National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

January 6, 2021

Reply to Attn of: AS01/SSFL

Mr. Roger Paulson
Chief, SSFL Project Support Unit
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento CA 95826

SUBJECT: Preliminary Assessment for Per- and Polyfluoroalkyl Substances, Santa Susana Field Laboratory Ventura County, California

Dear Mr. Paulson:

The National Aeronautics and Space Administration (NASA) is providing the attached Preliminary Assessment (PA) for Per- and Polyfluoroalkyl Substances (PFAS) to the California Department of Toxic Substances Control (DTSC). This PA documents NASA's evaluation of PFAS within administered areas at Santa Susana Field Laboratory (SSFL).

NASA performed this PA consistent with an agency-wide approach, methodically evaluating areas of potential concern for historical or potential use, storage, and disposal of PFAS compounds within NASA administered areas at SSFL, and in response to DTSC's comment on the *SSFL NASA Area I LOX and Area II Groundwater Monitoring Report Annual 2017 and 2018, and SSFL NASA Area II Post-Closure Permit PC-94/95-3-03 2018 Post-Closure Permit Groundwater Monitoring Reports* included in the April 7, 2020 letter from DTSC.

Please contact me at (202) 714-0496 or at peter.d.zorba@nasa.gov with any questions regarding the attached PA.

Sincerely,

Peter Zorba
NASA SSFL Project Director
NASA Site Management Office
Santa Susana Field Laboratory

Attachment

cc:

Paul Carpenter/DTSC
Tom Seckington/DTSC
Mark Schoppet/NASA
Jonathan Freed/CH2M HILL

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Preliminary Assessment for Per- and Polyfluoroalkyl Substances

Prepared for

National Aeronautics and Space Administration
Santa Susana Field Laboratory
Ventura County, California

January 2021

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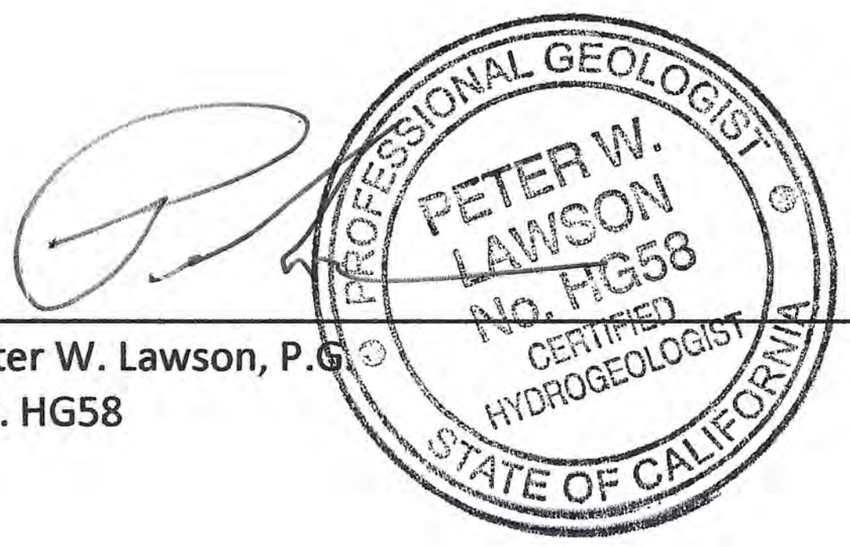
Professional Geologist's Certification

I certify that this document was prepared by me or under my direct control and personal supervision, based on knowledge and information in general accordance with commonly accepted standards of practice. This certification is not a guarantee or warranty, either expressed or implied.



1/6/21

Peter W. Lawson, P.G. No. HG58

Date:

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Contents

Acronyms and Abbreviations

AFFF	aqueous film-forming foam
AOPC	area of potential concern
Boeing	The Boeing Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HA	health advisory
IRIS	Integrated Risk Information System
ITRC	Interstate Technology and Regulatory Council
mg/kg-day	milligram(s) per kilogram per day
NAA	North American Aviation
NASA	National Aeronautics and Space Administration
ng/L	nanogram(s) per liter
PA	Preliminary Assessment
PFAA	perfluoroalkyl acid
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutane sulfonyl fluoride
PFDA	perfluorodecanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonate
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane-sulfonic acid
ppt	part(s) per trillion
RfD	reference doses
RSL	regional screening level
SAME	Society of American Military Engineers
SPA	Storable Propellant Area
SSFL	Santa Susana Field Laboratory

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SECTION 1

Introduction

This Preliminary Assessment (PA) documents the evaluation of areas of potential concern (AOPCs) of per- and polyfluoroalkyl substances (PFAS) at the Santa Susana Field Laboratory (SSFL) in Ventura County, California. This PA has been prepared for the National Aeronautics and Space Administration (NASA) and evaluates PFAS within the NASA-administered areas of SSFL, which include a portion of Area I and all of Area II.

1.1 Objectives

The objectives of this SSFL PFAS PA are:

- Complete site and source evaluation of AOPCs where past or present activities may have resulted in a release of PFAS into the environment
- Qualitatively evaluate migration potential of released PFAS to environmental media
- Identify potential receptors for exposure to PFAS that may have migrated to environmental media

To accomplish these objectives, the following activities have been completed:

- A review of existing storage, use, and discharge information to identify and evaluate potential PFAS release locations
- A review of existing information to identify potential offsite receptors within 1 mile of NASA-administered areas.

1.2 Preliminary Assessment Team and Subject Matter Experts

The SSFL PA team and subject matter experts are identified in Table 1-1.

Bill DiGuiseppi, Subject Matter Expert: Mr. DiGuiseppi is a Principal Hydrogeologist with over 30 years of experience characterizing and remediating hazardous waste sites. He is an internationally recognized expert on PFAS occurrence and behavior, having been an invited keynote speaker, steering committee member, session chair, presenter, or instructor at dozens of national and international conferences. Mr. DiGuiseppi is the Vice Chair for Emerging Issues for the Society of American Military Engineers (SAME), is a PFAS instructor for the Interstate Technology and Regulatory Council (ITRC), was an invited instructor on emerging contaminants at the U.S. Environmental Protection Agency (EPA) Annual Groundwater Summit, was an invited PFAS trainer for the U.S. Department of Energy's (DOE's) annual training event and is an adjunct faculty member at the Colorado School of Mines.

Derek Miller, Onsite Environmental Manager: Mr. Miller has worked in the NASA-administered areas of SSFL since January 2015. He maintains NASA's regulatory compliance with environmental permitting, waste storage, characterization, disposal, and other onsite field needs.

1.3 NASA SSFL Management Team

The NASA SSFL management team and NASA points of contact are identified in Table 1-1.

1.4 Report Organization

This PFAS PA is organized in the following sections, consistent with the PFAS PA Work Plan for Various NASA Centers and Facilities (Tetra Tech, 2019):

- Section 1, Introduction

- Section 2, PFAS Overview
- Section 3, NASA SSFL Background Information
- Section 4, Methodology and Activities
- Section 5, Reporting
- Section 6, References

SECTION 2

PFAS Overview

This section provides an overview of chemical and physical properties of PFAS; identifies the major sources of PFAS to the environment as a result of manufacturing and widespread use of these chemicals in many commercial products; and summarizes health effects, criteria, and regulatory status available for PFAS. This information is derived from the December 2019 *PFAS Preliminary Assessment Work Plan for Various NASA Centers and Facilities* (Tetra Tech, 2019) for consistency.

2.1 Chemical and Physical Properties

PFAS consist of more than 3,000 (some recent estimates are 5,000 to 10,000) manufactured chemicals (ITRC, 2020; EPA, 2018). The PFAS classes at the focus of the PA are the nonpolymer PFAS that have been identified as emerging contaminants by EPA. Structurally, PFAS have a polar and hydrophilic functional head and a hydrophobic and oleophobic (oil-resistant) tail, and therefore, many of the nonpolymer PFAS were manufactured and used as surfactants in a variety of commercial products, as identified in Section 2.2.

Currently, there is a wide variation in published values associated with chemical and physical properties of PFAS. However, the carbon-fluorine bonds in PFAS are exceptionally strong, resulting in resistance to degradation, low chemical reactivity, compound stability, and persistence in the environment. Longer-carbon chain PFAS may degrade in the environment to shorter-chain PFAS. Two of the most studied PFAS compounds detected in the environment are the eight-carbon chain (also known as C-8) perfluorooctanoic acid (PFOA) and perfluorooctane-sulfonic acid (PFOS). PFAS precursors can transform to PFOA, PFOS, and analogous shorter-chain compounds (collectively referred to as perfluoroalkyl acids [PFAAs]) under ambient environmental conditions, but PFOA, PFOS, and PFAAs are considered “terminal” PFAS because they are resistant to further degradation. Studies have focused on PFOA and PFOS due to their frequency of detection, persistence in the environment, and relatively high toxicity. High bioconcentration factors have been derived for PFOA and PFOS, indicating that these compounds will bioaccumulate in plants and animals. PFAS are also subject to leaching from soil to groundwater, with the leaching potential dependent on soil properties and PFAS chemical structures (that is, longer-chain PFAS typically have longer retention on soils than shorter-chain PFAS). Measured vapor pressures of select PFAS indicate that PFOA and PFOS are not significantly volatile under ambient conditions. Comprehensive information about PFAS can be found in documents prepared by ITRC, including Fact Sheets and a guidance document that can be found at https://pfas-1.itrcweb.org/fact-sheets/.

