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NASA's Progress with Environmental Remediation Activities at the Santa Susana Field Laboratory

March 19, 2019

Report No. IG-19-013

Office of Inspector General

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NASA Office of Inspector General
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RESULTS IN BRIEF

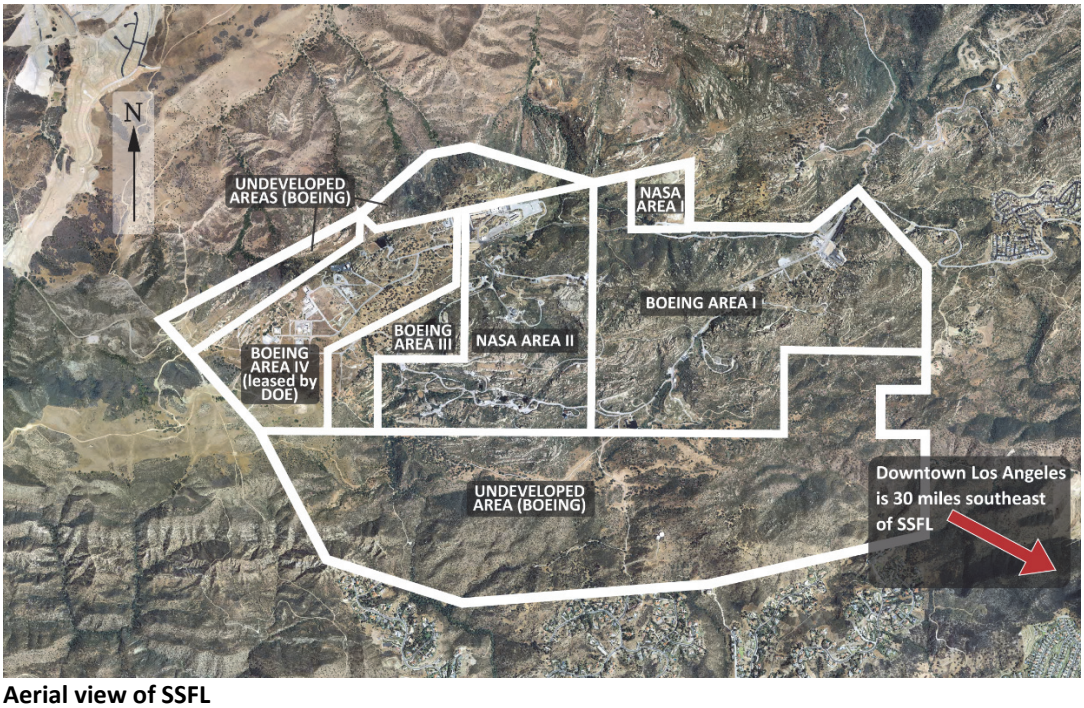
NASA's Progress with Environmental Remediation Activities at the Santa Susana Field Laboratory

March 19, 2019 IG-19-013 (A-18-013-00)

WHY WE PERFORMED THIS AUDIT

Beginning in 1948, the Santa Susana Field Laboratory (SSFL), located 30 miles northwest of downtown Los Angeles, was used for nuclear energy research by the Department of Energy (DOE) and rocket engine testing by the United States Air Force and NASA. Nuclear research concluded in 1988 and rocket engine testing concluded in 2006, resulting, respectively, in radiological and chemical contamination of the soil and groundwater at the site. Today, NASA is responsible for environmental remediation of more than 450 acres at SSFL, while DOE is responsible for cleanup of about 400 acres and the Boeing Company (Boeing) the remaining 2,000 acres.

In 2010, NASA agreed to clean the soil on its portion of the site to the most stringent standard, known as Background level, despite the fact that a risk-based cleanup typically would be less extensive. In a 2013 audit, we reported that cleaning the soil to a Background level by 2017 would cost $209 million. To date, soil cleanup has not begun, and the scope of the planned cleanup has grown significantly; NASA's current projections estimate the cost at over $500 million for an effort that could take until 2045 to complete. Further complicating the situation, the State of California has yet to finalize the exact parameters of the cleanup requirements for the NASA and DOE sites. Meanwhile, Boeing, the majority landowner at SSFL, plans to clean the soil on its portion of the site to a less stringent Recreational level.



Aerial view of SSFL

In light of the Agency's inability to advance its cleanup efforts, the more than doubling of estimated cleanup costs, and the substantial disparity in planned cleanup levels between the adjoining Boeing and NASA properties, we examined the status of NASA's environmental remediation activities at SSFL and assessed the extent to which the Agency is conducting these efforts in a cost-effective manner. In the course of our audit work, we also examined the financial impact of the

Agency's indecision on whether to preserve or demolish obsolete test stands at the site. To complete this audit, we reviewed NASA's remediation cost estimates and work plans, contract documents, environmental impact studies and reports, federal and state laws, and environmental policies, regulations, and procedures documentation; we interviewed NASA, California's Department of Toxic Substances Control, U.S. Environmental Protection Agency, DOE, U.S. Department of Justice, Boeing, and U.S. and California fish and wildlife services officials.

Towards the conclusion of our review, a major California wildfire known as the Woolsey Fire damaged almost 97,000 acres between the field lab and the Pacific coastline. A significant portion of NASA Area II burned, but estimates of the potential impact to the scope and schedule of cleanup activities in the NASA-administered areas of SSFL were not yet available.

WHAT WE FOUND

Under the terms of agreements signed with the State of California in 2007 and 2010, NASA is responsible for remediating groundwater and soil contamination at its portions of the SSFL site. However, we question the reasonableness and feasibility of the Agency's current agreement to clean the soil to a Background level. This cleanup approach is not based on risks to human health and the environment or the expected future use of the land—the standard practice for environmental remediation at similar sites. Further, a soil cleanup to the current levels set by the State of California is expected to cost NASA more than a half billion dollars, take as long as 25 years to complete, and significantly damage flora and fauna at the site. In contrast, soil cleanup to the Recreational level—the standard more in line with the expected future use of the land—would cost about $124 million and take approximately 4 years to complete. As such, we question a total of $377 million in unfunded environmental liability costs associated with NASA's current SSFL soil cleanup plans as funds that could be put to better use.

Compounding our concern is the fact that soil remediation levels envisioned by the existing cleanup strategy are likely not achievable. For example, NASA is currently required to take steps to ensure contaminants in the soil are reduced to an unprecedented degree—in some cases lower than naturally occurring levels. Such a strategy would result in highly invasive and prolonged soil removal efforts and difficulty locating soil sufficiently "clean" enough to use as backfill. At a minimum, this approach will likely result in significant destruction of the property's aesthetic value as well as its biological and cultural resources. Moreover, the significant difference in planned remediation levels between the NASA and Boeing sites coupled with the intertwined geography of the two properties will lead to continuous cross-contamination between the sites.

At the urging of several members of the California congressional delegation, NASA has delayed its decision on whether to demolish or preserve the remaining test stands and control houses at SSFL until soil cleanup is complete. By delaying this decision until as late as 2045, the Agency could potentially spend an additional $18.7 million for demolition or $17.2 million for preservation based on inflation alone—funds we believe could be put to better use if NASA made a more timely decision. The deteriorating physical condition of this infrastructure also represents a liability to the Agency as NASA seeks to clean up the site and prepare the property to be transferred or sold.

WHAT WE RECOMMENDED

To ensure the most effective and efficient cleanup of SSFL, we recommended that the NASA Administrator, with the assistance of the Associate Administrator for Mission Support and the Agency's General Counsel, (1) pursue all available options—administrative, legal, or political—to ensure NASA's SSFL soil cleanup is performed in an environmentally and financially responsible manner based on the future use of the property; and (2) decide whether to preserve or demolish the remaining test stands and related structures before soil remediation begins and take action on that decision.

In response to a draft of this report, NASA management concurred with our recommendations and described corrective actions they plan to take. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon verification and completion of the proposed corrective actions.

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Acronyms

AOC	Administrative Order on Consent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
DTSC	California Department of Toxic Substances Control
ECR	Environmental Compliance and Restoration Program
EIS	Environmental Impact Statement
EMD	Environmental Management Division
EPA	U.S. Environmental Protection Agency
FY	Fiscal Year
GSA	General Services Administration
LUT	Look Up Table
NETS	NASA Environmental Tracking System
OIG	Office of Inspector General
PAH	polycyclic aromatic hydrocarbon
PEIR	Program Environmental Impact Report
RCRA	Resource Conservation and Recovery Act
SSFL	Santa Susana Field Laboratory
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service

INTRODUCTION

The Santa Susana Field Laboratory (SSFL) is located on approximately 2,850 acres in the Simi Hills in Ventura County, California, 30 miles northwest of downtown Los Angeles. The facility, first opened in 1948, was used for research on civilian nuclear energy by the Department of Energy (DOE) and rocket engine testing for defense and space exploration by the United States Air Force and NASA. Nuclear research ended in 1988 and rocket engine testing in 2006 resulting, respectively, in radiological and chemical contamination of the soil and groundwater at the site. Since 2007, the state of California, primarily through its environmental regulator the Department of Toxic Substances Control (DTSC), has pushed for groundwater and soil cleanup. NASA is responsible for environmental remediation of more than 450 acres at SSFL, DOE is responsible for cleanup of about 400 acres, and the Boeing Company (Boeing) is responsible for cleanup of the remaining 2,000 acres.[1]

In 2010, NASA signed an agreement with the DTSC to clean the soil on its portion of the site to the most stringent standard, known as Background level, despite the fact that a typical risk-based cleanup for a large environmental project involving a federal agency would be less extensive. In our 2013 audit of NASA's environmental cleanup efforts at SSFL, we reported that soil remediation to a Background level completed by an agreed-upon 2017 deadline would cost $209 million.[2] However, soil remediation has not begun, and the Agency's current projections estimate the cost at over $500 million for an effort that could take until 2045 to complete. Meanwhile, Boeing—the majority landowner at SSFL—plans to clean the soil on its portion of the site to a less stringent Recreational level.

Since signing the 2010 agreement, DTSC has worked to develop the exact parameters of the cleanup requirements for the NASA and DOE sites. As a result, NASA has yet to formally begin soil and groundwater cleanup at SSFL but has instead completed sampling, laboratory analyses, treatability studies, and pilot testing in preparation for its planned comprehensive cleanup effort.[3] In addition, NASA's demolition activities, which began in 2015 and involve removal of obsolete buildings, roadways, and related infrastructure (but not test stands or control houses) to prepare the site for cleanup, are scheduled for completion by May 2019.[4]

In light of the Agency's difficulty in advancing its cleanup efforts, the more than doubling of estimated cleanup costs, and the substantial disparity in cleanup requirements between the adjoining Boeing and NASA properties, we examined the status of NASA's environmental remediation activities at SSFL and assessed the extent to which the Agency is conducting these efforts in a cost-effective manner. In the

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[1] DOE has responsibility for cleanup of soil in the 290-acre land it leases from Boeing and shares responsibility with NASA for cleanup of soil in the 182-acre Northern Buffer Zone. Specifically, NASA is responsible for any contamination that has migrated into the Northern Buffer Zone from NASA Areas I or II.

[2] NASA Office of Inspector General, "NASA's Environmental Remediation Efforts at the Santa Susana Field Laboratory" (IG-13-007, February 14, 2013).

[3] Treatability studies for remedial actions serve two primary purposes: (1) to aid in the selection of the remedy, and (2) to aid in the implementation of the selected remedy. In addition, such studies will indicate whether a given technology can meet the expected cleanup goals for the site.

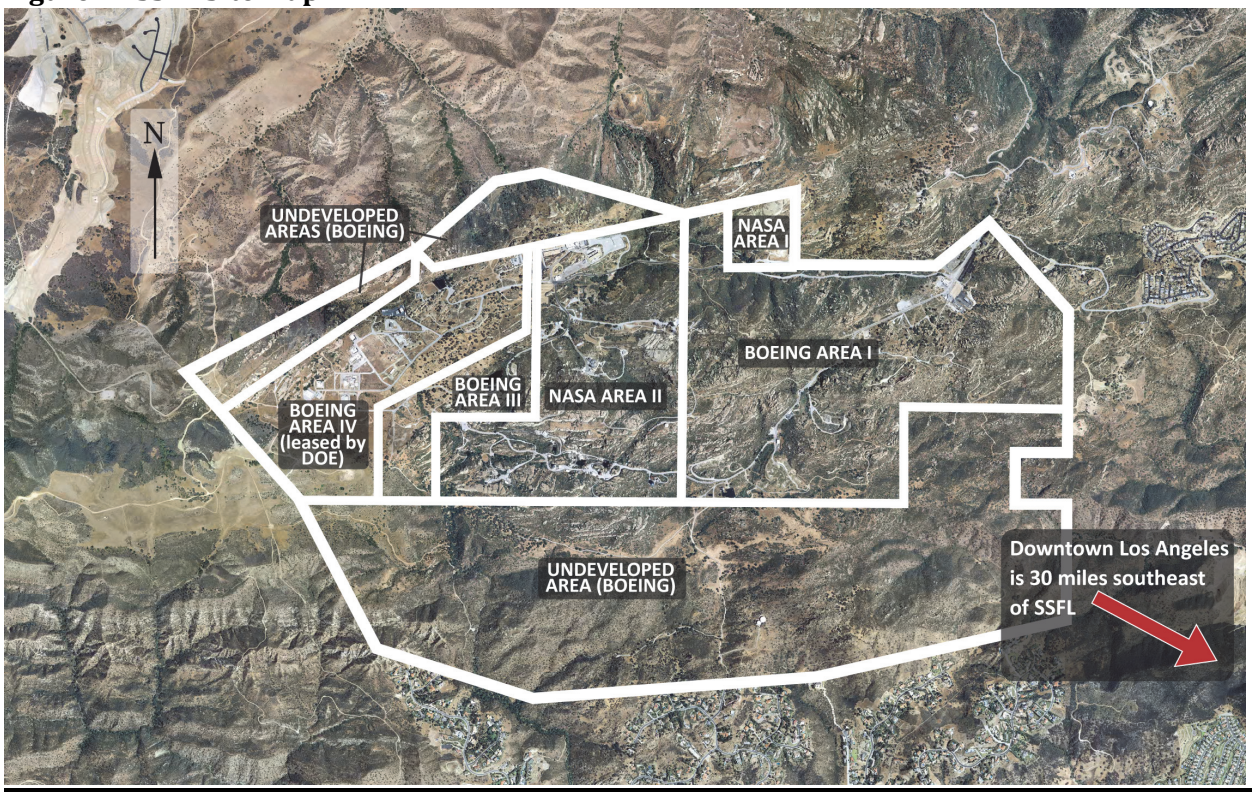
[4] Towards the end of our review, a major California wildfire known as the Woolsey Fire damaged almost 97,000 acres between the SSFL and the Pacific coastline. While a significant portion of NASA Area II was burned, the potential impact to the scope and schedule of cleanup activities in the NASA-administered areas has not been determined.

course of our audit work, we also examined the financial impact of the Agency's indecision on whether to preserve or demolish obsolete test stands at the site. See Appendix A for details of the audit's scope and methodology.

Background

SSFL is located on 2,850 acres of hilly terrain in the Simi Hills in California, nearly 30 miles northwest of downtown Los Angeles. The field laboratory is divided into four administrative areas, with undeveloped areas of land to the north and south (see Figure 1).

