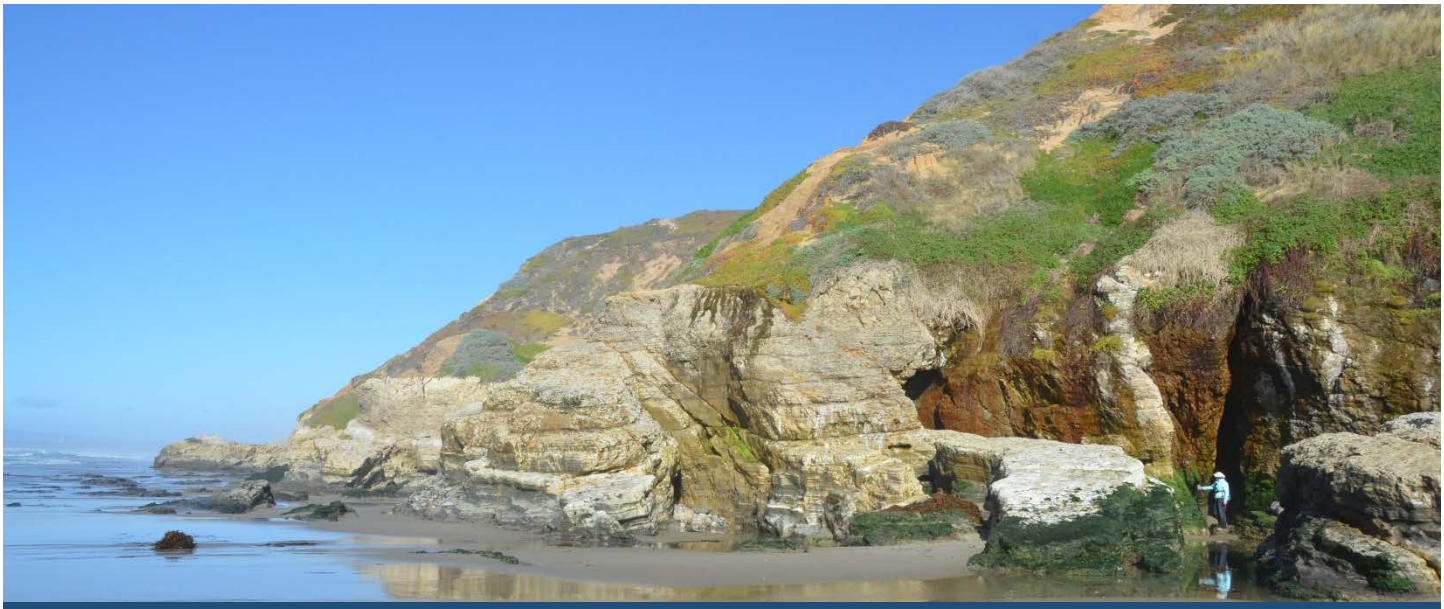


2018 Secretary of Defense

Environmental Awards

Environmental Restoration, Installation
Vandenberg AFB

Introduction

The 30th Space Wing, host unit at Vandenberg Air Force Base, supports West Coast launch activities for the Air Force, Department of Defense (DoD), National Aeronautics and Space Administration (NASA), national programs, and various private industry contractors. At more than 99,000 acres, Vandenberg AFB encompasses some of the highest quality coastal habitat in central California. With a wealth of invaluable cultural and ecological treasures, the Installation is recognized by regulators and the public for protecting and preserving 42 miles of pristine coastline, 9,000 acres of sand dunes, 5,000 acres of wetlands, more than 1,600 prehistoric archeological resources, 14 rock art sites, a National Historic Landmark, five Native American village sites, a National Historic Trail, 26 Cold War-era complexes, and 17 endangered or threatened species. Vandenberg AFB is home to 2,892 military personnel, 3,785 family members, 1,143 DoD civilians and 2,822 contractors, and serves approximately 8,000 military retirees living in the area.