Because of mounting environmental and public health concerns regarding C-8 PFAS, manufacturers have been developing replacement PFAS that are structurally similar to their predecessors with similar physical properties. Replacement technologies include substituting longer-chain PFAS (such as PFOS and PFOA) with shorter-chained PFAS such as six-carbon chain (C-6) compounds, fluorotelomer alcohols, perfluorobutane sulfonyl fluoride-based derivatives, and polyfluoroethers (such as GenX, ADONA, and F53B). Information regarding replacement PFAS is limited; however, studies suggest that some of the replacement PFAS (such as polyfluoroethers) may not be any less hazardous or readily degraded in the environment than their predecessors.

2.2 History and General Use of PFAS

The strong carbonfluorine bond and surfactant properties made PFAS ideal for use in a wide variety of commercial and industrial products, beginning in the 1940s with initial production for use in nonstick coatings (ITRC, 2020). Since the 1940s, PFAS were manufactured for use in stain- and water-resistant products, firefighting foam, protective coatings, food packaging, clothing, and personal care products (such as some insect repellents, sunscreens, and shampoo formulations). PFAS were detected in the blood of the general population in the 1990s after biomonitoring for this class of chemicals was added to the Center for

Disease Control's National Health and Nutrition Examination Survey protocol, and this was attributed to the pervasive use of PFAS in commercial and industrial products. The principal manufacturer of PFAS, The 3M Company, began to phase out production of longer-chain PFAS in the early 2000s, and EPA negotiated a stewardship program shortly thereafter with the eight major manufacturers of C-8 compounds to phase out production of PFOA in the United States by 2015. PFOA is still manufactured globally, and fluorochemistry is still an important industry in the United States.

2.3 Sources of PFAS in the Environment

Major sources of PFAS that have a potential to impact the environment include aqueous film-forming foam (AFFF) release sites, PFAS or PFAS products manufacturing facilities, landfills, and biosolids and effluent from wastewater treatment plants (IRTC, 2020). The aerospace industry also uses PFAS-containing products in coatings, paints, grease, resins, and elastomers because of their high-performance properties. Improper disposal of these materials may be a source of PFAS to the environment, although low-volume usage and release are less likely to result in impacted environmental media.

PFAS are present in a variety of AFFF formulations that were commonly used at military sites, airports, refineries, firefighting training sites, fire stations, fire response sites, and equipment test areas. Areas of interest for PFAS at an AFFF release site include those where AFFF may have been applied, released, or stored. These may include current and former firefighting training areas, fire stations, equipment test and cleanout areas, buildings with firefighting infrastructure (such as hangars, AFFF storage/handling areas, pump houses, and similar), emergency release areas (such as crash sites and fuel spills), fire suppression systems inside buildings, and associated infrastructure (such as holding ponds and oil/water separators).

Industrial sites consist of manufacturing facilities of PFAS or commercial products that used PFAS as a component of their product or production process. Examples of manufacturing facilities that may be sources of PFAS include textile and leather processing facilities, paper mills, metal plating and etching facilities (such as chromium), wire manufactures, and facilities that used surfactants, resins, molds, plastics, photolithography, and semiconductors (ITRC, 2020). Areas of interest for PFAS environmental investigations at PFAS products manufacturing facilities include wastewater discharges, disposal areas (onsite or offsite), accidental release areas (spills or leaks), areas receiving aerial deposition from stack emissions, areas where a fire response may have occurred, and buildings with fire suppression systems.

Landfills can be a major source of PFAS to the environment if PFAS-containing industrial waste, sewage sludge, or consumer goods (such as stain-resistant coatings) dating back to the 1950s were disposed at the facility. Unlined landfills, typically constructed before the 1990s, have a higher potential of contributing PFAS to the environment than lined landfills. Areas of interest for PFAS include landfill sites as well as downgradient areas receiving groundwater or stormwater runoff from a landfill and leachate discharges to surface water or publicly owned treatment works.

Because wastewater treatment facilities may receive PFAS-containing wastewater, these facilities can be a major source of PFAS to the environment. Areas of interest for PFAS releases from these operations include point source effluent discharge areas, areas receiving unintended releases from surface impoundments or aerial deposition from air emissions, and areas receiving runoff from biosolids land-application areas.

Because of the widespread use of PFAS, there may be activities other than those mentioned previously where PFAS were used. In particular, PFAS have been included in some antifouling and stain-resistant paint formulations. It is possible that in significant disposal amounts these could be sources of PFAS to the environment. Other potential sources of PFAS include sludges produced through wastewater treatment operations and land disposal of PFAS-containing materials.

2.4 Health Effects and Advisory Levels

There is limited information on a few PFAS regarding potential health effects. Currently, there are no Tier I toxicity values for any PFAS (EPA, 2020). Tier I toxicity values are the preferred source for toxicity factors for completion of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) human health risk assessments. However, EPA's Office of Water has used other sources of toxicity information to develop lifetime drinking water health advisories (HAs) for PFOA and PFOS.

The EPA Office of Water developed noncancer oral reference doses (RfDs) for PFOA and PFOS. The PFOA RfD (0.00002 milligram per kilogram per day [mg/kg-day]) is based on a developmental toxicity study using mice. The critical effects included reduced ossification in parts of the hands and feet and accelerated puberty in male pups following exposure during gestation and lactation (EPA, 2016a). The EPA Office of Water also classified PFOA as "suggestive evidence of carcinogenic potential" and estimated an oral cancer slope factor (0.07 per mg/kg-day) based on tumor development in rat testes. The EPA Office of Water RfD for PFOS (0.00002 mg/kg-day) is based on a developmental toxicity study in rats. The critical effect was decreased pup body weight following exposure during gestation and lactation (EPA, 2016b).

PFOA and PFOS have been shown to be transmitted to the fetus in cord blood and to the newborn in breast milk. Because the developing fetus and newborn seem particularly sensitive to PFOA- and PFOS-induced toxicity, the RfDs based on developmental effects are also protective of adverse effects in adults. Furthermore, EPA considers its RfD for PFOA as also protective of potential cancer effects.

In May 2016, the EPA Office of Water issued drinking water lifetime HAs for PFOA and PFOS based on these RfDs (EPA, 2016a, 2016b); HAs are not enforceable regulatory levels. A lifetime HA is set based on an assumption of a lifetime of exposure to PFOA and PFOS from drinking water. The lifetime HA is 70 nanograms per liter (ng/L) for PFOA and 70 parts per trillion (ppt) for PFOS. When both PFOA and PFOS are found in drinking water, the combined concentrations of PFOA and PFOS should be compared with the 70 ppt health advisory level.

EPA's *Interim Recommendations to Address Groundwater Contaminated with Perfluorooctanoic Acid and Perfluorooctane Sulfonate* (EPA, 2019) proposes the use of the Regional Screening Level (RSL) Calculator (which applies the Office of Water's RfDs for PFOA and PFOS) to derive risk-based screening values for PFOA and PFOS for groundwater not used as drinking water. The groundwater screening values calculated for PFOA and PFOS are each 40 ppt (assuming a hazard quotient of 0.1.) A recent DoD memorandum (DoD, 2019) directs the use of RSLs for PFOA and PFOS as screening criteria as well. The RSL calculator can also be used to calculate screening levels for other media (such as soil for default residential and industrial land use assumptions or surface water and sediment for site-specific exposure assumptions).

2.5 EPA Toxicity Assessment of PFAS

A provisional RfD (Tier II toxicity criteria) is available from EPA for one PFAS, perfluorobutane sulfonyl fluoride (PFBS), and it is used in the derivation of RSLs for PFBS. A more rigorous peer-review toxicity assessment is underway, and EPA released draft toxicity assessments for PFBS and GenX chemicals for public comment in 2018 (EPA, 2018). EPA compiled Systematic Review Protocols in 2019 for perfluorobutanoic acid (PFBA), perfluorodecanoic acid (PFDA), perfluorohexanesulfonate (PFHxS), perfluorohexanoic acid (PFHxA), and perfluorononanoic acid (PFNA), which is the first step in the EPA Integrated Risk Information System (IRIS) process for the generation of toxicity values (EPA, 2020).

2.6 Regulatory Status of PFAS

The regulatory status of PFAS varies widely across the United States and the world. Some states have adopted the EPA lifetime HAs for PFOA and PFOS as drinking water targets, while others have developed or are deriving their own regulatory guidance or screening values for PFOA and PFOS, and in some cases for

other PFAS (for instance, North Carolina has a drinking water provisional health goal for GenX, and New Jersey has adopted a maximum contaminant level for PFNA).

Several states are in the process of promulgating standards for PFAS. In February 2020, the California State Water Resources Control Board lowered the response levels for drinking water providers to address PFOA and PFOS impacts to the state's water supplies. The new response levels are 10 ng/L for PFOA and 40 ng/L for PFOS (SWRCB, 2020). The new response levels are based on updated health recommendations from the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment.

The reductions are part of the State Water Board's comprehensive investigation into the extent of PFOA and PFOS contamination in water systems and groundwater statewide.

California has not established groundwater cleanup standards for any PFAS at the state level.

SECTION 3

NASA SSFL Background Information

SSFL is located approximately 29 miles northwest of downtown Los Angeles, California, in the southeast corner of Ventura County (Figure 1). SSFL occupies approximately 2,850 acres of hilly terrain, with approximately 1,100 feet of topographic relief near the crest of the Simi Hills. The site is divided into four administrative areas (Areas I, II, III, and IV) and includes undeveloped land both to the north and south. Most of Area I and all of Areas III and IV are owned by The Boeing Company (Boeing). Ninety acres of Area IV were leased to the DOE, which also owns facilities in Area IV. The northern and southern undeveloped lands of SSFL were not used for industrial activities and are owned by Boeing.

