Draft Statement of Basis for the Phase 1 Groundwater Remedy Selection, NASA Santa Susana Field Laboratory

Prepared by the California Department of Toxic Substances Control

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Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

µg/L	microgram(s) per liter
µg/m3	microgram(s) per cubic meter
ABFF	Alfa Bravo Fuel Farm
ABSP	Alfa Bravo Skim Pond
AIG	area of impacted groundwater
AR	Administrative Record
AST	aboveground storage tank
B204	Building 204
bgs	below ground surface
Boeing	The Boeing Company
BVE	bedrock vapor extraction
CDFF	Coca Delta Fuel Farm
CEQA	California Environmental Quality Act
CFOU	Chatsworth Formation Operable Unit
CMD	Corrective Measures Design
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	chemical of concern
DCA	dichloroethane
DCE	dichloroethene
DOE	United States Department of Energy
DTSC	California Department of Toxic Substances Control
EISB	enhanced in situ bioremediation
ELV	Expendable Launch Vehicle
GETS	groundwater extraction and treatment system
GSA	United States General Services Administration

GSL	groundwater screening level
GWIM	groundwater interim measure
HHERA	human health and ecological risk assessment
HSU	hydrostratigraphic unit
HWSA	Hazardous Waste Storage Area
ISCO	in situ chemical oxidation
LA Water Board	Los Angeles Regional Water Quality Control Board
LOX	liquid oxygen
LUC	land use control
MCL	maximum contaminant level
MCO	media cleanup objective
MNA	monitored natural attenuation
NAA	North American Aviation
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NSGW	near-surface groundwater
O&M	operation and maintenance
P&T	pump and treat
PCB	polychlorinated biphenyl
PCP	Post-Closure Permit
PLF	Propellant Load Facility
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
SMOU	Surficial Media Operable Unit
SPA	Storable Propellant Area
SSFL	Santa Susana Field Laboratory
SWMU	solid waste management unit

TCE	trichloroethene
TTA	target treatment area
USAF	United States Air Force
U.S. EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
VC	vinyl chloride

1.0 Introduction

The Department of Toxic Substances Control (DTSC) has prepared this Draft Statement of Basis to solicit public comment on its proposed environmental cleanup decision for four Target Treatment Areas (TTAs) of groundwater and bedrock vapor contamination at National Aeronautics and Space Administration (NASA) administered federal property at the Santa Susana Field Laboratory (SSFL). SSFL is an approximately 2,850-acre former aerospace and energy testing and research facility located in the Simi Hills approximately 29 miles northwest of downtown Los Angeles, California, in the southeast corner of Ventura County near the town of Simi Valley (**Figure 1**).

The proposed groundwater treatment areas were evaluated by NASA in the Draft Phase 1 Groundwater Corrective Measures Study (Draft Phase 1 Groundwater CMS)[1], which was reviewed by DTSC and the Los Angeles Regional Water Quality Control Board (LA Water Board) and is available for public review and comment concurrently with this document. NASA has proposed implementing Phase 1 remediation measures to expedite cleanup of the areas with the highest contaminant mass of trichloroethene (TCE) and its daughter products (cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride) at four locations identified as the major NASA SSFL groundwater contaminant source areas.   Remediation measures for all other NASA groundwater contamination, including other contaminants of concern in the Phase 1 areas will be addressed in NASA's Phase 2 Groundwater CMS, which will be presented with a future Phase 2 Statement of Basis for public review and comment.

The four specific NASA areas proposed for remediation under Phase 1 have been designated as the ND-136 TTA, WS-09 TTA, C-6 TTA, and the Southern Seep Area TTA. The proposed remediation technologies for cleanup in Phase 1 include Enhanced In-Situ Bioremediation (EISB), Bedrock Vapor Extraction (BVE), Monitored Natural Attenuation (MNA), Pump and Treat (P&T), and Land Use Controls (LUCs), with a combination of multiple technologies proposed at each location. The NASA areas being addressed in the Phase 1 cleanup, the remediation technologies evaluated, and how the final alternatives were selected as the proposed remedies are described in greater detail in this Draft Statement of Basis.

[1] NASA submitted a draft Phase 1 Groundwater Corrective Measures Studies in 2020. Based on comments by DTSC and the Los Angeles Regional Water Quality Control Board, NASA submitted a revised version in January 2024 which it labeled as "Final". The January 2024 NASA Phase 1 Groundwater Corrective Measures Study is the version DTSC is noticing for public comment and is the subject of this Draft Statement of Basis. However, the NASA Phase 1 Groundwater CMS is not final until DTSC has received and addressed public comment. Therefore, although the Phase 1 CMS document noticed for comment is labeled as "Final", it is appropriately referenced as "Draft" in this Draft Statement of Basis.

This Draft Statement of Basis is issued by DTSC as part of its public participation responsibilities under the Resources Conservation and Recovery Act (RCRA), as delegated to DTSC under state law[2]. The Draft Statement of Basis highlights key information relied upon by DTSC in making its proposed remedy decision. However, the public is encouraged to review the Draft Phase 1 Groundwater CMS and other documents located in the Administrative Record (AR). The AR for the SSFL facility contains all documents, including data and quality assurance information, on which DTSC's proposed decision is based. For information on how you may review the AR, see **Section 6, Public Participation**.

DTSC will select the final remedial alternatives for Phase 1 of NASA's groundwater cleanup only after the public comment period has ended and the information submitted has been reviewed and considered. The selected Phase 1 groundwater corrective action is anticipated to begin implementation in 2025-2026, and remedial measures will be applied over the course of several decades.

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[2] Chapter 6.5 of Division 20 of the California Health and Safety Code is California's delegated RCRA authority. This proposed cleanup, or "corrective action", is conducted pursuant to this authority, as well as under a 2007 Consent Order, as described in Section 2.3 below.

2.0 Facility Background and Environmental History

2.1 SSFL Overview

SSFL is an inactive former aerospace and energy research facility located approximately 29 miles northwest of downtown Los Angeles in the southeastern corner of Ventura County, overlooking Simi Valley. Encompassing about 2,850 acres of rugged, undulating terrain, the site features an elevation change of roughly 1,100 feet near the apex of the Simi Hills. **Figure 1** depicts the SSFL geographical location, property demarcations, and relation to surrounding areas and communities.

The SSFL site is subdivided into four distinct administrative zones, designated as Areas I, II, III, and IV, with areas of undeveloped land to the north and south (see **Figure 2**). The Boeing Company (Boeing) owns the majority of Area I, as well as the entirety of Areas III and IV. Area II, spanning approximately 409.5 acres, is federally owned and administered by NASA, along with a small segment of Area I known as NASA-administered Area I, which spans about 41.7 acres. The United States Department of Energy (DOE) historically leased a portion of Area IV, totaling 90 acres, where it conducted nuclear energy research. The undeveloped northern and southern lands of SSFL are owned by Boeing and were not used for operational activities.

2.2 NASA Facilities Operational History

Beginning in 1948, North American Aviation (NAA) and its successor Rocketdyne developed the SSFL property for research, development, and testing of liquid-fueled rocket engines and associated components. In December 1958, Rocketdyne transferred SSFL Area II and the Liquid Oxygen (LOX) Plant area to the United States Air Force (USAF), operating as USAF Plant 57. In the 1970s, custody of about 451.2 acres of property changed from the USAF to NASA under the United States General Services Administration (GSA). The location of the NASA-administered property is highlighted in **Figure 2**. In addition to rocket engine and component testing in Areas I, II and III, nuclear energy research facilities were situated within the 90-acre portion of SSFL Area IV via a lease agreement with DOE, operating from the 1950s through the mid-1990s. Boeing acquired the aerospace divisions of Rockwell International in 1996 and is the current owner of the non-NASA portions of SSFL.

Engine testing at SSFL primarily involved the use of petroleum-based compounds as the fuel and LOX as the oxidizer. TCE served as the primary solvent for cleaning rocket engine components from the 1950s through the early 1970s, and large releases of this compound to the environment occurred during the early years of operations. These operations were conducted in Areas I and III in support of various government space programs, and in Area II on behalf of the USAF and later on behalf of NASA.

In Area II, rocket engine testing took place at four test stand areas constructed between 1954 and 1957 in the Alfa, Bravo, Coca, and Delta Areas. These areas also contained additional buildings for support activities and infrastructure.

Starting in the 1980s, NASA phased out operations, with the final tests conducted in 2006. Between 1996 and 2014, Boeing undertook operation and maintenance (O&M) activities on facilities within the NASA portion of SSFL. Following this period, NASA resumed O&M of its facilities.

As part of historical operations, NASA used four surface impoundments for managing hazardous wastewater (as shown on the Draft CMS Figure 2-5): Storable Propellant Area (SPA) Impoundment 1 (SPA-1), SPA-2, Alfa Bravo Skim Pond (ABSP), and Delta Skim Pond. However, their use was discontinued in the mid-1980s, and they were formally closed under a 1991 DTSC approved Closure Plan. Currently, these former impoundments are under post-closure care, overseen by a Hazardous Waste Facility Post-Closure Permit (PCP) Number PC-94/95-3-03 (DTSC, 2013).

In 2015, NASA began a long-term program of demolition of the majority of the former rocket test stands, buildings, and support infrastructure, and this program is expected to continue until 2026. NASA may preserve the remaining test stands and former control building in the Alfa area for historic purposes.

2.3 Groundwater Corrective Action Consent Order

Widespread groundwater contamination, mostly from historical TCE releases at the site, was discovered in the NASA areas in the 1980s. A program of investigation and interim remediation began at that time under the RCRA. The California Department of Health Services, and later DTSC, assumed oversight of the RCRA groundwater corrective action program at SSFL.

In August 2007, a Consent Order for Corrective Action (Consent Order) (DTSC Docket No. P3-07/08-003) was established between DTSC and the three responsible parties at SSFL. This Consent Order outlined the requirements for addressing environmental contamination at SSFL. The Consent Order separated the remediation of surface contamination and groundwater into two distinct units[3]:

a. The Surficial Media Operable Unit (SMOU) comprises saturated and unsaturated soil, sediment, surface water, near-surface groundwater (NSGW), air, biota, and weathered bedrock. NSGW occurs within alluvium or weathered bedrock material.

[3] As noted below, this Draft Phase 1 Groundwater CMS addresses only the CFOU. The SMOU will be addressed in the NASA Soils Remedial Action Implementation Plan (SRAIP)

b. The Chatsworth Formation Operable Unit (CFOU) comprises the Chatsworth formation aquifer, and both saturated and unsaturated unweathered (competent) bedrock.

2.4 NASA Groundwater RCRA Facility Investigations

The results of groundwater investigations at the NASA SSFL areas between the 1980s and the late 2000s were summarized and reported in the 2009 Draft Sitewide SSFL Groundwater RFI Report, submitted jointly by NASA, DOE, and Boeing. Subsequent groundwater investigations conducted by NASA between 2013 and 2019 were organized relative to four major Areas of Impacted Groundwater (AIGs). The AIGs represent the locations where major historic releases of contamination occurred (i.e., source areas) and are documented to have significantly impacted groundwater. These four NASA AIGs were designated as the Former LOX Plant AIG, the Building 204/Expendable Launch Vehicle (B204/ELV) AIG, the Alfa/Bravo AIG, and the Coca/Delta AIG. These AIGs are shown in **Figure 3**[4].

Based on the results of these investigations, NASA summarized and reported groundwater investigations in the 2020 Final NASA Groundwater RFI Report. DTSC reviewed this report and concluded that the nature and extent of NASA groundwater contamination was sufficiently defined to support completion of the RFI and evaluation of initial cleanup remedies in these four AIGs as the most impacted areas in the Draft Phase 1 CMS (discussed below, in **Section 2.6**). The nature and extent of groundwater contamination determined during the RFI process at the individual Phase 1 NASA AIGs covered in this decision document (the Alfa/Bravo AIG and the Coca/Delta AIG), are discussed in greater detail in **Section 3** of this document.

As noted in **Section 2.6** below, this Statement of Basis describes the proposed Corrective Measures Study (CMS) which evaluates alternatives and makes recommendations for Phase 1 of NASA's groundwater remedial actions. The CMS is not final until the public has commented on these documents and DTSC has responded to these comments, including any necessary changes to the proposed remediation. Once final, the selected remedial actions will be implemented under the Phase 1 Corrective Measures Implementation (CMI) process.