The space and missile launch mission at Vandenberg AFB is unlike most other Defense installations that focus on military training or weapon systems testing. These launch operations, particularly during the Cold War era, left behind a legacy of soil and groundwater contamination that is the focus of the Restoration Program. The resultant massive scale of environmental investigation and cleanup presents an immense programmatic and management challenge to ensure compatibility with critical ongoing and proposed mission activities.

Background

The Vandenberg AFB Environmental Restoration Program is the third largest in the Air Force. It comprises Installation Restoration Program (IRP) sites and Military Munitions Response Program (MMRP) sites. Initial investigation began in the mid-1980s under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Over 1,800 sites were identified, including former launch sites, storage tanks,

landfills, drainage areas, fire training areas, spill areas, inactive small-arms ranges, inactive bombing ranges, inactive artillery and armor training areas, radioactive waste sites, and waste disposal pits. Primary contaminants in soil and water include fuels, solvents, metals, polychlorinated biphenyls, and low-level radioactive waste. Potential unexploded ordnance concerns include small arms, signal flares, practice land mines, grenades, rockets, mortars, projectiles, and bombs. Despite its extensive program, Vandenberg AFB was not included in the United States Environmental Protection Agency's National Priorities List; therefore, regulatory authority was delegated to the State of California. The California Department of Toxic Substances Control and the California Regional Water Quality Control Board are key regulatory stakeholders.

The heart of the Vandenberg AFB Restoration Program is a team of six full-time civilian employees who work closely with Installation leadership and personnel, are mindful of community interests, and remain in contact with stakeholders of the Community Advisory Board. The Program has matured with continued investigation and cleanup, and has closed more than 90% of the Installation's 1,800 sites. The Restoration Program's approach is to conduct the investigation and cleanup in a cost-effective manner, using streamlined and innovative methods to expedite remedial actions, and ensure far reaching impacts beyond the current superior accomplishments.

Summary of Accomplishments

Accelerated Environmental Cleanup

Vandenberg AFB adeptly managed the Air Force's largest performance-based restoration (PBR) contract, valued at $125 million over a 10-year span to address 107 sites. This monumental task could only be achieved through masterful programming and project management. Through collaborative efforts, the team accelerated various aspects of the Program, resulting in 'Response Complete' or 'Site Closure' ahead of schedule for 44 PBR sites. Additionally, 55 sites are on track for on-time and/or 'Accelerated Closure'.

An abbreviated CERCLA process agreement accelerated closure at over 40 sites and shaved from two to as many as seven years from the schedule. Vandenberg AFB aggressively advocated for implementation of the new California low-threat underground storage tank closure policy, which reduced costs by more than $1.5 million. State agencies also agreed to effectively reduce dig-and-haul cleanup volumes, which cut greenhouse gas emissions and achieved an annual savings of approximately $350,000. Furthermore, thousands of DoD administrative and technical man-hours were

Vandenberg AFB

Panorama of Vandenberg AFB looking towards the Santa Barbara Channel from Tranquillon Peak. The Installation protects and preserves more than 42 miles of coastline.

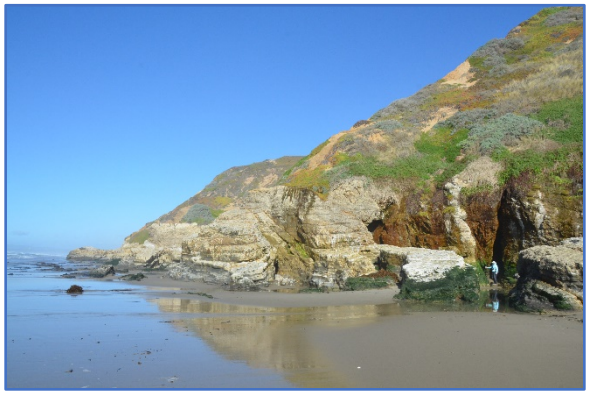
reduced, resulting in millions of dollars in cost savings. All of the above, along with the resultant decreased regulatory oversight, demonstrate a superior program.

