



**John F. Kennedy Space Center's  
Remediation Program  
a  
Perspective  
on  
25 Years  
of  
Challenges, Innovations, and Progress**

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John F. Kennedy Space Center**



# Presentation Outline

Kennedy Space Center

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- ◆ Site Background and History
- ◆ Staff
- ◆ Remediation Program
- ◆ 1994
- ◆ Challenges
- ◆ Innovations
- ◆ Progress
- ◆ Case Studies
- ◆ Questions





# Kennedy Space Center

Kennedy Space Center

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## ◆ Location

- Kennedy Space Center (KSC) is located within the Merritt Island-Cape Canaveral-Merritt barrier island complex

## ◆ Area and Land Use

- 140,000 acres (4,750 acres for Space Center operations)
- Merritt Island National Wildlife Refuge
  - Created as a buffer zone for NASA launch activities
  - Managed by the U. S. Fish and Wildlife Service
  - > 500 species, 16 Federally endangered
- Canaveral National Seashore
  - Managed by the National Park Service







# Kennedy Space Center Geology

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- ◆ Topographic relief is slight (sea level to 20 feet on Recent dunes)
  - Sand ridges and swales
- ◆ Lithology is dominated by varying amounts of fine-grained sand, medium sand with shell fragments, fine sand with shell fragments, fine-silty sand, sandy clay with silt and shell fragments to approximately 120 feet below land surface (BLS) – Miocene to Recent
  - Eocene carbonate bedrock at approximately 150 feet BLS
- ◆ Depth to groundwater (3-6 feet BLS)
  - Groundwater classified as potential drinking water (G-II) based upon total dissolved solids
- ◆ Dynamic interaction of groundwater and the surficial geology - wetlands represent  $\sim\frac{1}{4}$  KSC property

# Aerial View of the LC39 Area of KSC





# Site Background and History

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# Site Background and History

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- ◆ NASA's primary launch operations Center
- ◆ Construction began in the 1960's to support the Apollo Program
- ◆ Apollo Program (1967 – 1972)
- ◆ Skylab Program (1973 – 1974)
- ◆ Space Shuttle Program (1981 – 2011)
- ◆ International Space Station flight hardware processing and final checkout





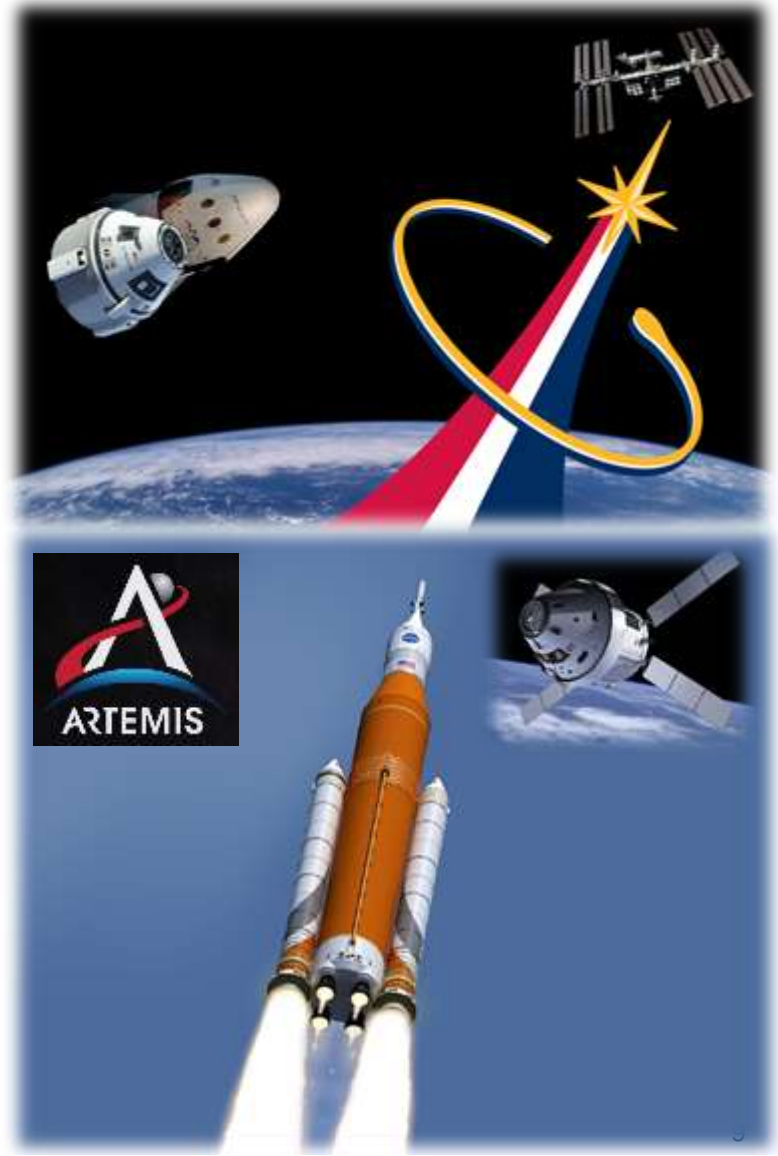


# Site Background and History

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- ◆ **Launch Services Program**
  - Manages unmanned NASA missions
- ◆ **Commercial Crew Program**
  - To provide access to the International Space Station
    - SpaceX – Crew Dragon
    - Boeing – CST 100 (Starliner)
- ◆ **Space Launch System**
  - NASA's next generation heavy lift rocket
  - Ground processing and support for Orion and SLS
  - Artemis Program





# Site Background and History

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## ◆ Multi-User Spaceport

- SpaceX operates LC39A – processing and launch
- Boeing operations in the Orbiter Processing Facilities – Starliner & X37
- Blue Origin – New Glenn
- OneWeb – satellite manufacturing and processing
- Space Florida – operates the Life Sciences Support Building and the former Shuttle Landing Facility
- Northrup Grumman – Omega – MLP3, VAB, LC39B







# Staff

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## ◆ Spaceport Integration & Services Directorate

- Medical and Environmental Services Division
  - Environmental Assurance Branch
    - Remediation Group

## ◆ ***“To provide environmentally unencumbered lands for NASA Programs and tenants”***

## ◆ Remediation Group

- Michael J. Deliz, P.G., Remediation Program Manager
- Anne M. Chrest, Remediation Project Manager
- Lindsay A. Morgan, Remediation Project Manager
- Ryan P. O’Meara, Remediation Project Manager
- Dinh X. Vo, Remediation Project Manager



# Remediation Program

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## ◆ Regulatory Framework

- Regulated under the Resource Conservation and Recovery Act (RCRA) and its Hazardous and Solid Waste Amendment and Florida Administrative Code (F.A.C.)
- Overseen by the Florida Department of Environmental Protection (FDEP), therefore the Program is conducted in accordance with Chapter 62-780, F.A.C.
- Toxics Substances and Control Act (TSCA) is managed by the Environmental Protection Administration (EPA) Region IV





# Soil Contamination

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## ◆ Common contaminants

- Polychlorinated biphenyls (PCBs) - primary sources were painted structures and transformers
- Metals – lead, copper, barium, arsenic, cadmium, chromium – various sources
- Polycyclic Aromatic Hydrocarbons (PAHs) - various sources
- Dioxins/furans – often associated with PCBs
- Total petroleum hydrocarbons
- Volatile organics compounds – shallow source areas



# Groundwater Contamination

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- ◆ Most common contaminants in groundwater are chlorinated volatile organic compounds (CVOCs)
  - Trichloroethene (TCE)
    - Used for the precision cleaning of spaceflight equipment and metals degreasing
  - Cis-1,2-dichloroethene
  - Vinyl Chloride
  - Trans-1,2-Dichloroethene
  - Tetrachloroethene
- ◆ Other contaminants
  - Trichlorofluoromethane
  - Metals - lead and antimony
  - Petroleum compounds - PAHs and Total petroleum hydrocarbons
  - Ammonia





# 1994

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- ◆ 2 Billion less people on the planet
  - Michael and Jessica were the most popular names for newborns in the United States
- ◆ Sports World
  - Florida State University won its 1<sup>st</sup> National Championship
  - Buffalo Bills lost their 4<sup>th</sup> straight Super Bowl
  - Figure skater Nancy Kerrigan “injures” her knee
  - Major League Baseball went on strike and there was no World Series
- ◆ Entertainment
  - Movie tickets averaged \$4
  - *Forest Gump* and *The Lion King* were released
  - *Schindler’s List* won the Academy Award for Best Picture
  - *Barney the Dinosaur* and *Friends* premier on network television





# 1994

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- ◆ There were no Soil Cleanup Target Levels
  - Soil impacts at petroleum sites under Chapter 62-770, F.A.C. were delineating “excessively contaminated soil” utilizing organic vapor analyzer headspace
  - FDEP Federal Facilities Subsection was utilizing “*Soil Cleanup Goals for the Military Sites in Florida*”
- ◆ Groundwater contamination was being delineated with monitoring wells
- ◆ Reports were submitted to the regulatory agencies and you waited for comments
  - Formal responses to comments.....begat additional comments
- ◆ KSC had 10 RCRA Facility Investigation Work Plans awaiting EPA review and two FDEP Central District Consent Orders



# Challenges

## Operational Launch Facility

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- ◆ Operational launch and vehicle processing facility in a National Wildlife Refuge
  - No Dig Days
  - Tortoise relocations
  - Nesting seasons
  - Weather warnings
    - Lightning





# Challenges Site Inventory

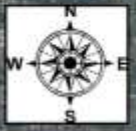
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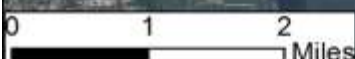
- ◆ NASA's largest cleanup program (based upon # of sites)
  - EPA RCRA Facility Assessment = 1990
    - No Further Action or RCRA Facility Investigation
  - During the past 25 years KSC conducted a Center-wide review of all of its facilities, operations, and potential waste disposal practices to determine potential impacts to the environment
    - Center divided into 3 Areas for SWMU Assessments
    - Created Potential Release Locations (PRLs) = 204
      - Locations of Concern (LOCs)
    - Conducted 40 Confirmatory Sampling efforts in the past 3 years
  - 365 total sites combined into 293 sites
    - SWMUs became parts of SWMUs
    - PRLs became SWMUs
  - Total sites with approved No Further Action (184) or Site Rehabilitation Completion Orders (33) = 217

