Navy's Portfolio Optimization: In Situ Remediation Sites

Presented By
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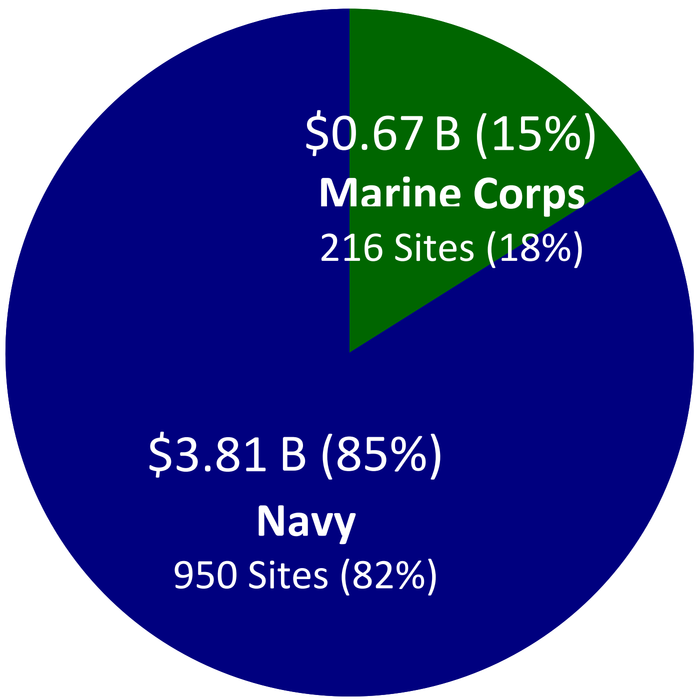
Objectives

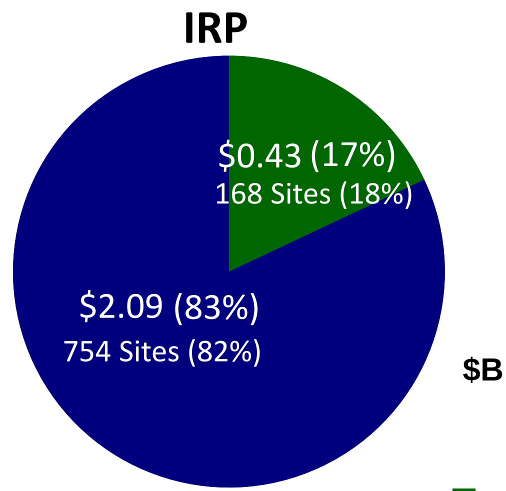
- Discuss challenges complex sites pose to the ER,N Program
- Describe technical and non-technical attributes of complex sites
- Discuss commons themes from Portfolio Optimization that relate to complex sites
- Describe Adaptive Site Management as means of managing site uncertainty and complexity
- Case study example site – NWIRP McGregor, TX

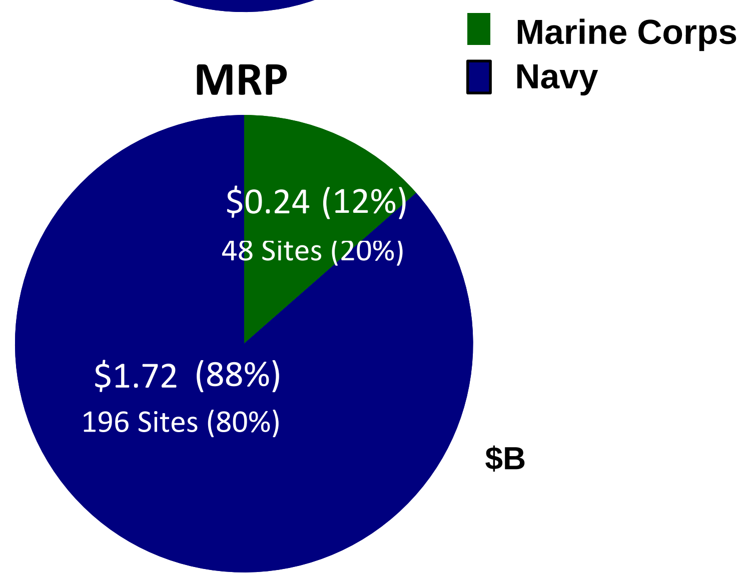
ER,N Cost to Complete (EOY FY17)

Total Marine Corps Sites: 1,104 (25%)



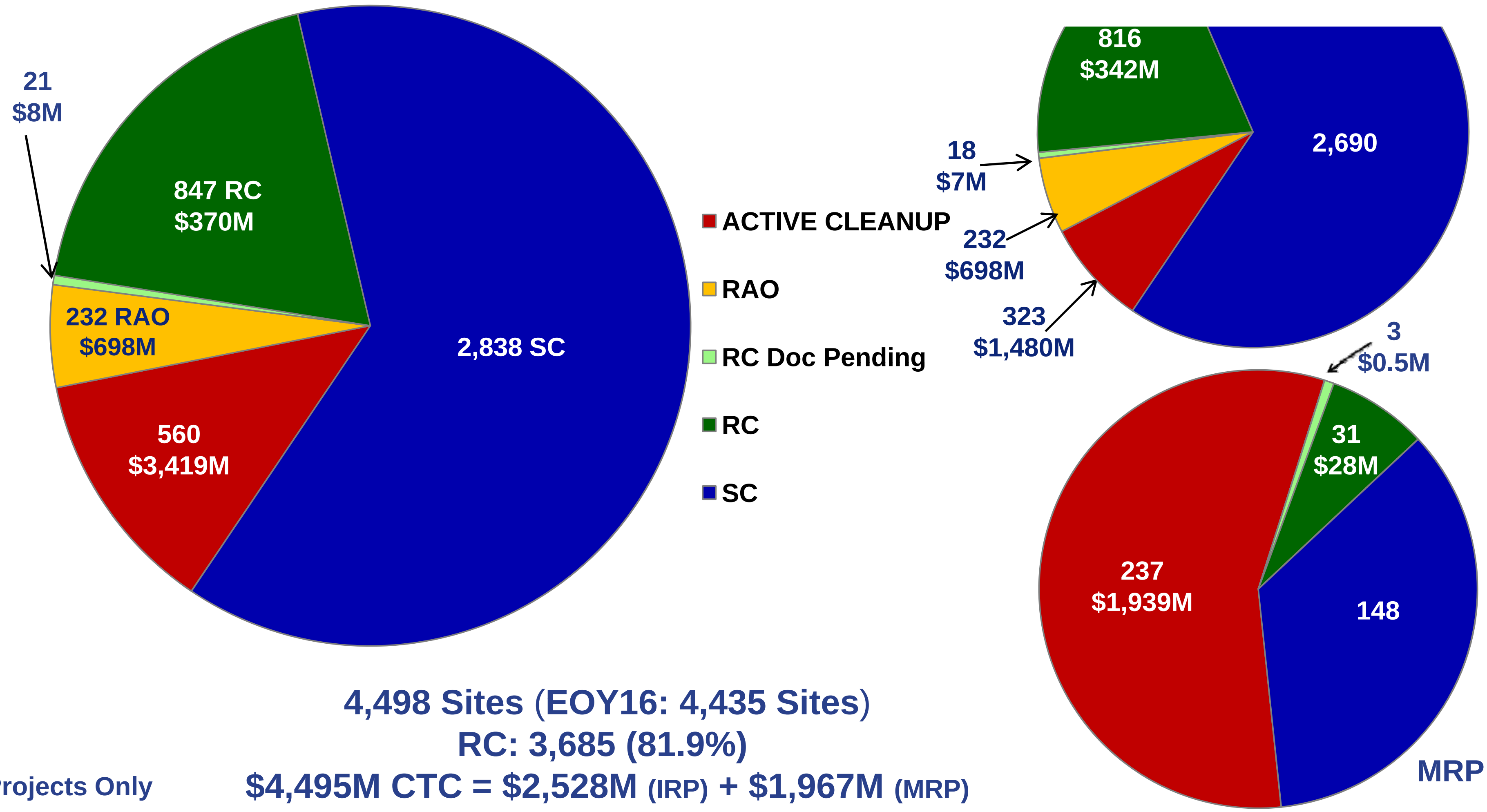
Total Navy Sites: 3,394 (75%)