In the future Phase 2 Groundwater Statement of Basis, sitewide NASA groundwater cleanup goals will be established. If any of these goals are lower than the screening

[4] As depicted in Figure 3, "Areas of Impacted Groundwater" delineate the general areas where TCE contamination from sources within NASA's areas of responsibility is confirmed. As referenced in Section 1.0 Introduction and discussed further below, "Targeted Treatment Areas" (TTA) are areas within the AIGs identified as highly contaminated based on meeting or exceeding a numerical "screening" level. This "screening" level is **not** a cleanup goal, but is used to identify the target areas of high TCE contamination to be addressed in Phase 1.

levels[5] used to characterize the site in the RFI, additional characterization may be required by DTSC. This characterization would be completed during the Phase 1 CMI phase of the project where goals of the Phase 2 will be determined. As noted in **Section 2.6** below, this Draft Statement of Basis is for the Draft Phase 1 Groundwater CMS, which, once final, will be implemented under the Phase 1 CMI.

2.5 NASA Groundwater Risk Assessments

Using the groundwater characterization data reported in the Final NASA Groundwater RFI Report, NASA performed risk assessments for the four NASA AIGs to assess if exposure to chemicals in groundwater, deep soil and bedrock vapor, seeps, and springs pose a current or potential risk to human health or ecological receptors. These risk assessments were developed between 2017 and 2024, with DTSC approving the Final NASA Groundwater Risk Assessment in July 2024.

The results of the NASA risk assessments were used in the Draft Phase 1 CMS and remedy selection process, in evaluating the remedial technologies and alternatives. Although the risk assessment process evaluated multiple chemicals of concern (COCs) in groundwater and seep water at all four NASA AIGs, only the evaluations related to TCE and its daughter products for the Alfa/Bravo and Coca/Delta AIGs were relevant to this Phase 1 groundwater remedy selection. The full range of COCs identified in the risk assessment will be addressed in the next phase of the NASA groundwater CMS (discussed in **Section 2.6**, below).

The results of the risk assessments and their application to the Phase 1 remedy selection are discussed further in **Section 3.3** of this document.

2.6 NASA Groundwater Corrective Measures Studies

In August 2018, NASA submitted a Draft Groundwater Corrective Measures Study (Draft Groundwater CMS) for the NASA-administered areas of SSFL for DTSC review. The Draft CMS provided an analysis of COCs in CFOU groundwater, with very limited active treatment of contamination evaluated. Based on the comments by DTSC and LA Water Board, which identified significant deficiencies, NASA proposed separating the NASA Groundwater CMS into two phases, with Phase 1 addressing groundwater and unweathered bedrock with the highest TCE concentrations, and Phase 2 addressing the remaining areas of NASA groundwater contamination and the full range of chemical contaminants. The NASA Draft Phase 1 Groundwater CMS would be the first step toward achieving cleanup goals for groundwater in compliance with federal, state, and local laws and the 2007 Consent Agreement.

[5] See Footnote 4 above and Section 2.6 below

DTSC concurred with the two-phase CMS approach, and NASA prepared the Draft Phase 1 Groundwater CMS evaluation to specifically address the NASA high-TCE concentration areas which met the following screening criteria:

a. High TCE Concentration Areas in Groundwater, defined as those areas where groundwater TCE concentrations exceed 10,000 micrograms per liter (µg/L).

b. High TCE Concentration Areas in Bedrock Vapor, defined as those areas where vapor TCE concentrations exceed 12,000,000 micrograms per cubic meter ($\mu g/m^3$) in the vadose zone.[6]

c. Seep Areas in the southern component of the Coca/Delta AIG and the northern portion of the B204/ELV AIG, which are the two documented locations where TCE-contaminated groundwater flows at surface seeps with the potential for offsite migration. A remedy for the Coca/Delta seep area (Southern Seep Area) is proposed in this Draft Statement of Basis. The Draft Phase 1 Groundwater CMS also evaluated potential remedies for seeps at the B204/ELV AIG (Northern Seep Area), but because these exhibit low TCE contaminant concentrations, a remedy for these seeps is not being proposed for Phase 1 of the NASA groundwater cleanup. Evaluation of the Northern Seep Area for future cleanup is ongoing and will be addressed in the Phase 2 Groundwater CMS.

Applying the three criteria above to the groundwater characterization data from the NASA AIGs identified the four Target Treatment Areas (TTAs) evaluated in the Draft Phase 1 CMS. **Section 4.1** of this document describes this process and defines the selected NASA Phase 1 TTAs.

As noted in Footnote 1 above, NASA submitted a Draft Phase 1 Groundwater CMS to DTSC in 2020. In response to DTSC and LA Water Board comments, NASA revised the document and submitted a revised Draft Phase 1 Groundwater CMS to DTSC in 2024. DTSC will make a decision on final approval of the NASA Final Phase 1Groundwater CMS document following public review and comment.

The evaluations performed in the NASA Draft Phase 1 Groundwater CMS used Federal and California Maximum Contaminant Levels (MCLs) as Phase 1-specific temporary target goals (see **Section 4.2**). Final NASA SSFL sitewide remedial actions and final media cleanup objectives (MCOs) will be established in the Phase 2 NASA groundwater CMS and the Phase 2 DTSC Statement of Basis, where final groundwater remediation concentration goals will be set. DTSC will apply these final MCOs to the four NASA TTAs presented in this document as part of the Phase 2 Statement of Basis.

[6] See Section 2.3.1 "Phase 1 CMS Site Selection" in the Draft Phase 1 Groundwater CMS for the origins of the groundwater and bedrock vapor screening criteria.

The Phase 2 Groundwater CMS will evaluate the effect of the Phase 1 remedies on source and plume areas, and assess other COCs in the Phase 1 TTAs, the remaining TCE source areas, other NASA groundwater areas outside of the Phase 1 TTAs, and the feasibility of achieving groundwater remediation to background levels in accordance with State Water Resources Control Board Resolution No. 92-49.

Public comment and DTSC approval of both Phase 1 and Phase 2 are required for NASA to complete the CMS groundwater phase of work at SSFL.

3.0 Summary of Chemical Releases and Risk Assessments

This section summarizes the chemical releases documented in groundwater, bedrock vapor, and discharge from seeps at the two NASA AIG locations (Alfa/Bravo and Coca/Delta) relevant to the remedial decisions being described in this Phase 1 Draft Statement of Basis. It also provides discussion of the results of risk assessments performed on the data collected at these areas.

3.1 Alfa/Bravo AIG

3.1.1 Alfa/Bravo Sites and Operations

The Alfa/Bravo AIG complex is located in the central part of NASA Area II (**Figure 3**). Within this AIG are the former operational areas for the Alfa Test Stand Area, Bravo Test Stand Area, Alfa/Bravo Fuel Farm (ABFF), SPA, and the Hazardous Waste Storage Area (HWSA). No identified groundwater seeps are associated with the Alfa/Bravo AIG.

The Alfa Area, located in the central-eastern part of Area II, housed three engine test stands with associated pipelines. It also included support buildings, debris areas, Aboveground Storage Tanks (ASTs), (with three designated as RCRA solid waste management units (SWMUs), septic leach fields, and the Alfa Skim Pond and Alfa Retention Pond (both designated as SWMUs). These ponds received cooling waters impacted by fuel and solvents from the test stands. Chemicals potentially used in the Alfa Area include solvents (notably TCE for engine flushing), oils, fuels, polychlorinated biphenyl s (PCBs), and oxidizers.

The Bravo Area, located in the central-western part of Area II, also featured three engine test stands designated as SWMUs, along with associated pipelines and support buildings. It included debris areas, ASTs (including the Bravo Waste Tank, designated as a SWMU), septic leach fields, former groundwater air-stripping towers, the Alfa/Bravo Skim Pond (ABSP, a closed hazardous waste-regulated unit designated as a SWMU), and the Bravo Skim Pond (also designated as a SWMU). The ABSP is a RCRA-closed regulated unit, and is underlain with drainage piping designated as an area of concern for groundwater contamination . Chemicals potentially used in the Bravo Area include solvents (including TCE), oils, fuels, and oxidizers.

The ABFF is located in Area II, northwest of the Bravo Area. It housed petroleum-based fuel ASTs with associated pipelines and pumps to support the Alfa and Bravo Test Stands. Potential chemicals used at the ABFF include solvents, fuels, lead-based paint, and PCBs.

The SPA, situated in Area II just west of the ABFF, extends into Areas III and IV to the west. The SPA served as a storage site for hazardous materials associated with test stand operations, featuring two former surface impoundments, SPA-1 and SPA-2, both designated as SWMUs and closed hazardous waste-regulated units. The area between the impoundments also contained hazardous materials. Potential chemicals used at the SPA are diverse and include solvents, fuels, acids, oxidizers, formaldehyde, fluoride, PCBs, energetics, N-nitrosodimethylamine (NDMA), metals, and pesticides.

The HWSA comprises two SWMUs: the HWSA Container Storage Area, a RCRA-permitted unit used for storing drummed wastes (now a closed container storage unit), and the Waste Coolant Tank. Potential chemicals used at the HWSA include solvents, oils, fuels, acids, oxidizers, bases, and metals.

3.1.2 Groundwater Contamination at Alfa/Bravo AIG

Phase 1 groundwater COCs for the Alfa/Bravo AIG include TCE, cis-1,2-dichloroethene (DCE), trans-1,2-DCE, and vinyl chloride (VC). The Phase 1 COCs form a groundwater plume that extends from the Alfa test stands to the Bravo test stands, encompassing the area in between, including the four ponds (Alfa Skim Pond, Alfa Retention Pond, Bravo Skim Pond, Alfa/Bravo Skim Pond). The horizontal extent of groundwater contamination at the Alfa/Bravo site is shown on **Figure 4**.

In the Alfa Area, TCE has been detected in groundwater at concentrations up to 13,000 micrograms per liter (μg/L) (well ND-136 near Alfa Test Stand 1). Concentrations decline with depth but have been detected above the 5 μg/L TCE MCL as deep as 530 feet below ground surface (bgs). Bedrock vapor concentrations of TCE have been detected at a maximum of 36,000,000 micrograms per cubic meter ($\mu g/m^3$) in ND-136 near Alfa Test Stand 1. The high groundwater and bedrock/soil vapor TCE concentrations in the Alfa Area are addressed in the Draft Phase 1 Groundwater CMS (ND-136 TTA).

In the Bravo area, TCE has been detected in groundwater at concentrations up to 30,000 μg/L (well WS-09). Concentrations decrease with depth but have been detected above the TCE MCL as deep as 800 feet bgs. Bedrock vapor concentrations of TCE have been detected at a maximum of 370,000 $\mu g/m^3$ (which is below the Phase 1 Groundwater CMS threshold concentration of 12,000,000 $\mu g/m^3$) near the Bravo Skim Pond. The high groundwater TCE concentrations in the Bravo Area are addressed in the Phase 1 Groundwater CMS (WS-09 TTA).

In the SPA site, TCE has been detected in groundwater at a maximum concentration of 190 μg/L, which is below the Phase 1 CMS threshold concentration of 10,000 μg/L. Bedrock vapor samples have not been collected, as this area has not been identified as a high concentration TCE source zone. COCs present at the SPA will be addressed in the Phase 2 CMS. The ABFF and the HWSA do not have TCE source areas. Other primary COCs detected in the Alfa/Bravo AIG include 1,4-dioxane and NDMA. These

COCs, along with lower concentration Phase 1 COCs, will be addressed in the Phase 2 Groundwater CMS.

3.2 Coca/Delta AIG

3.2.1 Coca/Delta AIG Sites and Operations

The Coca/Delta AIG is situated in the southern part of Area II (**Figure 3**). Former operation areas in this AIG include the Coca Area, Delta Area, Coca Delta Fuel Farm (CDFF), R-2 Ponds, and Propellant Load Facility (PLF). The Southern Seep Area is also classified as a component of this AIG.

