Headquarters U.S. Air Force

Integrity - Service - Excellence

Building Sustainability into the Air Force Remediation Process

Year of the Air Force Family

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Overview

- AF Environmental Restoration Program (ERP)
- AF Green and Sustainable Remediation (GSR)
- GSR in AF ERP
- GSR Technology
- GSR Through Optimization
- In-depth Case Study: Travis AFB
  - Necessary
  - Optimization
  - GSR Treatment Train
    - In situ Bioreactor → Phytoremediation → Biobarrier
  - Wrap-up
- Future Direction

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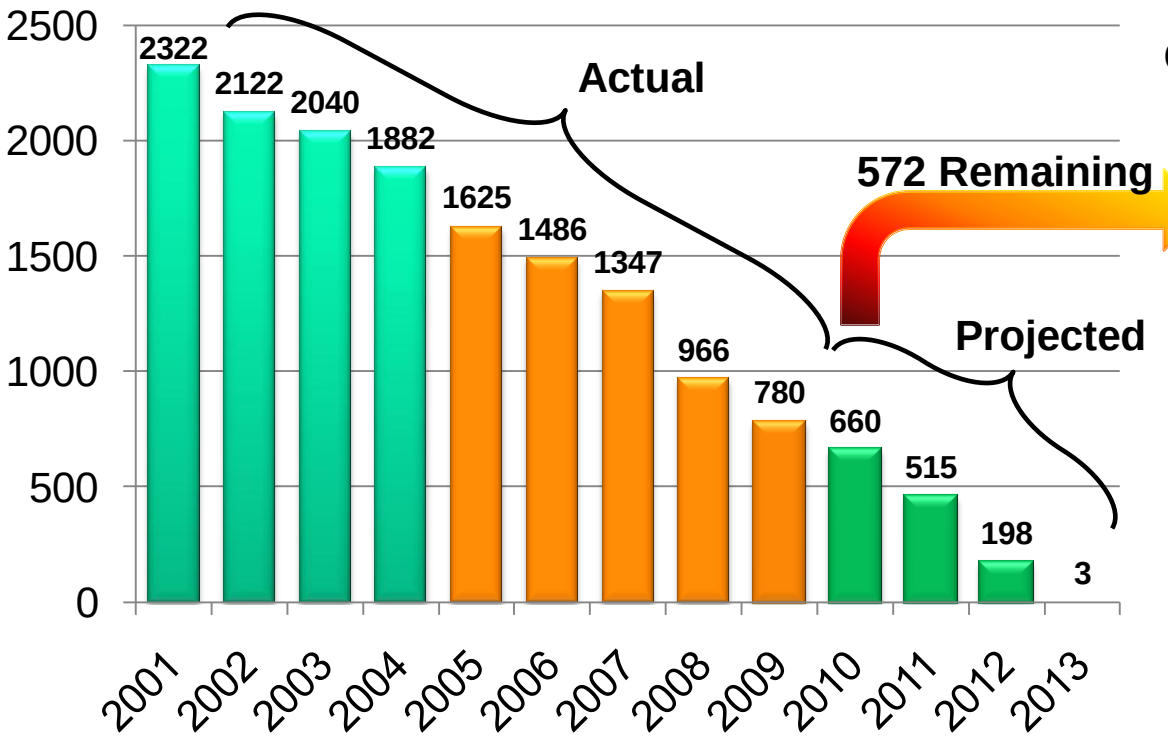
AF Environmental Restoration Program (ERP)