Area II and a portion of Area I are owned by the federal government and administered by NASA (Figure 2). The primary site activities at the NASA-administered areas of SSFL included research, development, and testing of liquid-fueled rocket engines and associated components (such as pumps, valves, and similar) (MWH, 2009; SAIC, 1994). Predecessor companies to Boeing have included North American Aviation (NAA), whose Rocketdyne division conducted rocket engine testing. NAA later merged with Rockwell Standard Corporation to form North American Rockwell, which later became Rockwell International Corporation. In 1966, Boeing acquired the aerospace and defense assets of Rockwell International Corporation, including the SSFL property.

Major operational activities at SSFL fit broadly into the following categories:

- Large rocket engine testing
- Small rocket or other engine testing
- Component testing
- Support or testing laboratories
- Other materials testing/production
- Storage areas
- Landfills
- Surface water ponds
- Fuel farms and storage tanks
- Sewage treatment plants and leach fields
- Maintenance/incinerator locations

Minor operational activities included facility and equipment maintenance, laboratory analysis, and metal plating.

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SECTION 4

Methodology and Activities

4.1 Preliminary Assessment Guidance Documents

This SSFL PFAS PA is consistent with the PFAS PA Work Plan for Various NASA Centers and Facilities (Tetra Tech, 2019) and the guidance for performing PAs under CERCLA (EPA, 1991).

4.2 Preliminary Assessment Activities

Three primary activities were completed as part of this PA: records review, site reconnaissance, and data evaluation. These activities were conducted in five steps, as described in the following sections. The data evaluation process includes the development of an initial PFAS conceptual site model (CSM) to support path-forward recommendations.

4.2.1 Step 1: Record Identification and Review

A keyword search was conducted on over 80,000 historical site documents; a list of terms is included in Table 4-1. The keywords used were words applicable to SSFL and the operations that occurred at this facility. Documents containing those words were manually reviewed for applicability. Search results primarily pointed to insignificant or unrelated documents or activities. For instance, searching for "AFFF" revealed standard operating procedures recommended for drillers working onsite that suggest, *"While the rig is operational, a fire-suppressant foam such as AFFF may be used to reduce the potential for sparking or flare-ups,"* though this suggestion provides no indication of whether AFFF was used onsite.

The May 2019 NASA Soil Data Summary Report (NASA, 2019) was reviewed for operational activities at each of the 16 soil sites. This summary report was used for a high-level review for typical PFAS usage areas, such as locations AFFF might have been stored, handled, or used.

A list of the chemicals stored at the Storable Propellant Area (SPA) at SSFL was reviewed for materials with the potential to contain PFAS.

PFAS-containing products were considered significant if they were present in a sufficient quantity (that is, greater than 16 ounces or 1 pound, quantity threshold anticipated to be of little concern), in a mobile state (that is, liquid, not solid or gel), or directly released to the environment (that is, discharged in an uncontrolled manner).

Information obtained through document research regarding the AOPCs identified and reviewed was confirmed by two workers physically located at the site, one of whom has 12.5 years of experience working at the SSFL.

4.2.2 Step 2: Identification of PFAS Areas of Potential Concern

Preliminary review of historical documents provided the following SSFL sites as AOPCs:

- Area II Landfill
- Area II Sewage Treatment Plant
- Building 2206
- Building 2207
- Alfa, Bravo, Coca, and Delta Test Stands
- Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds

Additionally, the following locations were considered, but it is recommended that they require no further action, per the following rationale (Figure 3):

- **SPA** – There is no evidence of storage of AFFF or the use of AFFF in a fire suppression system, or any PFAS-containing materials.
- **Area II Helipad** – There is no evidence of the storage or use of AFFF in a fire suppression system. There is no evidence of AFFF being used as an emergency response, and there is no evidence of training conducted at this location. There is no evidence of the storage or use of any PFAS-containing materials at the Area II Helipad.
- **Building 211 Leach Field** – The activities at this location pre-date the manufacturing of fluorinated AFFF.

4.2.3 Step 3: Initial PFAS Conceptual Site Model Development

The information gathered during the records review was used to develop an initial PFAS CSM (Table 4-2). The CSM compiles relevant information for the AOPCs to evaluate the potential for a PFAS release to soil, groundwater, surface water, or sediment and identifies potential transport mechanisms and human and ecological receptors potentially exposed to impacted media.

4.2.4 Step 4: Recommendations

Recommendations are based on the review of historical site documents, as noted in Section 4.2.1. Sites are recommended for further investigation if they have confirmed release, use, or storage of AFFF or PFAS-containing materials. The sites recommended for further investigation are listed as follows and are discussed further in Tables 4-2 through 4-7:

- Area II Landfill
- Area II Sewage Treatment Plant
- Building 2206
- Building 2207
- Alfa, Bravo, Coca, and Delta Test Stands
- Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds

SECTION 5

Reporting

This PA evaluates the potential for PFAS releases from AOPCs at the NASA-administered areas of SSFL. Ten areas were considered during the PA for potential releases of PFAS at SSFL. Based on the findings in this PA, three areas at SSFL require no further action, because there is no evidence that PFAS-containing materials were used or released at these locations. Seven AOPCs were identified as having the potential for PFAS presence and were recommended for investigation based on the potential for AFFF to have been stored, used, or released during operations or demolition. Potential receptors and migration pathways for the sites with potential PFAS presence are discussed in Tables 4-2 through 4-7. The recommended path forward and rationale for each location are provided in Table 5-1.

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SECTION 6

References

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Tables

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TABLE 1-1

Team Members and SMEs

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Team Member	Company/ Organization	Role	Email Address
Peter Zorba	NASA	Project Director	Peter.zorba@nasa.gov
Jonathan Freed	CH2M	Project Manager	Jonathan.Freed@jacobs.com
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Peter Lawson	CH2M	Senior Technical Consultant	Peter.lawson@jacobs.com
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CH2M = CH2M HILL, Inc. (a wholly owned subsidiary of Jacobs Engineering Group Inc.)
PA = Preliminary Assessment
PFAS = per- and polyfluoroalkyl substances
SME = subject matter expert

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TABLE 4-1
List of PFAS Keywords for Record Search
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

PFAS Keywords
AFFF
Aqueous film-forming foam
Braycote
Burn pit
C6
C8
Chlorofluorocarbon
Chromeplating
Class B foam
Emergency response
Fire
Fire Fighter
Fire training
Fluorinated
Fluorocarbon
Foam
Fume suppressant
Helipad
Heliport
High expansion foam
Hydraulic oil
Krytox
Landfill
Perfluoro
PFAS
PFC
PFOA
PFOS
Plating
Polyfluoro
Sewage treatment plant

TABLE 4-1
List of PFAS Keywords for Record Search
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

PFAS Keywords
Skim ponds
Skydrol
Spill
Suppression
Teflon
Wetting agent

AFFF = aqueous film-forming foam
PFAS = per- and polyfluoroalkyl substances
PFC = perfluorinated compound
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane-sulfonic acid

TABLE 4-2

Conceptual Site Model – Area II Landfill

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Area II Landfill Located north of Service Area Road Used from 1955 to 1980 **Site Use:** This location was used to dispose of unused fill materials, vegetation, some drums of unknown content, and construction debris (ICF Kaiser, 1993). Previous visual site investigations at the landfill reported that the waste appeared to consist of construction debris such as asphalt pieces, timber, vegetation, piping, cement, glass, and steel. **Size:** approximately 3.6 acres **Site History:** This landfill was built in 1955 and was historically used as a landfill until 1980. **Current Environmental Program Status:** RCRA Facility Investigation **Other Site Contaminants:** VOCs (Trichloroethene)
Environmental Setting	**Topography:** SSFL occupies approximately 2,850 acres of hilly terrain that expresses approximately 1,100 feet of topographic relief near the crest of the Simi Hills. The highest surface elevation at SSFL occurs near the center of the site at an approximate elevation of 2,245 feet above mean sea level. **Geology:** The Cretaceous Chatsworth Formation is one of the oldest and most extensively exposed units in the Simi Hills and directly underlies most of SSFL. It is a roughly 70-million-year-old and greater than 2,000-foot-thick composite turbidite sequence of sandstone interbedded with shale, siltstone, and conglomerate deposited in a sand-rich environment at water depths between 600 and 3,000 feet[a]. In the vicinity of SSFL, defined coarse-grained units are typically several hundred feet thick with discontinuous fine-grained interbeds that are 5 to 20 feet thick. Fine-grained units generally contain 50% or more interbedded siltstone and shale and range between 15 and 300 feet thick. Individual sandstone beds range in thickness from roughly 1 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. **Soil Types:** 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. 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. **Hydrogeology/Hydrology:** The aquifer system beneath SSFL can be divided into three general categories: • Shallow groundwater occurring within the alluvium and weathered bedrock that is perched above the competent bedrock aquifer • Shallow groundwater occurring within the alluvium and weathered bedrock that is continuous with the competent bedrock • Groundwater occurring in the competent bedrock aquifer Precipitation that falls on the site evaporates, flows offsite via surface drainages, or infiltrates into the shallow subsurface. Groundwater recharge to the aquifer system originates as infiltration through the ground surface, flows through alluvial and/or weathered bedrock where present, and continues downward migrating through a network of interconnected fractures in the competent Chatsworth Formation bedrock aquifer. The recharge causes groundwater to mound beneath SSFL and generates static groundwater levels hundreds of feet above the surrounding valleys. Once this infiltrating water encounters the saturated bedrock, it generally migrates three-dimensionally, both to the deeper regional aquifers and toward—and potentially discharging to—seeps, springs, and/or phreatophytes located along the SSFL perimeter[b]. Groundwater in the vicinity of the Area II Landfill flows to the northwest of SSFL. Surface water that collects and drains at SSFL is intermittent and is conveyed offsite via one of four drainages: the Northwestern Drainage, the Northern Drainage, the Happy Valley Drainage, and the Bell Creek Drainage.