The Coca Area, located in the southeast portion of Area II, housed four engine test stands designated as SWMUs, along with associated pipelines. It also included support buildings, debris areas, ASTs, Underground Storage Tanks (USTs), leach fields, transformers, and the Coca Skim Pond, designated as a SWMU. Chemicals potentially used in the Coca Area include solvents (notably TCE), oils, fuels, metals, fluoride, energetics, formaldehyde, Freon, PCBs, dioxins, and oxidizers.

The Delta Area, situated in the southwest portion of Area II, featured three engine test stands designated as SWMUs, along with associated pipelines. It also included support buildings, debris areas, ASTs, USTs, a leach field, transformers, the Delta Area Groundwater Extraction/Treatment Unit (including a Purge Water Tank and Delta Air Stripping Towers, designated as SWMUs), a fluorine scrubber, and the Delta Skim Pond, designated as a SWMU and a closed hazardous waste-regulated unit. Chemicals potentially used in the Delta Area include solvents (including TCE), oils, fuels, metals, anions, energetics, PCBs, dioxins and furans, Freon, amines, acids, bases, and oxidizers.

The CDFF is situated in the southwestern portion of Area II and extends into Area III. It housed petroleum-based fuel ASTs with associated pipelines and pumps to support the Coca and Delta Test Stands. Chemicals potentially associated with CDFF operations include solvents, oils, fuels, metals, anions, PCBs, dioxins and furans, formaldehyde, acids, and bases.

The R-2 Ponds, designated as a SWMU, are situated northwest of the Delta Area (Draft Phase 1 CMS Figure 2-5). Comprising two adjacent ponds (R-2A and R-2B), they received drainage water from skim and retention ponds spanning Areas I through IV. Potential chemicals associated with water collected in the R-2 Ponds include solvents, oils, fuels, PCBs, dioxins and furans, energetics, fluorine, and nitrates.

The PLF lies north of the Delta Area and east of the R-2 Ponds Draft CMS Figure 2-5). Serving as the control center for the Delta Test Area, it encompasses three SWMUs: the PLF Waste Tank, the PLF Ozonator Tank, and the PLF Surface Impoundment.

Additionally, it contains a leach field. Chemicals potentially associated with PLF operations include solvents, oils, fuels, metals, chromium VI, perchlorate, NDMA, energetics, PCBs, dioxins and furans, formaldehyde, and anions.

3.2.2 Groundwater Contamination at Coca/Delta AIG

Phase 1 groundwater COCs for the Coca/Delta AIG include TCE, cis-1,2-DCE, trans-1,2-DCE, and VC. The Phase 1 COCs form a groundwater plume in the Coca Area that extends from approximately Coca Test Stand 4 in the east down the valley to past the Coca Skim Pond to the west. The southern extent of the plume is bounded by the Coca Fault, and the northern extent is estimated to be bounded by the Upper Bravo Bed. The Phase 1 COCs form a separate groundwater plume in the Delta Area that generally extends from the R-2 ponds and Delta Skim south-southwest toward the WS-09A well area and the Southwest Drainage near the Burro Flats Fault Zone. Concentrations decline with depth but have been detected in the Delta Area as high as 2,100 µg/L at a depth of 900 feet below ground surface (bgs). The vertical extent of the TCE plume is unknown in the Delta Area. The inferred lateral extent of the groundwater plumes for the Coca/Delta AIG is shown on **Figure 5**.

In the Coca Area, TCE has been detected in groundwater at a maximum concentration of 630 µg/L, which is below the Phase I CMS threshold concentration of 10,000 µg/L. Bedrock vapor TCE has been detected at an estimated concentration of 7,100,000 µg/m^3, which is below the Phase 1 CMS threshold concentration of 12,000,000 µg/m^3. The Coca Area is not being considered for treatment in the Phase 1 CMS but will be reevaluated during the Phase 2 CMS.

In the Delta Area, TCE has been detected at the Delta Skim Pond source area at concentrations up to 150,000 µg/L in well C-6 and up to 98,000 µg/L in well ND-169. Bedrock vapor concentrations of up to 2,400,000 µg/m^3 have been detected in the Delta area, which is below the Phase 1 CMS threshold concentration of 12,000,000 µg/m^3. The high groundwater TCE concentrations in the Delta Area will be addressed in the Phase 1 CMS (C-6 TTA).

Fourteen seeps and pools have been identified south of the Coca/Delta AIG (Southern Seep Area), most of which are inside the SSFL property boundary. Most of the seeps and seep well clusters south of the Coca/Delta AIG could potentially be located along a COC migration pathway originating from Coca/Delta AIG source areas. The seeps and seep well clusters in the Southwest Drainage Area are the locations of primary concern. Concentrations of Phase 1 COCs (TCE, cis-1,2-DCE, and VC) have been detected above their respective DTSC-approved Groundwater Screening Levels (GSLs) in seep well cluster SP-890. Concentrations of cis-1,2-DCE have also been detected at seep well cluster SP-881 and SP-882, located downgradient of seep well cluster SP-890. Concentrations of cis-1,2-DCE decline downgradient, with COCs below screening levels a short distance south of the Burro Flats Fault Zone. Elevated Phase 1 COC concentrations in the Southern Seep Area will be addressed in the Phase 1 CMS.

The CDFF, R-2 Ponds, and PLF do not have high TCE source areas and are not considered for treatment in the Phase 1 CMS. Other primary COCs detected in the Alfa/Bravo AIG include 1,4-dioxane, NDMA, and formaldehyde. These COCs, along with the lower concentrations of Phase 1 COCs, will be addressed in the Phase 2 Groundwater CMS.

3.3 Health and Ecological Risk Evaluation Conclusions for NASA AIGs

As discussed in **Section 2.5**, the potential risks from exposures to groundwater, bedrock/soil vapor, and seeps/springs at the four NASA AIGs (Alfa/Bravo, Coca/Delta, B204/ELV, and LOX) were evaluated and documented in the August 2024 NASA Groundwater Human Health and Ecological Risk Assessment (NASA Groundwater HHERA) which was approved by DTSC in July 2024. The results and conclusions of the NASA Groundwater HHERA used in the evaluation of the remedies proposed in this document are described and summarized in this section.

Human Health Risks. For human health risks, NASA evaluated the chemicals documented to be present in groundwater, surface water (seeps), and bedrock/soil vapor in the NASA AIGs, applied to exposure scenarios for the following:

- Hypothetical Future Residents
- Current and Future Industrial/Commercial Workers
- Future Recreational Users

The exposure pathways included for these evaluations included ingestion, dermal contact, and inhalation, including from indoor vapor intrusion. The resident and industrial worker evaluation in the risk assessment is a conservative risk assessment approach when compared to an “open space” end use of the NASA property.

The NASA human health risk assessments confirmed that there are no current human exposures or pathways for significant offsite exposures from contamination at the NASA AIG areas, but that risks from hypothetical future onsite human exposures to current groundwater, water discharge at the southern seeps, and subsurface vapor at the contaminated NASA AIGs would be significant. These conclusions and the evaluation of the risks documented in the NASA Groundwater HHERA were directly applied to the Phase 1 CMS remedy evaluation and the decisions in this document, including the decisions for the application of LUCs.

Ecological Risks. For ecological risks, the NASA Groundwater HHERA also included an evaluation and summary of the potential ecological risks from contaminated seep discharge at the Coca/Delta AIG Southern Seep TTA, which is the sole area in the

Phase 1 NASA sites where a pathway exists between contaminated water and potential ecological receptors. The risk assessment concluded that risks for aquatic receptors in downstream receiving water bodies and birds and mammals that might ingest the water are classified as low.

4.0 Groundwater Remediation Treatment Alternative Selection and Evaluation

This section summarizes the process used to identify, evaluate and select the proposed Phase 1 remedies. This process is described in greater detail in Sections 4, 5, and 6 of the DTSC-reviewed NASA Draft Phase 1 Groundwater CMS document. To streamline this Draft Statement of Basis, the summaries provided below have been kept brief, with direct references and electronic links (highlighted in blue text) provided to the relevant portions of the NASA Draft Phase 1 Groundwater CMS document.

4.1 Target Treatment Area Selection

The Phase 1 selection criteria described in **Section 2.6** of this document were applied to the NASA groundwater, bedrock/soil vapor, and seep data to define the TCE-impacted Phase 1 TTAs. Though the individual TTAs were named after the groundwater or vapor wells with the highest concentrations in their respective areas, the TTA footprints extend well beyond just those wells. The locations of the four TTAs relative to groundwater contamination are shown in **Figure 4** (Alfa/Bravo AIG) and **Figure 5** (Coca/Delta AIG). The locations of the TTAs relative to hydrologic cross sections of groundwater contamination are shown in **Figure 6** and **Figure 7** (Alfa/Bravo AIG), and **Figure 8** (Coca/Delta AIG)

The resulting Phase 1 TTAs and the criteria used to define them are described below:

a. <u>High TCE Concentrations in Groundwater Areas</u>: Three areas have TCE concentrations in groundwater that exceed 10,000 µg/L. These will be collectively referred to as the Phase 1 groundwater treatment areas. They are defined as:
    - **ND-136 TTA (located in the Alfa Area),**
    - **WS-09 TTA (located in the Bravo Area), and**
    - **C-6 TTA (located in the Delta Area).**

b. <u>High TCE Concentrations in Soil/Bedrock Vapor Areas</u>: Of the three TTAs identified above with TCE concentrations above the screening criteria, one also has TCE concentrations in bedrock/soil vapor that exceed 12,000,000 µg/m^3 in the vadose zone. It is defined as:
    - **ND-136 TTA (located in the Alfa Area)**

c. <u>Seep Areas</u>: Groundwater seeps were assessed to determine if TCE-contaminated groundwater could migrate offsite. A seep area in the southern part of the Coca/Delta (Figures 5 and 8) has a long-documented history of TCE and daughter product detections, which are currently managed under the SSFL groundwater interim measure (GWIM). Because this southern area met the criteria of having seep discharges with the potential to migrate offsite, this area is defined as:

- **Southern Seep Area TTA**

4.2 Remedial Cleanup Goals for Phase 1

An important role of the RCRA CMS and Statement of Basis process is to evaluate and propose MCOs for the remediation project. These MCOs represent goals that not only serve as standards for completing the cleanup, they are also applied in the CMS to the evaluation and engineering analyses of cleanup technologies, timeframes, and resource needs.

As described in Section 2.6 of this document, the NASA groundwater CMS was divided into separate Phase 1 and Phase 2 components, with Phase 1 focusing on areas with the highest concentrations of TCE. Phase 1-specific target cleanup goals were established for application in the evaluation of potential remedial technologies, the development of alternatives, and the evaluation of those alternatives. The Draft Phase 1 Groundwater CMS uses federal and California MCLs for TCE, cis-1,2-DCE, trans-1,2-DCE andVC as the Phase 1- specific goals. These MCL concentrations (in µg/L) are:

- TCE: 5.0 µg/L
- cis-1,2-DCE: 6.0 µg/L
- trans-1,2-DCE: 10.0 µg/L
- VC: 0.5 µg/L

These Phase 1 Groundwater CMS MCOs identified above are interim cleanup levels used as a point of reference to evaluate alternatives in Phase 1. Final cleanup goals or MCOs for NASA-wide groundwater, which include the Phase 1 sites, will be established in the Phase 2 NASA Groundwater CMS and Phase 2 Statement of Basis based on the results of a technical and economic feasibility analysis.

As noted above, the Phase 2 Groundwater CMS will evaluate other COCs in the Phase 1 TTAs, the remaining TCE source areas, other contaminated NASA groundwater areas outside of the Phase 1 TTAs, and the feasibility of achieving groundwater remediation to background levels in accordance with State Water Resources Control Board Resolution No. 92-49.

4.3 Technologies Screened

The NASA Draft Phase 1 Groundwater CMS identified 16 proven and available technologies as candidates for application to groundwater cleanup at the High TCE Concentration TTAs and the Seep TTAs. The full list of technologies screened are listed below in **Table 1 (Technologies Screened for Target Treatment Areas)**, and a detailed description of each technology can be found in the following CMS Sections:

a. Treatment Technologies for Phase 1 Groundwater Areas – Section 4.3.1, Table 4.3 and Figure 4-7.

b. Treatment Technologies for Seep Areas – Section 4.3.2, Table 4-4 and Figure 4.8.

