Isopropylbenzene)	770	ug/L	Notification Level
Non-Halogenated VOCs	Ethanol	760000	ug/L	Taste/Odor
Non-Halogenated VOCs	Ethyl acetate	2600	ug/L	Taste/Odor
Non-Halogenated VOCs	Ethyl ether	750	ug/L	Taste/Odor
Non-Halogenated VOCs	Methanol	740000	ug/L	Taste/Odor
Non-Halogenated VOCs	m-Xylene & p-Xylene	1750	ug/L	Cal MCL
Non-Halogenated VOCs	n-Hexane	6.4	ug/L	Taste/Odor
Non-Halogenated VOCs	Pentanal	17	ug/L	Taste/Odor
Non-Halogenated VOCs	sec-Butyl alcohol	19000	ug/L	Taste/Odor
Non-Halogenated VOCs	tert-Butyl alcohol	12	ug/L	Notification Level
Non-Halogenated VOCs	1,3,5-Trimethylbenzene	330	ug/L	Notification Level
Non-Halogenated VOCs	1,2,4-Trimethylbenzene	330	ug/L	Notification Level
Non-Halogenated VOCs	2-Hexanone	250	ug/L	Taste/Odor
Non-Halogenated VOCs	Acetone	20000	ug/L	Taste/Odor
Non-Halogenated VOCs	Acetonitrile	300000	ug/L	Taste/Odor
Non-Halogenated VOCs	Acrolein	110	ug/L	Taste/Odor
Non-Halogenated VOCs	Acrylonitrile	910	ug/L	Taste/Odor
Non-Halogenated VOCs	Benzene	1	ug/L	Cal MCL
Non-Halogenated VOCs	Carbon Disulfide	160	ug/L	Notification Level
Non-Halogenated VOCs	Ethane	7500	ug/L	Taste/Odor
Non-Halogenated VOCs	Ethylbenzene	300	ug/L	Cal MCL
Non-Halogenated VOCs	Ethylene	39	ug/L	Taste/Odor
Non-Halogenated VOCs	Isopropanol	160000	ug/L	Taste/Odor
Non-Halogenated VOCs	m-Xylene	1750	ug/L	Cal MCL
Non-Halogenated VOCs	Methacrylonitrile	2100	ug/L	Taste/Odor
Non-Halogenated VOCs	Methane	3100	ug/L	SWGW RBSL
Non-Halogenated VOCs	Methyl ethyl ketone	3800	ug/L	SWGW RBSL
Non-Halogenated VOCs	Methyl isobutyl ketone (MIBK)	120	ug/L	Notification Level
Non-Halogenated VOCs	Methyl methacrylate	25	ug/L	Taste/Odor
Non-Halogenated VOCs	Methyl tert-butyl ether	5	ug/L	Secondary MCL
Non-Halogenated VOCs	n-Butylbenzene	260	ug/L	Notification Level
Non-Halogenated VOCs	n-Propylbenzene	260	ug/L	Notification Level
Non-Halogenated VOCs	o + p Xylene	1750	ug/L	Cal MCL
Non-Halogenated VOCs	o-Xylene	1750	ug/L	Cal MCL
Non-Halogenated VOCs	sec-Butylbenzene	260	ug/L	Notification Level
Non-Halogenated VOCs	Styrene	100	ug/L	Primary MCL
Non-Halogenated VOCs	tert-Butylbenzene	260	ug/L	Notification Level
Non-Halogenated VOCs	Toluene	150	ug/L	Cal MCL
Non-Halogenated VOCs	Vinyl acetate	88	ug/L	Taste/Odor
Non-Halogenated VOCs	Xylenes, Total	1750	ug/L	Cal MCL
Halogenated Benzenes	1,2,3-Trichlorobenzene	2.1	ug/L	SWGW RBSL
Halogenated Benzenes	1,2,4-Trichlorobenzene	5	ug/L	Cal MCL
Halogenated Benzenes	1,2-Dichlorobenzene	600	ug/L	Primary MCL
Halogenated Benzenes	1,3-Dichlorobenzene	600	ug/L	Archived Advisory Level
Halogenated Benzenes	1,4-Dichlorobenzene	5	ug/L	Cal MCL
Halogenated Benzenes	Chlorobenzene	70	ug/L	Cal MCL
Halogenated Propene/Propanes	1,2,3-Trichloropropane	0.005	ug/L	Notification Level
Halogenated Propene/Propanes	1,2-Dibromo-3-chloropropane	0.2	ug/L	Primary MCL
Halogenated Propene/Propanes	1,2-Dichloropropane	5	ug/L	Primary MCL
Halogenated Propene/Propanes	1,3-Dichloropropane	130	ug/L	SWGW RBSL
Halogenated Propene/Propanes	1,3-Dichloropropene	0.5	ug/L	Cal MCL

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
Halogenated Propene/Propanes	Allyl chloride	8.9	ug/L	Taste/Odor
Halogenated Propene/Propanes	cis-1,3-Dichloropropene	0.5	ug/L	Cal MCL
Halogenated Propene/Propanes	trans-1,3-Dichloropropene	0.81	ug/L	SWGW RBSL
Other Halogenated VOCs	o-Chlorotoluene	140	ug/L	Notification Level
Other Halogenated VOCs	p-Chlorotoluene	140	ug/L	Notification Level
1,4-Dioxane	1,4-Dioxane	1	ug/L	Notification Level
SVOC	Diphenyl ether	630	ug/L	SWGW RBSL
SVOC	p-Cresol	63	ug/L	SWGW RBSL
SVOC	p-Dinitrobenzene	1.3	ug/L	SWGW RBSL
SVOC	Diazinon	1.2	ug/L	Notification Level
SVOC	Diethyl phthalate	10000	ug/L	SWGW RBSL
SVOC	Ethylene glycol	14000	ug/L	Notification Level
SVOC	Formaldehyde	100	ug/L	Notification Level
SVOC	Hydrazine	160000	ug/L	Taste/Odor
SVOC	m-Cresol	37	ug/L	Taste/Odor
SVOC	o-Cresol	630	ug/L	SWGW RBSL
SVOC	1,3-Dinitrobenzene	1.3	ug/L	SWGW RBSL
SVOC	2,4,6-Trichlorophenol	2.1	ug/L	SWGW RBSL
SVOC	2,4-Dimethylphenol	100	ug/L	Archived Advisory Level
SVOC	2,6-Dinitrotoluene	0.22	ug/L	SWGW RBSL
SVOC	2-Chlorophenol	63	ug/L	SWGW RBSL
SVOC	3,3'-Dichlorobenzidine	0.12	ug/L	SWGW RBSL
SVOC	4,6-Dinitro-o-cresol	1.3	ug/L	SWGW RBSL
SVOC	Aniline	65000	ug/L	Taste/Odor
SVOC	Benzidine	0.0003	ug/L	SWGW RBSL
SVOC	Benzoic acid	50000	ug/L	SWGW RBSL
SVOC	bis(2-Chloroethoxy)methane	38	ug/L	SWGW RBSL
SVOC	bis(2-Chloroethyl) ether	360	ug/L	Taste/Odor
SVOC	bis(2-Ethylhexyl) phthalate	4	ug/L	Cal MCL
SVOC	Butyl benzyl phthalate	78	ug/L	SWGW RBSL
SVOC	Di-n-butyl phthalate	1300	ug/L	SWGW RBSL
SVOC	Di-n-octyl phthalate	500	ug/L	SWGW RBSL
SVOC	Dimethyl phthalate	130000	ug/L	SWGW RBSL
SVOC	Hexachlorobenzene	1	ug/L	Primary MCL
SVOC	Hexachlorocyclopentadiene	50	ug/L	Primary MCL
SVOC	Hexachloroethane	10	ug/L	Taste/Odor
SVOC	Isophorone	5400	ug/L	Taste/Odor
SVOC	n-Nitrosodi-n-propylamine	0.01	ug/L	Notification Level
SVOC	n-Nitrosodiethylamine	0.01	ug/L	Notification Level
SVOC	n-Nitrosodiphenylamine	16	ug/L	SWGW RBSL
SVOC	Nitrobenzene	110	ug/L	Taste/Odor
SVOC	o-Toluidine	11000	ug/L	Taste/Odor
SVOC	Pentachloronitrobenzene	20	ug/L	Archived Advisory Level
SVOC	Pentachlorophenol	1	ug/L	Primary MCL
SVOC	Phenol	4200	ug/L	Archived Advisory Level
SVOC	Pyridine	950	ug/L	Taste/Odor
PAH	1-Methyl naphthalene	2.6	ug/L	SWGW RBSL
PAH	2-Methylnaphthalene	50	ug/L	SWGW RBSL
PAH	Acenaphthene	380	ug/L	SWGW RBSL
PAH	Acenaphthylene	380	ug/L	SWGW RBSL
PAH	Anthracene	3800	ug/L	SWGW RBSL
PAH	Benzo(a)pyrene	0.2	ug/L	Primary MCL
PAH	Fluoranthene	250	ug/L	SWGW RBSL

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
PAH	Fluorene	250	ug/L	SWGW RBSL
PAH	Naphthalene	17	ug/L	Notification Level
PAH	Phenanthrene	3800	ug/L	SWGW RBSL
PAH	Pyrene	380	ug/L	SWGW RBSL
NDMA	n-Nitrosodimethylamine	0.01	ug/L	Notification Level
Energetics	Perchlorate	6	ug/L	Cal MCL
Energetics	2,4,6-Trinitrotoluene	1	ug/L	Notification Level
Energetics	HMX	350	ug/L	Notification Level
Energetics	RDX	0.3	ug/L	Notification Level
TPH	Fuel Hydrocarbons, C4-C12, as heavy Hydrocarbons	500	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C6-C14, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C6-C15, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C6-C16, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C6-C16, C21-C24, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C6-C7	500	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C7-C10, as gasoline	5	ug/L	Taste/Odor
TPH	Fuel Hydrocarbons, C7-C14, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C7-C16, as JP-4	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C8-C10, as gasoline	5	ug/L	Taste/Odor
TPH	Fuel Hydrocarbons, C8-C12, as heavy Hydrocarbons	1800	ug/L	SWGW RBSL
TPH	Fuel Hydrocarbons, C8-C14, as heavy Hydrocarbons	1800	ug/L	SWGW RBSL
TPH	Gasoline Range Organics (C4-C12)	5	ug/L	Taste/Odor
TPH	Gasoline Range Organics (C6-C14)	5	ug/L	Taste/Odor
TPH	Gasoline Range Organics (C7-C12)	5	ug/L	Taste/Odor
TPH	Diesel Range Organics	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C12-C14)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C13-C22)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C14-C20)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C15-C20)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C20-C30)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C21-C24)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C21-C30)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C8-C11)	100	ug/L	Taste/Odor
TPH	Diesel Range Organics (C8-C30)	100	ug/L	Taste/Odor
TPH	Fuel Hydrocarbons, C6-C17, as JP-4	1800	ug/L	SWGW RBSL
TPH	Gasoline Range Organics (C8-C11)	1800	ug/L	SWGW RBSL
TPH	Jet Fuel 4 (C6-C13)	1800	ug/L	SWGW RBSL
TPH	Kerosene (C10-C12)	1800	ug/L	SWGW RBSL
TPH	Kerosene (C10-C14)	1800	ug/L	SWGW RBSL
TPH	Kerosene Range Organics (C11-C14)	1800	ug/L	SWGW RBSL
TPH	Total Petroleum Hydrocarbons (as Kerosene)	1800	ug/L	SWGW RBSL
TPH	Gasoline Range Organics	5	ug/L	Taste/Odor
TPH	Gasoline Range Organics (C6-C12)	5	ug/L	Taste/Odor
PCB	Aroclor 1016	0.5	ug/L	Primary MCL
PCB	Polychlorinated biphenyls	0.5	ug/L	Primary MCL
PCB	Aroclor 1254	0.5	ug/L	Primary MCL
PCB	Aroclor 1260	0.5	ug/L	Primary MCL
PCB	Aroclor 1221	0.5	ug/L	Primary MCL
PCB	Aroclor 1232	0.5	ug/L	Primary MCL
PCB	Aroclor 1242	0.5	ug/L	Primary MCL
PCB	Aroclor 1248	0.5	ug/L	Primary MCL
Herbicides	2,4,5-Trichlorophenoxypropionic acid (Silvex)	50	ug/L	Cal MCL
Herbicides	2,4-Dichlorophenoxyacetic Acid (2,4-D)	130	ug/L	SWGW RBSL

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
Herbicides	2,4,5-T	130	ug/L	SWGW RBSL
Herbicides	Dalapon	200	ug/L	Cal MCL
Herbicides	Dinoseb	7	ug/L	Primary MCL
Herbicides	Propachlor	90	ug/L	Notification Level
Pesticides	Kepone	0.0093	ug/L	SWGW RBSL
Pesticides	Endosulfan I	75	ug/L	SWGW RBSL
Pesticides	Endosulfan II	75	ug/L	SWGW RBSL
Pesticides	gamma-BHC	0.2	ug/L	Primary MCL
Pesticides	Methyl parathion	2	ug/L	Archived Advisory Level
Pesticides	p,p'-Methoxychlor	30	ug/L	Cal MCL
Pesticides	Parathion	40	ug/L	Archived Advisory Level
Pesticides	Endosulfan sulfate	75	ug/L	SWGW RBSL
Pesticides	4,4'-DDE	0.44	ug/L	SWGW RBSL
Pesticides	Aldrin	0.002	ug/L	Archived Advisory Level
Pesticides	alpha-BHC	0.015	ug/L	Archived Advisory Level
Pesticides	beta-BHC	0.025	ug/L	Archived Advisory Level
Pesticides	Chlordane	0.1	ug/L	Cal MCL
Pesticides	Dieldrin	0.002	ug/L	Archived Advisory Level
Pesticides	Dimethoate	1	ug/L	Archived Advisory Level
Pesticides	4,4'-DDD	0.62	ug/L	SWGW RBSL
Pesticides	Toxaphene	3	ug/L	Primary MCL
Pesticides	Endrin	2	ug/L	Primary MCL
Pesticides	Heptachlor	0.01	ug/L	Cal MCL
Pesticides	Heptachlor epoxide	0.01	ug/L	Cal MCL
Dioxins/Furans	2,3,7,8-TCDD	0.00003	ug/L	Primary MCL
Metals	Aluminum, Dissolved	13000	ug/L	SWGW RBSL
Metals	Boron, Dissolved	340	ug/L	SSFL Comparison
Metals	Tin, Dissolved	2.4	ug/L	SSFL Comparison
Metals	Antimony, Dissolved	2.5	ug/L	SSFL Comparison
Metals	Arsenic, Dissolved	7.7	ug/L	SSFL Comparison
Metals	Barium, Dissolved	150	ug/L	SSFL Comparison
Metals	Beryllium, Dissolved	0.14	ug/L	SSFL Comparison
Metals	Cadmium, Dissolved	0.2	ug/L	SSFL Comparison
Metals	Chromium, Dissolved	14	ug/L	SSFL Comparison
Metals	Cobalt, Dissolved	1.9	ug/L	SSFL Comparison
Metals	Copper, Dissolved	4.7	ug/L	SSFL Comparison
Metals	Hexavalent Chromium, Dissolved	10	ug/L	Cal MCL
Metals	Iron, Dissolved	4100	ug/L	SSFL Comparison
Metals	Lead, Dissolved	11	ug/L	SSFL Comparison
Metals	Magnesium, Dissolved	77000	ug/L	SSFL Comparison
Metals	Manganese, Dissolved	150	ug/L	SSFL Comparison
Metals	Mercury, Dissolved	0.063	ug/L	SSFL Comparison
Metals	Molybdenum, Dissolved	2.2	ug/L	SSFL Comparison
Metals	Nickel, Dissolved	17	ug/L	SSFL Comparison
Metals	Potassium, Dissolved	9600	ug/L	SSFL Comparison
Metals	Selenium, Dissolved	1.6	ug/L	SSFL Comparison
Metals	Silver, Dissolved	0.17	ug/L	SSFL Comparison
Metals	Sodium, Dissolved	190000	ug/L	SSFL Comparison
Metals	Strontium, Dissolved	800	ug/L	SSFL Comparison
Metals	Thallium, Dissolved	0.13	ug/L	SSFL Comparison
Metals	Vanadium, Dissolved	2.6	ug/L	SSFL Comparison
Metals	Zinc, Dissolved	6300	ug/L	SSFL Comparison
Metals	Aluminum	200	ug/L	Secondary MCL

TABLE 6-5
GROUNDWATER CHARACTERIZATION LEVELS
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Analyte Group	Chemical Analyte	Reference Value	Units	Reference Type
Metals	Antimony	2.5	ug/L	SSFL Comparison
Metals	Arsenic	7.7	ug/L	SSFL Comparison
Metals	Barium	150	ug/L	SSFL Comparison
Metals	Beryllium	0.14	ug/L	SSFL Comparison
Metals	Boron	340	ug/L	SSFL Comparison
Metals	Cadmium	0.2	ug/L	SSFL Comparison
Metals	Chromium	14	ug/L	SSFL Comparison
Metals	Cobalt	1.9	ug/L	SSFL Comparison
Metals	Copper	4.7	ug/L	SSFL Comparison
Metals	Hexavalent Chromium	10	ug/L	Cal MCL
Metals	Iron	4100	ug/L	SSFL Comparison
Metals	Lead	11	ug/L	SSFL Comparison
Metals	Magnesium	77000	ug/L	SSFL Comparison
Metals	Manganese	150	ug/L	SSFL Comparison
Metals	Mercury	0.063	ug/L	SSFL Comparison
Metals	Molybdenum	2.2	ug/L	SSFL Comparison
Metals	Nickel	17	ug/L	SSFL Comparison
Metals	Potassium	9600	ug/L	SSFL Comparison
Metals	Selenium	1.6	ug/L	SSFL Comparison
Metals	Silver	0.17	ug/L	SSFL Comparison
Metals	Sodium	190000	ug/L	SSFL Comparison
Metals	Strontium	800	ug/L	SSFL Comparison
Metals	Thallium	0.13	ug/L	SSFL Comparison
Metals	Tin	2.4	ug/L	SSFL Comparison
Metals	Vanadium	2.6	ug/L	SSFL Comparison
Metals	Zinc	6300	ug/L	SSFL Comparison
Inorganics	Chlorine	4000	ug/L	Primary MCL
Inorganics	Nitrate-NO3	45000	ug/L	Cal MCL
Inorganics	Nitrite-NO2	3284	ug/L	Primary MCL [(c)]
Inorganics	Ammonia-N	30000	ug/L	Taste/Odor
Inorganics	Chloride	250000	ug/L	Secondary MCL
Inorganics	Chlorate	0.8	ug/L	Notification Level
Inorganics	Cyanides	150	ug/L	Cal MCL
Inorganics	Fluoride	800	ug/L	SSFL Comparison
Inorganics	Nitrate-N	10000	ug/L	Cal MCL
Inorganics	Nitrite-N	1000	ug/L	Primary MCL
Inorganics	Sulfate	376000	ug/L	SSFL Comparison
Inorganics	Total Dissolved Solids	500000	ug/L	Recommended SMCL
Inorganics	Total Dissolved Solids	1000000	ug/L	Upper SMCL
Inorganics	Total Dissolved Solids	1500000	ug/L	Short-Term SMCL
General Parameters	Formic Acid	1700000	ug/L	Taste/Odor
General Parameters	Turbidity	5	NTU	Secondary MCL
General Parameters	Specific conductivity	900	umhos/cm	Recommended SMCL
General Parameters	Specific conductivity	1600	umhos/cm	Upper SMCL
General Parameters	Specific conductivity	2200	umhos/cm	Short-Term SMCL

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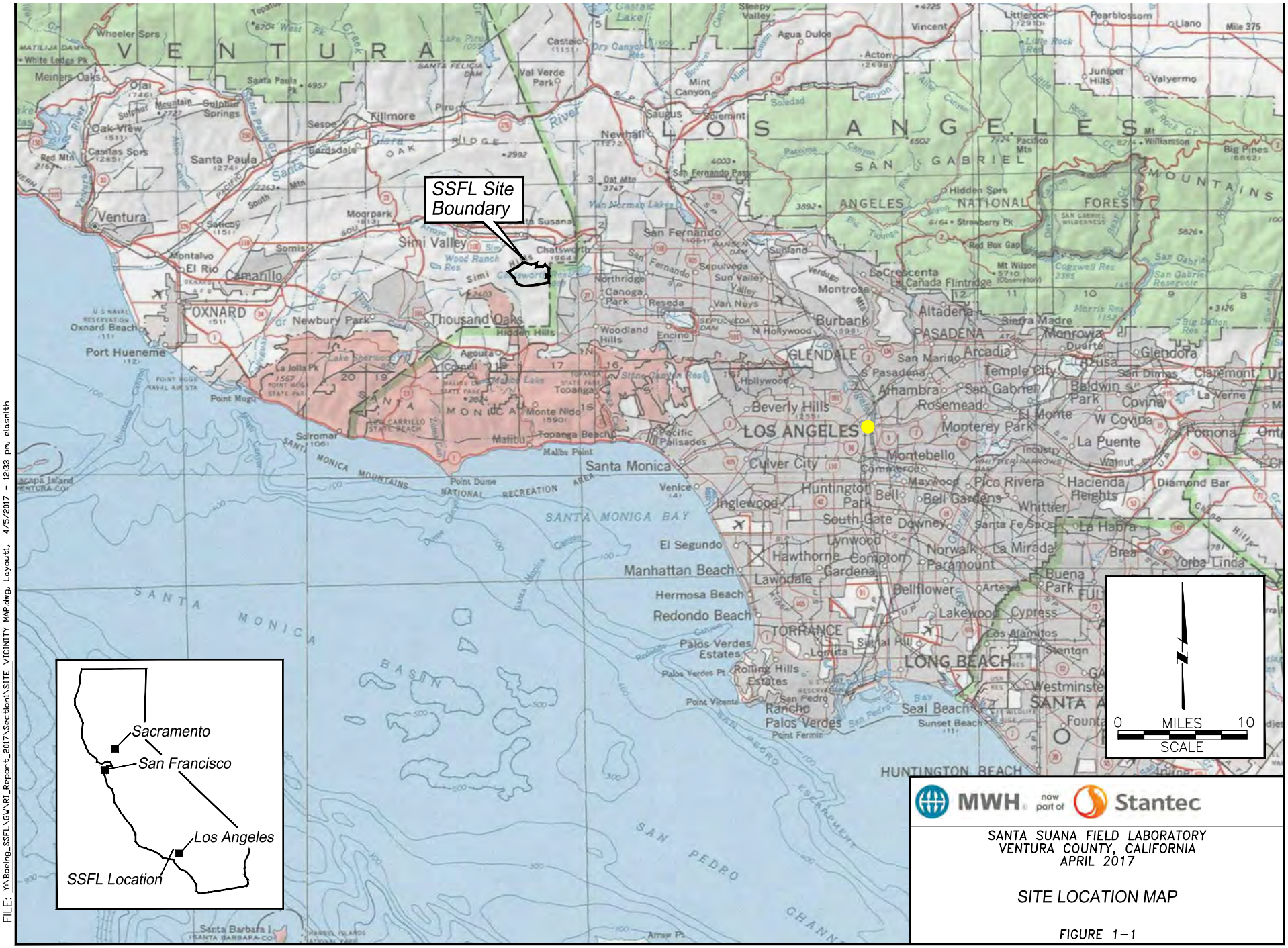
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Plates

Plate 2-1 SSFL Groundwater Chronology



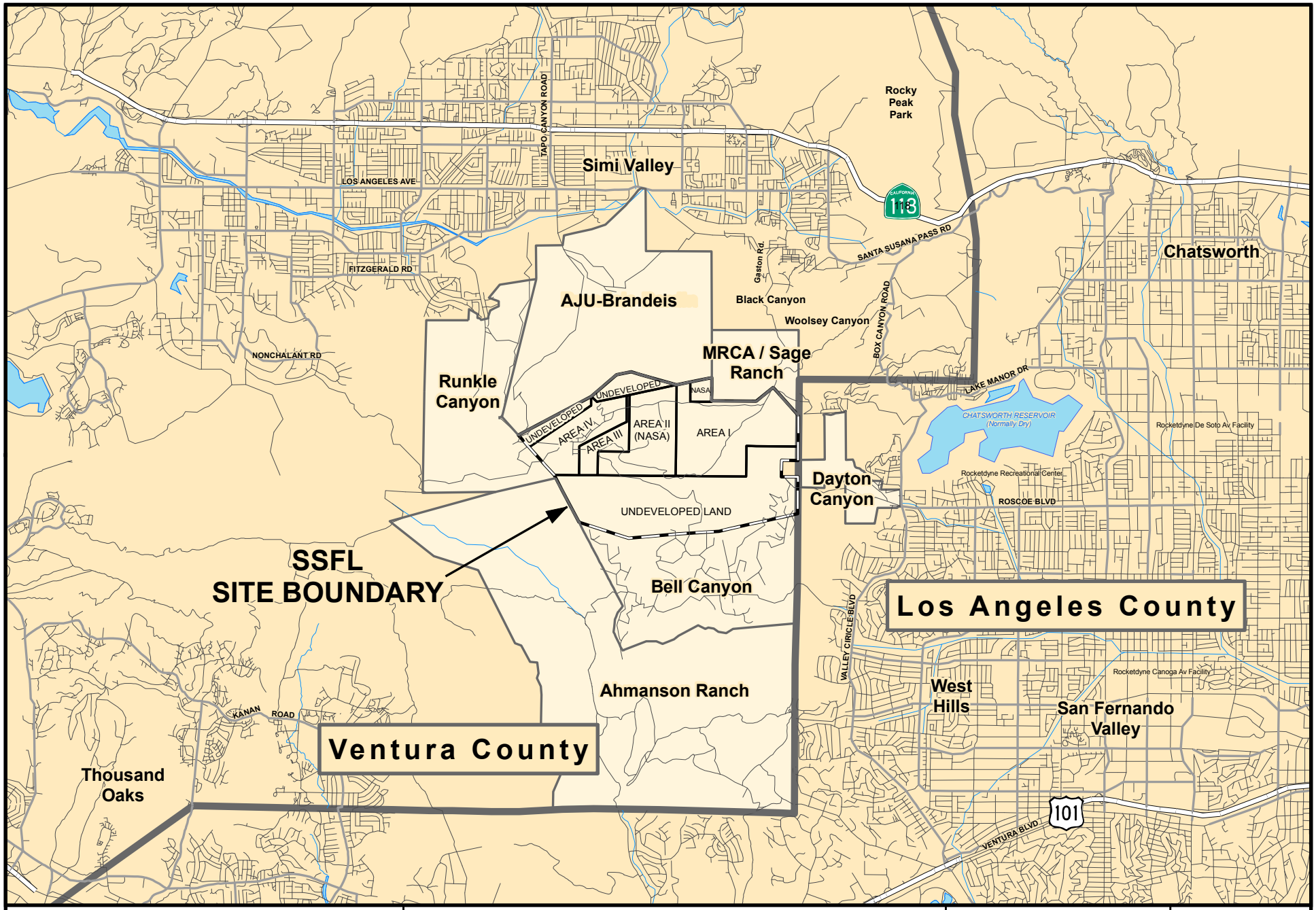
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MWH now part of Stantec

SANTA SUANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
APRIL 2017

SITE LOCATION MAP

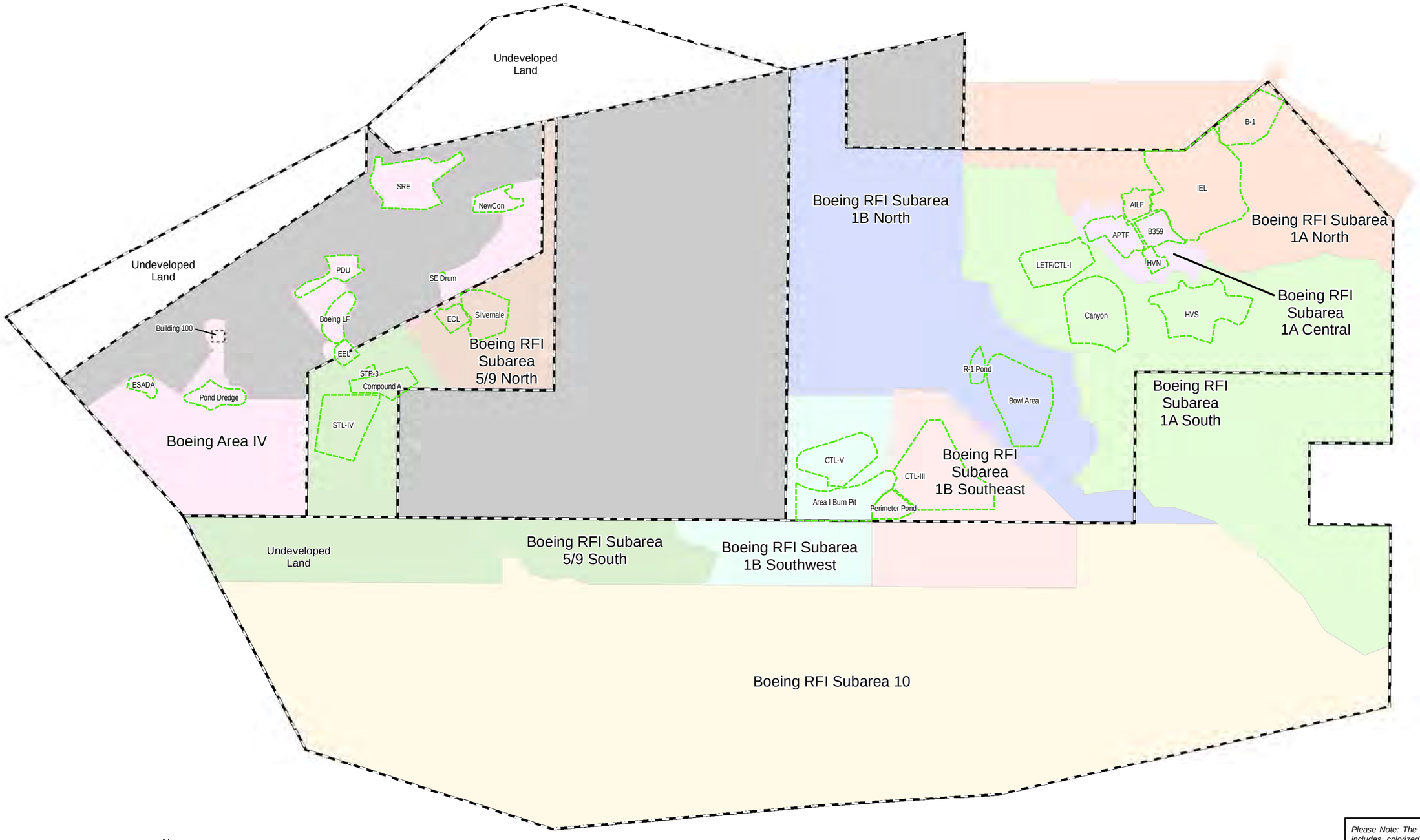
FIGURE 1-1



SANTA SUSANA FIELD LABORATORY

Site Vicinity Map

FIGURE 1-2



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

RFI Site Owner

Boeing

Administrative Area Boundary

Responsibility of NASA or DOE

MWH now part of Stantec

SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

BOEING GEOGRAPHIC AREA OF RESPONSIBILITY FOR GROUNDWATER RFI
FIGURE 1-3

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INSET I

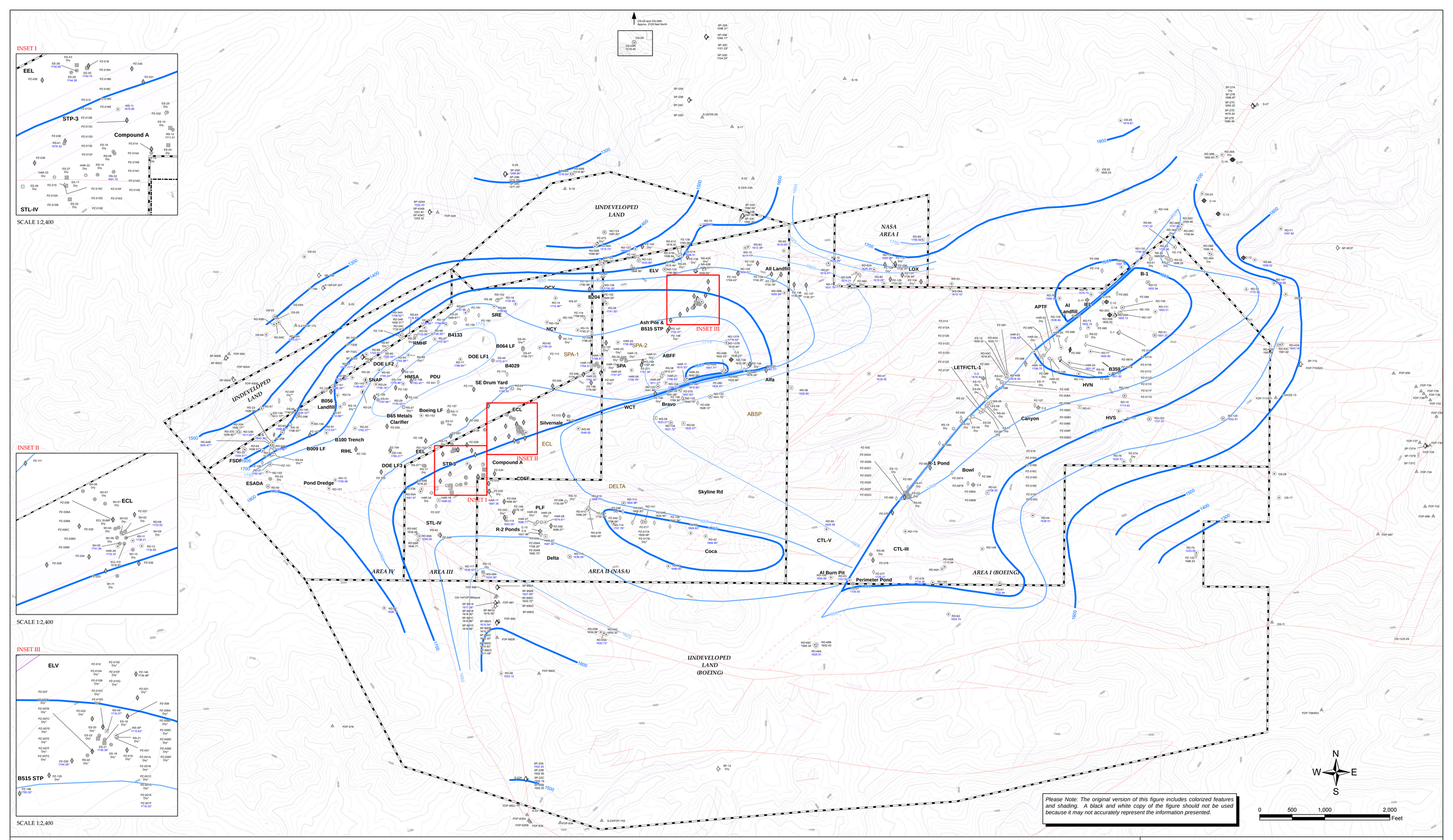
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INSET II