TABLE 4-2

Conceptual Site Model – Area II Landfill

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
	Vegetation: The local distribution and density of plant communities vary substantially at SSFL because of the differences in habitat quality and historical disturbances, such as development and wildfires. Approximately 230 acres of the 450 acres of the NASA-administered property at SSFL consist of rock outcrops.
	Current Land Use: Land use at SSFL was zoned by Ventura County as rural agricultural but was modified by a special use permit to allow industrial use. Buildings that formerly housed research and testing support facilities are inactive, are undergoing or planned for demolition, or are being used to support environmental cleanup.
	Future Land Use: The future intended land use for SSFL is open space for day-use recreational purposes only[c].
	Land Use Controls: Land use at SSFL was zoned by Ventura County as rural agricultural but was modified by a special use permit to allow industrial use. Buildings that formerly housed research and testing support facilities are inactive, are undergoing or planned for demolition, or are being used to support the environmental cleanup.
	Production or Manufacturing Use: N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A **Metal Plating Activities:** N/A **Waste Disposal:** Disposal of drums of unknown contents **Wastewater Treatment Plant:** N/A **Hangar Fire Suppression System Operations:** N/A **Unplanned Release Areas:** N/A **Foam Storage Area:** N/A **Emergency Equipment Maintenance Areas:** N/A **Receive Offsite Migration:** N/A **PFAS Sampling Results:** N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description)
	Onsite Targets: Potential receptors include workers, visitors, and trespassers.
	Offsite Targets: Potential receptors include workers, visitors, trespassers, recreators, and local community members.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Groundwater flow in this area is to the east. There are no sensitive receptors within 1 mile north of the Area II Landfill.
	Onsite Targets: The groundwater at SSFL is not used as drinking water. There are no onsite targets within a 1-mile radius of the Area II Landfill.
	Offsite Targets: The groundwater at SSFL is not used as drinking water. There are no offsite targets within a 1-mile radius of the Area II Landfill.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Flow in the Northern Drainage occurs seasonally, and in established natural and constructed channels.
	Onsite Targets: Potential receptors include workers, visitors, and trespassers.
	Offsite Targets: Potential receptors include workers, visitors, and trespassers.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-2

Conceptual Site Model – Area II Landfill

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors[d]	USFWS has identified threatened or endangered listed plant species that potentially are located within SSFL (USFWS, 2020). These species are Braunton's milk vetch (*Astragalus brauntonii*), Ventura Marsh Milk-vetch (*Astragalus pycnostachyus var. lanosissimus*), Island Barberry (B*erberis pinnata ssp. Insularis*), Conejo dudleya (*Dudleya abramsii ssp.parva*), Marcescent dudleya (*Dudleya cymosa ssp. Marcescens*), Southern mountain wild buckwheat (*Eriogonum kennedyi var. austromontanum*), Lyon's pentachaeta (*Pentachaeta lyonii*), Salt march bird's-beak (*Cordylanthus maritimus ssp. Maritimus*), California Orcutt grass (*Orcuttia californica*), Marsh Sandwort (*Arenaria paludicola*), Spreading navarretia (*Navarretia fossalis*), Verity's dudleya (*Dudleya verity*), Slender-horned spineflower (*Dodecahema leptoceras*), Kern mallow (*Eremalche kernensis*), California jewelflower (*Caulanthus californicus*), San Joaquin wooly-threads (*Monolopia lembertia congdonii*), Gambel's watercress (*Rorippa gambellii*), Santa Monica Mountains dudleyea (*Dudleya cymose ssp. Ovatifolia*), and Island malacothrix (*Malacothrix squalida*). USFWS has identified threatened or endangered listed amphibians that are potentially located within SSFL (USFWS, 2020). These species are Arroyo (*Anaxyrus californicus*), California red-legged frog (*Rana draytonii*), and Mountain yellow-legged frog (*Rana muscosa*). USFWS has identified threatened or endangered listed birds that are potential located within SSFL (USFWS, 2020). These species are California condor (*Gymnogyps californianus*), California least tern (*Sterna antillarum browni*), Light-footed clapper rail (*Rallus longirostris levipes*), Least Bell's vireo (*Vireo bellii pusillus*), Yellow-billed Cuckoo (*Coccyzus americanus*), Western snowy plover (*Chardrius nivosus nivosus*), Marbled murrelet (*Brachyramphus marmoratus*), Coastal California gnatcatcher (*Polioptila californica californica*), and Southwestern willow flycatcher (*Empidonax traillii extimus*). USFWS has identified one threatened or endangered listed insect that is potential located within SSFL (USFWS, 2020). This species is the Kern primrose sphinx moth (*Euproserpinus Euterpe*). USFWS has identified threatened or endangered listed mammals that are potential located within SSFL (USFWS, 2020). These species are San Joaquin kit fox (*Vulpes macrotis mutica*), Giant kangaroo rat (*Dipodomys ingens*), and Buena Vista Lake ornate Shrew (*Sorex orantus relictus*). USFWS has identified threatened or endangered listed reptiles that are potential located within SSFL (USFWS, 2020). These species are Blunt-nosed leopard lizard (*Gambelia silus*) and Island night lizard (*Xantusia riversiana*). The Burro Flats Cultural Resource Area has been identified beyond the 1-mile radius from the boundary of NASA Area II and Area I (LOX).

[a] Link M.H., R.L. Squires, and P. Colburn., 1984. Deep-sea fan facies and paleogeography of Upper Cretaceous Chatsworth Formation, Simi Hills, California. AAPG Bulletin, 68 (7), pp. 850-873.

[b] MWH. 2009. *Site-wide Groundwater Remedial Investigation Report, Santa Susana Field Laboratory, Ventura County, California*. Draft. December.

[c] The Boeing Company (Boeing). 2017. Grant Deed of Conservation Easement and Agreement between the Boeing Company and North American Land Trust, County of Ventura, California. April 24.

[d] U.S. Fish and Wildlife Service (USFWS). 2020. Endangered Species Database. Accessed July 16, 2020. https://ecos.fws.gov/ecp0/reports/species-by-current-range-county?fips=06111

LOX = liquid oxygen
N/A = not applicable
PFAS = per- and polyfluoroalkyl substances
RCRA = Resource Conservation and Recovery Act
SSFL = Santa Susana Field Laboratory
ssp. = species
USFWS = U.S. Fish and Wildlife Service
VOC = volatile organic compound

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TABLE 4-3

Conceptual Site Model – Area II Sewage Treatment Plant

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Area II STP
	Located south of Service Area Road and east of Test Area Road
	Building was constructed in 1961 and demolished in 2017.
	Site Use: This building received waste from the ELV and the Service Area.
	Size: approximately 0.25 acre
	Site History: The Area II STP was built in 1961 and used to receive waste from multiple locations within the ELV.
	Current Environmental Program Status: Ongoing Investigation
	Other Site Contaminants: Metals, VOCs, SVOCs
Environmental Setting	**Topography:** Refer to Table 4-2
	Geology: Refer to Table 4-2
	Soil Types: Refer to Table 4-2
	Hydrogeology/Hydrology: Refer to Table 4-2 Groundwater in the vicinity of the Area II STP flows to the north of SSFL.
	Vegetation: Refer to Table 4-2
	Current Land Use: Refer to Table 4-2
	Future Land Use: Refer to Table 4-2
	Land Use Controls: Refer to Table 4-2
	Production or Manufacturing Use: N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A
	Metal Plating Activities: N/A
	Waste Disposal: N/A
	Wastewater Treatment Plant: Area II STP received waste from the ELV, including Building 2207, which stored AFFF.
	Hangar Fire Suppression System Operations: N/A
	Unplanned Release Areas: N/A
	Foam Storage Area: N/A
	Emergency Equipment Maintenance Areas: N/A
	Receive Offsite Migration: N/A
	PFAS Sampling Results: N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description)
	Onsite Targets: Potential receptors include workers, visitors, and trespassers.
	Offsite Targets: Potential receptors include workers, visitors, trespassers, and recreators.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Groundwater flow in this area is to the north. There are no sensitive receptors within 1 mile north of the Area II STP.
	Onsite Targets: The groundwater at SSFL is not used as drinking water. There are no onsite targets within a 1-mile radius of the Area II STP.
	Offsite Targets: The groundwater at SSFL is not used as drinking water. There are no offsite targets within a 1-mile radius of the Area II STP.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-3

Conceptual Site Model – Area II Sewage Treatment Plant

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Flow is solely during precipitation events, and in established natural and constructed channels. **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include workers, visitors, and trespassers. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors	Refer to Table 4-2

AFFF = aqueous film-forming foam
ELV = Expendable Launch Vehicle
N/A = not applicable
PFAS = per- and polyfluoroalkyl substances
SSFL = Santa Susana Field Laboratory
STP = Sewage Treatment Plant
SVOC = semivolatile organic compound
VOC = volatile organic compound