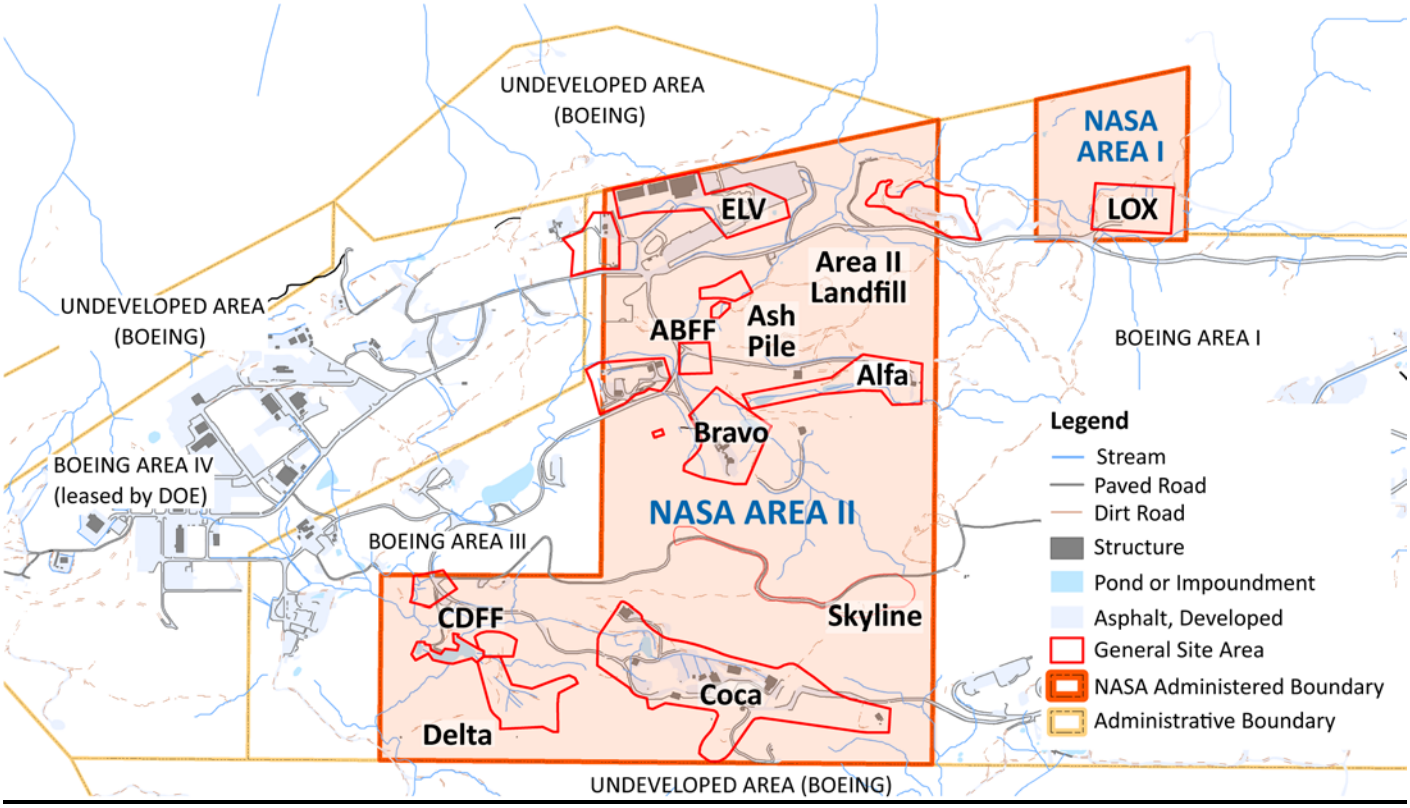
Figure 1: SSFL Site Map



Source: NASA Office of Inspector General (OIG) presentation of Santa Susana Field Laboratory information.

Most of Area I, all of Areas III and IV, and all of the undeveloped areas—amounting to 2,398.8 acres—are owned by Boeing. A small portion of Area I (41.7 acres) and all of Area II (409.5 acres) are owned by the U.S. Government and administered by NASA. DOE has long held a lease on Boeing-owned land in Area IV. Figure 2 depicts the NASA-administered areas of the site.

Figure 2: NASA Administrative Areas



Source: NASA OIG presentation of Santa Susana Field Laboratory information.

Notes: ABFF – Alfa/Bravo Fuel Farm; CDFF – Coca/Delta Fuel Farm; ELV – Expendable Launch Vehicle; LOX – Liquid Oxygen Plant. Alfa, Bravo, Coca, and Delta represent former test areas with infrastructure such as roads, storage tanks and test stands. General Site Area boundaries do not reflect the entire area requiring remediation.

From the mid-1950s until the mid-1990s, DOE and its predecessor agencies were involved in nuclear operations including the development, fabrication, disassembly, and examination of nuclear reactors, reactor fuel, and other radioactive materials.[5] A partial meltdown at one of its nuclear facilities in 1959 led to a release of radioactive contaminants.[6] Although radioactive contamination remains a concern on the DOE portion of SSFL, the primary contaminant in the NASA-administered areas is trichloroethylene, a nonflammable, colorless liquid characterized by the National Institutes of Health as a known human carcinogen. NASA and the Air Force used large quantities of trichloroethylene to clean rocket engines, and prior to the early 1960s when catch basins were installed at the test stands, allowed the substance to run freely onto the ground. Area II was used for research, development, and testing of rocket engines associated with the Mercury, Gemini, Apollo, and Space Shuttle Programs. Since its opening in 1948, officials estimate that 17,000 rocket engine tests have been conducted at SSFL, with the last engine testing occurring on the Alfa test stand in 2006.

[5] All nuclear research in Area IV ceased in 1988, when DOE shifted its focus from research to decontamination and decommissioning activities.

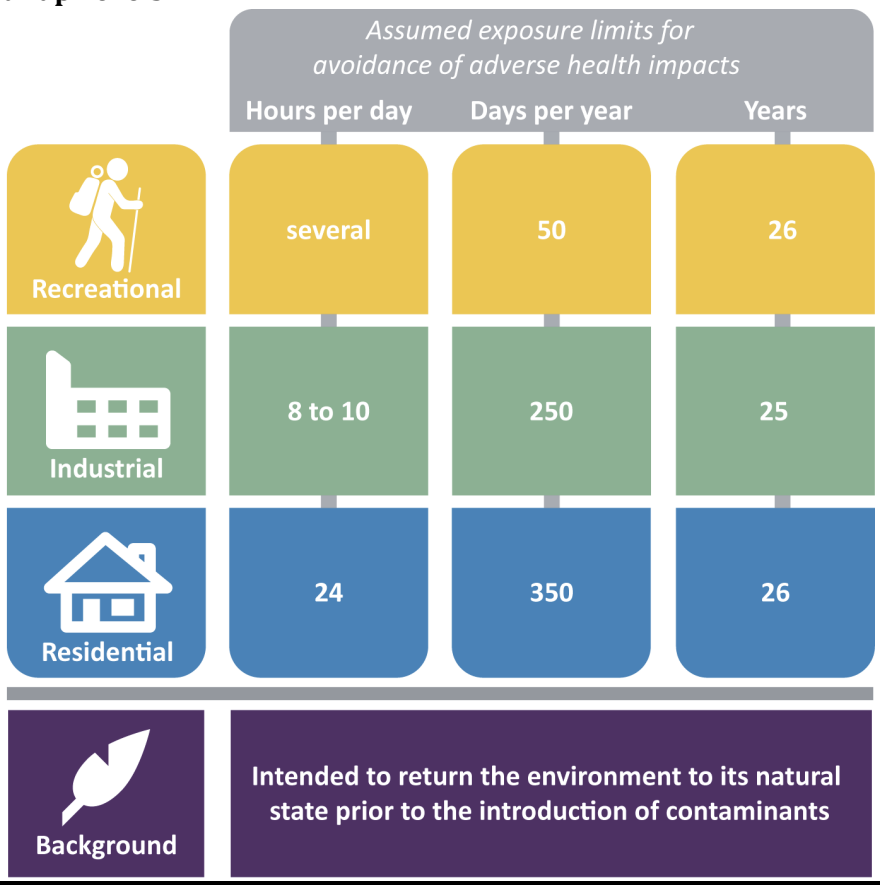
[6] The public was not informed of the partial meltdown of the nuclear reactor (known as the Sodium Reactor Experiment) until the early 1960s, leading to significant distrust between the local community and the government that continues to this day.

Since that time, all NASA related research and testing activities at SSFL have ceased and environmental cleanup activities—including demolition of obsolete buildings and supporting infrastructure like roads and parking lots—are underway. NASA, Boeing, and DOE are each responsible for cleanup of their respective areas, with California's DTSC overseeing the projects.[7] See Appendix B for more details on the site's history.

Agreements Governing Remediation

In August 2007, NASA, Boeing, and DOE signed a Consent Order for Corrective Action with DTSC under which the parties agreed to engage in a "risk-based" cleanup of SSFL groundwater and soil. The order required remediation of chemically contaminated soils no later than June 30, 2017. The degree of remediation would be determined by the risks to human health and the environment and would be tied to the expected future use of the land. For example, a site likely to be used for growing food would require a more extensive remediation than a site whose anticipated use was industrial; when cleanup was complete, higher concentrations of contaminants would be acceptable at a site slated for industrial use. Figure 3 depicts the various cleanup or remediation levels possible for a site like SSFL and the underlying assumptions associated with each level.

Figure 3: Cleanup Levels



Source: NASA SSFL Fact Sheet.

[7] DTSC employs over 900 scientists, engineers, toxicologists, chemists, geologists, attorneys, criminal investigators, and administrative staff with a mission to protect California's citizens and environment from harmful effects of toxic substances. DTSC had a budget of $292.9 million in 2018-2019.

Under this assessment process, the reasonably foreseeable future use of a site is determined by considering several factors including the current use of the land, general land use plans, topography and natural resources, cultural resources, and the presence of endangered species. This risk-based cleanup approach is the standard process for sites like SSFL under two federal statutes: the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).[8]

Two months after the 2007 consent order was signed, the California legislature enacted Senate Bill 990, which mandated soil cleanup at SSFL be "either suburban residential or rural residential (agricultural) whichever produces the lower permissible residual concentration for each contaminant."[9] In response to Senate Bill 990, Boeing filed a lawsuit in November 2009 alleging the legislation violated the Due Process and Equal Protection Clauses of the 14th Amendment to the U.S. Constitution by "irrationally and arbitrarily" singling out this one site for disparate treatment.[10] At the time, NASA officials contacted the Environmental Protection Agency (EPA) and Department of Justice (DOJ) regarding the enforceability of Senate Bill 990, but these agencies declined to intervene.

In April 2011, a California federal district court ruled in Boeing's favor that Senate Bill 990 violated the U.S. Constitution and in September 2014 the Ninth Circuit Court of Appeals upheld that ruling, finding that the legislation violated the doctrine of intergovernmental immunity because it regulated a federal agency's environmental cleanup "in direct violation of the Supremacy Clause" of the U.S. Constitution.[11] As a result, Boeing's soil cleanup is governed by the 2007 Consent Order, which uses the risk-based methodology that takes into account the expected future use of the land.

Meanwhile, in December 2010 while Boeing's challenge to Senate Bill 990 was pending in the courts, NASA and DOE entered into separate Administrative Order on Consent (AOC) agreements with DTSC that required soil cleanup at the site to be consistent with the Background standard, which is intended to return the environment to its natural state prior to the introduction of contaminants.[12] NASA also agreed that it would complete soil cleanup at SSFL by 2017. Pressure from members of California's congressional delegation (in particular former U.S. Senator Barbara Boxer) and state and local political officials played a significant role in NASA's decision to sign the AOC. The 2010 AOC governs NASA's soil

[8] Resource Conservation and Recovery Act of 1976, codified at 42 U.S.C. §6901 et seq. (1976); Comprehensive Environmental Response, Compensation, and Liability Act, codified at 42 U.S.C. §9601 et seq. (1980). CERCLA, also known as the "Superfund," addresses remediation at inactive and abandoned hazardous waste sites. The federal government controls cleanup of areas designated as Superfund sites. In addition, RCRA establishes an environmental corrective action program administered by the EPA and 43 states and territories to work with responsible facilities to investigate and clean up hazardous releases.

[9] At the time Senate Bill 990 was enacted, "Suburban Residential" referred to safe exposure levels for a residential or community neighborhood area and "Rural Residential" referred to safe exposure levels for an agricultural or farmland area where food is grown or livestock raised.

[10] Amended Complaint by Boeing, filed December 28, 2009 (U.S. District Court, Central District of California, Case No. CV 10-04839-JFW (MANx)).

[11] Boeing Co. v. Robinson, 2011 U.S. Dist. LEXIS 52507 (C.D. Cal. Apr. 26, 2011). Boeing Co. v. Movassaghi, 768 F.3d 832 (9th Cir. 2014). Under the Supremacy Clause, the activities of the federal government are free from regulation by any state. The doctrine of intergovernmental immunity is derived from the Supremacy Clause and prevents the federal and state governments from encroaching on one another's sovereignty. The Ninth Circuit found that Senate Bill 990 violated the doctrine of intergovernmental immunity because it regulated a federal agency's cleanup activities in a manner that "directly interferes" with the functions of the federal government.

[12] "Background" and "Rural Residential" referred to similar levels of cleanup at the time Senate Bill 990 was enacted.

cleanup responsibilities at SSFL, while the 2007 Consent Order governs groundwater cleanup using a risk-based methodology.

At NASA's insistence, the AOC included a provision requiring the Agency to "make its specific decisions on how to conduct the cleanup to background defined in this agreement in accordance with the requirements of the National Environmental Policy Act," including completion of an Environmental Impact Statement (EIS) for its planned cleanup activities at Santa Susana. As part of its outreach process to define the scope of the EIS, NASA initially identified five possible alternatives for remediation of the site, including cleaning to Residential and Recreational levels. However, NASA's inclusion of alternatives other than cleanup to Background levels caused concern among DTSC officials, California political leaders, and interest groups.

In March 2012, Senator Boxer sent a letter to the NASA Administrator citing NASA's commitment to "clean up the site to the conditions that existed prior to NASA's activities." Two months later, DTSC sent a letter to the NASA Administrator to request that "NASA modify its…process to align itself with…a cleanup of the site to background levels…in compliance with the AOC" rather than evaluate less stringent cleanup alternatives. At the same time, Senator Boxer asked the Council on Environmental Quality, a White House office that coordinates federal environmental efforts and works closely with agencies in the development of environmental policies, whether NASA was legally required to consider cleanup options other than Background level.[13] After the Council on Environmental Quality advised the Senator that there was no such requirement, NASA limited its EIS process to consideration of only one cleanup standard: Background.

In 2015, Boeing announced its plan to clean its portion of the SSFL to a Suburban Residential standard. However, in April 2017, Boeing—working with the North American Land Trust under California Civil Code section 815—obtained a conservation easement for its SSFL property that prohibits residential or agricultural development on the site in perpetuity.[14] Subsequently, Boeing announced plans to clean its SSFL site to the substantially less extensive Recreational level, given that the future use of the land cannot be residential or agricultural. As of October 2018, DTSC had not accepted Boeing's proposed recreational cleanup plans.[15] Nonetheless, despite Boeing's evolving cleanup plans, soil remediation activities by NASA and DOE continue to be bound by the Background cleanup levels agreed to in the 2010 AOC.

[13] The Council on Environmental Quality ensures federal agencies meet their obligations under the National Environmental Policy Act, which requires agencies to consider the environmental impacts of their actions and reasonable alternatives to those actions. The duties of the council include gathering information on conditions and trends in environmental quality; evaluating federal programs in light of the goals established in the act; developing and promoting national policies on environmental quality; and conducting studies, surveys, research, and analyses relating to ecosystems and environmental quality. The National Environmental Policy Act of 1969, as amended, codified at 42 U.S.C. §§ 4321-4347.

[14] The North American Land Trust is a nonprofit that partners with land owners to preserve and manage open space with ecological, agricultural, or historical significance.

[15] DTSC officials were careful to point out that the future use of the site has not formally been deemed recreational. Current zoning for the property is "OS-160" or open space with 160-acre minimum parcels. Open space zoning means the land could conceivably have many uses including agricultural (e.g., crops and orchards), animal keeping (e.g., horses or other equines), and residential (e.g., single and multi-family dwelling units). In addition, DTSC stated that Boeing will need to evaluate risk of cleaning to levels other than recreational.

Status of Cleanup Efforts

NASA's cleanup at SSFL will require three primary activities—demolition, groundwater cleanup, and soil cleanup. Once cleanup is complete, the General Services Administration (GSA) will attempt to transfer or sell the property. However, NASA will continue to retain control and must maintain the property until it is taken over by another federal, state, local, or private entity. As of December 2018, NASA had completed almost all planned demolition activities and had completed sampling, analyses, studies, and investigations pertaining to groundwater and soil cleanup.

Demolition

While awaiting DTSC approval to begin large-scale soil cleanup, NASA began demolition activities in early 2015 to prepare the site. Through 2017, contractors had removed "hard-scape" (e.g., walkways, retaining walls, and driveways), and buildings or structures consisting of approximately 14,700 tons of concrete, roughly 8,600 tons of asphalt, and nearly 3,600 tons of steel. NASA officials expect the Agency's four phases of demolition activity to be completed by May 2019.