SCALE 1:2,400

INSET III

SCALE 1:2,400



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

0 500 1,000 2,000 Feet

N W E S

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface (Monitors Regional Water Table)
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface (Monitors Regional Water Table)
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface (Monitors Regional Water Table)
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

Basemap

- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

Approximate Groundwater Elevation Contours (feet above sea level)

- 25-foot Contour
- 50-foot Contour
- 100-foot Contour
- 1629.20 — Groundwater Level Elevation in Feet Above Mean Sea Level
- 1629.20 — Groundwater Level Elevation in Feet Above Mean Sea Level (water level was not used to generate contour line)
- ECW — Water stranded in the well casing end cap; not representative of water level in formation (well is effectively dry)

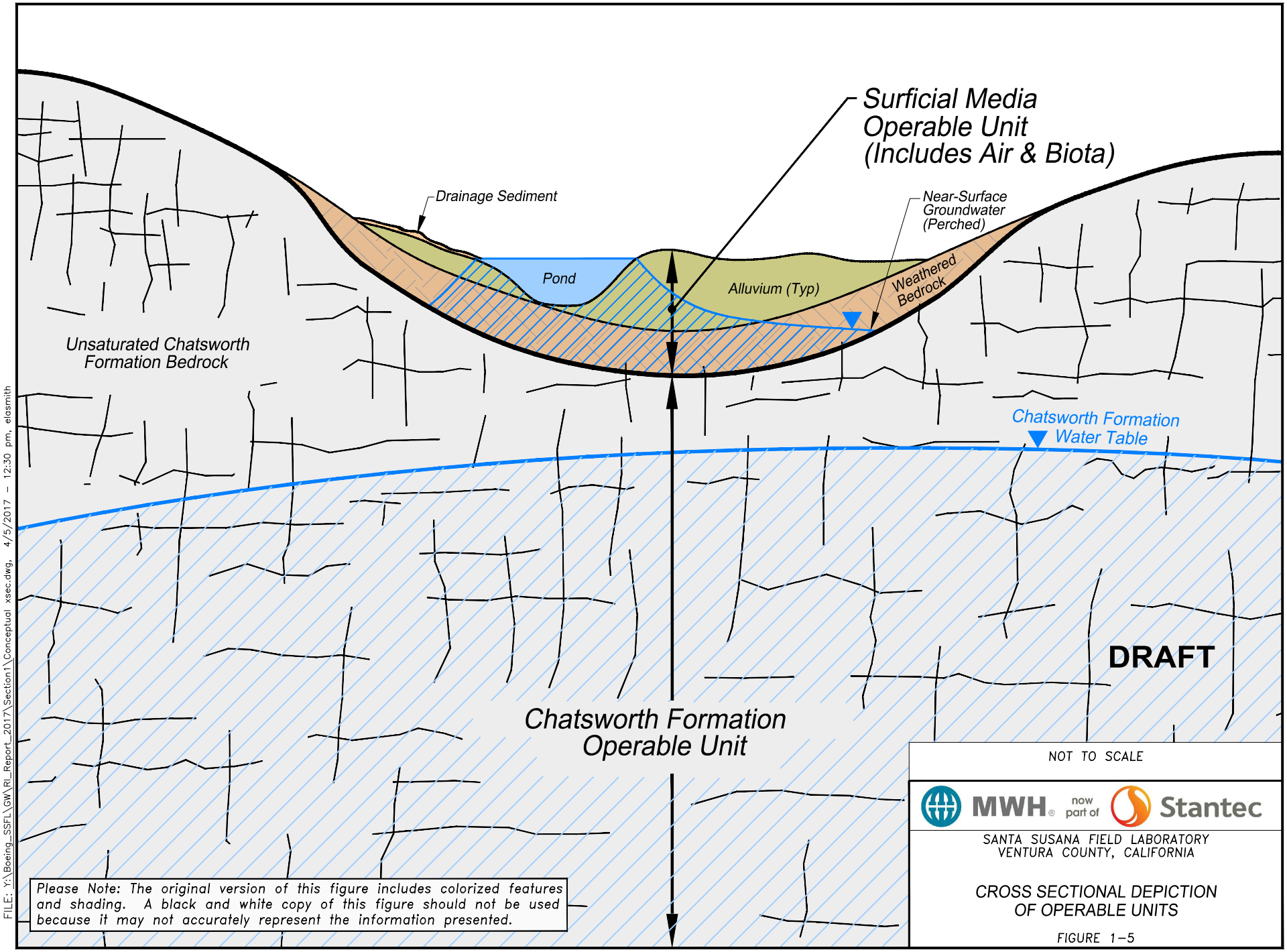
Information used to develop the groundwater elevation contours includes topography; the approximate elevations of identified seeps and springs; historical water level data for wells and piezometers not gauged during the fourth quarter of 2016; and the recognition that groundwater level discontinuities coincide with certain fault segments and other geologic structures.
The site-wide groundwater elevation contours presented on this map were developed collaboratively with NASA and DOE. The groundwater elevations shown for NASA-sponsored wells were collected and provided by NASA (indicated with *), and DOE-sponsored wells were collected and provided by DOE (indicated with **),and are presented in their respective 2016 annual groundwater monitoring reports. Water levels were measured in October at Boeing, NASA, and DOE –sponsored wells.

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VENTURA COUNTY, CALIFORNIA

SSFL GROUNDWATER MONITORING LOCATIONS AND POTENTIOMETRIC SURFACE OCTOBER 2016
FIGURE 1-4

Printing Date: 5/17/2017
U:\BoeingSantaSusana\MXD\RI_Report_2017\Section1\Fig1_4_WaterTable.mxd


Surficial Media
Operable Unit
(Includes Air & Biota)
Drainage Sediment
Near-Surface
Groundwater
(Perched)
Pond
Alluvium (Typ)
Weathered
Bedrock
Unsaturated Chatsworth
Formation Bedrock
Chatsworth Formation
Water Table
DRAFT
Chatsworth Formation
Operable Unit
NOT TO SCALE
Please Note: The original version of this figure includes colorized features and shading. A black and white copy of this figure should not be used because it may not accurately represent the information presented.
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SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
CROSS SECTIONAL DEPICTION
OF OPERABLE UNITS
FIGURE 1-5
FILE: Y:\Boeing_SSFL\GW\RI_Report_2017\Section1\Conceptual xsec.dwg, 4/5/2017 - 12:30 pm, elasmith

Undeveloped Land

Undeveloped Land

Undeveloped Land

AREA I NASA

AREA I

AREA II

AREA III

AREA IV

SRE Pond

Building 56 Excavation Ponds

Silvernale Reservoir

Outfall 018 SWTS

R-2B

R-2A

Coca Skim Pond

Elevation 2245 ft

R-1 Pond

Outfall 011 SWTS

GETS

Perimeter Pond

Elevation 1175 ft

1 2 3 4 5 6 7 8 9 10 11 18 19

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- NPDES Outfall
- Stormwater Treatment System (SWTS)
- Groundwater Extraction and Treatment System (GETS)
- Drainage Basin Divide
- Surface Water Ponds/Feature
- Drainage
- Administrative Area Boundary
- Ground Elevation Contour (25 ft)

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SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

SSFL SITE FEATURES
FIGURE 2-1

Path: U:\BoeingSantaSusana\MXD\RI_Report_2017\Section2\2_1_SiteFeatures.mxd

Undeveloped Land

Undeveloped Land

AREA I NASA

AREA IV

AREA III

AREA II

AREA I

Undeveloped Land

GETS

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

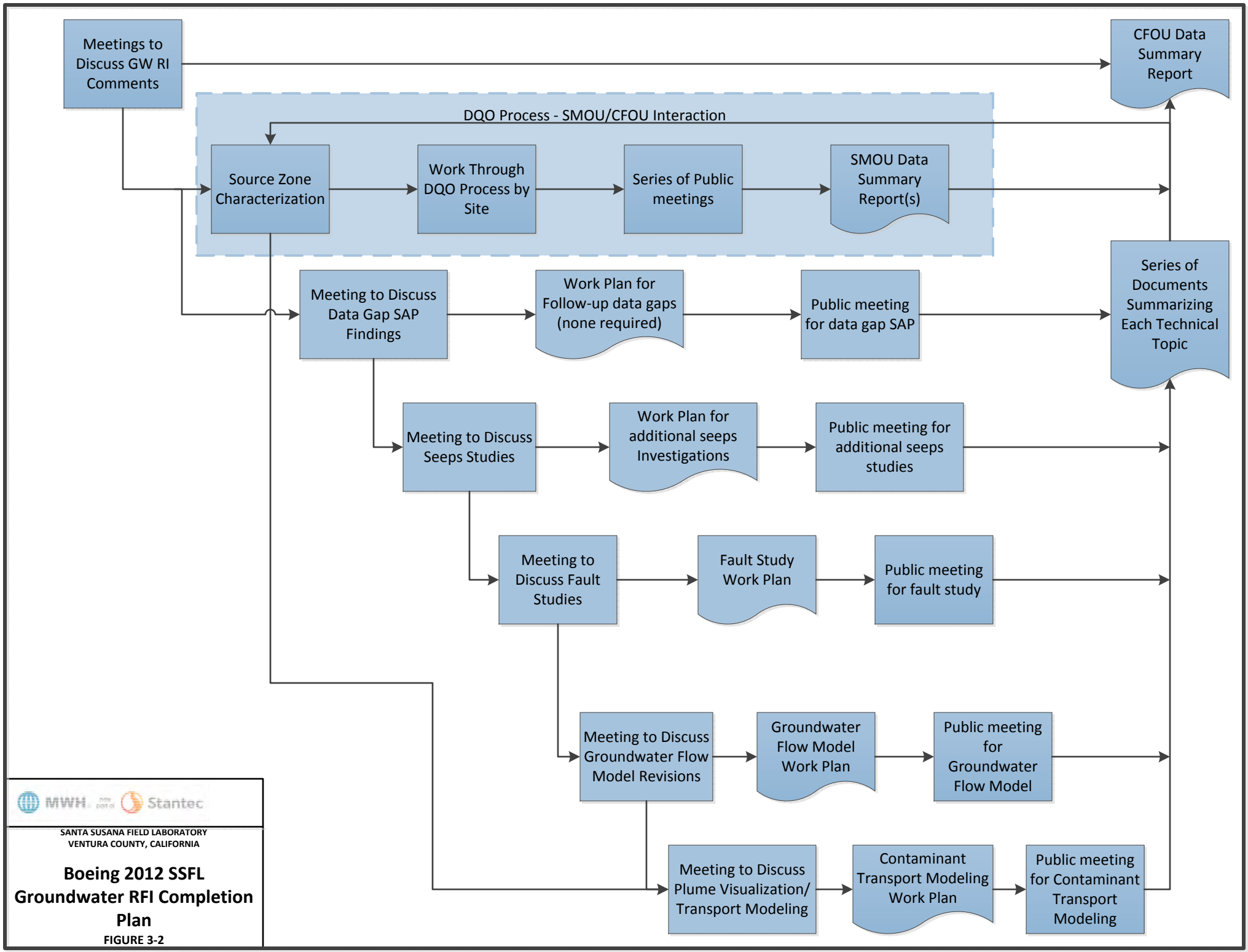
- Groundwater Monitoring Location (installed 2010 to 2016)
- Groundwater Monitoring Location (installed prior to 2010)
- Geophysical Survey (conducted 2014)
- Groundwater Extraction and Treatment System (GETS) Installed 2010
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

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SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

LOCATIONS OF FIELD INVESTIGATIONS CONDUCTED SINCE 2009
FIGURE 3-1

Path: U:\BoeingSantaSusana\MXD\RI_Report_2017\Section3\3_1_FieldInvestigations.mxd



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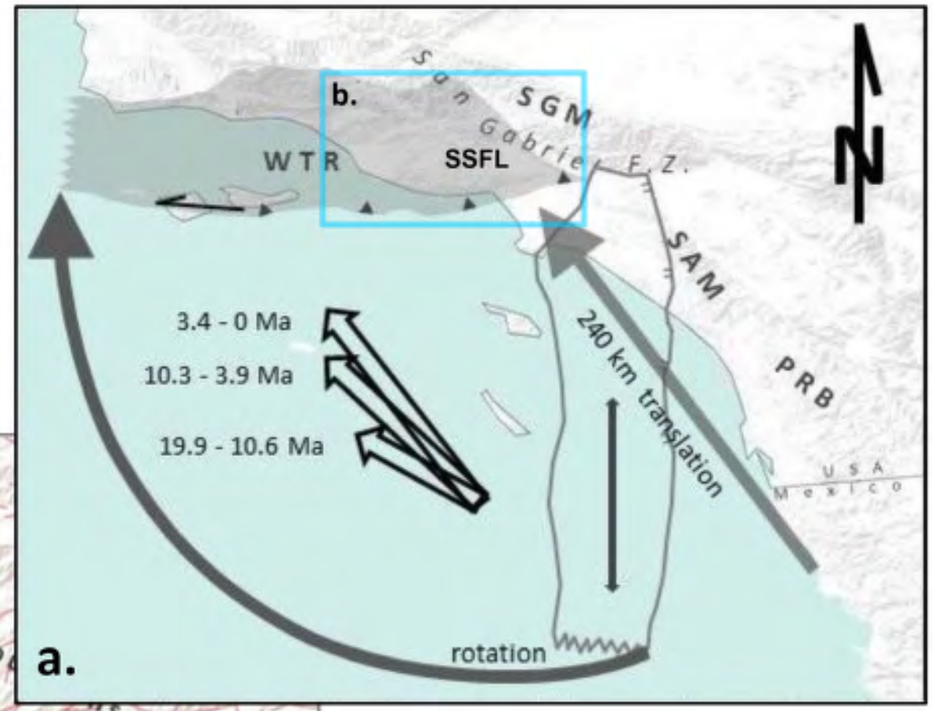
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

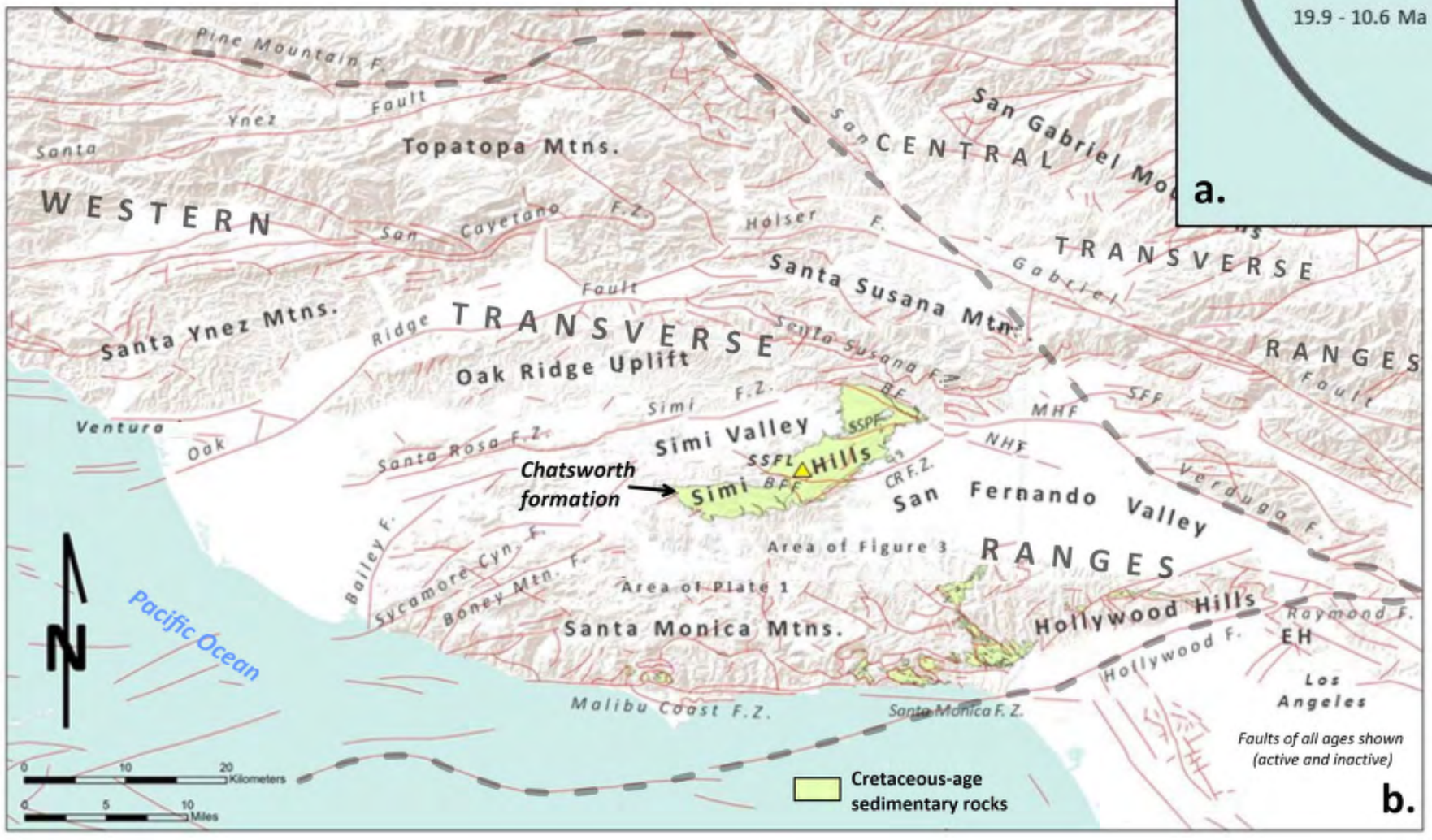
Boeing 2012 SSFL Groundwater RFI Completion Plan

FIGURE 3-2



Present (shaded) and approximate pre-rotation (outlined) Early Miocene (20 million years ago) position of the western Transverse Ranges (WTR).



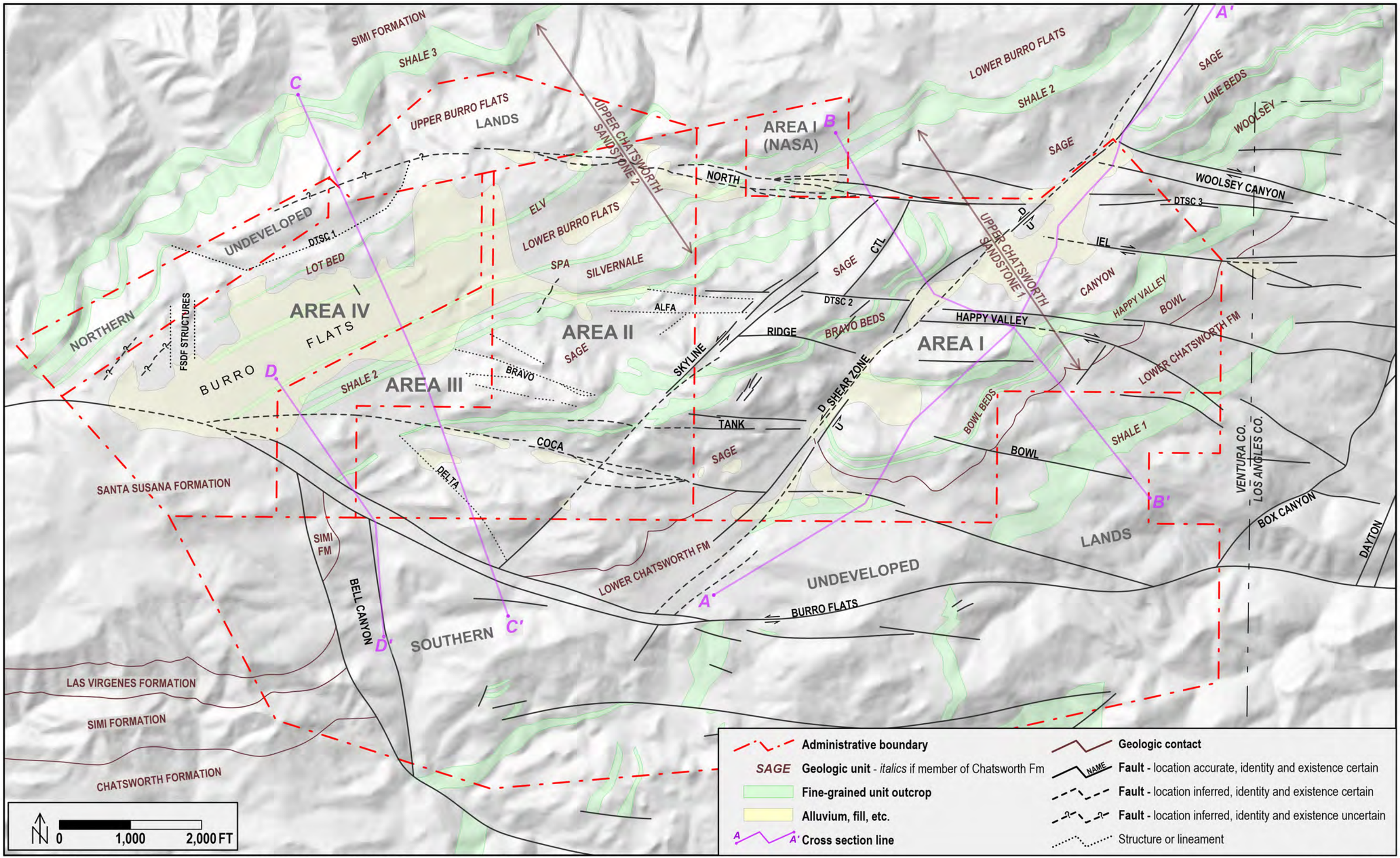


Abbreviations

BF	Brugher fault
BFF	Burro Flats fault
CRFZ	Chatsworth Reservoir fault zone
EH	Elysian Hills
MHF	Mission Hills fault
NHF	Northridge Hills fault
PRB	Peninsular Ranges block
SAF	San Andreas fault
SAM	Santa Ana Mountains
SFF	San Fernando fault
SGM	San Gabriel Mountains
SSFL	Santa Susana Field Laboratory
SSPF	Santa Susana Pass fault
WTR	western Transverse Ranges (outlined)

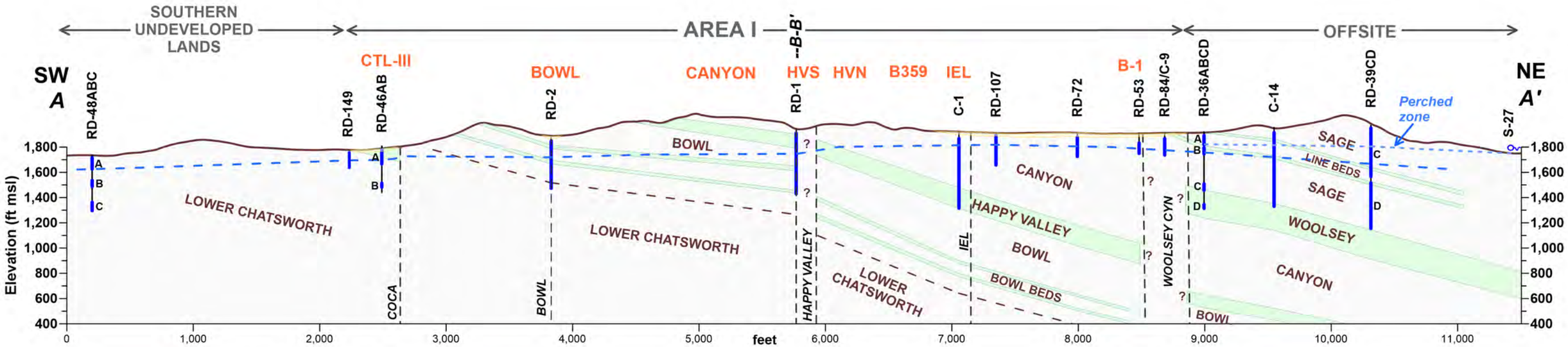
adopted from MWH, 2014

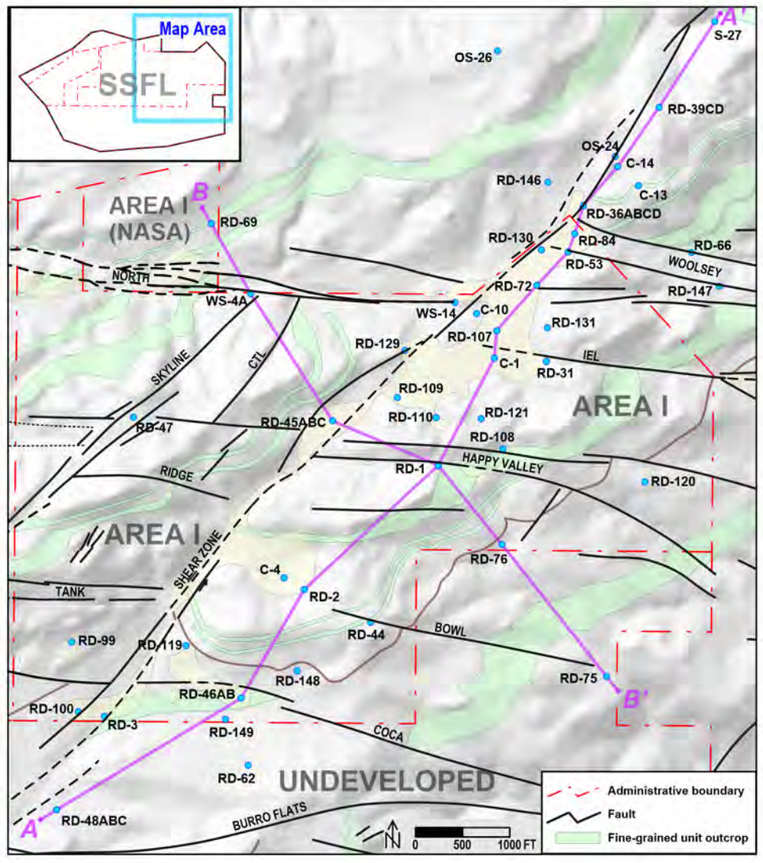
Figure 4-1
Location of SSFL, the Chtasworth Formation, and the Simi Hills in the Western Transverse Ranges Physiographic Province
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

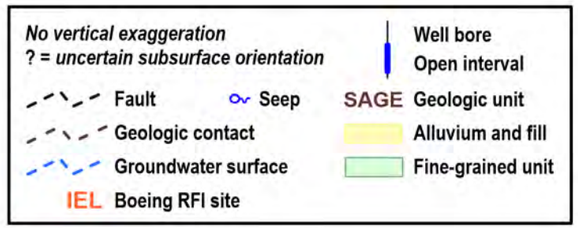


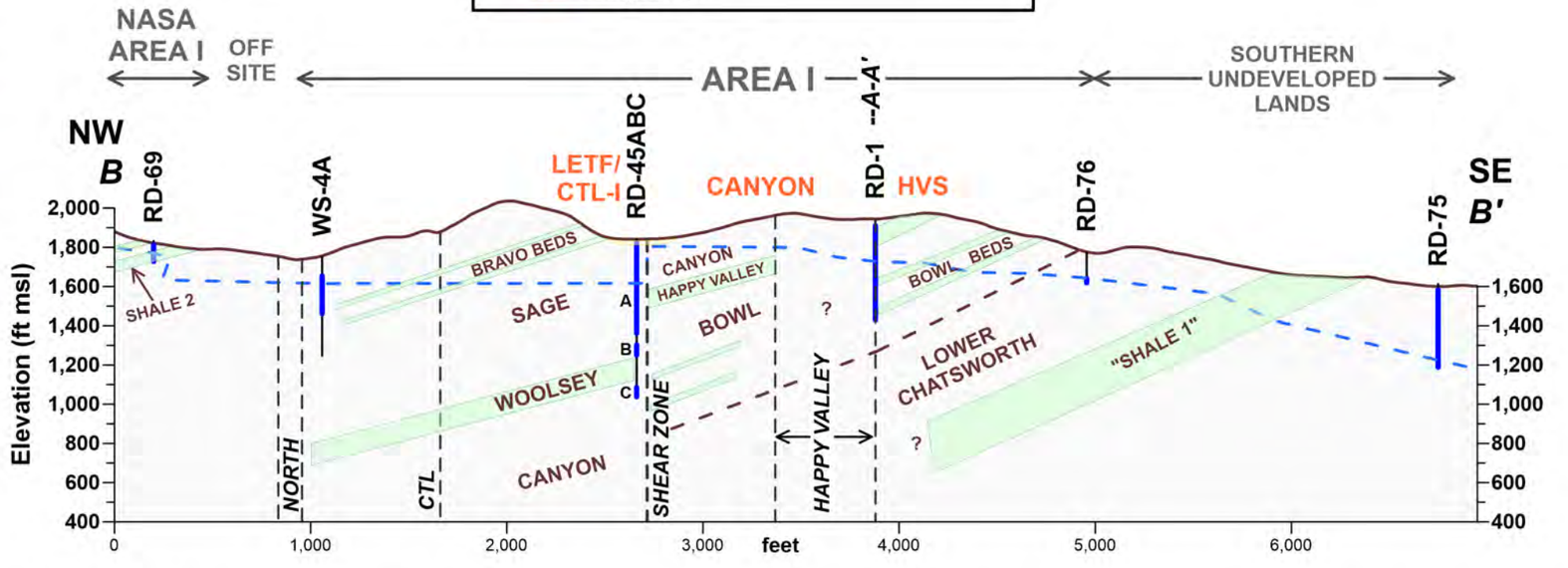
Sources: Diblee, 1992; Yerkes and Campbell, 2005; MWH, 2007, 2009; Cilona and others, 2016; CH2M HILL, 2016.

Figure 4-2
SSFL Geologic Map
SANTA SUSANA FIELD LABORATORY, VENTURA CO., CA









Portrayed depth of alluvium is schematic.
Relatively shallow montoring wells (<100 ft) not shown.
Groundwater levels generally representative of autumn conditions 2014-2016.
Elevation in feet relative to mean sea level (ft msl), State Plane, Zone 5, NAD27.

