



Site Background and Current Setting

From the mid-1940s until 2003, Vieques Island served as the Navy’s premier training range for ensuring combat readiness of US and NATO forces. Over that time, more than 300,000 munitions were fired during military training operations. In 2005, large portions of Vieques and the surrounding waters were placed on the National Priorities List (NPL) for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The environmental restoration of Vieques remains the highest priority and the costliest project in the Navy's Munitions Response Program.

The former installation was transferred to federal and local agencies, mostly for conservation as part of the Vieques National Wildlife Refuge. The refuge houses a variety of natural resources, including sensitive habitats such as mangroves, subtropical dry forests, lagoons, and coral reefs, and endangered species such as sea turtles, manatees, and brown pelicans. As the cleanup progresses, areas are opened to the general public for recreation and for access to culturally significant sites.



Figure 1. The former Vieques Naval Installation is 23,000 acres, with another 12,000 acres of surrounding waters.

Team Background

VIEQUES ENVIRONMENTAL RESTORATION PROGRAM TEAM:

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Figure 2. Due to unique regulatory, environmental, and natural and cultural resource conditions associated with Vieques, NAVAC Atlantic teams with over a dozen Federal and Commonwealth agencies throughout the East Coast and Puerto Rico. To promote effective communications, the Vieques Environmental Restoration Program Team meets frequently among themselves and with the many other stakeholders, including the local community, academia, and scientific organizations.

Team Position Description

The environmental restoration of Vieques faces the challenges of unexploded ordnance (UXO) and associated contaminants across more than 25,000 acres of land and seafloor, abundant ecologically and culturally sensitive resources, and the often-conflicting objectives of numerous stakeholders, including the local community, educational and scientific organizations, and various advocacy groups. To meet these challenges, the Vieques Environmental Restoration Program Team comprises representatives from Naval Facilities Engineering Command (NAVFAC) Atlantic, the Environmental Protection Agency (EPA), Puerto Rico Department of Natural and Environmental Resources (PRDNER), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Department of Interior (DOI), and United States Fish and Wildlife Service (USFWS).

Team Purpose and Goals

The 2007 Federal Facilities Agreement (FFA) establishes the framework under CERCLA for the stakeholder agencies on the Vieques team to collaboratively implement the Environmental Restoration Program to achieve the following objectives:

- Develop safe, innovative, and cost-effective techniques to reduce risk
- Engage the local community to promote safety and public involvement in the cleanup process
- Apply sustainable approaches to preserve sensitive habitat and endangered species
- Partner with federal, commonwealth, and local authorities to return land to beneficial reuse as quickly as possible
- Support the DoD research community in developing and transferring new approaches to others

Summary of Accomplishments

Risk Reduction and Green Remediation following Hurricane Maria: On September 20, 2017, Hurricane Maria struck Puerto Rico and caused catastrophic damage, including island-wide loss of electricity, water, telecommunications, and most other public services and supplies. In order to ensure public safety, Navy UXO technicians acted immediately after the storm to inspect over 50 beaches and all roads where munitions might have become exposed. Other members of the Vieques Restoration Team volunteered their time to distribute emergency supplies, set up satellite telephone communications, disseminate munitions safety information, and assist the local community with removal of fallen trees and scattered debris.

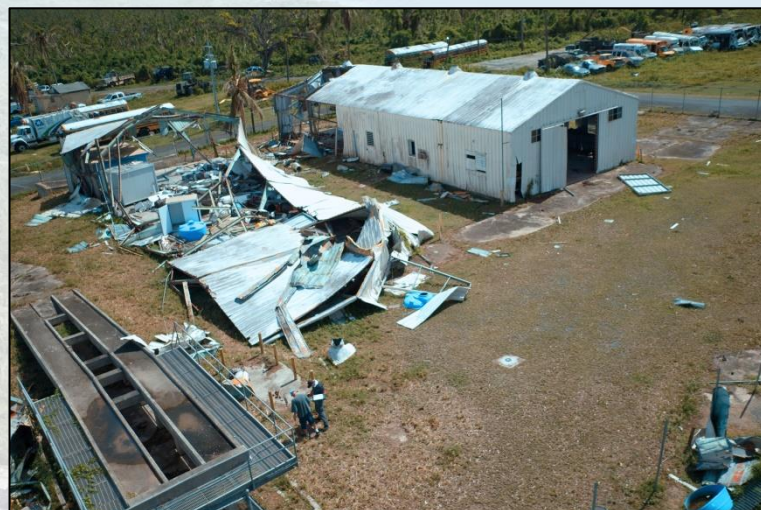


Figure 3. Hurricane Maria damaged or destroyed much of the Navy's Environmental Restoration Program and island's infrastructure.