- *Phase One (completed)*. Phase 1 involved approximately 45 acres in the northern-most part of Area II. Structures demolished in this area included former engineering offices, maintenance buildings, and the expendable launch vehicle final assembly building. Utility poles, piping, concrete, and roadways in this area were also removed. Phase 1 began in February 2015 and was completed in November 2015.
- *Phase Two (completed).* Phase 2 involved removing obsolete buildings and infrastructure across approximately 100 acres throughout Area II, excluding the test stands, in two sub-phases.[16] Phase 2-A consisted of removing water tanks and pipeline along Skyline Drive, the Alfa/Bravo and Coca/Delta Fuel Farms, the Sewage Treatment Plant, and the Liquid Oxygen Plant. Phase 2-B covered the former Delta Test Area. Phase 2 began in February 2016 and was completed in January 2018.
- *Phase Three (completed)*. Phase 3 involved removing ancillary structures and buildings across 200 acres in the Alfa, Bravo, and Coca Test Areas. No decision has been made about demolishing the six existing test stands and three control houses on the NASA property. Instead, demolition in these areas involved obsolete structures such as inactive storage tanks, asphalt parking lots, and abandoned office buildings. Similar to Phase 2, Phase 3 occurred in two sub-phases with Phase 3-A addressing the Alfa and Bravo Test Areas, while Phase 3-B consisted of the Coca Test Area. Phase 3 began in Summer 2017 and was completed in February 2019.
- *Phase Four (ongoing)*. Phase 4 began in Summer 2018 and involves demolishing the blast wall at the Bravo Test Area and remaining concrete in the former Liquid Oxygen Plant area. This phase is expected to be complete by May 2019.

[16] Test stands and control houses were excluded from demolition because the decision to preserve or demolish them has been deferred by NASA at the urging of several members of the California congressional delegation and local Indian tribes.

Groundwater Cleanup

Boeing owns and operates the SSFL groundwater treatment system that became operational in 2009.[17] The treatment system—which is an interim groundwater cleanup measure— is shared by Boeing and NASA. The system treats extracted groundwater both from NASA wells in Area II and Boeing wells in Area I and pumps it to a treatment facility in Boeing's Area I. The treatment facility was shut down in 2012 for maintenance and upgrades, and to enable NASA to complete its groundwater investigations to characterize the nature and extent of groundwater contamination at its sites, determine the groundwater flow direction and rate, and understand the behavior of groundwater flow with respect to bedrock faults and fractures.[18]

Per the 2007 Consent Order, NASA submitted its groundwater investigation reports in 2017 to help select the appropriate remediation technologies. While awaiting DTSC's concurrence, NASA published a separate National Environmental Policy Act Record of Decision for its proposed groundwater cleanup in October 2018 with remediation work anticipated to begin in 2020.[19] The active cleanup of groundwater could take up to 25 years with monitoring expected to continue for many years afterwards.[20]

Soil Cleanup

The 2010 AOC provides that the term Background level would be further defined by DTSC in a subsequent document called the Look Up Table (LUT), which it provisionally provided to NASA in June 2013.[21] The LUT contains values intended to represent the estimated levels for 130 chemicals in the soil before any industrial activities took place at SSFL. Chemical classes contained in the LUT include naturally occurring alcohols, anions, cyanide, dioxins, formaldehyde, metals, mercury, and perchlorate. See Appendix C for a full listing of the provisional LUT values.

Since August 2011, NASA has completed soil sampling, laboratory analyses, treatability studies, and pilot testing to prepare for its comprehensive soil cleanup. As part of the process, NASA examined soil at 15 sites within Area II and the former Liquid Oxygen Plant area and sent the results to the DTSC for

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[17] The groundwater treatment system is an interim action directed by DTSC until a final cleanup decision is made. NASA reimburses Boeing for the use of the company's treatment system. The system is capable of treating approximately 100 gallons of water per minute and removes chemicals like trichloroethylene (TCE) and 1,2-dichloroethylene (1,2-DCE).

[18] Just as groundwater generally moves slowly, so do many contaminants contained in the groundwater. Because of this slow movement, contaminants tend to remain concentrated in the form of a plume that flows along the same path as the groundwater. The size and speed of the plume depend on the amount and type of contaminant, its solubility and density, and the velocity of the surrounding groundwater. Data to date shows these plumes are in a steady state, indicating the contaminants are no longer migrating away from the source.

[19] A Record of Decision includes a summary of the National Environmental Policy Act process and Final Environmental Impact Statement, public involvement in the decision-making process, alternatives considered, key environmental issues evaluated, statement of the decision made, and the basis for the decision.

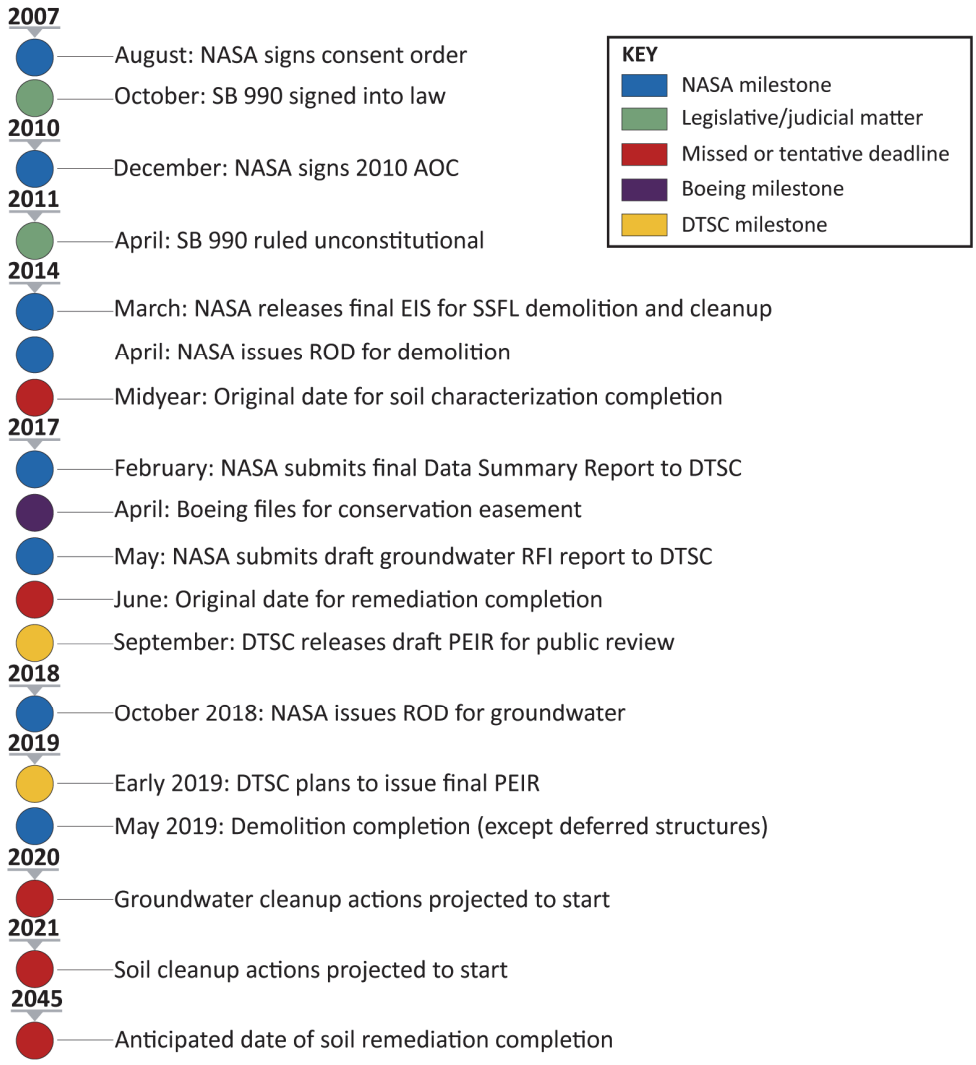
[20] As of August 2018, NASA estimated groundwater monitoring liability to be $848,817 per year.

[21] DTSC officials told us that the current LUT is provisional for soil investigation purposes, and a cleanup LUT would be provided at a later time. However, the June 2013 DTSC Technical Memorandum states, "The chemical Look-Up Table is not provisional because it provides analytical goals for multiple laboratories to report and use when establishing data quality objectives." As a result, NASA and DOE officials have been operating on the assumption that the values in this document are final since the tables were released in 2013. NASA has expressed concern over the stringency of the LUT values in meetings with the DTSC and more formally in comments on DTSC's Program Environmental Impact Report it issued in December 2017. Nonetheless, as of October 2018, DTSC had not communicated any revisions to the original LUT values.

approval in February 2017.[22] NASA is currently awaiting DTSC's response. To date, the Agency has taken several interim soil cleanup actions such as removing 3,000 cubic yards of mercury-contaminated soil, completing soil removal actions associated with the Northern Drainage area, and removing five underground storage tanks.

Figure 4 provides a timeline of events for SSFL cleanup activity since NASA signed the 2007 Consent Order.

Figure 4: SSFL Timeline of Events through Estimated Soil Cleanup End Date



Source: NASA OIG presentation of SSFL key events.
Note: EIS: Environmental Impact Statement; ROD: Record of Decision; RFI: Resource Conservation and Recovery Act Facility Investigation; PEIR: Program Environmental Impact Report.

[22] Results of the investigation were compiled in a Data Summary Report that summarizes the nature and extent of soil contamination at the 16 sites on NASA-administered property at SSFL. The data was compiled from 3,734 surface soil and 1,860 subsurface soil samples, 43 sediment samples, and 744 soil vapor samples dating from 1983 through 2014. In 2014, DTSC communicated to NASA that sufficient soil characterization sampling under the 2011-2014 Field Sampling Plans was performed to proceed to the Data Summary Report and commented in the 2016 Data Summary Report review that any additional NASA sampling may be performed during post-remediation confirmation sampling. DTSC officials said in order for NASA to move forward with its planned cleanup, NEPA, CEQA, and decision document milestones must be completed.

Woolsey Fire

In November 2018, the Woolsey Fire—a massive wildfire in southern California—burned across a significant portion of NASA's Area II and in total included almost 97,000 acres of the surrounding region. Media reports and community organizations raised questions at the time as to whether contaminants at the SSFL site were released into the air as a result of the fire. DTSC subsequently issued a statement reporting that its staff had assessed the situation in light of the wildfire and initial testing showed no radiation levels above background levels and no elevated levels of hazardous compounds other than those normally present after a wildfire. At the time this audit report was being finalized, additional investigations were ongoing.

Costs of NASA's Environmental Remediation Efforts

The Environmental Management Division (EMD) at NASA Headquarters manages the Agency's Environmental Compliance and Restoration (ECR) Program. EMD provides guidance on how to comply with federal, state, and local environmental laws and regulations, while ECR Program officials monitor and oversee Agency restoration and cleanup efforts.[23] To facilitate the budget planning and project management process, Agency officials gather information regarding funding requirements for environmental restoration projects into a database known as the NASA Environmental Tracking System (NETS). Officials also use NETS to estimate unfunded liabilities associated with environmental issues as part of NASA's annual financial statements.[24]

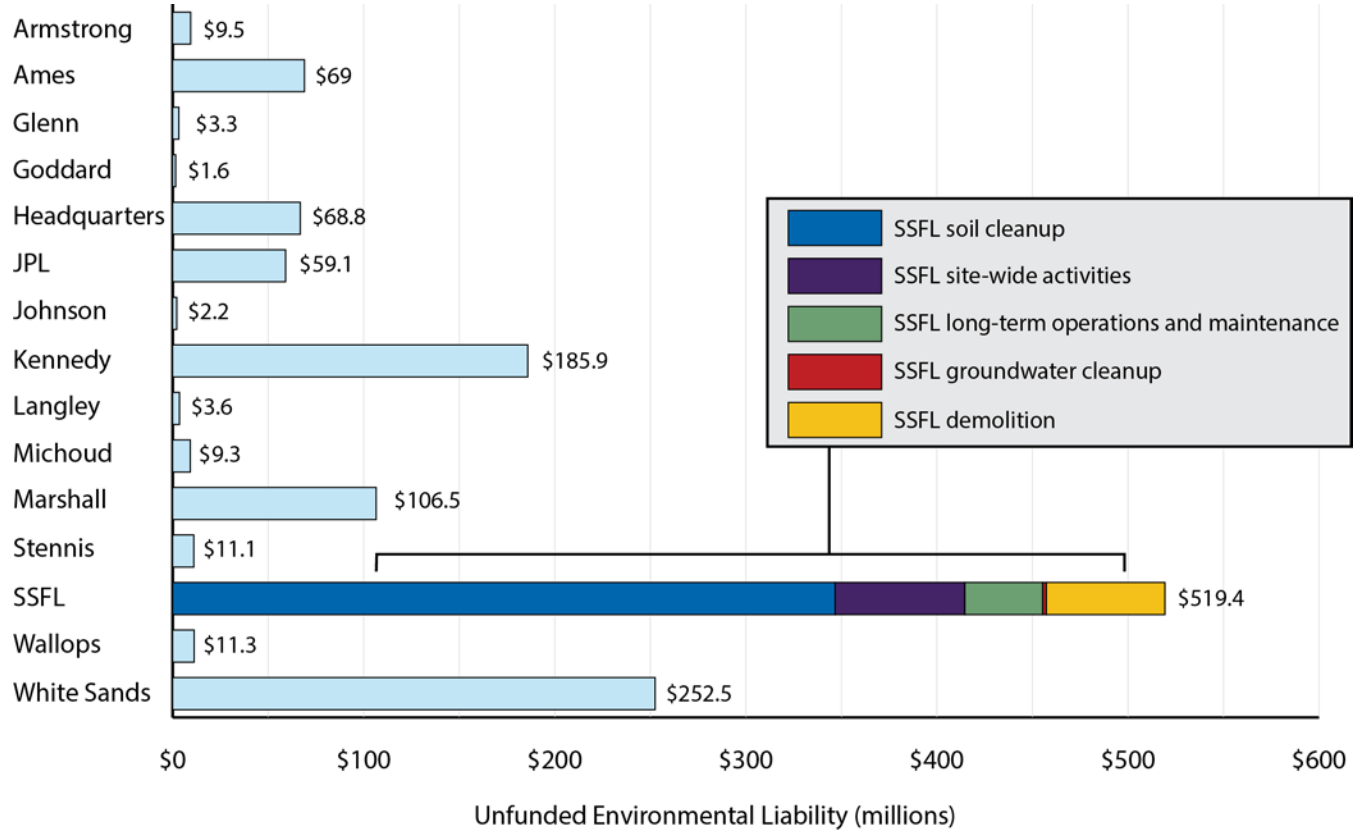
As of August 2018, NASA's total Agency-wide liability for environmental cleanup projects was $1.3 billion, of which 40 percent—$519.3 million—was estimated for SSFL.[25] Figure 5 compares the cleanup liability for SSFL to all other projects for which NASA is responsible. The SSFL soil cleanup estimate alone is nearly $100 million more than NASA's next most expensive project even though SSFL is not ranked as the Agency's highest cleanup priority. The remediation project to remove contaminants from drinking water used by communities surrounding the Jet Propulsion Laboratory is a higher environmental remediation priority than SSFL and is estimated to cost almost nine times less.

[23] NASA EMD, "Environmental Compliance and Restoration Program" 8590.1A, April 5, 2016.

[24] Unfunded environmental liabilities are the amounts estimated but not yet funded to clean up environmental sites and the associated cost of operations, maintenance, and monitoring expected to take place over a 30-year period.

[25] NASA recorded a total estimated liability of $1.425 billion—$113.6 million funded and $1.311 billion unfunded—for all restoration projects in its Fiscal Year 2018 Agency Financial Report.

Figure 5: Unfunded Environmental Liability Estimates for All NASA Sites



Source: NETS data query, August 2018.

Note: The estimate for Unfunded Environmental Liability for soil cleanup at SSFL is $346.7 million, an estimate that assumes excavation and offsite disposal of approximately 626,000 cubic yards of soil. As of August 2018, SSFL officials increased the amount of soil removal to 870,000 cubic yards resulting in an increase in the time required for soil cleanup from 15 to 25 years. In addition, the cost projection for soil cleanup increased to $555 million, a figure not finalized at the time of our review.

The cost of NASA's SSFL remediation is grouped into five separate projects: soil cleanup, site-wide activities, long-term operations and maintenance, groundwater cleanup, and demolition.

- *Soil Cleanup.* The total cost estimate for soil cleanup and associated long-term air monitoring as of fiscal year (FY) 2018 was $346.7 million, a figure representing 66 percent growth from the 2013 estimate of $209 million. Since that time, NASA has completed a series of soil investigations including sampling, laboratory analyses, treatability studies, and pilot testing in preparation for conducting comprehensive soil cleanup. The increase in cost is largely due to the increase in the number of cubic yards of soil to be removed in order to comply with DTSC requirements as mandated in the 2010 AOC.
- *Site-wide Activities.* The total cost estimate for site-wide activities on the NASA-administered areas of SSFL as of FY 2018 was $67.8 million. This includes project management, cultural and

natural resource management such as Native American Monitoring and archaeologist and biological support, and an average payment of $1.1 million per year to DTSC for oversight.[26]

- *Long-term Operations and Maintenance.* The long-term operations and maintenance cost estimate as of FY 2018 was $40.8 million and pertains primarily to groundwater monitoring over a 30-year period. Boeing and NASA completed the Groundwater Extraction and Treatment System upgrades in 2017. Work to characterize the nature and extent of contaminant releases in groundwater at the Area I Liquid Oxygen Plant and Area II was completed in spring 2018.
- *Groundwater Cleanup Costs.* The total cost estimate for groundwater cleanup as of FY 2018 was $2 million.[27] NASA completed its groundwater investigation in 2016 and submitted a draft site-wide RCRA Facility Investigation report to DTSC in May 2017. NASA is awaiting DTSC's approval.
- *Demolition Cleanup Costs.* The total cost estimate for demolition as of FY 2018 was $62 million. Demolition work is coordinated by the Army Corps of Engineers on a reimbursable basis using contractors who compete for the work.

