



Protecting Yesterday's Dream, Today's Mission, Tomorrow's Vision



Introduction and Mission

Cape Canaveral Air Force Station (CCAFS) is the operational hub for the Eastern Range, managed by the 45th Space Wing (45SW). CCAFS occupies 15,800 acres of the Central Florida Coast. Since the inception of the U.S. Space Program, CCAFS has served as the world's premier gateway to space. Its global importance is underscored by 16 launches during the award period, with payloads worth up to \$500M. Wing activities bring 22,000 people and >\$1B of annual economic activity to the area.



Historical view of CCAFS coastline during the early space program. Most of these launch complexes are now ERP Sites.

Mission support, aerospace worker protection, and aggressive natural/cultural resource preservation are major considerations in the CCAFS environmental restoration program (ERP). As a barrier island facility, CCAFS occupies unique, sensitive dunal and scrub habitat nestled between the Atlantic Ocean and the Banana River Lagoon, which is part of the most ecologically-diverse estuary system in North America. The barrier island ecosystem provides a home for dozens of rare and threatened species and is also the location of numerous historical sites. Space launch, environmental restoration, and environmental stewardship go hand-in-hand at CCAFS!

Restoration Program Overview

Historic space launch activities resulted in significant environmental contamination. Early management practices led to the release of toxic industrial chemicals and fuels. Industrial solvent

use left a legacy of 1,000+ acres of contaminated groundwater (GW) and highly-contaminated source areas. Historical paint containing polychlorinated biphenyls and metals led to widespread soil impacts due to sandblasting with little dispersion control.

The 45SW ERP meets and surmounts these challenges using cutting-edge technology, innovation, and teamwork to ensure the safety of the workforce and the integrity of the Wing's unique natural assets. Since inception, the ERP has identified 127 Sites covering almost 2,500 acres. Of the Sites, 74% have been returned for unrestricted mission use and another 24% cleared for safe industrial use with controls, as shown in Figure 1. At 2 of the 3 remaining sites, final remedies were initiated during the award period. At the final site, an active launch complex, ERP personnel are working with the deactivation team to align cleanup with mission needs for the site's final launch. **All sites are on-track to achieve RIP by 2012, exceeding DoD's 2014 goal!**

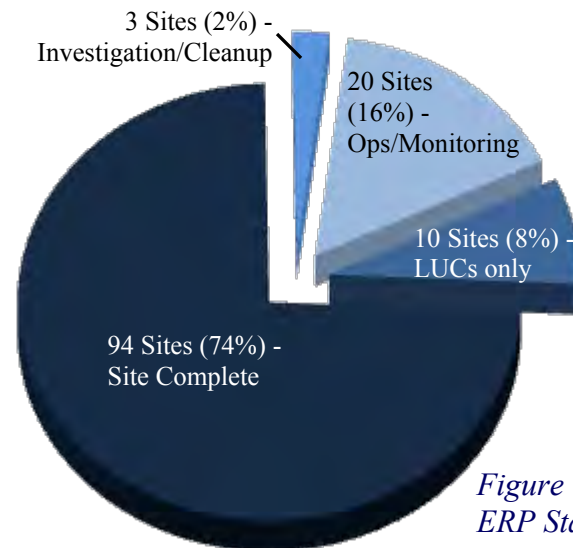


Figure 1 —
ERP Status

Restoration Management

Cape Canaveral's management team (3 project managers, an engineering technician and 3 support contractors) oversaw a suite of remediation contractors, including 3E (8A), CORE (HUB Zone), Tantara (8A), and Jacobs, and executed \$23 million of investigation and cleanup during FY09-FY10 using Army Corps of Engineers contracts.



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The CCAFS ERP operates under a Resource Conservation and Recovery Act (RCRA) permit (Feb 2010). Recent discussions with the Florida Department of Environmental Protection (FDEP) eliminated an 11-year regulatory overlap, combining the petroleum and RCRA regulatory management plans.

FDEP oversees both RCRA and petroleum cleanup. Other regulatory entities coordinate and comment as appropriate, including the Environmental Protection Agency (EPA), Fish and Wildlife Service, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, St. Johns River Water Management District, and National Estuary Program.

The formal partnering relationship established among key stakeholders in 1995 is the foundation of the program's success. Delegated decision-making forged this successful cooperative relationship by giving ownership to working-level team members. Guiding principles include standard ground rules, specialized decision tools, and custom guidance documents, ensuring consistency and seamless member transition (Table 1). The Restoration Partnering Team (RPT) is a model for formal partnering and is consistently recognized as a leader in environmental cleanup.