Projects Only

EOY FY17 Snapshot of ER,N Program



4,498 Sites (EOY16: 4,435 Sites)

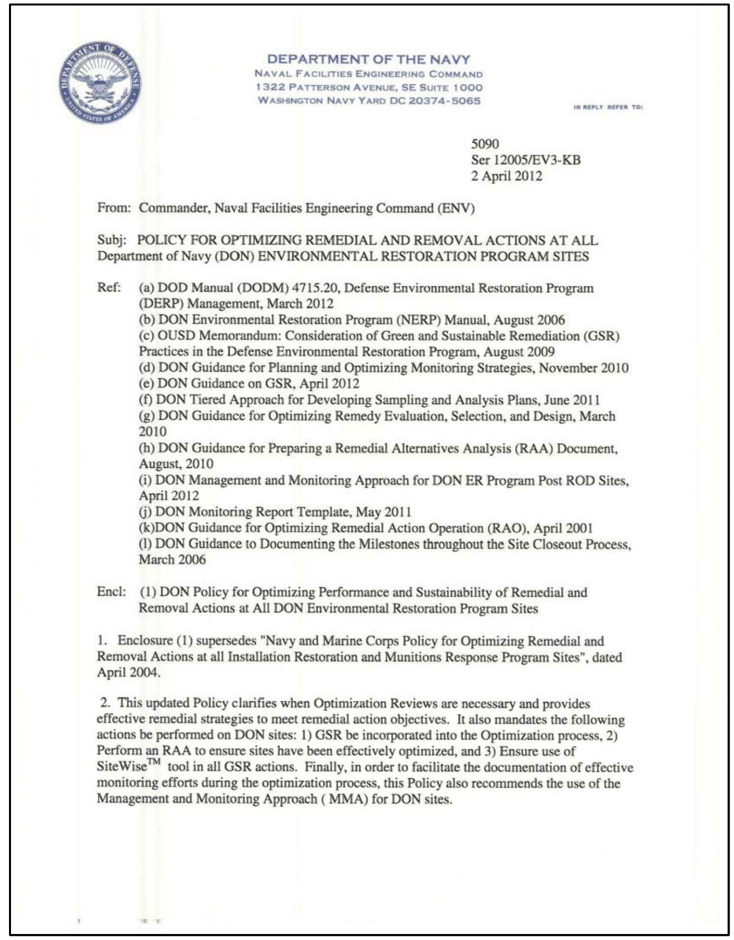
RC: 3,685 (81.9%)

$4,495M CTC = $2,528M (IRP) + $1,967M (MRP)

Projects Only

Navy Optimization Policy and Guidance

- DON Policy for Optimizing Remedial and Removal Actions at all DON Restoration Sites (April 2012)
- NAVFAC Guidance for Optimizing Remedial Action Operation (October 2012)
- DON Guidance for Planning and Optimizing Monitoring Strategies (November 2010)
- DON Guidance for Optimizing Remedy Evaluation, Selection, and Design (March 2010)



DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
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WASHINGTON NAVY YARD DC 20374-5065

IN REPLY REFER TO:

5090
Ser 12005/EV3-KB
2 April 2012

From: Commander, Naval Facilities Engineering Command (ENV)

Subj: POLICY FOR OPTIMIZING REMEDIAL AND REMOVAL ACTIONS AT ALL Department of Navy (DON) ENVIRONMENTAL RESTORATION PROGRAM SITES

Ref: (a) DOD Manual (DODM) 4715.20, Defense Environmental Restoration Program (DERP) Management, March 2012
(b) DON Environmental Restoration Program (NERP) Manual, August 2006
(c) OUSD Memorandum: Consideration of Green and Sustainable Remediation (GSR) Practices in the Defense Environmental Restoration Program, August 2009
(d) DON Guidance for Planning and Optimizing Monitoring Strategies, November 2010
(e) DON Guidance on GSR, April 2012
(f) DON Tiered Approach for Developing Sampling and Analysis Plans, June 2011
(g) DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010
(h) DON Guidance for Preparing a Remedial Alternatives Analysis (RAA) Document, August, 2010
(i) DON Management and Monitoring Approach for DON ER Program Post ROD Sites, April 2012
(j) DON Monitoring Report Template, May 2011
(k)DON Guidance for Optimizing Remedial Action Operation (RAO), April 2001
(l) DON Guidance to Documenting the Milestones throughout the Site Closeout Process, March 2006

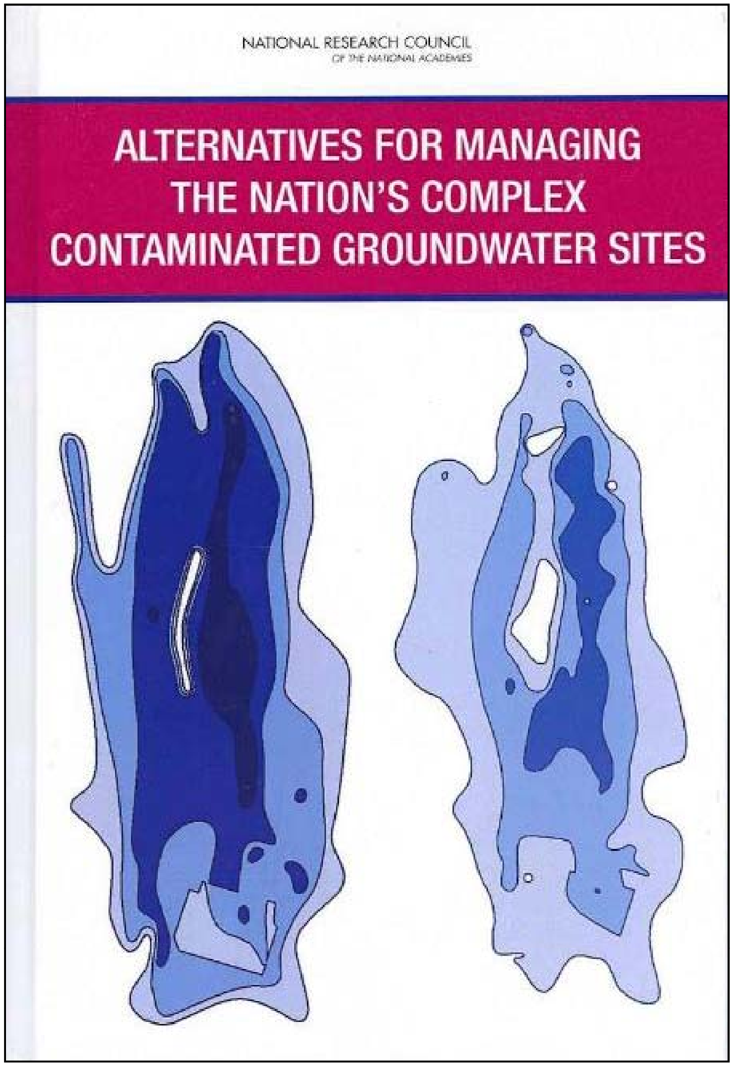
Encl: (1) DON Policy for Optimizing Performance and Sustainability of Remedial and Removal Actions at All DON Environmental Restoration Program Sites

1. Enclosure (1) supersedes "Navy and Marine Corps Policy for Optimizing Remedial and Removal Actions at all Installation Restoration and Munitions Response Program Sites", dated April 2004.