DTSC Oversight Costs

Both the 2007 Consent Order and 2010 AOC require NASA to reimburse DTSC for costs associated with oversight and implementation of the agreements, such as reviewing and finalizing NASA's Data Summary Report, providing comments on the draft RCRA Facility Investigation Workplan, and addressing California Environmental Quality Act issues. Accordingly, NASA has paid DTSC $7.6 million since 2011, with $1.4 million paid in FY 2017. NASA officials said the amount paid to DTSC is higher than any other agreement associated with an Agency cleanup effort because of (1) closer scrutiny from DTSC upper management and a large number of DTSC personnel reviewing the information for SSFL due to the political sensitivity of the cleanup, (2) Boeing, DOE, and NASA paying DTSC to develop the Program Environmental Impact Report (PEIR), and (3) DTSC managing the groundwater cleanup at SSFL instead of the California Regional Water Quality Control Board, the more typical approach.[28] While these costs are expected to decrease as the cleanup progresses, NASA will continue to be responsible for paying for some level of oversight costs to DTSC until the cleanup effort at SSFL is complete.

[26] Per the 2007 Consent Order and 2010 AOC, NASA is required to reimburse DTSC for overseeing NASA's remediation efforts.

[27] This is the current estimate for groundwater cleanup at SSFL. However, due to continuing uncertainty, NASA is unable to provide an estimate for the total anticipated cost of groundwater cleanup.

[28] From 2011 to 2014, NASA and Boeing had an agreement in which Boeing paid DTSC and NASA reimbursed the company. Amounts from 2011 to 2014 are from the Boeing invoices, while amounts from 2015 to 2018 are drawn from NASA's financial system. The PEIR is a 1,100-page document developed by DTSC that explains the environmental impacts that could result from NASA, Boeing, and DOE cleanup activities at SSFL, and identifies alternatives to avoid or reduce those impacts. DTSC officials stated that since the contamination is a result of releases at a RCRA facility regulated by DTSC, DTSC is the recognized regulatory lead for groundwater cleanup, while the California Regional Water Quality Control Board regulates surface water discharges.

Biological and Cultural Considerations

Santa Susana is part of a vital habitat in the Simi Valley area, home to endangered and protected animals and plant life including the two-striped garter snake and Braunton's milk-vetch. In addition, Native American rock shelter caves containing prehistoric pictographs (rock art paintings) and petroglyphs (rock art that has been scored or incised into the rock surface)—some of which are on both the National and California registries of historic places—are scattered throughout the SSFL site.

Biological Considerations

SSFL includes some of last remaining large contiguous areas of open space in the Santa Monica and Santa Susana mountains and serves as a wildlife corridor to neighboring undeveloped areas surrounding the densely populated San Fernando Valley on the outskirts of Los Angeles. Among the wildlife at SSFL are mountain lions, bobcats, coyotes, deer, hawks, and bald and golden eagles. In addition, SSFL's oak woodlands and upland areas are home to many native plants and grasses. Figure 6 depicts the landscape of one portion of the SSFL. For a more detailed listing of endangered and threatened species at SSFL, see Appendix D.

Figure 6: SSFL Landscape—Former Delta Test Area

Source: NASA OIG, June 2018.

Cultural Considerations

Burro Flats Painted Cave, an archaeological site that features prehistoric Native American pictographs dating from at least 1200-1800 C.E., is located within the NASA-administered portion of SSFL. As such, several tribes have cited the importance of the SSFL archaeology to their heritage and culture including the Fernandeño, the Gabrieleño, the Kizh, and the Tataviam. However, the only federally recognized tribe asserting claim to the area is the Santa Ynez Band of Chumash Indians.[29] Accordingly, SSFL has received formal designation by the Santa Ynez Band of Chumash Indians as an Indian Sacred Site under Executive Order 13007.[30] However, no single federal authority requires preservation or protection of Indian sacred sites. Instead, a number of federal statutes and Executive Orders require consultation with tribes before making decisions that might affect Indian sacred sites.[31] Consequently, the Santa Ynez Band of Chumash Indians, NASA, the California State Historic Preservation Officer, and other interested parties collaborated to identify measures NASA could take to address potential adverse effects on historic cultural sites from demolition and cleanup activities at SSFL.[32]

[29] A federally recognized tribe is an American Indian or Alaska Native tribal entity having a government-to-government relationship with the United States eligible for funding and services from the Bureau of Indian Affairs. Furthermore, federally recognized tribes possess certain inherent rights of self-government (i.e., tribal sovereignty) and are entitled to receive federal benefits, services, and protections because of their special relationship with the United States. At present, 573 American Indian and Alaska Native tribes and villages are federally recognized.

[30] Indian Sacred Sites are defined in Executive Order 13007 as "any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian Tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the Tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

[31] The National Historic Preservation Act of 1966, as amended, requires federal agencies to take into account the effect of their actions on historic properties eligible for the National Register of Historic Places and give the Advisory Council on Historic Preservation the opportunity to comment. However, these considerations apply only to government actions affecting the property and not Boeing's use of the property.

[32] Representatives from the five tribes identified SSFL as a Traditional Cultural Property (TCP)—property eligible for inclusion in the National Register of Historic Places based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community—as well as a sacred site. Mitigation measures against adverse impacts to TCPs are codified in the 2014 Programmatic Agreement.

NASA Remains Committed to an Unnecessarily Costly and Possibly Unachievable Level of Cleanup at Santa Susana

When NASA signed the 2010 AOC, it agreed to clean the soil in its portion of SSFL to a Background level. In the intervening years, it has appeared increasingly likely that Boeing—the majority landowner at the site—will clean its soil to a Recreational level. Cleanup to a Background level is the costliest and most time-consuming remediation option, currently estimated to cost more than a half billion dollars and require approximately 25 years to complete. This is more than four times the approximately $124 million NASA estimates it would cost to clean the site to the Recreational level. As such we question a total of $377 million in funds that could be put to better use. Furthermore, soil cleanup to the level currently required in the AOC likely would be impracticable given the values in the LUT are inconsistent with guidance from California and federal agencies for comparable site remediation, and the fact it may prove impossible to find backfill soil that meets the LUT standards. In addition, DTSC selected an unconventional method of confirmation sampling, the process used to determine whether an entity responsible for cleanup has met its remediation requirements. Moreover, the significant difference in remediation levels between the NASA and Boeing sites makes little sense given the intertwined geography of the two properties that will lead to continuous cross-contamination between the Boeing and NASA sites. Finally, cleanup to Background levels will adversely impact the site's biological resources, which include several endangered and special status species as well as historic cultural resources such as the Burro Flats Painted Cave.

Cleaning Site to AOC Background Level Will Substantially Increase Costs and Time Required to Remediate Soil

NASA's Costs Have More than Doubled for the SSFL Cleanup

The soil cleanup level specified in the 2010 AOC is not based on the risks to human health and the environment associated with the expected future use of the SSFL land as is typical with cleanups conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). As noted in our 2013 report, due to political pressure and a Council on Environmental Quality legal interpretation, NASA did not consider alternative cleanup levels in its Environmental Impact Statement as is routine under CERCLA and RCRA.[33]

[33] An Environmental Impact Statement is a detailed evaluation of the agency's proposed environmental remediation plan and possible alternatives. The public, other federal agencies, and outside parties may provide input into its development and are afforded an opportunity to comment on the resulting document.

Instead, DTSC examined soil samples from pristine areas outside of SSFL boundaries they considered to be most like SSFL before the site became industrialized in order to inform the Look Up Table (LUT) values that would ultimately dictate the acceptable levels for 130 chemicals at the site.

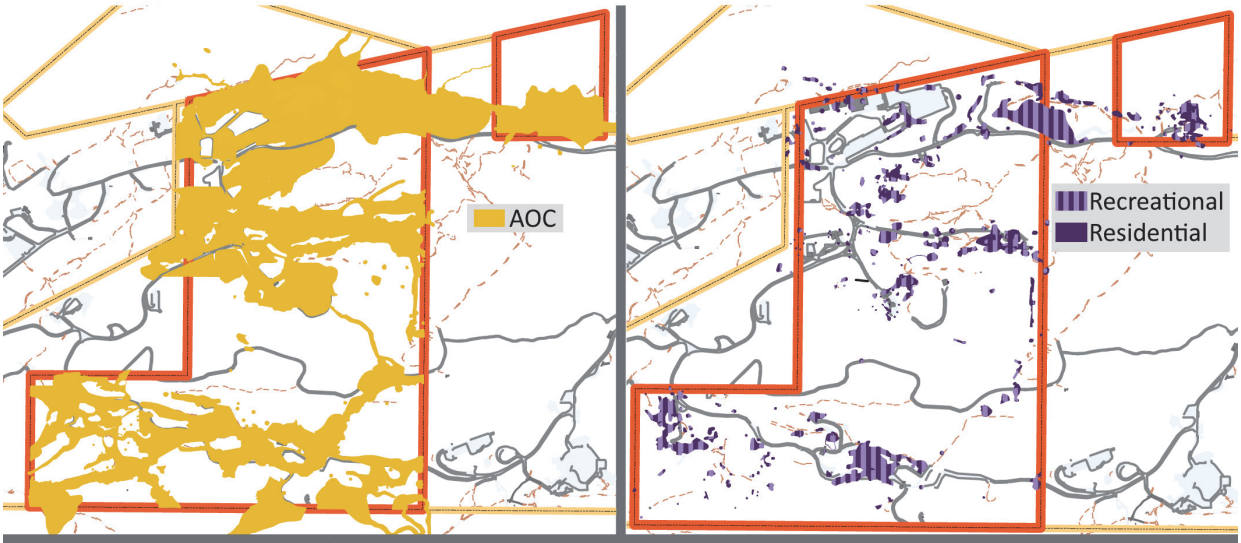
DTSC published the provisional LUT in 2013 and, according to NASA officials, its values were more stringent than expected.[34] Based on the LUT information and NASA's ongoing work to ready SSFL for remediation, the Agency projects the amount of soil to be removed from the NASA-administered sites at SSFL will increase from the 502,000 cubic yards estimated in 2013 to 870,000 cubic yards. These updates project an increase in soil cleanup costs by nearly $300 million—from an estimated $209 million in 2013 to more than $500 million in 2018. In its 2017 Draft Program Environmental Impact Report, DTSC estimated that total soil cleanup and restoration for all of SSFL—including backfill—would require 15 years to complete. NASA's current schedule indicates it could take up to 25 years: over 16 years for excavation and disposal of soil, and another 8 years for importation of backfill materials for its portion of SSFL alone.

As discussed earlier in this report, prior to NASA agreeing in the 2010 AOC to a Background cleanup level for soil, its cleanup plans tracked to the August 2007 Consent Order under which NASA, Boeing, and DOE agreed to a risk-based cleanup of groundwater and soil. Subsequently, California Senate Bill 990 required that SSFL soil be restored to either a Suburban Residential or a Rural Residential (agricultural) level, whichever would produce the lower permissible residual concentration for each contaminant.

In August 2018, NASA estimated it would cost $159 million and take 4.6 years to excavate and dispose of soil to meet the Suburban Residential level. NASA's current estimate for excavation and disposal of soil to meet the Recreational level of remediation is $124 million over 3.6 years. Figure 7 shows various levels of cleanup, the related costs, the amount of soil to be removed, and the timeframe for each potential cleanup option. The timeframes below are for soil removal only; additional time will be required for backfill upon completion of soil removal. Recreational level cleanup—the standard most in line with the future intended use of the Boeing property—involves the least amount of soil removed, as shown in light purple. Residential level cleanup (in dark purple) includes all recreational areas and adds other selected areas. An AOC-level cleanup includes all of the recreational and residential areas plus a much more extended area, as shown in orange.

[34] NASA officials told us the idea of cleanup to Background level in the AOC came from DOE and was the result of a misunderstanding. DOE suggested a Background level cleanup in order to expedite the risk assessment process. However, rather than applying EPA's standards for a risk-based Background level remediation, the DTSC employed a more complicated process for determining the LUT levels, resulting in unusually stringent cleanup standards. DTSC stated that the LUT was developed in accordance with the AOC and its associated Agreement in Principle, which requires a cleanup to Background levels.

Figure 7: Cleanup Levels and Associated Soil Removal, Cost Estimates, and Timeframe (as of August 2018)



	Volume (cubic yards)	Truckloads	Years[a]	Cost (millions)[b]
AOC Background	870,000	65,414	16.4	$501[c]
Suburban Residential	201,000	18,571	4.6	$159
Recreational	192,000	14,436	3.6	$124

Source: NASA OIG presentation of SSFL information.

[a] Estimates for number of years to complete soil removal are for excavation and disposal only, and do not include importation of backfill materials.

[b] Cost estimates pertain solely to soil remediation. These amounts do not include the cost to clean the groundwater or other activities required to complete the cleanup at SSFL.

[c] NASA's official estimate for Unfunded Environmental Liability for soil cleanup is $346.7 million—this assumes excavation and offsite disposal of approximately 626,000 cubic yards of soil. However, 2018 estimates indicated that strict AOC conformance will result in removal of approximately 870,000 cubic yards of soil, thereby increasing this estimate to $501 million. As of September 2018, NASA officials informally revised this estimate to $555 million, a figure not finalized at the time of our review.

While ultimate ownership and use of the 451.2 acres of NASA-administered land at SSFL post-cleanup will be determined through the GSA disposal process, NASA officials said they expect the Agency's portion will ultimately be used for recreation. Moreover, Boeing's 2017 conservation easement likely will have a significant impact on the future use of the entire SSFL site, including the NASA and DOE areas, because the company's land accounts for 84 percent of the 2,850 acres that make up SSFL.[35] Consequently, it is highly unlikely that the NASA property, which cannot be reached without driving through Boeing's land, ultimately will be used for any purpose other than recreation. As such, we question the Agency's plan to clean up soil to AOC Background levels, since a risk-based approach based on the future intended use of the land would likely require cleanup to the Recreational level. In the absence of renegotiating the terms of the 2010 AOC, NASA will spend a total of $377 million in unnecessary cleanup costs—funds that could be put to better use (see Appendix E).[36]

DTSC Schedule Estimates Are Overly Optimistic

In its Draft Program Environmental Impact Report, DTSC estimates that soil cleanup to AOC Background level will take 15 years. We find this estimate overly optimistic. Despite agreeing to a 2017 deadline to complete soil cleanup in the 2010 AOC, NASA has been unable to begin the cleanup in earnest due to the growing scope of work for site cleanup and DTSC delays in approving documents and work plans. For example, DTSC did not provide the provisional LUT values to the Agency until 2013—more than a year after NASA anticipated they would be made available. NASA officials also said they have been waiting 2 years for DTSC's feedback on NASA's Final Data Summary Report, a document summarizing the nature and extent of soil contamination within or emanating from NASA sites on SSFL. NASA officials expressed frustration with DTSC's lack of timeliness in reviewing documents required by the 2010 AOC. Ironically, the AOC contains a clause stating the DTSC "shall use its best efforts to review, comment, and render a decision on any work plan, report, specification, or schedule submitted by NASA in a timely fashion, with the goal of rendering a decision within 120 days of NASA's submittal."

DTSC officials we spoke with agreed that issuance of the Program Environmental Impact Report (PEIR)—which explains the environmental impacts that could result from NASA, Boeing, and DOE cleanup activities at SSFL, and identifies alternatives to avoid or reduce those impacts—has taken longer than expected, and admitted to lengthy delays in reviewing the Final Data Summary Report, citing internal and external challenges.[37] Internally, DTSC has been unable to fill key vacancies in its organization while externally, officials attributed their slow review process to shortcomings on NASA's part, such as incomplete analysis and missing or lack of detailed data. In addition, DTSC officials indicated that NASA's revisions and amendments to the Data Summary Report have also delayed approval.