Table 2 highlights key members of the CCAFS ERP team during the award period. Nearly 400 collective years of professional experience enables the team to make difficult decisions, find innovative solutions, surmount obstacles, and reach consensus on potentially divisive issues.

Objectives and Accomplishments

Overall objectives of the ERP at CCAFS are to:

- 1) Support the Wing mission by returning contaminated land for mission re-use
- 2) Protect against worker exposure on Sites
- 3) Effectively steward all resources on ERP Sites
- 4) Seek new technologies and opportunities that increase sustainability and innovate, streamline, and accelerate the program
- 5) Maintain an open dialogue with stakeholders

Table 1—Governing Documents & Decision Tools

RCRA Permit and CAMP , Feb 2010
Petroleum Memorandum of Agreement , Aug 1999
Decision Process Document , Sept 2006
Field Sampling Procedures , Oct 2009
Cape Operating Procedures , May 2010
Quality Assurance Program Plan (QAPP) (including generic Wing template for the UFP-QAPP), Oct 2010
Conceptual Site Models , June 2009
Programmatic Exit Strategy Process Flow , Jul 2010 (draft)
Comprehensive Restoration Information Tracking—Electronic Repository (CRIT-ER) database
Program Orientation and Status Update Manual , Mar 2010
Community Relations Plan , June 2010

The following subsections describe how these objectives were successfully accomplished.

Partnerships—The 45SW ERP is built on a foundation of partnering and cooperation. The Wing's Tier I RPT serves as a DoD benchmark for team building, effective communication, and efficient site closure. The decision tools and guidance documents developed and maintained by the RPT (Table 1) provide the foundation for consistent decisions, but also encourage streamlining and technical innovation.

Table 2—ERP Team Members

Patrick Giniewski , 45 CES/CEA, Asset Manager and RPM
Michael Bowers , 45 CES/CEAN, Project Manager
Regina Butler , 45 CES/CEAN, Project Manager
Mark Kershner , 45 CES/CEAN, Project Manager
Ronald Bond , 45 CES/CEAN, Engineering Technician
John Armstrong , FDEP
Bob Beacham , Army Corps of Engineers—Mobile
Harlan Faircloth , CORE Engineering and Construction
Joe Foran , The Management Edge
Paul Goldsmith , CORE Engineering and Construction
Jayson Ilic , Air Force Center for Engineering and Environment
Brad Jackson , Army Corps of Engineers—Mobile
Deda Johansen , Jacobs Engineering Group
Loren Lorenz , Portage, Inc.
Lindsay Morgan , Portage, Inc.
Eric Nuzie , FDEP
Ariane Staples , Portage, Inc.
Sharon Stone , Space Command Headquarters
Dennis Theoret , 3E



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Progress at one of the remaining Sites moving toward Remedy in Place is a concrete example of how the RPT has streamlined restoration. Twenty-seven separate operational areas included in the Site have low to moderate soil contamination. Based on past experience with similar contamination, interim measures (IMs) have been initiated and all 29 are proceeding through streamlined assessment and cleanup, going from “Site Investigation” to full delineation to IM soil removal to a “No Further Action” (NFA) decision document (unrestricted re-use). In 2010, the removal of approximately 7,000 cubic yards (CY) or 3.5 acres of contaminated soil was contracted. All 29 areas will thus achieve unrestricted re-use, closing out the Site. This streamlined process relies on years of team experience. It ensures worker protection, mission support, and complete site characterization, while eliminating the need for the full cadre of RCRA documents in each area. This avoided millions of dollars and 3 to 5 years of additional work.

The recent construction of two innovative hydrologic treatment basins in the CCAFS industrial area underscores the installation's many successful stakeholder relationships. Regulatory conflicts between storm water management and groundwater cleanup were identified and resolved in consultation with state regulators. While technically feasible, there was initially great regulatory resistance to a marriage of storm water management and groundwater plume control. The RPT worked diligently to break down barriers encountered during design and implementation. Tireless coordination with 10+ regulatory and government agencies achieved success. The \$4 million basins came on-line in 2010, providing an unprecedented combination of plume and storm water control, and a highly visible example of Green Remediation.

In addition to regulatory partners, the RPT reaches out to other stakeholders, including tenants like the National Aeronautics and Space Administration, the National Reconnaissance Office, and the Navy, as well as groups who have an interest in the Wing's cultural assets, such as

the Lighthouse Foundation (LF), the Federally-Recognized Tribes (FRT), and the State Historic Preservation Office (SHPO).