# KSC Remediation Sites SWMUs and PRLs

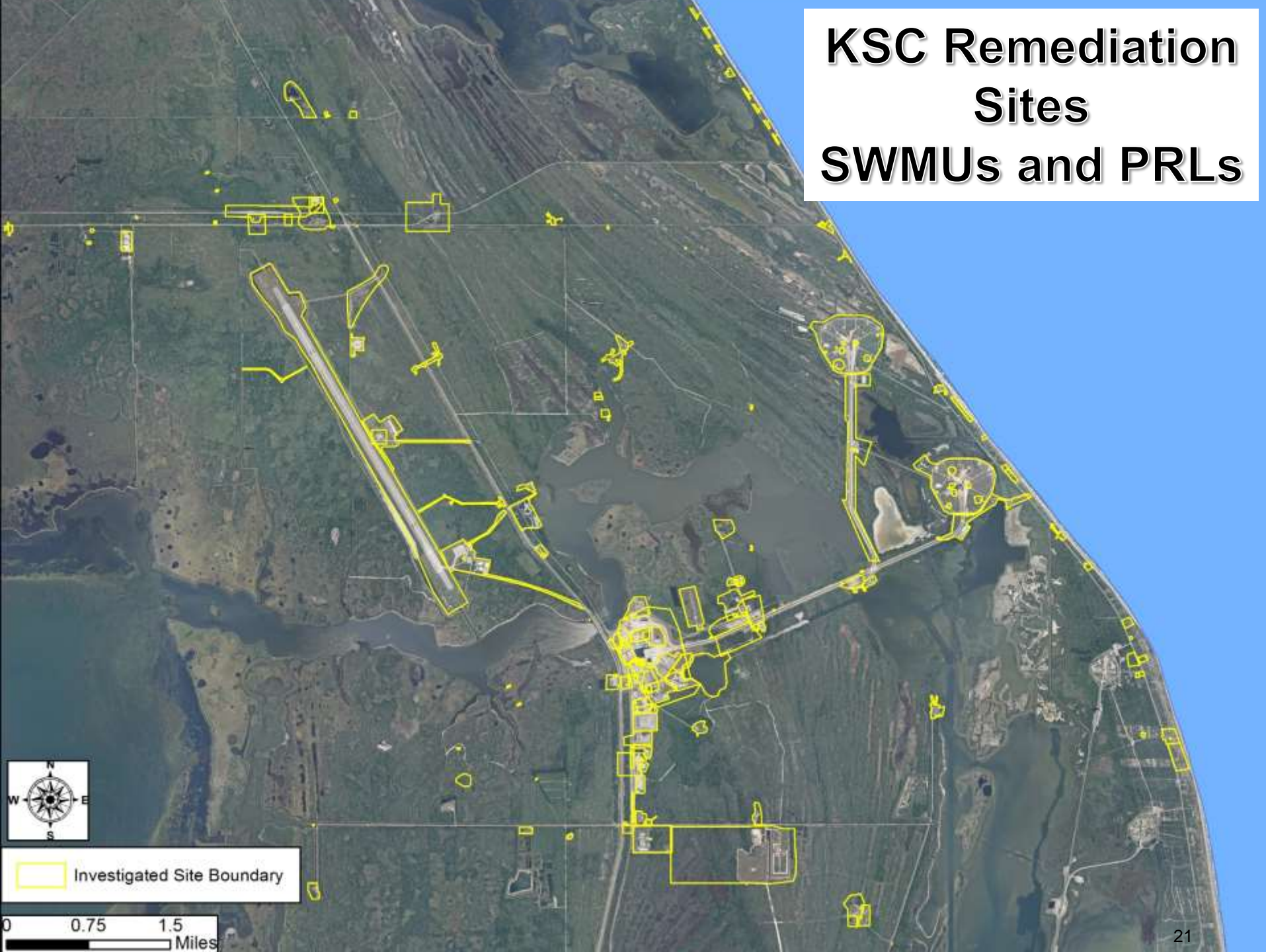
Atlantic Ocean



 Investigated Site Boundary

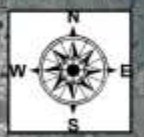


# KSC Remediation Sites SWMUs and PRLs

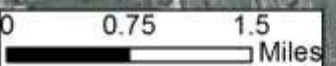




Atlantic Ocean



Investigated Site Boundary



# KSC Remediation Sites SWMUs and PRLs



# Challenges Site Inventory

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- Total Active Sites = 76
- Prioritization of Funding
  - Required to demonstrate progress
  - Early Days
    - Studies versus Cleanups (“paralysis by analysis”)
      - Studies were considered lower priority
    - Rush to Cleanup
      - Remedy-in-Place, Final Remedy-in-Place, etc.
      - “Getting a Bean”
  - Past 15 Years
    - Pushing back on “Management/Regulatory Driven Cleanup Decisions”
    - Breaking the perception that it did not matter how contaminated a site was in the source area
      - Rush to cleanups led to oversimplified Conceptual Site Models and the potential to miss additional source areas
  - Risk-based prioritization (eliminating direct exposure issues)
    - Potential soil exposure versus no consumption of groundwater

# Challenges Site Inventory





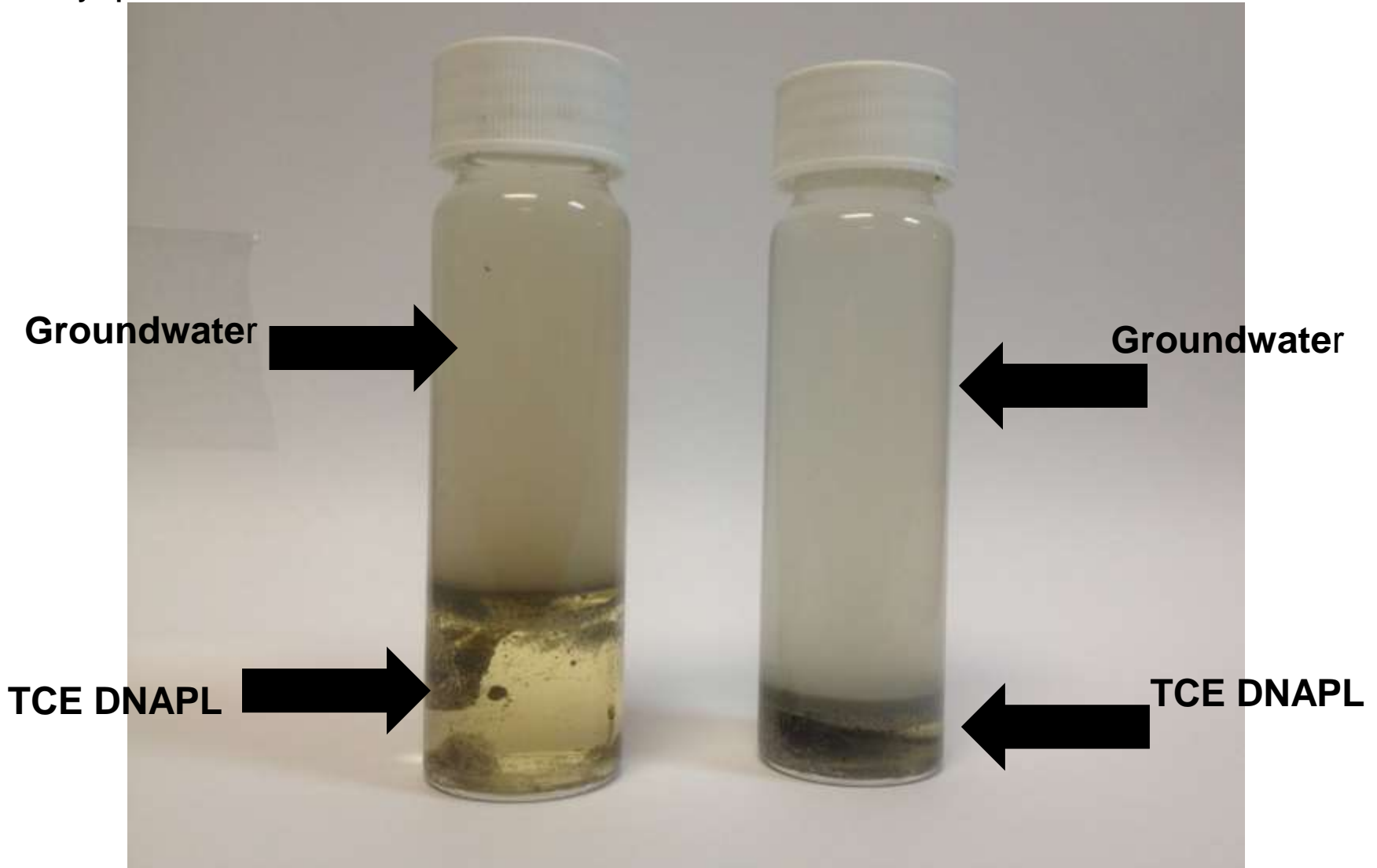


# Challenges

## Dense Non-Aqueous Phase Liquid

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# **Challenges**

## **Dense Non-Aqueous Phase Liquid**

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- ◆ Launch Complex 34 – TCE\*
- ◆ Wilson Corners – TCE\* and Freon
- ◆ Hypergol Maintenance Facility North – TCE\* and Freon\*
- ◆ Components Cleaning Facility – TCE and Freon\*
- ◆ Converter Compressor Building - TCE
- ◆ Mobile Launch Platform Rehabilitation Sites/VAB Area – TCE
- ◆ Central Heat Plant – PCE
- ◆ GSA Reclamation Yard – PCE and PCBs\*
- ◆ Former Drum Storage Area – TCE

\*visible DNAPL observed at site



# Challenges

## Per- and Polyfluoroalkyl Substances

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# *Innovations* Technologies

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- ◆ Innovative technology test bed
  - Biopiles
  - Air Sparging with soil vapor extraction
  - 6 Phase Heating
  - Steam Injection
  - Chemical Oxidation - Potassium Permanganate
  - Bioaugmentation (KB-1®)
  - Emulsified Zero-Valent Iron
  - Sequential Application of In-Situ Chemical Oxidation and Enhanced Bioremediation
  - Bioremediation Utilizing a Partitioning Electron Donor (Butyl Acetate)
  - Solar Powered Groundwater Recirculation Systems



# Innovations Remediation Team

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- ◆ KSC Remediation Team (KSCRT)
  - Comprised of NASA civil servants (5)
  - FDEP Remedial Program Manager
  - A representatives from each Consulting firm
  - Team Processes
    - Ground Rules
    - Peer review all of each others work
    - Collaborative decision making
  - Meets 1-2 days every 8 weeks to discuss site progress and make decisions on paths forward
  - Decision Process Document
    - Recipe for implementing RCRA Corrective Actions at KSC
      - Technical approach
      - Screening levels
      - Repository for KSC Reference Values
      - Templates for documents



# *Innovations*

## **High-Resolution Site Characterization**

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- ◆ KSC implemented the frequent use of high-resolution site characterization (HRSC) in 2008 following the conclusion that many of the legacy sites at the Center were under assessed horizontally and vertically
  - Unidentified sources were impacting site cleanups
  - “Knife” edges both horizontally and vertically were found repeatedly at numerous sites that were under investigation at the time
  - Previous groundwater delineation efforts had no minimum distance between sampling point (horizontally and vertically)
- ◆ As a result a multi-step process was developed by the KSCRT
  - Adequate site characterization (includes minimal distances)
  - Participate in evaluation of remedial technologies
  - Review preliminary designs
  - Evaluate efficacy of interim measures