Figure 4-3
Geologic Cross Sections *A-A'* and *B-B'*
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NORTHERN UNDEVELOPED LANDS | AREA IV | AREA III | AREA II | SOUTHERN UNDEVELOPED LANDS

NW C — SE C′

SRE | B064 LF DOE LF1 | B029 | SE Drum Yard | Silvernale ECL | PLF | DELTA

Broad band of deformation mapped along inferred extension of North fault

RD-85, RD-102, DD-143, RD-86, RD-17, RD-44, RD-45, RD-47, RD-16, RS-38, RD-8, RD-11, HAR-26, RD-12, RD-41ABC, HAR-8, C-15, C-6, HAR-7, ND-116, RD-5ABC

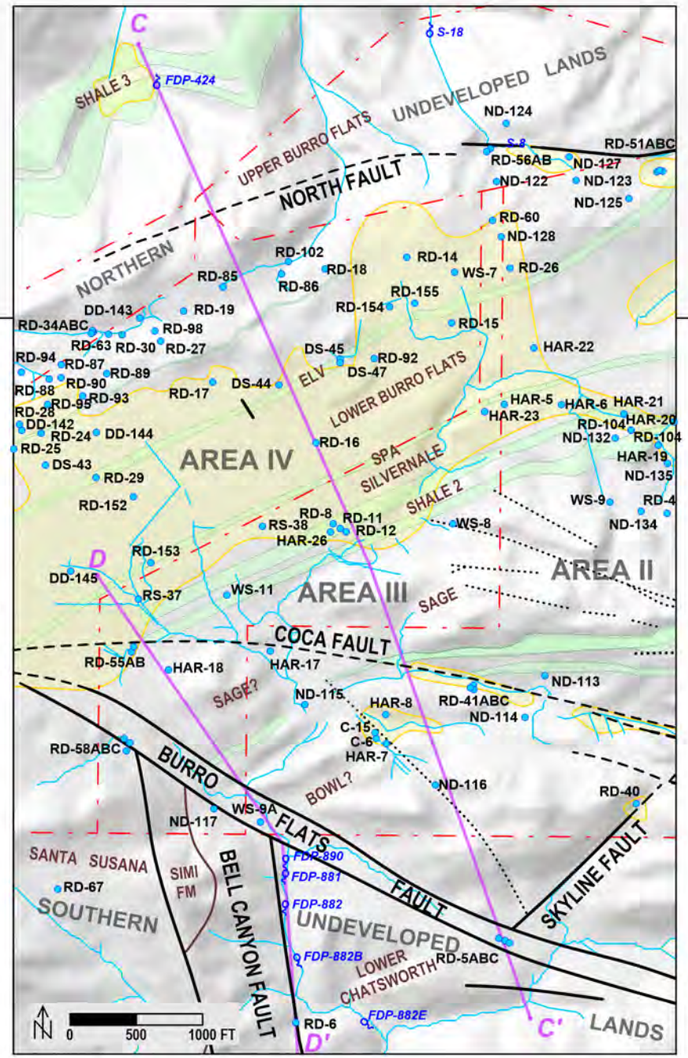
SP-424ABC (flowing artesian) FDP-424

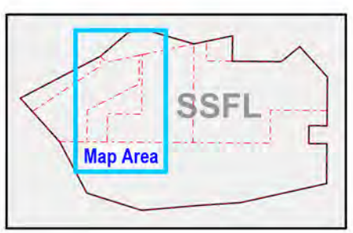
SHALE 3 | UPPER BURRO FLATS | NORTH FAULT EXTENSION ? | DTSC FAULT (?) | LOT BED | EVA | LOWER BURRO FLATS | SPA | SILVERNALE | SHALE 2 | SAGE | ALLUVIUM / FILL | LOWER LINE BED | COCA FAULT | WOOLSEY | CANYON | DELTA STRUCTURE | BURRO FLATS FAULT ZONE | BURRO FLATS FAULT SPUR ? | LOWER CHATSWORTH FM

Elevation (ft msl)

0 | 200 | 400 | 600 | 800 | 1,000 | 1,200 | 1,600 | 1,400

0 | 1,000 | 5,000 | 6,000 | 7,000



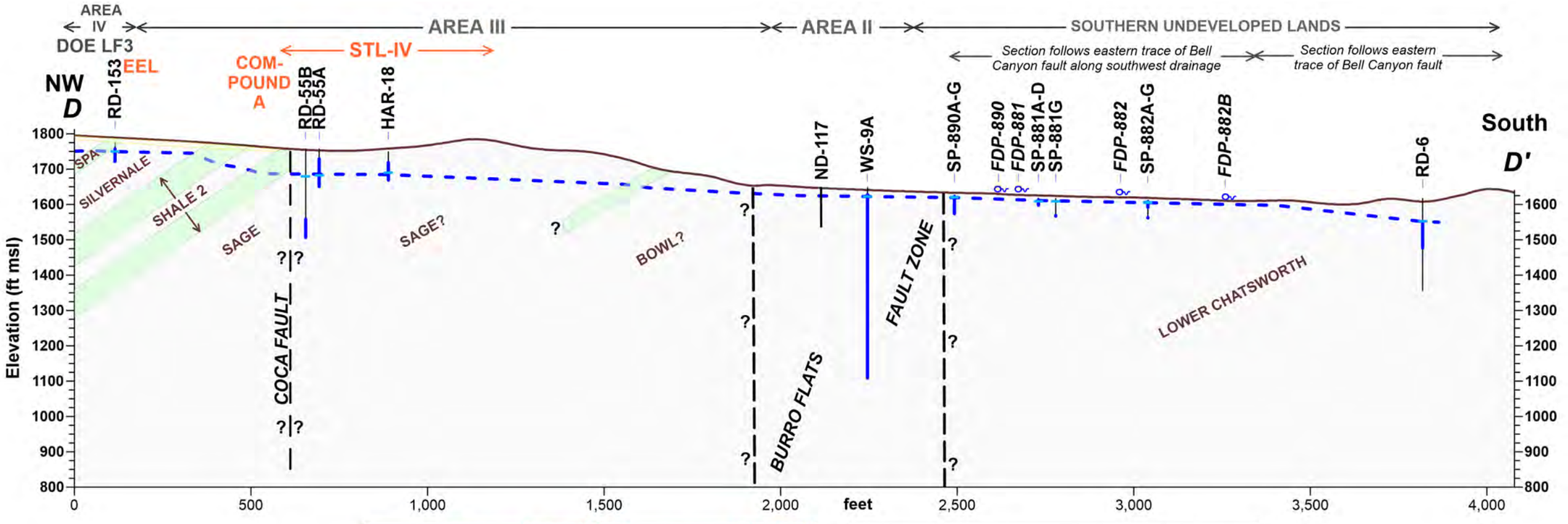


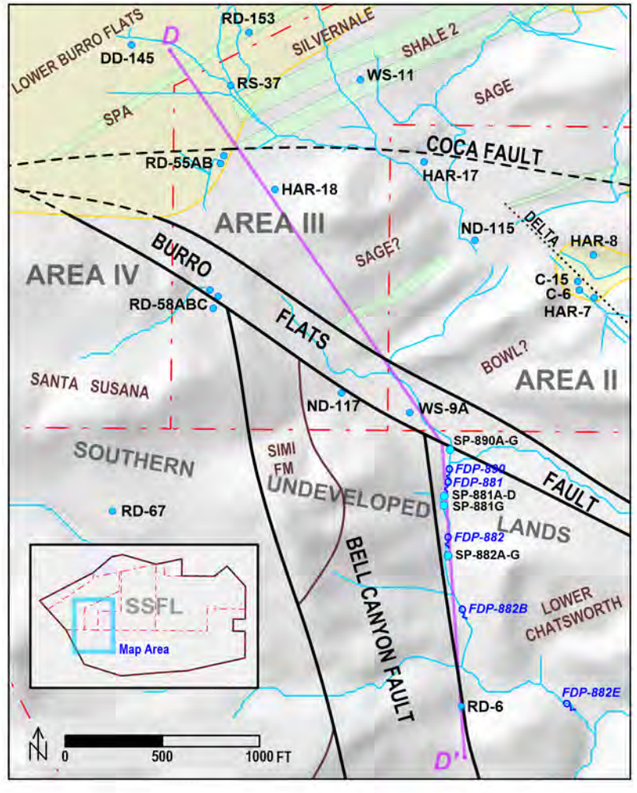
No vertical exaggeration
? = uncertain subsurface orientation

Well bore
Open interval
Fault
Seep
SAGE Geologic unit
Groundwater surface
Alluvium and fill
ECL Boeing RFI site
Fine-grained unit
PLF Other RFI site

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Figure 4-4
Geologic Cross Section *C-C′*
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA



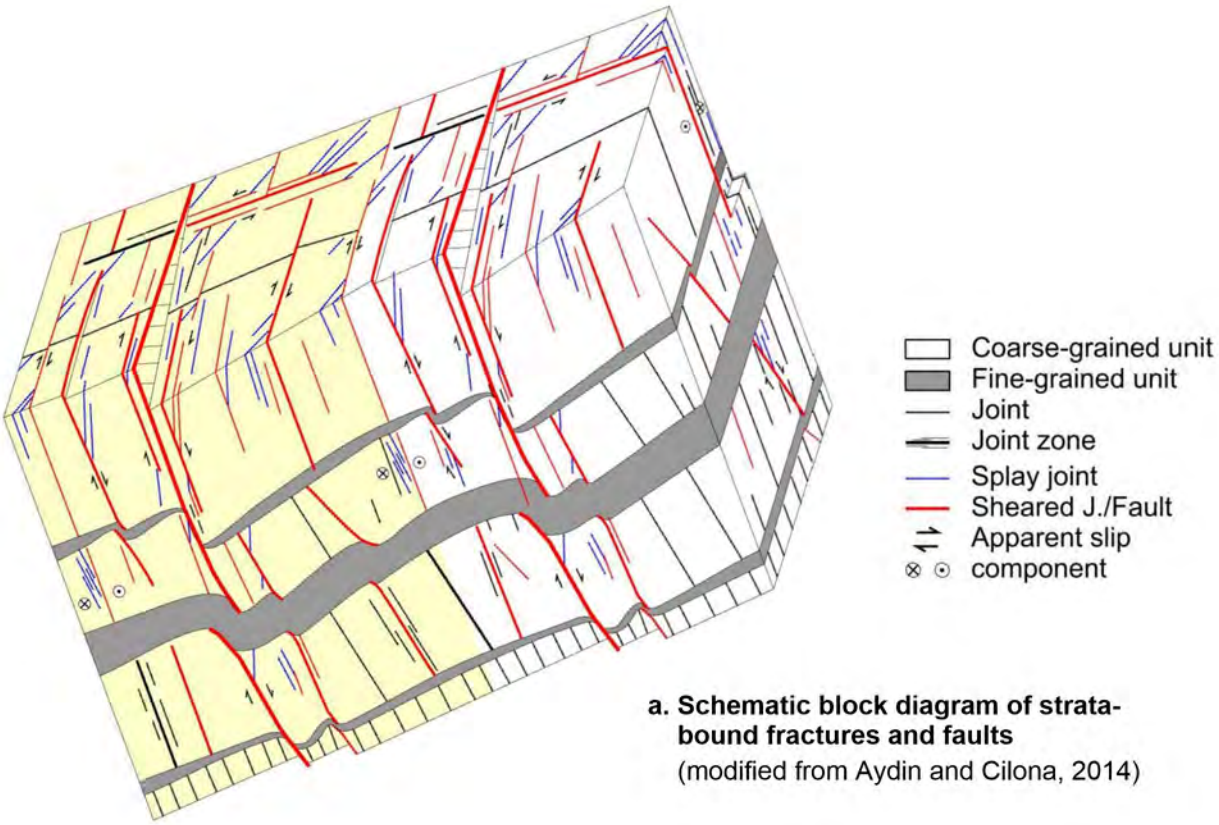


No vertical exaggeration
? = uncertain subsurface orientation

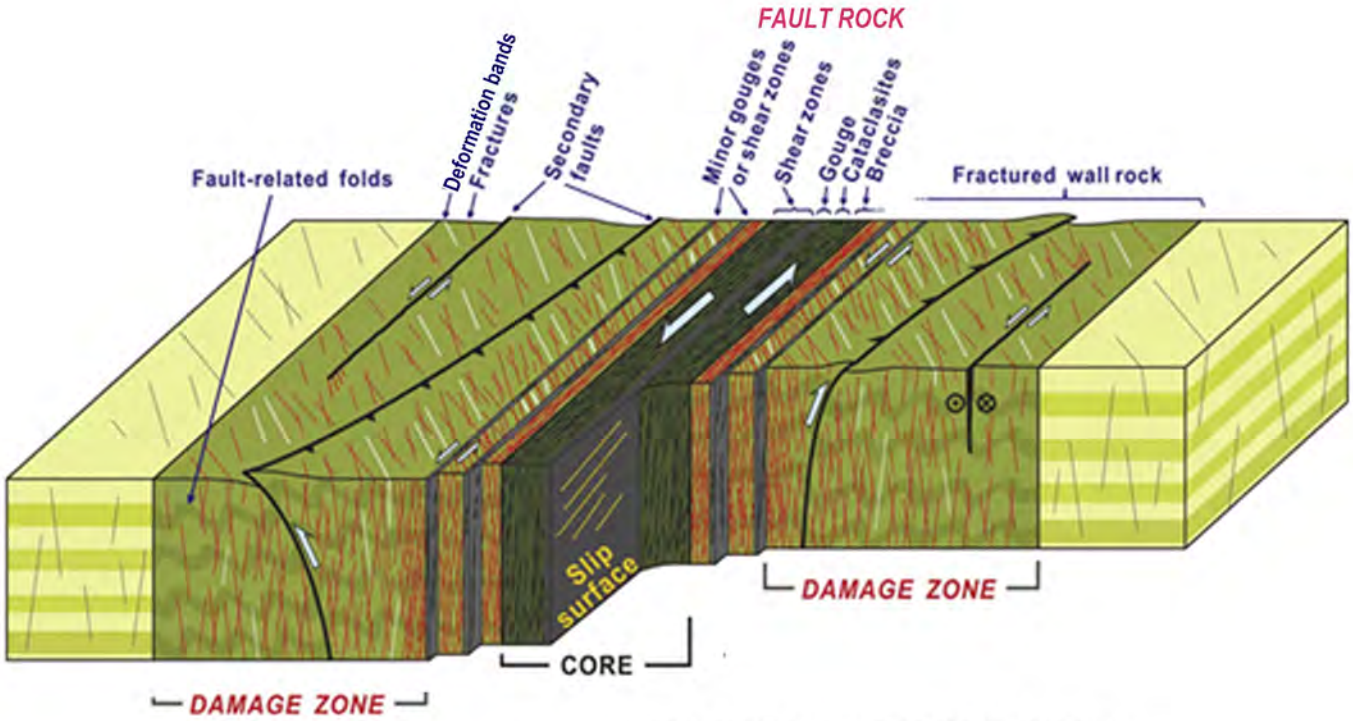
Well bore
Open interval
Fault
Seep
SAGE Geologic unit
Groundwater surface
Alluvium and fill
ECL Boeing RFI site
Fine-grained unit
PLF Other RFI site

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Figure 4-5
Geologic Cross Section *D-D'*
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

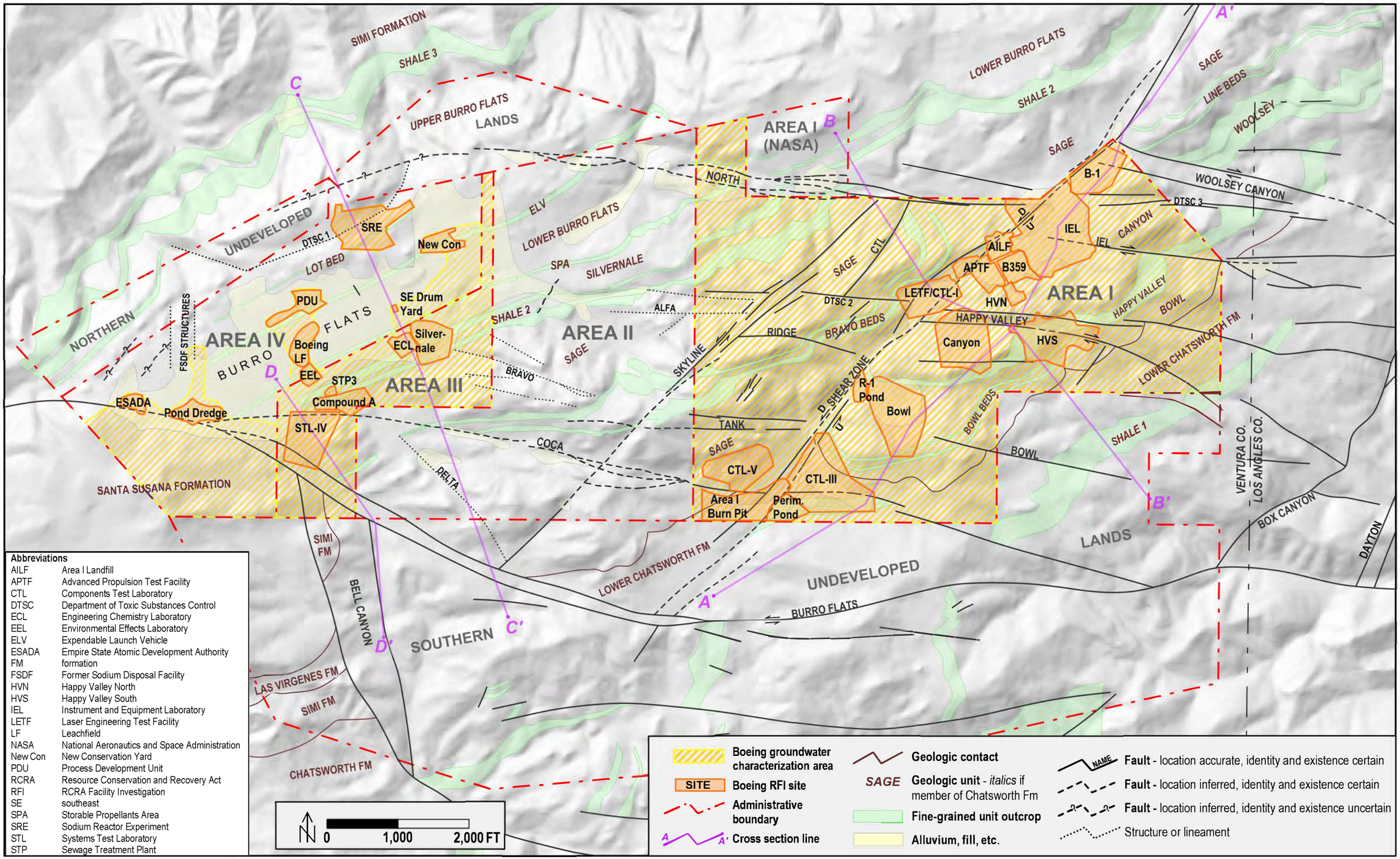


a. Schematic block diagram of strata-bound fractures and faults
(modified from Aydin and Cilona, 2014)



b. Fault-zone conceptual block-diagram
(modified from Choi and others, 2016)

Figure 4-6
Fracture and Fault-Zone Conceptual Models
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA



Abbreviations

AILF	Area I Landfill
APTF	Advanced Propulsion Test Facility
CTL	Components Test Laboratory
DTSC	Department of Toxic Substances Control
ECL	Engineering Chemistry Laboratory
EEL	Environmental Effects Laboratory
ELV	Expendable Launch Vehicle
ESADA	Empire State Atomic Development Authority
FM	formation
FSDF	Former Sodium Disposal Facility
HVN	Happy Valley North
HVS	Happy Valley South
IEL	Instrument and Equipment Laboratory
LETF	Laser Engineering Test Facility
LF	Leachfield
NASA	National Aeronautics and Space Administration
New Con	New Conservation Yard
PDU	Process Development Unit
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SE	southeast
SPA	Storable Propellants Area
SRE	Sodium Reactor Experiment
STL	Systems Test Laboratory
STP	Sewage Treatment Plant

Boeing groundwater characterization area
SITE Boeing RFI site
Administrative boundary
A A' Cross section line
Geologic contact
SAGE Geologic unit - *italics* if member of Chatsworth Fm
Fine-grained unit outcrop
Alluvium, fill, etc.
NAME Fault - location accurate, identity and existence certain
Fault - location inferred, identity and existence certain
Fault - location inferred, identity and existence uncertain
Structure or lineament

Figure 4-7
Geology Beneath Boeing RFI Sites
SANTA SUSANA FIELD LABORATORY, VENTURA CO., CA

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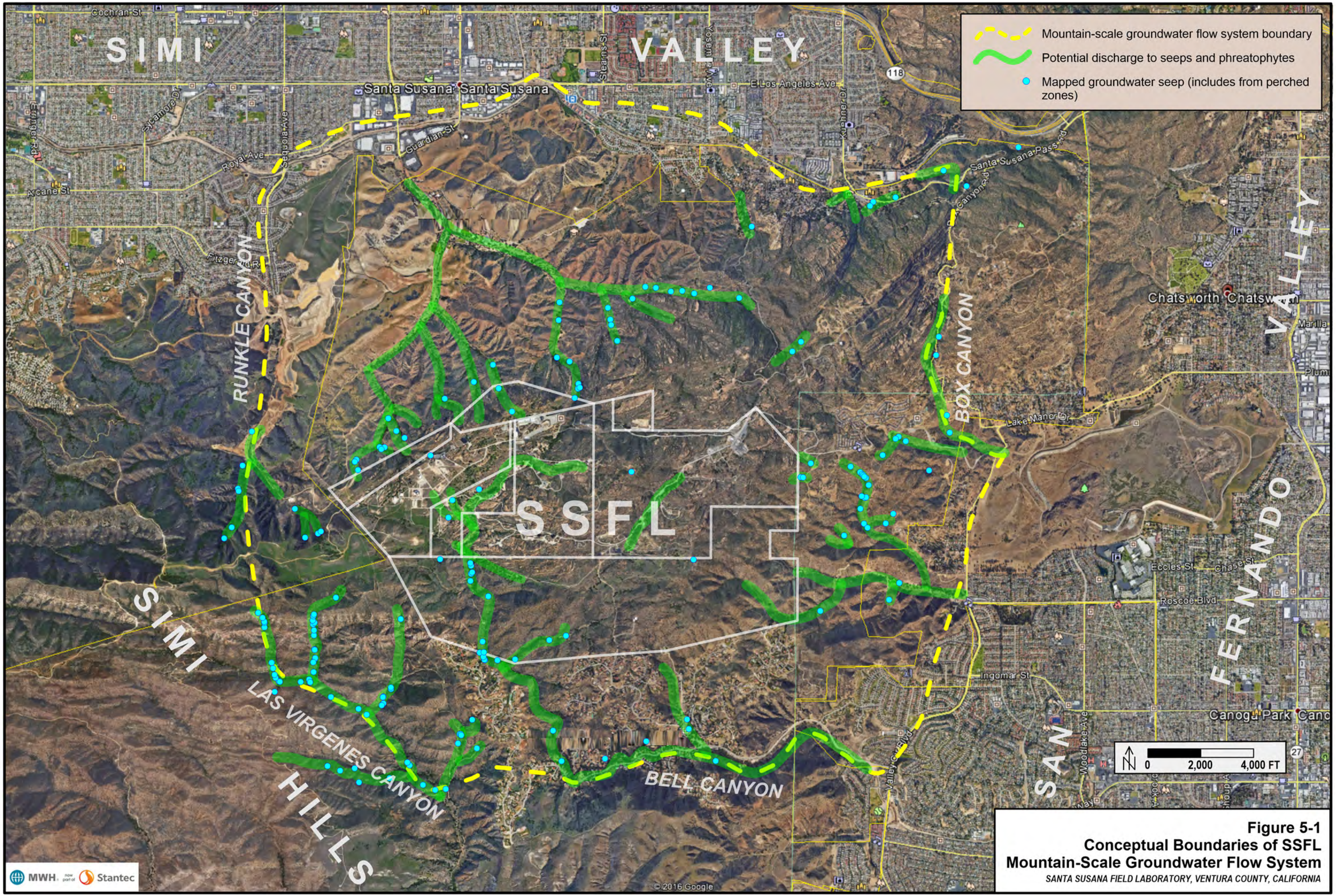


Figure 5-1
Conceptual Boundaries of SSFL Mountain-Scale Groundwater Flow System
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

Mountain-scale groundwater flow system
Geologic contact
Dominant fault
Chatsworth Formation fine-grained unit

SIMI VALLEY
SIMI HILLS
SAN FERNANDO VALLEY
SSFL
LLAJAS FM
SANTA SUSANA FM
SIMI FORMATION
SANDSTONE 2
SHALE 3
SHALE 2
SHEAR ZONE
SANDSTONE 1
SHALE 1
UPPER CHATSWORTH FM
LOWER CHATSWORTH FM
SANTA SUSANA PASS FLT
BURRO FLATS FLT
BELL CANYON
LAS VIRGENES FM
SIMI FM
LINDERO FM
Santa Susana
Chatsworth
Canoga Park
Cochran St
Royal Ave
Guardian St
Arcane St
Fitzgerald Rd
Sycamore Dr
Erringer Rd
Stearns St
Yosemite Ave
E Los Angeles Ave
Kuhner Dr
Santa Susana Pass Rd
Canyon Dr
Lake Manor Dr
Marilla
Plum
Eccles St
Chase St
Roscoe Blvd
Ingomar St
Valley Circle Blvd
Woodlake Ave
Sherman Way
Parthenia St
Plummer St
118
27

0 2,000 4,000 FT

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Figure 5-2
Mountain-Scale Geologic Map
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

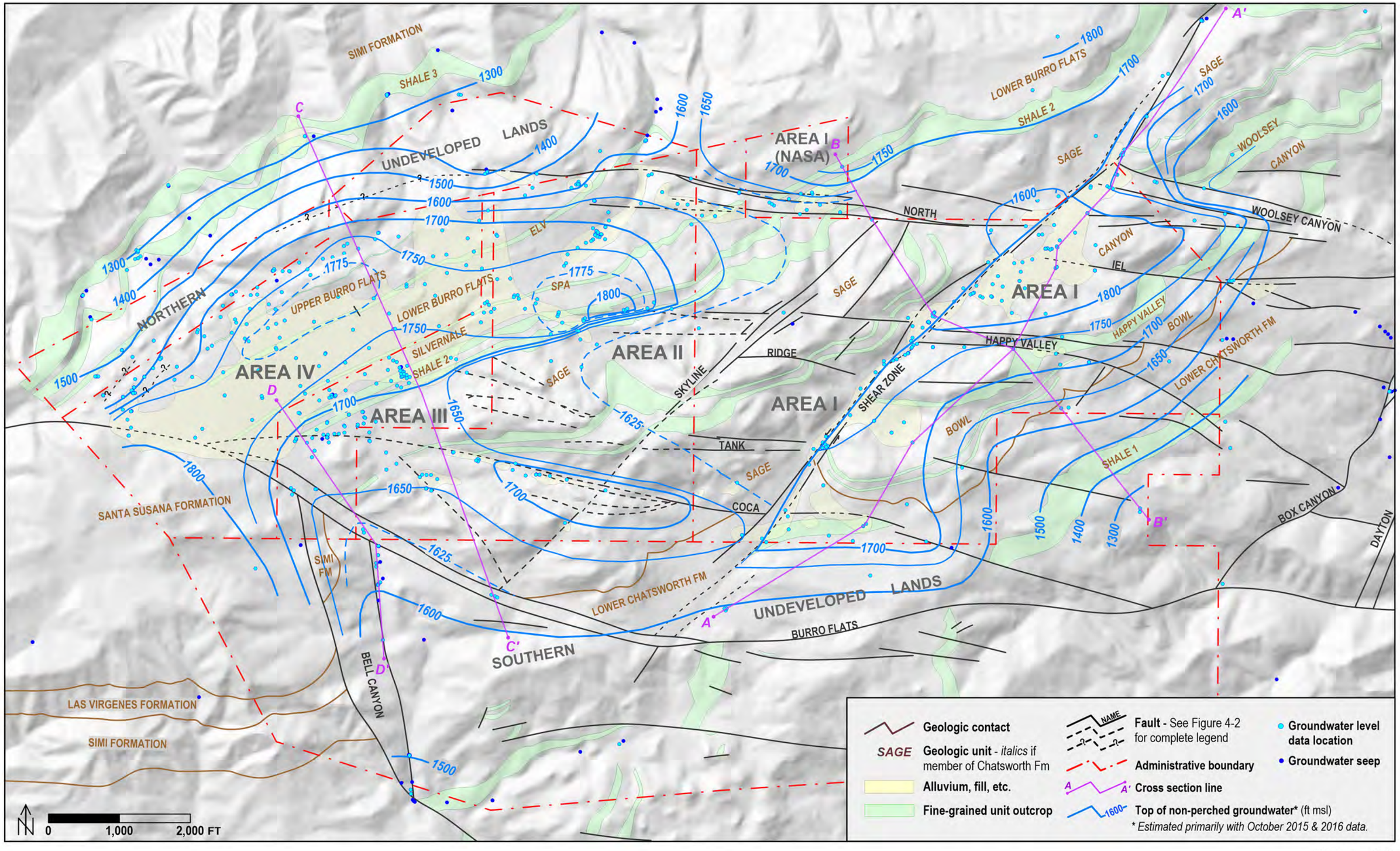
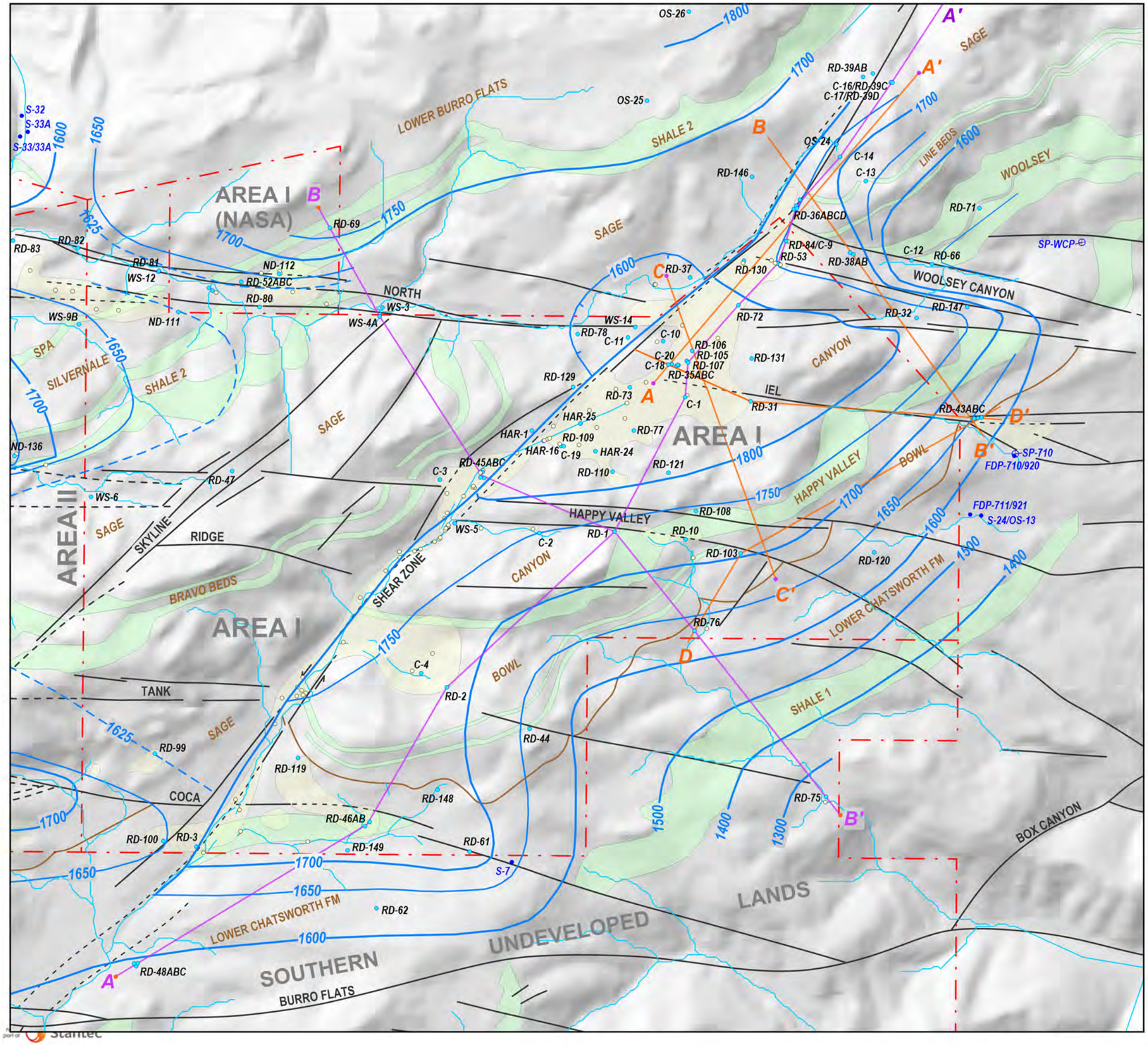
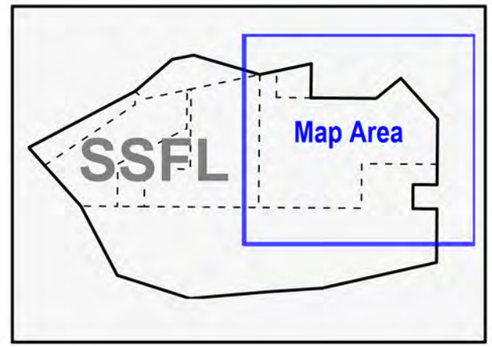


Figure 5-3
Approximate Top of Non-Perched Groundwater, Autumn 2015 and 2016
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

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- Administrative boundary
- A A' Line of section
- Drainage
- Geologic contact
- SAGE Geologic unit
- Alluvium and fill
- Fine-grained unit outcrop - hachured where uncertain
- NAME Fault - location accurate, identity and existence certain
- Fault - location inferred, identity and existence certain
- Fault - location inferred, identity and existence uncertain
- 1600 Top of non-perched groundwater* (ft msl)
- Monitoring Well >50 ft deep
- Monitoring well or piezometer <50 ft deep
- Groundwater seep
- Seep monitoring well cluster

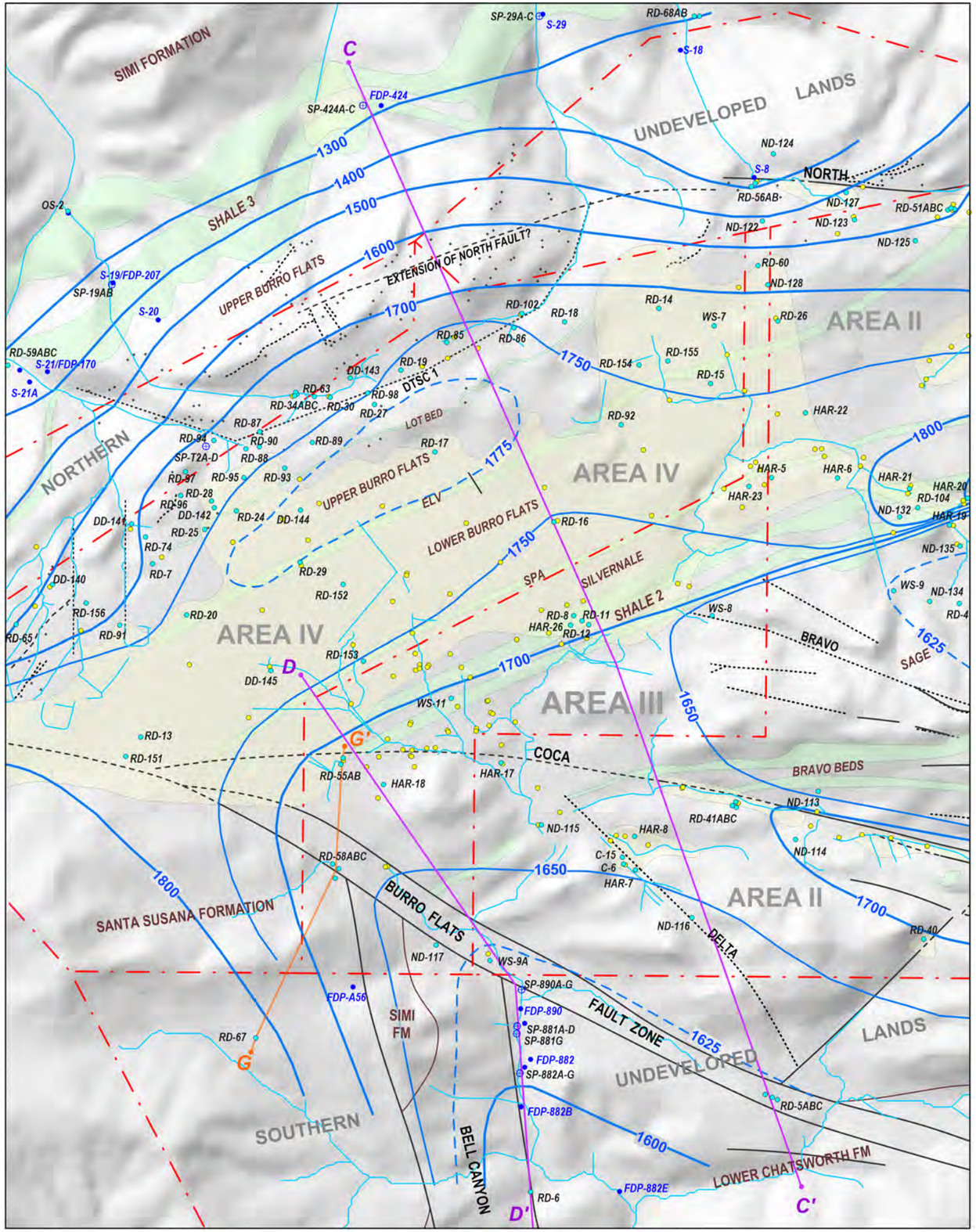
* *Estimated primarily with October 2015 & 2016 data.*

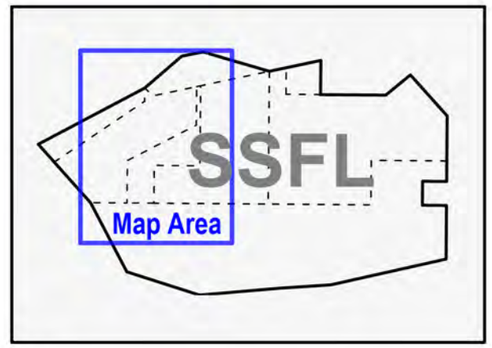
Cross sections ***A-A'*** and ***B-B'*** provided in Figure 4-3.
Cross sections ***A-A'*** through ***F-F'*** provided in Appendix 5-B.

