Secretary of Defense
2021 ENVIRONMENTAL AWARD

INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was commissioned in 1941 with a mission that still holds true to this day: to maintain combat-ready warfighters for expeditionary deployment. Camp Lejeune is a training base that promotes combat readiness of the operating forces and missions of other tenant commands by providing training venues, facilities, services, and support in order to be responsive to the needs of Marines, sailors, and their families.

Environmental, Geographical, and Regional Setting

Camp Lejeune covers more than 156,000 acres in the Atlantic coastal plain of southeastern North Carolina in Onslow County, adjacent to the City of Jacksonville. The Base consists of a diverse environmental setting including approximately 72,000 acres of upland forests, 49,000 acres of wetlands, 26,000 acres of water, and 7,500 acres of urban/developed land with elevations ranging from sea level to 70 feet above mean sea level. The surrounding land uses are a mix of urban, suburban, small town, and agricultural, as Onslow County has grown and developed with Camp Lejeune. Estuaries along the coast support commercial fishing, recreation, and tourism, and residential resort areas along the coast are important to the regional economy.

Community Setting

Camp Lejeune and the surrounding community are home to a large concentration of Marines and Sailors, with an active duty, dependent, retiree, and civilian employee population of approximately 170,000 people. Camp Lejeune enjoys a close relationship with the Base community and neighboring civilian communities.

BACKGROUND

Historical operations, storage, and disposal practices at Camp Lejeune resulted in environmental impacts to soil and groundwater. As a result, Camp Lejeune has been actively engaged in environmental investigations and remediation programs since 1981. In 1989, the United States Environmental Protection Agency (USEPA) placed Camp Lejeune on the National Priorities List (NPL). Camp Lejeune is a leading Department of Defense (DoD) installation, operating at the forefront of environmental restoration programs. By maintaining collaborative relationships with regulatory agencies and the supportive local community, the team has made tremendous progress in investigating and cleaning up over 500 sites to-date under several environmental programs; including Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that covers the Installation Restoration Program (IRP) and Military Munitions Response Program (MMRP), Resource Conservation, and Recovery Act (RCRA), and the Underground Storage Tank (UST) program; with a goal to ensure continued protection of those living and working aboard Camp Lejeune.

Organization, Staffing, and Management Approach

Base Environmental Management Division (EMD) leads the environmental compliance and restoration programs to manage over 75 active sites. The Base is supported by technical, acquisition, and

legal professionals across the Naval Facilities Engineering Systems Command (NAVFAC) organization. Experienced Partnering Teams for the CERCLA (formed in the 1990s) and for the UST programs consist of representatives of Camp Lejeune, NAVFAC, North Carolina Department of Environmental Quality (NCDEQ), and/or USEPA. The teams meet quarterly and are supported by multiple environmental consulting firms supporting the environmental investigations and cleanup process. By bringing these key parties together in regular, structured meetings to discuss and resolve issues, the Partnering Team promotes trust and cooperation that enables the remediation process to move forward more quickly than possible under traditional procedures.

During this achievement period, the team installed over 200 monitoring wells, collected over 1,000 environmental samples (soil, groundwater, surface water, sediment, pore water, sewer vapor, soil gas, indoor air, outdoor air), investigated nature and extent of munitions items at over 5,000 digital geophysical mapping targets, and managed over 4,200 acres of land use controls. The teams' key challenges during Fiscal Years 2019 and 2020 included:

- Assessing the extensive damage from Hurricane Florence and supporting recovery efforts through repairs to damaged treatment systems, land use controls, and monitoring wells; and assisting military construction (MILCON) with critical infrastructure repairs and replacements.
- Identifying and addressing emerging contaminants such as general radioactive material (GRAM) and per- and polyfluoroalkyl substances (PFAS).
- Continuing to implement mission-critical work during the COVID-19 pandemic, including a large-scale munitions investigation, and facilitating virtual Partnering Team meetings.

Community Involvement

The Base provides information regarding investigation and cleanup efforts to the public through the community relations program which includes a Community Involvement Plan, Restoration Advisory Board (RAB), Information Repository file at the Onslow County Library, and public announcements. The first CIP was prepared for Camp Lejeune in 1990, following the Base's inclusion on the NPL, and is updated every five years. The RAB was established in 1995 and meetings are held quarterly, are open to the public, and provide an information exchange among community members and the Partnering Team. During this achievement period, the key successes include:

- Publishing PFAS communication tools including handouts, fact sheets, and an informational website.