2. This updated Policy clarifies when Optimization Reviews are necessary and provides effective remedial strategies to meet remedial action objectives. It also mandates the following actions be performed on DON sites: 1) GSR be incorporated into the Optimization process, 2) Perform an RAA to ensure sites have been effectively optimized, and 3) Ensure use of SiteWise™ tool in all GSR actions. Finally, in order to facilitate the documentation of effective monitoring efforts during the optimization process, this Policy also recommends the use of the Management and Monitoring Approach (MMA) for DON sites.

2013 NRC Report on Complex Sites

- National Research Council report on managing the nation's complex sites
- Team of experts from industry, academia, and government
- Estimated roughly 10% of sites are "complex" and will not meet cleanup objectives in reasonable timeframe
- Estimated cost to remediate ~$127 billion



NRC 2013 on Achieving Site Closure

"…<u>at complex sites</u> characterized by multiple contaminant sources, large past releases of chemicals, or highly complex geologic environments, <u>meeting the DoD's ambitious programmatic goals for remedy in place/response complete seems unlikely and site closure almost an impossibility</u>."

"…the Committee has concluded that <u>regardless of the remedial technologies applied at complex sites</u>, removal of sufficient mass to reduce contaminant concentrations in groundwater to levels that allow for <u>unlimited use and unrestricted exposure is unlikely for many decades</u>."

NRC 2013 on Breakthrough Technologies

"Furthermore, no transformational remedial technology or combination of technologies appears capable of overcoming the inherent technical challenges to restoration at these complex sites."

"Rather, the nation's cleanup programs are transitioning from remedy selection into remedy operation and long-term management (LTM), potentially over long timeframes."

2014-17 ITRC Complex Sites Team

- **2017 ITRC Complex Site Definition – *“Remediation progress is uncertain and remediation may not achieve closure or even long term management within a reasonable time frame”***

- **“Reasonable time frame” for restoring groundwater resource to beneficial use is subject to interpretation and depends on site circumstances**

Source: ITRC Remediation Management of Complex Sites

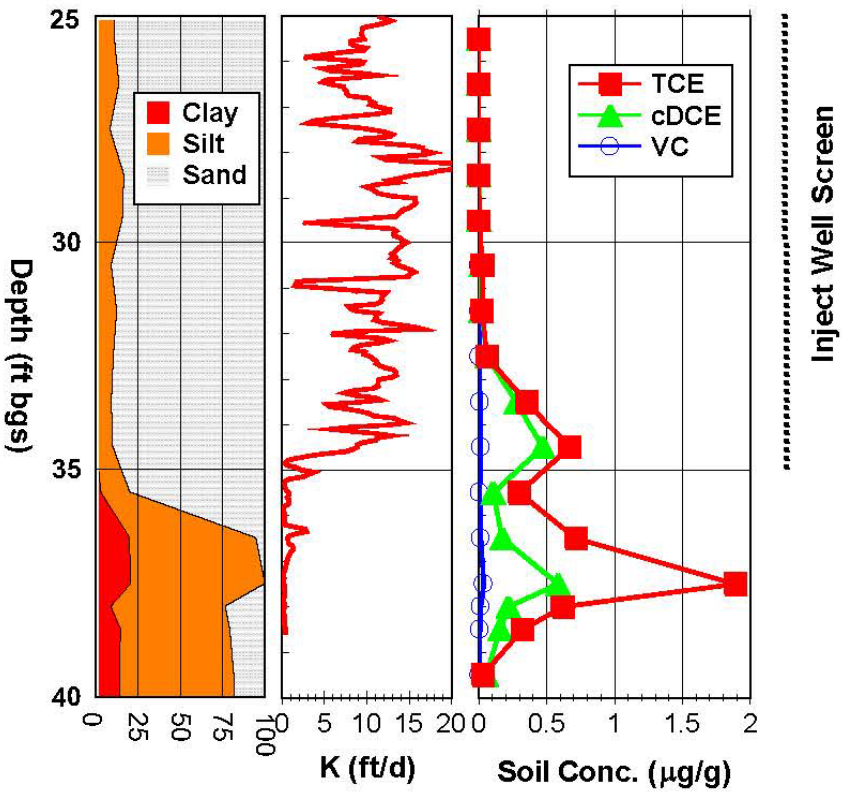
Site Challenges/Complexities

Technical Challenges	Examples	Non-Technical Challenges	Examples
Geologic conditions	Fractured bedrock, karst geology, low-permeability sediments	***Site objectives***	Deviations from promulgated screening values or closure criteria (e.g. MCLs)
Hydrogeologic Conditions	Groundwater table fluctuations, groundwater-surface water interactions	***Managing changes that may occur over long time frames***	Phased remediation, multiple PRPs, loss of institutional knowledge
Geochemical Conditions	Low/high pH, alkalinity, elevated electron acceptors	***Overlapping regulatory responsibilities***	Federal/state cooperation, numerous stakeholders
Contaminant-related Conditions	LNAPL/DNAPL, emerging contaminants, back diffusion	***Institutional controls***	Tracking and managing ICs, enforcement
Large-scale site	Size and depth of plume, number and variety of receptors	***Changes in land use***	Site access, redevelopment, land/water use change
		Funding	Uncertain funding, politics