N
0 1,000 2,000 FT

Figure 5-4
SSFL Area I Groundwater Monitoring Locations
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

MWH Stantec





- Administrative boundary
- A A' Line of section
- Drainage
- Geologic contact
- SAGE Geologic unit
- Alluvium and fill
- Fine-grained unit outcrop - hachured where uncertain
- NAME Fault - location accurate, identity and existence certain
- Fault - location inferred, identity and existence certain
- Fault - location inferred, identity and existence uncertain
- Structure or lineament
- Deformation band
- 1600 Top of non-perched groundwater* (ft msl)
- Monitoring Well >50 ft deep
- Monitoring well or piezometer <50 ft deep
- Groundwater seep
- Seep monitoring well cluster

** Estimated primarily with October 2015 & 2016 data.*

Cross sections *C-C'* and *D-D'* provided in Figures 4-4 and 4-5.
Cross section *G-G'* provided in Appendix 5-A.

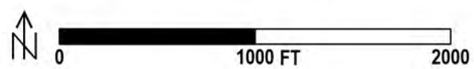
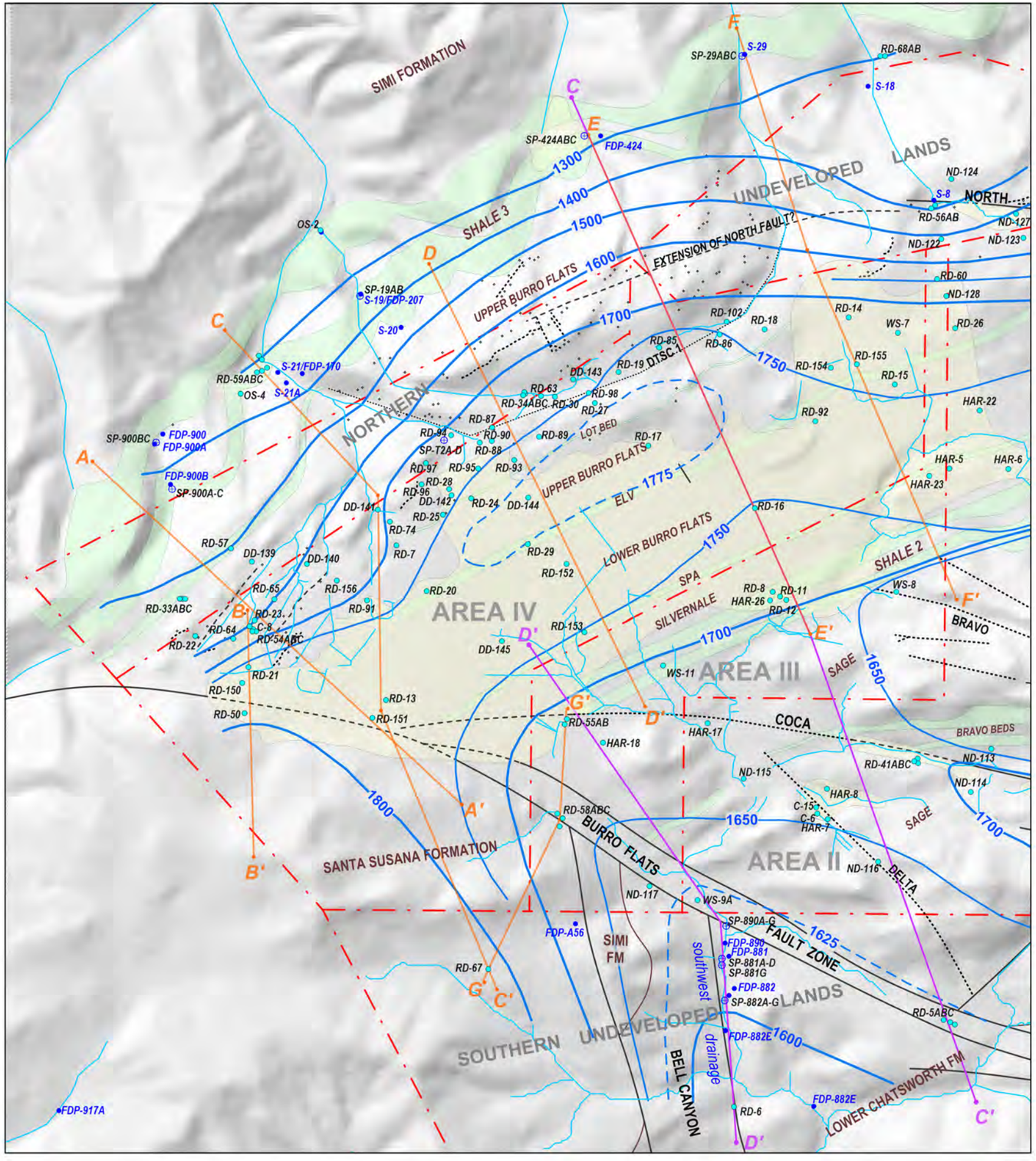
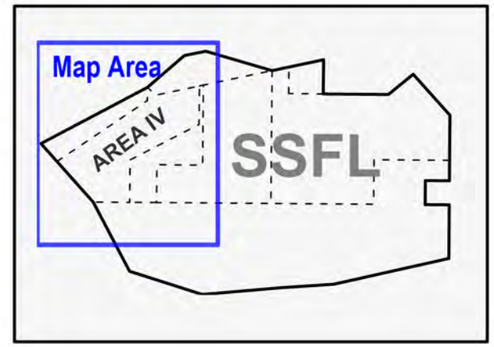


Figure 5-5
Area III Groundwater Monitoring Locations
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

MWH, now part of Stantec





- Administrative boundary
- A A' Line of section
- Drainage
- Geologic contact
- SAGE Geologic unit
- Alluvium and fill
- Fine-grained unit outcrop - hachured where uncertain
- NAME Fault - location accurate, identity and existence certain
- Fault - location inferred, identity and existence certain
- Fault - location inferred, identity and existence uncertain
- Structure or lineament
- Deformation band
- 1600 Top of non-perched groundwater* (ft msl)
- Monitoring Well >50 ft deep
- Monitoring well or piezometer <50 ft deep
- Groundwater seep
- Seep monitoring well cluster

* *Estimated primarily with October 2015 & 2016 data.*

Cross sections *A-A'* through *G-G'* provided in Appendix 5-A.
Cross sections *C-C'* and *D-D'* provided in Figures 4-4 and 4-5.

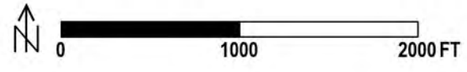


Figure 5-6
SSFL Area IV Groundwater Monitoring Locations
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

Undeveloped Land

Undeveloped Land

Boeing RFI Subarea 5/9 North

Boeing Area IV

Boeing RFI Subarea 1B North

Boeing RFI Subarea 1A North

Boeing RFI Subarea 1A Central

Boeing RFI Subarea 1A South

Undeveloped Land

Boeing RFI Subarea 5/9 South

Boeing RFI Subarea 1B Southwest

Boeing RFI Subarea 1B Southeast

Boeing RFI Subarea 10

0 600 1,200 2,400 Feet

1 inch = 1,200 feet
Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Chemical Use Areas
- Chemical Use Area Cluster
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

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CHEMICAL USE AREA AND CLUSTER LOCATIONS
FIGURE 6-1

Path: U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_01_BoeingCUAs.mxd

Undeveloped Land

Undeveloped Land

AREA I NASA

AREA IV

AREA III

AREA II

AREA I

Undeveloped Land

0 600 1,200 2,400 Feet

1 inch = 1,200 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Porewater
- Soil
- Soil Vapor
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

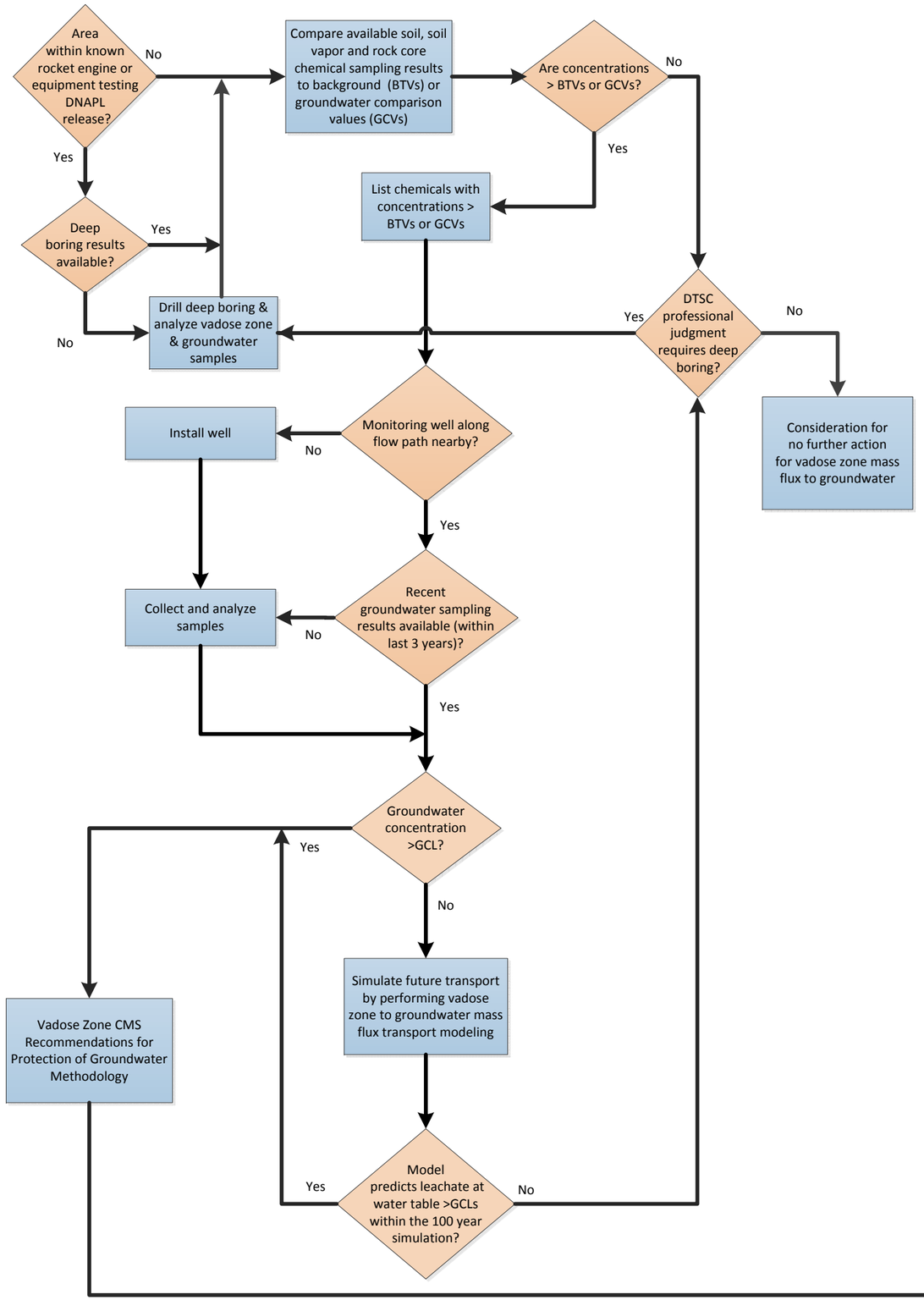
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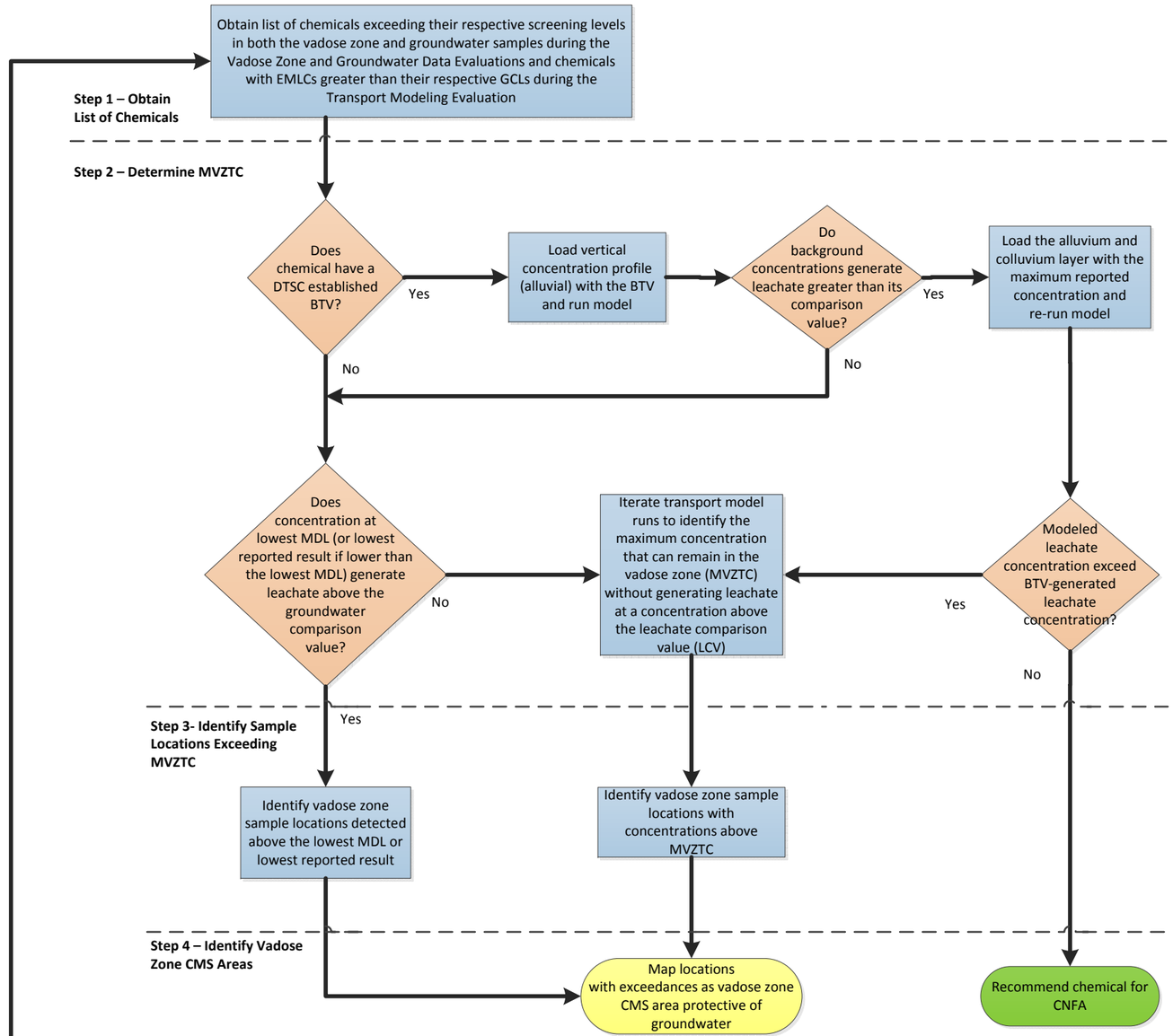
SOIL, SOIL VAPOR AND VADOSE ZONE BEDROCK SAMPLE LOCATIONS
FIGURE 6-2

Path: U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_02_SM_Samples.mxd

Methodology for Evaluating Chemical Transport from Sources in Vadose Zone to Groundwater



Methodology for Estimating Chemical Concentrations in Soil that Can Impact Groundwater



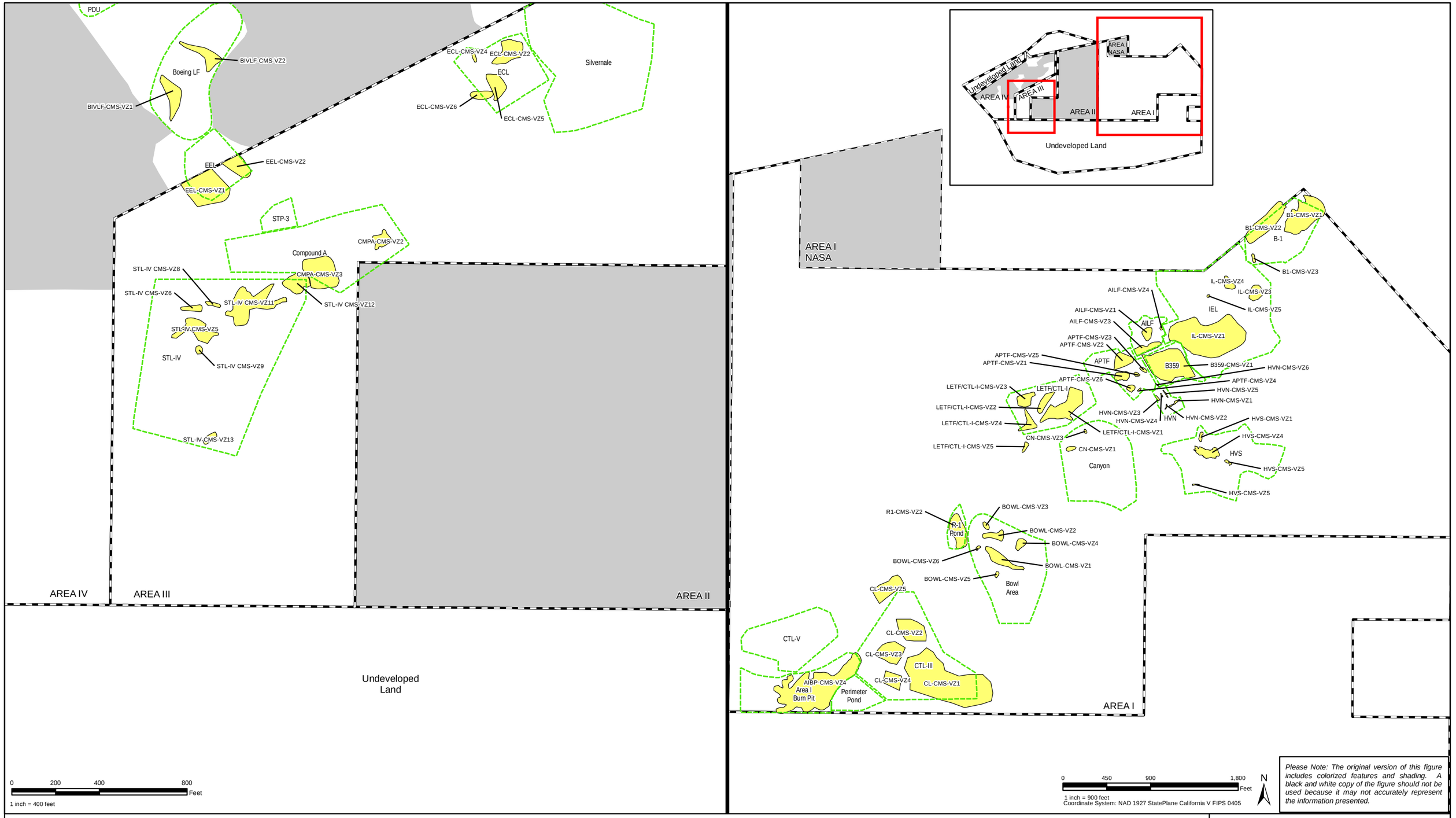
Abbreviations:

BTV	background threshold value
CMS	corrective measures study
CNFA	conditional no further action
DNAPL	dense non-aqueous phase liquid
DTSC	Department of Toxic Substances Control
MVZTC	Modeled vadose zone threshold concentration: concentration that can remain without producing leachate at the water table at concentrations above the GCL
GCL	groundwater characterization level
GCV	groundwater comparison value
LCV	leachate comparison values. LCV equals GCL for chemicals with no DTSC established BTV and higher value between GCL and modeled leachate concentration generated by BTV loaded to vertical concentration file for chemicals where DTSC established BTV is available
MDL	method detection limit

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METHODOLOGY FOR CHARACTERIZING VADOSE ZONE CHEMICAL TRANSPORT TO GROUNDWATER
FIGURE 6-3



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

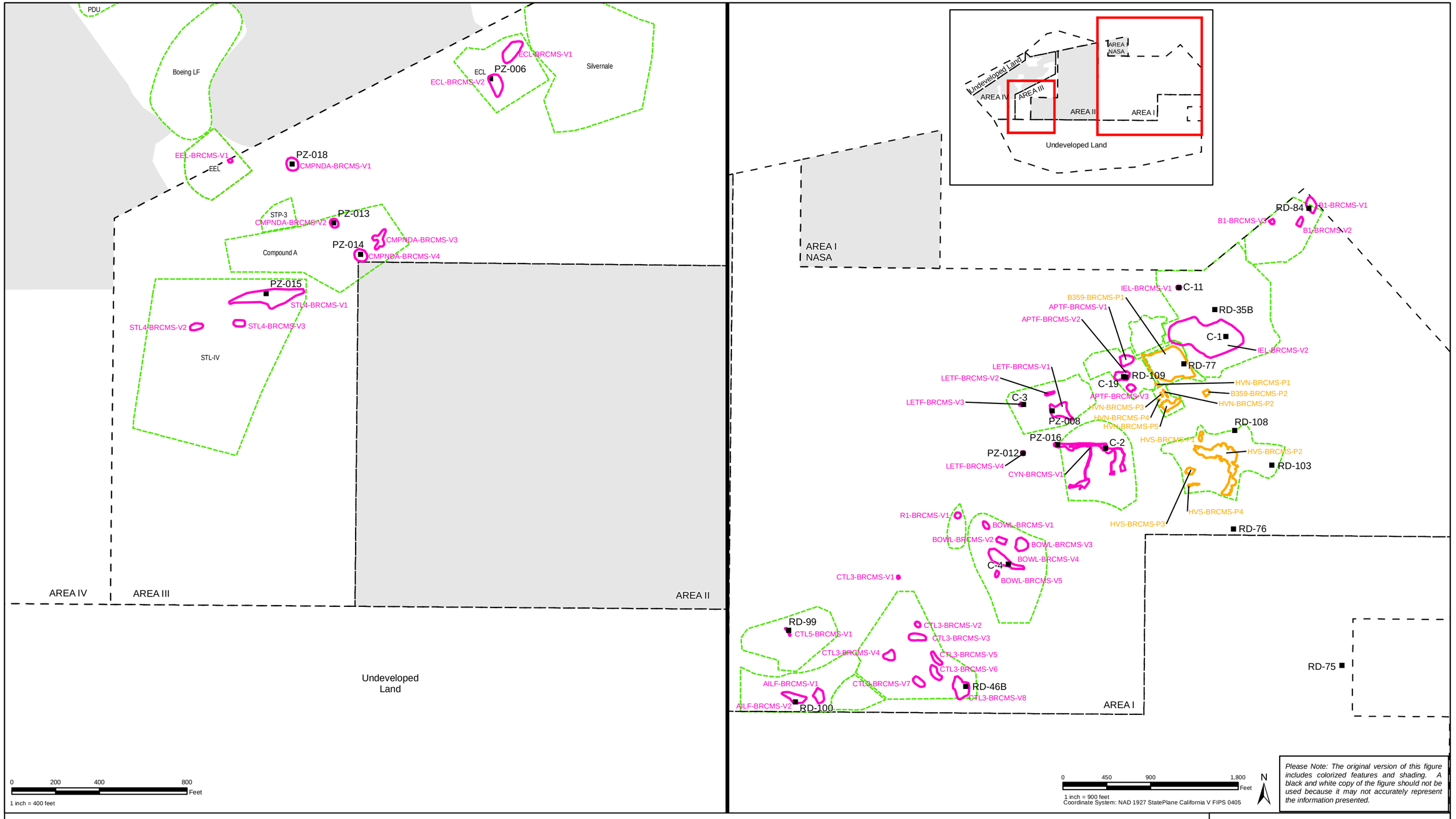
- Estimated Areas in Soil of Chemical Sources to Groundwater
- Boeing RFI Site
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

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ESTIMATED AREAS IN SOIL OF CHEMICAL SOURCES TO GROUNDWATER
FIGURE 6-4

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_04_SoilSources.mxd 6/2/2017



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

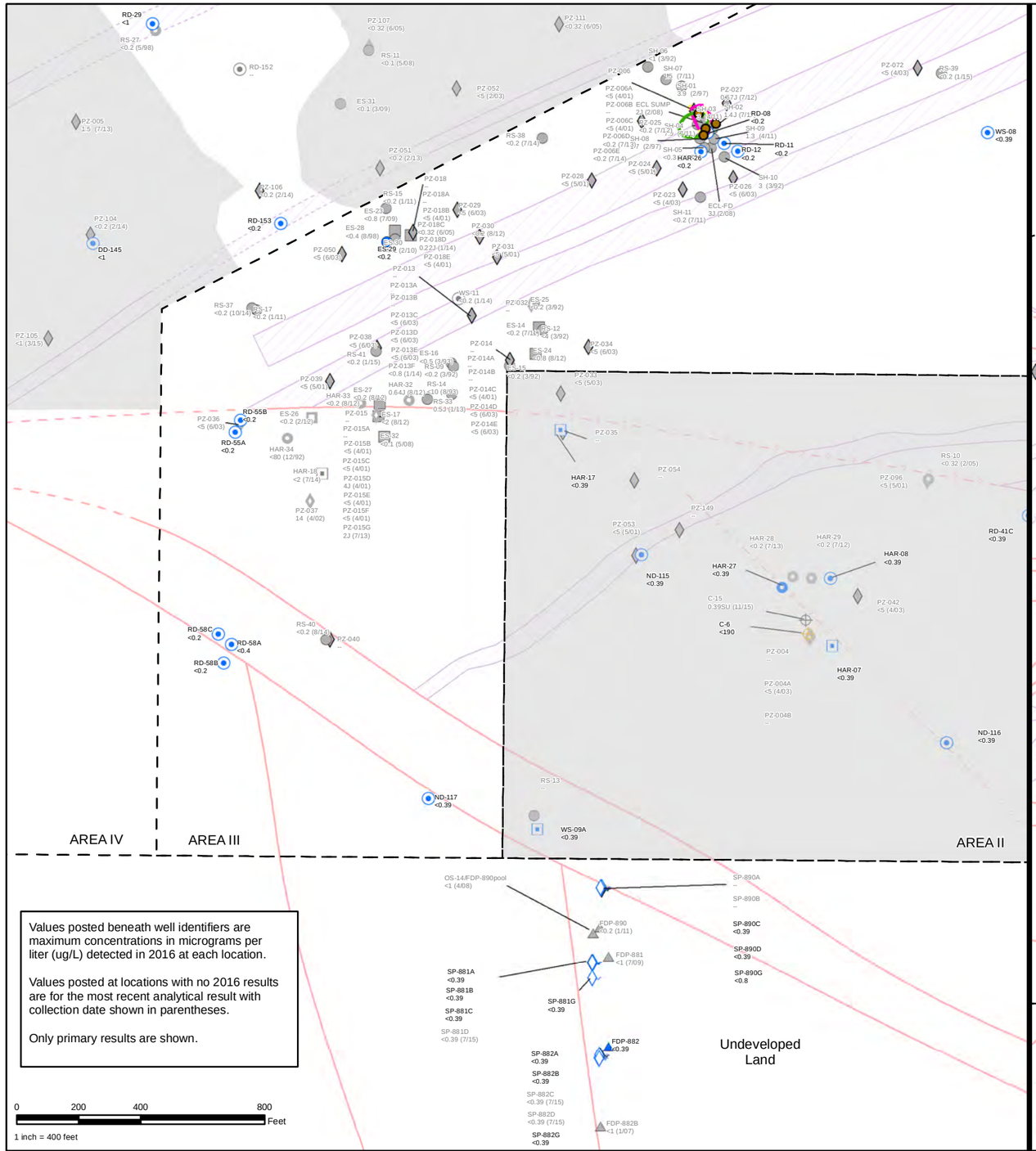
- Vadose Zone Porewater Location
- Estimated Areas of Impacted Bedrock and Sources to Groundwater from Trichloroethene
- Estimated Areas of Impacted Bedrock and Sources to Groundwater from Perchlorate
- Boeing RFI Site
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

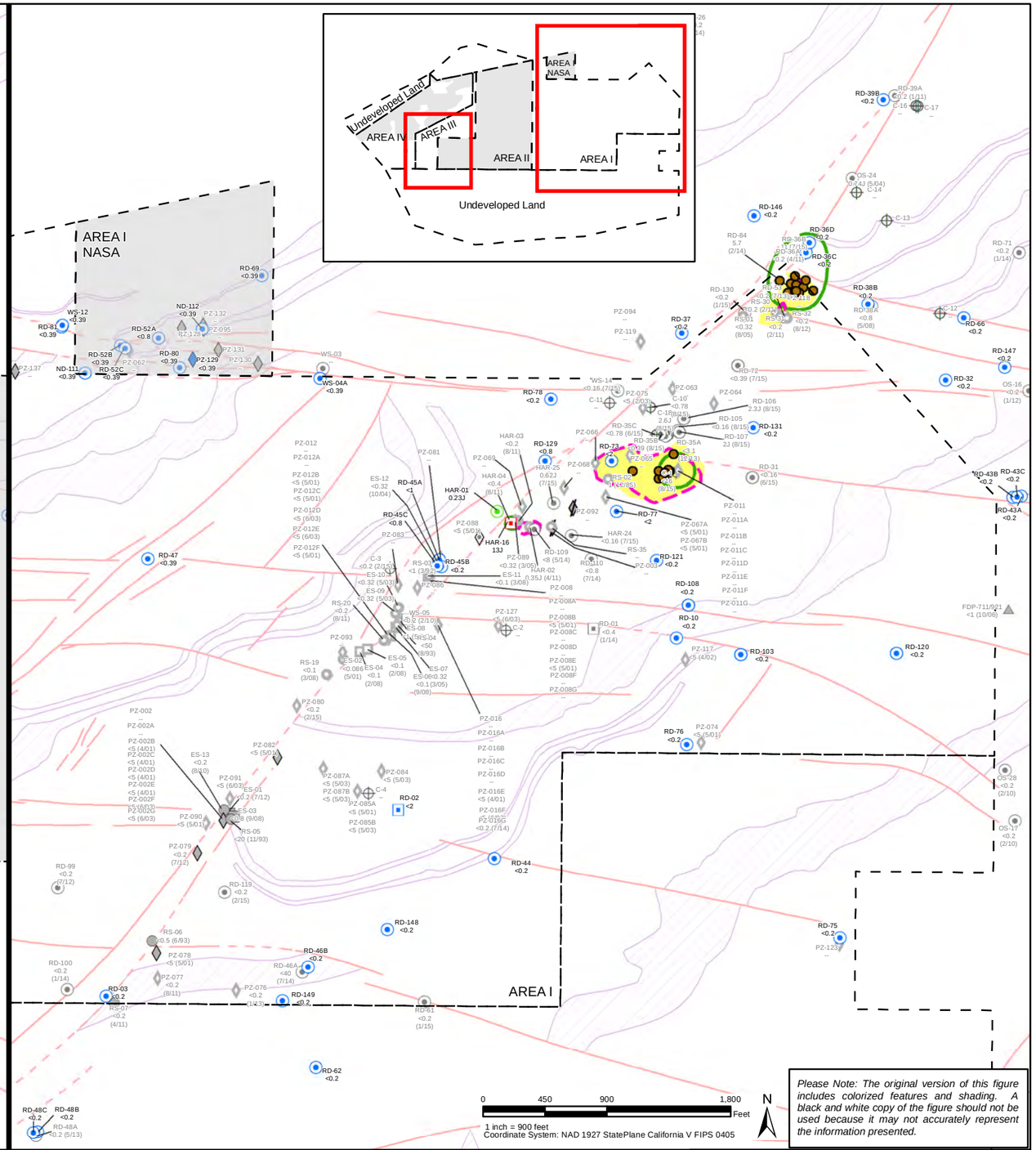
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ESTIMATED AREAS OF IMPACTED BEDROCK AND SOURCES TO GROUNDWATER
FIGURE 6-5

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_05_ImpactedBedrock.mxd 6/1/2017





Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Interpreted area of impacted bedrock
- Tetrachloroethene in Groundwater above Primary MCL of 5 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

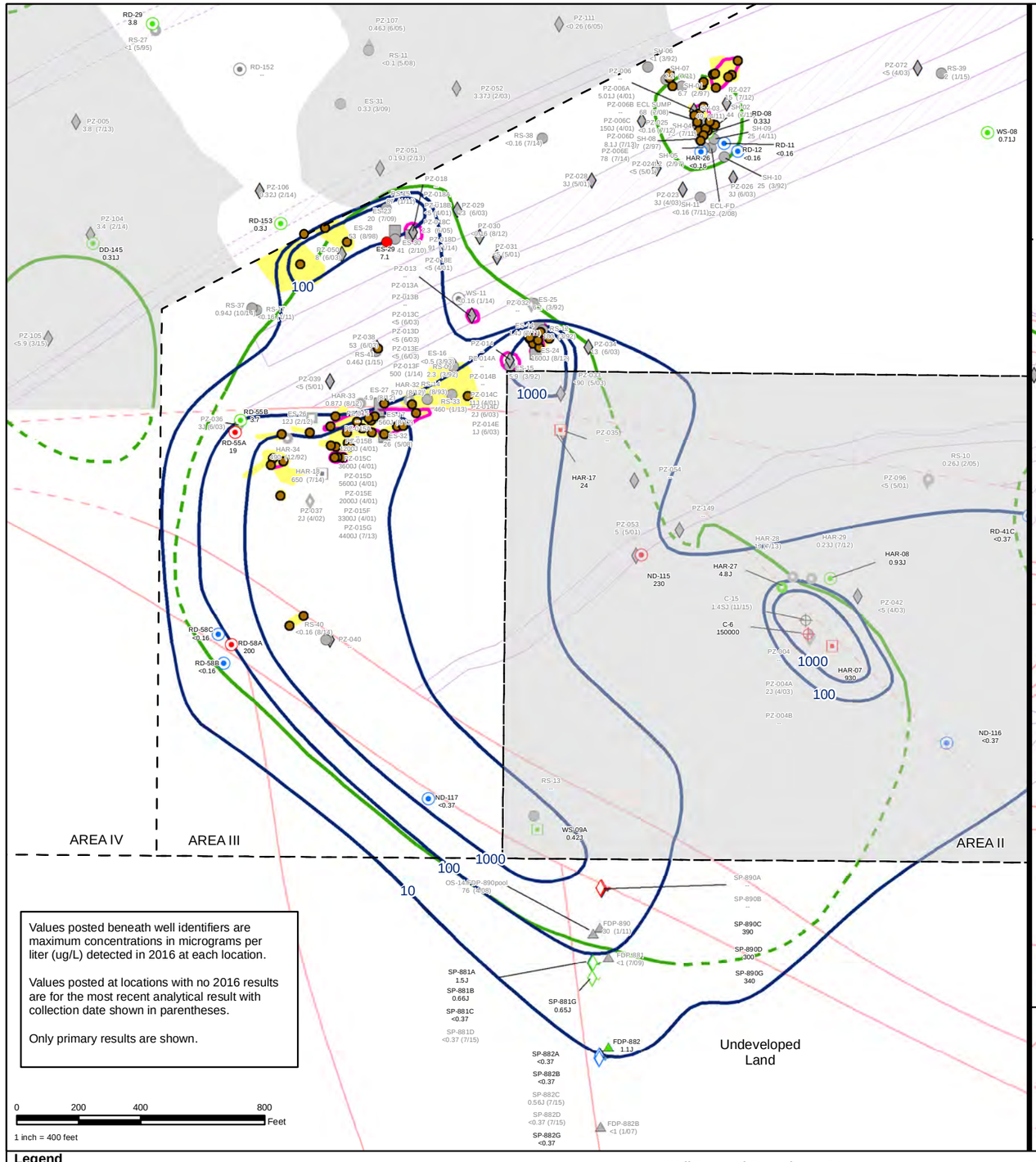
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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PCE IN GROUNDWATER: SOIL AND BEDROCK SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-6