TABLE 4-4

Conceptual Site Model – Building 2206

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Building 2206
	Located north of Service Area Road and east of Ctl II Road
	Building was constructed in 1989 and demolished in 2015
	Site Use: This building was used as engine assembly, chemical storage, and office space.
	Size: 8.5 acre area
	Site History: This building was built in 1989 and was originally called the Component Test Laboratory. It was used for final assembly which included engine component testing, cleaning, and assembly. Metal plating operations were located at this building, including ductile nickel plating, gold plating, copper plating, cadmium plating, hard anodizing aluminum alloys, electroplating, electro-milling and anodizing, hard chromium chromic acid and sulfuric acid anodizing of aluminum alloys. No decorative or hard chromium plating operations were identified in site documentation. A small catchment pond was located southwest of the building to contain testing operations wastes (NASA, 2008).
	Current Environmental Program Status: RCRA Program
	Other Site Contaminants: VOCs (Trichloroethene)
Environmental Setting	**Topography:** Refer to Table 4-2
	Geology: Refer to Table 4-2
	Soil Types: Refer to Table 4-2
	Hydrogeology/Hydrology: Refer to Table 4-2 Groundwater in the vicinity of Building 2206 flows to the north of SSFL.
	Vegetation: Refer to Table 4-2
	Current Land Use: Refer to Table 4-2
	Future Land Use: Refer to Table 4-2
	Land Use Controls: Refer to Table 4-2
	Production or Manufacturing Use: N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A
	Metal Plating Activities: Metal plating occurred at this location and may have used PFAS-containing materials.
	Waste Disposal: N/A
	Wastewater Treatment Plant: N/A
	Hangar Fire Suppression System Operations: N/A
	Unplanned Release Areas: N/A
	Foam Storage Area: N/A
	Emergency Equipment Maintenance Areas: N/A
	Receive Offsite Migration: N/A
	PFAS Sampling Results: N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media
	Migration Routes: Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description)
	Onsite Targets: Potential receptors include workers, visitors, and trespassers.
	Offsite Targets: Potential receptors include workers, visitors, trespassers, and recreators.
	PFAS Sampling Results: There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-4

Conceptual Site Model – Building 2206

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Groundwater flow in this area is to the north. There are no sensitive receptors within 1 mile north of Building 2206. **Onsite Targets:** The groundwater at SSFL is not used as drinking water. There are no onsite targets within a 1-mile radius of Building 2206. **Offsite Targets:** The groundwater at SSFL is not used as drinking water. There are no offsite targets within a 1-mile radius of Building 2206. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Flow is solely during precipitation events, and in established natural and constructed channels. **Onsite Targets:** There are no onsite targets within a 1-mile radius of Building 2206. **Offsite Targets:** There are no offsite targets within a 1-mile radius of Building 2206. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors	Refer to Table 4-2

National Aeronautics and Space Administration (NASA). 2008. *RCRA Facility Investigation, Santa Susana Field Laboratory, Ventura County, California.* Draft. November.

N/A = not applicable

PFAS = per- and polyfluoroalkyl substances

RCRA = Resource Conservation and Recovery Act

SSFL = Santa Susana Field Laboratory

VOC = volatile organic compound

TABLE 4-5

Conceptual Site Model – Building 2207

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Building 2207 Located near the northern border of Area II at the intersection of Area II Road and Test Area Road Building was constructed in 1956 and demolished in 2015. **Site Use:** This building was used as a security control center, fire station, and Protective Services Building until 2006. **Size:** 6,634 SF **Site History:** This building was built in 1956 and was historically used for security and fire protection. **Current Environmental Program Status:** N/A **Other Site Contaminants:** VOCs (Tetrachloroethene; Trichloroethene; cis-1,2-Dichloroethene; trans-1,2-Dichloroethene; Vinyl Chloride; 1,1-Dichloroethene; 1,2-Dichloroethane; 1,1-Dichloroethane; 1,1,1-Trichloroethane; 1,2,3-Trichloropropane; Carbon Tetrachloride; Benzene; 1,4-Dioxane), Formaldehyde, NDMA, Gasoline and Diesel, Tritium, Ce-137, Sr-90, Fluoride, Nitrate, Cadmium, Copper, Lead, Manganese, Molybdenum, Selenium, and Perchlorate.
Environmental Setting	**Topography:** Refer to Table 4-2 **Geology:** Refer to Table 4-2 **Soil Types:** Refer to Table 4-2 **Hydrogeology/Hydrology:** Refer to Table 4-2 Groundwater in the vicinity of Building 2207 flows to the north of SSFL. **Vegetation:** Refer to Table 4-2 **Current Land Use:** Refer to Table 4-2 **Future Land Use:** Refer to Table 4-2 **Land Use Controls:** Refer to Table 4-2 **Production or Manufacturing Use:** N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A **Metal Plating Activities:** N/A **Waste Disposal:** N/A **Wastewater Treatment Plant:** N/A **Hangar Fire Suppression System Operations:** N/A **Unplanned Release Areas:** N/A **Foam Storage Area:** Per photographs from April 2008 , AFFF was stored in Building 2207 **Emergency Equipment Maintenance Areas:** N/A **Receive Offsite Migration:** N/A **PFAS Sampling Results:** N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description) **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include workers, visitors, trespassers, and recreators. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Groundwater flow in this area is to the north. There are no sensitive receptors within 1 mile north of Building 2207. **Onsite Targets:** The groundwater at SSFL is not used as drinking water. There are no onsite targets within a 1-mile radius of Building 2207. **Offsite Targets:** The groundwater at SSFL is not used as drinking water. There are no offsite targets within a 1-mile radius of Building 2207. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-5

Conceptual Site Model – Building 2207

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media Migration Routes: Flow is solely during precipitation events, and in established natural and constructed channels. **Onsite Targets:** There are no onsite targets within a 1-mile radius of Building 2207. **Offsite Targets:** There are no offsite targets within a 1-mile radius of Building 2207. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors	Refer to Table 4-2

AFFF = aqueous film-forming foam
N/A = not applicable
NDMA = n-nitrosodimethylamine
PFAS = per- and polyfluoroalkyl substances
SSFL = Santa Susana Field Laboratory
VOC = volatile organic compound

TABLE 4-6

Conceptual Site Model – Alfa, Bravo, Coca, and Delta Test Stands

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Alfa Test Stands, Bravo Test Stands, Coca Test Stands, and Delta Test Stands Multiple locations across SSFL Constructed in 1955 to 1957 **Site Use:** The Alfa, Bravo, Coca, and Delta Test Stands were used for engine testing, maintenance, and cleaning. **Size:** Varies **Site History:** The test stands were built from 1955 to 1957 and were historically used for engine testing, maintenance, and cleaning. The Alfa Test Stands were deactivated by 2006, the Bravo Test Stands were deactivated by 2005, the Coca Test Stands were deactivated by 1988, and the Delta Test Stands were deactivated by 1974. **Current Environmental Program Status:** N/A **Other Site Contaminants:** VOCs (Trichloroethene)
Environmental Setting	**Topography:** Refer to Table 4-2 **Geology:** Refer to Table 4-2 **Soil Types:** Refer to Table 4-2 **Hydrogeology/Hydrology:** Refer to Table 4-2 Groundwater in the vicinity of the Alfa Test Stand flows to the north of SSFL. Groundwater in the vicinity of the Bravo Test Stand flows to the east of SSFL. Groundwater in the vicinity of the Coca Test Stand flows to the north of SSFL. Groundwater in the vicinity of the Delta Test Stand flows to the south of SSFL. **Vegetation:** Refer to Table 4-2 **Current Land Use:** Refer to Table 4-2 **Future Land Use:** Refer to Table 4-2 **Land Use Controls:** Refer to Table 4-2 **Production or Manufacturing Use:** N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A **Metal Plating Activities:** N/A **Waste Disposal:** The test stands used Braycote hydraulic oil, which is known to be a PFAS-containing material. It was also commonplace to use chlorofluorocarbons as a cleaning solution, which is known to be a PFAS-containing material, at the test stands. Waste from the use of this oil and cleaning solution may have been released at the site and transported to the skim ponds. **Wastewater Treatment Plant:** N/A **Hangar Fire Suppression System Operations:** N/A **Unplanned Release Areas:** N/A **Foam Storage Area:** N/A **Emergency Equipment Maintenance Areas:** N/A **Receive Offsite Migration:** N/A **PFAS Sampling Results:** N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description) **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include workers, visitors, and recreators. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-6

Conceptual Site Model – Alfa, Bravo, Coca, and Delta Test Stands

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Groundwater flow at the test stands varies; refer to Figures 7 to 10 for groundwater flow. There are no sensitive receptors within a 1-mile radius of the Alfa, Bravo, Coca, and Delta Test Stands. **Onsite Targets:** The groundwater at SSFL is not used as drinking water. Due to groundwater seeps located in the south of the Coca and Delta Test Stand locations, potential receptors include workers, visitors, and trespassers. **Offsite Targets:** The groundwater at SSFL is not used as drinking water. Due to groundwater seeps located in the south of the Coca and Delta Test Stand locations, potential receptors include workers, visitors, trespassers, and local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media Migration Routes: Flow is solely during precipitation events, and in established natural and constructed channels. **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors could include workers, visitors, and recreators. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors	Refer to Table 4-2

N/A = not applicable
PFAS = per- and polyfluoroalkyl substances
SSFL = Santa Susana Field Laboratory
VOC = volatile organic compound