Table 1 Technologies Screened for Target Treatment Areas

High TCE Concentration TTAs	Seep TTAs
In Situ Thermal Treatment (ISTT)	Permeable Reactive Barrier
Enhanced In Situ Bioremediation (EISB)	EISB Barrier Treatment Zone
Thermally Assisted EISB	Phytoremediation
In Situ Chemical Oxidation (ISCO)	Constructed Treatment Wetlands
Biosparging	Hydraulic Control
Air Sparging	Fine Bubble Diffused Aeration
Bedrock Vapor Extraction (BVE)	MNA
Pump and Treat (P&T)	--
In Situ Fracking	--
Monitored Natural Attenuation (MNA)	--

When evaluating one or more remedial options, United States Environmental Protection Agency (U.S. EPA) guidance indicates that only appropriate and implementable approaches need to be considered. [7]

NASA conducted an initial screening of the 16 technologies identified above by evaluating the potential effectiveness and ability to implement each technology.

Effectiveness: This criterion assesses the achievable reduction in contaminant concentrations by applying the candidate technology.

Implementability: This criterion evaluates the ability to implement the alternative at the TTA, based on factors such as site accessibility, availability of services, service providers, and related infrastructure such as electricity at the project site.

Based on this review, NASA retained the following eight technologies for remedial alternatives evaluation. These selected technologies are described in detail in Draft Phase 1 Groundwater CMS Section 4 and Draft Phase 1 Groundwater CMS Section 6

[7] U. S. Environmental Protection Agency (EPA) 2000a Fact Sheet No. 3, Final Remedy Selection for Results-Based RCRA Corrective Action. March.

with a brief description of each technology is provided below. Each technology is also linked to its corresponding discussion in the Draft Phase 1 Groundwater CMS (please click on the links to access the text of these discussions.)

a. Pump and Treat (P&T) – Pumping contaminated groundwater from extraction wells and transferring the contaminated water to above-ground treatment units.

b. Enhanced In-Situ Bioremediation (EISB) – Injecting fluids with nutrients and chemicals into groundwater to enhance the natural biological breakdown of contaminants.

c. Thermally-Assisted EISB – Enhancing EISB processes by increasing the temperature of the target areas of groundwater treatment.

d. In-Situ Chemical Oxidation (ISCO) – Injecting an oxidizing chemical into groundwater to promote the destruction of contaminants. Chemicals used include ozone, peroxide, or permanganate.

e. Bedrock Vapor Extraction (BVE) – Removing volatile chemical vapors from the bedrock beneath the ground surface by applying a vacuum to extraction wells and transferring the vapor to above-ground treatment units.

f. Monitored Natural Attenuation (MNA) – Using natural processes to break down environmental contaminants, through a combination of biological, physical, and chemical processes. When used as a cleanup remedy, the effectiveness of these processes is closely monitored to assure the reduction of contaminants.

g. Hydraulic Control – Using pumping to control the movement of groundwater and seep discharges, to prevent contamination from migrating.

h. EISB Barrier Treatment Zone – Installing a solid treatment material, such as carbon, into contaminated groundwater to act as a food source for natural bacteria to degrade contaminants such as TCE as they come into contact with the treatment material.

These eight technologies were then combined (where appropriate and compatible) into five potential remedial alternatives for the three NASA SSFL Phase 1 High TCE Concentration Area TTAs, and three potential remedial alternatives for the Southern Seep TTA. The process and rationale used in the development of these alternatives is discussed in Draft Phase 1 Groundwater CMS Section 5.0.

The sections below describe the alternatives evaluated for the two High TCE Concentration TTA categories (groundwater and soil/bedrock vapor) and the Southern Seep TTA, and the evaluation methods used to arrive at the final selected remedy.

4.4 Groundwater and Bedrock Remedial Alternatives Evaluated

The five groundwater and soil/bedrock vapor remedial alternatives developed in Section 5 of the Draft Phase 1 Groundwater CMS are described below.

Alternative 1: MNA and LUCs. This alternative relies on natural attenuation, which has been demonstrated to be successful in some locations at SSFL, and LUCs to prevent the use of groundwater and limit future site use until cleanup objectives are achieved. LUCs include institutional controls and engineering controls that will prevent access to groundwater and limit future site use until MCOs are achieved.

Alternative 2a: Groundwater treatment using EISB followed by MNA, BVE for soil/bedrock vapor, and LUCs. This alternative adds to Alternative 1 the use of BVE at the ND-136 TTA and treatment of groundwater using EISB at the ND-136 TTA, WS-09 TTA, and C-6 TTA.

Alternative 2b: Groundwater treatment using EISB with thermal heating followed by MNA, BVE for soil/bedrock vapor, and LUCs. These are the same treatment technologies described in Alternative 2a with the addition of heating the EISB fluids prior to injection to facilitate faster microbial degradation.

Alternative 3: Groundwater treatment using P&T followed by MNA, BVE for soil/bedrock vapor, and LUCs. This alternative adds to Alternative 1 the use of BVE at the ND-136 TTA and treatment of groundwater using P&T at the ND-136 TTA, WS-09 TTA, and C-6 TTA.

Alternative 4: Groundwater treatment using ISCO followed by MNA, BVE for soil/bedrock vapor, and LUCs. This alternative adds to Alternative 1 the use of BVE at the ND-136 TTA and treatment of groundwater using ISCO at the ND-136 TTA, WS-09 TTA, and C-6 TTA.

A detailed analysis of these alternatives is provided in the NASA Draft Phase 1 Groundwater CMS Section 6.

4.5 Seep Area Remedial Alternatives Evaluated

Three seep area remedial alternatives were developed in the NASA Draft Phase 1 Groundwater CMS Section 5 and are described below.

Alternative SP-1: MNA and LUCs. This alternative relies on natural attenuation, which has been demonstrated to be successful in some locations at SSFL, and LUCs to prevent the use of groundwater and limit future site use until MCOs are achieved.

Alternative SP-2: Hydraulic Control of Seep Water, MNA, and LUCs. This alternative is similar to Alternative 3 (for the Phase 1 groundwater TTAs) in that contaminated groundwater is extracted and treated at the existing SSFL groundwater extraction and treatment system (GETS). Instead of targeting source areas, this technology is deployed to intercept contaminated groundwater before it emerges as seeps. This alternative includes MNA, which would be used after hydraulic control has achieved its practical application limits.

Alternative SP-3: EISB, MNA, and LUCs. This alternative is similar to Alternative 2a (for the Phase 1 groundwater TTAs) in that EISB is used to enhance degradation of contaminants in the subsurface. However, instead of applying the EISB technology in a source area, EISB would be deployed upgradient of where contaminated groundwater is emerging as seep water. This method is expected to treat contaminated groundwater prior to it appearing as seeps. This alternative includes MNA, which would be used after EISB has achieved its practical application.

A detailed analysis of these alternatives is provided in the NASA Draft Phase 1 Groundwater CMS Section 6.

4.6 Remedial Alternative Evaluation Criteria and Methods

For each of the above alternatives, the Draft Phase 1 Groundwater CMS developed engineering concepts which included the required technologies, system components, configurations, support needs, and operational timeframes. Capital and operational cost estimates were also developed for each alternative based on these concepts.

The Draft Phase 1 Groundwater CMS detailed analysis of the alternatives followed the EPA guidance "Final Remedy Selection for Results-Based RCRA Corrective Action." Each of the ten criteria applicable to the analysis is listed below and described in Draft Phase 1 CMS Section 6.2.

The guidance specifies three **performance standards** (defined as measurable criteria that can be compared to decision thresholds of remedy acceptability). These three criteria are:

- Protect human health and the environment
- Achieve media cleanup objectives
- Remediate the sources of releases

In addition to these performance criteria, EPA has identified seven **balancing/evaluation criteria** (defined as criteria used to weigh the positive and negative factors of a remedial alternative when making a decision). These seven criteria are:

- Long-Term Effectiveness
- Toxicity, Mobility, and Volume Reduction
- Short-Term Effectiveness
- Implementability

- Cost
- Community Acceptance
- State Acceptance

A scoring scale based on the potential effectiveness and ability to implement was applied to evaluate the remediation alternatives. The NASA Draft Phase 1 Groundwater CMS Section 6 provides a detailed description of the application and scoring. Total scores were summed and alternatives were ranked from highest to lowest. Scores are summarized below in Table 2.

Table 2 Scoring for Groundwater and Seep Alternatives

Summary of Detailed Analysis Scores For Groundwater Alternatives

Criterion	Alternative 1 - MNA and LUCs	Alternative 2a - EISB, BVE, MNA, and LUCs	Alternative 2b - Thermally Assisted EISB, BVE, MNA, and LUCs	Alt 3 - P&T, BVE, MNA, and LUCs	Alt 4 - ISCO, BVE, MNA, and LUCs
Protection of Human Health and Environment	3.0	4.0	4.0	4.0	3.5
Attain Media Cleanup Objectives	1.0	3.0	3.0	3.0	2.0
Control Source Releases	1.0	5.0	5.0	5.0	5.0
Long-term Effectiveness	1.7	5.0	5.0	5.0	4.7
Reduction in Toxicity, Mobility, and Volume	1.5	4.4	4.4	4.9	3.6
Short-term Effectiveness	4.7	3.8	3.7	2.7	3.7
Implementability (ND-136 and WS-09)	4.0	4.8	4.6	5.0	4.8
Implementability (C-6)	4.0	4.5	4.4	5.0	4.5
Cost	5.0	2.5	1.5	3.8	2.0
Total Score (ND-136 and WS-09)	**21.9**	**32.5**	**31.2**	**33.4**	**29.3**
Total Score (C-6)	**21.9**	**32.2**	**31.0**	**33.4**	**29.0**

LUCs = Land Use Controls

Summary of Detailed Analysis Scores for Seep Water Alternatives

Decision Criterion	Alternative SP1 (South) - MNA and LUCs	Alternative SP2 (South) - Hydraulic Containment and LUCs	Alternative SP3 (South) - EISB Treatment Zone and LUCs
Protection of Human Health and Environment	5.0	5.0	3.0
Attain Media Cleanup Objectives	1.0	3.0	2.0
Long-term Effectiveness	3.7	5.0	4.3
Reduction in Toxicity, Mobility, and Volume	2.0	4.9	4.2
Short-term Effectiveness	4.7	2.7	3.7
Implementability	4.0	5.0	5.0
Cost	5.0	4.0	5.0
Total	**25.4**	**29.6**	**27.2**

The rankings resulting from this scoring process were used in selecting the proposed NASA Phase 1 groundwater, bedrock/soil vapor, and seep remedies, which are discussed below in **Section 5.0**.

Note that the balancing/evaluation criteria “State Acceptance” and “Community Acceptance” were not scored in the Draft Phase 1 Groundwater CMS evaluation, because these criteria will be evaluated following comments provided by the public during the public comment period for the Draft Phase 1 CMS and this Draft Statement of Basis.

5.0 Selected Remedies

DTSC has independently reviewed and evaluated the technical and regulatory content and conclusions presented by NASA in the Draft Phase 1 Groundwater CMS, with consultation and support from the LA Water Board. The groundwater, bedrock/soil vapor, and seep remedies selected in this document are the most appropriate alternatives for performing the NASA Phase 1 groundwater cleanup, based on the EPA scoring criteria, and were selected in accordance with appropriate regulatory guidance and the best available science.

Based on the Draft Phase 1 Groundwater CMS evaluation and the scoring criteria applied to the remedial alternatives described and presented in **Section 4** of this document, DTSC proposes that the following combination of remediation technologies be applied for the remediation of groundwater, bedrock/soil vapor, and seep contamination at the Phase 1 NASA TTAs.

As stated in **Section 4.6** of this document, the community and State acceptance of these proposed remedies is an important additional evaluation factor that will be applied following DTSC review of comments received during the public comment period.

5.1 Selected Remedies for NASA Phase 1 Groundwater TTAs

For the Phase 1 Groundwater Alternatives, Alternatives 2a and 3 received the highest scores, with Alternative 2b scoring slightly lower. Alternative 4 scored the lowest among the active treatment options, and Alternative 1 had the lowest overall score. Due to the close scoring between Alternatives 2a and 3, both are considered suitable for implementation at the source areas.