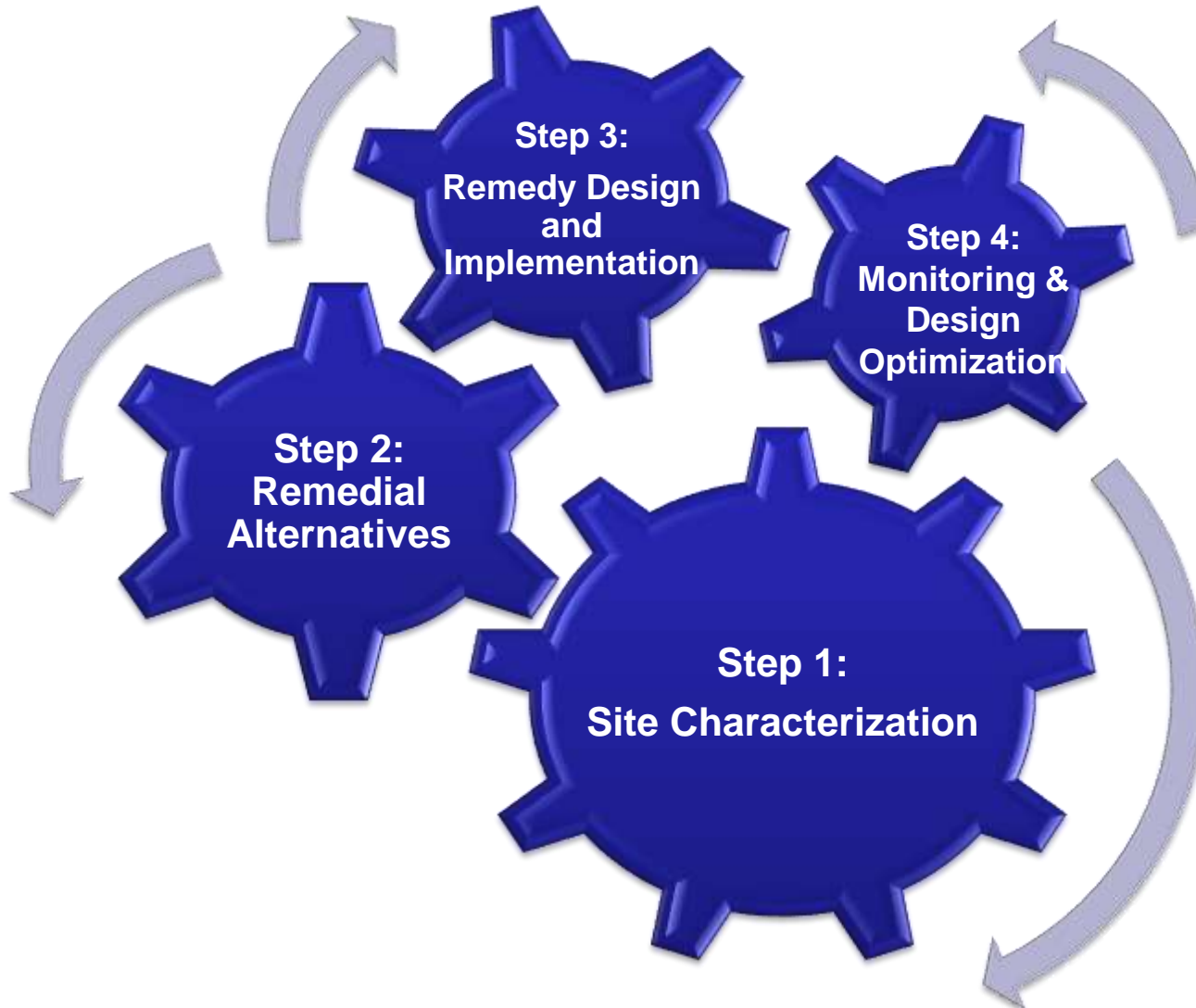


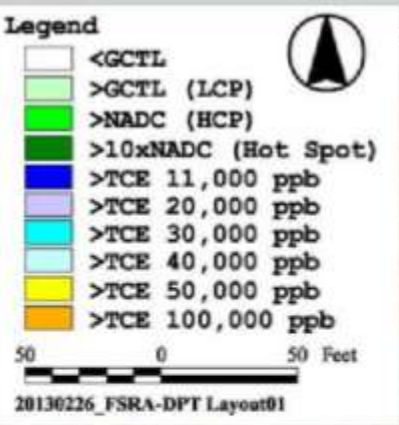
# *Innovations*

## **Multi-Step Engineering Evaluation Process**

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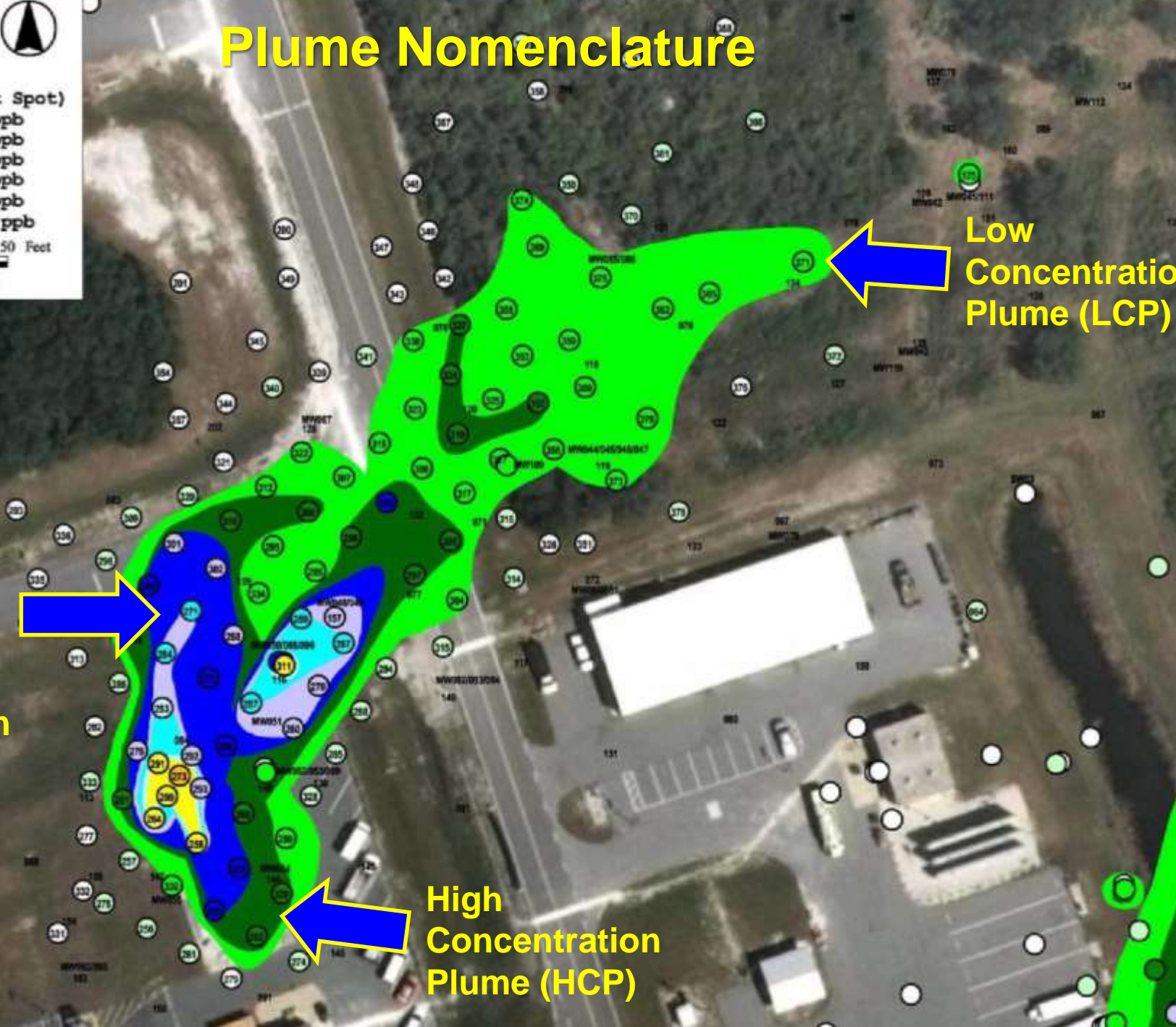


# Plume Nomenclature

Hot Spot =  
10x FDEP  
Natural  
Attenuation  
Default  
Criteria  
(NADC)

Low  
Concentration  
Plume (LCP)

High  
Concentration  
Plume (HCP)





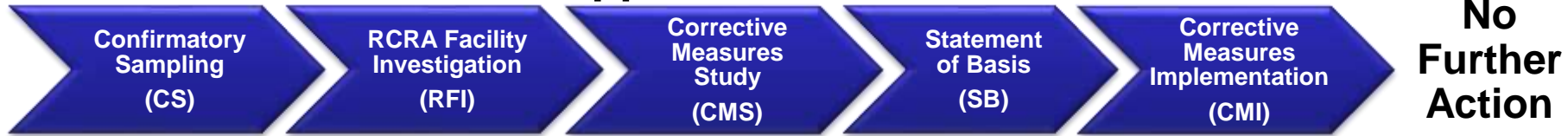


# Innovations

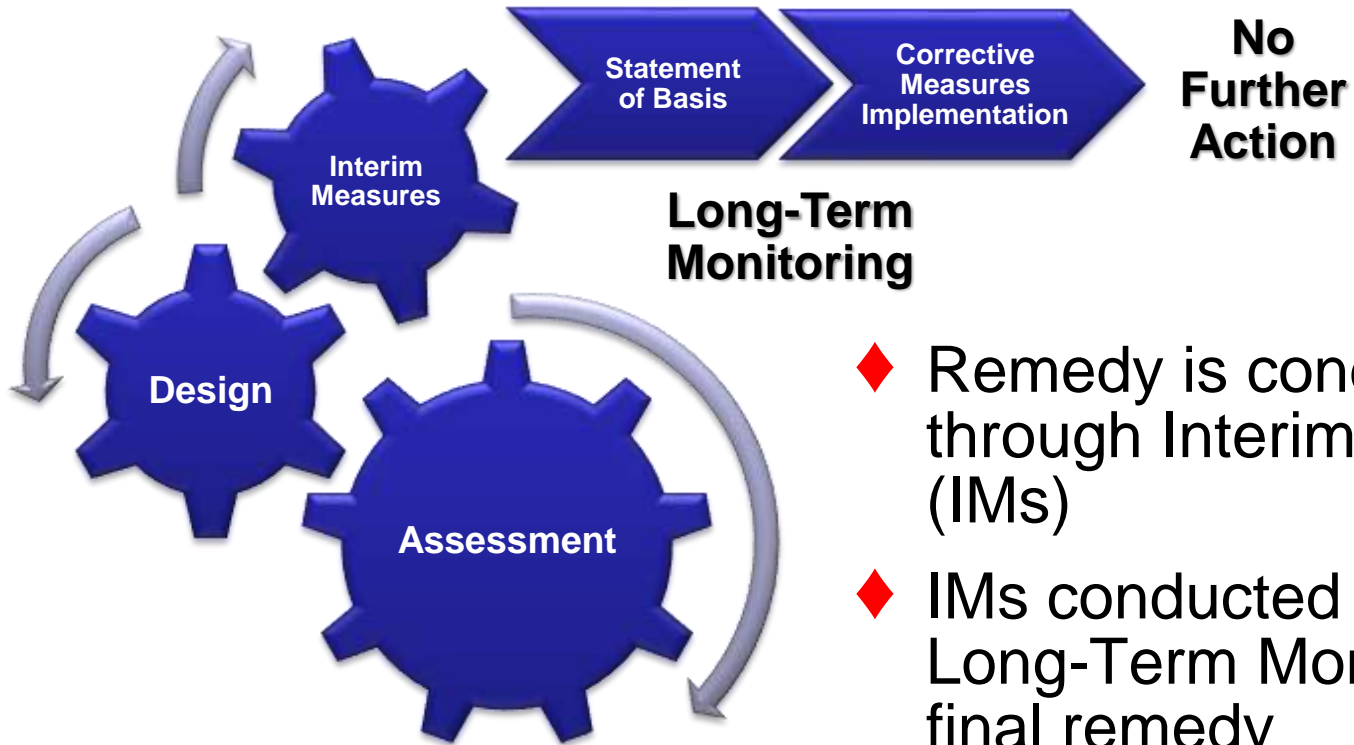
## KSC Variation of RCRA Corrective Actions