NASA and contractor officials at the site estimate that cleanup to an AOC Background level will take at least 10 more years than DTSC's estimate of 15 years. For example, DTSC's 15-year estimate does not

[35] The conservation easement alone does not change the cleanup standard, but it does put restrictions on the future use of the land. Since Boeing did not sign the 2010 AOC, its soil cleanup falls under the 2007 Consent Order and is therefore risk-based premised on the future use of the land. As of December 2018, DTSC had not officially accepted Boeing's proposed recreational cleanup plans, likely due to the interest from local activist groups in the final outcome of all cleanup efforts at SSFL. DTSC officials told us that Boeing's formal soil cleanup goals have not yet been established and its cleanup cannot begin until DTSC's PEIR is certified.

[36] In our 2013 report, we questioned $184 million that could be put to better use—the difference between the AOC cost estimate at the time and the cost for cleanup to the Recreational level.

[37] Preparation of the 1,100-page PEIR is a significant undertaking by the DTSC that is required under the California Environmental Quality Act. Completion of the final PEIR must take place before final cleanup decisions can be made and the final LUT values can be determined.

take into account what is known as the "fluff factor" property of soil, where once soil is removed from the ground its volume increases by approximately 30 percent due to decreased density post-evacuation, thereby increasing the volume of soil that needs to be removed.[38] The officials explained that this is a well-known property of soil that DTSC should have included in its draft PEIR estimates. Furthermore, when calculating the number of truckloads required to transport soil off the premises, DTSC only took into account the amount of mass each truck can transport without accounting for volumetric constraints. Officials said this miscalculation could lead to a 30-40 percent reduction in the estimated amount of soil that can fit in a single truck, requiring 12 more truckloads a day than included in the current schedule assumptions. Moreover, DTSC assumed that each truck leaving the site with contaminated soil would return with "clean" backfill. However, NASA officials state this is simply not possible due to the amount of soil being removed and the lack of a site to store the "clean" soil while contaminated soil is excavated and removed. NASA estimates that completing the backfill alone will require roughly 8 additional years and 33,684 truckloads. DTSC has estimated soil remediation could be completed using 48 trucks a day—16 each for the NASA, DOE, and Boeing sites—but NASA officials believe that 36 trucks a day (12 for each responsible party) would be more realistic based on their experience with SSFL demolition activities to date.[39] DTSC officials told us it is possible that the cleanup may take longer than calculated in the PEIR, but said they still believe the effort to estimate the cleanup schedule was well-informed. Nevertheless, in our assessment these questionable assumptions increase the risk that soil cleanup will not be completed by the current estimated date of 2045.

Remediation to Background Level May Be Unachievable

AOC Background Cleanup May Be Unattainable as Currently Defined in LUT

The AOC requires soil on the NASA-administered portions of SSFL to be cleaned to local background levels or, when background values are not available, to laboratory reporting limits with the goal of ending up with soil free of contaminants that resulted from NASA activities.[40] The values in the LUT specify the maximum allowable presence of each chemical in the soil after remediation. To develop the provisional LUT, DTSC performed a chemical background study of the Chatsworth and Santa Susana geologic formations and developed a list of 130 chemicals with values based on either the background study or laboratory testing. NASA officials told us that the LUT values are significantly more stringent than EPA standards and soil cleanup values at other California remediation sites when considering risks to humans or the environment (see Table 1). Some LUT chemical limits range from approximately two times more conservative than a risk-based cleanup standard—for Lead, for example—to 6.5 million times more conservative, for polycyclic aromatic hydrocarbon (PAH) Anthracene. Moreover, the LUT levels, in some cases, are lower than the naturally occurring levels of the chemicals in the soil. According to NASA officials, the presence of some naturally occurring chemicals has no harmful effects on humans or the environment. Agency officials also said one of the reasons the LUT values are so stringent is because the AOC was drafted, in part, in response to local community mistrust stemming from anger over DOE's partial nuclear meltdown at the site.

[38] The loss of natural compaction increases the volume of the soil.

[39] In Appendix J of the Draft PEIR, DTSC estimated 48 trucks per day for soil removal for years 1–2, 67 trucks a day for years 3–4, 51 trucks a day for years 5–10, and 27 trucks a day for years 11–15.

[40] The laboratory method reporting limit is the minimum level that an analytical instrument can report and provide a reliable result.

Table 1: AOC LUT Values Compared with Standard EPA/California Cleanup Values

Component	AOC LUT	EPA Screening Level	California Human Health Screening Level	California Regional Water Quality Control Board	Units
Polycyclic aromatic hydrocarbons (PAH)	4.47	110	33	16	ug/kg
Total petroleum hydrocarbons (TPH)	5	82	NA [a]	1,000	mg/kg
Dioxin	0.912	4.8	4.6	4.9	pg/g
Antimony	0.86	31	30	31	mg/kg
Silver	0.2	390	380	390	mg/kg
Cadmium	0.7	71	1.7	39	mg/kg
Acetone	20	61,000,000	NA [a]	500	ug/kg

Source: NASA.

Note: kg – kilogram; mg – milligram; pg – picogram; ug – microgram

[a] The California Human Health Screening Levels table does not provide TPH or acetone screening criteria.

Furthermore, NASA officials noted that it will be nearly impossible to find suitable soil to replace the soil hauled away because the only backfill that satisfies the LUT values is sand or gravel. In fact, when searching for a source of backfill soil to meet the LUT requirements, DOE officials found that soil purchased from two local home improvement stores exceeded the LUT levels for total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, pesticides, and herbicides. When asked, DTSC told us that although they remain committed to the terms of the 2010 AOC, they plan to continue working with NASA to locate soil sources that meet the LUT requirements.[41] DTSC officials also said they will work with NASA to explore alternative measures—such as cleaning some of the soil on-site—to minimize the need for post-remediation soil backfill at the NASA SSFL sites. Moreover, DTSC emphasized that final soil chemical LUT concentrations for the NASA cleanup have not yet been developed and the provisional values could change. However, NASA officials said the "provisional" LUT values issued in 2013 are all they have to work with at this time, forcing the Agency to continue working under the assumption that those levels will remain the same until DTSC communicates otherwise.

NASA has also identified issues with DTSC's methodology for confirmation sampling, the process used to determine whether an entity responsible for cleanup has met its remediation requirements. The 2010 AOC states that if during site survey efforts or during confirmatory sampling the level of any component detected in a soil sample is above local background levels, additional "step-out" samples will be taken to delineate the contamination so additional soil can be removed; soil above local background will not be averaged with other soil.[42] NASA's comments to DTSC's Draft PEIR state that this method of confirmation sampling "is so unconventional that the endpoint of the cleanup may never be

[41] Specifically, DTSC officials told us that if an onsite or offsite source of backfill soil that meets all LUT values cannot be found, then DTSC, DOE, and EPA would enter into a consultation process with DTSC determining the best available source of backfill.

[42] Step-out sampling is the practice of taking a step in all directions of the area in which a sample exceeds the standard and continuing to take additional samples and steps away from the initial sample location until no more contamination is found.

achievable."[43] The Agency also noted that naturally occurring chemicals such as dioxins resulting from wildfires will mean that certain chemicals present in the soil will "consistently exceed LUT tables." This point became even more pressing when a November 2018 wildfire damaged significant portions of SSFL. NASA officials told us that the burned area included sections of Area II that previously were not considered to contain contaminated soil and thus required no cleanup. However, as a result of the fire the LUT value for dioxins would likely be exceeded in those areas, according to NASA officials.[44]

DTSC officials told us they do not agree with NASA's conclusion that the AOC requirements for confirmation sampling will necessarily prevent an achievable cleanup because the final LUT values have not been developed by DTSC. DTSC also believes that many of the technical challenges involved in meeting the AOC requirements may be addressed (1) when NASA and DTSC develop the post-remediation soil sampling plans in conjunction with the Soil Remedial Action Implementation Plans, and (2) when the actual soil confirmation program begins and field experience can be used to guide and adapt sampling strategies.[45]

As part of the cleanup, the replacement soil, sand, or gravel planned for backfill at the site will be hydroseeded, a technique that distributes seed in a stream of water propelled through a hose. However, U.S. Fish and Wildlife Service (USFWS) officials told us that hydroseeding at SSFL has a low probability of success because of the large amount of maintenance required for at least the first five years, such as watering, irrigation, and weeding to keep out invasive weeds and grasses—maintenance that NASA currently does not plan to do. In addition, USFWS officials said hydroseeding alone will not be sufficient to establish a functioning ecosystem similar to the one that existed prior to soil removal, and should be paired with installation of mature plants, which NASA officials confirmed is also not part of their restoration plans.

Recontamination from the Surrounding Boeing Property Could Nullify NASA's Cleanup Efforts

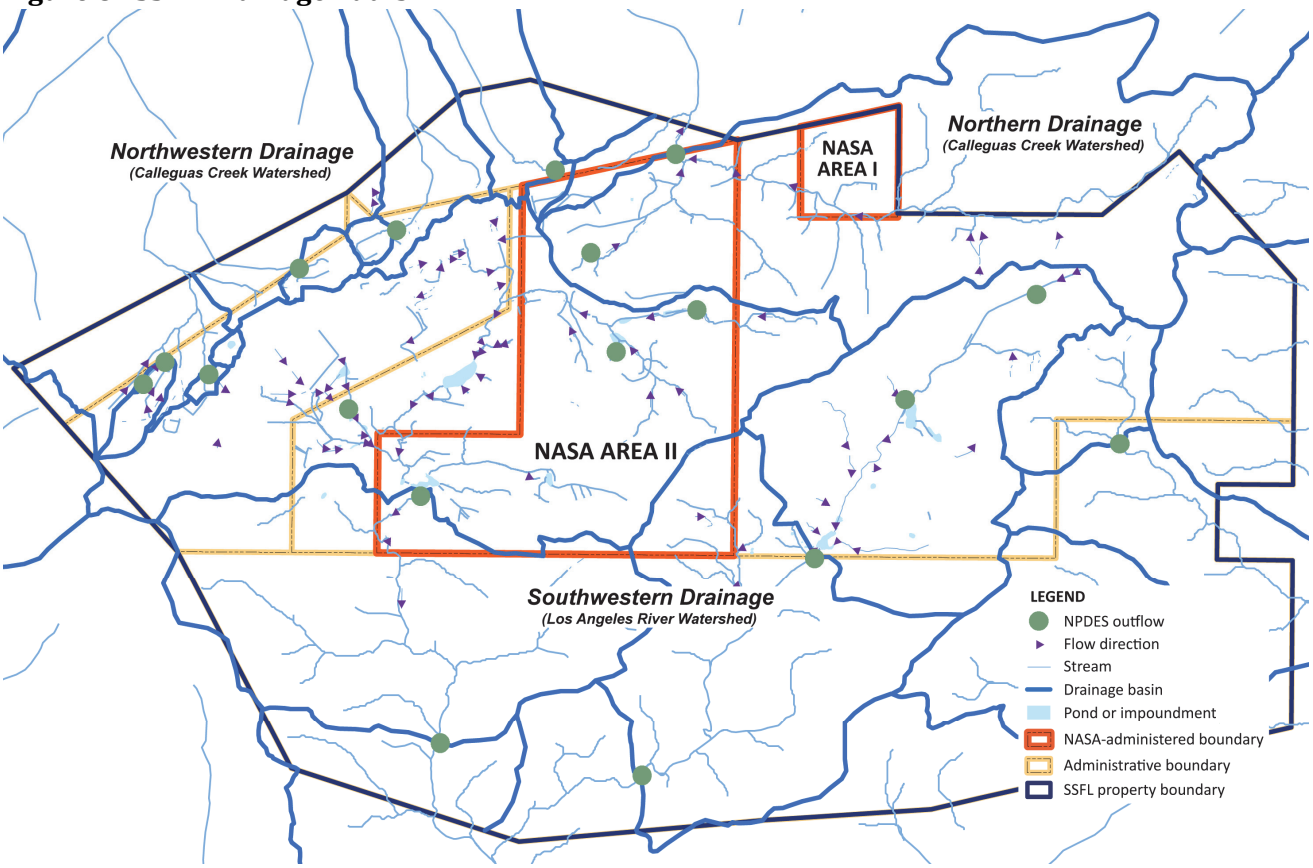
The differing standards for soil remediation between Boeing and NASA create a strong likelihood of contamination between the adjacent properties. As of December 2018, DTSC has not accepted Boeing's plans to clean the soil on its property to the Recreational level. However, this level allows for a far greater presence of chemicals in the soil than the AOC Background level standard currently in place for the NASA site. Agency officials said recontamination is an issue because NASA and Boeing property drainage paths extend into each other's property. For example, Figure 8 illustrates how water flows freely across administrative boundaries in the Northern Drainage area, which includes all of NASA Area I and northern portions of NASA Area II and Boeing Area I. As such, after remediation of both properties is complete, run-off from Boeing's property may pose a risk of recontamination to NASA-administered property. If this recontamination were to occur, NASA will no longer meet the cleanup standards set forth in the AOC and will be responsible for additional cleanup costs. DTSC officials told us cross-boundary issues will be addressed during cleanup implementation, planning, and construction.

[43] NASA officials explained that the reason this method of soil sampling is unconventional is because sampling results are typically averaged within an exposure area rather than comparing the result from each individual sample to a LUT value.

[44] DTSC officials noted that the soil background study was designed to statistically determine background concentrations of chemicals and radionuclides for SSFL by evaluating the same geologic formations found on the site that have not been impacted. Like SSFL, the background study area has encountered wildfires, so fire-generated chemical signatures should be consistent across the different areas.

[45] NASA's development of the Soil Remedial Action Implementation Plans commences as soon as DTSC issues the final PEIR.

Figure 8: SSFL Drainage Paths



Source: NASA Environmental Impact Statement, 2014.

Note: The National Pollutant Discharge Elimination System (NPDES) permit program, created in 1972 by the Clean Water Act, helps address water pollution by regulating point sources that discharge pollutants to waters of the United States.

AOC Background Cleanup Requirement Would Be Harmful to Biological and Cultural Resources

Biological Resources

NASA surveys in 2010 and 2011 identified 74 plant species on Agency-administered land at SSFL including the Santa Susana tarplant, which is listed as a threatened species by the California Department of Fish and Game.[46] The wildlife inventory listed 60 birds, 15 mammals, 11 reptiles and amphibians, and 11 butterflies.[47] The federally listed (Endangered) Least Bell's vireo, and the state-listed Loggerhead shrike and Two-Striped garter snake were among the species observed on NASA-administered property.[48]

Least Bell's Vireo

Source: Steven Mlodinow.

NASA's analysis comparing various cleanup scenarios found that if the site is remediated to the Background level, the ecosystem may never fully recover to its current state, and large areas of habitat will be destroyed.[49] According to NASA, a risk-based recreational cleanup level would result in better preservation of the habitats on which endangered and threatened species depend. Moreover, no negative impacts on the site's plants and animals have been cited due to the existing level of contamination at SSFL.

NASA identified a series of environmental concerns with the AOC Background level cleanup, including:[50]

- An adverse impact expected on Braunton's milk-vetch (an herb native to California) and other special status species;

[46] Habitat surveys of the NASA-administered property conducted in 2010 identified eight natural terrestrial habitat types and two aquatic habitat types. Two of the habitats—the southern willow scrub and Venturan coastal sage scrub—are considered sensitive by the California Department of Fish and Game.

[47] See Appendix D for more information on the threatened or endangered species of plants and animals found at SSFL.

[48] The 2010 AOC provides for exceptions under the Endangered Species Act of 1973 (ESA; 16 U.S.C. § 1531 et seq.) The purpose of the act is to protect and recover imperiled species and the ecosystems upon which they depend. Under the Endangered Species Act, species may be listed as either endangered or threatened. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future.