Note that all TTA remedies discussed below include LUCs to prevent groundwater use during the application of the active treatment technologies.

The following technologies have been selected and are proposed for application to the Phase 1 NASA groundwater cleanup:

a. **The WS-09 TTA (Bravo Area) and C-6 TTA (Delta Area) will both use the remediation technologies of Alternative 3, with Pump &Treat followed by Monitored Natural Attenuation and Bedrock Vapor Extraction**.

   Justification: The active treatment technology for groundwater selected as part of Alternative 3 (P&T) has been demonstrated to be the most effective method to achieve a primary cleanup goal of removing contaminant mass from groundwater at the NASA AIG sites. Nearby existing infrastructure supports this alternative at both sites. EISB treatment methods were not selected for the WS-09 and C-6 TTAs because this would not add significant benefit, while requiring the installation of new infrastructure. For the C-6 TTA, the nearby Delta Skim Pond limits necessary well installation options for EISB.

b. **The ND-136 TTA (Alfa Area) will use the remediation technologies of Alternative 2a, with a mixture of Enhanced In-Situ Bioremediation for groundwater along with Bedrock Vapor Extraction for soil/bedrock vapor followed by Monitored Natural Attenuation for groundwater**.

   Justification: A remedy option using EISB without a P&T remedy component is selected for the ND-136 TTA. The selected option instead uses EISB, with BVE applied for the removal of contaminants from soil and bedrock vapor. This decision is supported by the high score of the EISB approach in the Draft Phase 1 CMS evaluation. The presence of existing infrastructure at the ND-136 TTA supports the selection of Alternative 2a. The ND-136 TTA has existing infrastructure to support both Alternatives 2a and 3, and DTSC may require implementation of Alternative 3 if pilot testing and monitoring demonstrates the EISB methods do not prove to be more effective than P&T.

5.2 Selected Remedy for NASA Phase 1 Southern Seep Area TTA

In the Southern Seep Area, Alternative SP-2 received the highest score, followed by Alternative SP-3, with Alternative SP-1 scoring the lowest. Alternative SP-2 scored high in aspects such as protecting human health and the environment, achieving cleanup objectives, long-term effectiveness, and reducing toxicity, mobility, and volume.

The selected remedy for the Southern Seep Area is Alternative SP-2, which is extraction, treatment, and hydraulic control of contaminated seep water, followed by Monitored Natural Attenuation.

Justification: This method uses pumping to extract and treat contaminated groundwater before it can daylight at surface seeps. Although Alternative SP-3 (which includes EISB methods) was rated higher for short-term effectiveness and cost, Alternative SP-2 was rated higher for other criteria, except both leading alternatives were deemed comparable in terms of implementability. The presence of existing pumping and conveyance infrastructure is a critical factor in the selection of this treatment method for the Southern Seep Area.

6.0 Public Participation

DTSC is currently inviting public comments on the following documents and the proposed remedy, which will be open for a 45-day review period:

Key Documents:

- NASA Draft Phase 1 Groundwater Corrective Measures Study, January 2024
- DTSC Draft Statement of Basis for the NASA Phase 1 Groundwater Remedy Selection, April 2025

The public comment period begins **April 29, 2025** and ends **June 10, 2025**. Public input on both the proposed Phase 1 groundwater remedy and the information that led to its selection is crucial to the decision-making process. Following the receipt of public comments, DTSC will carefully consider all input before making a final determination on the remedy.

DTSC will host a public meeting during the comment period for the Draft Statement of Basis, scheduled for **May 13, 2025** from 6:00-8:00pm. To participate virtually via Zoom, please register in advance at:

https://bit.ly/NASAGWCMSSBPH1.

The complete project administrative record, including investigation reports and CMS Reports, is available for review at:

DTSC's Regional Office in Chatsworth
9211 Oakdale Avenue
Chatsworth, CA 91311-6505
(818) 717-6521
Fax number: (818) 717-6526
ChatsworthFileRoom@dtsc.ca.gov
Attn: Public Records Coordinator

Simi Valley Library
2969 Tapo Canyon Road
Simi Valley, CA 93063
(805) 526-1735
Attention: Librarian

Links to the key documents and supporting documents related to the NASA SSFL groundwater investigation are also available at:

- The DTSC Website for the NASA Phase 1 groundwater remedy selection: https://dtsc.ca.gov/santa_susana_field_lab/santa-susana-field-laboratory-nasa-phase-1-groundwater-cms/

- The DTSC Envirostor site: http://www.envirostor.dtsc.ca.gov/public

The public comment period begins **April 29, 2025 to midnight PDT on June 10, 2025**. To be considered in the decision making, public comments must be received or postmarked by the end of the public comment period and can be emailed to DTSC SSFLPublicComments@dtsc.ca.gov, or mailed to the address below, postmarked by June 10, 2025:

DTSC
Attn: Paul Carpenter
SSFL NASA GW CMS SB Phase 1 Public Comment
8800 Cal Center Drive
Sacramento, CA 95826

7.0 Next Steps

The next steps for the NASA Phase 1 groundwater cleanup are as follows:

- Once the public comment period is closed and comments have been received for this Draft Statement of Basis and the NASA Draft Phase 1 CMS, DTSC will review and consider the comments.
- Both documents will be revised based on comments, and the final updated documents will be approved by DTSC. The Final Statement of Basis will be the formal NASA Phase 1 groundwater remedy selection document.
- DTSC will file a California Environmental Quality Act (CEQA) Notice of Determination for the SSFL cleanup project and the NASA Phase 1 Groundwater Cleanup.
- NASA will prepare and DTSC will review a Phase 1 Groundwater Corrective Measures Implementation (CMI) Plan, including a Corrective Measures Design (CMD). This final approved document will constitute the Phase 1 remedy design.
- The Phase 1 project will be approved by DTSC for implementation.
- DTSC and NASA will provide community updates on the progress of Phase 1 Groundwater remedy implementation throughout all processes.

The selected Phase 1 groundwater corrective action is anticipated to begin implementation in 2025-2026, and remedial measures will be applied over the course of several decades.

8.0 References

RFI Reports

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National Aeronautics and Space Administration (NASA). 2017. *NASA Groundwater RFI Report, Santa Susana Field Laboratory, Ventura County, California*. Draft. May.

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Department of Toxic Substances Control (DTSC). 2021. *Conditional Approval of RCRA Facility Groundwater Remedial Investigation Report for NASA Area II And Area I LOX, Santa Susana Field Laboratory, Ventura County, California*. April 21.

The Boeing Company, U.S. Department of Energy (DOE), National Aeronautics and Space Administration (NASA). 2025. *Groundwater RFI Sitewide Summary*. March.

WQSAP

Haley & Aldrich, Inc. (Haley & Aldrich). 2010. *Site-Wide Water Quality Sampling and Analysis Plan, Santa Susana Field Laboratory, Ventura County, California*. Revision 1. December.

Groundwater CMS

National Aeronautics and Space Administration (NASA). 2018. *NASA Groundwater Corrective Measures Study, Santa Susana Field Laboratory, Ventura County, California*. Draft. August.

National Aeronautics and Space Administration (NASA). 2020. *NASA Phase 1 Groundwater Corrective Measures Study, Santa Susana Field Laboratory, Ventura County, California*. Draft. September.

Department of Toxic Substances Control (DTSC). 2021. *Review of Draft Nasa Phase 1 Groundwater Corrective Measures Study*. September.

National Aeronautics and Space Administration (NASA). 2024. *NASA Phase 1 Groundwater Corrective Measures Study, Santa Susana Field Laboratory, Ventura County, California*. Draft Final. January.

Risk Assessments

National Aeronautics and Space Administration (NASA). 2017a. *Human Health and Ecological Risk Assessments for NASA AIGs, Santa Susana Field Laboratory, Ventura County, California*. Draft. June.

National Aeronautics and Space Administration (NASA). 2021. *Human Health and Ecological Risk Assessments for NASA AIGs, Santa Susana Field Laboratory, Ventura County, California*. Draft Final. January.

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Department of Toxic Substances Control (DTSC). 2024. *DTSC Approval of NASA Human Health and Ecological Risk Assessments for NASA Areas of Impacted Groundwater, Santa Susana Field Laboratory, Ventura County, California*. October.

Other Documents

State Water Resources Control Board, Resolution No. 92-49, 1994 and 1996. *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304*.

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State of California, Environmental Protection Agency, Department of Toxic Substances Control. 2007. *Consent Order for Corrective Action*.

Department of Toxic Substances Control (DTSC). 2013. H*azardous Waste Facility Post-Closure Permit (PCP) Number PC-94/95-3-03*.

9.0 Glossary

Alluvium: Unconsolidated clay, silt, sand, or gravel present at or near the surface.

Aquifer: A body of rock or sediment that holds groundwater.

Areas of Impacted Groundwater (AIGs): The four administrative divisions applied to the NASA SSFL property as a framework for the investigation and cleanup of contaminated groundwater and bedrock. These AIGs are defined based on their geographic location, the former site operations, and the documented occurrence of groundwater and bedrock contamination in the subsurface. The four NASA AIGs are: (1) LOX AIG, (2) B204/ELV AIG, (3) Alfa/Bravo AIG, and (4) Coca/Delta AIG.

Balancing Criteria: Criteria used to weigh the positive and negative factors in the selection of a remedy from a range of alternatives.

Bedrock Vapor Extraction (BVE): Removing volatile chemical vapors from beneath the ground surface by applying a vacuum to extraction wells and transferring the vapor to above-ground treatment units.

Chatsworth Formation Operable Unit (CFOU): The regulatory definition of groundwater contained within both the saturated and unsaturated bedrock of the geologic Chatsworth Formation at SSFL. The Chatsworth Formation bedrock is composed of thickly bedded sandstone with interbeds of siltstone and shale.

Chemicals of Concern: Chemical elements or compounds (e.g., TCE) documented or suspected of being present in environmental media at a site, such as groundwater, soil, or bedrock.

Enhanced In-Situ Bioremediation (EISB): Groundwater cleanup method that uses the injection of fluids with nutrients and chemicals into groundwater to enhance the natural biological breakdown of contaminants.

EISB Barrier Treatment Zone: Groundwater cleanup method that uses a solid treatment material, such as carbon, installed directly into contaminated groundwater to act as a food source for natural bacteria to degrade contaminants such as TCE.

Extraction Wells: Wells that are used primarily to remove contaminated groundwater from the ground. Water level measurements and water samples can also be collected from extraction wells.

Groundwater: Water occurring beneath the ground surface, filling the pore spaces and fractures within soil, sediment, or bedrock. Groundwater is recharged from surface water infiltrating into the ground, flows through the subsurface, and is accessed by drilling wells.

Groundwater Screening Levels (GSLs): Sitewide SSFL-specific groundwater chemical and radiological contamination concentrations established as decision criteria for the investigation of SSFL. DTSC-approved GSLs were established for the SSFL sitewide groundwater monitoring program in the Site-Wide Water Quality Sampling and Analysis Plan (Haley & Aldrich, Inc. 2010). The final groundwater cleanup goals at SSFL (MCOs) have not been established.

Hydraulic Control: Groundwater cleanup method that uses pumping to control the movement of groundwater and seep/spring discharges, to prevent contamination from migrating.

Hydrostratigraphic Unit: Portion of a body of rock or geologic formation that forms a distinct hydrologic unit with respect to the flow of ground water.

In-Situ Cleanup Technologies: Technologies which reduce or treat contamination directly in the subsurface, without removing groundwater or soil.

In-Situ Chemical Oxidation (ISCO): Groundwater cleanup method that injects an oxidizing agent into groundwater to promote the destruction of contaminants. Chemicals used may include ozone, peroxide, or permanganate.

Land Use Controls: Administrative and legal controls that restrict the use of, or access to, property to prevent exposure to hazardous substances.

Liquid oxygen (LOX): The term is often applied to the NASA SSFL cleanup site formerly occupied by a liquid oxygen plant.

Maximum Contaminant Levels (MCLs): Drinking water standards for chemicals to be met by public water systems. They are enforceable standards defined in regulation by the federal government and the State of California.

Media Cleanup Objectives (MCOs): The target goal concentrations for chemicals in a media (groundwater, bedrock, or soil) to be achieved by the application of remediation technologies. The attainment of MCOs is a performance measure used to judge success in a cleanup.