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### Traditional Linear Approach RCRA Corrective Actions



### KSC Approach RCRA Corrective Actions



- ◆ Remedy is conducted through Interim Measure(s) (IMs)
- ◆ IMs conducted such that Long-Term Monitoring is the final remedy



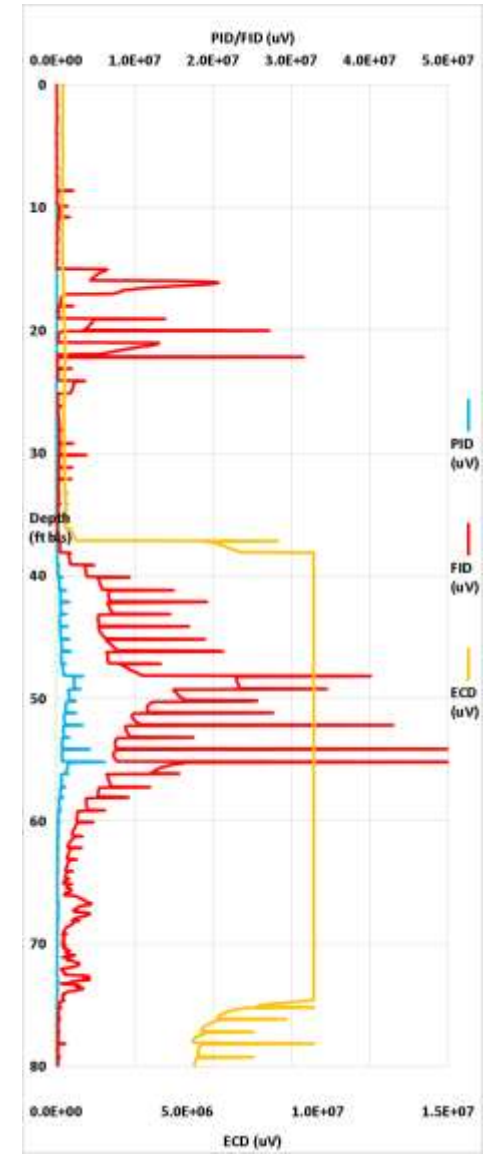
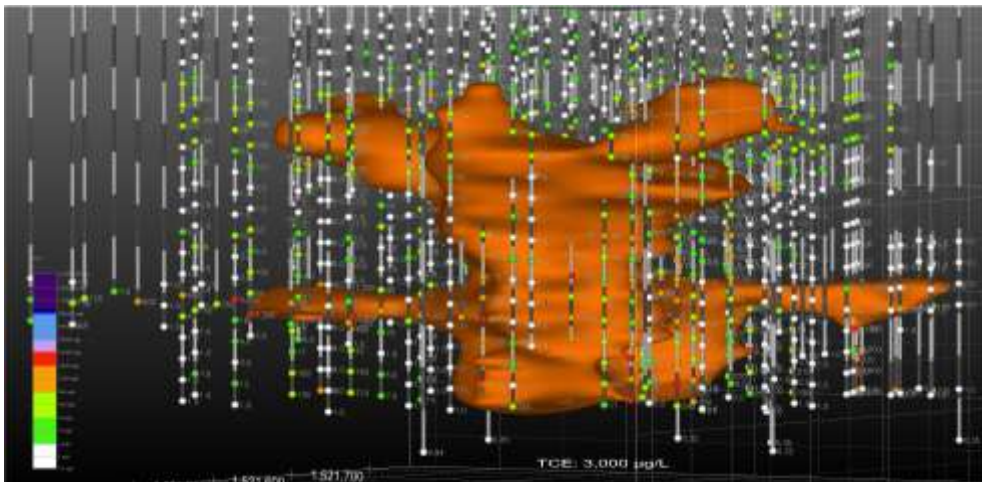
# Innovations

## High-Resolution Site Characterization

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### ◆ HRSC Tool Box

- Direct Push Technology (DPT) and Mobile Laboratories
- Membrane Interface Probe (MIP)
  - Confirm previous or develop new sampling intervals
- Earth Volumetric Software (EVS)
- Hydraulic Profiling Tool (HPT)
- Saturated Soil Sampling



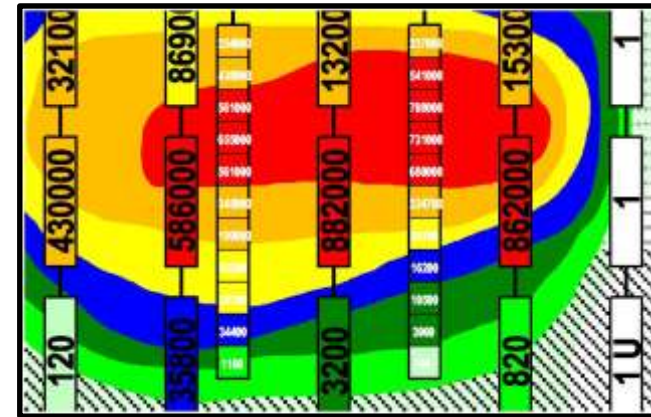


# *Innovations*

## Benefits of High-Resolution Site Characterization

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- ◆ Since 2008, 24 sites have been assessed/re-assessed utilizing HRSC
  - All phases of the RCRA Corrective Action Program (RFI – CMI)
- ◆ 8,500 DPT sampling points and 50,000 groundwater samples
- ◆ Refined Conceptual Site Models
  - Plume delineation and interpretation based upon DPTs
    - Higher fidelity representation of the plume morphology
    - Reduced uncertainty on the horizontal and vertical extent of contaminant distribution
    - Better understanding of the source mass distribution
      - Horizontally and vertically
    - Better understanding of treatment zones
    - Better ability to predict cleanup timeframes





# *Innovations*

## **Benefits of High-Resolution Site Characterization**

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- ◆ Refined Conceptual Site Models - continued
  - Provides improved technology selection
    - Designs based upon HRSC versus monitoring wells
    - Helps reduce the risk of missing a source area and/or treating the wrong area(s)
  - Improved Budget Planning
    - Engineering estimates more accurately reflect the capital and operations, maintenance, and monitoring costs
      - Allows KSC to decide on treatment areas (source, hot spot, HCP)
    - Better engineering estimates allows more accurate budget planning in the out-years
  - Allows the implementation of a groundwater IM or a series of IMs that reach KSC's goal of transitioning to monitored natural attenuation
    - 30 groundwater cleanups (including expansions) since 2012

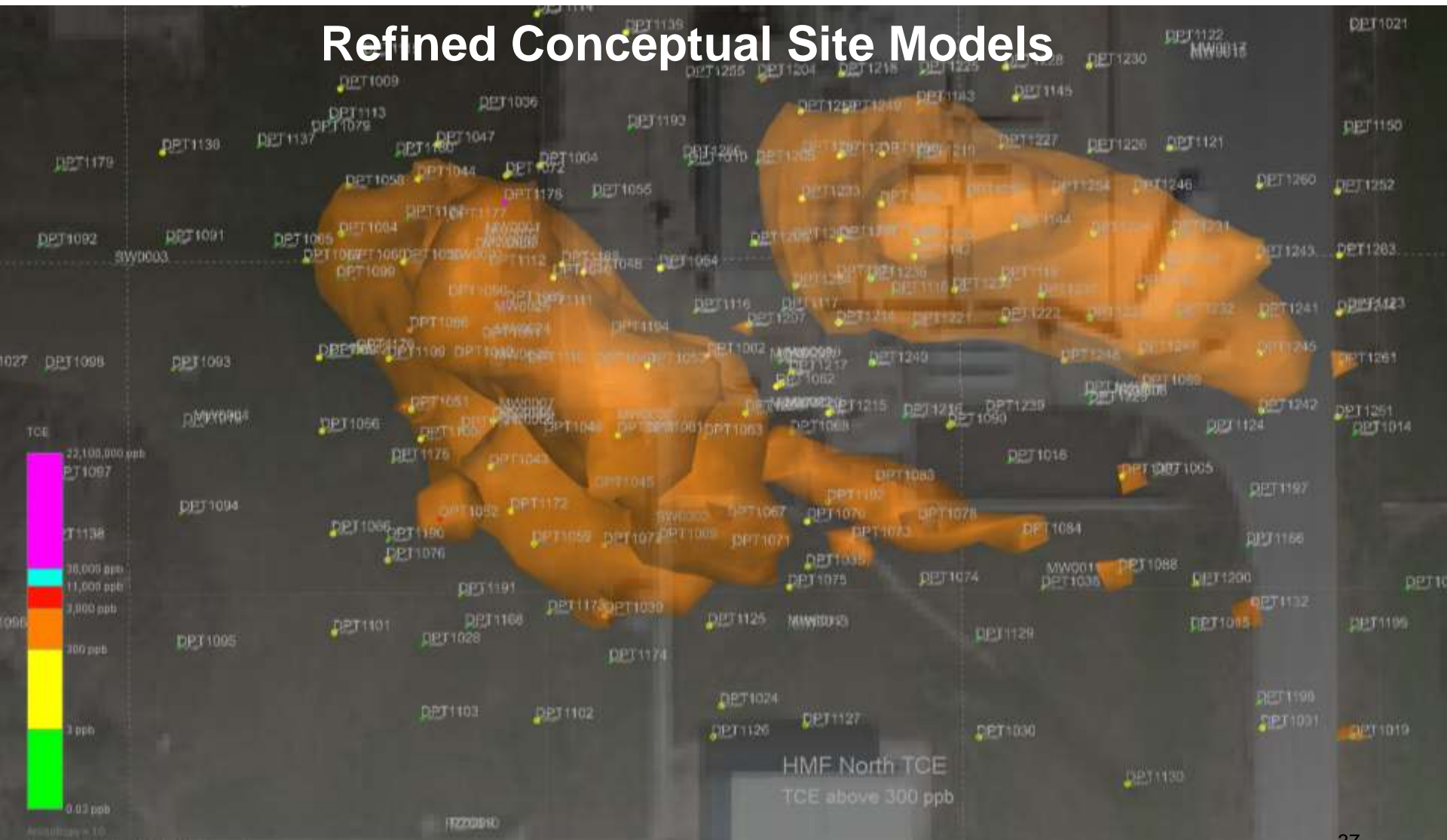


# Innovations

## Benefits of High-Resolution Site Characterization

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### Refined Conceptual Site Models





# *Innovations*

## **Benefits of High-Resolution Site Characterization**

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- ◆ DPTs are being used to adjust designs prior to implementation
  - Interim Measure Work Plans/Designs may be several years old
    - Hot Spots and HCPs migrate over time
    - Currently two air sparge treatment systems are being redesigned to include additional wells based upon the recently collected DPT data
- ◆ DPTs have been used to determine treatment efficacy
  - Easily identifies intervals that are not remediating or are cleaning up at a slower rate
    - Facilitates the potential to adjust flow rates to sparge wells
    - Identifies areas that may require treatment
  - Changes in plume morphology over time with treatment
    - Plumes retreating back to source areas
    - DPTs have been determined to be more useful than performance monitoring wells