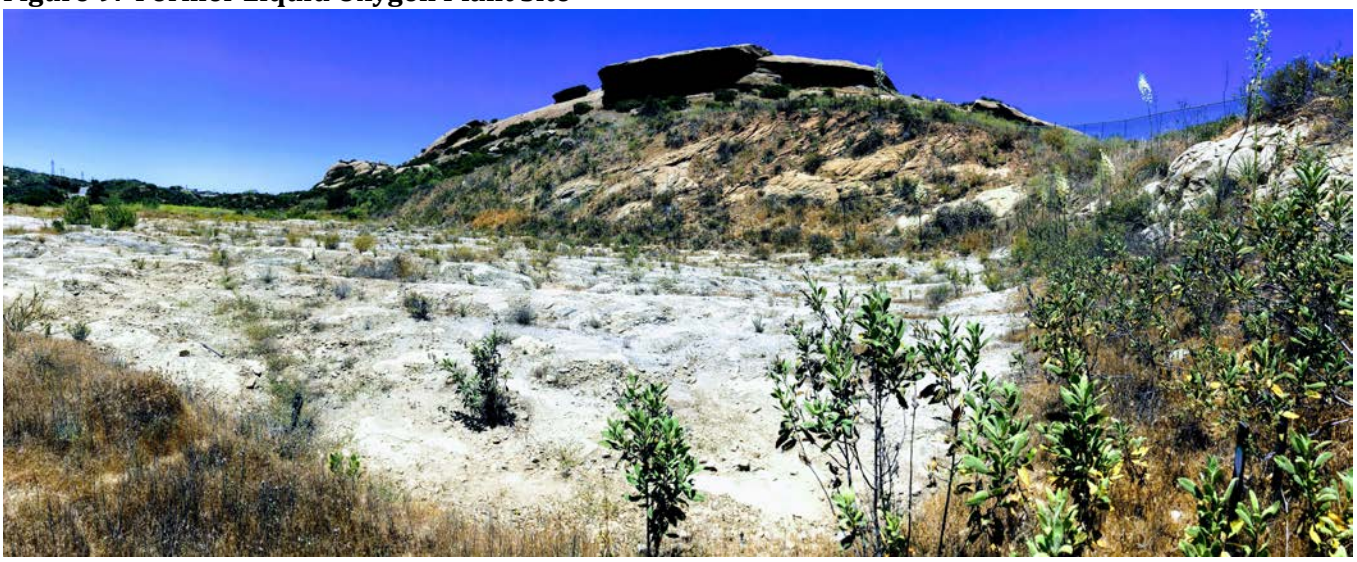
[49] "Comparative Analysis of Background versus Risk-based Cleanup Scenarios for the Soils at Santa Susana Field Laboratory, Ventura County, California," prepared for National Aeronautics and Space Administration, George C. Marshall Space Flight Center by NASA contractor CH2M Hill, March 2014.

[50] The Agency's concerns have been communicated in multiple documents, including NASA's Record of Decision Environmental Impact Statement (EIS) for Proposed Demolition and Environmental Cleanup Activities at Santa Susana Field Laboratory in California (April 2014), and in NASA comments to the DTSC's draft PEIR (January 2018).

- Reasonably foreseeable accidents during remediation that could impact the local habitats such as disturbance of wildlife nesting on test stands;
- Excavation of surface soils on more than 39 acres of native habitat with the potential to permanently destroy the existing micro-ecosystems;
- Soil instability resulting from the extensive level of excavation necessary to meet AOC standards which could result in increased landslide potential, decreased vegetative biodiversity, and increased spread of invasive weeds; and
- Impacts to air quality resulting from the over 100,000 truckloads of soil and debris required to be transported.

In an effort to understand how a cleanup to AOC Background levels would affect biological resources at SSFL, in 2012 NASA performed initial remediation activities on almost 2 acres of land, removing 6,434 cubic yards of soil on the site where the Liquid Oxygen Plant was previously located (see Figure 9). The remediated, bare area in the middle of the picture shows the impact of the Background-level soil cleanup compared to adjoining non-treated land.

Figure 9: Former Liquid Oxygen Plant Site



Source: NASA OIG, June 2018.

Cultural Resources

The NASA-administered portion of SSFL encompasses archaeological remains and landscapes, structures, and natural features of historic significance to Native Americans. Several tribes observe the summer and winter solstices with ceremonies at the Burro Flats Painted Cave (see Figure 10). In addition, the federally recognized Santa Ynez Band of Chumash Indians has formally designated SSFL as an Indian Sacred Site under Executive Order 13007, a designation that requires NASA to take into account the effects of any planned remediation on the property. Tribal representatives have pressed NASA to push for AOC exemptions to the cleanup requirements for areas—such as the painted cave—where contaminants do not pose a risk to human health or the environment.

Figure 10: Burro Flats Painted Cave

Source: NASA OIG, June 2018.

DTSC's draft Program Environmental Impact Report (PEIR) indicates exceptions to the Background level cleanup may be made if DTSC determines the proposed cleanup would impact cultural resources in a way that would be "significant and unavoidable." However, NASA officials said they are unaware how or if DTSC intends to exercise these exceptions. In its comments to the draft PEIR, NASA stated that the Background level cleanup would have adverse effects on archaeological sites qualifying as historical resources or unique archaeological resources and an adverse effect on tribal cultural artifacts. NASA has also stated that mitigation measures proposed by DTSC "would do irreparable harm to cultural resources." Furthermore, if a burial site is discovered on NASA's SSFL property after remediation activities begin, several laws, including the Native American Graves Protection and Repatriation Act and the Archaeological Resources Protection Act, could result in suspension of all soil remediation work within 30 meters of the discovery.[51] DTSC officials told us they will make exceptions to the cleanup protocols in biologically or culturally significant areas, as necessary, in accordance with local, state and federal laws and regulations, noting that the AOC cannot supersede those laws and regulations.

NASA's Options for a More Achievable Cleanup Strategy

Revision of the AOC

DTSC is scheduled to publish the final LUT values after the PEIR is finalized in early 2019. A modification of less than a dozen LUT values—including polycyclic aromatic hydrocarbons (PAH) and dioxins—would have a significant impact on the scope of soil cleanup required at SSFL.[52] If NASA and DTSC cannot agree to reform the current AOC to develop a more achievable soil remediation strategy, NASA could trigger the dispute resolution clause in the AOC, which begins with informal meetings between NASA and DTSC Project Directors and, if unsuccessful, escalates to NASA filing a formal objection with DTSC that results

[51] 25 U.S.C. § 3001-3013, 18 U.S.C.§1170, Native American Graves Protection and Repatriation Act; 16 U.S.C. §470aa-470mm, Archaeological Resources Protection Act.

[52] Dioxins—a naturally occurring component found in soil after fires, including camp fires and wildfires—have an AOC LUT limit 5 times lower than a risk-based limit, while PAH Anthracene, a green oil derived from coal-tar, has an AOC LUT more than 6.5 million times lower. Some dioxin contamination, such as the ash pile at SSFL, is a direct result of NASA operation at SSFL. Likewise, PAH contamination results from vehicles burning gasoline, and thus is also a product of NASA activity.

in formal discussions between the two agencies.[53] The Secretary of the California Environmental Protection Agency would then provide NASA a written decision on the dispute. NASA can challenge the Secretary's decision in federal court or, alternatively, DTSC can file a civil action seeking enforcement of the agreement.

In addition to the potential for revising the AOC using its dispute resolution process, NASA may have legal remedies available outside the agreement. The AOC contains strong language which, on its face, seems to greatly limit NASA's ability to question or challenge the enforceability of the cleanup requirements set forth in the AOC, regardless of any change in circumstances whether foreseen or unforeseeable.[54] Nevertheless, we believe the AOC may be open to legal challenge because its primary purpose was to enforce NASA's compliance with legal obligations under SB 990—a bill deemed unconstitutional by a federal appeals court in 2014. Paragraph 1.5 of the AOC states, in part, that:

> DTSC agrees that compliance with this Order and the 2007 Order shall constitute NASA's full and complete compliance with all applicable provisions of […] the California Hazardous Waste Control Law […] and the California Hazardous Substances Account Act […] including specifically, but not limited to, California Senate Bill 990 (Stats. 2007, c. 729), which has been codified as Section 25359.20 of the California Health and Safety Code […].

However, as a result of the 2014 decision of the U.S. Court of Appeals for the Ninth Circuit in the Boeing litigation, NASA has no continuing legal obligations under SB 990.[55] Since the AOC is predicated on the assumption, shared by both NASA and DTSC at the time, that the requirements of SB 990 were enforceable against NASA, the court's ruling striking down the law raises questions about the enforceability of the AOC under common law contract principles.[56]

Prospects for EPA and DOJ Support

Large environmental cleanup projects involving federal agencies typically fall under the purview of the EPA and are included on the National Priorities List, also known as the Superfund, with their remediation governed by CERCLA. However, in 2009 the California state government objected to an EPA proposal to designate SSFL as a Superfund site because, in the state's view, federal cleanup standards were not sufficiently stringent. EPA acquiesced, and SSFL cleanup is proceeding under California laws and

[53] In November 2018, DOE issued its Final EIS for remediation of SSFL Area IV and the Northern Buffer Zone. DOE's preferred alternative for soil remediation is the "Conservation of Natural Resources, Open Space Scenario" which uses a risk assessment approach that is protective of human health and the environment rather than LUT values, an approach typically used at other DOE sites, other DTSC regulated sites, and EPA CERCLA sites. The approach also is consistent with the process being used by Boeing for the land it owns at SSFL.

[54] Paragraph 5.19.8 of the AOC includes the following: "NASA agrees solely for purposes of any potential enforcement of [the AOC], and for no other purposes, that NASA shall not contest DTSC's allegation that the standards and requirements in [the AOC] are no more stringent than the standards and requirements that would be applicable to a similar facility by a private party."

[55] Boeing Co. v. Movassaghi, 768 F.3d 832 (9th Cir. 2014).

[56] A comprehensive listing of potential contractual remedies available to NASA is beyond the scope of this report. However, an example of one remedy could include the Restatement 2d of Contracts (1981), at § 152, which sets forth the principle of "mistake" in contract law as follows: "Where a mistake of both parties at the time a contract was made as to a basic assumption on which the contract was made has a material effect on the agreed exchange of performances, the contract is voidable by the adversely affected party unless he bears the risk of the mistake […]."

regulations.[57] EPA officials we spoke with said that they do not intend to designate SSFL a Superfund site unless requested by California.[58]

As noted in our 2013 report, several NASA officials expressed reservations in 2010 about signing the AOC. In fact, Agency officials met with representatives of the DOJ prior to signing the AOC to express concerns, but NASA officials said DOJ was unwilling to intervene on NASA's behalf at the time. Since signing the AOC, NASA officials have been in intermittent contact with DOJ to discuss potential adjustments to the agreement. We discussed with DOJ possible options for NASA, given that SB 990—which tracks to the AOC's cleanup requirements—was deemed unconstitutional by a federal appellate court. The DOJ officials we spoke with stated they see no obstacle to NASA going back to California to seek modifications to the AOC based on the court's ruling on Senate Bill 990, or based on budgetary, environmental, or practical concerns associated with the proposed soil removal plan.

[57] EPA officials told us it is possible for states to require more stringent cleanup standards and that it would consider the state's recommendation if the requirements were more stringent than the EPA's.

[58] SSFL cannot be put on the National Priorities List without California's concurrence.

DELAYING TEST STAND DEMOLITION UNTIL COMPLETION OF SOIL CLEANUP WILL RESULT IN ADDITIONAL COSTS

At the urging of several members of the California congressional delegation, NASA has delayed its decision on whether to demolish or preserve the 6 remaining test stands and 3 control houses at SSFL until soil cleanup is complete. By delaying this decision until as late as 2045, the Agency could potentially spend an additional $18.7 million for demolition or $17.2 million for preservation based on inflation alone—funds we believe could be put to better use if NASA made a more timely decision. In addition, the deteriorating physical condition of this infrastructure will increase the costs of future conservation efforts and represents a liability to the Agency as NASA seeks to clean up the site and prepare the property to be transferred or sold by GSA.

Preservation and Demolition Costs

In April 2014, NASA issued a Programmatic Agreement signed with the California State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the Santa Ynez Band of the Chumash Indians that details measures NASA plans to take to protect and preserve cultural resources during cleanup at SSFL. The agreement—the result of two years of consultation with more than 35 parties regarding disposition of historic properties resulting from proposed demolition and cleanup—provides for preservation of test stands through photograph and video documentation and the potential retention of at least one test stand and control house in either the Alfa or Bravo areas of the site. In April 2015, the Santa Ynez Band of Chumash Indians submitted a letter to NASA requesting support for their proposal to designate the SSFL a national monument under the Antiquities Act of 1906. In addition, the letter requested that any demolition of the rocket test stands, especially Coca, be deferred for as long as possible to maximize the chances of monument designation (see Figure 11).[59] In March 2017, NASA received a letter from a bipartisan California congressional delegation urging the Agency to protect the "historic" test stands. In response, NASA has deferred demolition of all test stands and their associated control houses unless they pose a risk to safety, human health, or the environment until remediation of the soil at SSFL is complete.

[59] According to NASA officials, the effort to declare SSFL a National Monument stalled out after the change in Administration in January 2017.

Figure 11: Coca Test Stand Area

Source: NASA OIG, June 2018.

Under its current timetable, NASA may not complete soil remediation until 2045. Deferment of preservation or demolition of the test stands and control houses until that time would result in additional costs of $17.2 million or $18.7 million, respectively.[60] The current estimated cost to preserve the 6 test stands and 3 control houses by stripping, repainting, and securing the structures is $19.6 million.[61] Once preserved, the total annual maintenance costs for the tests stands and control houses are estimated at $34,500 per year. In comparison, current demolition costs for the test stands and control houses is $21.4 million. Table 2 shows the estimated costs to preserve or demolish the test stands and control houses in FY 2018 and FY 2045 dollars, accounting for inflation. Moreover, preservation costs will likely rise as the structures continue to degrade over the next 25 years.

[60] The estimate for demolition assumes NASA will preserve the control house (Building No. 2208) and test stand No. 1 (structure No. 2727) at the Alfa site. The preservation estimate assumes preservation of all control houses and test stands at SSFL. See Appendix E for more information on our calculation of funds put to better use.

[61] For preservation and demolition purposes, NASA identifies 6 test stands at SSFL (2 at Alfa, 2 at Bravo, and 2 at Coca).

Table 2: Current and Anticipated Preservation and Demolition Estimates for SSFL Test Stands and Control Houses

Preservation [a]	FY 2018 Estimate	FY 2045 Escalated Estimate [b]
Alfa	$4,716,265	$8,853,514
Bravo	6,340,131	11,901,884
Coca	8,534,446	16,021,200
Total	**$19,590,842**	**$36,776,598**
Demolition [c]	**FY 2018 Estimate**	**FY 2045 Escalated Estimate [b]**
Alfa [d]	$2,482,961	$4,661,089
Bravo	4,244,518	7,967,937
Coca	14,637,633	27,478,204
Total	**$21,365,112**	**$40,107,229**

Source: NASA OIG presentation of SSFL Program information.

Notes:

[a] Preservation costs include only initial preservation costs such as stripping, repainting, and securing the test stands and do not include estimates for repainting the test stands as necessary after initial preservation. The preservation estimate assumes preservation of all control houses and test stands at SSFL.

[b] Future estimates are escalated by 2.36 percent per year based on the prior 27 years average historical inflation rate. Numbers are rounded.

[c] The estimated salvage value has been removed from the demolition estimates because once the test stands are demolished they will be recycled with the recycle value returned to NASA.

[d] The estimate assumes NASA will preserve the control house (Building No. 2208) and test stand No. 1 (structure No. 2727) at the Alfa site.

Whether the structures are preserved or demolished, maintenance work such as removing fluids and draining fuel lines from the test stands is necessary and was ongoing at the time of this review. Additional work to preserve the test stands and control houses includes: (a) asbestos removal, (b) lead paint abatement and repainting the test stands, and (c) securing the test stands. Likewise, demolition of the test stands will require asbestos and lead paint removal.

Test Stands are in Poor Condition and Represent a Liability to NASA

NASA officials recognize that the remaining test stands are in poor condition and represent a safety hazard and liability. For example, when we visited SSFL in June 2018 we observed that the Coca stand had portions rusted through and that small metal pieces had fallen into the flame bucket below.

Last used in 2006, the test stands will never be used again for engine testing. NASA has taken steps to document and record evidence of the structures in accordance with the Agency's Programmatic Agreement. Multiple videos and pictures of the site document the design and assembly of the structures, as well as the achievements that took place there.[62] Although the Programmatic Agreement conditionally requires NASA to retain and preserve at least one test stand and control house at Alfa or Bravo, a separate provision in the Agreement provides alternatives should retention of a test stand or control house not be possible. Program officials told us that all of the test stands could be demolished if necessary. NASA officials said if they decide to demolish the test stands, they may retain several pieces of the structures for display on site or in local museums.

Test Stand at SSFL Coca Site

Source: NASA.

If the test stands are preserved, their future is unclear once soil remediation is complete.[63] NASA reported the property as excess to GSA in September 2009. Once cleanup is complete, GSA will act as a real estate broker by attempting to sell or transfer the property. However, until that time, NASA retains control and must maintain the property. Further complicating this issue are repeated incidents of trespassing on the test stands. Although SSFL is a gated site with controlled access, its layout and topography make it easy for individuals to gain unauthorized access to the property, creating the potential for personal injury claims involving accidents on the test stands or other structures.

[62] The National Park service has also completed Historic American Engineering Record documentation for the Library of Congress.