Monitored Natural Attenuation (MNA): A groundwater cleanup method where the breakdown of chemicals in groundwater or soil from natural processes leads to decreasing concentrations of COPCs, as verified by the measurement and evaluation of these processes over time.

Operable Unit (OU): Regulatory term for a defined area of a cleanup site targeted for investigation and remediation. An OU may be defined based on such factors such geographic location at the site, processes which led to the releases, or type(s) of contamination present. For the SSFL groundwater cleanup, the operable units are defined by the hydrostratigraphic units containing contamination.

Performance Criteria: Standards used to measure and evaluate the quality, efficiency, and effectiveness of a cleanup technology.

Pump and Treat (P&T): A groundwater cleanup method that uses pumping of contaminated groundwater from extraction wells, and removal of the contaminants in above-ground treatment units.

Resource Conservation and Recovery Act (RCRA): a federal law that regulates the management of hazardous and solid waste, including the cleanup and disposal of groundwater and soil contaminated by such waste. The U.S. EPA authorizes DTSC to apply and enforce RCRA requirements for sites in California, including the cleanup at SSFL.

Saturated (Soil/Bedrock): Soil or bedrock where pore spaces or fractures are 100% filled with water. In the subsurface, this occurs below the water table.

Seeps and Springs: Locations where groundwater flows to the surface. Springs are generally characterized from seeps by higher, steadier flow of water.

Statement of Basis (SB): Decision document which summarizes essential information from the RCRA Facility Investigation (RFI) and CMS reports and the administrative record, and proposes the final selected remedial measures.

Thermally Assisted EISB: Enhancing EISB processes by increasing the temperature of the target areas of groundwater treatment.

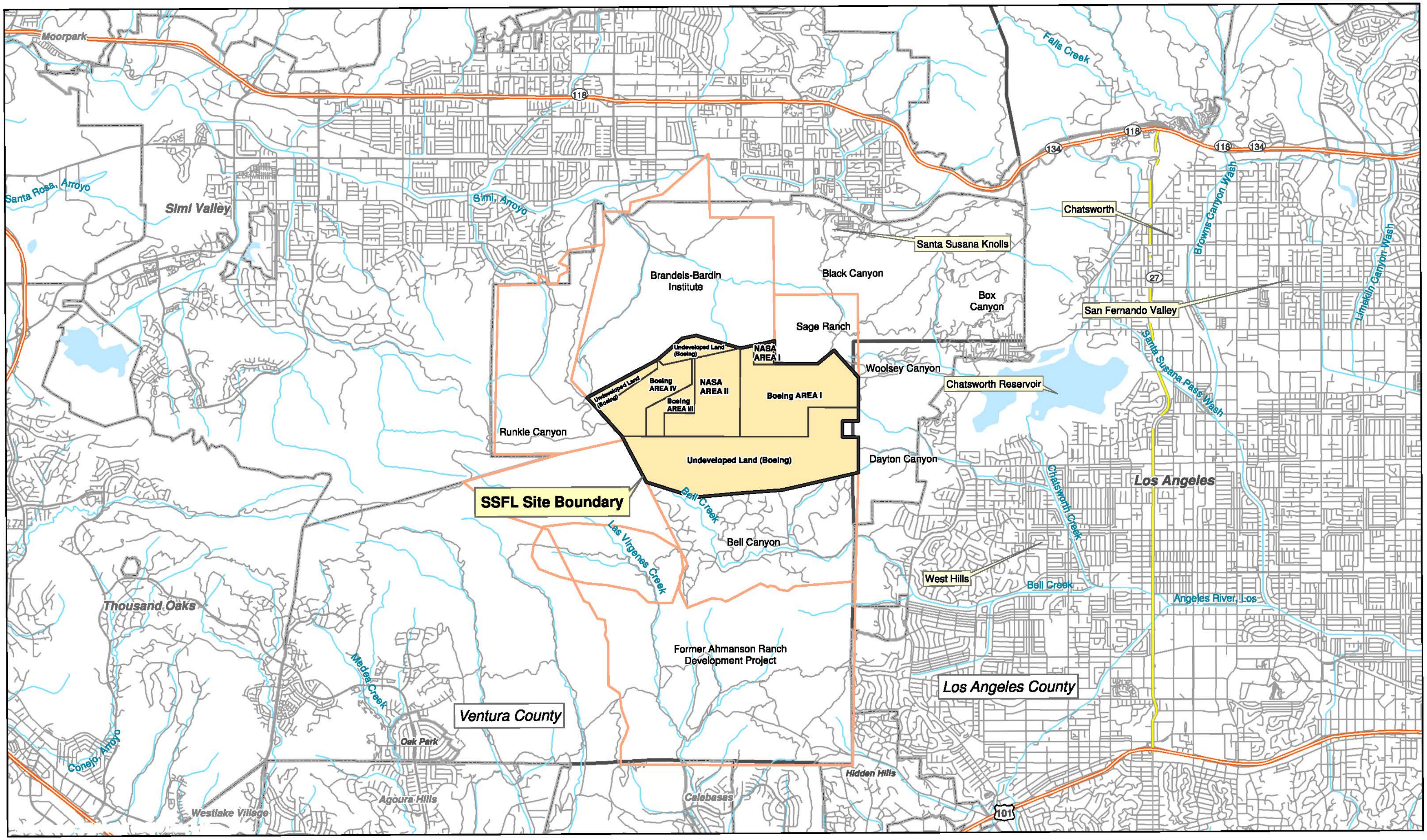
Unsaturated (Soil/Bedrock): Soil or bedrock where pore spaces or fractures are not 100% filled with water. In the subsurface, this occurs above the water table.

Solid Waste Management Unit (SWMU): under RCRA, any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste.

Vadose Zone: Underground zone where soil and/or bedrock pore spaces and fractures are not saturated with groundwater. This zone lies below the ground surface and above the water table.

Water Table: The depth beneath the ground surface where soil and/or bedrock pore spaces and fractures become saturated with groundwater. The water table is the depth at which a hole or well drilled into the earth will produce water.

Figures



Note: This map was adapted from the NASA Area I Liquid Oxygen Plant (LOX) and Area II 2023 Annual Groundwater Monitoring Report.

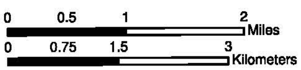
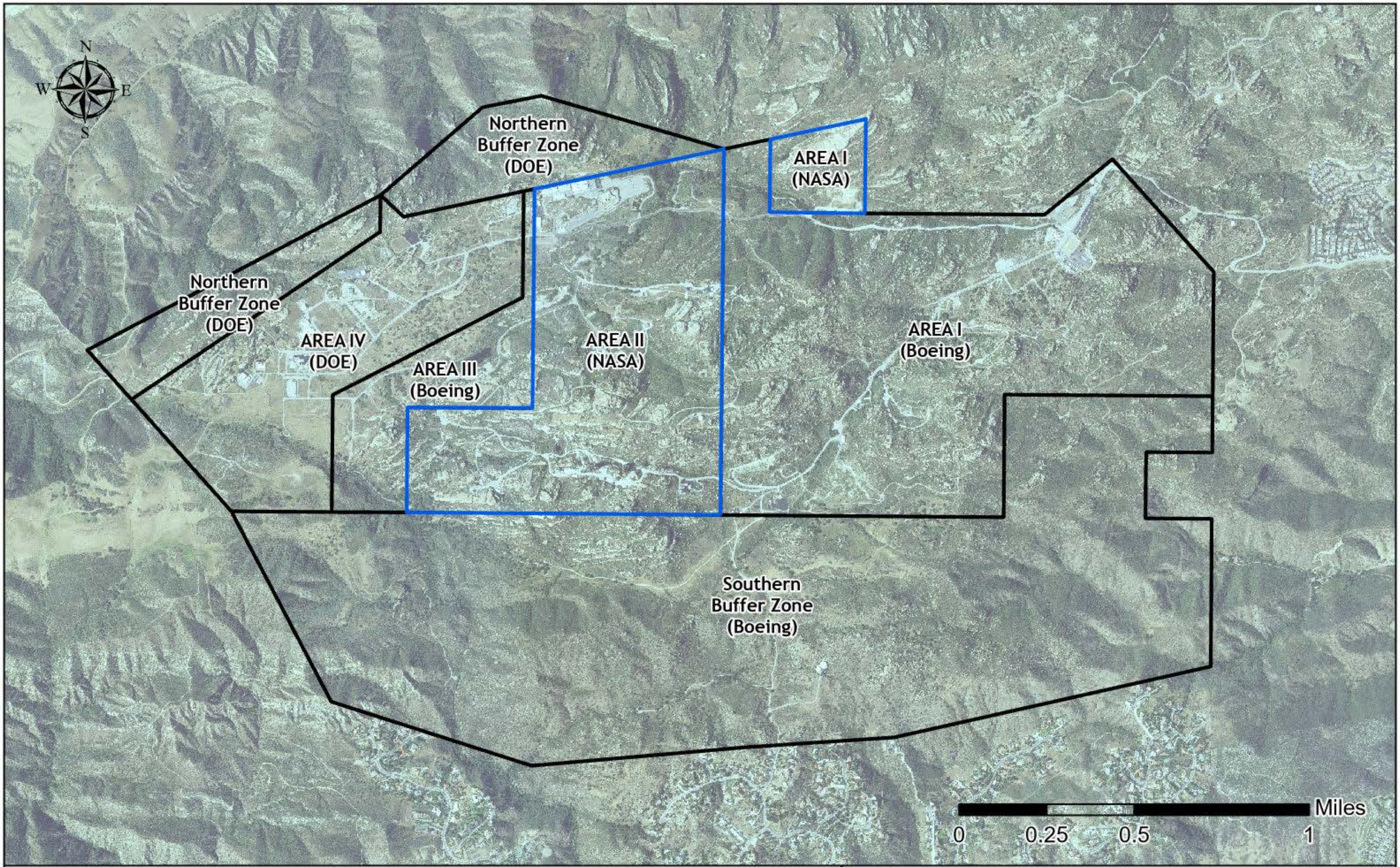


Figure 1
SSFL Facility Location
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California