# Progress Soil Cleanups

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- ◆ 81 soil cleanups have been conducted at 62 sites
  - Site volumes ranged from 2 to 107,500 tons
  - Total volume of soil remediated = 281,541 tons (including 6,800 tons of soil with PCB concentrations > 50 parts per million)
    - Approximates a 2 foot dig over 50 football fields





# Progress Groundwater Cleanups

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- ◆ Active Groundwater Cleanup Technologies Implemented at KSC
  - Air Sparging (17 and 4 Fiscal Year 2020 implementations)
  - Bioremediation (10 and 4 pilot tests)
  - Saturated Source Zone Excavation (9)
  - Pump and Treat for hydraulic containment (4)
  - Soil Vapor Extraction (4)
  - Chemical Oxidation (3 and 1 pilot test)
  - Emulsified Zero-Valent Iron (1 and 1 pilot test)
  - Large Diameter Augers with Steam (1)
  - Electrical Resistive Heating (1 and 1 pilot test)
  - Ozone Injection (1)

(#) = number of sites





# Progress

## Groundwater Cleanups

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### ◆ Air Sparging

- Converter Compressor Building Area (**228 + 145 = 373 ASWs**)
- Launch Complex 34 (**160 + 140 = 300 ASWs**)
- Launch Complex 39B (**279 ASWs**)
- Hypergol Maintenance Facility North (**213 ASWs**) – contracted
- Paint and Oil Locker Area (**165 ASWs**) - contracted
- Launch Complex 39A (**140 ASWs**)
- Former Drum Storage Area (**137 ASWs**)
- Central Heat Plant (**125 ASWs**) - contracted

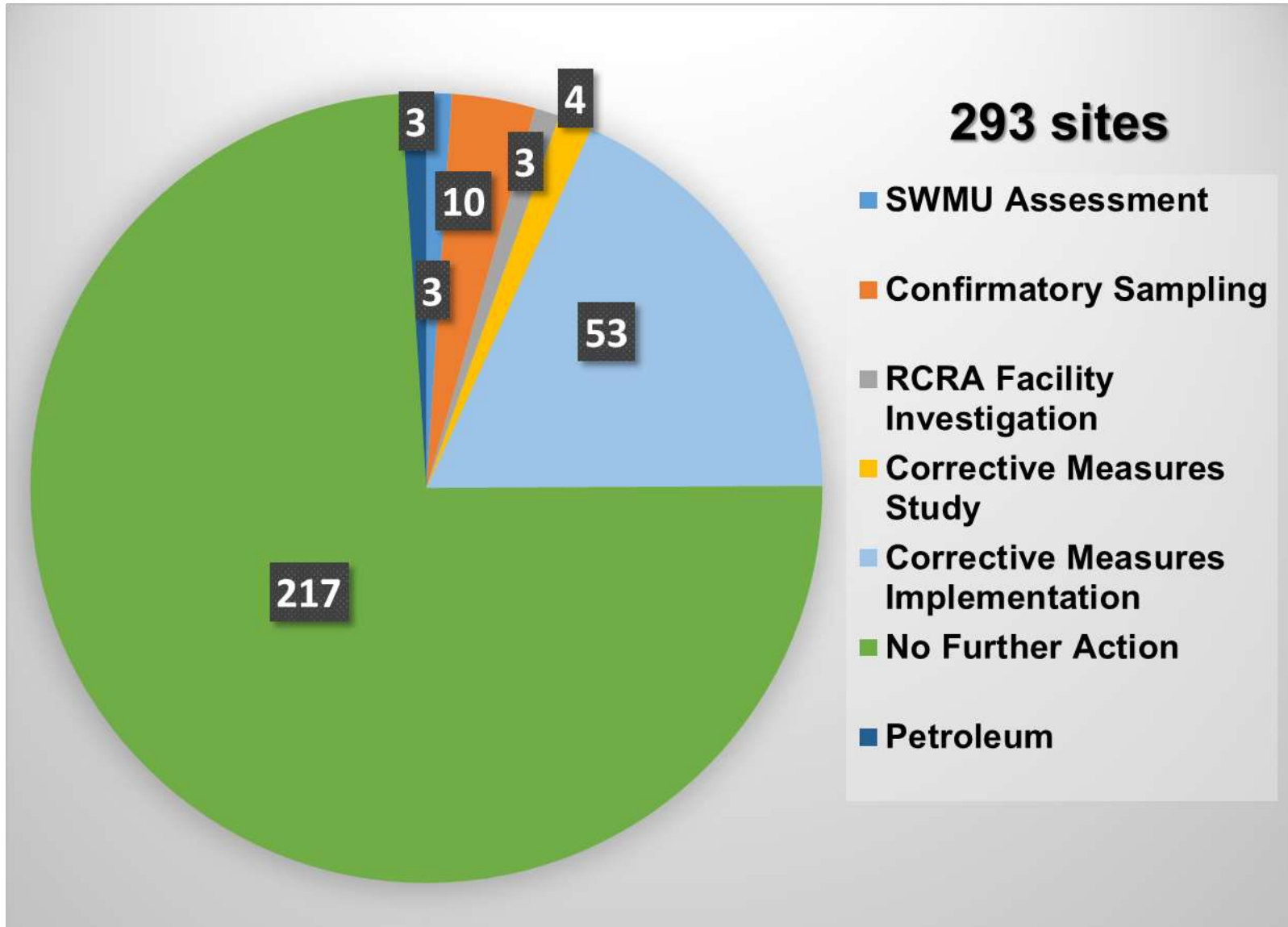
All are treating High Concentration Plumes versus Hot Spots

(ASWs) = air sparge wells



# Progress Site Inventory

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# Case Studies

## Former Drum Storage Area

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### ◆ Former Drum Storage Area

- A RCRA Facility Investigation (RFI) was conducted in multiple phases and delineated a CVOC plume > 2.5 acres in size
- Corrective Measures Study (CMS) selected bioremediation as the preferred alternative
  - Bioremediation pilot study was implemented in 2008
  - Performance monitoring wells identified much higher TCE concentrations than were anticipated
  - KSCRT determined the plume interior was not adequately characterized
- HRSC was initiated in 2009
  - 195 DPT locations
  - 630 groundwater samples
  - Provided a well defined treatment zone
- Remedy was re-evaluated
- Selected air sparging of the Hot Spot and HCP

**Legend**

- Groundwater Sample
- Low Concentration Plume, exceeds GCTL
- High Concentration Plume, exceeds NADC

100 0 100 Feet

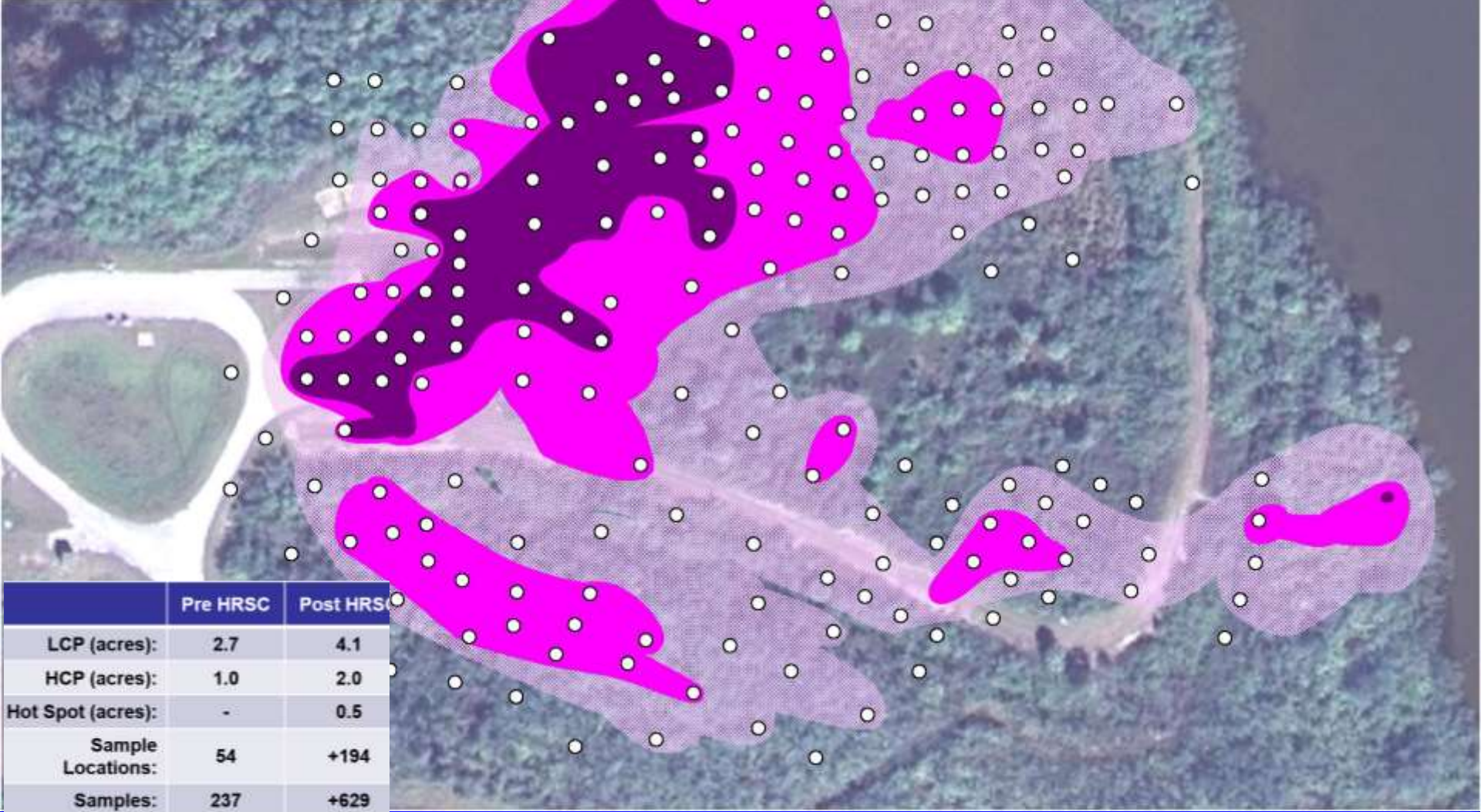


**FDSA Pre-HRSC Plume Delineation**

**Legend**

- Groundwater Sample
- Low Concentration Plume, exceeds GCTL
- High Concentration Plume, exceeds NADC
- Hot Spot, exceeds 10xNADC

100 0 100 Feet







	Pre HRSC	Post HRSC
LCP (acres):	2.7	4.1
HCP (acres):	1.0	2.0
Hot Spot (acres):	-	0.5
Sample Locations:	54	+194
Samples:	237	+629