In addition, the Navy provided logistical support to USFWS and the US Coast Guard in their efforts to salvage numerous boats that had been damaged and grounded during the hurricane. Of particular significance was the 133-foot ship “Ferrel” that ran aground and flipped upside down just offshore of the former Live Impact Area. Due to its size, the Ferrel contained thousands of gallons of diesel fuel that needed to be removed without disturbing the underwater munitions immediately around the ship. The Vieques team provided timely munitions avoidance and other logistical support, enabling the US Coast Guard to remove the fuel before it could leak from the capsized vessel and contaminate the marine environment.



Figure 4. The Navy and its munitions-response contractor provided munitions avoidance and other logistical support to the US Coast Guard during fuel removal from the capsized Ferrel to avoid a release to the surrounding marine environment.

Hurricane Maria caused extensive damage to the office buildings, maintenance facilities, vehicles, access roads, and equipment necessary for the cleanup. Also damaged were signs, fences, and other land use controls intended to raise public awareness and protect public safety. Immediately after the hurricane, the Vieques team used chartered aircraft and cargo ships to bring in portable generators, solar panels, and other mission-critical supplies to quickly repair roads and other infrastructure. As a result, full cleanup activities resumed in December 2017, less than 3 months after the hurricane and despite continued island-wide outages of most services and supplies. The quick response prevented significant delays to the cleanup schedule, restored warning signs and fences to protect public safety, and contributed to the local economy by providing full time work for over 30 local staff.

The base of cleanup operations was rebuilt utilizing significant green and sustainable practices, such as old Conex shipping containers re-purposed for storage and maintenance, solar and LED lighting, energy efficient windows, on-demand water heaters, and repair/reuse of existing materials and equipment where possible. These sustainable approaches are expected to realize a cost savings of several hundred thousand dollars.



Figure 5. Immediately following Hurricane Maria’s devastation, Vieques Restoration Team members volunteered their time to support emergency response in the community, including clearing debris and fallen trees from public areas and delivering munitions safety information along with much-needed supplies to Vieques residents.



Figure 6. The new Environmental Restoration Program base of operations constructed using green and sustainable practices.

Risk Reduction, Accelerated Cleanup, and Green Remediation: Between October 2017 and September 2019, the accomplishments described here demonstrate the safety-focused, cost-effective, and innovative approaches characteristic of the Vieques Environmental Restoration Program. These accomplishments are distinct from past successes submitted previously:

- *Radiological Investigation Addresses Significant Public Concern* – In 1999, depleted uranium (DU) armor-penetrating projectiles were accidentally fired during military training exercises on Vieques. The Nuclear Regulatory Commission and the Navy immediately implemented a cleanup effort, but not all DU projectiles were recovered. In January 2018, working closely with EPA and the Navy’s Radiological Affairs Support Office (RASO), a combined radiological and munitions response team performed a position-correlated gamma scan across the DU area,



Figure 7. Team comprising radiological and UXO specialists locate and remove depleted uranium projectiles and collect soil samples.

followed by intrusive investigations of radiological anomalies, removal of DU projectiles, and collection of confirmatory soil samples. To enable EPA to fulfill their oversight responsibilities within the explosive safety exclusion zones, the Navy provided live video feeds of the DU projectile excavations and sample collection. The use of highly sensitive radiological instruments allowed for detection and removal of DU projectiles not previously identified. The instrument readings and soil analytical results, including split samples collected by EPA, demonstrated that the DU removals were successful in remediating all potential radiological risk.

- *Accelerating Public Access* – Located just offshore of one of the Vieques National Wildlife Refuge’s most visited public beaches is Cayo La Chiva, a 12-acre island of significant importance to the local community and visitors. As a result of a collaborative effort by the Navy, land manager (PRDNER), and members of the local community, the Navy implemented a “green” remedial action in 2019 that accelerated the availability of the island for its planned use by an estimated 3 years, preserved natural resources, and saved an estimated \$2.5 million. The remedial action involved performing munitions clearance in all areas accessible to the public while preserving the island-wide vegetation, with primary focus on planned trails and picnic and overlook areas. Additionally, an educational kiosk was installed to guide visitors to access planned public use areas and discourage access to other areas.