Innovative Technology Demonstration/ Validation and Implementation

Vandenberg AFB is on the forefront in remediation technology, most notably for innovative technology projects associated with treating 1,4-dioxane. This emerging contaminant is toxic and difficult to treat because of its high solubility and mobility. Propane biosparging was first applied as a pilot study to treat groundwater concentrations as high as 2,000 micrograms per liter (µg/L). The initial results documented greater than 99% reduction of 1,4-dioxane in groundwater, but the mechanism was not well understood. The Restoration Program took on a second phase of the study to confirm the biodegradation mechanism via stable isotope probing. Results of this additional testing confirmed in-situ biodegradation of 1,4-dioxane under engineered conditions. Results were included as a peer-reviewed article in *Remediation* (Winter 2016) and were presented at multiple conferences in 2016 and 2017.

The Vandenberg Restoration Program adeptly employs innovative techniques to simplify processes and to test new treatments for emerging compounds. Vandenberg samples 184 to 700 wells in any given quarter. To streamline the field sampling effort and reduce data entry errors, technicians switched from using paper forms in the field to entering data directly into tablet computers. This effort automated analysis, reduced data errors, and economized labor and supply costs. Information was shared with the public during a Community Advisory Board meeting.

Vandenberg developed a unique system to integrate Restoration Program data into the Installation Geographical Information System (GIS), providing users the capability to summon decades of data for viewing and analysis in a geospatial system. This provided a vast improvement over the traditional method of interpreting non-spatial data, and enabled users to immediately visualize the changes in concentrations of dozens of analytes over significant periods of time.



Seep Sampling

Vandenberg AFB employs an extensive groundwater monitoring program. The Program includes seep sampling along the Installation's spectacular coastline.

The Vandenberg Restoration Program is integral to the work request review system to ensure that construction occurs at appropriate locations in a manner compatible with environmental conditions. Thorough analysis is expedited with an enhanced GIS system that fully integrates restoration site data into Air Force geospatial databases, enabling users to determine whether risks may be present at given locations and to suggest means for minimizing or avoiding such risk. Reviews of approximately 450 work requests were conducted to evaluate potential program impacts during the accomplishment period, vastly facilitating Air Force, NASA, and commercial mission success without delays.

The Vandenberg Restoration Program expertly built and maintained a digital

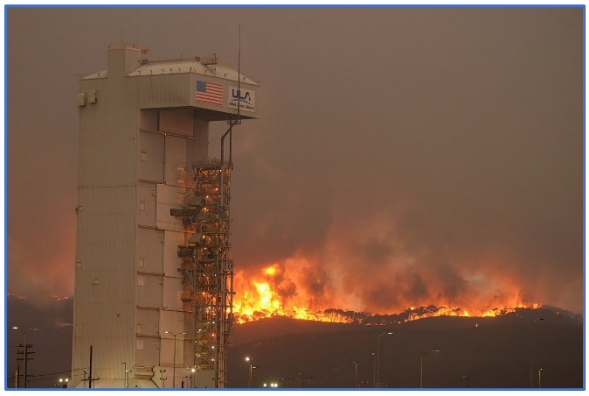
Administrative Record exceeding 4,000 documents. Recently, an additional 357 new entries were appended to ensure the record fully captured the correspondence, technical volumes, and other documents culminating decades of work costing tens of millions of dollars. Demonstrating innovative technology and validating new solutions, coupled with communicating those successes, are hallmarks of the Vandenberg Restoration Program leadership.

Partnerships Addressing Environmental Issues Between DoD and Other Entities

Vandenberg's proactive communications and teaming relationship with regulators and consultants paid productive dividends with a feasibility study that evaluated treatment alternatives for eight MMRP areas spanning approximately 11,000 acres. Thanks to continuous dialogue, no time was wasted in developing a range of alternatives to manage broad swaths of land to ensure protection of human health and the environment, while advancing the Air Force's space launch mission at Vandenberg.