[63] An August 2015 letter to DTSC from the Santa Susana Mountain Park Association indicated the National Park Service may ultimately be a manager of the NASA site due to expansion of the Santa Monica Mountains National Recreation Area as a result of a Rim of the Valley study completed and transmitted to Congress in February 2016. Of the alternatives listed, one suggestion from the Association was to expand the boundaries of the Santa Monica Mountains National Recreation Area to provide more parks and protect habitat linkages, with an emphasis on creating more recreational opportunities near urban areas. Expansion of these boundaries would include land from SSFL. The "Rim of the Valley Corridor Preservation Act," introduced in Congress in October 2017, would add more than 191,000 acres of the Rim of the Valley Corridor to the Santa Monica Mountains National Recreation Area. As of March 2019, the bill was awaiting action in the House Natural Resources Subcommittee on Federal Lands.

CONCLUSION

Under the terms of agreements signed with the State of California in 2007 and 2010, NASA is responsible for remediating its portion of the groundwater and soil contamination at SSFL. However, we question the reasonableness and feasibility of the current requirements to clean the soil to a Background level as currently defined by the provisional LUT. This cleanup approach is not based on risks to human health and the environment or the expected future use of the land, the standard practice for environmental remediation at similar sites. Further, soil cleanup levels currently set by DTSC are expected to cost over $500 million, take as long as 25 years to complete, and impose significant damage to the flora and fauna at the site. In contrast, a cleanup to the Recreational level—the standard more in line with the expected future use of the land—would cost about $124 million and take approximately 4 years to complete. As a result, we question a total of $377 million in unnecessary cleanup costs which represent funds that could be put to better use.

Compounding our concern is the fact that soil remediation levels envisioned by the current cleanup strategy are likely not achievable. For example, NASA is currently required to take steps to ensure contaminants in the soil are reduced to an unprecedented degree—in some cases lower than naturally occurring levels. Such a strategy would result in highly invasive and prolonged soil removal efforts and difficulty locating soil sufficiently "clean" to use as backfill. At a minimum, this approach will likely result in significant destruction of the property's aesthetic value as well as its biological and cultural resources.

DTSC stated that the LUT values are currently provisional and indicated there may be some flexibility when it issues the final values; however, in our view the lack of communication about the LUT values since 2013 is unhelpful as NASA prepares for soil cleanup. Given these concerns, we encourage the Agency to reexamine its current plans for soil cleanup on the NASA-administered portion of SSFL to ensure its environmental remediation is conducted in the most efficient and cost-effective manner consistent with the anticipated future use of the property.

Moreover, by delaying a decision on whether to preserve or demolish obsolete test stands and control houses at SSFL, the Agency may need to spend an additional $18.7 million for demolition or $17.2 million for preservation—funds we believe could be put to better use. Further, the deteriorating physical condition of the infrastructure represents a liability to the Agency as NASA seeks to clean up the site and, eventually, transfer or sell the property with the assistance of GSA.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

In order to ensure the most effective and efficient cleanup of SSFL, we recommended that the NASA Administrator, with the assistance of the Associate Administrator for Mission Support and the Agency's General Counsel:

1. Pursue all available options—administrative, legal, or political—to ensure NASA's SSFL soil cleanup is performed in an environmentally and financially responsible manner based on the intended future use of the property.

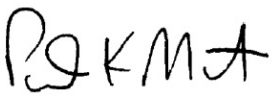
2. Decide whether to preserve or demolish the remaining six test stands and related structures before soil remediation begins and take action on that decision.

We provided a draft of this report to NASA management for review and comment; management's comments are reproduced in Appendix F. Technical comments provided by management have also been incorporated, as appropriate.

NASA management concurred with both our recommendations and described in their comments corrective actions the Agency plans to take to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon verification and completion of the proposed corrective actions.

Major contributors to this report include Ridge Bowman, Space Operations Director; Letisha Antone, Project Manager; David Balajthy; Amy Bannister; Gina Davenport-Bartholomew; and Thomas Dodd. Matt Ward provided editorial and graphics assistance. Earl Baker provided legal assistance.

If you have questions about this report or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or laurence.b.hawkins@nasa.gov.



Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from April 2018 through February 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Our overall audit objective was to examine the status of NASA's environmental remediation activities at SSFL and assess the extent to which the Agency is conducting these efforts in a cost-effective manner. In the course of our audit work, we also examined the financial impact of the Agency's indecision on whether to preserve or demolish obsolete test stands at the site.

We performed work at NASA Headquarters, Marshall Space Flight Center, and Santa Susana Field Laboratory in Simi Valley, California. We interviewed representatives from NASA's EMD Division, Marshall Space Flight Center's SSFL Project officials, and NASA's legal counsel, as well as DTSC, EPA, DOE, DOJ, Boeing, and the U.S. and California fish and wildlife services. We reviewed NASA's EIS and DTSC's draft PEIR documents, NASA's contract documents, the 2007 Consent Order, the 2010 AOC, DTSC hourly invoices, and NASA's FY 2018 budget and project list. We also reviewed federal and state laws, and environmental policies, regulations, and procedures to determine the requirements, criteria, and processes for assessing environmental remediation cleanup.

Use of Computer-Processed Data

We relied on computer-processed data such as cost data obtained from Business Objects and the NASA Environmental Tracking System. We corroborated information with other sources where possible and performed audit steps to validate the accuracy of a limited amount of data contained in the databases; however, the data is only as accurate as that entered by the database personnel. The accuracy of the data did not affect our conclusions.

Review of Internal Controls

We reviewed and evaluated internal controls associated with environmental remediation efforts at SSFL, including the decision process used in determining the cleanup level, cost estimates, and other impacts of cleaning up the site to a background exposure level. Our review included an evaluation of the actions planned and taken by NASA.

Prior Coverage

During the last five years, the NASA Office of Inspector General (OIG) has issued 2 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at https://oig.nasa.gov/audits/auditReports.html.

NASA OIG, *NASA's Environmental Restoration Efforts at Santa Susana Field Laboratory* (IG-13-007, February, 14, 2013).

NASA OIG, *NASA's Environmental Restoration Efforts* (IG-14-021, July 2, 2014).

APPENDIX B: HISTORY OF SANTA SUSANA

This information is taken from the Santa Susana Field Laboratory (SSFL) website: https://ssfl.msfc.nasa.gov/history.

SSFL is located on approximately 2,850 acres in the Simi Hills in Ventura County, California. The Simi Hills are bordered to the east by the San Fernando Valley and to the north by the Simi Valley. SSFL is divided into four administrative areas—Area I, Area II, Area III, and Area IV—and two undeveloped areas. Areas I, III, and IV and the undeveloped areas are owned and operated by the Boeing Company. Area II, consisting of 409.5 acres, along with 41.7 acres in Area I, are owned by the U.S. government and administered by NASA. The U.S. Department of Energy (DOE) has long held a lease on land in Area IV.

Pre-1900s

Three Native American groups occupied Ventura County in the areas surrounding the Simi Hills during late prehistory: the Chumash, the Tongva, and the Tataviam. All were seminomadic hunter-gatherers, while the Chumash and Tongva focused much of their subsistence activities on marine resources, supplementing that with resources available inland.

Burro Flats Painted Cave is a prehistoric archaeological site that is famous for its pictographs (rock art paintings) and petroglyphs (rock art that has been scored or incised into the rock surface). The site also includes evidence of habitation. The Chumash of the Simi Valley and Simi Hills and the Tongva of the San Fernando Valley may both have visited the Burro Flats Painted Cave area. There is speculation that the area may have been an interface between the two groups, and the rock art has been described as suggesting both cultures.

Burro Flats Painted Cave was first occupied from at least 1100 C.E. until 1810 to 1820, although its occupation may extend back to as early as 900 C.E.

1900s

After World War II, North American Aviation leased and later purchased land in the Simi Hills for rocket engine testing. North American Aviation formed the aerospace company called Rocketdyne, which later merged with Rockwell International Corporation (Rockwell). In 1954, North American Aviation obtained an adjacent 838-acre area of undeveloped land from Henry Silvernale and Elizabeth Hall. (Property ownership records identify Henry Silvernale and Elizabeth Hall as the earliest recorded owners of the property.) This new parcel included the land that would become Area II, as well as the 41.7 acres in Area I that later would make up the Liquid Oxygen plant. These portions subsequently were transferred to the U.S. government.

In December 1958, North American Aviation deeded three parcels of the former Silvernale property to the U.S. Air Force (USAF). Parcels 1 and 2, consisting of 409.5 acres, became the site of USAF Plant 57, now Area II. Parcel 3 was used for USAF Plant 64, now the Liquid Oxygen plant. The Grant Deed also granted legal access for roads.

Since 1954, Area II has been operated by Boeing, Rockwell, and its predecessor, North American Aviation, under USAF facility contracts. In 1973, the USAF Plant 57 (Area II) land was transferred to NASA and the USAF Plant 57 designation was no longer used.

In 1976, the U.S. General Services Administration transferred the Liquid Oxygen plant (USAF Plant 64) from the USAF to NASA, but the Air Force retained possession of the structures. Under the terms of a facilities contract, Rockwell administered the Liquid Oxygen plant for NASA. The Plant was removed in the early 1970s with the exception of a small weigh station and concrete tank supports.

APPENDIX C: DTSC PROVISIONAL LUT VALUES

Table 3: DTSC Chemical Look-Up Table for NASA and DOE at SSFL

Chemical Constituent	Units	Look-Up Table Value	Basis
Alcohols - EPA Method 8015B			
Ethanol	mg/kg	0.7	BG MRL
Methanol	mg/kg	0.7	BG MRL
Anions - EPA Methods 300.0 / 9056A			
Fluoride	mg/kg	10.2	BTV
Nitrate	mg/kg	22.3	BTV
Cyanide - EPA Method 9012A			
Cyanide	mg/kg	0.6	BG MRL
Dioxin-Furans - EPA Method 1613B			
1,2,3,4,6,7,8-HpCDD	pg/g	see note a	---
1,2,3,4,6,7,8-HpCDF	pg/g	see note a	---
1,2,3,4,7,8,9-HpCDF	pg/g	see note a	---
1,2,3,4,7,8-HxCDD	pg/g	see note a	---
1,2,3,4,7,8-HxCDF	pg/g	see note a	---
1,2,3,6,7,8-HxCDD	pg/g	see note a	---
1,2,3,6,7,8-HxCDF	pg/g	see note a	---
1,2,3,7,8,9-HxCDD	pg/g	see note a	---
1,2,3,7,8,9-HxCDF	pg/g	see note a	---
1,2,3,7,8-PeCDD	pg/g	see note a	---
1,2,3,7,8-PeCDF	pg/g	see note a	---
2,3,4,6,7,8-HxCDF	pg/g	see note a	---
2,3,4,7,8-PeCDF	pg/g	see note a	---
2,3,7,8-TCDD	pg/g	see note a	---
2,3,7,8-TCDF	pg/g	see note a	---
OCDD	pg/g	see note a	---
OCDF	pg/g	see note a	---
2,3,7,8-TCDD TEQ			
2,3,7,8-TCDD TEQ[a]	pg/g	0.912 (see note a)	BTV-TEQ
Energetics - EPA Method 8330			
RDX	µg/kg	300	M-L MRL
Formaldehyde - EPA Method 8315A			
Formaldehyde	µg/kg	1,870	BG MRL
Herbicides - EPA Method 8151A			
2,4,5-T	µg/kg	1.2	BTV
2,4,5-TP	µg/kg	0.63	BTV
2,4-D	µg/kg	5.8	BTV

Chemical Constituent	Units	Look-Up Table Value	Basis
Herbicides - EPA Method 8151A (cont'd)			
2,4-DB	µg/kg	2.4	BG MRL
2,4-DP (Dichloroprop)	µg/kg	2.4	BTV
Dalapon	µg/kg	12.5	BG MRL
Dicamba	µg/kg	1.3	BTV
Dinoseb	µg/kg	3.3	BG MRL
MCPA	µg/kg	761	BTV
MCPP (Mecoprop)	µg/kg	377	BTV
Pentachlorophenol	µg/kg	170	M-L MRL
Metals - EPA Methods 6010B/6020A			
Aluminum	mg/kg	58,600	BTV
Antimony	mg/kg	0.86	BTV
Arsenic	mg/kg	46	BTV
Barium	mg/kg	371	BTV
Beryllium	mg/kg	2.2	BTV
Boron	mg/kg	34	BTV
Cadmium	mg/kg	0.7	BTV
Chromium	mg/kg	94	BTV
Cobalt	mg/kg	44	BTV
Copper	mg/kg	119	BTV
Lead	mg/kg	49	BTV
Lithium	mg/kg	91	BTV
Manganese	mg/kg	1,120	BTV
Molybdenum	mg/kg	3.2	BTV
Nickel	mg/kg	132	BTV
Potassium	mg/kg	14,400	BTV
Selenium	mg/kg	1	BTV
Silver	mg/kg	0.2	BTV
Sodium	mg/kg	1,780	BTV
Strontium	mg/kg	163	BTV
Thallium	mg/kg	1.2	BTV
Vanadium	mg/kg	175	BTV
Zinc	mg/kg	215	BTV
Zirconium	mg/kg	19	BTV
Hexavalent Chromium - EPA Methods 7199/7196A			
Hexavalent Chromium	mg/kg	2	BTV
Mercury - EPA Methods 7471A/7470A			
Mercury	mg/kg	0.13	BG MRL
Methyl Mercury - EPA Method 1630 (Mod)			
Methyl Mercury	µg/kg	0.05	M-L MRL
PCBs / PCTs - EPA Method 8082			
Aroclor 1016	µg/kg	17	M-L MRL

Chemical Constituent	Units	Look-Up Table Value	Basis
PCBs / PCTs - EPA Method 8082 (cont'd)			
Aroclor 1221	µg/kg	33	M-L MRL
Aroclor 1232	µg/kg	17	M-L MRL
Aroclor 1262	µg/kg	33	M-L MRL
Aroclor 1254	µg/kg	17	M-L MRL
Aroclor 1260	µg/kg	17	M-L MRL
Aroclor 1268	µg/kg	33	M-L MRL
Aroclor 1242	µg/kg	17	M-L MRL
Aroclor 1248	µg/kg	17	M-L MRL
Aroclor 5432	µg/kg	50	M-L MRL
Aroclor 5442	µg/kg	50	M-L MRL
Aroclor 5460	µg/kg	50	M-L MRL
Perchlorate - EPA Methods 6850/6860			
Perchlorate	µg/kg	1.63	BTV
Pesticides - EPA Method 8081A			
Aldrin	µg/kg	0.24	BG MRL
Alpha-BHC	µg/kg	0.24	BG MRL
Beta-BHC	µg/kg	0.23	BTV
Chlordane	µg/kg	7	BTV
Delta-BHC	µg/kg	0.22	BTV
Dieldrin	µg/kg	0.48	BG MRL
Endosulfan I	µg/kg	0.24	BG MRL
Endosulfan II	µg/kg	0.48	BG MRL
Endosulfan Sulfate	µg/kg	0.48	BG MRL
Endrin	µg/kg	0.48	BG MRL
Endrin Aldehyde	µg/kg	0.7	BTV
Endrin Ketone	µg/kg	0.7	BTV
Gamma-BHC - Lindane	µg/kg	0.24	BG MRL
Heptachlor	µg/kg	0.24	BG MRL
Heptachlor Epoxide	µg/kg	0.24	BG MRL
Methoxychlor	µg/kg	2.4	BG MRL
Mirex	µg/kg	0.5	BTV
p,p-DDD	µg/kg	0.48	BG MRL
p,p-DDE	µg/kg	8.6	BTV
p,p-DDT	µg/kg	13	BTV
Toxaphene	µg/kg	8.8	BG MRL
Semi-Volatiles (SVOCs)/PAHs - EPA Method 8270C(SIM)			
Acenaphthylene	µg/kg	2.5	BG MRL
Anthracene	µg/kg	2.5	BG MRL
Benzo(a)anthracene	µg/kg	see note b	---
Benzo(a)pyrene	µg/kg	see note b	---
Benzo(b)fluoranthene	µg/kg	see note b	---

Chemical Constituent	Units	Look-Up Table Value	Basis
Semi-Volatiles (SVOCs)/PAHs - EPA Method 8270C(SIM) (cont'd)			
Benzo(g,h,i)perylene	µg/kg	2.5	BG MRL
Benzo(k)fluoranthene	µg/kg	see note b	---
Bis(2-Ethylhexyl)phthalate	µg/kg	61	BTV
Butylbenzylphthalate	µg/kg	100	BTV
Chrysene	µg/kg	see note b	---
Dibenz(a,h)anthracene	µg/kg	see note b	---
Diethyl phthalate	µg/kg	27	BG MRL
Dimethyl phthalate	µg/kg	27	BG MRL
Di-n-butylphthalate	µg/kg	27	BG MRL
Di-n-octylphthalate	µg/kg	27	BG MRL
Fluoranthene	µg/kg	5.2	BTV
Fluorene	µg/kg	3.8	BTV
Indeno(1,2,3-cd)pyrene	µg/kg	see note b	---
Naphthalene	µg/kg	3.6	BTV
Phenanthrene	µg/kg	3.9	BTV
Pyrene	µg/kg	5.6	BTV
1-Methyl naphthalene	µg/kg	2.5	BG MRL
2-Methylnaphthalene	µg/kg	2.5	BG MRL
Acenaphthene	µg/kg	2.5	BG MRL
Benzo(a)pyrene Equivalent			
Benzo(a)pyrene TEQ[b]	µg/kg	4.47 (see note b)	BTV-TEQ
Other SVOCs			
Benzoic Acid - EPA 8270	µg/kg	660	M-L MRL
N-Nitrosodimethylamine - 8270C(SIM)	µg/kg	10	M-L MRL
Phenol - EPA 8270	µg/kg	170	M-L MRL
TPH - EPA Method 8015			
TPH EFH (C15-C20)[c]	mg/kg	5 (see note c)	M-L MRL
Terphenyls - EPA Method 8015			
o-Terphenyl	mg/kg	7	M-L MRL
VOCs - EPA Method 8260			
1,1-Dichloroethene	µg/kg	5	M-L MRL
1,4-Dioxane - EPA 8260 (SIM)	µg/kg	10	M-L MRL
2-Hexanone	µg/kg	10	M-L MRL
Acetone	µg/kg	20	M-L MRL
Benzene	µg/kg	5	M-L MRL
cis-1,2-Dichloroethene	µg/kg	5	M-L MRL
Ethylbenzene	µg/kg	5	M-L MRL
Hexachlorobutadiene	µg/kg	5	M-L MRL
Methylene chloride	µg/kg	10	M-L MRL
Tetrachloroethene	µg/kg	5	M-L MRL
Toluene	µg/kg	5	M-L MRL

Chemical Constituent	Units	Look-Up Table Value	Basis
VOCs - EPA Method 8260 (cont'd)			
Trichloroethene	µg/kg	5	M-L MRL
Vinyl chloride	µg/kg	5	M-L MRL

Source: DTSC "Chemical Look-Up Table Memorandum, Santa Susana Field Laboratory, Ventura County, California" (June 11, 2013).