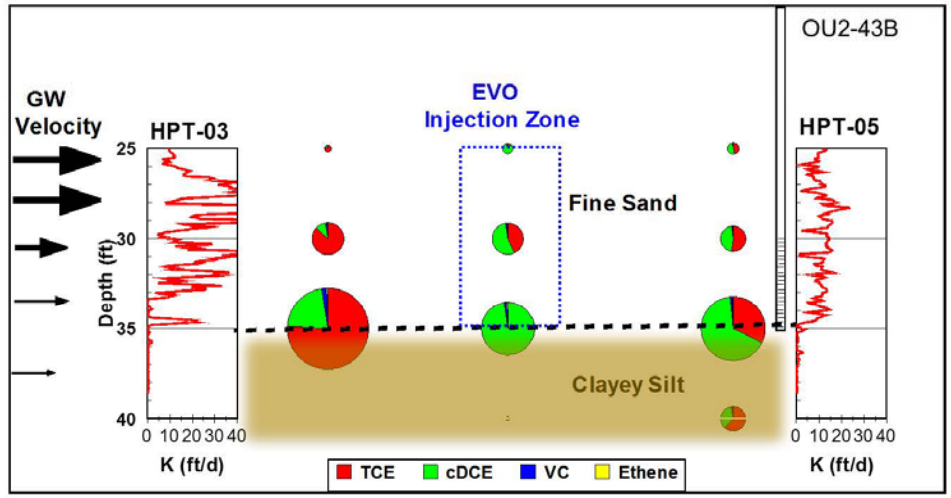
Source: Modified from ITRC 2017

Back Diffusion Example

OU2, Former NTC Orlando



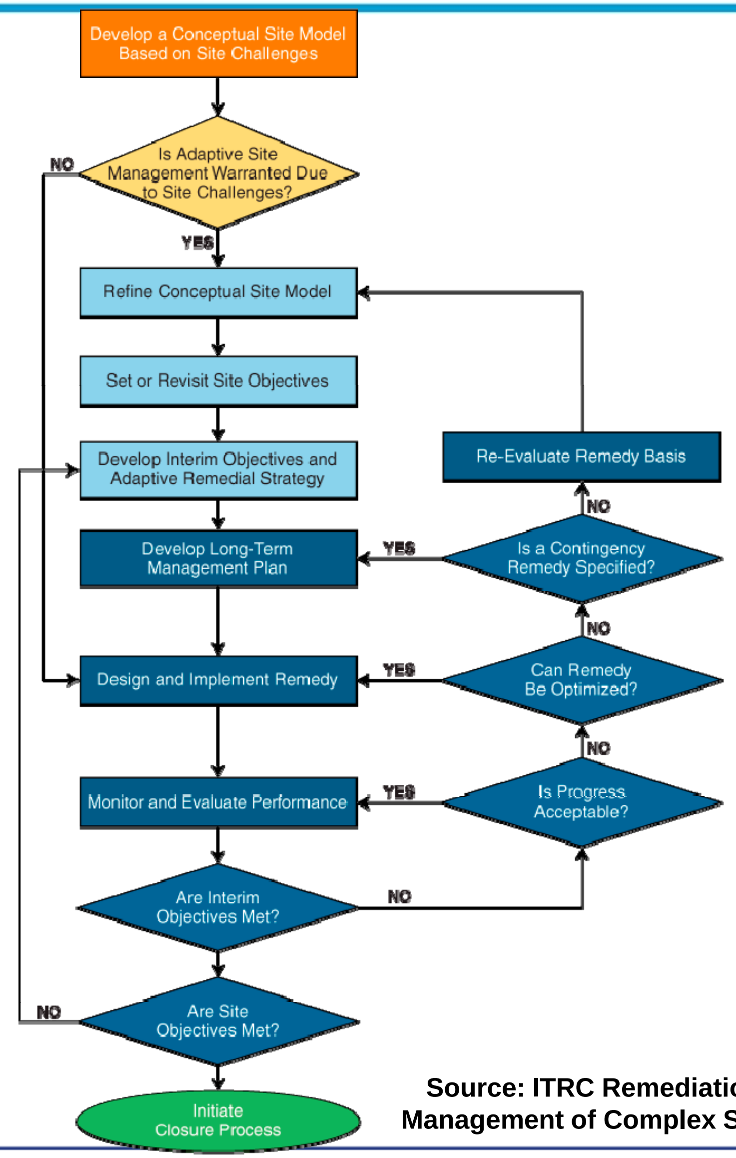
Source: ESTCP 201581-PR



- TCE and daughter products stored in low permeability silt layer
- Bio-barrier injection wells screened only in overlying sand unit
- Back diffusion likely contributing to long-term plume persistence

Adaptive Site Management

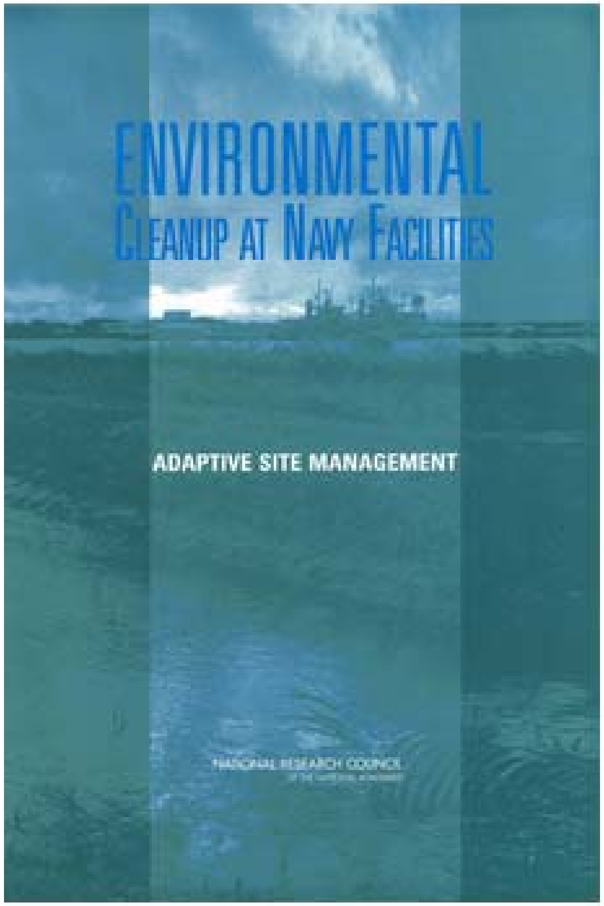
- Refine CSM
- Set or re-visit site objectives
- Develop interim objectives
- Adaptive remedial strategy
- Develop long-term management plan
- Transition Assessments



Source: ITRC Remediation Management of Complex Sites

2003 NRC Adaptive Site Management

- NRC study on latter stages of site cleanup at Navy installations
- NRC committee proposed comprehensive and flexible approach – "Adaptive Site Management"
- Express recognition that system responses will be monitored, interpreted, and used to adjust approach in iterative manner over time



Source: NRC 2003

Types of Cleanup Endpoints

- **Traditional**
  - Established by regulation
  - ARARs
  - Risk-based objectives
- **Alternative**
  - ARAR waivers
  - State designations and programs
  - Groundwater reclassification
  - Alternate concentration limits (ACLs)