The assessment of a World War II-era (WWII) artillery range that extended into the Pacific Ocean represented a unique challenge. The traditional method to evaluate unexploded ordnance (UXO) mobility in the 38,700-acre ocean range would have cost more than $10 million. A new approach was devised to reduce the survey area and perform studies along transects, resulting in a massive cost reduction to approximately $1.2 million. The exceptional working relationship with regulatory agencies resulted in a new approach that was quickly accepted and contracted. Work plans for this project are currently being developed so that fieldwork can commence in Fall, 2018.

The WWII-era Army training at the historic Camp Cooke contributed to the triumph of the United States and allies over the Axis powers, and helped prepare soldiers for conflict on the Korean peninsula. But it also left an enduring legacy in the form of UXO at dozens of munitions response sites encompassing thousands of acres at Vandenberg AFB. A massive wildfire in 2016 swept across 12,500 acres, requiring concerted efforts by approximately 900 firefighters and several air tankers to suppress the inferno. Because vast swaths of the fire area overlapped with UXO risk areas, extensive coordination was necessary to ensure personnel safety. This was achieved through essential dialogue between the MMRP manager, safety personnel, and firefighters using a robust GIS that accurately and clearly communicated the UXO risk in various areas. The dedication, knowledge, and ingenuity of the Environmental Restoration Program personnel resulted in risk management tools and communications to avoid potential casualties.



Canyon Fire

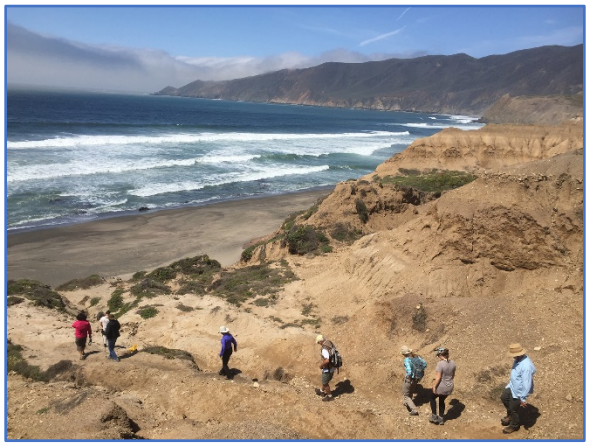
The Canyon Fire ravaged land near launch areas and burned 12,500 acres. The Restoration Program used UXO data and maps to ensure safety of firefighters and quickly developed an emergent Time-Critical Removal Action for 4,300 acres.

Although the fire partially or completely destroyed habitat for numerous listed species, it had the beneficial effect of exposing UXO by removing extremely dense vegetation that precluded previous removal efforts. The Vandenberg Restoration Program leapt into

action to map these areas and build an $8.6 million emergent requirement to perform a Time-Critical Removal Action spanning an area of 4,300 acres. Out-of-cycle requirements of this magnitude usually stand little chance of being funded. High visibility and substantive justification documents resulted in immediate funding.

Vandenberg AFB built consensus on investigation approaches and strategies to achieve 'Response Complete' or 'Site Closure' at Restoration Program sites. Through highly effective teamwork with all stakeholders, including regulators and contractors, the Installation gained regulatory approval for over 100 remediation work plans, oversaw effective implementation, and kept projects on schedule. Vandenberg AFB achieved substantial progress during the accomplishment period, masterfully negotiating with regulators on 12 feasibility studies, and proposed plans and Records of Decision related to highly complex sites. These represent huge accomplishments of effective communication in one of the toughest and most highly regulated states in the country.

Proactive community engagement by Vandenberg AFB continued through public outreach. Community Advisory Board meetings engaged members with a broad range of topics and sparked interest and requests from the community for team members to speak at events. The Restoration Program conducted extensive outreach, with 17 community members interviewed as part of the Community Involvement Plan update. Additionally, staff trained budding geologists by serving as hosts for 11 field trips for students and researchers, and presenting lectures to civic groups. The Vandenberg Restoration Program outreach has far reaching impacts into the local community, global scientific community, and space mission.