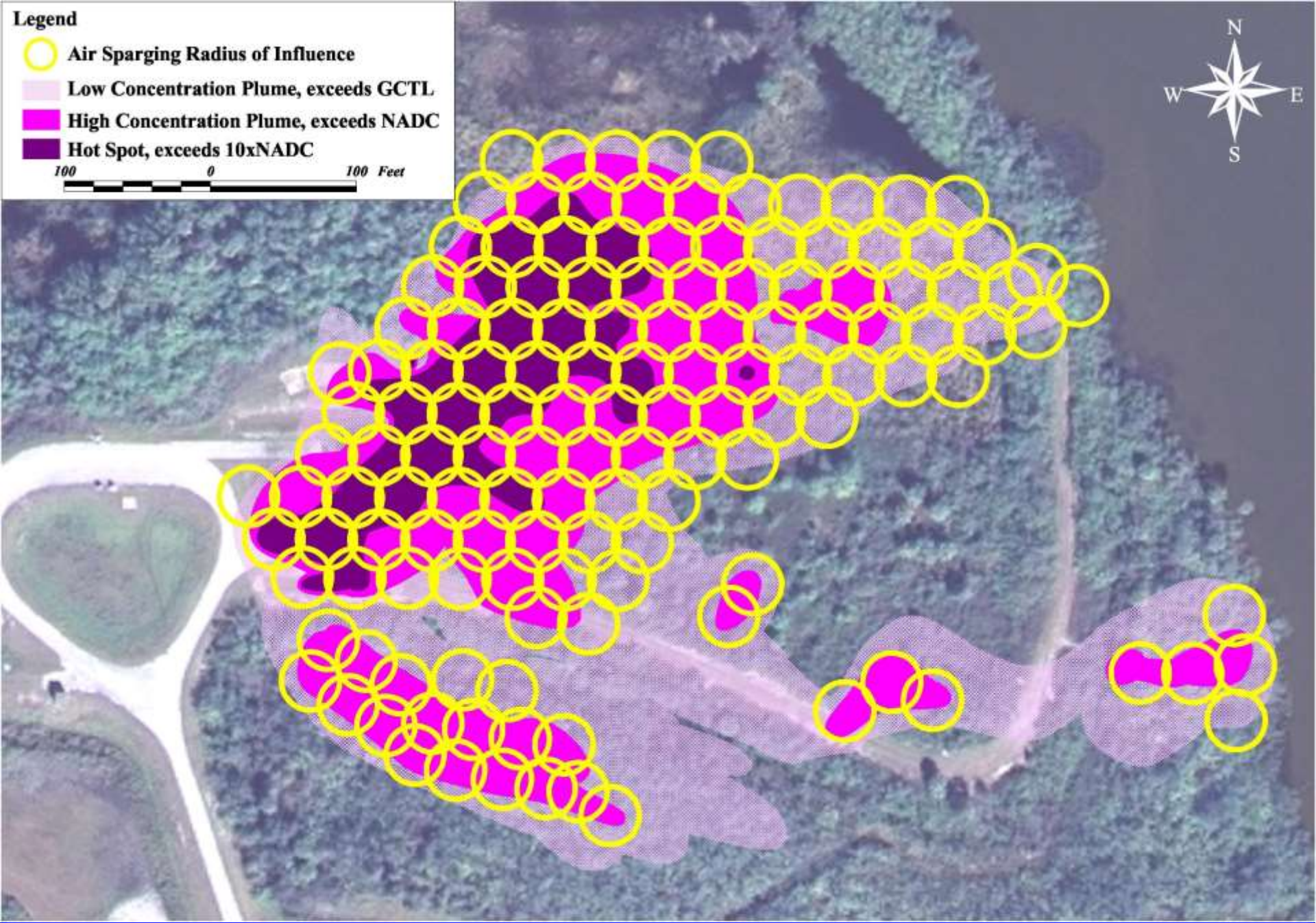
Average distance between Sampling points	125	40
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# FDSA Post-HRSC Plume Delineation

**Legend**

-  Air Sparging Radius of Influence
-  Low Concentration Plume, exceeds GCTL
-  High Concentration Plume, exceeds NADC
-  Hot Spot, exceeds 10xNADC

100 0 100 Feet



**FDSA Treatment Area**

## Legend

 Low Concentration Plume, exceeds GCTL

100 0 100 Feet



# FDSA Current Plume Delineation



# Case Studies

## Components Cleaning Facility (CCF)

### Area South of Facility 516 (516S)

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#### ◆ CCF

- RFI delineated a CVOC groundwater plume with a TCE DNAPL source area and three areas with Freon DNAPL
- Corrective Measures Implementation (CMI) was conducted in the early 2000's
  - Excavation of shallow TCE source area
  - Air Sparge (AS)/Soil Vapor Extraction (SVE) of HCP – 56 ASWs and 51 SVE points
  - Hydraulic containment
  - Performance monitoring over time showed increasing CVOC concentrations

#### ◆ 516S

- Secondary Hot Spot identified south of the Crawlerway
  - HRSC implemented across the entire area (CCF and 516S)
    - 831 DPT locations
    - 5,153 groundwater samples





# Case Studies

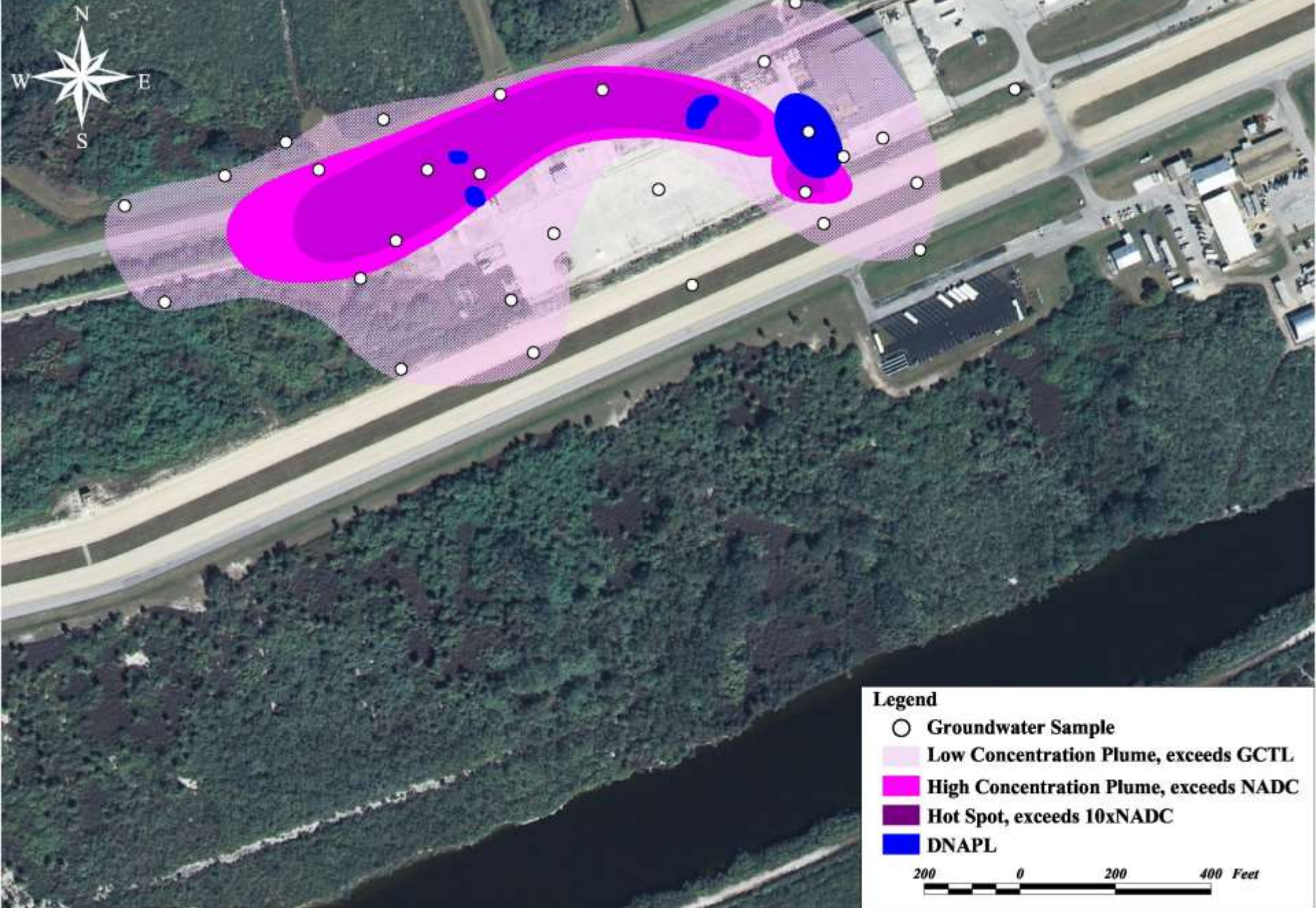
## Components Cleaning Facility (CCF)

### Area South of Facility 516 (516S)

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- Significantly changed the conceptual site model
  - The CVOC plumes at both sites were connected and that CCF was the source
  - Provided well defined treatment zones
- Adaptive site management
  - Let site conditions dictate additional remedial actions
- Remedial alternatives were evaluated and selected to be implemented as multiple IMs over the past 8 years
  - Air Sparge Cut-Off Wall @ 516S - 16 ASWs
  - Air Sparging of Eastern Hot Spot @ 516S - 40 ASWs
  - Electrical Resistive Heating of DNAPL Source Zone @ CCF
  - Air Sparging of Western Hot Spot/HCP @ CCF - 61 ASWs
  - Air Sparging of Eastern Hot Spot/HCP @ CCF (planned – 80 ASWs)