PFAS communication tools

Virtual Partnering Team Meetings – Installation Restoration (left) and UST (right)

- Implementing enhancements based on community interviews and feedback including:
  - Increasing the advertisement of RAB and public meeting announcements on the Camp Lejeune Facebook page, through public service announcements, community calendars, and the Base's weekly email "blast" to spread the word and gain attendees.
  - Publishing success stories in newspapers and on digital media addressing timely topics such as use of solar power for operating treatment systems and hurricane preparedness.
- Receiving positive feedback at a RAB meeting when requesting input for the Community Involvement Plan Update.

Environmental Restoration Agreements and Plans

This timeline shows the key environmental restoration agreements, dates of preparation, and last revision.

Environmental Restoration Agreements and Plans (Latest Revisions)

Relevant Environmental Restoration Documents

The Camp Lejeune team has been developing the investigation and remediation strategies for the IRP, MMRP, RCRA, and UST Program, working to develop solutions that support the mission of the Marine Corps, while meeting Navy metrics and regulatory requirements. During Fiscal Years 2019 and 2020, 70 work plans and reports were approved by the regulatory agencies and finalized and included the key tabulated documents.

Environmental Restoration Work Plans and Reports Fiscal Years 2019–2020	
Program Management Documents and Schedules	4
Proposed Plans, Decision Document, Records of Decision (RODs), and post-ROD Documents	15
Long-Term Monitoring (LTM) Work Plans and Reports	20
Installation Restoration Program Investigations	4
Munitions Response Program Investigations	4
Pilot Studies	6
Emerging Contaminants	4
Vapor Intrusion	13
TOTAL	**70**

SUMMARY OF ACCOMPLISHMENTS

Accelerated Environmental Cleanup: Site 88 Permanganate Tracer Study Leads to Optimization of the Selected Remedy

IRP Site 88, a former dry-cleaning facility, consists of a 51-acre tetrachloroethene (PCE) plume. To optimize treatment, the site has been divided into three zones and a combined remedy approach was designed to complement the specific conditions in each zone.

In the Record of Decision (2019), the selected remedy for Zone 2, where volatile organic compounds (VOCs) are present in groundwater up to 180 feet bgs at concentrations more than 1,000 times their cleanup levels and indicative of dense non-aqueous phase liquid, was in situ chemical oxidation (ISCO) via horizontal directionally drilled (HDD) injection wells and groundwater recirculation. During the conceptual design phase in the Feasibility Study, this alternative was presumed to require the distribution of permanganate through 17 HDD wells in four rows ranging in depth from 40 to 180 feet apart, oriented perpendicular to groundwater flow. It was estimated that groundwater would require three years to travel between rows.

A tracer study was conducted to evaluate the technical feasibility of permanganate distribution through a double-ended HDD injection well and whether extraction and recirculation would enhance the distribution of permanganate at depth. The extent of distribution was evaluated by analyzing the presence of sodium chloride tracer and changes in concentrations of PCE and daughter products in groundwater, as well as through geophysical mapping, before and after injection and recirculation. The study indicated that the HDD well, coupled with the extraction and recirculation system, could effectively deliver and distribute oxidant into the deeper aquifer. Lateral influence of recirculation was observed between 150 and 200 feet from the injection well. Based on the findings of this study, the Remedial Design specified 10 blind-end HDD injection wells in three rows spaced between 125 to 200 feet apart to target the treatment area,

Site 88 Pre-Remedial Design Study

Site 88 Horizontal Well Driving

representing a savings of approximately $2M in drilling costs. Through injection and recirculation, permanganate will contact one full pore volume in Zone 2 within one year.

In addition, active remediation goals, or intermediate endpoints for active treatment, were defined based on the concentration for each VOC at which predictive modeling indicates attenuation to the Federal Maximum Contaminant Levels within 100 years. Regulatory concurrence of the active remediation goals provided an exit strategy and yields cost savings of approximately $4M for each injection event avoided by transitioning from active treatment to monitored natural attenuation. Implementation of the full-scale remedy was initiated in summer 2020.