Training Budding Geologists
Restoration Program staff escorted geologists to unique rock outcrops on Vandenberg AFB. Staff served as hosts for 11 field trips for students and researchers during the accomplishment period.

Reducing Risk to Human Health and the Environment

The Vandenberg Restoration Program works closely with regulators to quickly reduce risk to human health and the environment through interim removal actions, and then follows up with final remediation after the Record of Decision.

The Restoration Program applied innovative approaches to the Installation's large-scale monitoring program and leveraged unique methodologies to achieve Site Closure based on risk. A fresh human health risk assessment approach was applied to total petroleum hydrocarbon evaluation. This approach achieved Site Closure for dozens of sites with contamination as high as 230,000 parts per million left in place. The Program also reinvented monitoring well development with a custom-built rig for use on dune sands. The rig uses a collapsible winch tower operated by an off-road forklift. The Restoration Program transitioned 500 installation-wide monitoring wells to passive sampling. Statistical analysis limited side-

by-side method comparison testing to 5%, allowing the changeover to be fast-tracked in less than nine months.

To minimize waste streams during the large-scale installation of 65 injection and/or extraction wells at a Vandenberg AFB restoration site, the Restoration Program obtained stakeholder approval to divert 39,000 gallons of development water through an on-site treatment system before reinjecting into the subsurface. In addition, approximately 150 cubic yards of cuttings were approved for distribution on site. Using data from previous studies, along with current characterization, stakeholders agreed the materials met standards of protection for both human health and the environment.

Well Development Reinvented
The contractor developed and built a collapsible mobile well development rig. The winch tower is operated and transferred from location to location with an off-road forklift.

Positioned in a climate transition zone, Vandenberg AFB is rich in habitat diversity. A green sustainable approach enables the Restoration Program to fully integrate protection of natural resources, avoiding adverse effects to 17 federally-listed species. Biologists monitor site investigation and remediation activities, marking protected areas and guiding crews through sensitive areas. Over 150 acres of endangered butterfly habitat were protected with only 15 host plants lost. When a groundwater plume encroached on the habitat of the endangered California red-legged frog, a bio-barrier pilot test was implemented and the crucial habitat was protected.

Green Remediation

The Vandenberg Restoration Program fielded multiple successful treatment systems which showed significant results using groundwater recirculation. Systems extract, treat, and then reinject groundwater, with treatment substrates added to create in-situ bioremediation zones in the subsurface. In one instance, a nine-acre plume was reduced from 23,000 µg/L to less than 5,000 µg/L in one year. These systems exemplify green and sustainable remediation. By not adding water, the systems are projected to save over 1.1 billion gallons of scarce water over a five-year period. The Program judiciously placed in-situ bioremediation systems to treat 100 acres of source area, achieving mitigation of contaminated groundwater over a 450-acre expanse and a 50% reduction in plume footprint. Through proactive implementation, the Vandenberg Restoration Program achieved a 99% reduction of volatile organic compounds from 26,900 µg/L to 159 µg/L at one site. At another site, the soil vapor extraction system was converted to passive solar power resulting in $75,000 annual savings in fuel and eliminated carbon emission impacts.