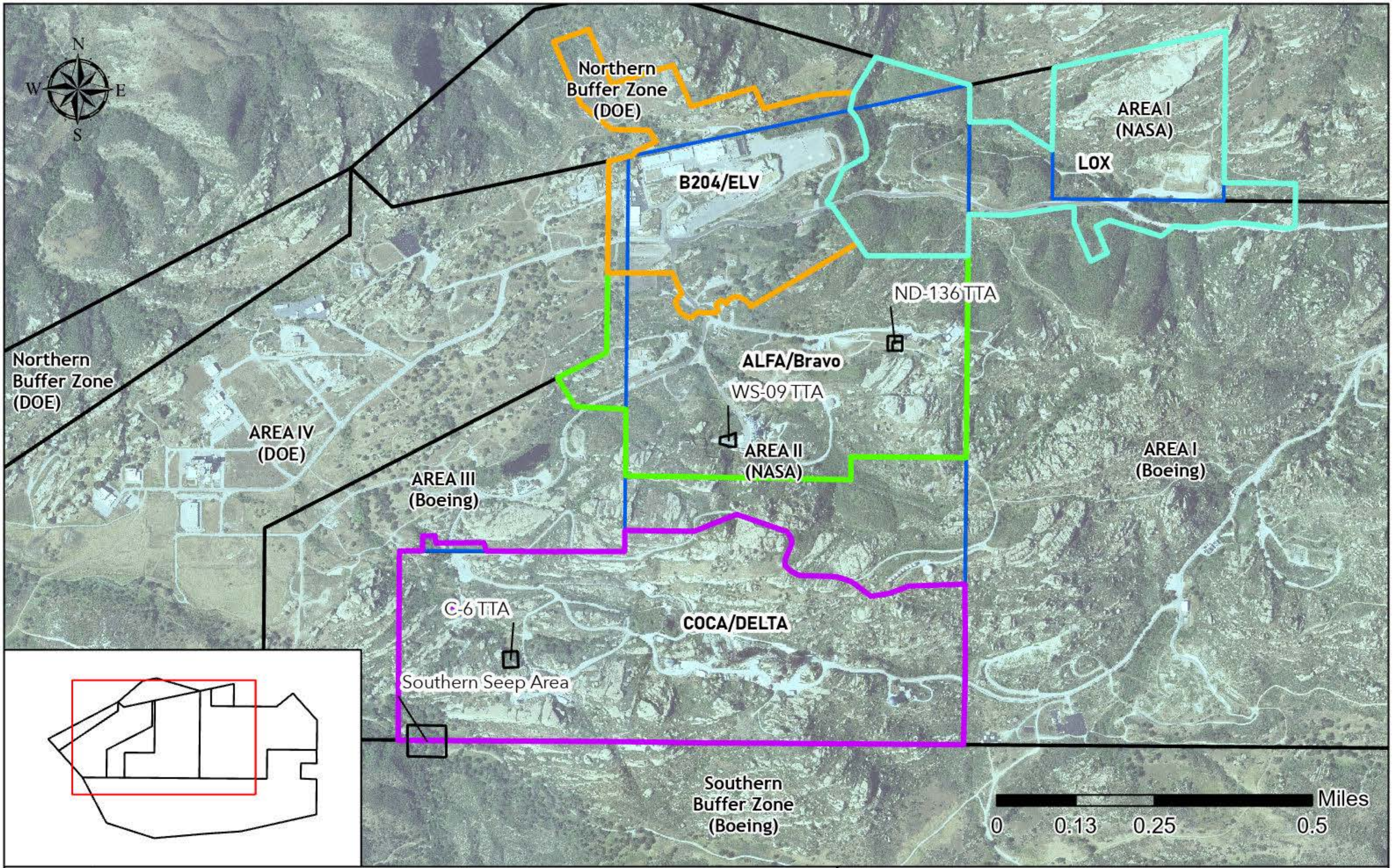


Legend

NASA Administrative Boundary

SSFL Site Property Boundary

Figure 2
NASA Administrative Areas
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California



Legend

Areas of Impacted Groundwater

ALFA/Bravo

B204/ELV

COCA/DELTA

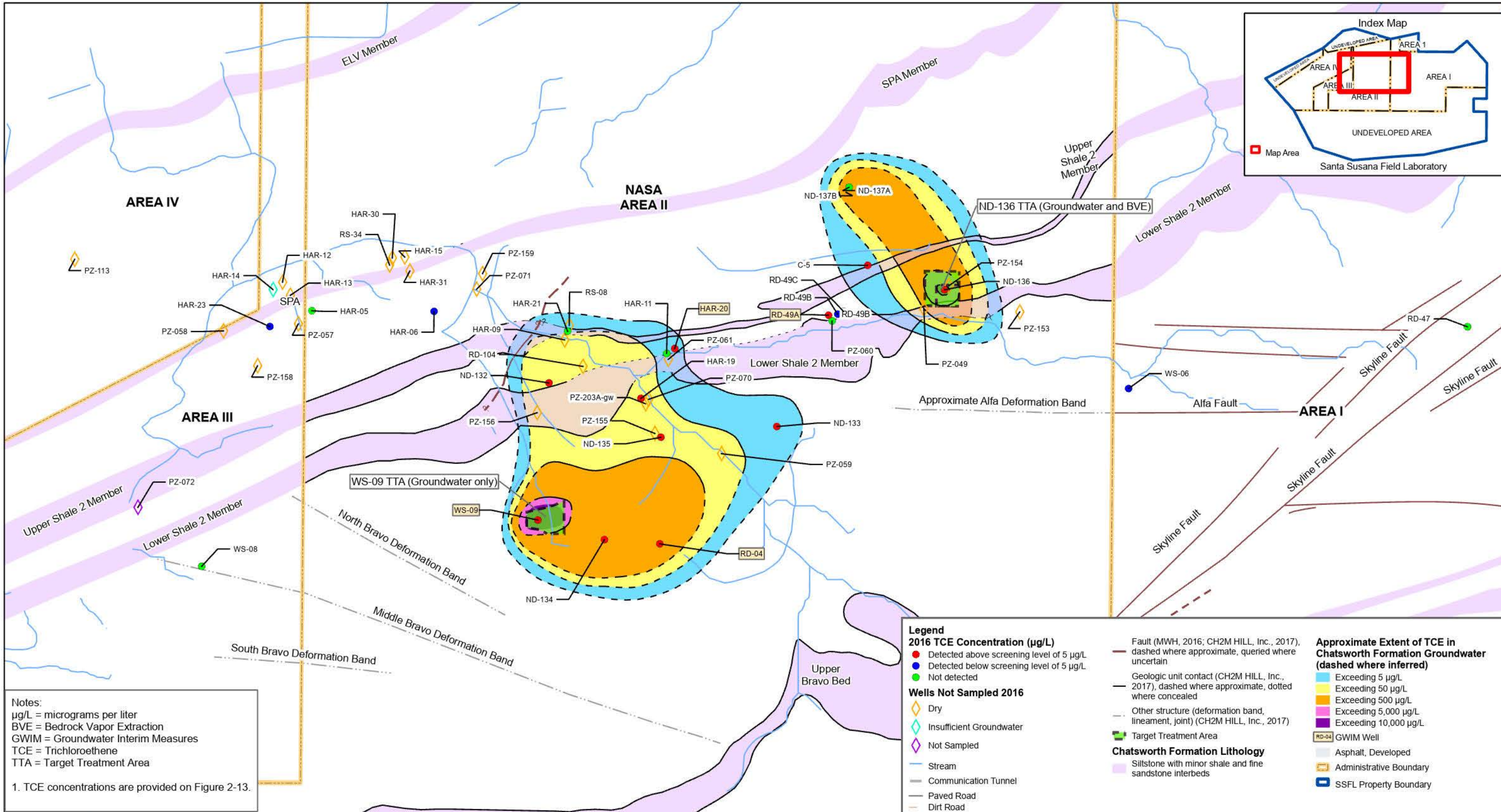
LOX

Groundwater CMS Target Treatment Area

NASA Administrative Areas

SSFL Site Property Boundary

Figure 3
NASA Areas of Impacted Groundwater (AIGs) and
Target Treatment Areas (TTAs)
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California

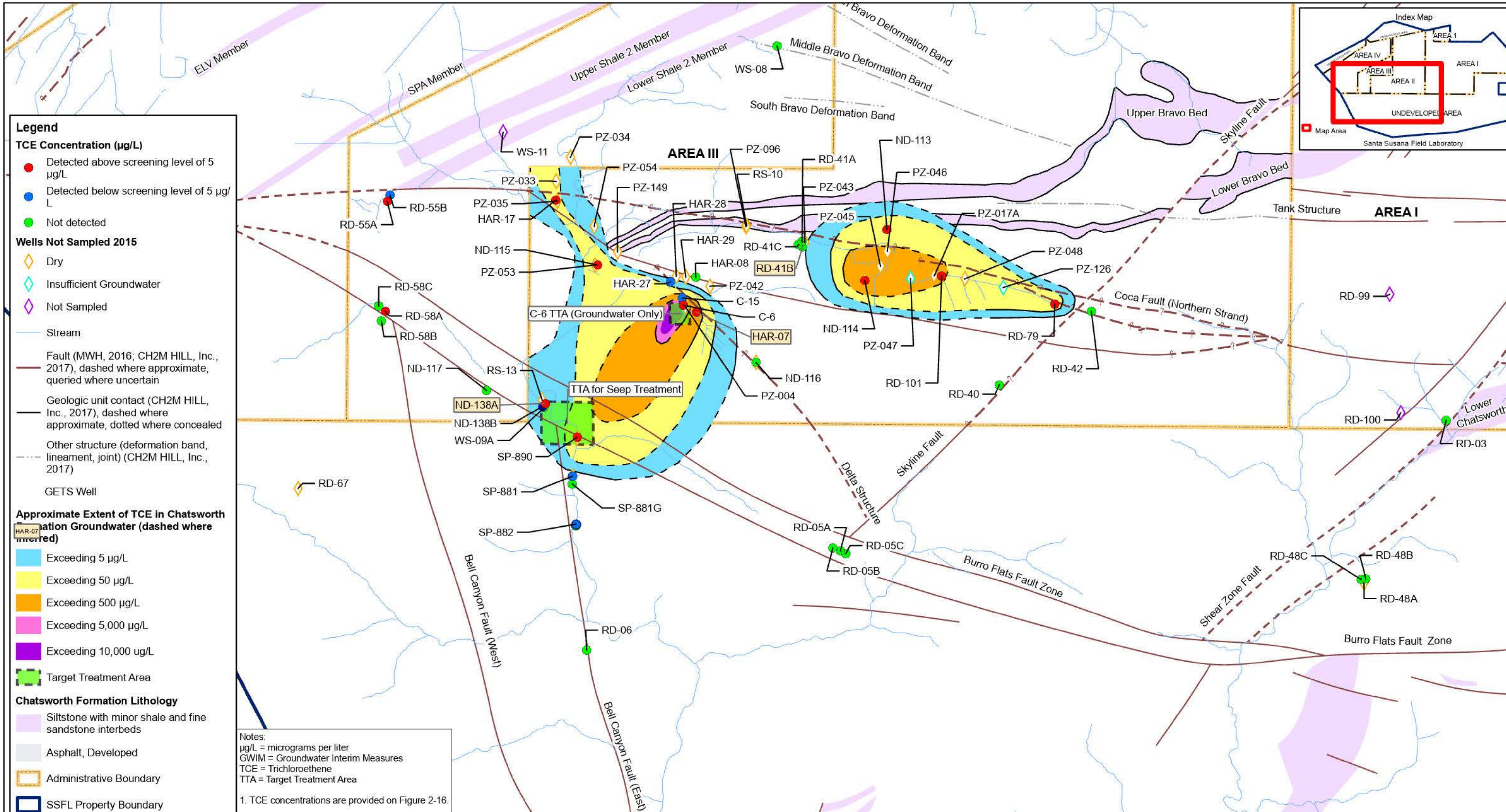


Note: This figure was adapted from the NASA Phase I Groundwater Corrective Measures Study Report, Figure 4-2.