TABLE 4-7

Conceptual Site Model – Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Site Profile	Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds Multiple locations across SSFL. Constructed in 1956 **Site Use:** These locations were used to collect liquid waste from the Alfa, Bravo, Coca, and Delta Test Stands, respectively **Size:** The Alfa Skim Pond has a 500,000-gallon capacity. The Bravo Skim Pond has a 150,000-gallon capacity. The Alfa-Bravo Skim Pond has a 200,000-gallon capacity. The Coca Skim Pond has a 300,000-gallon capacity. The Delta Skim Pond has a 725,000-gallon capacity. **Site History:** These locations were used to contain the wastes from the Alfa, Bravo, Coca, and Delta Test Stands. These are unlined retention ponds for spent cooling water and residual trichloroethene from the Alfa, Bravo, Coca, and Delta Test Stands testing and cleaning activities. The skim ponds are inactive and dry; however, surface water collects in the pond occasionally during the rainy season. **Current Environmental Program Status:** N/A **Other Site Contaminants:** VOCs (Trichloroethene)
Environmental Setting	**Topography:** Refer to Table 4-2 **Geology:** Refer to Table 4-2 **Soil Types:** Refer to Table 4-2 **Hydrogeology/Hydrology:** Refer to Table 4-2 Groundwater in the vicinity of Building 2207 flows to the northeast of SSFL. **Vegetation:** Refer to Table 4-2 **Current Land Use:** Refer to Table 4-2 **Future Land Use:** Refer to Table 4-2 **Land Use Controls:** Refer to Table 4-2 **Production or Manufacturing Use:** N/A
PFAS Site-Source Profile	**Firefighting Foam Use:** N/A **Metal Plating Activities:** N/A **Waste Disposal:** Releases from the use of Braycote hydraulic oil and chlorofluorocarbons may have been transported from the Alfa, Bravo, Coca, and Delta Test Stands to the skim ponds. **Wastewater Treatment Plant:** N/A **Hangar Fire Suppression System Operations:** N/A **Unplanned Release Areas:** N/A **Foam Storage Area:** N/A **Emergency Equipment Maintenance Areas:** N/A **Receive Offsite Migration:** N/A **PFAS Sampling Results:** N/A
Soil	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Soil erosion (refer to sediment description), fugitive dust (refer to air description), migration to groundwater (refer to groundwater description) **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include workers, visitors, and recreators. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.

TABLE 4-7

Conceptual Site Model – Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds

PFAS PA, Santa Susana Field Laboratory, Ventura County, California

Profile	Description
Groundwater	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Groundwater flow at the test stands varies, refer to Figures 7 to 10 for groundwater flow. There are no sensitive receptors within a 1-mile radius of the Alfa, Bravo, Coca, and Delta Test Stands. **Onsite Targets:** The groundwater at SSFL is not used as drinking water. Due to groundwater seeps located in the south of the Coca and Delta locations, potential receptors include workers, visitors, and trespassers. **Offsite Targets:** The groundwater at SSFL is not used as drinking water. Due to groundwater seeps located in the south of the Coca and Delta locations, potential receptors include workers, visitors, trespassers, and local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Surface Water and Sediment	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media Migration Routes: Flow is solely during precipitation events, and in established natural and constructed channels. **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include workers, visitors, and recreators. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Air	**Release Potential:** Low, due to lack of evidence of PFAS discharge to this media **Migration Routes:** Volatilization, fugitive dust **Onsite Targets:** Potential receptors include workers, visitors, and trespassers. **Offsite Targets:** Potential receptors include local community members. **PFAS Sampling Results:** There have been no previous PFAS investigations conducted at SSFL.
Sensitive Environments and Ecological Receptors	Refer to Table 4-2

N/A = not applicable
SSFL = Santa Susana Field Laboratory
VOC = volatile organic compound

TABLE 5-1
Summary, Conclusions, and Recommendations
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

AOPC	Site Description	Years of Operation	Waste Operations/PFAS Use	Current Operation Status	Proposed Path Forward (Further Investigation or NFA)	Rationale for Proposed Path Forward
Area II Landfill	The Area II Landfill is in the northern portions of Areas I and II. The 5.5-acre landfill was active from approximately 1955 to 1980, but the years of primary use were between 1965 and 1978[a]. As part of the Ventura County Environmental Health Division landfill program, the Area II Landfill has been designated a "closed landfill"[b] (MWH, 2003).	1955–1980	The Area II Landfill received unused fill materials, vegetation, some drums of unknown content, and construction debris[c]. Previous visual site investigations at the landfill reported that the waste appeared to consist of construction debris such as asphalt pieces, timber, vegetation, piping, cement, glass, and steel. Several rusted drums of unknown contents were reported to have been observed on the flat surface of the north- facing slope of the landfill[d].	Inactive	Further Investigation	Because drums of unknown content were disposed in the Area II Landfill. AFFF and PFAS-containing material are documented to have been present in the NASA-administered areas of SSFL; therefore, the Area II Landfill is recommended for further investigation.
SPA	Used to store bulk quantities of hazardous materials. Currently used to manage waste from environmental investigations.	1956–2005	There is no evidence of storage of AFFF or the use of AFFF in a fire suppression system, or any PFAS-containing materials.	Active	NFA (Refer to Section 4.2.2)	There is no evidence of storage of AFFF or the use of AFFF in a fire suppression system or any PFAS-containing materials.
Helipad	Flat open land to the north east of Building 2206 used as a helipad	Unknown	There is no evidence of storage or use of AFFF or PFAS-containing materials.	Inactive	NFA (Refer to Section 4.2.2)	There is no evidence of storage or use of AFFF or PFAS-containing materials.

TABLE 5-1
Summary, Conclusions, and Recommendations
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

AOPC	Site Description	Years of Operation	Waste Operations/PFAS Use	Current Operation Status	Proposed Path Forward (Further Investigation or NFA)	Rationale for Proposed Path Forward
Area II Sewage Treatment Plant	Below-grade and concrete-lined. Received waste from Areas II, III, and IV.	1961–2018	The Area II Sewage Treatment Plant received waste from many areas within SSFL.	Inactive	Further Investigation	AFFF and PFAS-containing materials are documented to have been located in the NASA-administered areas at SSFL. While there is no documentation of a spill, if a spill had occurred, it would be likely to have reached the Area II Sewage Treatment Plant. The Area II Sewage Treatment Plant is recommended for further investigation.
Building 211 Leach Field	Located to the east of Building 515 of the Sewage Treatment Plant	1954–1961	The Building 211 Leach Field received waste from several buildings in the Service Area. It was active from 1954 to 1961 and has been inactive since the Area II Sewage Treatment Plant was constructed.	Inactive	NFA (Refer to Section 4.2.2)	Operations pre-date manufacturing of AFFF and documented use of PFAS-containing materials.

TABLE 5-1
Summary, Conclusions, and Recommendations
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

AOPC	Site Description	Years of Operation	Waste Operations/PFAS Use	Current Operation Status	Proposed Path Forward (Further Investigation or NFA)	Rationale for Proposed Path Forward
Building 2206	Building 2206 was used as engine assembly, chemical storage, and office space. Operations in the building included rocket engine component testing, engine component cleaning, machining of components, welding brazing, engine assembly, painting, hazardous materials storage, heat treating, chemical processing, cleaning, vapor degreasing, phosphate treatment, ductile nickel plating, gold plating, copper plating, cadmium plating, hard anodizing aluminum alloys, electroplating, electro-milling and anodizing, hard chromium chromic acid and sulfuric acid anodizing of aluminum alloys, applying chemical films to aluminum, and cleaning and passivating of corrosion-resistant alloys, as well as many other alloys[e,f,g] (MacFarlane, 1989; Rockwell, 1989; Rockwell, 1995).	1989–2006	Metal plating operations occurred at Building 2206. Some plating operations (principally hard chromium electroplating) have been known to utilize PFAS-containing materials.	Inactive	Further Investigation	Due to metal plating operations occurring at Building 2206, it is recommended for further investigation.

TABLE 5-1
Summary, Conclusions, and Recommendations
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

AOPC	Site Description	Years of Operation	Waste Operations/PFAS Use	Current Operation Status	Proposed Path Forward (Further Investigation or NFA)	Rationale for Proposed Path Forward
Building 2207	Located near the northern border of Area II at the intersection of Area II Road and Service Area Road. Previously used as a Fire Station and Protective Services building.	1956–2015	Historical photographs from April 2008 show nine 55-gallon drums of AFFF stored at this location. A 2005 inventory shows that 740 gallons of AFFF were stored at Building 2207. The AFFF appears to be located in a containment area.	Demolished	Further investigation	AFFF is known to have been stored in this location. It is unknown in what capacity it was used or how it was disposed. Due to the documented presence of AFFF, Building 2207 is recommended for further investigation.
Alfa, Bravo, Coca, and Delta Test Stands	The Alfa, Bravo, Coca, and Delta Test Stands were used for engine testing, maintenance, and cleaning between 1955 and 2005.	1956–2006	An inventory in 2005 showed that Bravo Test Stand 1 (Building 2730) was the location of 575 gallons of Braycote hydraulic oil. It is unknown whether a spill occurred at this location. The Delta Skim Pond received chlorofluorocarbon waste[h] that was likely used in the cleaning activities at the Delta test stands. It is common practice to use similar materials and processes at all test stands.	Inactive Delta Test Stand has been demolished.	Further Investigation	Due to the potential use of Braycote hydraulic oil and chlorofluorocarbons; the Alfa, Bravo, Coca, and Delta Test Stands are recommended for further investigation.