In 2009, the RPT consulted with cultural stakeholders while pioneering a flexible and innovative soil remedy to address lead contamination at the historic Cape Canaveral Lighthouse. The process integrated base management, the base archaeologist, the SHPO, the FRT, and the non-profit LF. Initially, the presence of early settler and prehistoric artifacts almost derailed the project, threatening to permanently close the historic site to public access. Through consultations with the SHPO, FRT and LF, the RPT identified a creative combination of excavation (200 CY) with screening and tilling (3,374 CY, 1.6 acres) to remediate the lead contamination and address stakeholder concerns.

In 2009, the team proactively organized a tour for senior-level Southeast Region managers (Tier III Partnering Team), including representatives from all services and various regulatory entities. The tour visited 8 ERP sites, highlighting natural, cultural, and mission-related challenges.

In summer 2010, organizers of EPA's Technical Support Project (TSP) conference in Orlando felt that members of all three TSP forums (Federal Facilities, Groundwater, Engineering) would benefit from a first-hand view of AF Sites, remediation projects, and real-world challenges at CCAFS. The TSP provides technical input on complex projects throughout EPA.



Larger hydrologic treatment basin during construction—Jun 09. An innovative sustainable approach to plume control!



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At the request of EPA's TSP leads, RPT personnel worked throughout summer and fall 2010 to organize a first-hand view of sites, projects, and real world challenges at CCAFS. During the full-day tour 80+ participants visited 9 Sites and 3 remediation systems. A poster session displayed 17 posters and multi-media presentations on base cleanup and environmental initiatives, many of which have been presented at national and international conferences. The Federal Facilities Forum co-chair called it "an excellent (informative and diverse) field trip...a good mix of environmental cleanup actions, technical posters, information exchange...a great success!"

Cape Canaveral RPT members routinely transfer lessons learned and success stories. Technical briefings are presented at DoD, state, national, and international conferences. Over the award period, 7 different briefings or posters were presented at 5 venues (Table 3).

Table 3—Publications and Conferences

<i>Event</i>	<i>Presentation</i>
Florida Remediation Conference, Oct 2008	Briefing: Innovation and Implementation—A Retrospective on Cleanup Technologies Tested & Deployed at CCAFS
FDEP Industry Conference, Dec 08	
EPA Clean-Up Information (CLU-IN) Triad Month, Aug 2009	Webinar/Pod-Cast: Tools and Approaches for Managing Multi-Year, Multi-Site Datasets to Allow and Enhance Triad Implementation
AFCEE Technology Transfer Conference, Apr 2010	Briefing: Comprehensive CSMS: Paving the Way for Success at Complex Sites
	Briefing: Multi-Site, Multi-Project Triad
Remediation of Chlorinated and Recalcitrant Compounds—International Conference (Battelle)	Poster: In-Situ Chemical Oxidation Treatment within Active Launch Complex 37
	Poster: Emulsified Vegetable Oil Treatment on CCAFS Chlorinated Solvent Source Areas
	Briefing: Complete In-Situ Reduction of DNAPL Using Thermal and ZVI Soil Mixing

Accelerated Cleanup—While proactively seeking opportunities to accelerate projects and support mission requirements, the RPT aggressively monitors milestones, schedule, and budget to ensure the ERP remains on track. During the award period, the ERP planned and executed projects totaling approximately \$23 million (70 projects on 33 sites). More than 90% of the budget was performance-based, exceeding the 50% AF performance-based contract (PBC) goal.

Altering the technical and contracting approach of a large project to focus it on sustainability, the RPT achieved more than \$3.5 million in lifecycle cost savings. To realize this savings, in 10 months the RPT modified the Corrective Measures Study and the Statement of Basis/Record of Decision (SB/ROD), expedited legal/technical review, met public participation requirements, finalized the SB/ROD, and contracted the work under a performance-based strategy.

Leveraging these savings, astute planning allowed for acceleration of existing project schedules to meet Air Force RIP goals. The RPT was able to fast-track 12 projects totaling approximately \$3.5 million in response to new data and Environmental Restoration Program Optimization (ERP-O) or Five-Year Review recommendations, with the following results:

- Accelerated investigation activities at 44 facilities by 1 year, allowing early initiation of related removal actions.
- Accelerated 5 soil removals to return 29 areas (3.5 acres) for unrestricted soil re-use 1 to 2 years early.
- Designed or implemented changes to increase efficiency of 2 systems, with a projected cost reduction of \$10K/yr (electric) and \$13.5K/yr (operations), saving \$2.5M lifetime.
- Fast-tracked Five-Year Review recommendations to complete GW conceptual site model at 2 Sites and identify an unknown source area.
- Implemented an ERP-O-recommended vapor intrusion study to ensure worker protection at 8 facilities.