Vandenberg AFB garnered stakeholder approval to convert from traditional purge sampling procedures to passive groundwater sampling techniques. Passive groundwater sampling methods are more sustainable than traditional sampling methods as they require less field labor and equipment, consume less energy, and generate less waste. Instead of side-by-side studies, Vandenberg AFB employed a programmatic statistical comparison of passive sampling data to

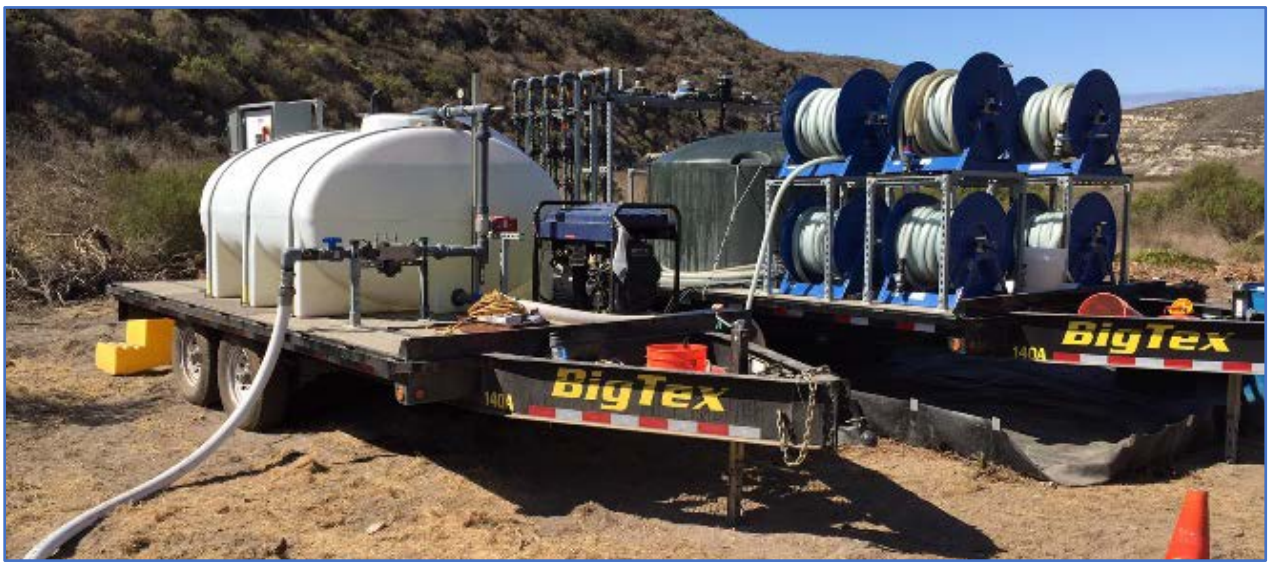
historical data. Working through key data requirements the transition was implemented in just nine months with full stakeholder concurrence. No-purge sampling yielded high-quality data and achieved an overall cost reduction of 20%. Furthermore, the Vandenberg Restoration Program was invited to present its passive sampling transition findings at the Navy's 2016 Remediation Innovative Technology Seminar and again at the 2017 Battelle Technical Conference.

Impacts/Outcomes

Site Closure and return of unencumbered land to support the DoD mission is the overarching priority and most notable success of the Vandenberg Restoration Program. There were 44 IRP sites closed during the accomplishment period with another 55 sites on track to close by 2024. The MMRP is also on track to close 30 of 32 sites by 2021 and reduce UXO risk on 4,300 acres. A continuous process to review protectiveness of treatment systems and technical suitability of new technologies provides a framework to meet Air Force environmental restoration goals, and ultimately DoD mission objectives.

Engagement and ongoing relationships with research institutions safeguard the standing of Vandenberg AFB's place as a testbed for emerging technologies. Current studies demonstrating and validating innovative methods for vapor intrusion at Installation facilities will inform design, development, and placement of sub-slab treatment systems, as well as across DoD sites worldwide.

Enduring relationships between the Vandenberg Restoration Program, state agencies, consultants, and community stakeholders underpin the Program's distinct successful progress. In summary, the Installation's superior qualitative and quantitative environmental restoration endeavors further enhance a secure mission for Vandenberg AFB's trajectory into the future.



Mobile In-Situ Remediation Equipment
The contractor developed mobile in-situ remediation equipment. The equipment helps to implement a sustainable approach to efficiently remediate the array of sites at Vandenberg AFB.