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_06_PCE.mxd 5/31/2017



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- TCE, cDCE, tDCE, 1-1-DCE or vinyl chloride locations in soil or soil vapor indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Interpreted area of impacted bedrock
- TCE in Groundwater above Primary MCL of 5 ug/L
- Equivalent TCE Iso-concentration Contour

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

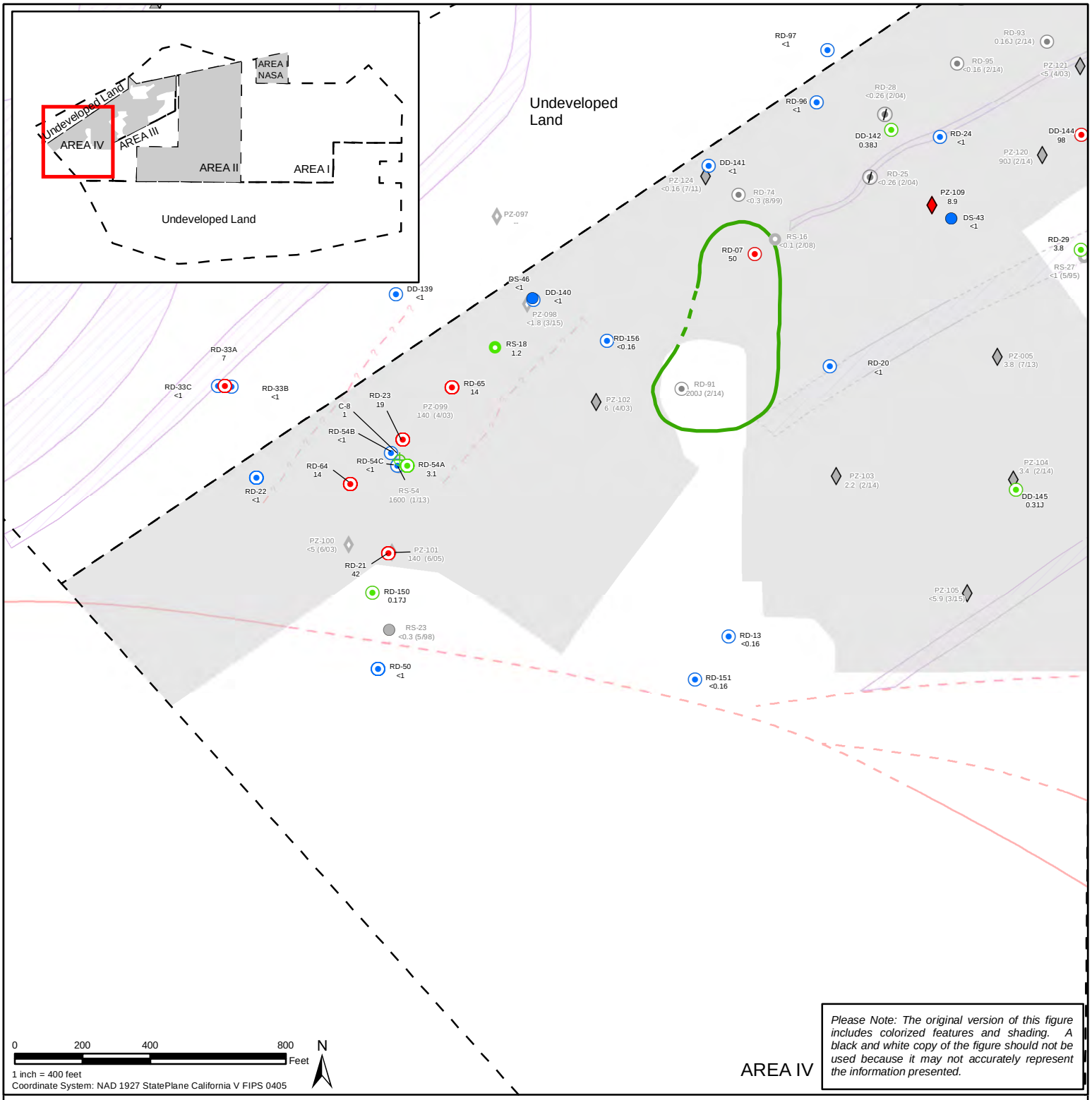
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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TCE IN GROUNDWATER: SOIL AND BEDROCK SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER, AREAS I AND III
FIGURE 6-7

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_07_TCE.mxd 6/2/2017



Legend

Symbol Color for Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

TCE in Groundwater above Primary MCL of 5 ug/L

Areas of NASA or DOE responsibility

Administrative Area Boundary

Fault - location accurate, identity and existance certain

Fault - location inferred, identity and existance certain

Fault - location inferred, identity and existance uncertain

Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

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TCE IN GROUNDWATER, AREA IV, BOEING
FIGURE 6-8

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_08_TCE_AreaIV.mxd 6/1/2017

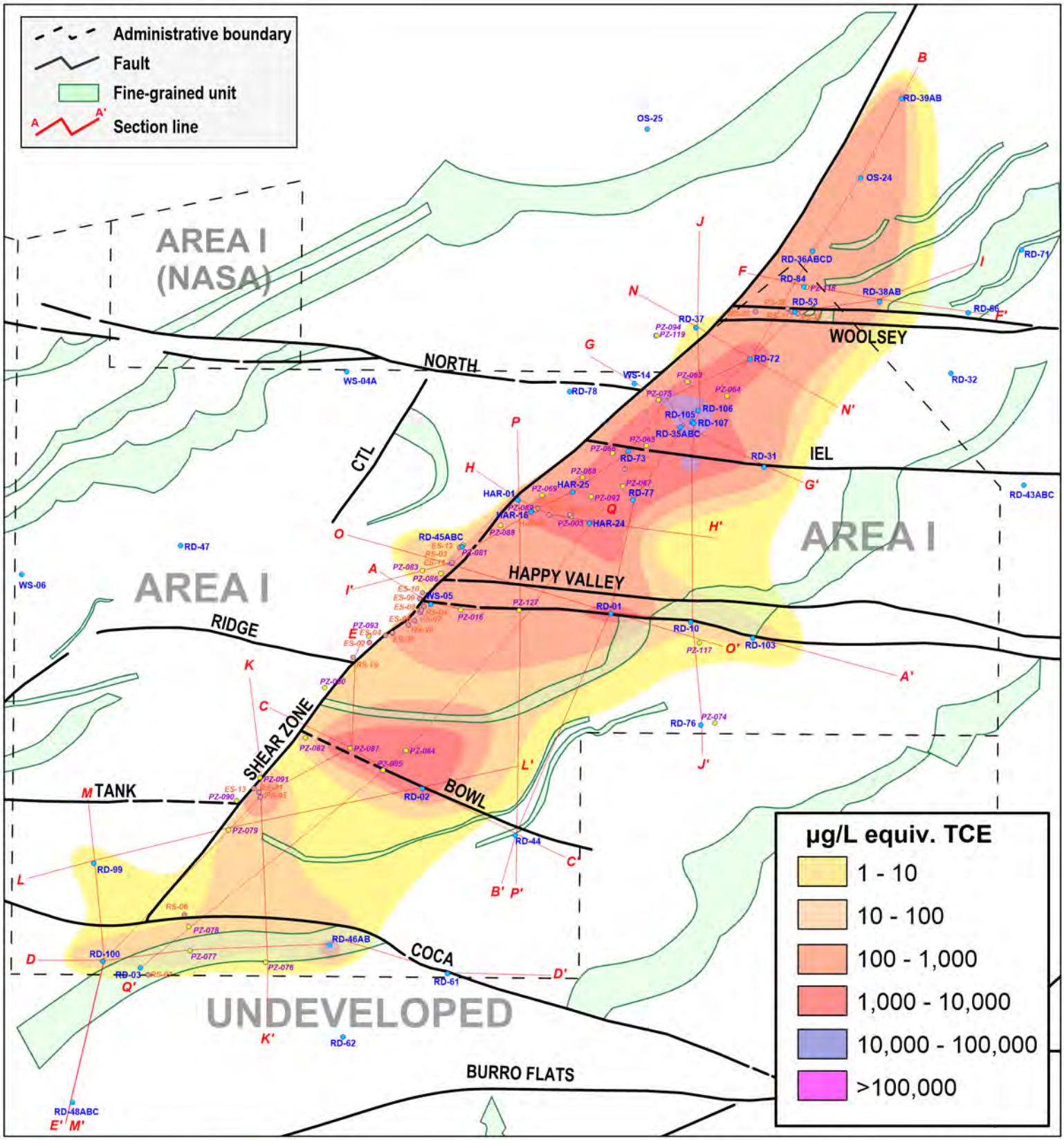
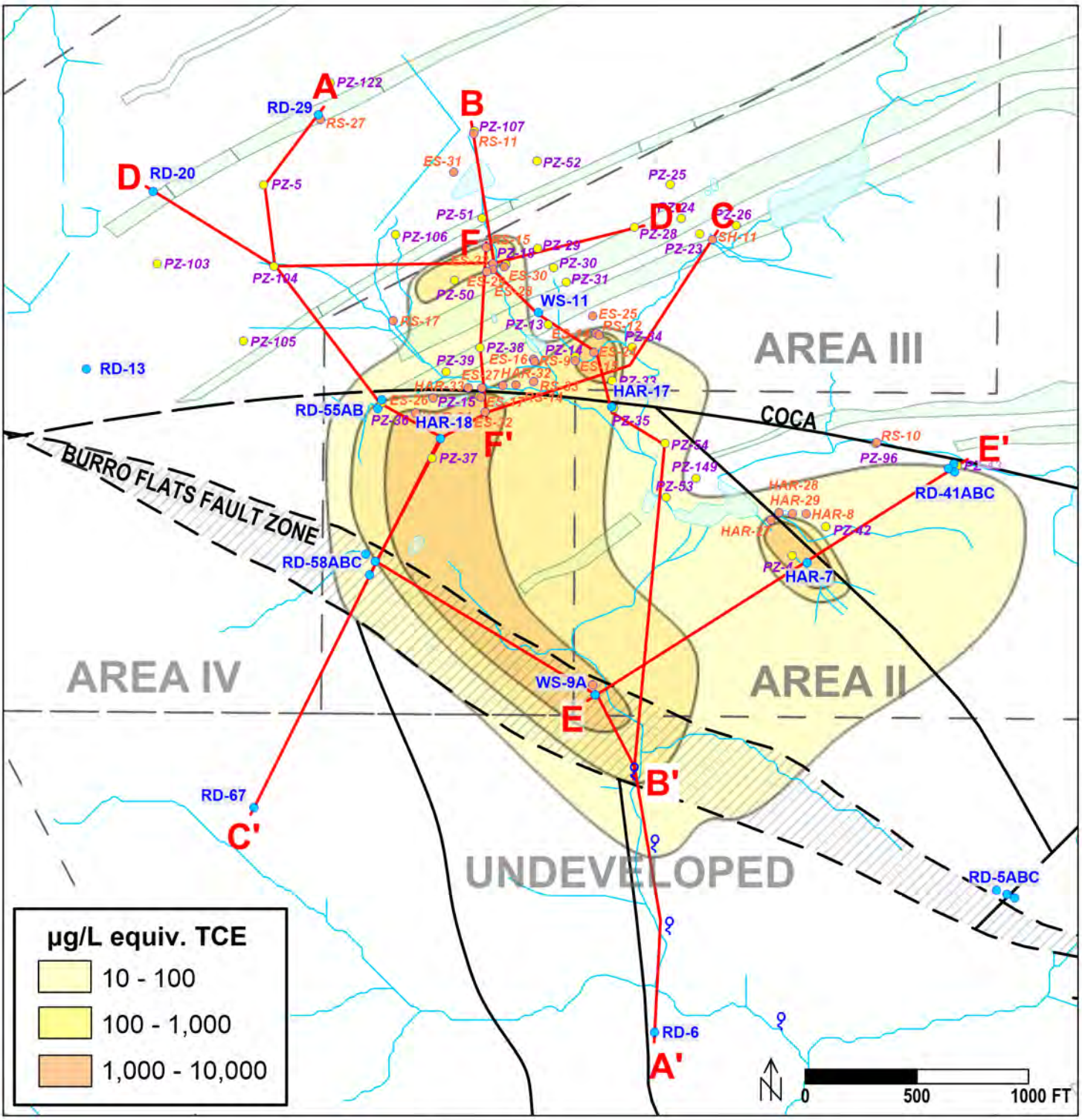


Figure 6-9
Maximum Equivalent TCE Concentrations in Groundwater - Area I

SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

MWH Stantec

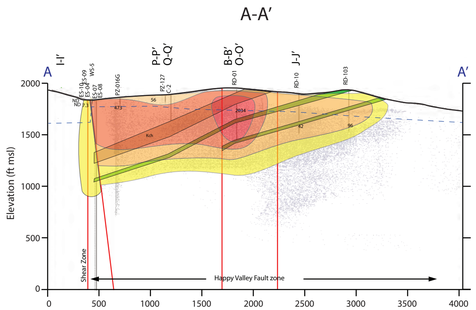


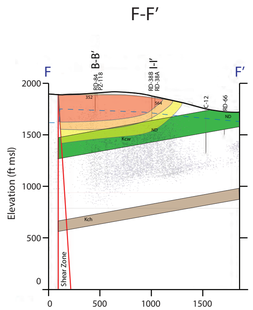
Equivalent TCE is the sum concentration of TCE and its degradation products, normalized to the molecular weight of TCE.

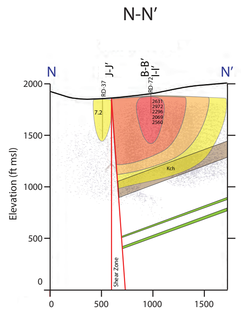
The interpolated concentrations and extent of TCE and its degradation products within Areas II and IV are subject to final interpretation by NASA and DOE, respectively.

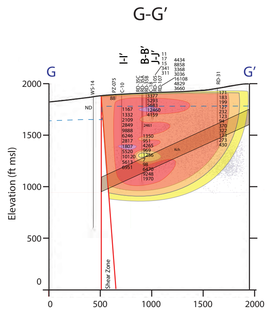
Figure 6-10
Maximum Equivalent TCE Concentrations in Groundwater - Area III
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

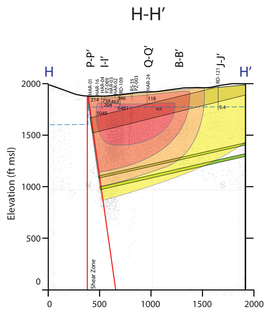
MWH Stantec

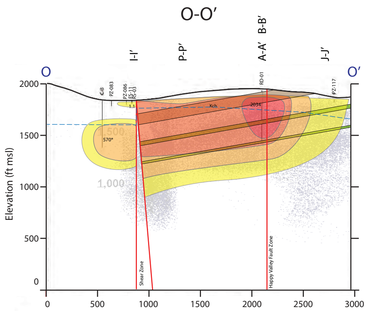


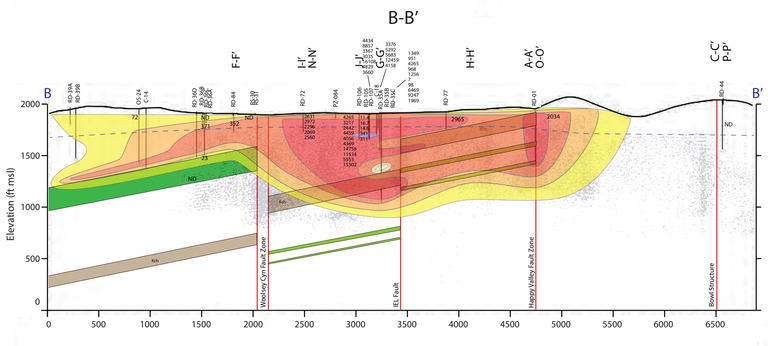


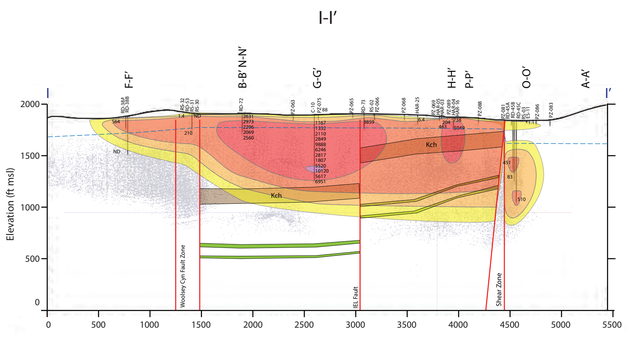


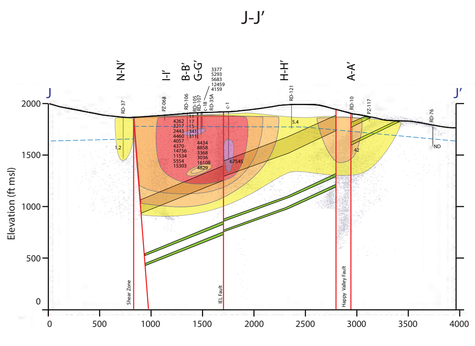


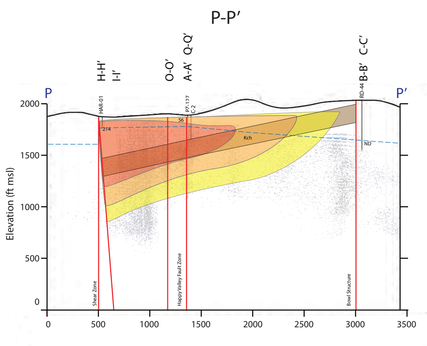


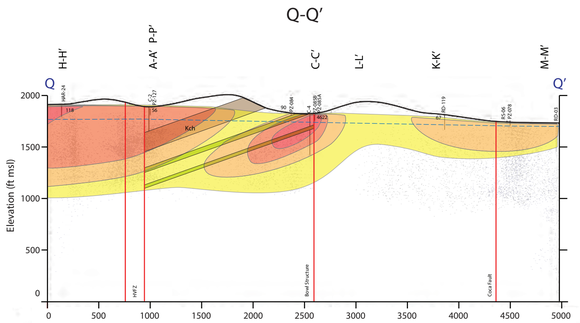


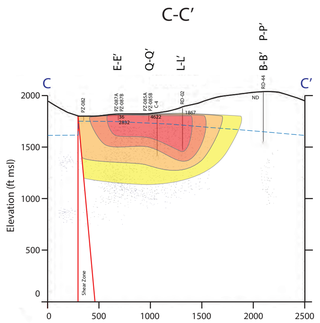


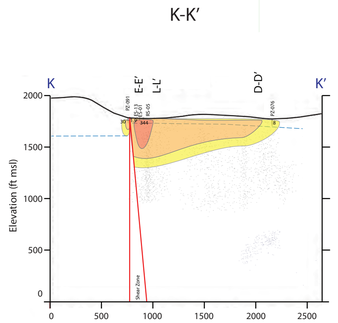


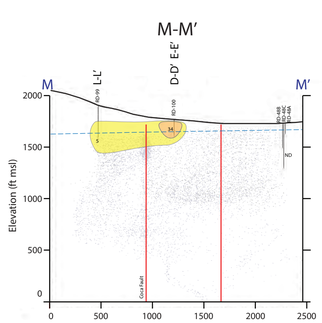


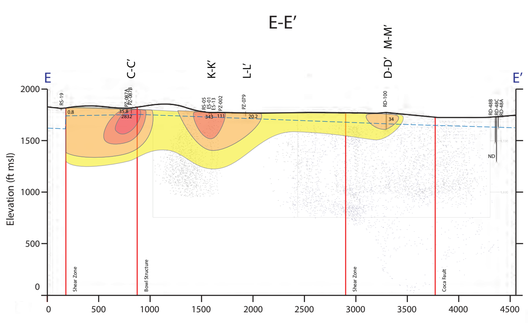


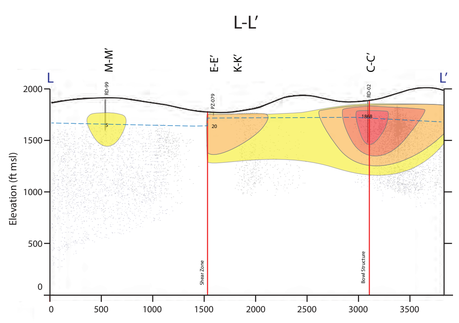


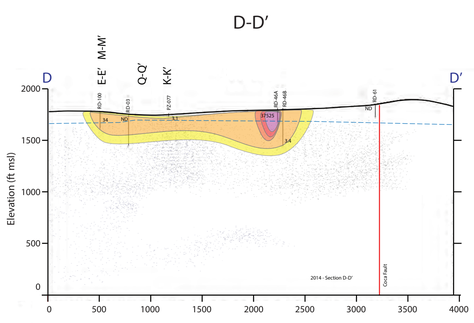












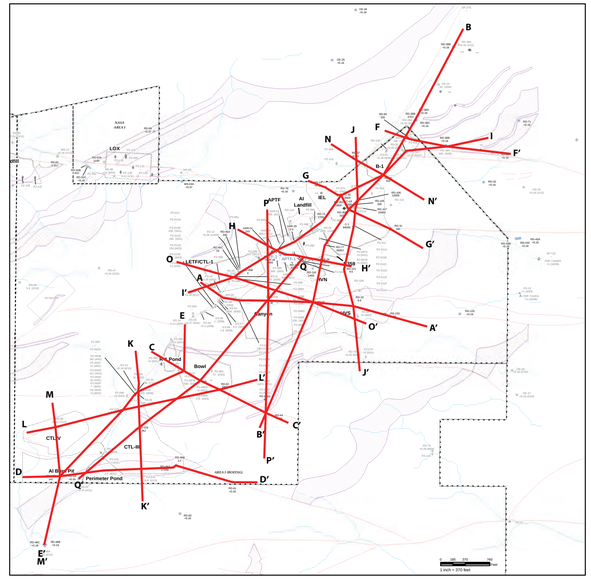
µg/L equivelent TCE

- 1 - 10
- 10 - 100
- 100 - 1,000
- 1,000 - 10,000
- >10,000

Plumes truncated at groundwater surface during digital interpolation

- Approximate non-perched groundwater surface
- Simulated particle track intersection with with plane of cross section (± 100 ft)

No vertical exaggeration

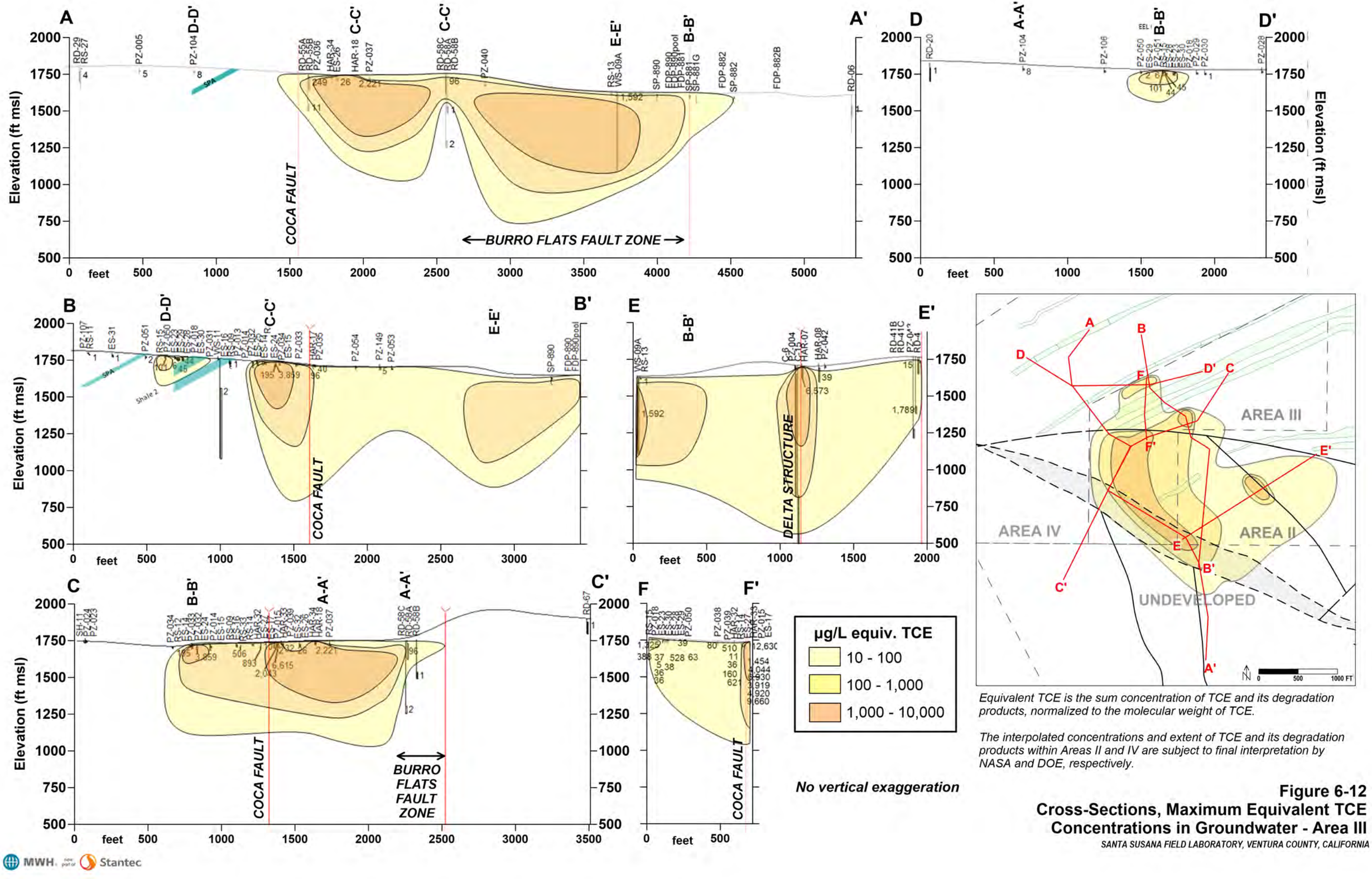


Equivalent TCE is the sum concentration of TCE and its degradation products, normalized to the molecular weight of TCE.

Figure 6-11
Cross Sections, Maximum Equivalent TCE Concentrations in Groundwater - Area I

SANTA SUSANA FIELD LABORATORY, VENTRUA COUNTY, CALIFORNIA

MWH a Tetra Tech company Stantec

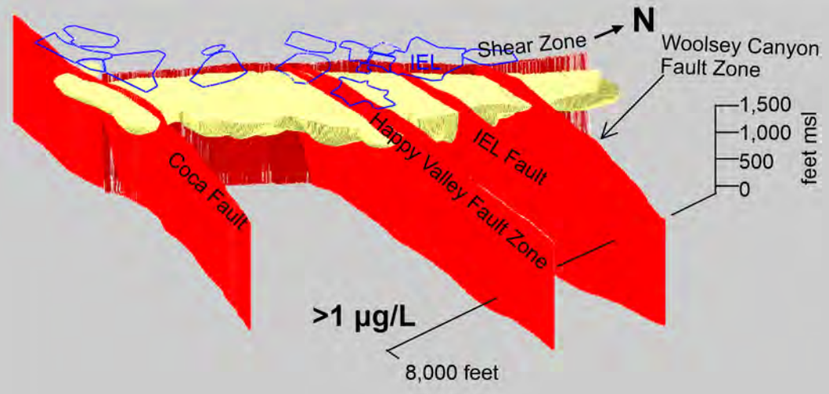


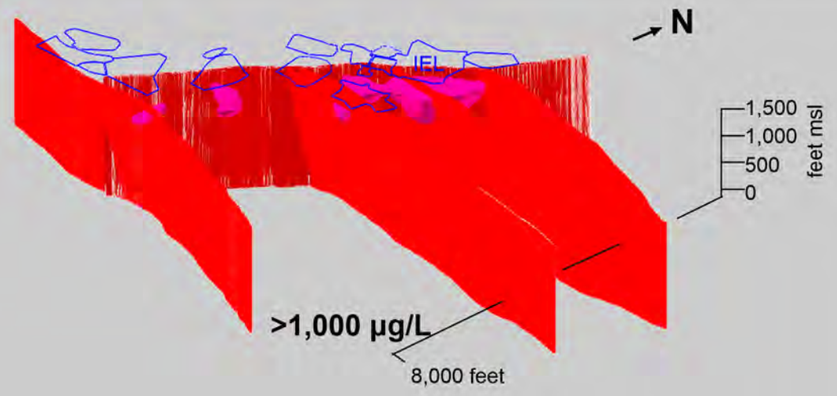
Equivalent TCE is the sum concentration of TCE and its degradation products, normalized to the molecular weight of TCE.

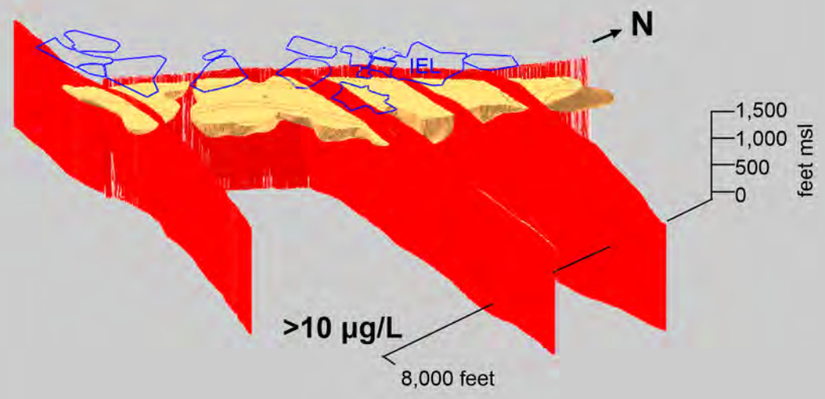
The interpolated concentrations and extent of TCE and its degradation products within Areas II and IV are subject to final interpretation by NASA and DOE, respectively.

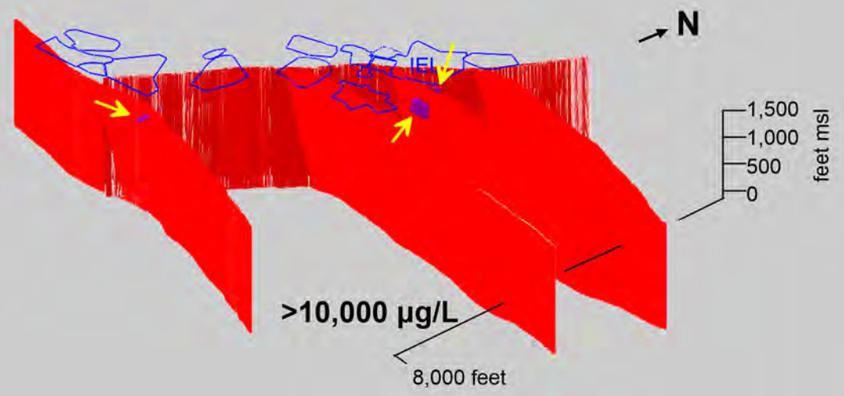
Figure 6-12
Cross-Sections, Maximum Equivalent TCE Concentrations in Groundwater - Area III
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

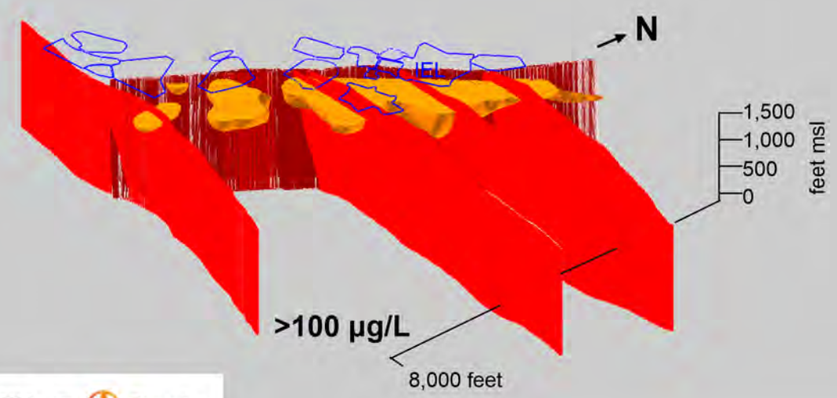
MWH Stantec

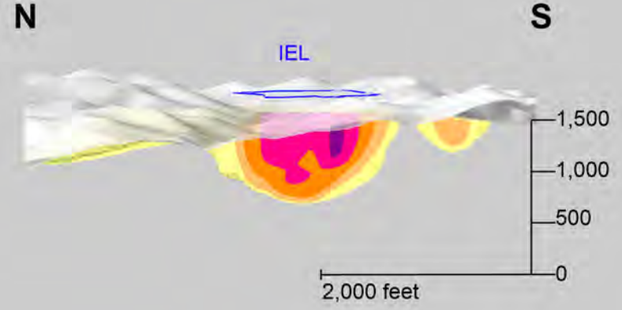










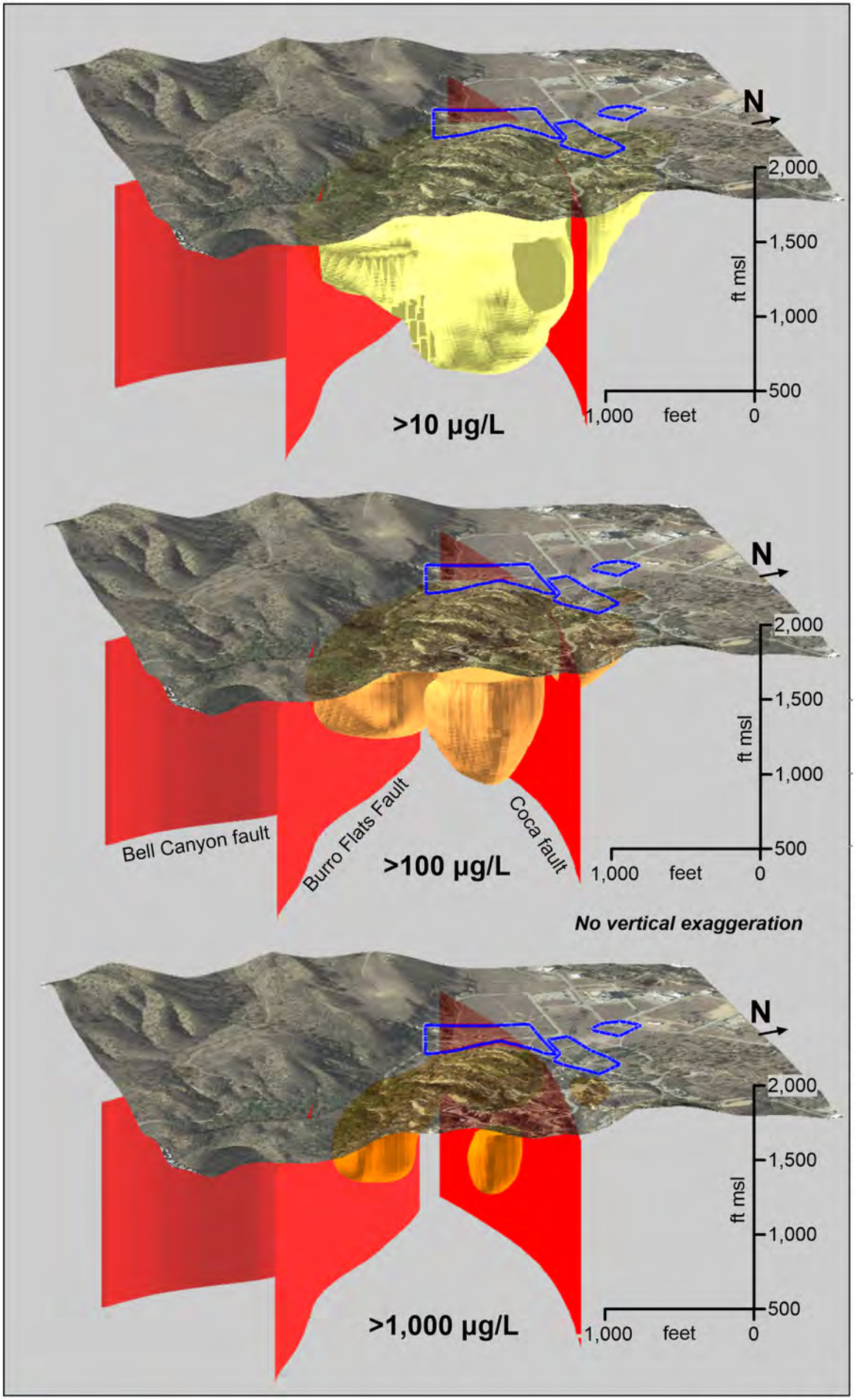


Three-Dimensional Interpolation Beneath IEL

Equivalent TCE is the sum concentration of TCE and its degradation products, normalized to the molecular weight of TCE.