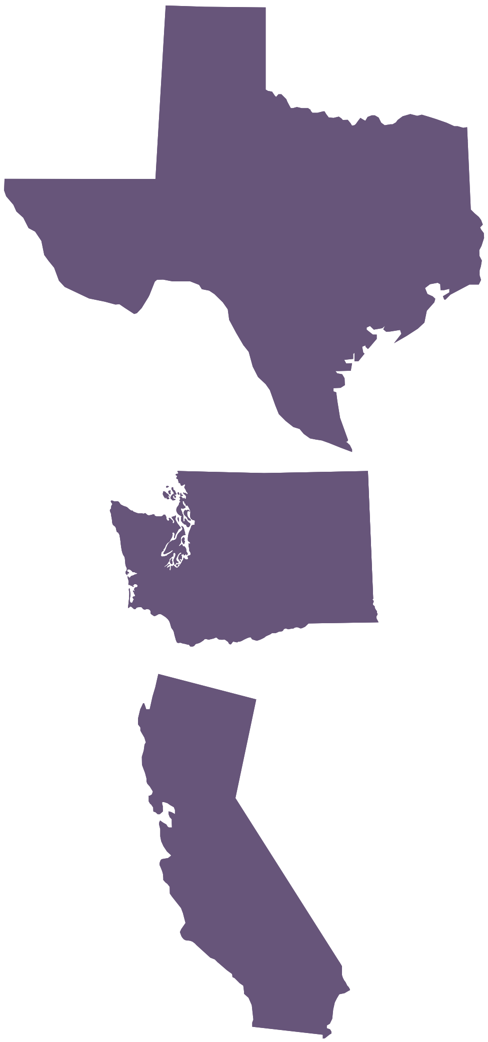
Other Alternative Endpoints

MNA over extended timeframes

Adaptive Site Management

Source: Navy 2016

States Regulatory Programs



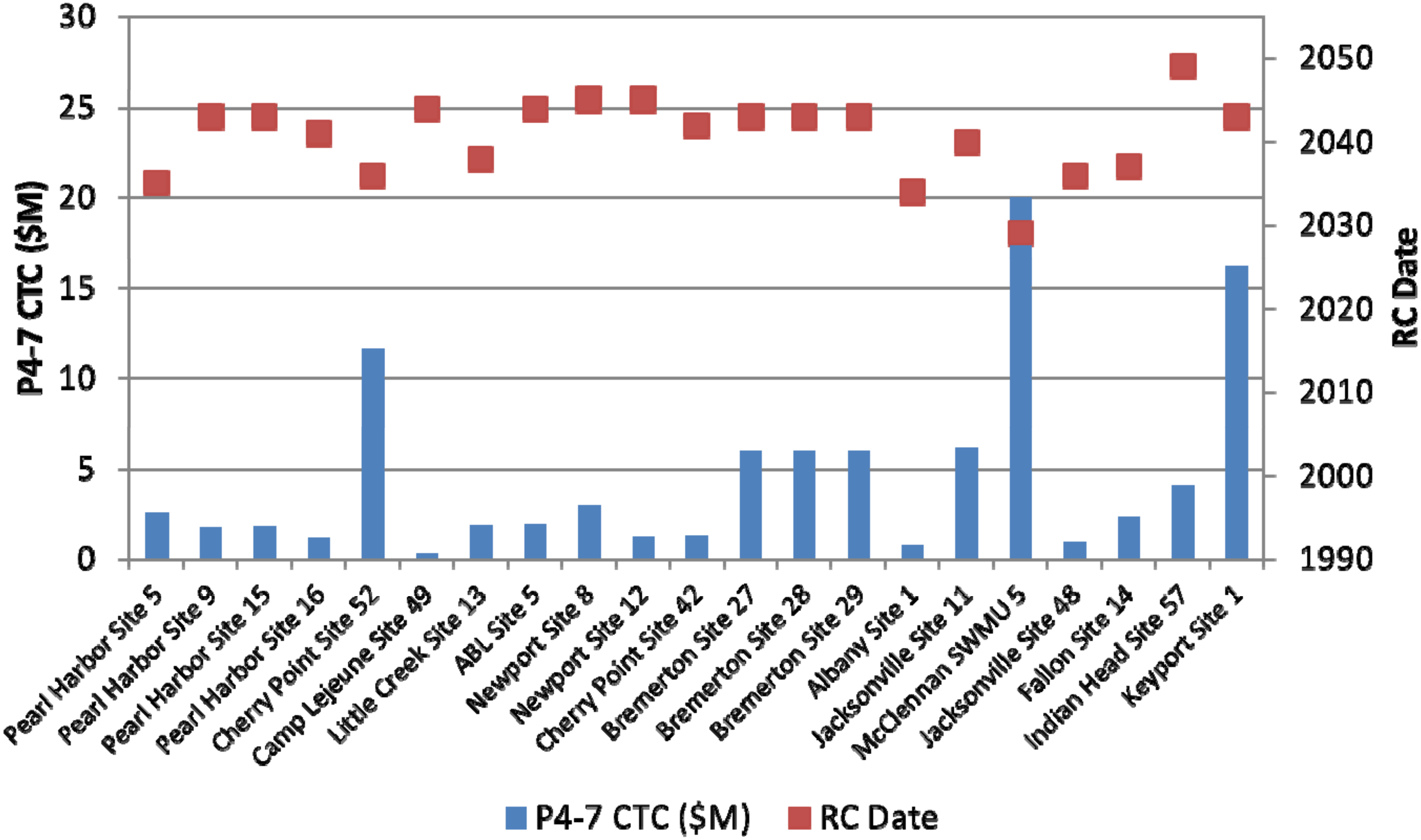
Source: Navy 2016

- State Programs/Policy
  - Typically follow Risk-Based Corrective Action (RBCA)
  - Low-Threat Closure (California)
  - Texas Risk Reduction Program (TRRP)
  - Florida Risk Management Options (RMO I, II, III)
- State Designations
  - Containment Zone
  - Plume Management Zone (PMZ)
    - Texas (NWIRP Dallas, NWIRP McGregor)
  - Conditional points of compliance
    - Washington, Florida

Navy Portfolio Optimization (P-OPT) Phase I Review of Complex Sites (2015-17)

- Primary objectives were to identify opportunities to reduce remediation timeframe (accelerate RC), improve remedy effectiveness, and achieve cost avoidance
- In-house Navy subject matter experts (SMEs) developed preliminary findings and recommendations
- External SMEs, each with more than 20 or 30 years experience in the industry, were used to further vet the findings
- Portfolio-wide themes were developed by analyzing common findings from all sites
- Findings and recommendations discussed with RPMs and FECs – and adjusted based on additional insights from end users
- Navy SMEs continuing to work with RPMs and FEC Managers to implement the Phase I recommendations

Complex Sites with In Situ Treatment Trains



Summary of Site Findings

- Restoration timeframes estimated at >30 years for most sites (actual timeframe typically greater)
- Source reduction technology (e.g. bioremediation, ISCO) typically implemented with natural attenuation and other passive technologies to treat/control downgradient plume
- Few opportunities to accelerate remediation timeframes
  - Inherent technical difficulties prevented site closure, meeting MCLs (e.g. DNAPL, complex geology, contaminant back diffusion)
- Long-term monitoring/management requirements drive costs
- Long-term management appropriate goal for most complex sites in Phase I
- Guidance needed for RPMs to determine when to transition sites from active treatment to passive management

When Are Aggressive Remedies Appropriate?

- Relatively Higher Risk Situations where unacceptable risk is likely to be present (fewer sites)
  - Receptor is already impacted (e.g., supply well impacted or vapor intrusion causing unacceptable indoor air levels)
  - Probability of impact to nearby receptor is high (e.g., nearby supply well and fast-moving groundwater; building on top of shallow subsurface sources)
  - Plume is expanding
  - Plume is migrating towards a drinking water supply well
  - Plume is migrating offsite
- Aggressive treatment is often required for plume control

Passive Remedies and Longer Timeframes

- <u>Relatively Lower Risk Situations </u>where “unacceptable risk” is unlikely to be present
- Sites that pose no excess risk to actual receptors, but ARARs have not been met
  - Plume is stable or decreasing
  - Groundwater not threatening surface water
  - Groundwater not threatening drinking water wells
  - Groundwater has TDS and/or yield characteristics that make it unsuitable for drinking
  - Site contaminants are primarily petroleum related
- Partial source treatment; often coupled with MNA
- Institutional controls to limit exposure and maintain protection of human health and environment

Key Messages on Complex Sites

- Approximately 10% of all sites classified as complex (NRC 2013)
  - Navy P-OPT identified a subset of complex sites where it will be difficult to meet restoration goals within 30 years
  - P-OPT identified few opportunities to accelerate remediation timeframes
- Adaptive Site Management identified as suitable approach for addressing complex sites (ITRC 2017)
  - P-OPT recommended phased technical approach prioritizing sites exhibiting unacceptable risk to human health and environment
  - Life cycle CSM used to guide decision-making throughout restoration process
- Long-term passive management appropriate long-term goal for most complex sites (NRC 2013)
  - Focus remedial efforts on sites with uncontrolled risks
  - Long-term cleanup goals (e.g. MCLs) achieved through natural attenuation
  - Interim institutional controls to prevent exposure
  - Continuously update CSM and optimize remedy

Key Messages (Cont.)