0 125 250 500 Feet

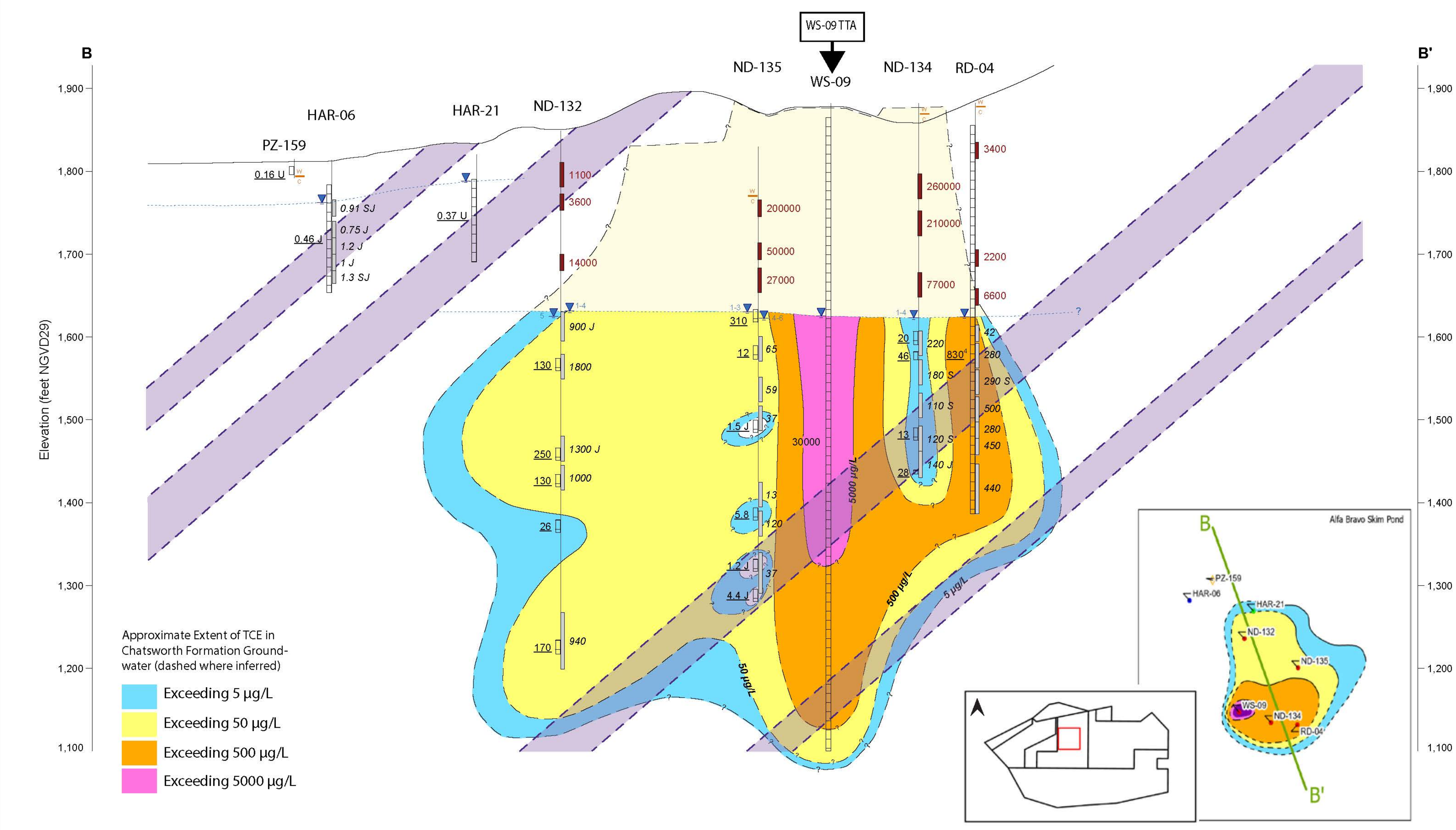
0 37.5 75 150 Meters

Figure 4 - Horizontal Extent of Groundwater Contamination at the Alfa and Bravo Sites
NASA Area II
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California



Note: This figure was adapted from the NASA Phase I Groundwater Corrective Measures Study Report, Figure 4-3.

Figure 5 - Horizontal Extent of Groundwater Contamination at the Coca and Delta Sites
NASA Area II
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California



Notes:

1. This cross section is a simplified version of Draft Final NASA Phase 1 CMS Figure D-5. Please refer to that CMS figure to see a detailed description of the information shown here.
2. Numbers shown in black are groundwater TCE concentrations in micrograms per liter (µg/L).
3. Numbers shown in red are soil vapor TCE concentration in micrograms per cubic meter (µg/m3).

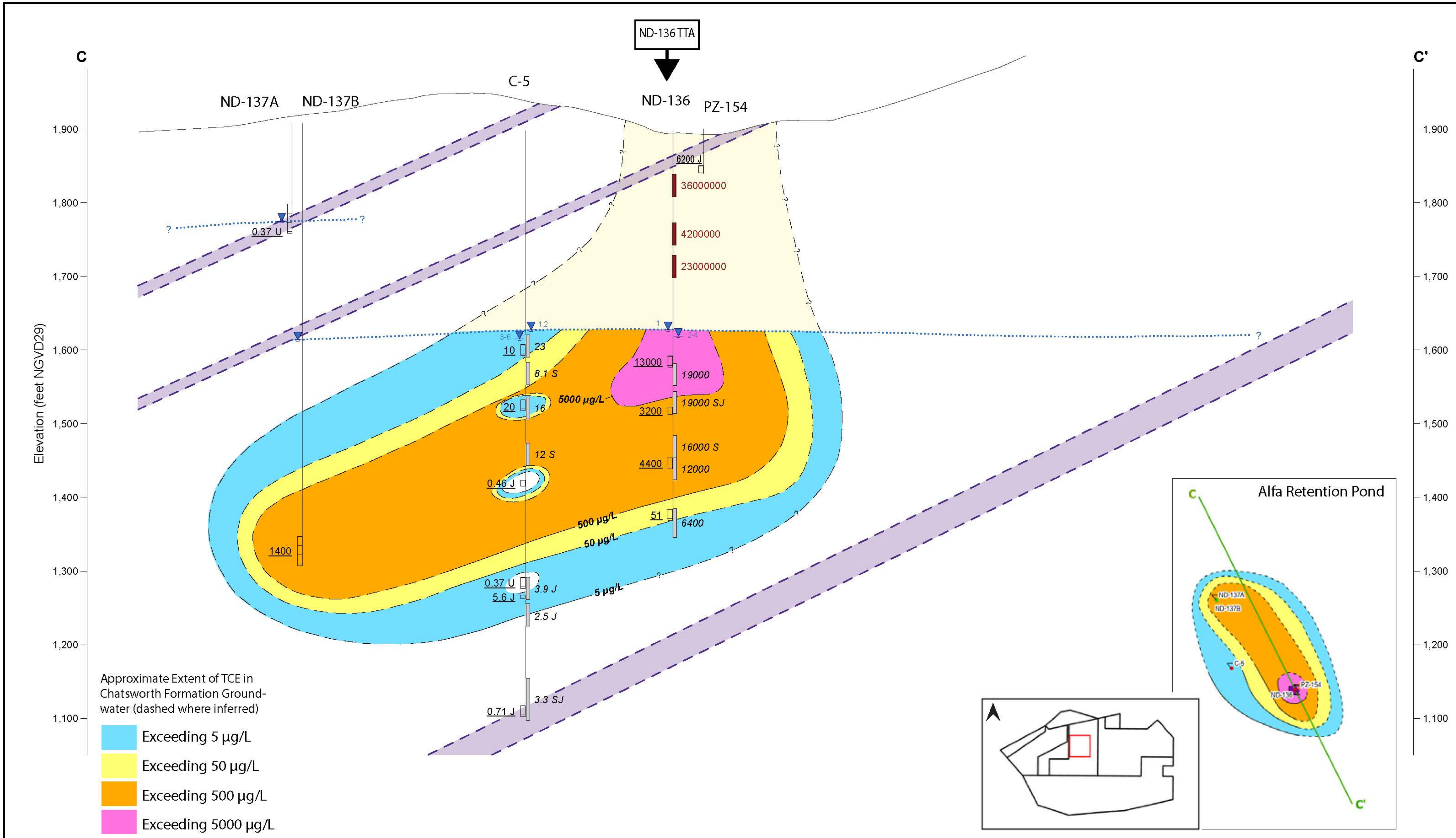
Approximate Extent of TCE in Chatsworth Formation Groundwater (dashed where inferred)

Inferred Extent of TCE in Vadose Zone

Siltstone with Minor Shale and Fine Sandstone Interbeds

0 75 150
(IN FEET)
Horizontal Scale 1 inch = 150 feet
Vertical Exaggeration: 1.35x

Figure 6
Cross Section of WS-09 Target Treatment Area
NASA Area II
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California



Notes:

1. This cross section is a simplified version of Draft Final NASA Phase 1 CMS Figure D-4. Please refer to that CMS figure to see a detailed description of the information shown here.
2. Numbers shown in black are groundwater TCE concentrations in micrograms per liter (µg/L).
3. Numbers shown in red are soil vapor TCE concentration in micrograms per cubic meter (µg/m3).

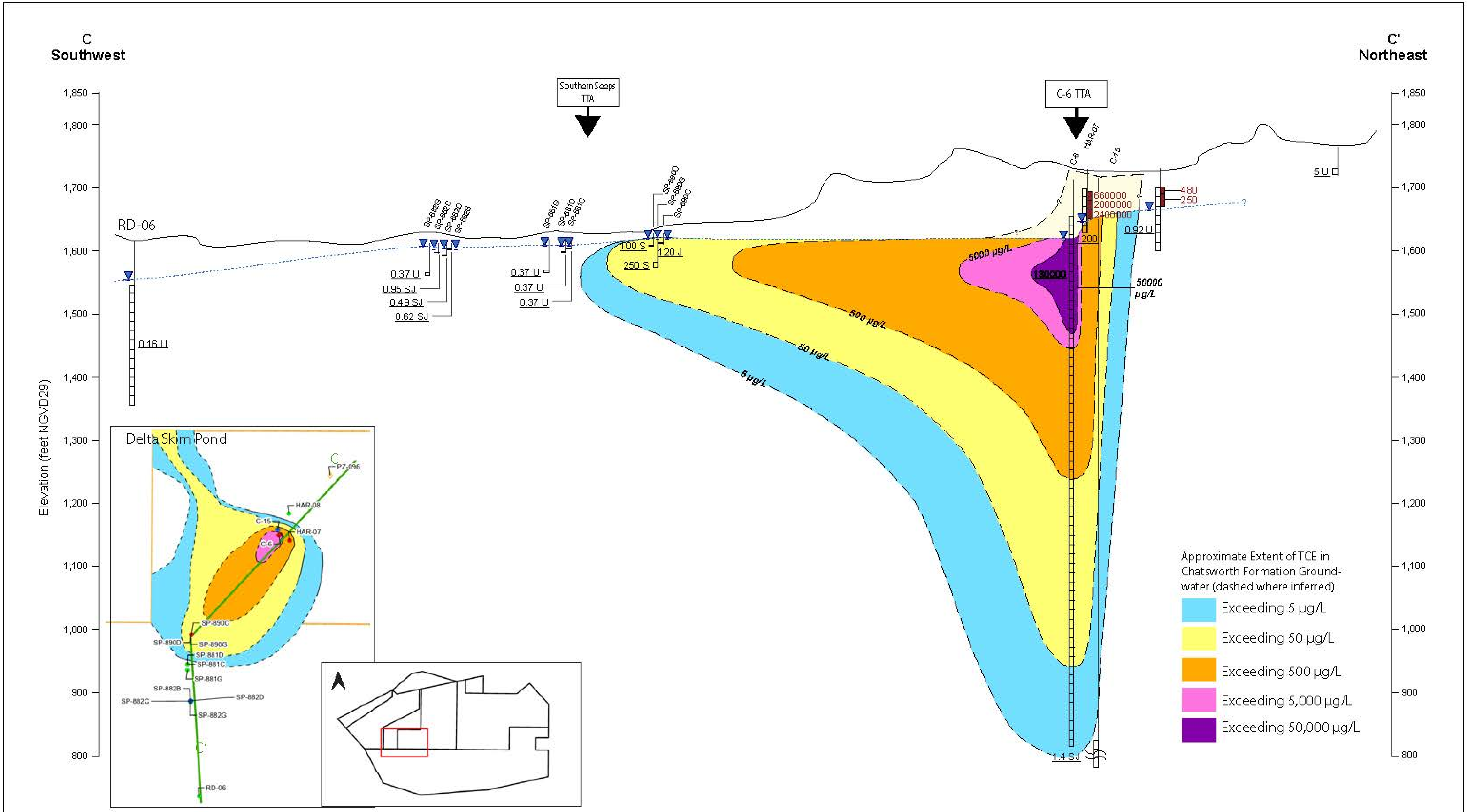
Approximate Extent of TCE in Chatsworth Formation Groundwater (dashed where inferred)

Inferred Extent of TCE in Vadose Zone

Siltstone with Minor Shale and Fine Sandstone Interbeds

0 56 112 (IN FEET)
Horizontal Scale 1 inch = 112 feet
Vertical Exaggeration: 0.9x

Figure 7
Cross Section of ND-136 Target Treatment Area
NASA Area II
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, CA



Notes:

1. This cross section is a simplified version of Draft Final NASA Phase 1 CMS Figure D-9 Please refer to that CMS figure to see a detailed description of the information shown here.
2. Numbers shown in black are groundwater TCE concentrations in micro-grams per liter (µg/L).
3. Numbers shown in red are soil vapor TCE concentration in micrograms per cubic meter (µg/m3).

Approximate Extent of TCE in Chatsworth Formation Groundwater (dashed where inferred)

Inferred Extent of TCE in Vadose Zone

Siltstone with Minor Shale and Fine Sandstone Interbeds

0 110 220
(IN FEET)
Horizontal Scale 1 inch = 220 feet
Vertical Exaggeration: 1.57x

Figure 8 - Cross Section of
Southern Seep and C-6 Target Treatment Area
NASA Area II
DTSC Draft Statement of Basis
Santa Susana Field Laboratory
Ventura County, California