No vertical exaggeration

Figure 6-13
Three-Dimentional Interpolation of Maximum Equivalent TCE Concentrations - Area I
SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA



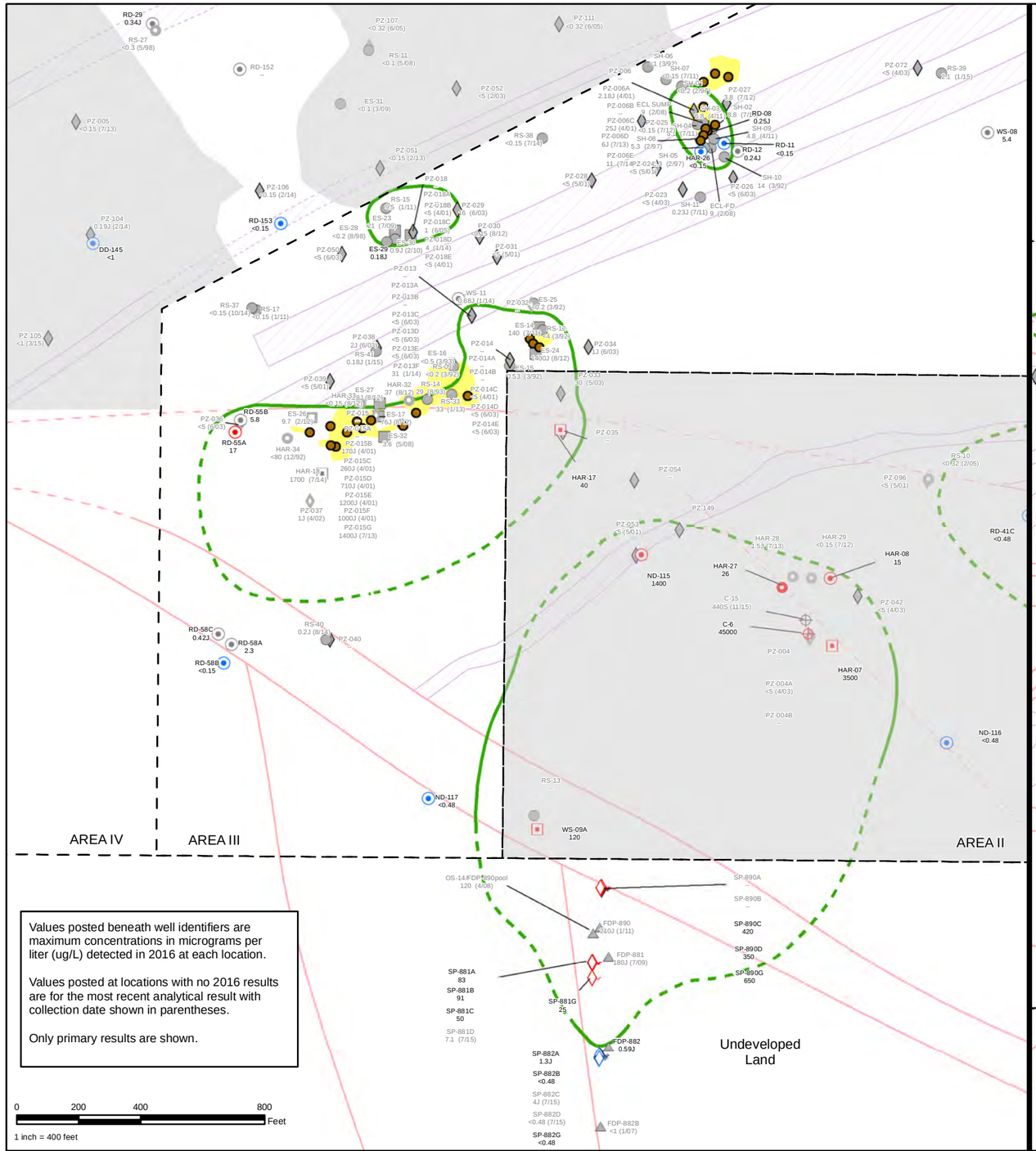
Equivalent TCE is the sum concentration of TCE and its degradation products, normalized to the molecular weight of TCE.

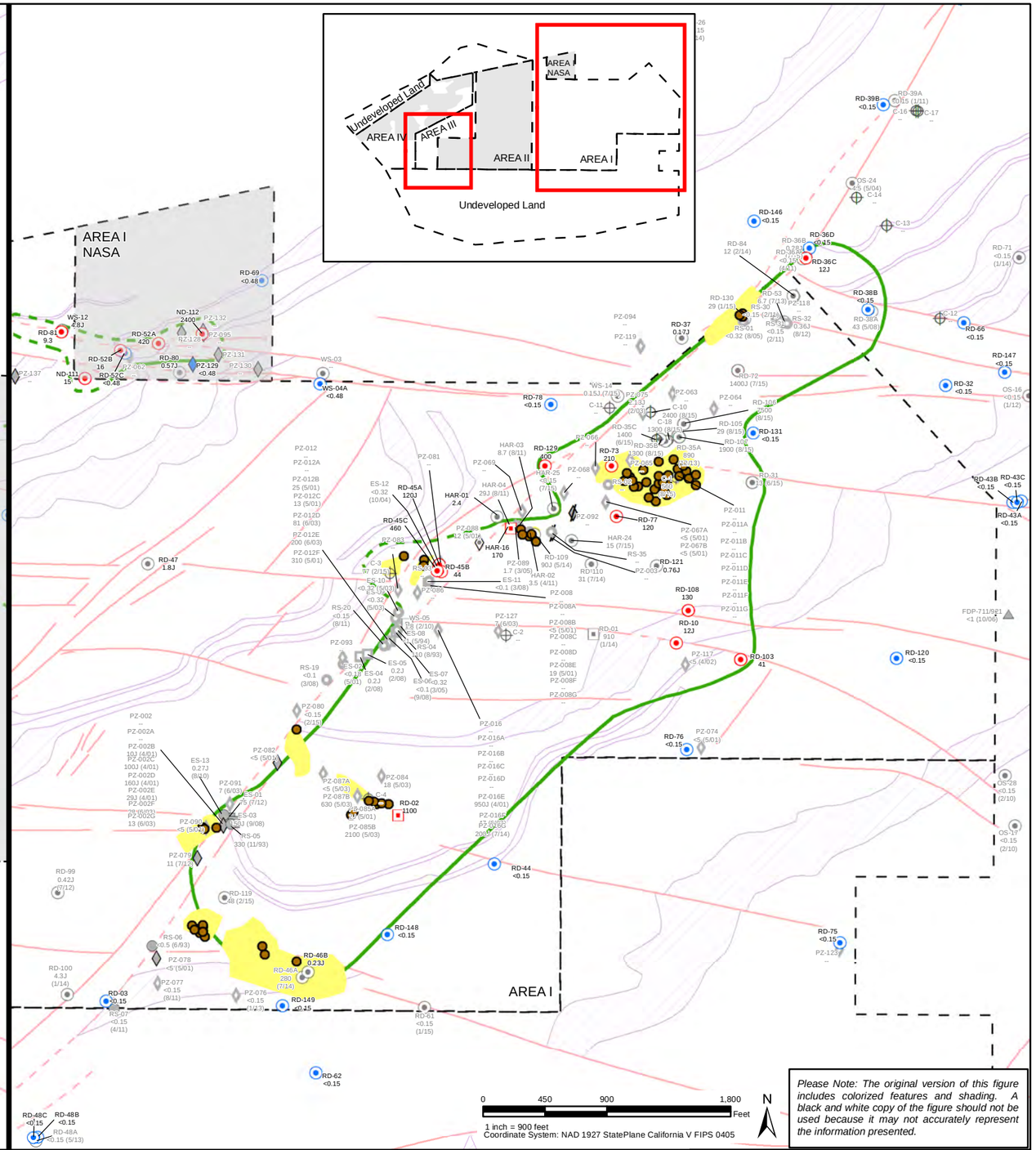
The interpolated concentrations and extent of TCE and its degradation products within Areas II and IV are subject to final interpretation by NASA and DOE, respectively.

Figure 6-14
Three-Dimentional Interpolation of Maximum Equivalent TCE Concentrations - Area III

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Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- cis-1,2-Dichloroethene in Groundwater above Cal MCL of 6 ug/L

Symbol Color for Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

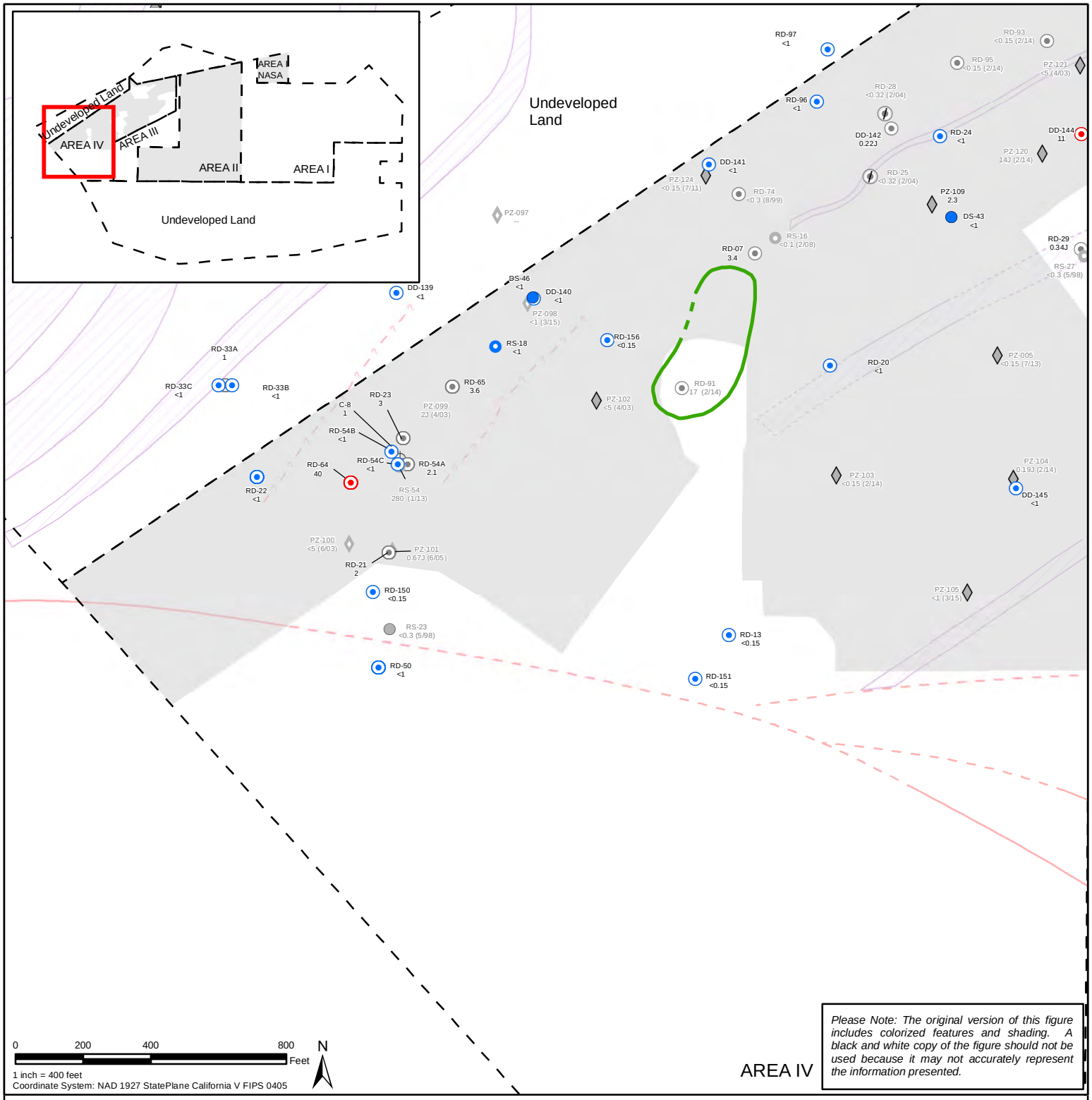
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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cDCE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-15

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_15_cDCE.mxd 6/2/2017



Legend

Symbol Color for Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

- TCE in Groundwater above Primary MCL of 5 ug/L
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

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VENTURA COUNTY, CALIFORNIA

cDCE IN GROUNDWATER, AREA IV, BOEING
FIGURE 6-16

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_16_cDCE_AreaIV.mxd 6/1/2017

AREA IV

AREA III

AREA II

AREA I
NASA

Undeveloped Land

Undeveloped Land

AREA I

AREA II

AREA III

AREA IV

Undeveloped Land

Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.

0 200 400 800 Feet

1 inch = 400 feet

0 450 900 1,800 Feet

1 inch = 900 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

trans-1,2-Dichloroethene in Groundwater above Cal MCL of 10 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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LATERAL EXTENT OF tDCE IN GROUNDWATER
FIGURE 6-17

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urrent
rent

AREA IV

AREA III

AREA II

AREA I
NASA

Undeveloped Land

Undeveloped Land

Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.

0 200 400 800 Feet

1 inch = 400 feet

0 450 900 1,800 Feet

1 inch = 900 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Vinyl Chloride in Groundwater above Cal MCL of 0.5 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

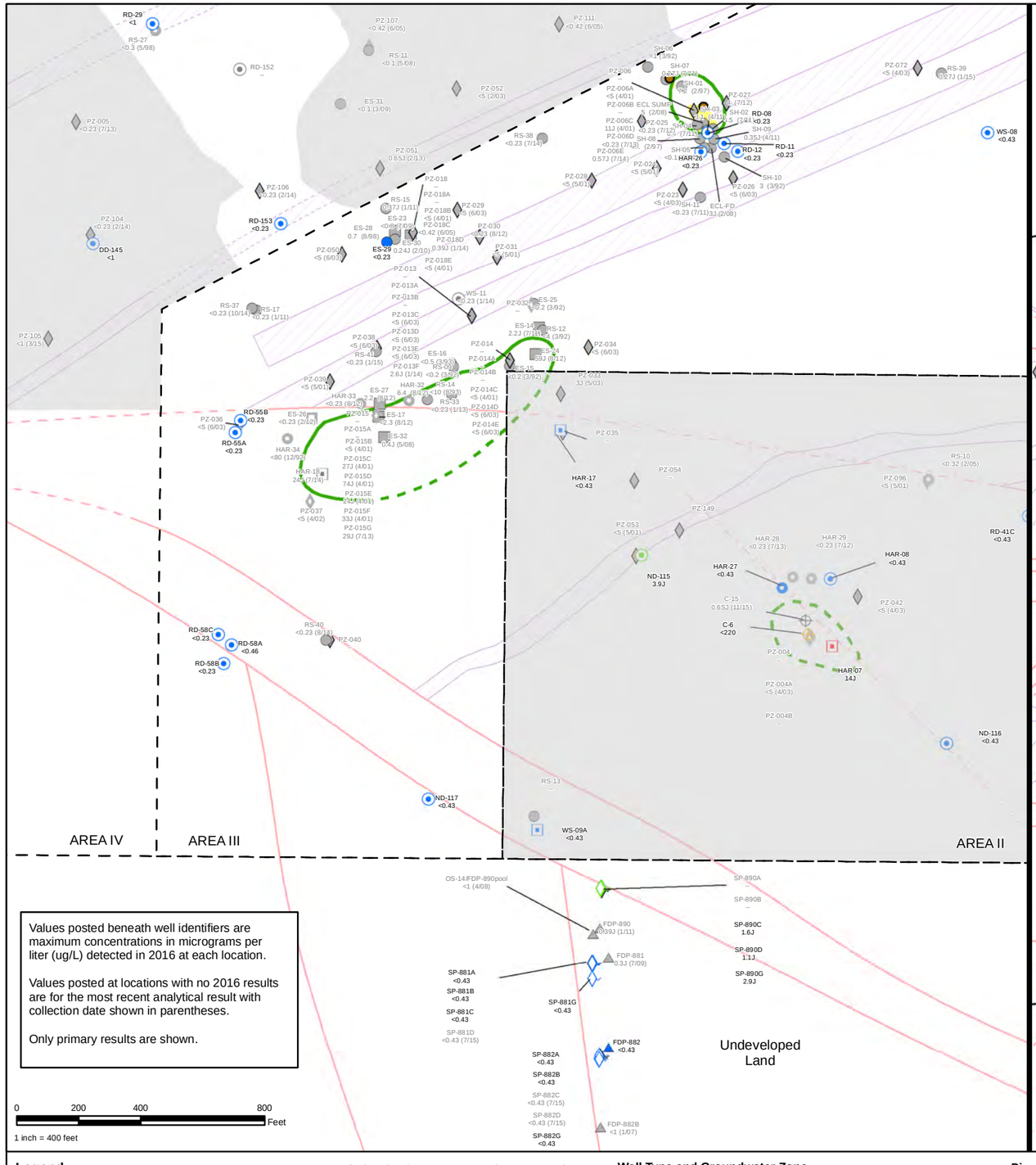
- Abandoned Well
- Core Holes

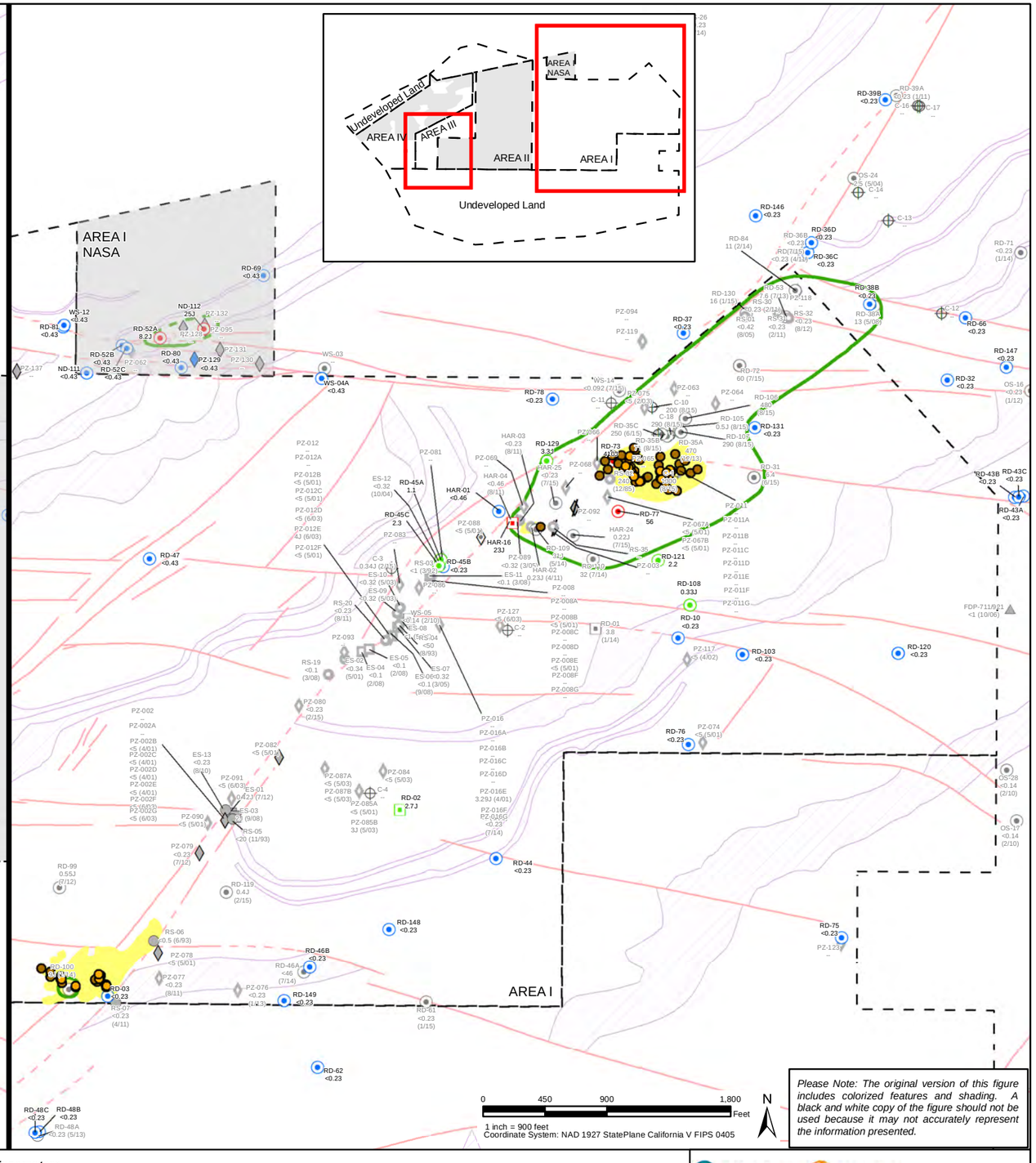
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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VINYL CHLORIDE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-18

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Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- 1,1,1-TCA and 1,1,2-TCA soil or soil vapor locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- 1,1-Dichloroethene in Groundwater above Cal MCL of 6 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

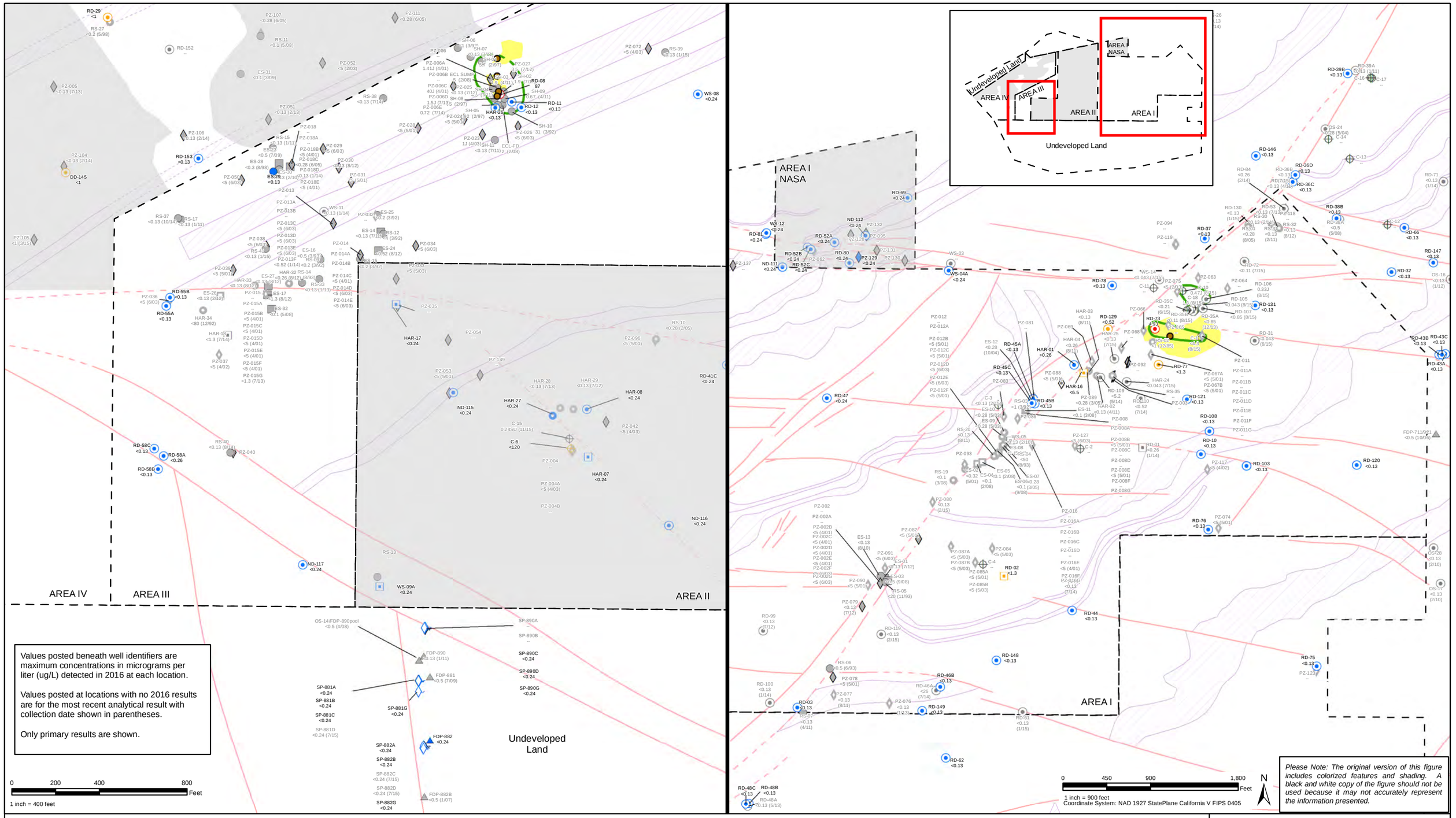
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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1,1-DCE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-19

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_19_11DCE.mxd 6/2/2017



Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- 1,2-Dichloroethane in Groundwater above Cal MCL of 0.5 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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1,2-DCA IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-20

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AREA IV

AREA III

AREA II

AREA I NASA

Undeveloped Land

Undeveloped Land

AREA I

AREA II

AREA III

AREA IV

AREA I NASA

Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.

0 200 400 800 Feet

1 inch = 400 feet

0 450 900 1,800 Feet

1 inch = 900 feet

Coordinate System: NAD 1927 StatePlane California V FIPS 0405

N

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- 1,1-Dichloroethane in Groundwater above Cal MCL of 5 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

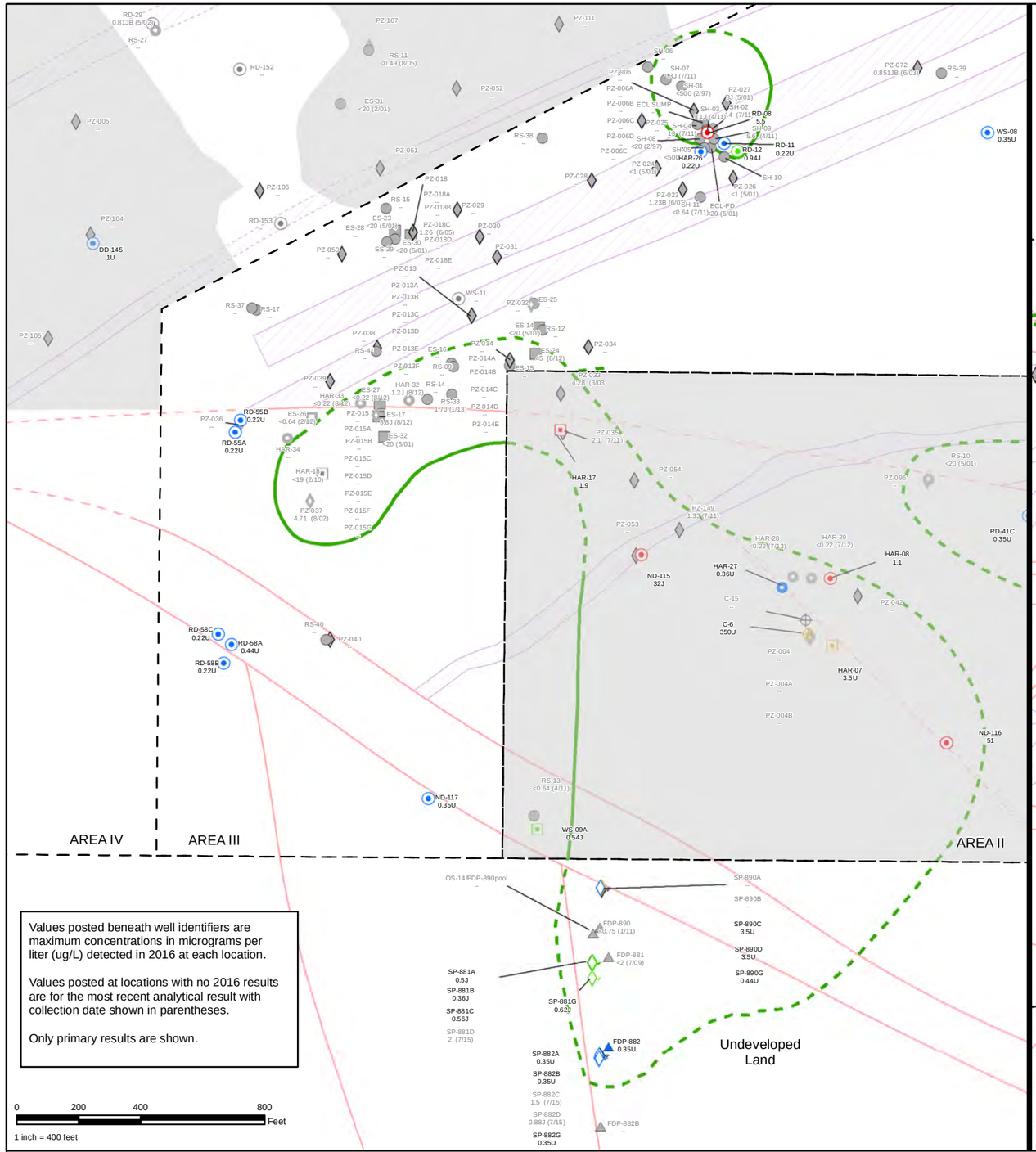
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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VENTURA COUNTY, CALIFORNIA

1,1-DCA IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-21

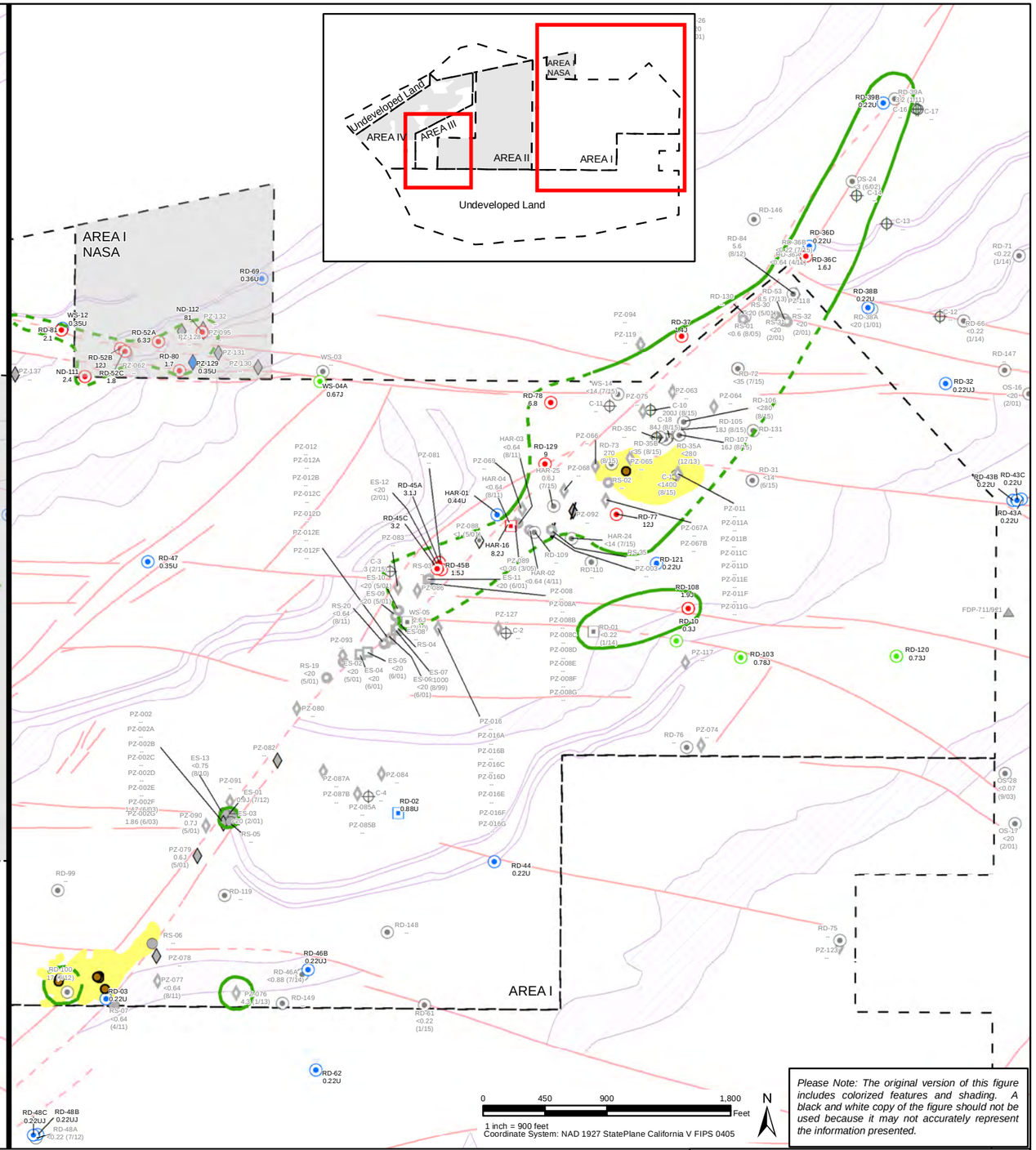
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Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- 1,4-Dioxane in Groundwater above Notification Level of 1 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