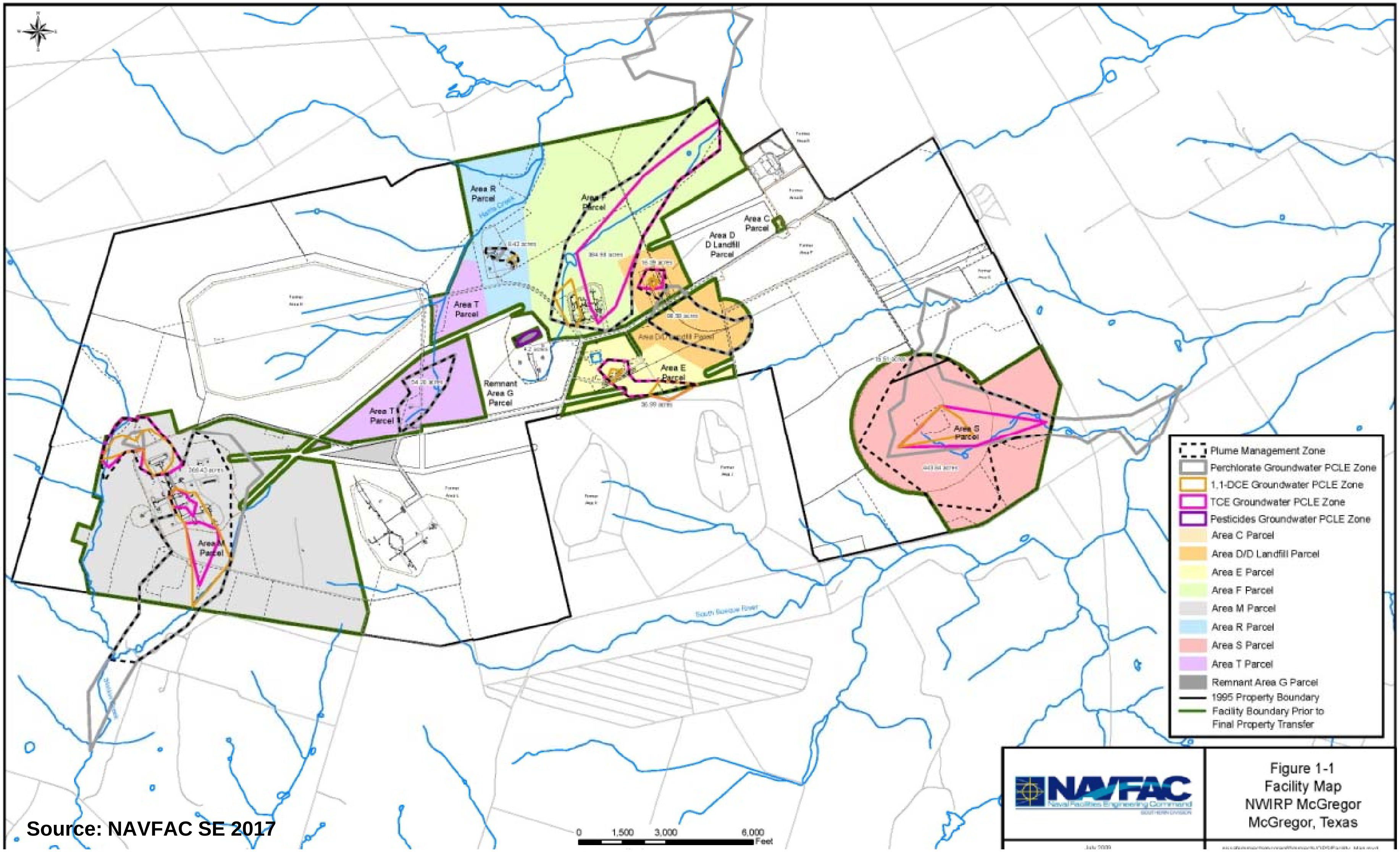
- **Interim goals often necessary to guide progress towards overall site objectives (ITRC 2017)**
  - **Phased remediation approaches – feedback loop, updated CSM**
- **Transition assessments to evaluate remedy performance and select new remedies or transition to long-term management (NRC 2013)**
  - **P-OPT recommended additional RPM guidance on transition assessments and development of new tools**
  - **Case studies demonstrating successful transition assessments (e.g. NWIRP McGregor)**

Example Site - Optimization at Former NWIRP McGregor, TX

NWIRP McGregor Background

- Naval Weapons Industrial Reserve Plant (NWIRP) McGregor used until 1995 as a bomb and rocket motor manufacturing facility
- Isolated industrial sites located on 9,700 acres, 20 miles west of Waco, Texas
- Former government-owned, contractor-operated (GOCO)
- Ammonium perchlorate was released to the environment through "hog out" operations of rocket motors
- Property transferred to City of McGregor in 1995
- Leased portions of property to industrial and agricultural companies
  - SpaceX static rocket test and launch/landing facility
- Navy maintains cleanup responsibility/liability and continues long-term management on properties through access agreements

Former NWIRP McGregor



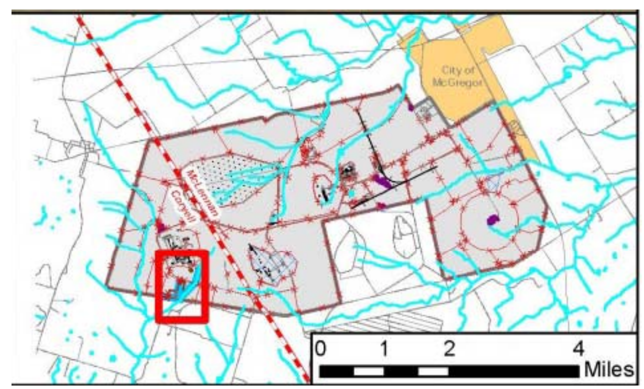
Source: NAVFAC SE 2017

Life-Cycle Optimization Timeline

- Initial optimization efforts to improve automation and remote monitoring of FBR operations ***(2004 05)***
- Long-term monitoring program optimization ***(2005–17)***
- Evaluate attenuation capacity of groundwater to surface water pathway ***(2014-15)***
- Re-evaluation of groundwater resource classification with goal of changing groundwater classification from Class II to Class III (raising cleanup level X100) thus reducing the area of regulatory Plume Management Zone (PMZ) ***(2016)***
- Risk evaluation of ecological surface water exposure to perchlorate ***(2016)***
- Transition groundwater collection and FBR system to a series of passive in situ bio-barriers ***(2017-2020)***

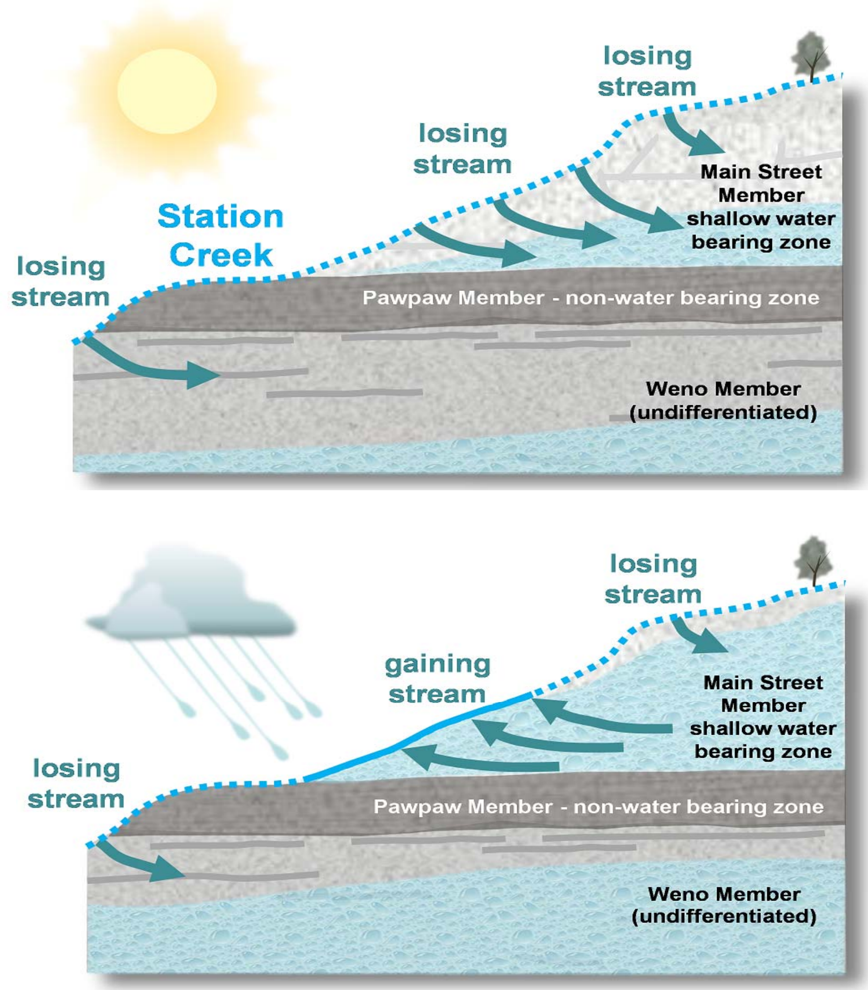
NWIRP McGregor

- A-Line Trench – 1,680' long, 20-25' deep
- B-Line Trench – 2,950' long, 12-15' deep
- C-Line Trench - 1,425' long, 15-18' deep
- Trenches initially filled with compost, eventually used for collection only
- Pump Station B maintains groundwater elevation to prevent discharge to unnamed tributary



Conceptual Site Model

- Streams and tributaries at facility experience both gaining and losing conditions
- Majority of precipitation occurs in Spring
- Perchlorate attenuation through dilution and mixing within dynamic system
- Dilution study conducted in 2014-15 to evaluate perchlorate concentrations along GW/SW flow path