Notes:
mg/kg: milligrams per kilogram (parts per million)
µg/kg: micrograms per kilogram (parts per billion)
pg/g: picograms per gram (parts per trillion)
BTV: Background threshold value
BG-MRL: Background method reporting limit
M-L MRL: Multi-Lab method reporting limit
PAH: Polyaromatic hydrocarbon
PCB: Polychlorinated biphenyl
PCT: Polychlorinated terphenyl
RDX: Research Department Explosive
SIM: Selective ion monitoring
SVOC: Semi-volatile organic compound
TEQ: Toxicity equivalency
TPH EFH: Total petroleum hydrocarbon - extractable fuel hydrocarbon
VOC: Volatile organic compound

[a] DTSC applied the World Health Organization's 2,3,7,8-TCDD toxicity equivalence approach for dioxin-furans. To evaluate 2,3,7,8-TCDD equivalence, dioxin-furans need to meet respective background study MRLs.

[b] Benzo(a)pyrene equivalence developed based on sum of carcinogenic PAHs. In order to evaluate Benzo(a)pyrene equivalence, carcinogenic PAHs need to meet respective background study MRLs.

[c] For locations where TPH is the sole contaminant, a cleanup strategy will be considered based on the findings of the soil treatability study.

APPENDIX D: ENDANGERED AND THREATENED SPECIES AT SSFL

The species of plants and wildlife identified as present or likely to occur near Areas I and II of the Santa Susana Field Laboratory were compiled from surveys conducted in 2010 and 2011 for NASA's Environmental Impact Statement (EIS) for Demolition and Environmental Cleanup Activities at Santa Susana Field Laboratory in California (March 2014) and Marshall Space Flight Center's Santa Susana Field Laboratory Environmental Cleanup and Closure website. For a comprehensive listing, go to https://ssfl.msfc.nasa.gov/about/environmental-setting.

Terminology

FE – Endangered: A species in danger of extinction throughout all or a significant portion of its range.

FT – Threatened: A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

FC – Candidate: A species under consideration for official listing for which there is sufficient information to support listing.

SS – Special Status: Special Status Species is a universal term used in the scientific community for species that are considered sufficiently rare that they require special consideration and/or protection and should be, or have been, listed as rare, threatened, or endangered by the Federal and/or State governments.

CP – California Fully Protected Species: The classification of Fully Protected was the state's initial effort in the 1960's to identify and provide additional protection to those animals that were rare or faced possible extinction. Lists were created for fish, amphibians, reptiles, birds, and mammals. Most fully protected species have also been listed as threatened or endangered under more recent endangered species laws and regulations.

CC – California Species of Concern: A species for which existing information indicates it may warrant listing as threatened or endangered but for which substantial information for listing is still lacking.

Table 4: Endangered and Threatened Plants at SSFL

Santa Susana tarweed

Marcescent dudleya

Slender mariposa lily

Common Name	Scientific Name	Status
Braunton's milk-vetch	*Astragalus brauntonii*	FE
Lyon's pentachaeta	*Pentachaeta lyonii*	FE
Spreading navarretia	*Navarretia fossalis*	FT
Conejo dudleya	*Dudleya abramsii* ssp. *parva* [*Dudleya parva*]	FT
Santa Monica Mountains dudleya	*Dudleya cymosa* ssp. *ovatifolia* [inclusive of *Dudleya cymosa* ssp. *agourensis*]	FT
Marcescent dudleya	*Dudleya cymosa* ssp. *marcescens*	FT
California Orcutt grass	*Orcuttia californica*	FT
San Fernando Valley spineflower	*Chorizanthe parryi* var. Fernandina	FC
Santa Susana tarweed	*Deinandra minthornii*	SS
Plummer's mariposa lily	*Calochortus plummerae*	SS
Slender mariposa lily	*Calochortus clavatus var. gracilis*	SS

Photo credits: Santa Susana tarweed: Hartmut Wisch;
Marcescent dudleya: Sangeet Khalsa
Slender mariposa lily: Robert A. Hamilton

Table 5: Endangered and Threatened Birds at SSFL

Coastal California gnatcatcher

Loggerhead Shrike

Common Name	Scientific Name	Status
Coastal California gnatcatcher	*Polioptila californica*	FT
Least Bell's vireo	*Vireo bellii pusillus*	FE
Loggerhead shrike	*Lanius ludovicianus*	CC

Photo credits: Coastal California gnatcatcher: Dominic Sherony
Loggerhead shrike: Chris Crowe, Smithsonian Conservation Biology Institute

Table 6: Endangered and Threatened Reptiles and Amphibians at SSFL

California red-legged frog

Two-striped Garter Snake

Common Name	Scientific Name	Status
California red-legged frog	*Rana draytonii*	FT
Two-striped garter snake	*Thamnophis hammondii*	CC
Coast horned lizard	*Phrynosoma blainvillii*	CC

Photo credits: California red-legged frog: Neosha Kashef
Two-striped Garter Snake: William Flaxington

Table 7: Endangered and Threatened Invertebrates at SSFL

Quino checkerspot butterfly

Vernal pool fairy shrimp

Common Name	Scientific Name	Status
Quino checkerspot butterfly	*Euphydryas editha quino*	FE
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT
Riverside fairy shrimp	*Streptocephalus woottoni*	FE

Photo credits: Quino checkerspot butterfly: Andrew Fisher/USFWS Volunteer Biologist
Vernal pool fairy shrimp: Dwight Harvey/USFWS

Table 8: Endangered and Threatened Mammals at SSFL

Ring-tailed cat

Common Name	Scientific Name	Status
Ring-tailed cat	*Bassariscus astutus*	CP

Photo credit: Craig Warren Benkman

APPENDIX E: FUNDS PUT TO BETTER USE

In our 2013 report, we noted $184 million in projected SSFL cleanup costs for NASA that could be put to better use—that figure represented the difference between the AOC cost estimate at the time and the estimate for a cleanup to the Recreational level. Boeing's conservation easement, which covers a majority of the land at SSFL, adds significant weight to the case for a Recreational level cleanup on the NASA portion of the site. As such, we now question an additional $193 million for soil remediation, which is the current $501 million estimate for cleanup to the AOC Background level, minus the $124 million to clean up to the Recreational level and the $184 million questioned previously (see Table 9).

Table 9: SSFL Soil Remediation Funds Put to Better Use

Cost Estimates/Funds Put to Better Use (dollars in millions)	
Current AOC Cost Estimate (Background Level)	$501
Current Recreational Level Cleanup Estimate	(124)
Previously Noted Funds Put to Better Use	(184)
Total Additional Funds Put to Better Use	**$193**

Source: NASA OIG calculation.

NASA's decision to defer preservation or demolition of the test stands and control houses until soil remediation is complete in 2045 could result in additional costs due to inflation alone. In order to calculate the cost of putting off the decision, we escalated current cost estimates by 2.36 percent per year based on the prior 27 years' average historical inflation rate. We used the prior 27 years to determine the average inflation rate because NASA estimates that soil cleanup at SSFL will take at least 25 years, and be completed in 2045. Based on this decision by NASA, we have calculated Funds Put to Better Use for the SSFL test stand demolition or preservation from between $17.2 million to $18.7 million (see Table 10).

Table 10: SSFL Test Stand and Control House Preservation or Demolition Funds Put to Better Use

	Preservation [a]	Demolition [b, c]
FY 2018 Estimate	$19,590,842	$21,365,112
FY 2045 Escalated Estimate	36,776,598	40,107,229
Funds Put to Better Use (difference)	**$17,185,756**	**$18,742,117**

Source: NASA OIG calculation.

Notes:

[a] Preservation costs include only initial preservation costs such as stripping, repainting, and securing the test stands and do not include estimates for repainting the test stands as necessary after initial preservation. The preservation estimate assumes preservation of all control houses and test stands at SSFL.

[b] The estimated salvage value has been removed from the demolition estimates because once the test stands are demolished they will be recycled and the recycle value will be returned to NASA.

[c] The demolition estimate assumes NASA will preserve the control house (Building No. 2208) and test stand No. 1 (structure No. 2727) at the Alfa site.

APPENDIX F: MANAGEMENT'S COMMENTS

National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

March 11, 2019

Reply to Attn of: Office of Strategic Infrastructure

TO: Assistant Inspector General for Audits

FROM: Assistant Administrator for Strategic Infrastructure

SUBJECT: Agency Response to OIG Draft Report, "NASA's Progress in Environmental Remediation Activities at the Santa Susana Field Laboratory" (A-18-013-00)

NASA appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Progress in Environmental Remediation Activities at the Santa Susana Field Laboratory" (A-18-013-00), dated February 13, 2019.

In order to ensure the most effective and efficient cleanup of the Santa Susana Field Laboratory (SSFL), the OIG recommends the following:

Recommendation 1: Pursue all available options—administrative, legal, or political—to ensure NASA's SSFL soil cleanup is performed in an environmentally and financially responsible manner based on the intended future use of the property.

Management's Response: NASA concurs with this recommendation. The OIG's draft report identifies many issues and concerns with implementing a soil cleanup as prescribed in the Administrative Order on Consent (AOC) utilizing the provisional Lookup Table (LUT) the State of California Department of Toxic Substance Control (DTSC) developed.

NASA entered into the 2010 AOC in good faith with the expectation that the State of California would use sound regulatory discretion in calculating cleanup levels for the site that would be both fully protective of public health and practically and technically achievable. The soil cleanup described in DTSC's draft Programmatic Environmental Impact Report (PEIR) requires substantially greater soil removal than original estimates contemplated in the 2010 AOC. NASA has substantial concerns about the implementability of such a cleanup and the significant environmental impacts to the valuable cultural and natural resources within the site. As a result, NASA has provided extensive comments on DTSC's draft PEIR and expressed concerns about the technical feasibility of a soil cleanup to the LUT values developed by DTSC.

NASA remains firmly committed to achieving a cleanup at SSFL that is protective of public health and the environment. NASA will continue to work with DTSC and all interested stakeholders to implement a cleanup that is based in science, technically achievable, protective of the surrounding community, and eliminates or greatly reduces significant damage to SSFL's habitat and cultural resources and the impacts to the community. At this time, DTSC has not issued its final PEIR and associated plan for implementation. Once released, NASA will be in a better position to determine further actions. Additionally, NASA recognizes that the Department of Energy (DOE) has recently published its final Environmental Impact Statement (EIS) for SSFL. DOE's preferred alternative for soil cleanup is a suburban residential cleanup scenario, which is consistent with cleanups regulated by the Environmental Protection Agency across the country.

In order to ensure NASA's SSFL soil cleanup is performed in an environmentally and financially responsible manner, NASA proposes the following:

- Because of the significant increase in the soil volumes from NASA's 2013 EIS to the volumes reported in DTSC's PEIR, NASA will supplement its soil evaluation in accordance with the National Environmental Policy Act (NEPA) to evaluate the issues identified by the OIG.
- NASA will continue to monitor DTSC's progress on its PEIR and final LUT for the cleanup phase.
- NASA will continue to work with DTSC and all interested stakeholders to implement a cleanup that ensures that human health and the environment are protected, as well as the site's important cultural and natural resources.

Schedule for Completion:

Action	Estimated Completion Date
Review DTSC's Final PEIR and associated Management Plan and Look-up Tables for Cleanup.	TBD, expected in 2019
Through the NEPA process, thoroughly evaluate the impacts associated with soil cleanup.	June 30, 2020

Recommendation 2: Decide whether to preserve or demolish the remaining six test stands and related structures before soil remediation begins and take action on that decision.

Management's Response: NASA concurs with this recommendation. The OIG's draft report identifies a number of issues and concerns with deferring action on the remaining six test stands and three associated control houses.

In 2015, NASA made the decision to defer demolition of the Coca test stands in order to support a proposal to include SSFL as a national monument. In April 2017, NASA reaffirmed this decision and agreed to defer demolition of all test stands for as long as possible unless the test stands pose risks to safety, health, or the

environment that cannot be mitigated. As a result, the deferral was expected to remain in effect until after the completion of cleanup activities.

Since that time, there have been many instances of trespassing and vandalism on the test stands and associated historic structures despite installation of security fencing and the presence of onsite security. Based on the OIG report and in accordance with its 2014 Programmatic Agreement with the California State Historic Preservation Office (SHPO) and other interested stakeholders, NASA will proceed with making a final decision about the preservation or demolition of the remaining test stands and control houses. NASA's decision to preserve or demolish structures will be based on a number of factors, including the impact to prospective future stewards/owners resulting from the General Services Administration disposition process, the long-term cost to maintain the test stand structures, and the risks to public health or public safety by maintaining the structures.

Schedule for Completion:

Action	Estimated Completion Date
Evaluate the paths forward regarding test stand demolition or retention, including required consultation in accordance with the 2014 Programmatic Agreement, and notify required parties of decision.	March 31, 2020
Implement decision and complete activities at test stands and control houses.	TBD

The OIG identified funds that could be put to better use relating to soil remediation in the amount of $193 million, as well as funds that could be put to better use relating to Test Stand and Control House preservation or demolition, ranging between $17.2M and $18.7M. While the OIG estimates are a rough order of magnitude, they represent scenarios which may be outside NASA's control. NASA agrees with the OIG's general methodology and conclusions regarding these estimates.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Fatima Johnson on (202) 358-1631.

Calvin F. Williams

cc:
Administrator/Mr. Bridenstine
General Counsel/Ms. Thompson-King
Associate Administrator for Mission Support Directorate/Mr. Tenney

APPENDIX G: REPORT DISTRIBUTION

National Aeronautics and Space Administration

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Deputy Administrator
Associate Administrator
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Associate Administrator for Mission Support Directorate
    Assistant Administrator for the Office of Strategic Infrastructure
Director, Marshall Space Flight Center
    Program Director, Santa Susana Field Laboratory

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Office of Management and Budget
    Deputy Associate Director, Energy and Space Programs Division

Government Accountability Office
    Director, Office of Acquisition and Sourcing Management

California Department of Toxic Substances Control
    Acting Director, Department of Toxic Substances Control

Congressional Committees and Subcommittees, Chairman and Ranking Member

Senate Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

Senate Committee on Commerce, Science, and Transportation
    Subcommittee on Aviation and Space

Senate Committee on Homeland Security and Governmental Affairs

House Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

House Committee on Oversight and Reform
    Subcommittee on Government Operations

House Committee on Science, Space, and Technology
    Subcommittee on Investigations and Oversight
    Subcommittee on Space and Aeronautics

(Assignment No. A-18-013-00)