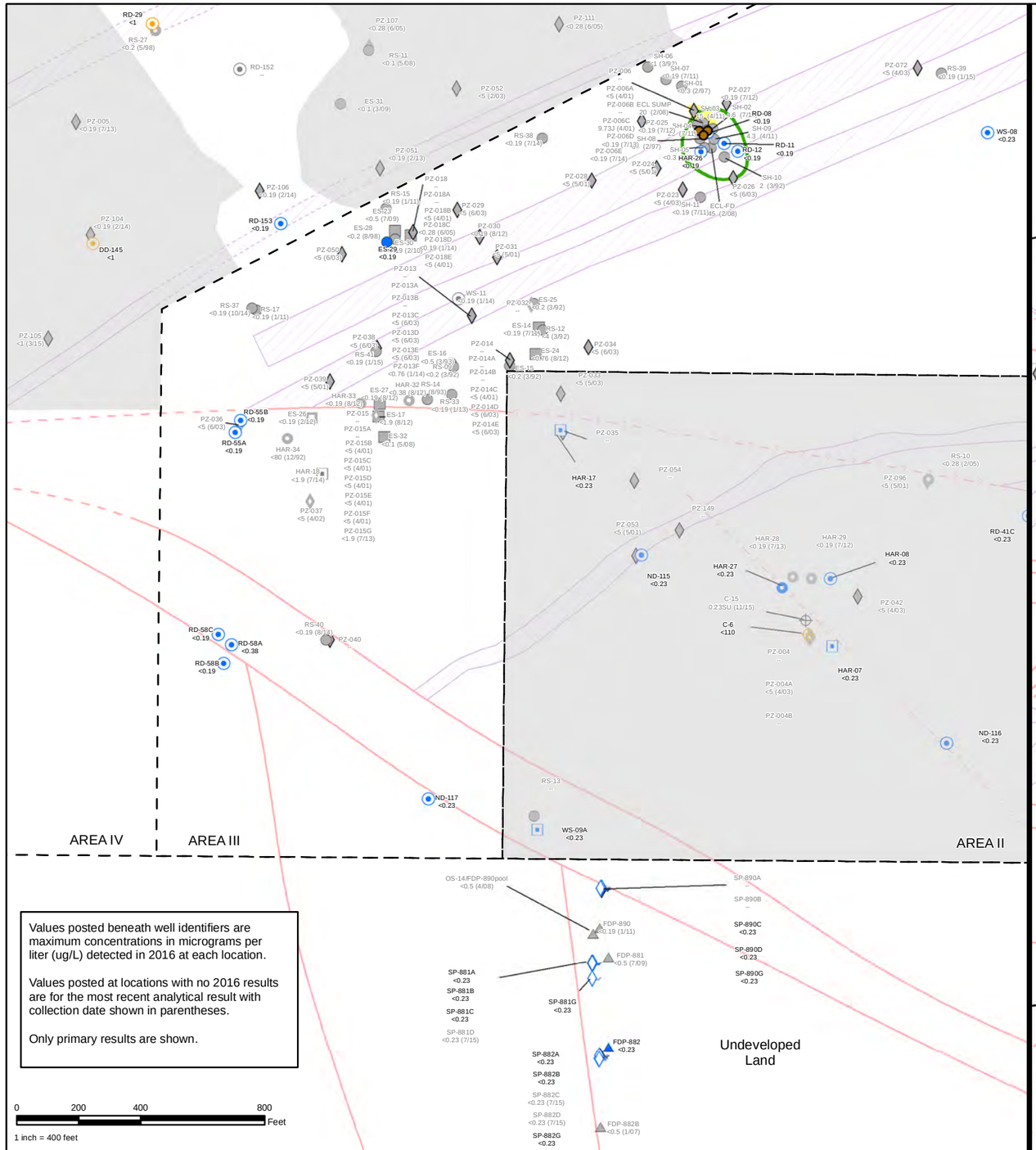
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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1,4-DIOXANE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-22

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Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Carbon Tetrachloride in Groundwater above Cal MCL of 0.5 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

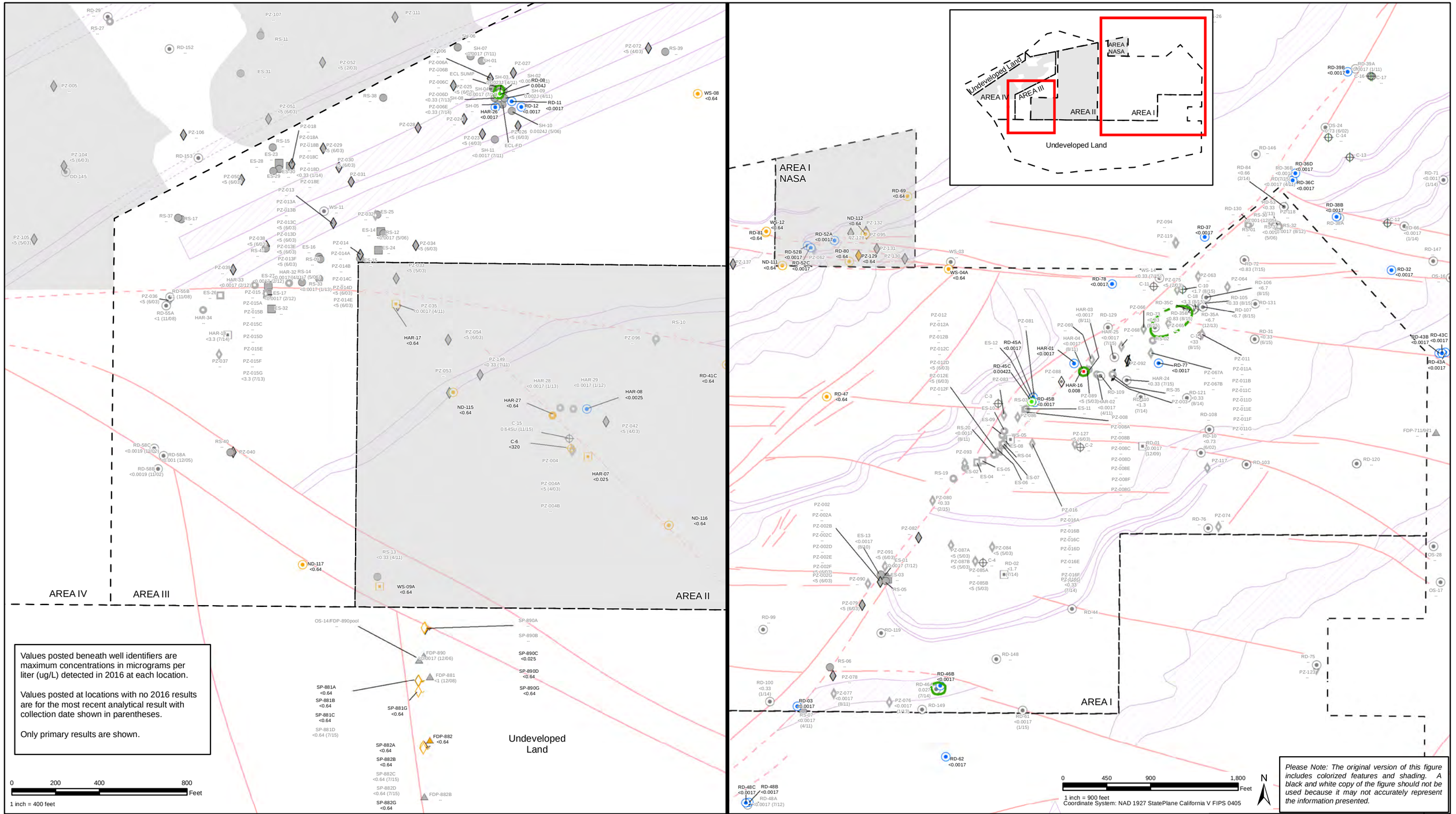
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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CARBON TETRACHLORIDE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-23

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Legend

1,2,3-Trichloropropane in Groundwater above Notification Level of 0.005 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

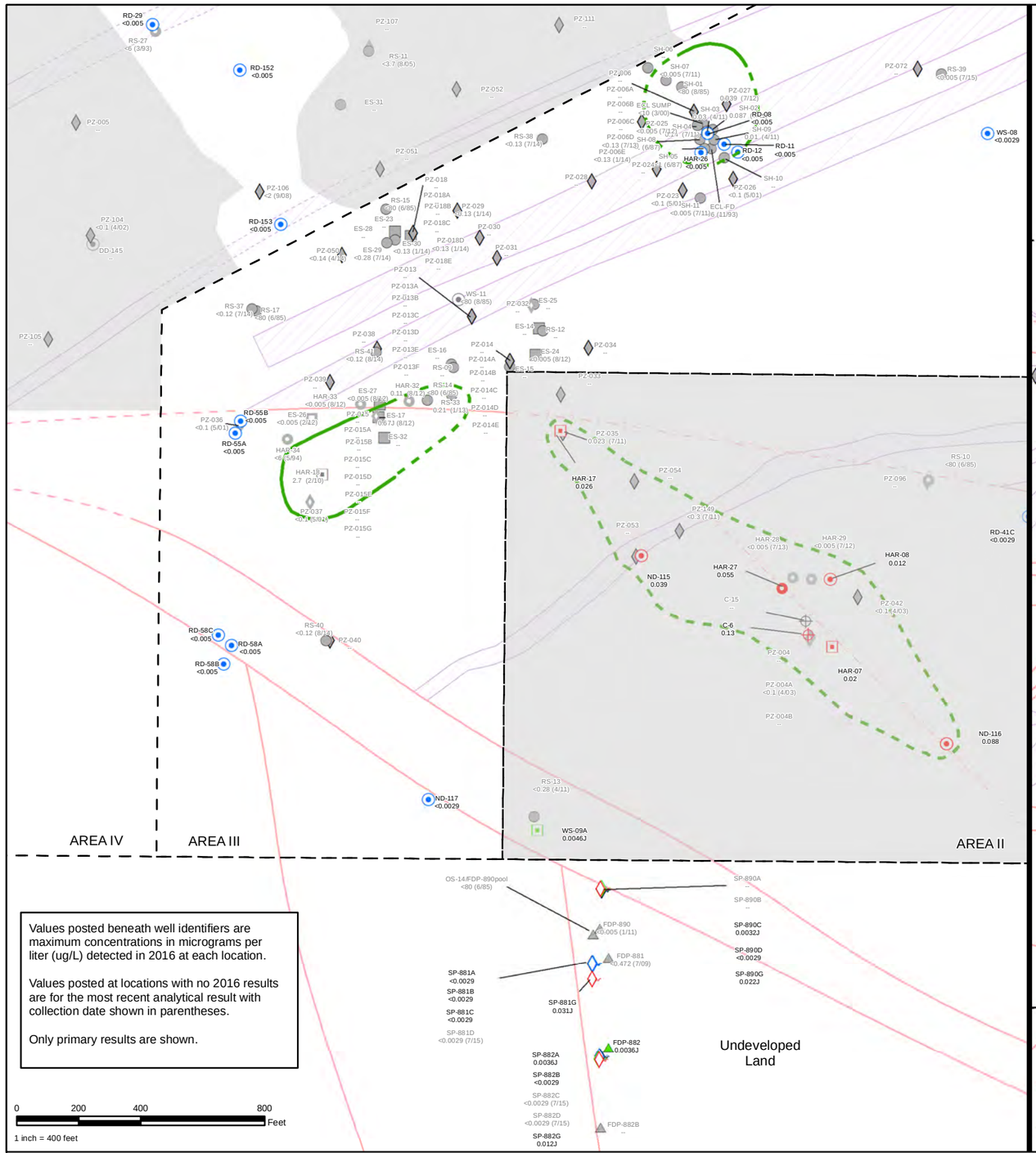
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

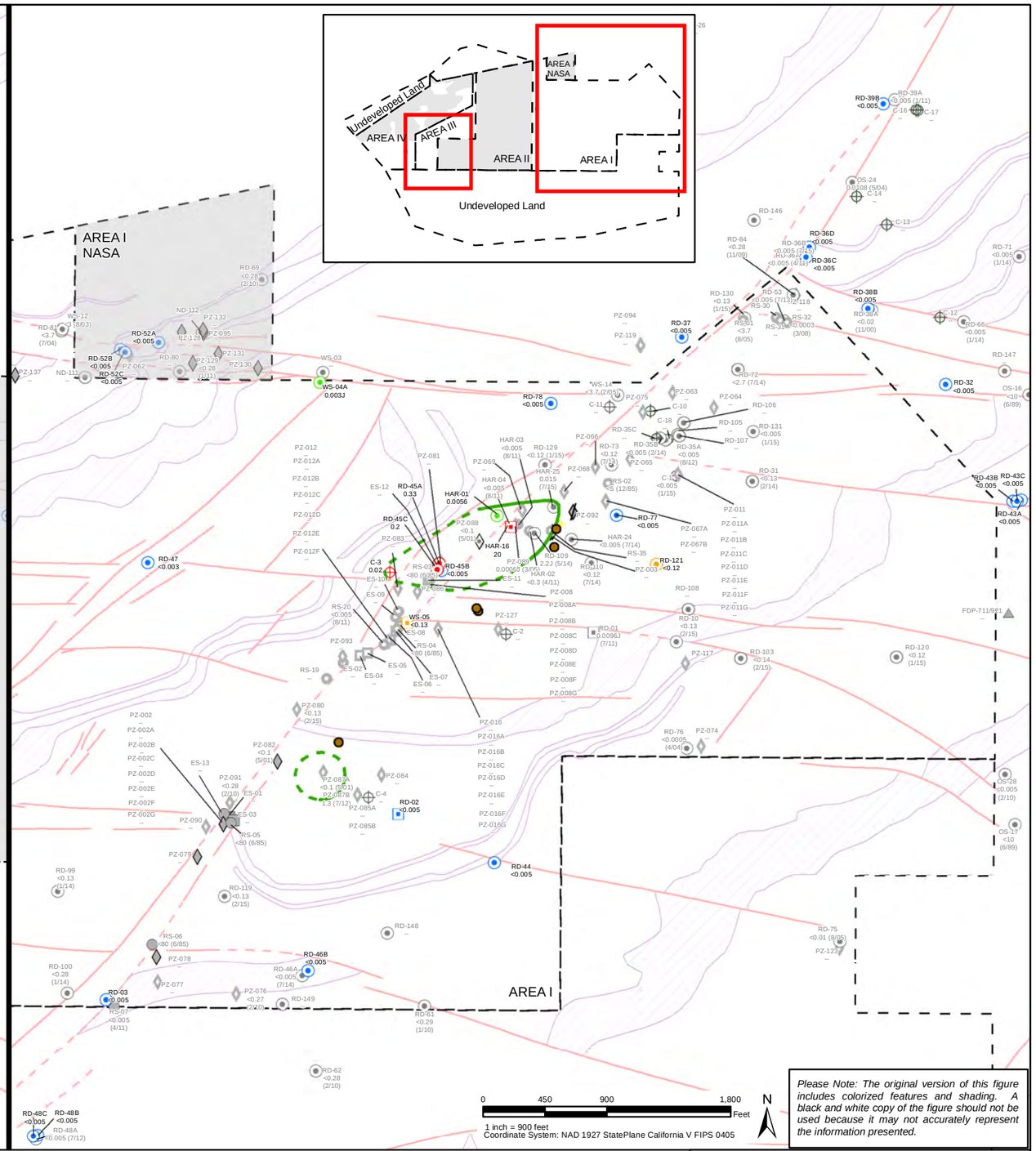
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VENTURA COUNTY, CALIFORNIA

LATERAL EXTENT OF 1,2,3-TCP IN GROUNDWATER
FIGURE 6-24

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Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- n-Nitrosodimethylamine in Groundwater above Notification Level of 0.01 ug/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

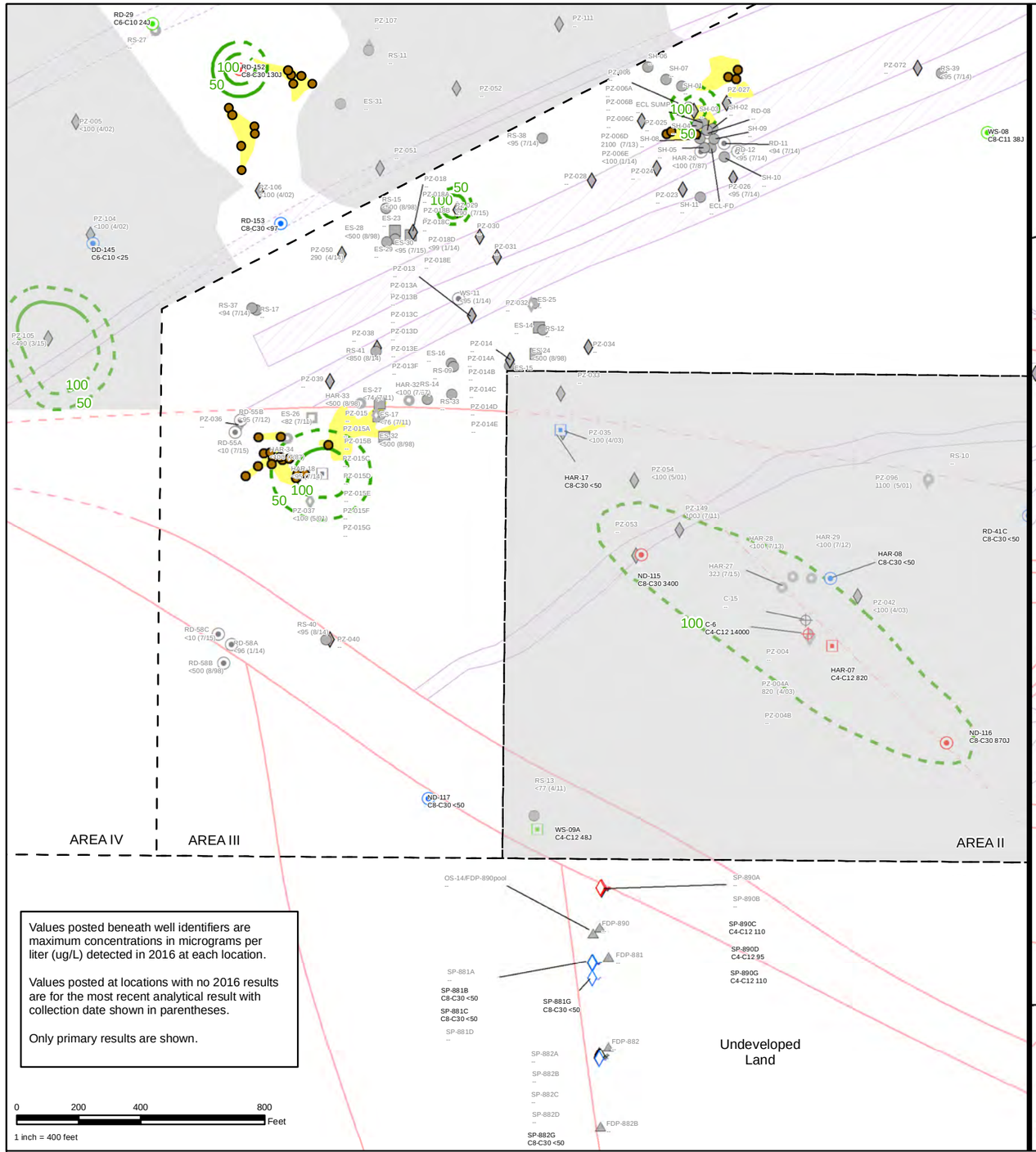
- Abandoned Well
- Core Holes

- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
NDMA IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-25

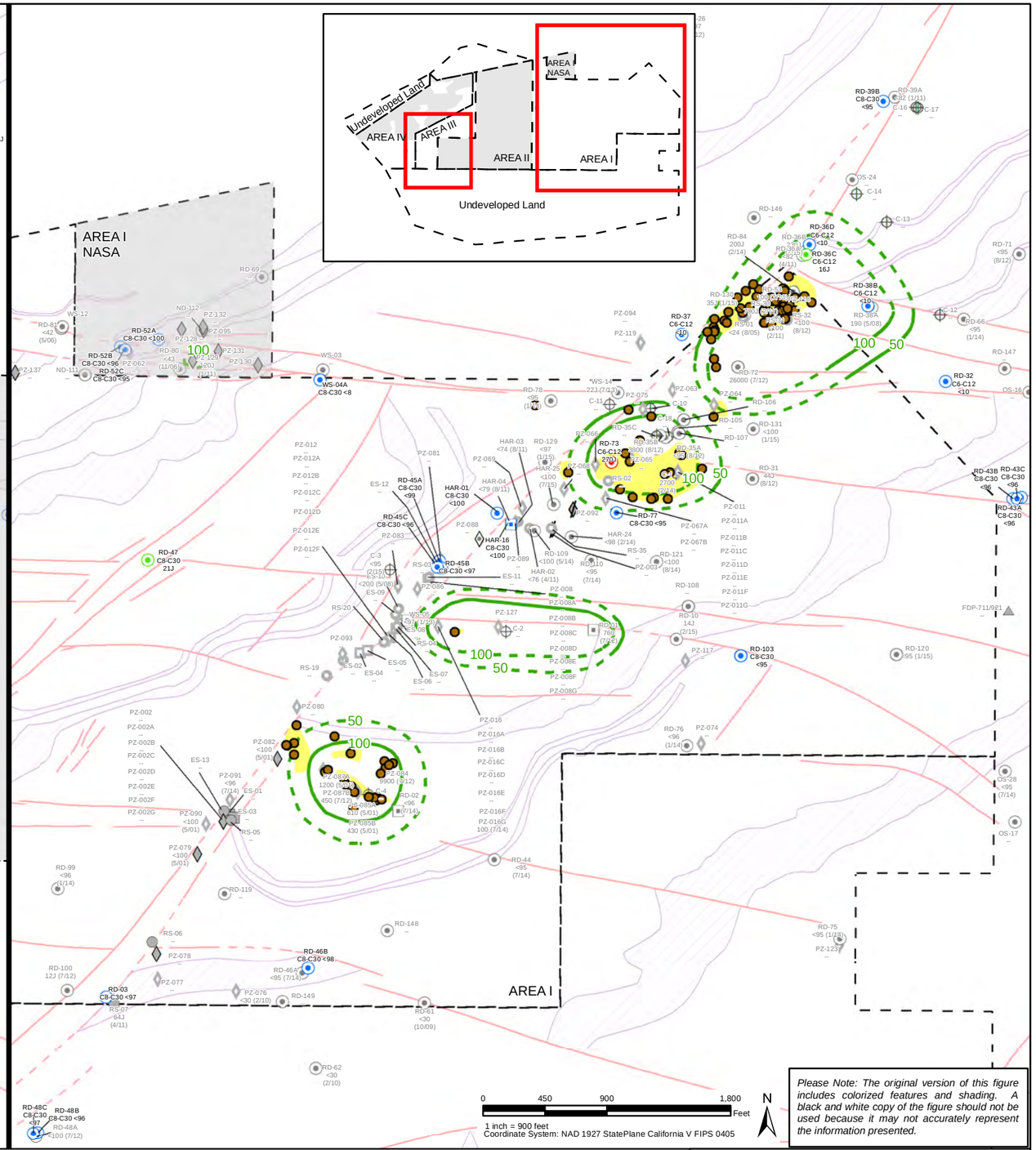
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Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.



Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- TPH in Groundwater above Taste/Odor Threshold of 100 ug/L for TPH C12-C30, and reporting limit of 50 ug/L for TPH C4-C12

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

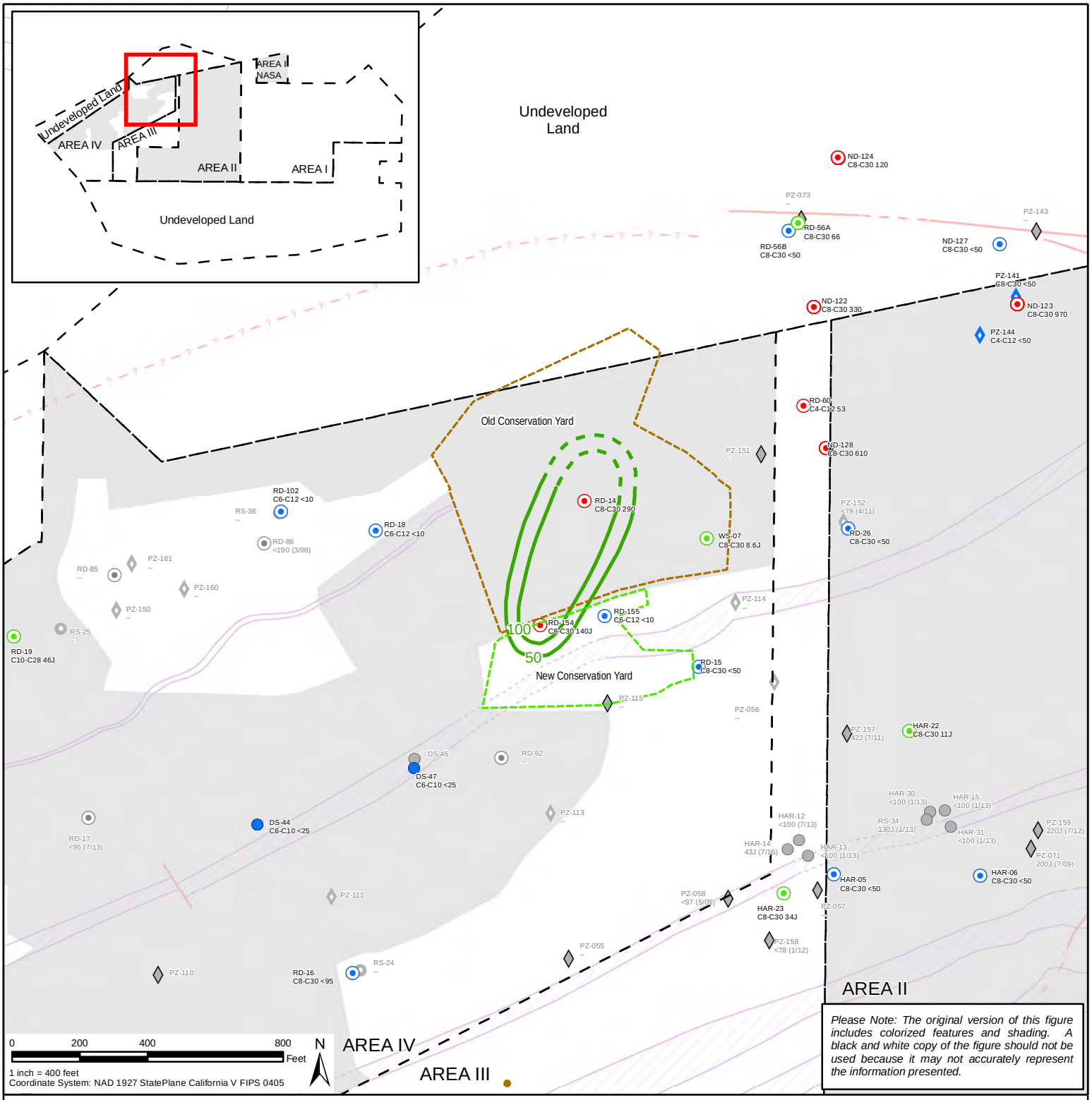
Other

- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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PETROLEUM HYDROCARBONS IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-26

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Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

Symbol Color for Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

- TPH in Groundwater above Taste/Odor Threshold of 100 ug/L for TPH C12-C30, and reporting limit of 50 ug/L for TPH C4-C12
- Areas of NASA or DOE responsibility
- Administrative Area Boundary

- Boeing RFI Site
- DOE RFI Site
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

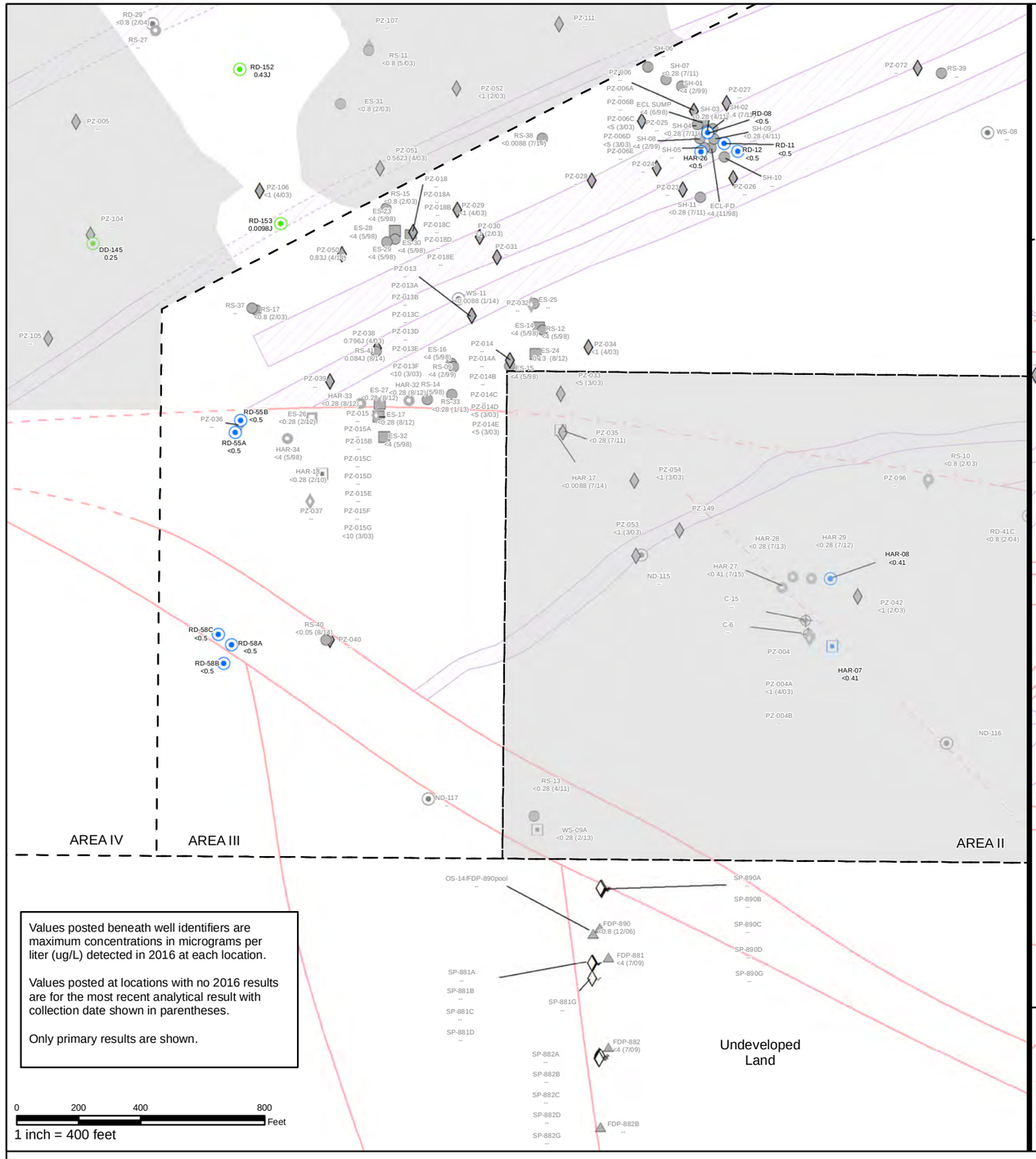
- Abandoned Well
- Core Holes

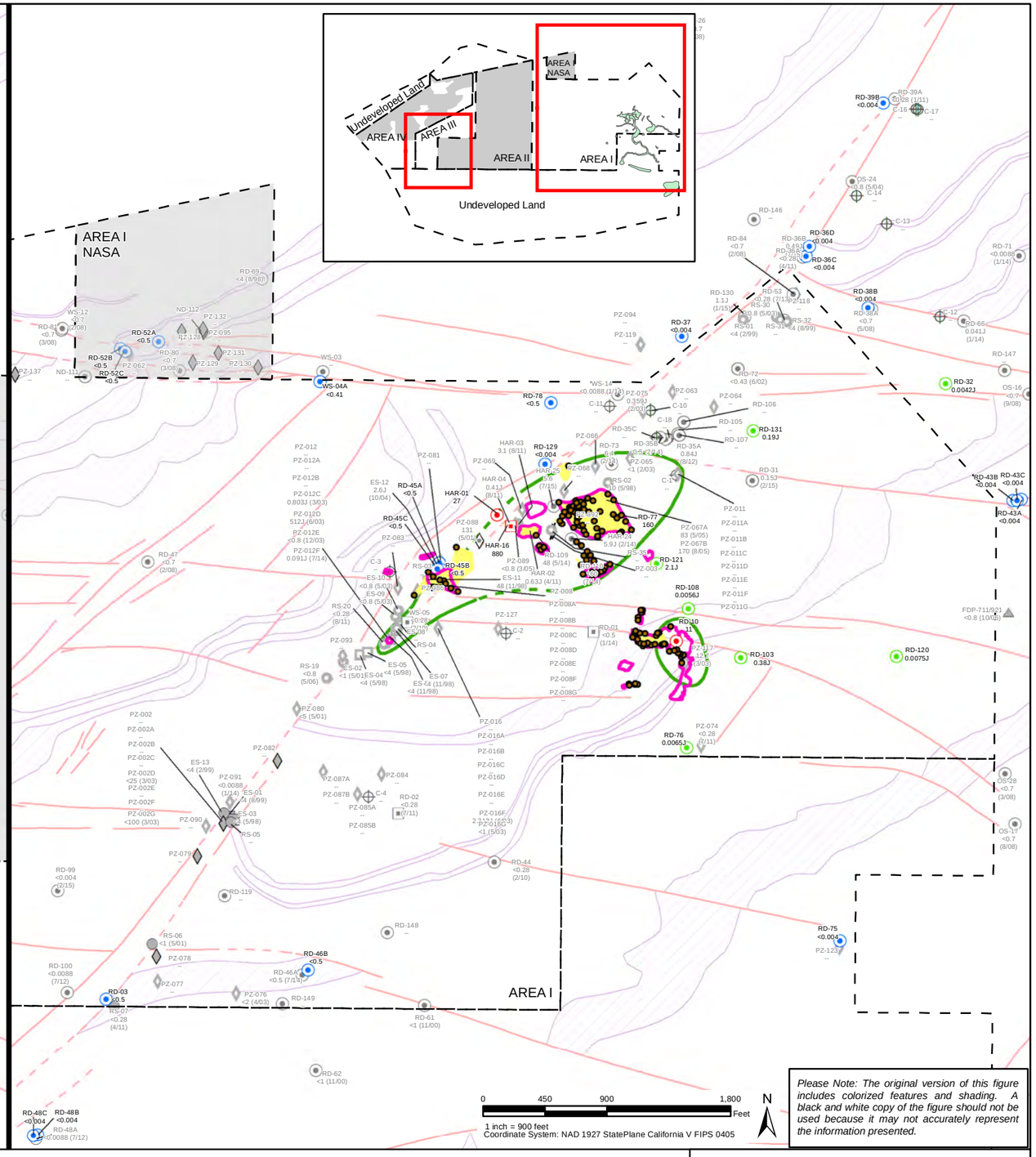
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TPH IN GROUNDWATER, AREA IV, BOEING
FIGURE 6-27