Source: NAVFAC SE 2017

Groundwater Treatment System

Interceptor trench system and aboveground water storage

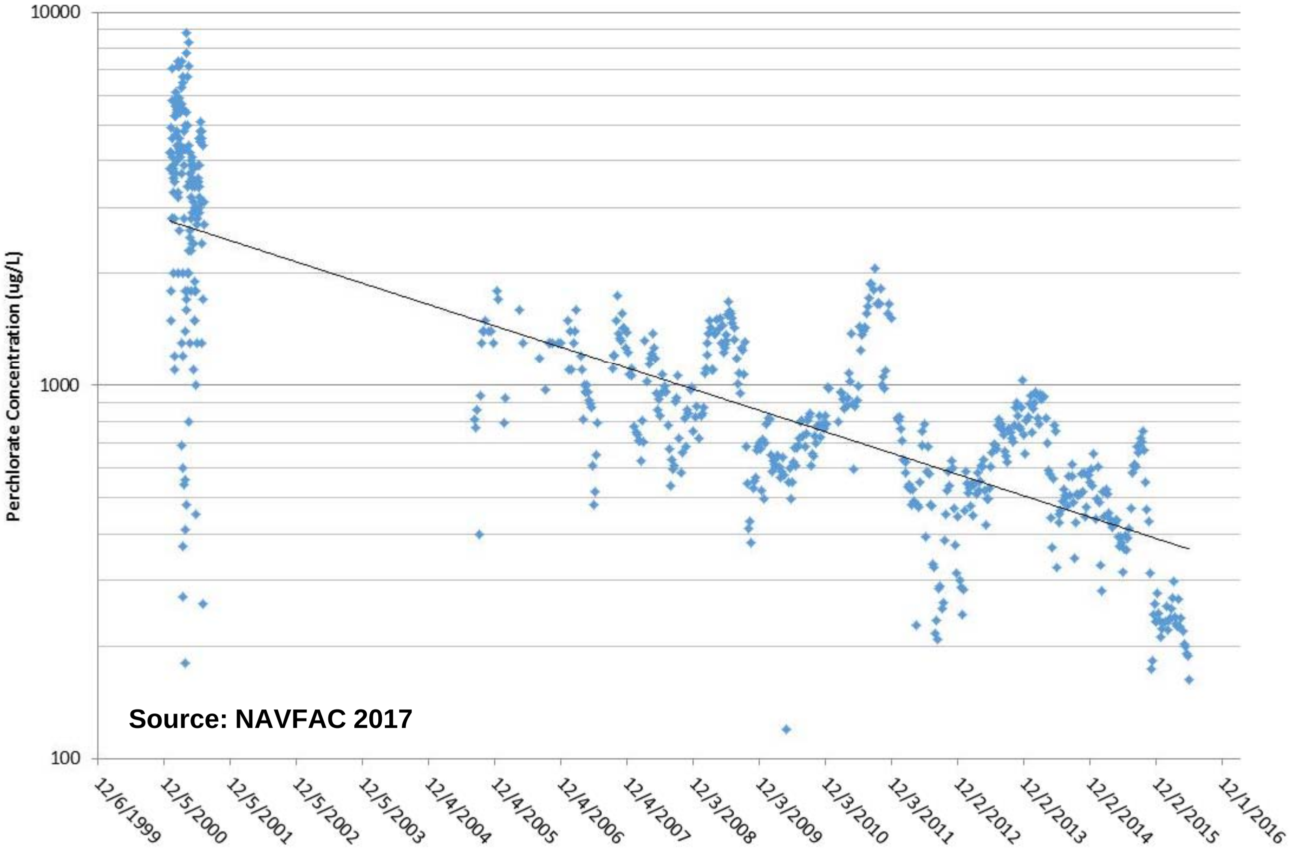
- Lagoon A – 10.8M Gal
- Soil Cell A – 1.2M Gal
- Soil Cell B – 1.5M Gal
- Soil Cell C – 1.7M Gal

Fluidized bed reactor

- Treats up to 400 gpm
- Discharges directly to outfall or to aboveground storage

Source: NAVFAC SE 2017

Perchlorate Influent History



- Perchlorate influent concentrations from 2000 to 2016 show overall decreasing concentrations
- Combination of source removal, natural flushing, and mixing with un-impacted groundwater resulted in perchlorate attenuation over time

Transition Assessment

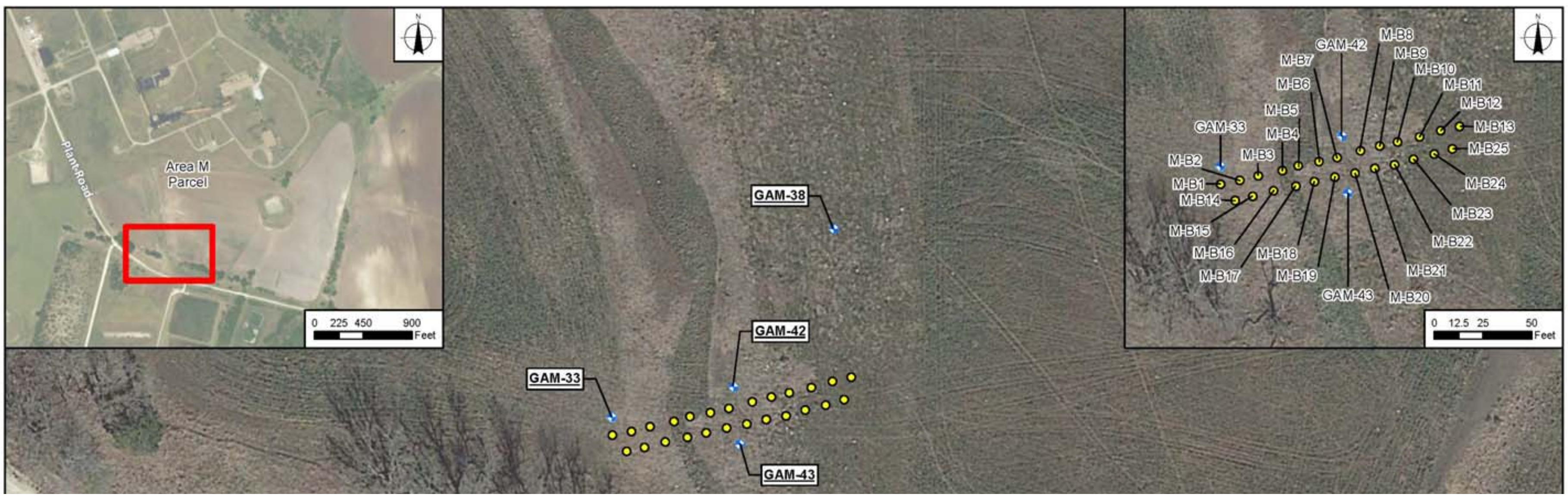
- Goal to transition from aggressive pump and treat technology to passive in situ remediation
  - Reduce O&M, monitoring, and energy costs
  - Rely on in situ containment of the perchlorate plume
- Navy negotiated with TCEQ to temporarily shut down treatment system during 2016-17
- Continue to monitor groundwater and surface water quality in evaluating attenuation capacity
- Pilot test in situ bio-borings to control perchlorate migration from remaining source