Figure 8. Educational kiosk at trail entrance on Cayo La Chiva.

- *Green Remediation* – In 2019, an eco-friendly remedial action was implemented at a 131-acre munitions site established as a conservation area for USFWS management, saving an estimated \$8.5 million. As part of the remedy, a 2,500-foot-long demarcation boundary was designed and installed to deter unauthorized human access while allowing free passage for local wildlife. Additionally, in cooperation with USFWS, the Navy removed invasive plant species and planted native sea grapes along an important nesting beach for sea turtles, including the endangered hawksbill sea turtle.
- *Preserving the Ecology during Underwater Munitions Removal* – During the removal of underwater munitions to reduce explosive risk, the Vieques team also focuses on preserving the marine ecology, especially threatened and endangered coral species and sea turtles. Prior to munitions removal, scientific divers identify marine animal, coral, and seagrass species that could be damaged or destroyed during removal activities. Three species of federally threatened corals have been identified, as well as coral and seagrass communities that are components of essential fish habitat in the Caribbean. Working together with NMFS, methods have been developed for coral removal and transplantation, as well as restoration of disturbed seagrasses, and these methods are implemented during underwater munitions removal.



Figure 9. Sea grape restoration on an important sea turtle nesting beach.



Figure 10. Abundant corals on and adjacent to a Mark 84 bomb. The Navy worked collaboratively with NMFS to develop methods for coral transplantation to avoid or minimize impacts to the marine ecology, especially threatened and endangered species and critical habitats.

Groundbreaking Technologies and Innovative Strategies:

Identifying and implementing new technologies to reduce both risk and cost is fundamental to the Vieques Environmental Restoration Program. Innovative technologies continue to be identified that will contribute to tens of millions in cleanup cost savings, including:

- *Innovative Cofferdam Reduces Site Worker Risk* – Munitions removal is an inherently dangerous operation and using divers to perform removals underwater significantly increases that risk. To address munitions located offshore, the Navy deployed a temporary, water-filled cofferdam to isolate and dewater the removal area. This innovative approach allowed UXO technicians to successfully conduct the munitions removal without the need for UXO divers. The cofferdam provided for more effective visual and physical access by exposing the formerly underwater environment and munitions, thus accelerating the cleanup while increasing the safety of the operation. Of particular note, the cofferdam exposed many large, heavily encrusted munitions that could be safely removed

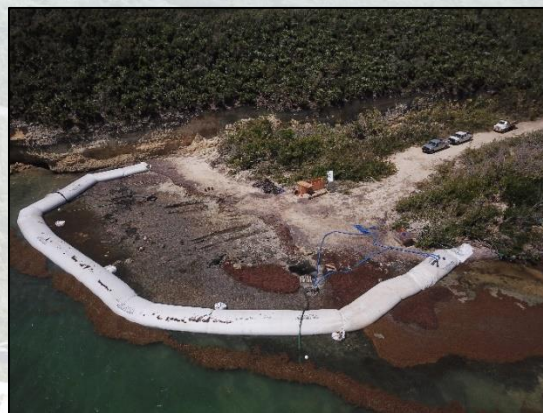


Figure 11. Innovative use of a temporary, water-filled cofferdam significantly enhanced the safety and efficiency of removing munitions located just offshore.

using a remote excavator, an approach that further reduced worker risk by eliminating the need for personnel to be in physical contact with the munitions.

- *Photographic Documentation Yields Key Underwater Munitions Stability Information –*

Throughout DOD, managers of underwater munitions sites have limited information on the potential movement of underwater munitions during major storms and hurricanes; thus, the impact of Hurricane Maria on Vieques offered a rare and significant learning opportunity. In 2019, the Vieques team deployed UXO and scientific divers to locate and photograph hundreds of underwater munitions around the island. These post-Maria munitions locations were compared to historical locations recorded during underwater investigations prior to Hurricane Maria. The evaluation of munitions coordinates and detailed analysis of before-and-after photographs indicated that Hurricane Maria did not cause widespread lateral movement of munitions; in fact, most munitions stayed in place. This information has major implications for the management and cleanup of underwater munitions across the entire DOD Military Munitions Response Program, because it indicates that even major storms like Hurricane Maria are not expected to confound the long-term management of underwater sites. Currently, the Vieques team is sharing this hurricane study with researchers for the DOD Strategic Environmental Research and Development Program (SERDP). The Vieques team is also working with the NAVFAC Munitions Response Workgroup to disseminate information to project managers throughout the entire Navy Munitions Response Program.