Innovative Technology Demonstration/ Validation and Implementation: Summing Up Ten Years of Optimization of the Environmental Program

Long-term Monitoring (LTM) at sites with remedies-in-place has been ongoing at Camp Lejeune for more than 25 years. To minimize remediation timeframes and reduce life cycle costs, the LTM program has been aggressively optimized through innovative technologies and focused treatment. The

Navy has invested approximately $2M at seven different sites to evaluate a range of technologies including in situ aerobic bioremediation, in situ chemical oxidation (ISCO), ERD, air sparging (AS), biobarriers, groundwater recirculation to enhance substrate delivery and reduce potable water use, bioaugmentation, and subgrade biogeochemical reactors (SBGRs) to remediate polycyclic aromatic hydrocarbons and chlorinated volatile organic compounds (CVOCs). Where the technology evaluations effectively reduced contaminant mass, remediation timeframes were reduced. Where treatment was not as effective, the frequency and scope of LTM was optimized to reduce life cycle costs. Three sites with notable findings are discussed below.

In conventional applications, AS has been demonstrated to be effective at Camp Lejeune. In support of LTM optimization, the effectiveness of innovative applications of AS was evaluated at two sites. At the first site, low concentrations (less than 30 µg/L) of trichloroethene (TCE) and vinyl chloride (VC) in surficial aquifer groundwater were attenuating slower than anticipated. The surficial aquifer at the site is locally confined by a clay lens. AS was cost-effectively conducted by injecting air into an existing monitoring well screened beneath the clay lens using a skid-mounted compressor for two one-week injection events. Immediately after the test, TCE and VC concentrations reduced to below cleanup levels, proving the concept that AS beneath the clay lens was effective to treat surficial aquifer groundwater. Three months following treatment, the TCE concentration increased above the cleanup level. A more robust application of AS is planned in Fiscal Year 2021, with the expected outcome of closing the site well ahead of projected timeframes.

At the second AS site, elevated concentrations of CVOCs (approximately 19,000 µg/L) were discovered in groundwater in an area outside of the influence of an existing pump and treat system, up to 125 feet bgs. Nested AS wells were installed at 135 feet bgs, 95 feet bgs, and 40 feet bgs to treat impacted groundwater at depth. This 'booster' approach to treating the full water column proved successful, as CVOC concentrations decreased 94 to 99% and accumulation was not observed in the shallower groundwater. Because of this focused treatment in the high concentration area, the selected remedy in this area may be monitored natural attenuation, instead of active treatment, representing a total life cycle costs savings of up to $4M.

At another site where CVOCs in groundwater were attenuating slower than anticipated, a solar-powered SBGR was installed to promote anaerobic biodegradation. The SBGR technology is an in situ remediation concept that represents an effective, sustainable, and cost effective remediation approach. Contaminated groundwater is extracted and treated within the SBGR, and groundwater that infiltrates out of the SBGR bottom is laden with organic carbon and other nutrients. The amended groundwater that leaves the SBGR under the enhanced and sustained hydraulic gradient follows the same preferential pathways as the site contaminants when they naturally migrated out of the source area over time, providing an effective in situ treatment in these contaminated zones. The application was successful at the site, as conditions conducive to reductive dechlorination were created and decreasing trends of parent products and increasing trends in daughter products were observed. As a result, a second SBGR was installed at the site in Fiscal Year 2020 to reduce CVOC concentrations downgradient in a low-lying area, where the high groundwater table has excluded other forms of active remediation. The effectiveness of the SBGR is projected to reduce the remediation timeframe of the site by 50 years, resulting in life cycle costs savings of approximately $1M.

SBGR with Solar Power

Air Sparging

Partnerships Addressing Environmental Restoration Issues Between DoD and Other Entities: Basewide PFAS Preliminary Assessment and Site Inspection

In 2018-2019, a Basewide Preliminary Assessment (PA) was conducted to evaluate whether there were potential PFAS release areas. The objective was to identify areas on the Base where aqueous film forming foam (AFFF) or other PFAS-containing materials may have been released to the environment. Over 200 areas were initially identified through the archive search, interviews, and site reconnaissance. Two weeks of interviews were coordinated and conducted to confirm information from document search, obtain new supporting documents, and gain new information about other possible releases. The interviews included over 30 individuals across many Base commands (e.g., EMD, public works, fire department, aircraft rescue and firefighting, Marine Flight Operations, and Marine Corps Air Station New River Operations, Range Control). Because of the team's close working relationship with Base commands, the information gathering process was seamless; therefore, expediting the process for identifying or ruling out sites.