Fluidized Bed Reactor

Source: NAVFAC SE 2017

Bio-Boring Pilot Test

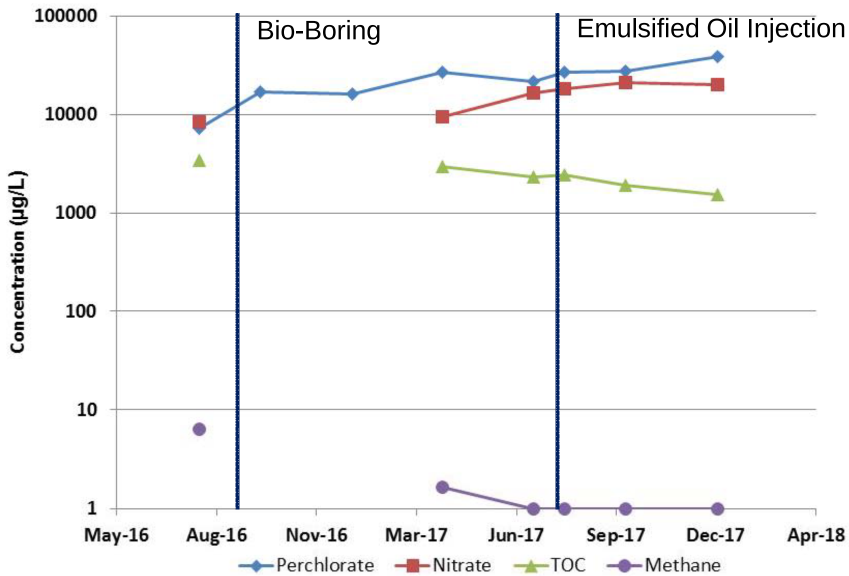
- Two rows of bio-borings installed for a total of 25 wells in August 2016
- Initial compost and wood chip mixture did not provide sufficient reducing power to drive reduction of perchlorate
- Injected emulsified oil in July 2017
- Immediate reductions of perchlorate and nitrate; increase in methane concentrations



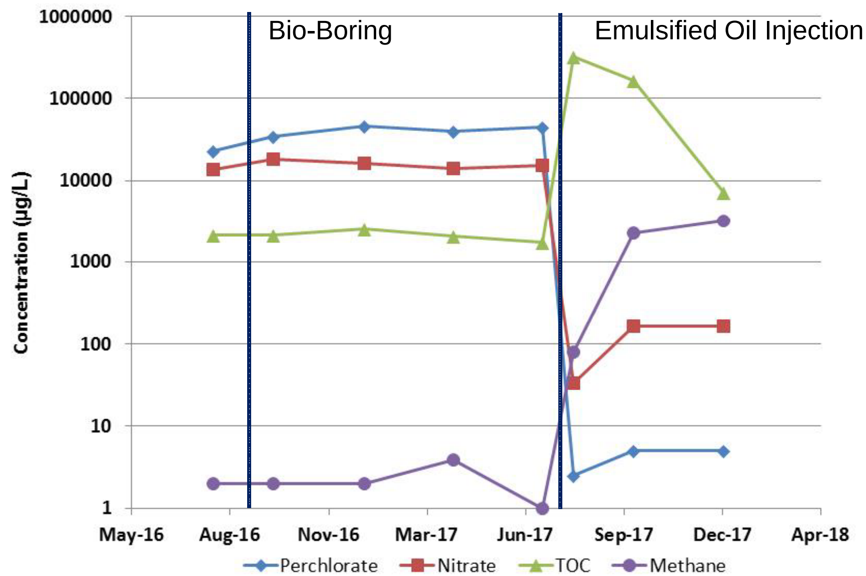
Source: NAVFAC SE 2017

Bio-Boring Performance Monitoring

GAM-42 (Upgradient Well)



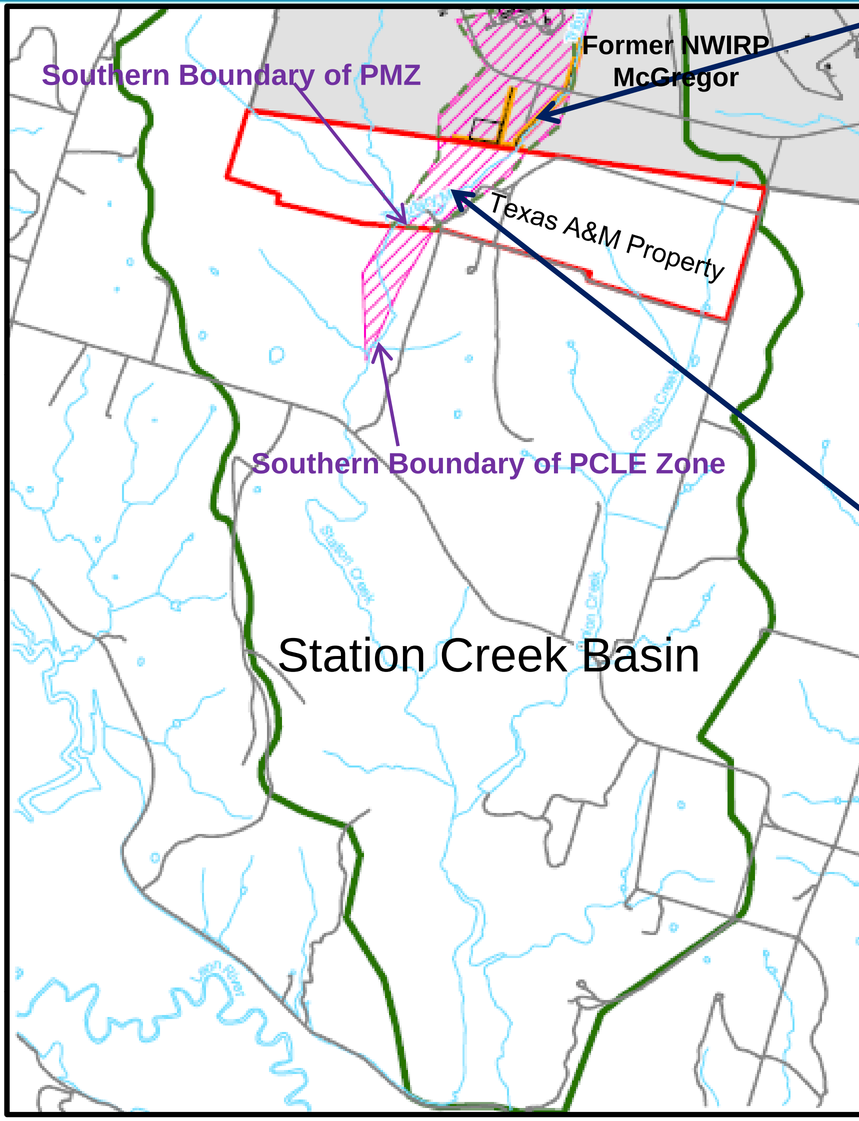
GAM-43 (Downgradient Well)



Source: NAVFAC SE 2017

- **Following injection of emulsified oil, rapid perchlorate and nitrate reduction, methane production**
- **Bio-borings will likely require frequent emulsified oil replenishment to maintain containment of residual perchlorate source**

Groundwater Reclassification



TCEQ's PCLs Onsite Area PMZ		
Medium	Commercial/Industrial (µg/L)	Ecological (µg/L)
Class II Groundwater Classification * TRRP §350.52	51.1	>8,000
Class III Groundwater Classification ** TRRP §350.52	5,110	>8,000
Surface Water	--	>8,000

TCEQ's PCLs Offsite Texas A&M Portion of PMZ		
Medium	Commercial/Industrial (µg/L)	Ecological (µg/L)
Class II Groundwater Classification * TRRP §350.52	51.1	>8,000
Class III Groundwater Classification ** TRRP §350.52	5,110	>8,000
Surface Water	--	>8,000

Source: NAVFAC 2014

Summary

- Life-cycle optimization achieved through a combination of management approaches
  - Groundwater re-classification resulted in less stringent perchlorate cleanup standard (5,100 µg/L vs. 51 µg/L)
  - Developed natural attenuation conceptual model based on site-specific hydrology relying on flushing and mixing in dynamic groundwater/surface water system
  - Transitioning pump and treat system to passive in situ technology
  - Successful pilot study demonstrated feasible bio-barrier approach to plume containment
  - Ecological risk assessment documented no adverse impacts to sensitive receptors from exposure to perchlorate in surface water
- Long-term adaptive site management approach will result in significant annual cost avoidance while maintaining protection of human health and environment

Contacts and Questions

Points of Contact

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Questions ?