During the award period, the CCAFS ERP underwent its first external ERP-O. The RPT's exceptional attention to detail and site knowledge facilitated a mutually beneficial review. A 150-page informational package summarizing history/status at 32 sites and presenting detailed conceptual site models for 13 complex sites made a 1 week ERP-O possible (versus 2 weeks elsewhere). During ERP-O team deliberations and



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document reviews, data requests were resolved on a same day basis using well-organized and easily-accessible databases to provide key information. At ERP-O conclusion, the team lead praised the unprecedented planning and data availability that ensured true collaboration!



Members of the visiting ERP-O Team enjoy a tour of various IRP sites in June 2009.

Reducing Risk to Human Health and the Environment

—In anticipation of new missions and tenants in the dynamic Wing environment, the ERP worked from 2002 to 2008 to complete a comprehensive Preliminary Assessment of 1,281 previously unassessed facilities. A thorough but streamlined screening process allowed Cape Canaveral to eliminate 1,090 (85%) of the original facilities for no further action. Delineation and/or expanded sampling at the remaining 191 facilities garnered an additional 155 NFA recommendations. The remaining 36 areas were fast-tracked for remediation, with 3 soil removals completed during the reporting period, 29 additional removals fully funded in FY2010, and 4 areas grouped with nearby sites. An astonishing 1,248 facilities were cleared for safe and unrestricted future land use over the course of this exhaustive effort.

Mindful of ERP's important role as a mission partner in the safety and health of aerospace workers, land use controls (LUCs) are promptly instituted anywhere environmental contamination is identified, thus protecting health and mitigating possible contaminant spread. Currently 32 Sites are in the formal LUC

program due to residual contamination. Another 29 areas have interim LUCs, needed only until pending actions are complete.

Approximately 2,000 acres are currently managed under the CCAFS LUC program. As part of this program, ERP personnel actively participate in the dig, design, and construction review process (including AF Form 103s, 332s, and 813s), completing an average of 34 reviews per month. The interaction with construction project proponents during weekly meetings enhances the protectiveness of the work clearance process. During this dialogue, ERP personnel are able to assess potential impacts from upcoming mission-related construction and, where possible, adjust the schedule of planned ERP activities to best support the mission, protect workers, and contain contamination.

Between detailed studies, aggressive actions, and protective LUCs, the ERP ensures that no stone is left unturned in pursuit of risk reduction and worker protection.

Innovative Technologies—As little as 10 years ago, dense non-aqueous phase liquid (DNAPL) chlorinated solvents were believed to be nearly impossible to remove. Although they still present a significant and persistent challenge, innovative technologies made treatment a viable option. Between 2003 and 2008, CCAFS successfully implemented over \$30 million of innovative treatment technologies targeting DNAPL in GW. Models indicate that these technologies will reduce cleanup time by tens to hundreds of years, depending on the site. During the award period, additional treatment totaling ~\$12.5M was funded at 9 hotspots across 6 Sites (>7 acres). One Site has already achieved RIP as a result of this treatment. Another will achieve FY11 RIP due to award-period activities. The remaining Sites are already in RIP with on-going treatment.

Emulsified vegetable oil (EVO) and emulsified zero valent iron (EZVI), two innovative technologies that were tested and developed at CCAFS, have been implemented successfully at multiple Sites. Both technologies rely on



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enhanced bioremediation and sequestration. During the award period, over 750,000 gallons of EVO injection was initiated or completed across six chlorinated solvent hot spots and high concentration secondary sources. Additionally, two EZVI injection projects were funded in FY09 and FY10 to treat three DNAPL source areas (1.7 acres) with >55,000 gallons of EZVI. Results from recent injections are still pending, but experience at other Sites indicates that trichloroethene mass destruction approaching 95% is achieved by EZVI and >90% reduction of daughter products is achieved by EVO. Both technologies are considered “green,” with no long term operational or electrical requirements.

In situ chemical oxidation using ozone sparging, another innovative technology, is being utilized to treat 3 other high concentration secondary solvent hotspots at 2 Sites. The injection systems are monitored, maintained, and optimized remotely over the internet. Ozone is being injected into 150 sparge points at a rate of 5 to 25 lbs/day. In addition to achieving >75% contaminant mass reduction, the oxidation process completely destroys contaminants without leaving more toxic by-products.