As a result of the due diligence process and collaboration with USEPA and NCDEQ during the PA, agreement to investigate 52 out of the over 200 areas was achieved. A Site Inspection was conducted in 2020 to evaluate the presence or absence of PFAS at the 52 areas. Over 190 new groundwater monitoring wells were installed at these areas, over 100 soil samples were collected, and over 240 groundwater samples were collected from existing and newly installed monitoring wells. Multiple large field teams were mobilized to increase efficiency, minimize impacts to Base operations, and reduce costs. Founded on a long-established working relationship over a dozen years, the team was able to realize cost avoidance of $7M by reducing the number of sites to investigate and expedited fieldwork.

PFAS Investigation

Because Camp Lejeune was one of the first installations to conduct such a large scale Basewide PFAS PA/SI, it is used as an example for other Navy and Marine Corps Installations. Lessons learned from conducting this work are passed along to the other installations.

Reducing Risk to Human Health and the Environment: Supplemental Remedial Investigation at Sites 6 and 82

As a follow-on to previous investigations, aquifer testing, and groundwater treatment plant evaluations at IRP Sites 6 and 82, pilot studies were conducted to evaluate alternative treatment technologies to reduce risks to human health and the environment and for future remedy optimization. The sites consist of a large waste disposal area with potential munitions items and volatile organic compounds (VOCs) in groundwater where the remedy has been in-place since the early 1990s. Investigations discovered new contaminant sources (radiological) and groundwater contamination were more widespread than the existing remedy was designed to address.

Two pilot studies, using different technologies, were conducted to evaluate the effectiveness of treatment of VOCs in a complex, multi-aquifer layered system that includes unconsolidated sand, cemented sand, and limestone.

- The first study was biosparging to treat chlorobenzene, following a time-critical removal action to remove drums identified as the source. Residual soil concentrations of up to 2,600,000 micrograms per kilogram (µg/kg) remained in place following the removal action, and the maximum groundwater concentration was 4,000 micrograms per liter (µg/L). As a result of the study, soil concentrations were reduced to below screening criteria, and remained below four months after discontinuing biosparging. Groundwater concentrations were also reduced to below cleanup levels. The biosparge wells' radius


SBGR Trenching


SBGR Installation


SBGR Recirculating System


Radiological Screening

of influence extended at least 50 feet and impacts were seen as far as 230 feet from the nearest injection point. The results indicate the biosparge system effectively removed chlorobenzene from the soil and groundwater.

- The second study was installation of SBGRs and a recirculation system to treat three VOC source areas not being captured by the groundwater treatment plant. The pilot study created favorable conditions for enhanced reductive dechlorination at distances up to at least 100 feet downgradient from the SBGRs in the surficial aquifer. Parent compound concentrations within the SBGRs were completely degraded via biotic and abiotic processes, while the influent concentrations were stable. Based on calculated first-order decay rates at monitoring wells within the SBGR-influenced areas, a remediation timeframe to achieve cleanup levels is estimated at 10 years with continued system operation. Overall, SBGRs provide an effective means of mass removal through three processes: mass removal within the SBGR footprints through excavation (e.g., 30-40 tons of PCE removed from SBGR); enhancement of reductive dechlorination in the zones downgradient from the SBGR; and recovery and treatment of recirculated contaminated groundwater within the SBGRs.

Results from these studies treated source areas to significantly reduce long-term risk to human health and the environment and the results will be used to re-evaluate the overall site remedy.

During installation of the SBGRs, onsite munitions support and radiological monitoring were conducted based on formal waste disposal activities and the potential to encounter GRAM. During monitoring, radiation levels exceeded the project action levels. The soil was spread out on radiological screening yard pads by an excavator in approximately 6-inch thick layers and surveyed. A total of 650 tons of soil and 103 radiological commodities were generated and packaged for disposal as low-level radioactive waste.

Green Remediation: Tracking Sustainability Metrics

Cleaning up sites improves environmental conditions, but cleanup activities also use energy, water, and natural resources, cost money, and affect the community. Camp Lejeune strives to implement best management practices into each phase of cleanup activities. During this achievement period the following practices were implemented:

- Solar power was used to fuel the treatment of 21,000 gallons of contaminated groundwater, saving 200 kilowatts per hour.
- New sampling technologies were implemented, reducing the wastewater generated by 1,500 gallons and saving $20,000.
- Recycled 8 tons of material, reducing carbon dioxide emissions by 14 metric tons.
- Reduced potable water use by ~23,000 gallons (a 90% reduction) during pilot study implementation.


Using Solar Power for Site Cleanup