# CCF/516S Pre-HRSC Plume Delineation



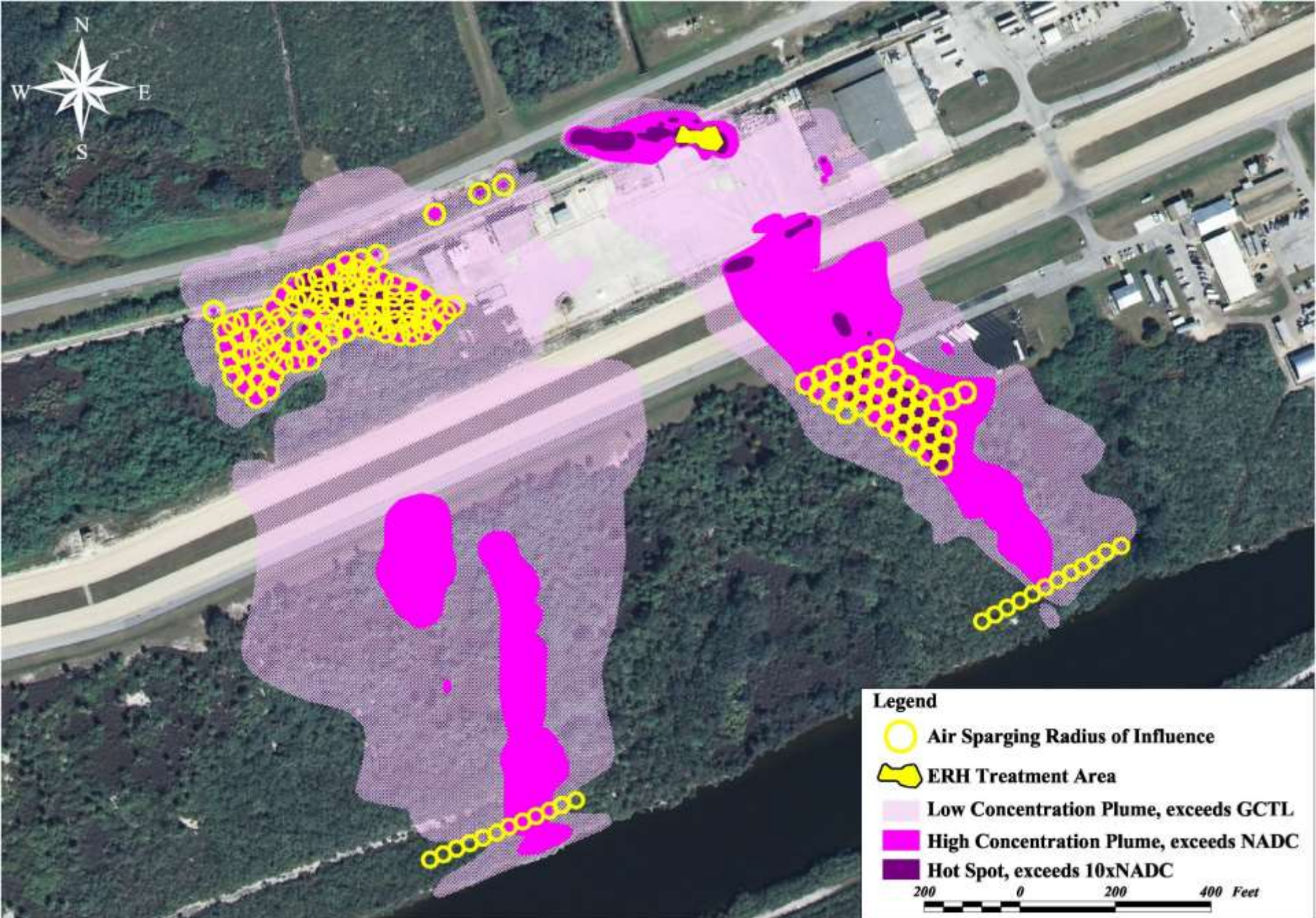
	Pre HRSC	Post HRSC
LCP (acres):	14.9	34.1
HCP (acres):	5.5	8.4
Hot Spot (acres):	3.3	1.0
Sample Locations:	82	+387
Samples:	208	+2,631
Average distance between	250	65

**Legend**






- Groundwater Sample
- Low Concentration Plume, exceeds GCTL
- High Concentration Plume, exceeds NADC
- Hot Spot, exceeds 10xNADC



**Post-HRSC Plume Delineation**



**Legend**

-  Air Sparging Radius of Influence
  -  ERH Treatment Area
  -  Low Concentration Plume, exceeds GCTL
  -  High Concentration Plume, exceeds NADC
  -  Hot Spot, exceeds 10xNADC
- 200 0 200 400 Feet

**CCF/516S Treatment Areas**



# Case Studies

## Launch Complex 34



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Medical and Environmental Services Division

- ◆ Pad constructed between 1959 and 1961 for the Saturn 1 and 1B rocket programs
  - Seven launches from 1961-1968
- ◆ Remediation history
  - RFI began in 1997
  - Interagency DNAPL Consortium 1999 to 2001 – Pilot Tests
    - Chemical Oxidation with Potassium Permanganate
    - Steam Injection
    - Six Phase Heating
      - Estimated mass removal = 59,500 pounds (4,900 gallons) of CVOCs





# Case Studies

## Launch Complex 34



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Medical and Environmental Services Division

- NASA Funded Small Business Initiatives
  - Bioaugmentation (KB-1®)
  - Emulsified Zero-Valent Iron
- Environmental Security Technology Certification Program (ESTCP)
  - Sequential Application of In-Situ Chemical Oxidation and Enhanced Bioremediation
  - Bioremediation Utilizing a Partitioning Electron Donor
- RFI Addendum and CMS estimated that over 100,000 pounds of TCE DNAPL remained in the source zone
  - Under and around the former Engineering Support Building
  - DNAPL source zone and multiple hot spots created a 330 acre CVOC plume
    - 1 mile long





# **Case Studies**

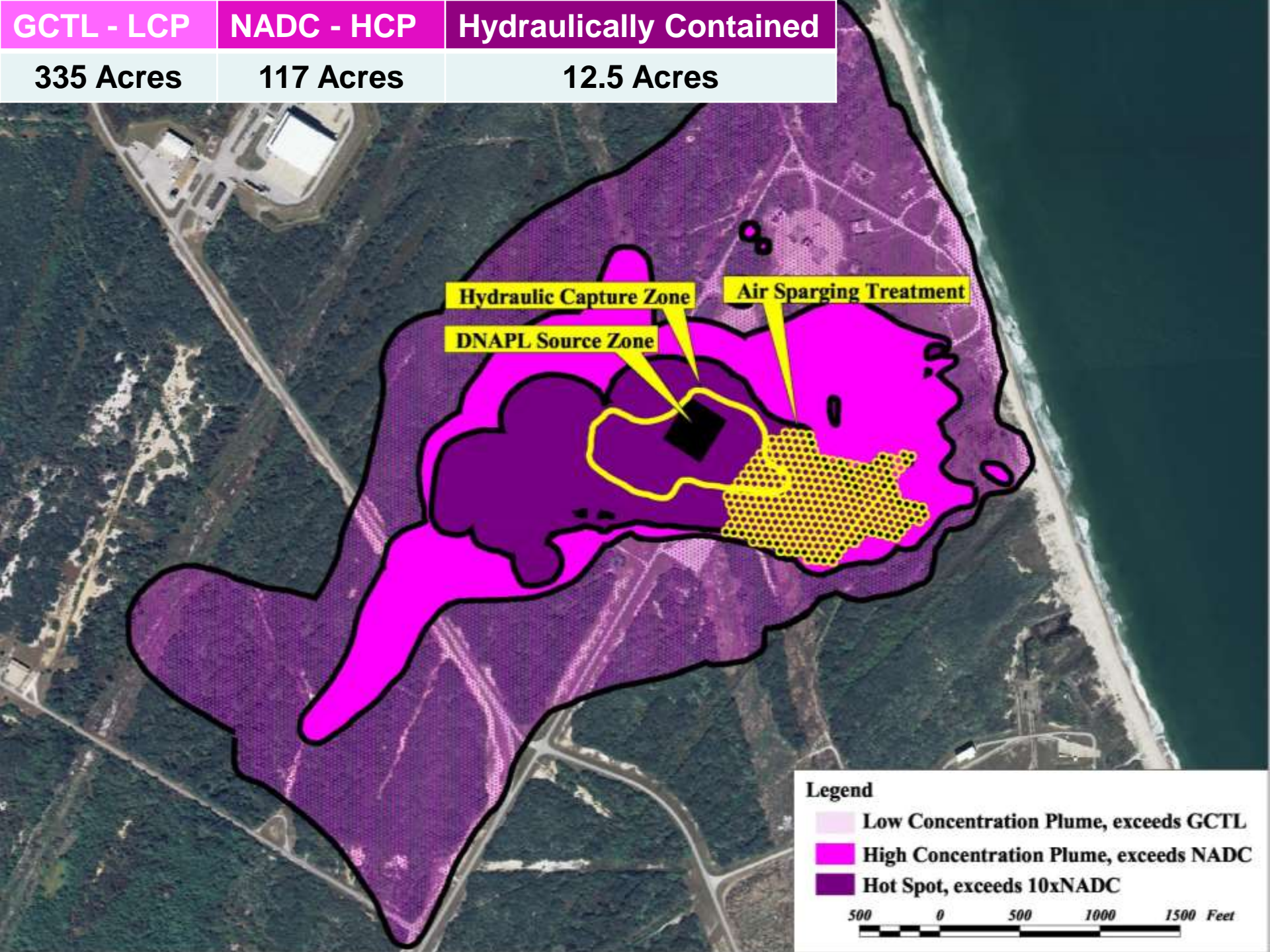
## **Launch Complex 34**

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- ◆ CMS submitted in 2008
  - Recommended hydraulic containment of the DNAPL Source Zone and supplemental Hot Spot assessments
- ◆ HRSC was implemented to support work plan design
  - Initial Hot Spot assessments expanded the containment zone
- ◆ Hydraulic containment implemented as an IM in 2009
  - Catalytic oxidizer (cat ox) unit destroys CVOOC vapors
- ◆ Containment system expanded and cat ox refurbished in 2014 following additional HRSC
  - Secondary round of MIPs data and Hydraulic Profiling Tool (HPT) utilized for hydraulic containment treatment system optimization
- ◆ 67,000 pounds of CVOOCs have been destroyed to date
  - 205 million gallons of groundwater

<b>GCTL - LCP</b>	<b>NADC - HCP</b>	<b>Hydraulically Contained</b>
<b>335 Acres</b>	<b>117 Acres</b>	<b>12.5 Acres</b>



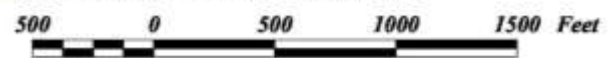
**Hydraulic Capture Zone**

**Air Sparging Treatment**

**DNAPL Source Zone**

**Legend**

- Low Concentration Plume, exceeds GCTL
- High Concentration Plume, exceeds NADC
- Hot Spot, exceeds 10xNADC







# Case Studies

## Launch Complex 34

Kennedy Space Center

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- ◆ HRSC continuously refines the conceptual model for one of the most assessed sites in the state of Florida
  - DPT = 4,250 groundwater samples from 665 locations
  - Monitoring Wells = 1,483 groundwater samples from 237 locations
  - MIPs = 52
  - Hydraulic Profiling Tool (HPT) = 8
  - MIPs/HPT Pairings = 6
  - Saturated soil locations = 1,080 from 607 locations
  - EVS
    - Saturated Soil (DNAPL Source Zone)
    - Groundwater