Promoting Small Business—CCAFS plays a vital role in the Space Coast economy. By partnering with local small and disadvantaged businesses, the ERP supports program goals and contributes to surrounding communities. Creating jobs, strengthening the local economy, reducing environmental impacts from travel, and building local expertise are significant benefits of these relationships. Additionally, local businesses are routinely more flexible and responsive to changing needs than larger firms outside the region.

The ERP's commitment to promoting small businesses and building a dynamic, diverse, and innovative team is underscored by the award of \$19.8M (88% of the CCAFS ERP budget) to 8(a) small and economically-disadvantaged companies, Alaska Native corporations, and HUBZone businesses during the award period. Annually in 2009 to 2010, this created and sustained more than 30 local jobs.

Restoration Advisory Board—The RAB has been an integral part of the ERP since 1995. The 19 members represent a cross-section of residents from 11 neighboring communities and 5 local and state government organizations.

The RPT nurtures this alliance by providing updates on key projects, conducting tours, ensuring open communication, responding rapidly to feedback, disseminating program summaries and statistics, and deploying user-friendly web-based applications. Eight quarterly RAB meetings were held in 2009 and 2010, incorporating 32 presentations on varied topics. In 2009, RAB members were offered a tour showcasing 8 remediation Sites. Dr. Norman Murphy, RAB Community Co-Chair, commented “The tour provided a ‘hands on’ realistic look at ERP sites and projects.”

To provide greater transparency, the RPT developed and maintains a publically-available web-based



EZVI and EVO injections at Hangar K, Sept 2010.



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electronic archive” (EA), which contains over 11,268 document and correspondence items. During the award period, 157 documents and 241 correspondence items were incorporated, including an updated version of CCAFS’s RCRA Permit and two SB/RODs.

The EA ensures public access requirements are met and exceeded, while providing remote access to off-site stakeholders. In 2009, the website was accessed over 2,500 times from 300+ locations, ensuring continued program transparency.

Green Remediation—

CCAFS’s commitment to green remediation is illustrated by the RPT’s routine evaluation of ongoing projects, seeking opportunities to enhance sustainability by reducing carbon dioxide (CO₂) emissions, cost and overall environmental footprint. The hydrologic treatment basins discussed under the “Partnerships” section are a prime example. Designed to control large groundwater contaminant plumes emanating from multiple solvent releases in the Cape industrial area, the 14-acre 2-basin system exerts hydraulic control on contaminated groundwater.

Completed in 2010, the system protects the Banana River Lagoon by capturing low-level residual solvents as groundwater transports them downgradient. The basin system replaced two energy-intensive systems with sustainable treatment technologies including 8 solar-powered aerators, 6,900+ native plants that enhance phytoremediation and evapotranspiration, natural mixing, and photooxidation. This “first of its kind” marriage of environmental cleanup and storm water control protects the sensitive lagoon from contaminant migration, as well as from unmitigated storm water flow.

From cradle to grave, the project was engineered for sustainability. Tangible benefits include:

- \$60K/yr electrical savings vs legacy systems
- \$30K/yr operational savings vs legacy systems
- ~\$18M savings over 200-year life of plume
- 200,000 cubic yards of soil stockpiled on-base for future use
 - o \$4M savings in future fill costs
 - o Reduced hauling lowers CO₂ emissions
- Constructed alternate haul route to minimize transportation of soil, eliminating 6,500 miles of travel and 14.8 tons of CO₂ emission
- Recycled 1,700 tons of concrete for use in stabilization, saving \$85K

Based on this success, a smaller interceptor basin has been conceptualized at another Site. This simpler system will save ~\$10K/yr in energy versus current electric canal aerators, paying for itself in 20 to 30 years projected plume duration: 100-200 yrs).

Sustainability is also key to source treatment, as demonstrated by cleanup at the Wing’s last major DNAPL source area. Original plans

specified alcohol flushing over 2 acres. Between FY09 and FY10, the RPT adopted an energy efficient and less laborious approach using EZVI and EVO. This modification reduced cost by \$3.5M and eliminated a \$400K/yr energy expenditure for alcohol circulation.

Conclusion

The 45SW takes pride in their mission and its role in assuring access to the high frontier. ERP personnel work diligently to support that mission, translating the AF legacy of vision, innovation, and responsibility into efficient, effective, and dynamic restoration activities.



Basin solar panel and compressor