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Legend

- Soil sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Interpreted area of impacted bedrock
- Perchlorate in Groundwater above Primary MCL of 6 ug/L

Symbol Color for Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

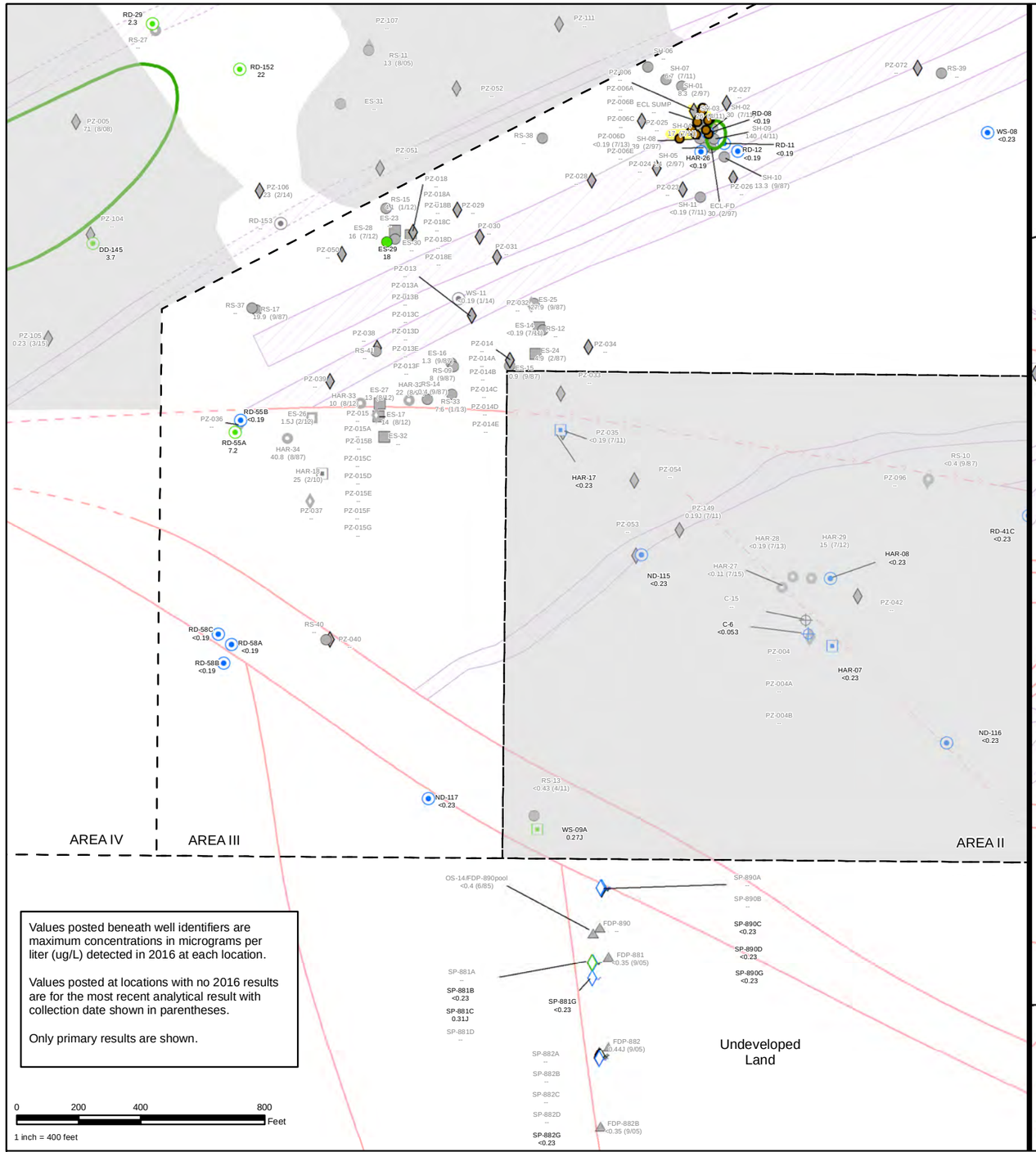
- Abandoned Well
- Core Holes
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

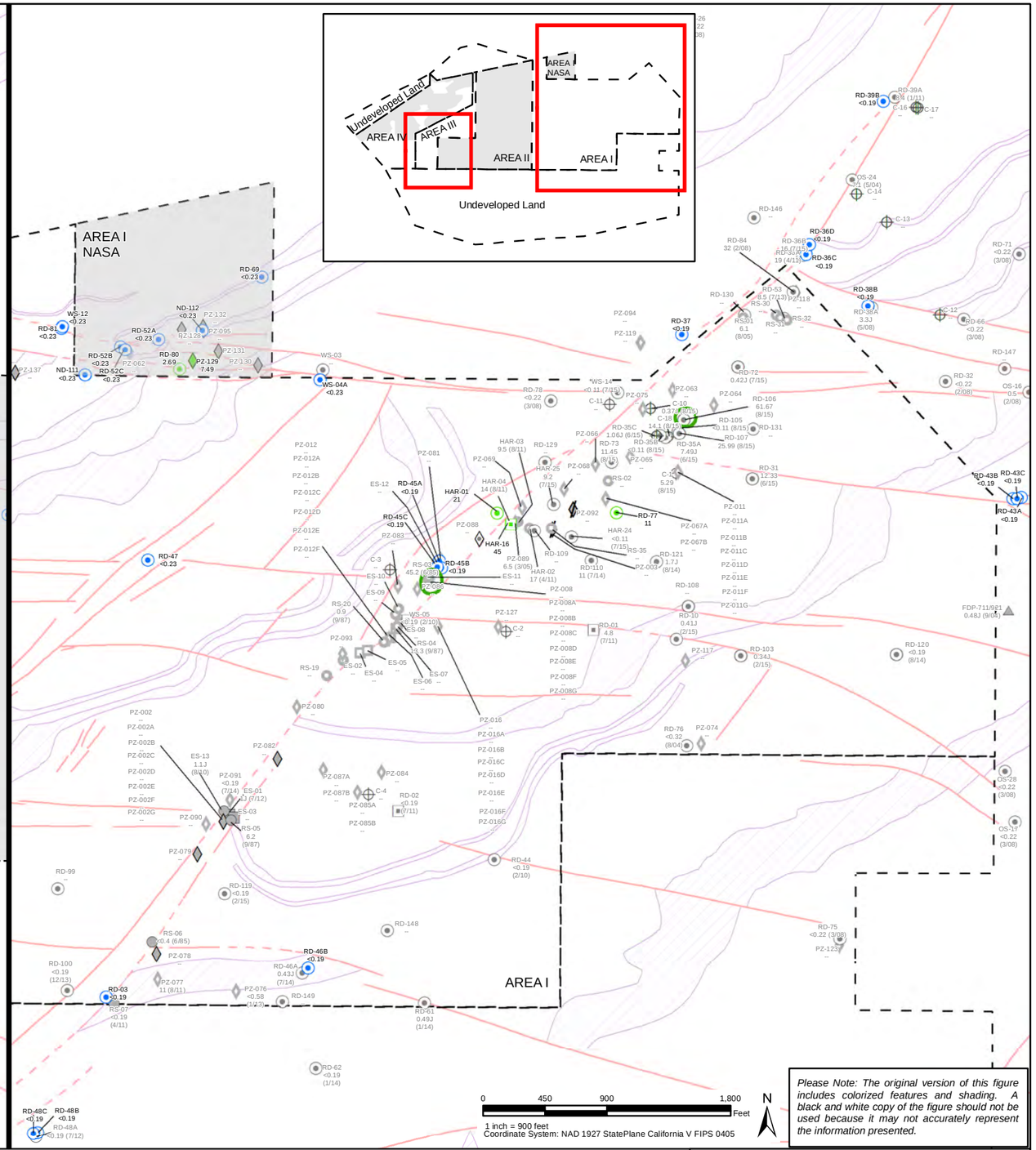
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PERCHLORATE IN GROUNDWATER: SOIL AND BEDROCK SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-28

U:\BoeingSantaSusana\MXD\RI_Report_2017\Section6\6_28_Perchlorate.mxd 6/2/2017





Values posted beneath well identifiers are maximum concentrations in micrograms per liter (ug/L) detected in 2016 at each location.

Values posted at locations with no 2016 results are for the most recent analytical result with collection date shown in parentheses.

Only primary results are shown.

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Legend

- Soil or soil vapor sample locations indicative of impacting groundwater
- Interpreted area of impacted soil (typically includes multiple chemicals)
- Nitrate-NO3 in Groundwater above Cal MCL of 45 mg/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

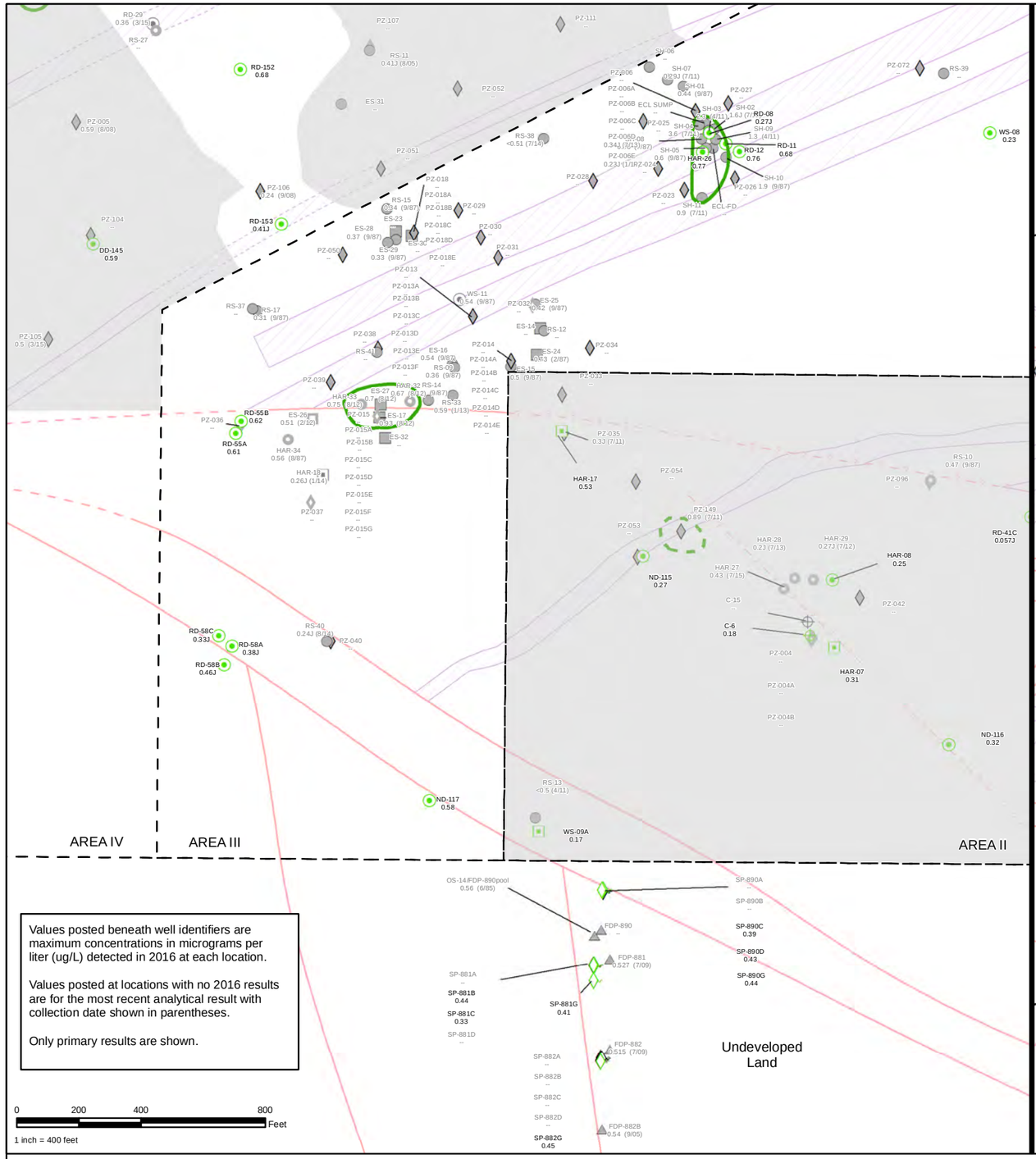
- Abandoned Well
- Core Holes

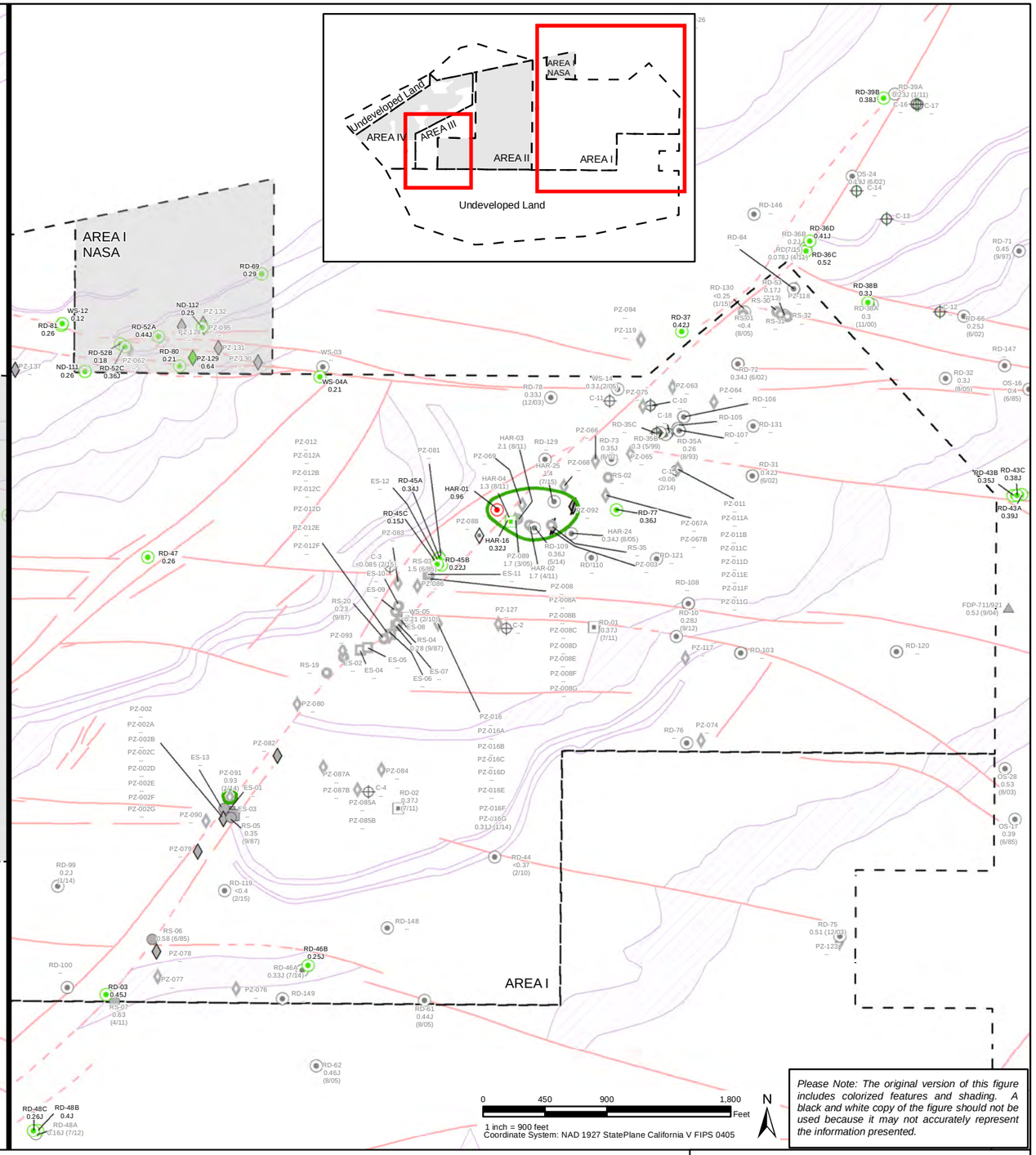
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
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- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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NITRATE IN GROUNDWATER: SOIL SOURCES AND LATERAL EXTENT OF IMPACTED GROUNDWATER
FIGURE 6-29

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Legend

Fluoride in Groundwater above SSFL Comparison of 0.8 mg/L

Symbol Color for 2016 Groundwater Results

- Detected above screening level
- Detected at or below screening level
- Not detected
- Detection limit exceeds screening level for all results at this location
- Not sampled/analyzed

Well Type and Groundwater Zone

Groundwater Extraction Wells

- Groundwater Extraction Well, Perched
- Groundwater Extraction Well, Near Surface
- Groundwater Extraction Well, Chatsworth Formation

Groundwater Monitoring Wells

- Groundwater Monitoring Well, Perched
- Groundwater Monitoring Well, Near Surface
- Groundwater Monitoring Well, Chatsworth Formation

Piezometers

- Piezometer, Perched
- Piezometer, Near Surface
- Piezometer, Chatsworth Formation
- Piezometer, Seep

Seeps/Springs

- Seep/spring

Other

- Abandoned Well
- Core Holes

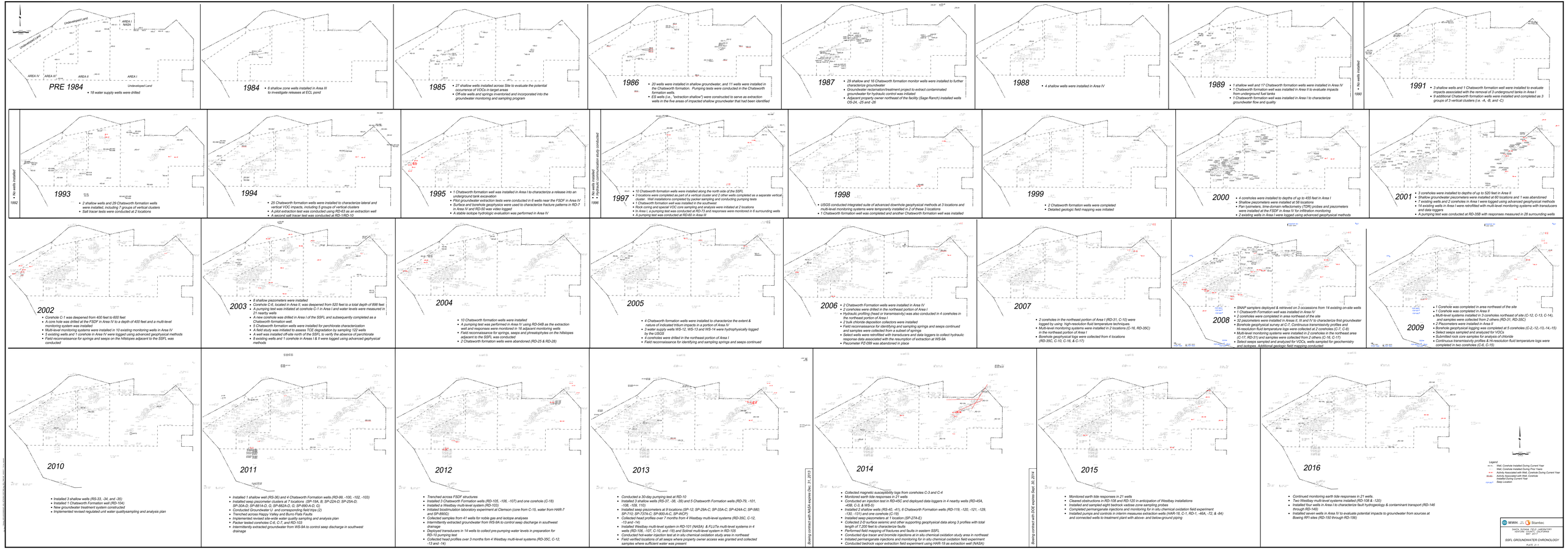
- Areas of NASA or DOE responsibility
- Administrative Area Boundary
- Fault - location accurate, identity and existance certain
- Fault - location inferred, identity and existance certain
- Fault - location inferred, identity and existance uncertain
- Fine-Grained Unit (shale/siltstone) Dashed Where Inferred

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LATERAL EXTENT OF FLUORIDE IN GROUNDWATER
FIGURE 6-30

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Undeveloped Land
AREA I
NASA
AREA IV
AREA III
AREA II
AREA I
PRE 1984
• 18 water supply wells were drilled
1984
• 6 shallow zone wells installed in Area III to investigate releases at ECL pond
1985
• 27 shallow wells installed across Site to evaluate the potential occurrence of VOCs in target areas
• Off-site wells and springs inventoried and incorporated into the groundwater monitoring and sampling program
1986
• 20 wells were installed in shallow groundwater, and 11 wells were installed in the Chatsworth formation. Pumping tests were conducted in the Chatsworth formation wells.
• ES wells (i.e., "extraction shallow") were constructed to serve as extraction wells in the five areas of impacted shallow groundwater that had been identified
1987
• 29 shallow and 16 Chatsworth formation monitor wells were installed to further characterize groundwater
• Groundwater reclamation/treatment project to extract contaminated groundwater for hydraulic control was initiated
• Adjacent property owner notified of the facility (Sage Ranch) installed wells OS-24, -25 and -26
1988
• 4 shallow wells were installed in Area IV
1989
• 1 shallow well and 17 Chatsworth formation wells were installed in Area IV
• 1 Chatsworth formation well was installed in Area II to evaluate impacts from underground fuel tanks
• 1 Chatsworth formation well was installed in Area I to characterize groundwater flow and quality
• No wells installed
1990
1991
• 3 shallow wells and 1 Chatsworth formation well were installed to evaluate impacts associated with the removal of 3 underground tanks in Area I
• 9 additional Chatsworth formation wells were installed and completed as 3 groups of 3 vertical clusters (i.e. -A, -B, and -C)
• No wells installed
1992
1993
• 2 shallow wells and 29 Chatsworth formation wells were installed, including 7 groups of vertical clusters
• Salt tracer tests were conducted at 2 locations
1994
• 25 Chatsworth formation wells were installed to characterize lateral and vertical VOC impacts, including 5 groups of vertical clusters
• A pilot extraction test was conducted using RD-63 as an extraction well
• A second salt tracer test was conducted at RD-18/D-10
1995
• 1 Chatsworth formation well was installed in Area I to characterize a release into an underground tank excavation
• Pilot groundwater extraction tests were conducted in 6 wells near the FSDF in Area IV
• Surface and borehole geophysics were used to characterize fracture patterns in RD-7 in Area IV and RD-50 was video logged
• A stable isotope hydrologic evaluation was performed in Area IV
• No wells installed
• Hydraulic communication study conducted
1996
1997
• 10 Chatsworth formation wells were installed along the north side of the SSFL
• 3 locations were completed as part of a vertical cluster and 3 other wells completed as a separate vertical cluster. Well installations completed by packer sampling and conducting pumping tests
• 1 Chatsworth formation well was installed in the southwest
• Rock coring and special VOC core sampling and analysis were initiated at 2 locations
• In Area I, a pumping test was conducted at RD-73 and responses were monitored in 6 surrounding wells
• A pumping test was conducted at RD-60 in Area III
1998
• USGS conducted integrated suite of advanced downhole geophysical methods at 3 locations and multi-level monitoring systems were temporarily installed in 2 of these 3 locations
• 1 Chatsworth formation well was completed and another Chatsworth formation well was installed
1999
• 2 Chatsworth formation wells were completed
• Detailed geologic field mapping was initiated
2000
• 4 coreholes were installed to depths of up to 455 feet in Area I
• Shallow piezometers were installed at 56 locations
• Pan lysimeters, time-domain reflectometry (TDR) probes and piezometers were installed at the FSDF in Area IV for infiltration monitoring
• 2 existing wells in Area I were logged using advanced geophysical methods
2001
• 3 coreholes were installed to depths of up to 520 feet in Area III
• Shallow groundwater piezometers were installed at 60 locations and 1 was abandoned
• 7 existing wells and 2 coreholes in Area I were logged using advanced geophysical methods
• 14 existing wells in Area I were retrofitted with multi-level monitoring systems with transducers and data loggers
• A pumping test was conducted at RD-35B with responses measured in 28 surrounding wells
2002
• Corehole C-1 was deepened from 400 feet to 600 feet
• A core hole was drilled at the FSDF in Area IV to a depth of 400 feet and a multi-level monitoring system was installed
• Multi-level monitoring systems were installed in 10 existing monitoring wells in Area IV
• 5 existing wells and 1 corehole in Area IV were logged using advanced geophysical methods
• Field reconnaissance for springs and seeps on the hillslopes adjacent to the SSFL was conducted
2003
• 8 shallow piezometers were installed
• Corehole C-6, located in Area II, was deepened from 520 feet to a total depth of 696 feet
• A pumping test was initiated at corehole C-1 in Area I and water levels were measured in 21 nearby wells
• A new corehole was drilled in Area I of the SSFL and subsequently completed as a Chatsworth formation well.
• 5 Chatsworth formation wells were installed for perchlorate characterization
• A field study was initiated to assess TCE degradation by sampling 122 wells
• A well was installed off-site north of the SSFL to verify the absence of perchlorate
• 8 existing wells and 1 corehole in Areas I & II were logged using advanced gephysical methods
2004
• 10 Chatsworth formation wells were installed
• A pumping test was performed in Area IV using RD-54B as the extraction well and responses were monitored in 16 adjacent monitoring wells
• Field reconnaissance for springs, seeps and phreatophytes on the hillslopes adjacent to the SSFL was conducted
• 2 Chatsworth formation wells were abandoned (RD-25 & RD-28)
2005
• 4 Chatsworth formation wells were installed to characterize the extent & nature of indicated tritium impacts in a portion of Area IV
• 3 water supply wells WS-12, WS-13 and WS-14 were hydrophysically logged by the USGS
• 4 coreholes were drilled in the northeast portion of Area I
• Field reconnaissance for identifying and sampling springs and seeps continued
2006
• 2 Chatsworth Formation wells were installed in Area IV
• 2 coreholes were drilled in the northeast portion of Area I
• Hydraulic profiling (head or transmissivity) was also conducted in 4 coreholes in the northeast portion of Area I
• 2 bulk chloride deposition collectors were installed
• Field reconnaissance for identifying and sampling springs and seeps continued and samples were collected from a subset of springs
• Select wells were retrofitted with transducers and data loggers to collect hydraulic response data associated with the resumption of extraction at WS-9A
• Piezometer PZ-39B was abandoned in place
2007
• 2 coreholes in the northeast portion of Area I (RD-31, C-10) were logged by using high-resolution fluid temperature techniques.
• Multi-level monitoring systems were installed in 2 locations (C-16, RD-35C) in the northeast portion of Area I
• Borehole geophysical logs were collected from 4 locations (RD-35C, C-10, C-16, & C-17)
2008
• SNAP samplers deployed & retrieved on 3 occassions from 14 existing on-site wells
• 1 Chatsworth Formation well was installed in Area IV
• 2 coreholes were completed in area northeast of the site
• 32 piezometers were installed in Areas II, III and IV to characterize first groundwater
• Borehole geophysical survey at C-7. Continuous transmissivity profiles and Hi-resolution fluid temperature logs were collected at 2 coreholes (C-7, C-8)
• Multi-level monitoring systems were installed in 2 coreholes in the northeast area (C-17, RD-31) and samples were collected from 2 others (C-16, C-17)
• Select seeps sampled and analyzed for VOCs, wells sampled for geochemistry and isotopes. Additional geologic field mapping conducted
2009
• 1 Corehole was completed in area northeast of the site
• 1 Corehole was completed in Area II
• Multi-level systems installed in 3 coreholes northeast of site (C-12, C-13, C-14), and samples were collected from 2 others (RD-31, RD-35C)
• 2 Piezometers were installed in Area II
• Borehole geophysical logging was completed at 5 coreholes (C-2,-12,-13,-14,-15)
• Select seeps sampled and analyzed for VOCs
• Submitted rock core samples for analysis of chloride
• Continuous transmissivity profiles & Hi-resolution fluid temperature logs were completed in two coreholes (C-6, C-15)
2010
• Installed 3 shallow wells (RS-33, -34, and -35)
• Installed 1 Chatsworth Formation well (RD-104)
• New groundwater treatment system constructed
• Implemented revised regulated unit water quality/sampling and analysis plan
2011
• Installed 1 shallow well (RS-36) and 4 Chatsworth Formation wells (RD-99, -100, -102, -103)
• Installed seep piezometer clusters at 7 locations (SP-19A, B; SP-22A-D; SP-25A-D; SP-30A-D; SP-881A-D, G; SP-882A-D, G; SP-890-A-D, G)
• Conducted Groundwater U and corresponding field trips (2)
• Trenched across Happy Valley and Burro Flats Faults
• Implemented revised site-wide water quality sampling and analysis plan
• Packer tested coreholes C-6, C-7, and RD-103
• Intermittently extracted groundwater from WS-9A to control seep discharge in southwest drainage
2012
• Trenched across FSDF structures
• Installed 3 Chatsworth Formation wells (RD-105, -106, -107) and one corehole (C-18)
• Installed a Westbay multi-level system (RD-103)
• Initiated biostimulation laboratory experiment at Clemson (core from C-15, water from HAR-7 and SP-890C)
• Collected samples from 41 wells for noble gas and isotope analyses
• Intermittently extracted groundwater from WS-9A to control seep discharge in southwest drainage
• Deployed transducers in 14 wells to collect pre-pumping water levels in preparation for RD-10 pumping test
• Collected head profiles over 3 months from 4 Westbay multi-level systems (RD-35C, C-12, -13 and -14)
Biology contract with NASA expires (Dec. 31, 2012)
2013
• Conducted a 30-day pumping test at RD-10
• Installed 3 shallow wells (RS-37, -38, -39) and 5 Chatsworth Formation wells (RD-79, -101, -108, -109, 110)
• Installed seep piezometers at 9 locations (SP-12; SP-29A-C; SP-33A-C; SP-424A-C; SP-580; SP-710; SP-737A-C; SP-900-A-C, SP-WCP)
• Collected head profiles over 7 months from 4 Westbay multi-level systems (RD-35C, C-12, -13 and -14)
• Installed Westbay multi-level system in RD-101 (NASA). & FLUTe multi-level systems in 4 wells (RD-106, -107, C-10, and -18) and Solinst multi-level system in RD-105
• Conducted hot-water injection test at in situ chemical oxidation study area in northeast
• Field verified locations of all seeps where property owner access was granted and collected samples where sufficient water was present
Biology contract with DOE expires Sept. 30, 2014
2014
• Collected magnetic susceptibility logs from coreholes C-3 and C-4
• Monitored earth tide responses in 21 wells
• Conducted an injection test in RD-45C and deployed data loggers in 4 nearby wells (RD-45A, -45B, C-3, & WS-9)
• Installed 2 shallow wells (RS-40, -41), 6 Chatsworth Formation wells (RD-119, -120, -121, -129, -130, -131) and one corehole (C-19)
• Installed seep piezometers at 1 location (SP-27A-E)
• Collected 2-D surface seismic and other supporting geophysical data along 3 profiles with total length of 7,200 feet to characterize faults
• Performed field mapping of fractures and faults in eastern SSFL
• Conducted dye tracer and bromide injections at in situ chemical oxidation study area in northeast
• Initiated permanganate injections and monitoring for in situ chemical oxidation field experiment
• Conducted bedrock vapor extraction field experiment using HAR-19 as extraction well (NASA)
2015
• Monitored earth tide responses in 21 wells
• Cleared obstructions in RD-108 and RD-120 in anticipation of Westbay installations
• Installed and sampled eight bedrock vadose zone sampling probes
• Completed permanganate injections and monitoring for in situ chemical oxidation field experiment
• Installed pumps and controls in interim measures extraction wells (HAR-18, C-1, RD-1, -46A, -72, & -84) and connected wells to treatment plant with above- and below-ground piping
2016
• Continued monitoring earth tide responses in 21 wells.
• Two Westbay multi-level systems installed (RD-108 & -120)
• Installed four wells in Area I to characterize fault hydrogeology & contaminant transport (RD-146 through RD-149)
• Installed seven wells in Area IV to evaluate potential impacts to groundwater from sources at Boeing RFI sites (RD-150 through RD-156)
Legend
RD-1C Well, Corehole Installed During Current Year
C-1 Corehole Installed During Current Year
Activity Associated with Well, Corehole During Current Year
RD-99C Activity Associated with Well, Corehole Installed During Current Year
FSP-WCP Seep Location
MWH
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CENTRAL COAST, CALIFORNIA
MAY 2013
SSFL GROUNDWATER CHRONOLOGY
PLATE 2-1