Figure 12. 2006 photograph of a Mark 82 general purpose bomb lying on top of a 5-inch projectile on the ocean floor.



Figure 13. 2019 photograph demonstrating the munitions items have not moved over 13 years, even under the influence of such events as Hurricane Maria in 2017.

- *State-of-the-Science Geophysics to Make Roads Safer –* In order to support munitions clearance from approximately 30 miles of access roads throughout the former training areas, the Navy is using the MetalMapper 2x2 for Advanced Geophysical Classification (AGC). This state of the science technology was developed from the TEMTADS system used previously at the site. The MetalMapper 2x2 distinguishes munitions from scrap metal in the subsurface, thereby reducing the amount of digging required to clear the many miles of roads. The Navy and stakeholder agencies are using this technology to carry out removal actions that will support both current and planned road uses, with estimated cost savings of several million dollars.

Partnerships with Government, Academic, Scientific, and Community Stakeholders:

- *Team Approach to Protect Marine Species and Habitat –* Working collaboratively with NMFS and USFWS, the Navy prepared a Programmatic Biological Assessment to support planned underwater munitions removal that may affect protected species or habitats, including developing effective avoidance and mitigation procedures. The Programmatic Biological Assessment includes an innovative online mapping tool that displays NOAA benthic habitat delineations, underwater videos of species/habitats, spatially-located underwater and aerial photographs of munitions, seafloor magnetic anomaly density layers, and locations of planned

underwater munitions removal actions, all part of information that will be regularly updated to allow near-real-time review by NOAA and USFWS staff. This innovative Programmatic Biological Assessment approach will save significant time and resources and foster continued collaboration between the Navy and stakeholder agencies throughout the underwater munitions cleanup implementation.

- *Innovative Community Involvement Program has Local and National Influence* – The Vieques Community Involvement Program is a groundbreaking collaborative effort among the Navy, regulatory agencies, and other stakeholders to provide the public with timely information and an array of opportunities for all sectors of the community to engage in the environmental restoration process. The community involvement strategies incorporate an understanding of the culture and language of the people of Vieques, including reaching out to younger generations to encourage their growth as future integral components of the community and Commonwealth.

In July 2018, Navy representatives attended the EPA’s 2018 Community Involvement Training Program where they shared best practices from the Vieques Community Involvement Program with EPA managers and technical staff from around the country actively involved in community involvement, stewardship, outreach, and educational programs. Collaboration techniques and insight from the innovative Vieques Community Involvement Program were shared on such topics as engaging and revitalizing communities, cultural and stakeholder considerations, crafting collaborative communication, and public meeting facilitation.

In August 2018, the Navy sponsored a Science, Technology, Engineering, and Mathematics (STEM) fair at the Vieques National Wildlife Refuge. The event, the first of its kind in Vieques, brought together students, parents, teachers, the Navy, USFWS, and other stakeholders to engage all Vieques high school students on STEM education, careers, and opportunities. The fair was organized around the types of STEM professionals employed in the Vieques cleanup, including Biologist, Chemist, Engineer, Geologist, Safety Manager, UXO Technician, and GIS Professional. Students received hands on experience with metal detectors, water testing equipment, and rock types. The goal of the fair was to impart knowledge, share experience, and help the students understand how STEM can have a positive impact on their lives and their communities. This invaluable interaction included an open discussion with students about career paths, educational choices, and how to use academic opportunities to achieve professional success and satisfaction. Competencies like teamwork, leadership, and perseverance were emphasized as key to professional and personal success. Each student received educational handouts with information about STEM careers featuring notable Puerto Rican technical professionals as examples.



Figure 14. Vieques Environmental Restoration Team members sponsor the STEM fair. Demonstrations included distinguishing different rock compositions and geological strata found in Vieques, and showcasing surrogates of different munition types and instruments used to detect them.