TABLE 5-1
Summary, Conclusions, and Recommendations
PFAS PA, Santa Susana Field Laboratory, Ventura County, California

AOPC	Site Description	Years of Operation	Waste Operations/PFAS Use	Current Operation Status	Proposed Path Forward (Further Investigation or NFA)	Rationale for Proposed Path Forward
Alfa, Bravo, Alfa-Bravo, Coca, and Delta Skim Ponds	The skim ponds are unlined retention ponds that are connected by channels to the Alfa, Bravo, Coca, and Delta Test Stands. In 1988, the Alfa-Bravo Skim Pond was drained and the impoundment was excavated and backfilled with native, onsite soil, capped with topsoil and seeded[h]. In 1989 the Delta Skim Pond impoundment was excavated, backfilled with native soil from an onsite borrow source, capped with topsoil and hydro seeded.	1950s–present	The skim ponds are used as retention ponds for waste from testing, maintenance, and cleaning activities performed at the test stands. The Delta Skim Pond received chlorofluorocarbon waste[h] which was likely used in the cleaning activities at the Delta test stands. It is common practice to use similar materials and processes at all test stands.	Inactive	Further Investigation	Due to the potential of PFAS-containing hydraulic fluid and chlorofluorocarbons being transported from the Alfa, Bravo, Coca, and Delta test stands; The Alfa, Bravo, Alfa-Bravo, Coca, and Delta skim ponds are recommended for further investigation.

[a] MWH. 2005. *NASA Site Summaries, Santa Susana Field Laboratory, Ventura County, California.*
[b] MWH. 2003. *Area I and Area II Landfills Investigation Work Plan, Revised Final, SWMU 4.2 and SWMU 5.1*. Santa Susana Field Laboratory, Ventura County. October.
[c] ICF Kaiser Engineers (ICF). 1993. *Current Conditions Report (CCR) and Draft RCRA Facility Investigation Work Plan, Area II and Area I LOX Plant.* October.
[d] SAIC. 1994. *Final RCRA Facility Assessment (RFA) Report*. Prepared for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California. May.
[e] Macfarlane, D. 1989. Engineering Support to ELV Manufacturing. April 18.
[f] Rockwell International. 1989. Internal Letter: *Usage of Chromium Compounds in ELV Programs*. September.
[g] Rockwell International. 1995. Internal Letter: *Aqueous Clean Alternate to Vapor Degreasing, Specification RA0607-037*.
[h] Hayley and Aldrich. 2003. *Supplemental Data Summary for the Water Quality Sampling and Analysis Plan, Volume I, Santa Susana Field Laboratory, Ventura County, California.* May.
AFFF = aqueous film-forming foam
AOPC = area of potential concern
NASA = National Aeronautics and Space Administration
NFA = no further action
PFAS = per- and polyfluoroalkyl substances

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Figures

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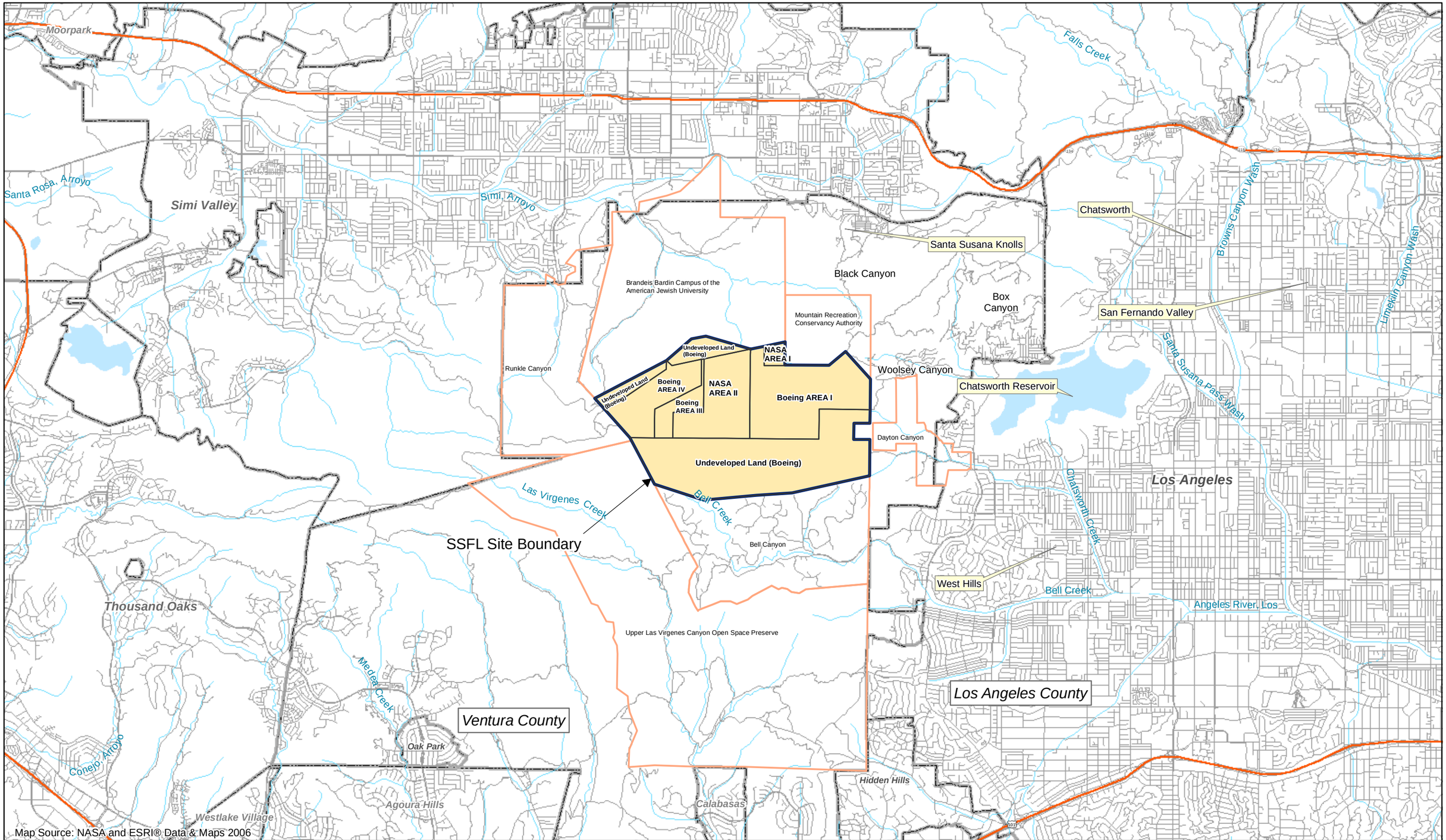


Figure 1
SSFL Site Location
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_SiteLocation.mxd