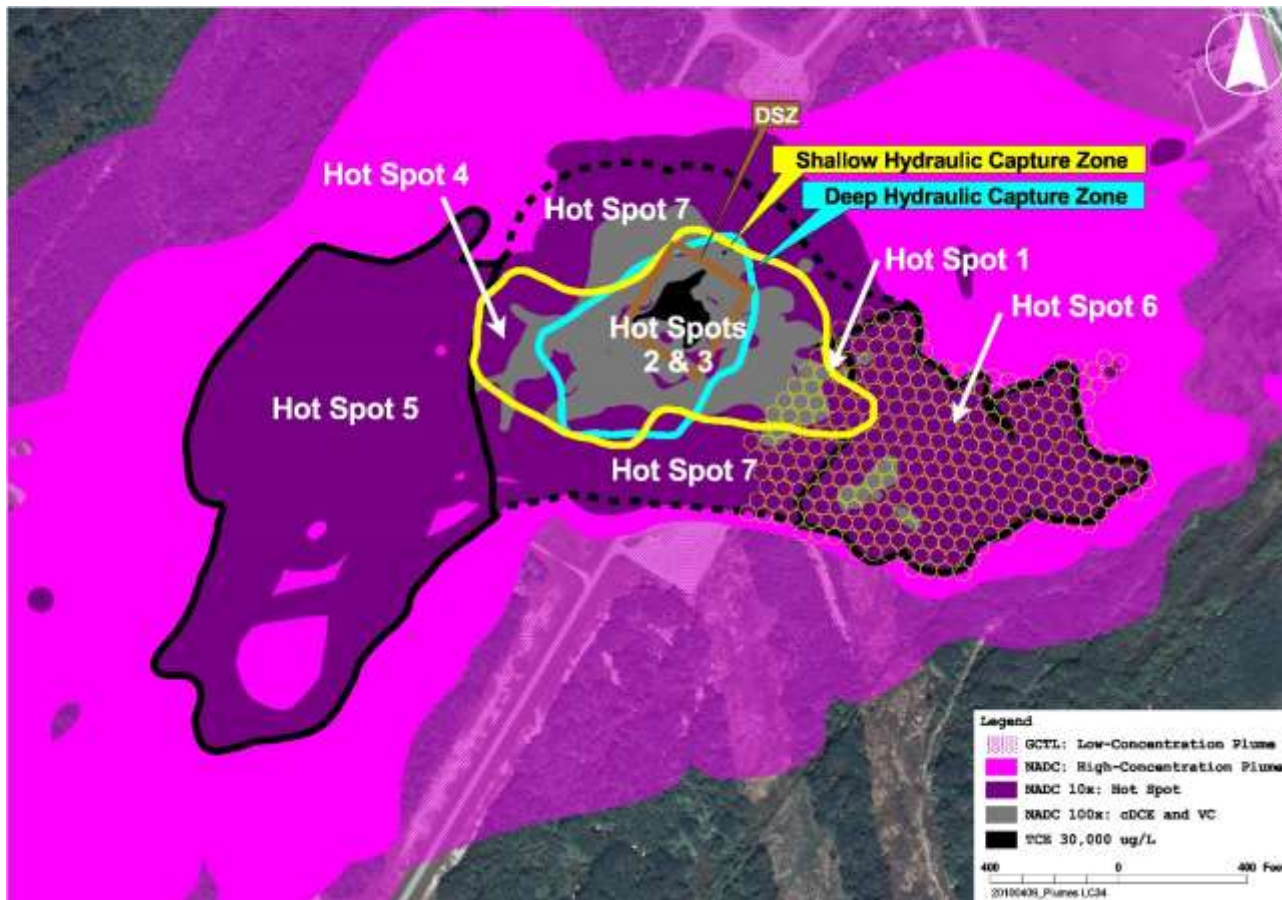


# Case Studies

## Launch Complex 34

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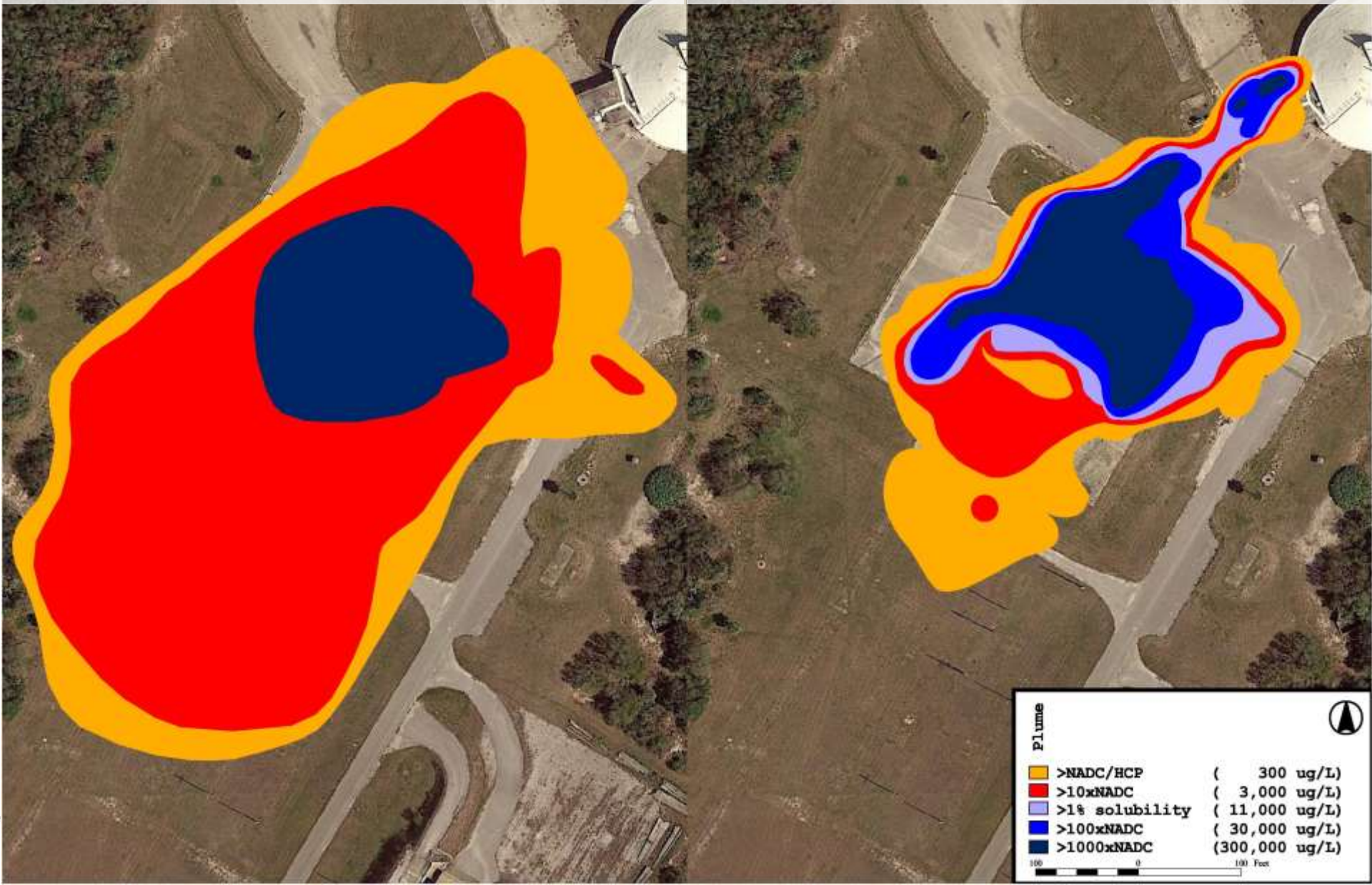
- ◆ Air sparge IM was implemented in Hot Spot 6 in 2018
- ◆ Soil IMs removed 2,590 tons of PCB-contaminated soil in 2018 and 2019



# DNAPL Source Zone

TCE Prior to HCS (2009)

TCE Site Characterization (2019)





# Conclusions

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- ◆ Spending the dollars to perform additional assessment has provided significant value to KSC's Remediation Program
  - HRSC has facilitated the development of more accurate CSMs – higher level of certainty of contaminant distribution
  - Facilitates effective remedy evaluations and remediation technology selection
  - Enabled KSC to treat larger areas due to the fidelity of the assessments
  - Sites transitioning to monitored natural attenuation following 3-5 years of treatment
- ◆ KSCRT and FDEP's flexibility has allowed KSC to implement an aggressive and robust cleanup program
- ◆ Remaining DNAPL sites will continue to be problematic
- ◆ PFAS will be KSC's next big challenge

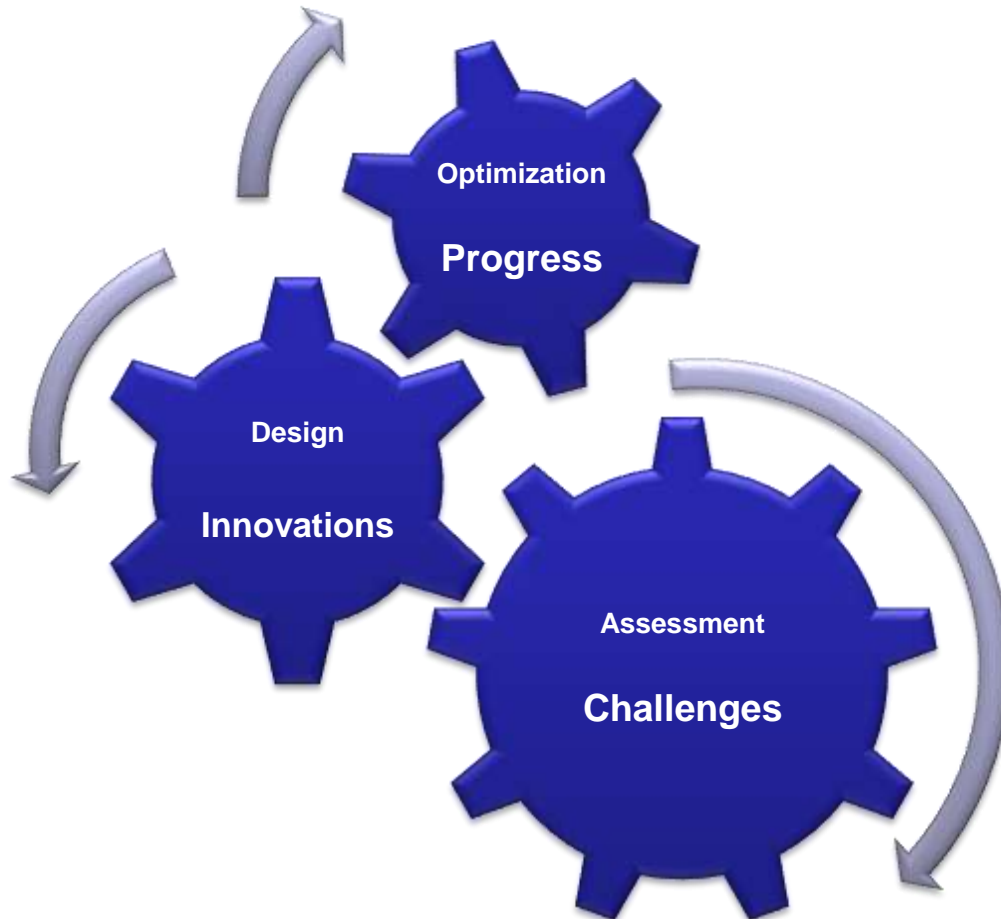


# Conclusions

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- Assessment/**Challenges** (*DO NOT END WITH DESIGN*)
- Design/**Innovations** (*DO NOT END WITH IMPLEMENTATION*)
- Optimization Evaluations/**Progress** (*THROUGHOUT*)





# Thanks

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- ◆ NASA Headquarters Environmental Management Division
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- ◆ Florida Department of Environmental Protection
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- ◆ KSC Environmental Contractors
  - HSW Engineering, Inc.
  - HSA Engineers & Scientists, Inc./G & E Engineering, Inc./ Conestoga-Rovers & Associates
  - Universal Engineering Sciences
  - Geosyntec Consultants, Inc.
  - Tetra Tech NUS, Inc.
  - Levine-Fricke, Inc./Arcadis, Inc.
  - Jacobs Engineering, Inc.
  - Tetra Tech Inc., AECOM Technical Services, Inc., and HydroGeoLogic, Inc.

An aerial photograph of a space shuttle launch complex. In the foreground, a white space shuttle with an orange external tank and white boosters is mounted on a mobile launcher platform, positioned on the launch pad. To the right, a tall, slender water tower stands prominently. In the background, another shuttle is visible on a distant launch pad, surrounded by various support structures and buildings. The landscape is a mix of green fields, water bodies, and industrial infrastructure under a cloudy sky.

# Questions