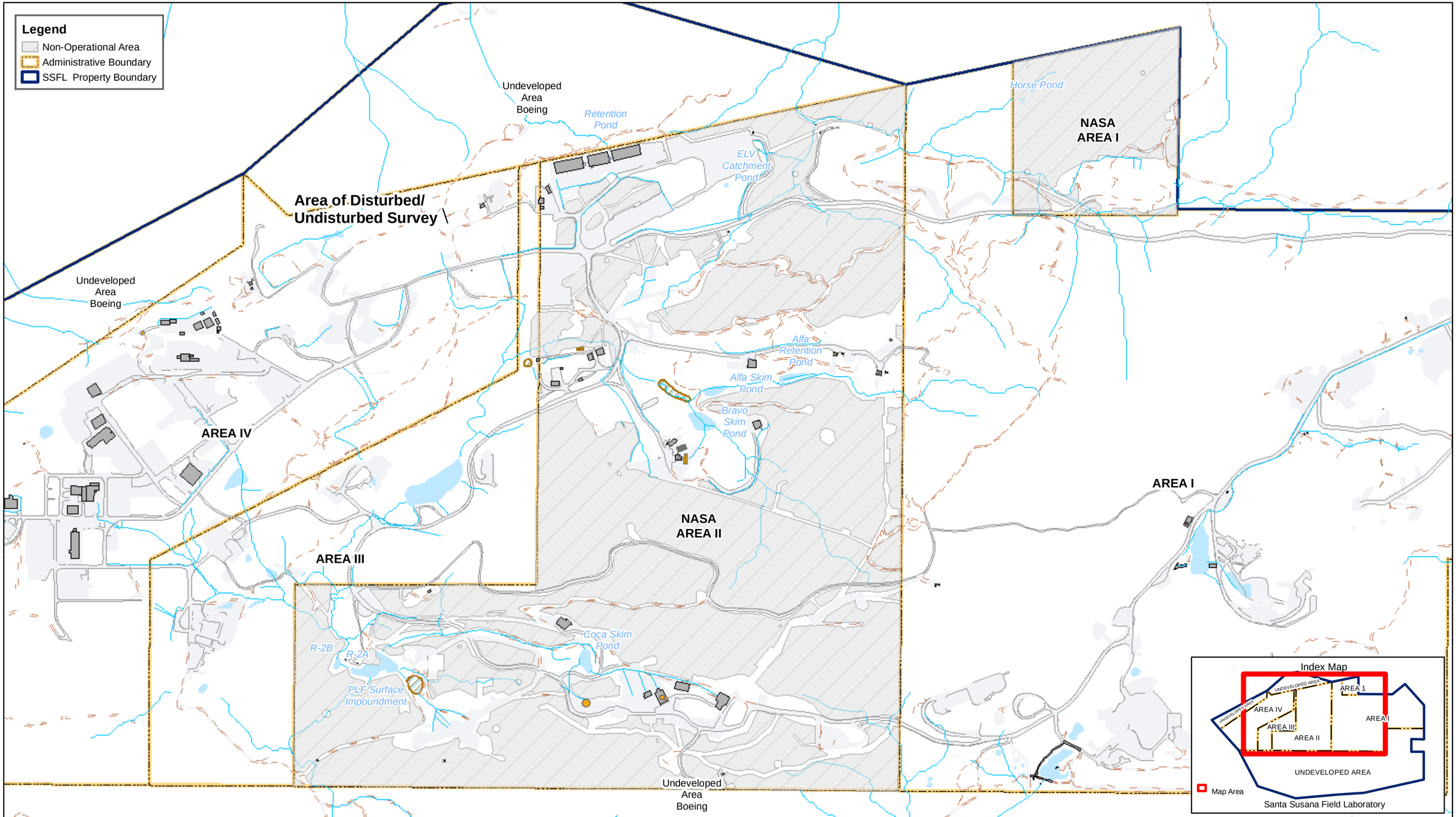
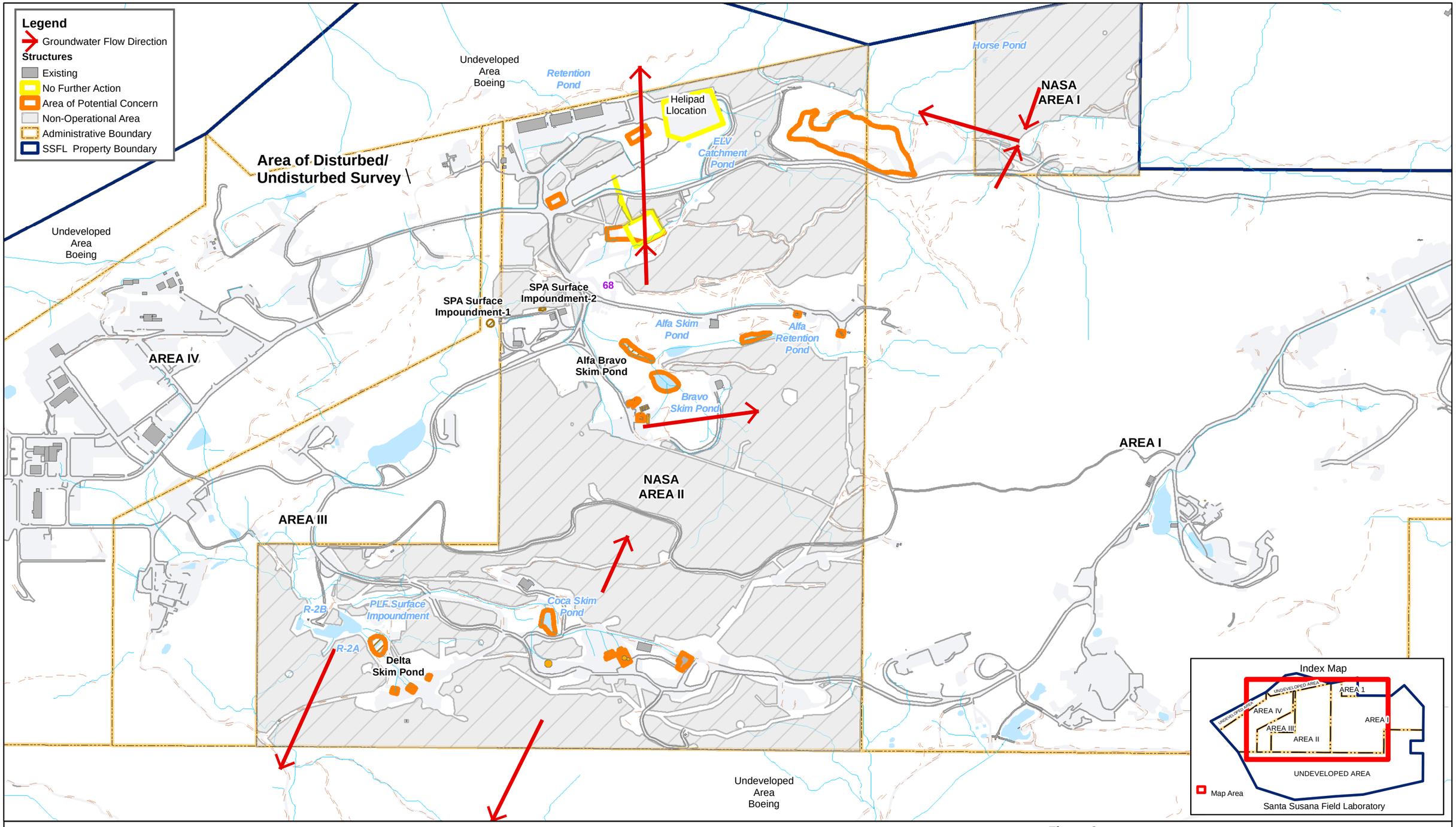


Figure 2
SSFL Facility Layout
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_FacilityLayout.mxd



27-Oct-2020
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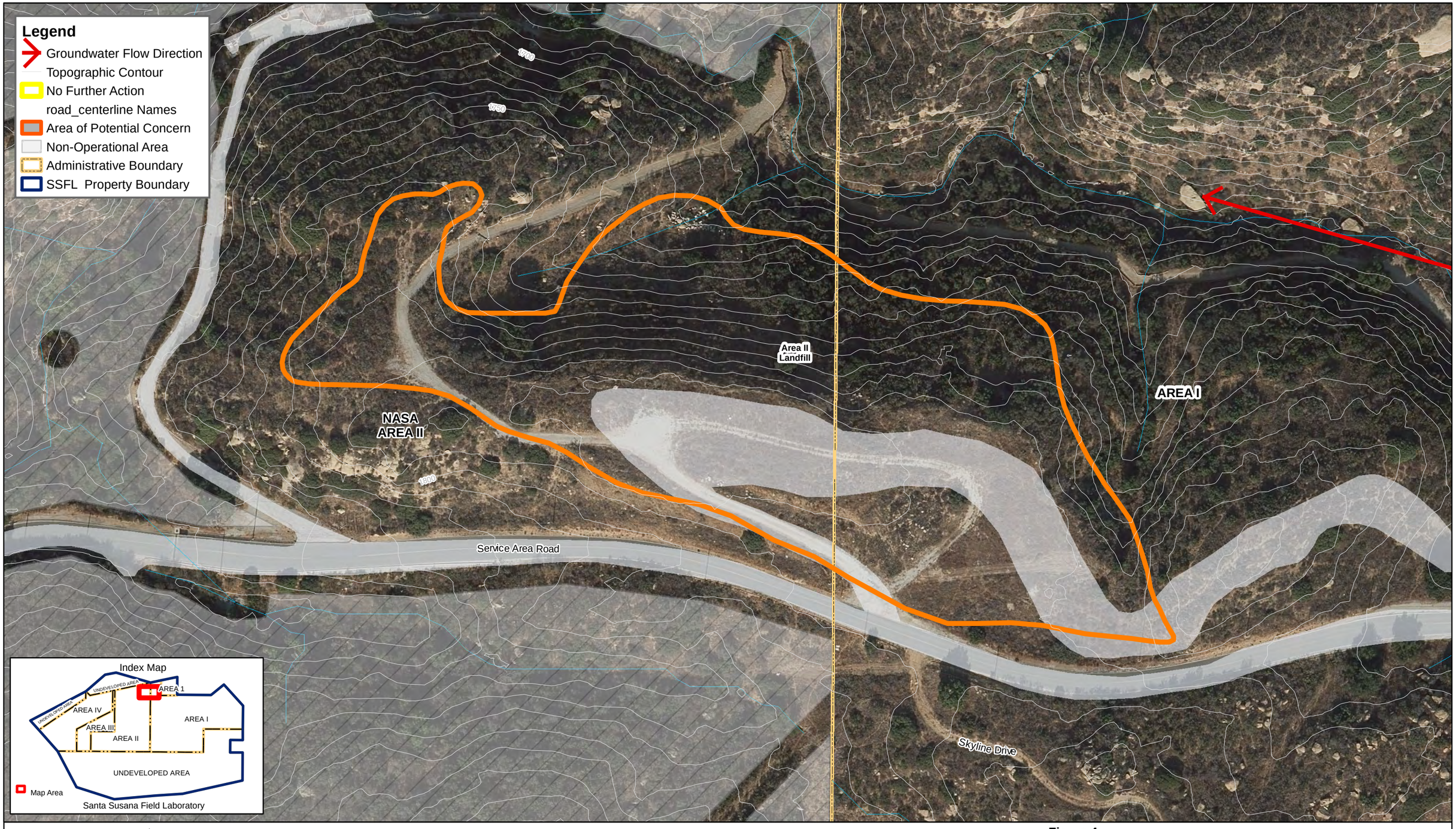
A. Cooley

Figure 3
SSFL Areas Investigated
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_AreasInvestigated.mxd



N
W E
S

0 50 100 200 Feet

0 15 30 60 Meters

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S, Stevens

Figure 4
SSFL Area II Landfill
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_A2LF.mxd

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Figure 5
SSFL Building 2207, Building 515 Sewage Treatment Plant, and Building 211 Leach Field
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_Bld2207.mxd

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Figure 6
SSFL Building 2206
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_Bld2206.mxd

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Figure 7
Alfa Test Stands and Alfa Skim Pond
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_AlfaArea.mxd

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Figure 8
Bravo Test Stands, Alfa-Bravo Skim Pond, and Bravo Skim Pond
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_2730_BravoSkimPond.mxd

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Figure 9
Coca Test Stands and Coca Skim Pond
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_Coca.mxd

Figure 10
Delta Test Stands and Delta Skim Pond
Preliminary Assessment for Per- and Polyfluoroalkyl Substances
Santa Susana Field Laboratory
Ventura County, California

Map Document: O:\NASA\SSFL\maps\PFAS\PFAS_DeltaArea.mxd