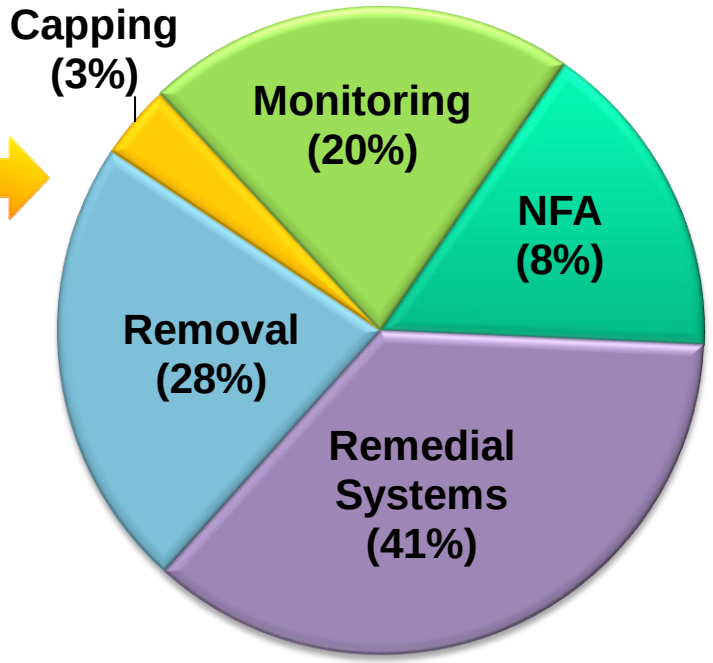
- Installation Restoration Program (IRP) – 572 sites in 2010
  - 6,078 sites closed, response complete, or RIP
  - Cleanup of pre-1986 contaminated sites
  - Achieve Remedy-in-Place (RIP) by 2012
- Compliance Restoration Program (CRP) – 952 sites in 2009
  - Compliance cleanup sites (post-1986 releases)
- Military Munitions Response Program (MMRP) – 455 open munitions response sites
  - Cleanup of non-operational ranges
  - Achieve RIP/Response Complete (RC) by 2020
- FY10 Budget: $414M for 648 active projects

AF ERP

Non RIP Sites at Start of FY



91% of sites have achieved RIP



Anticipated Remedies

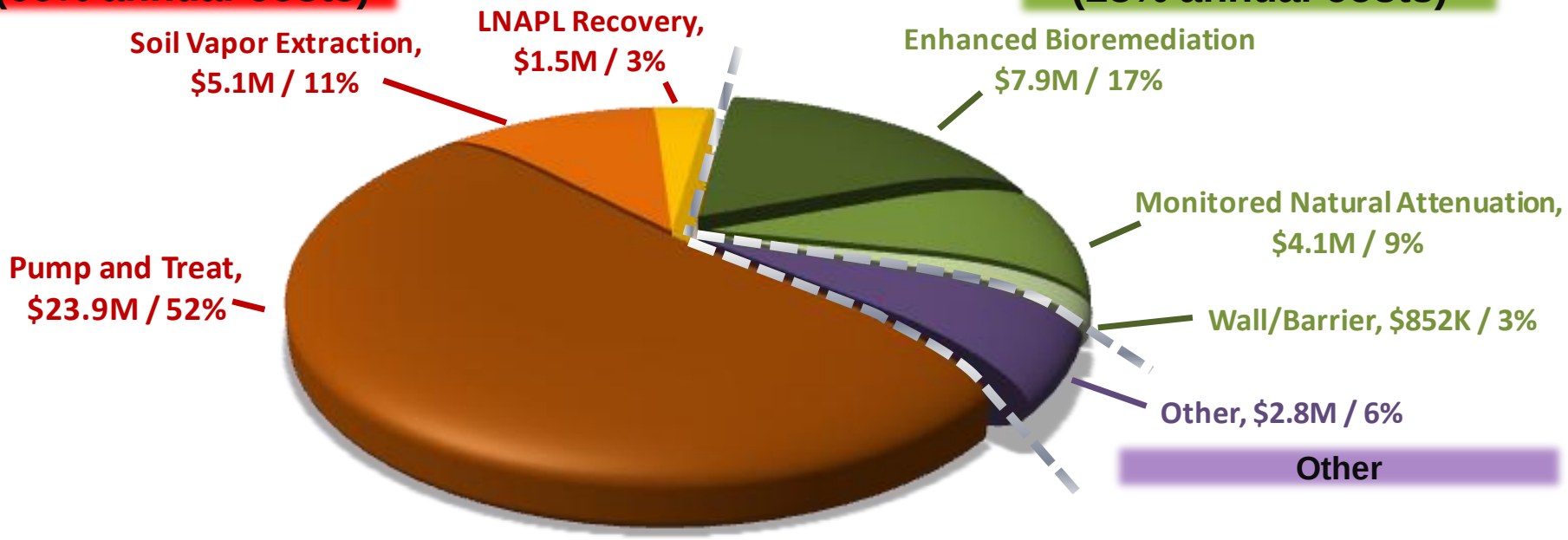
System Inventory Costs
381 Remedial Systems in Operation*

38%

48%

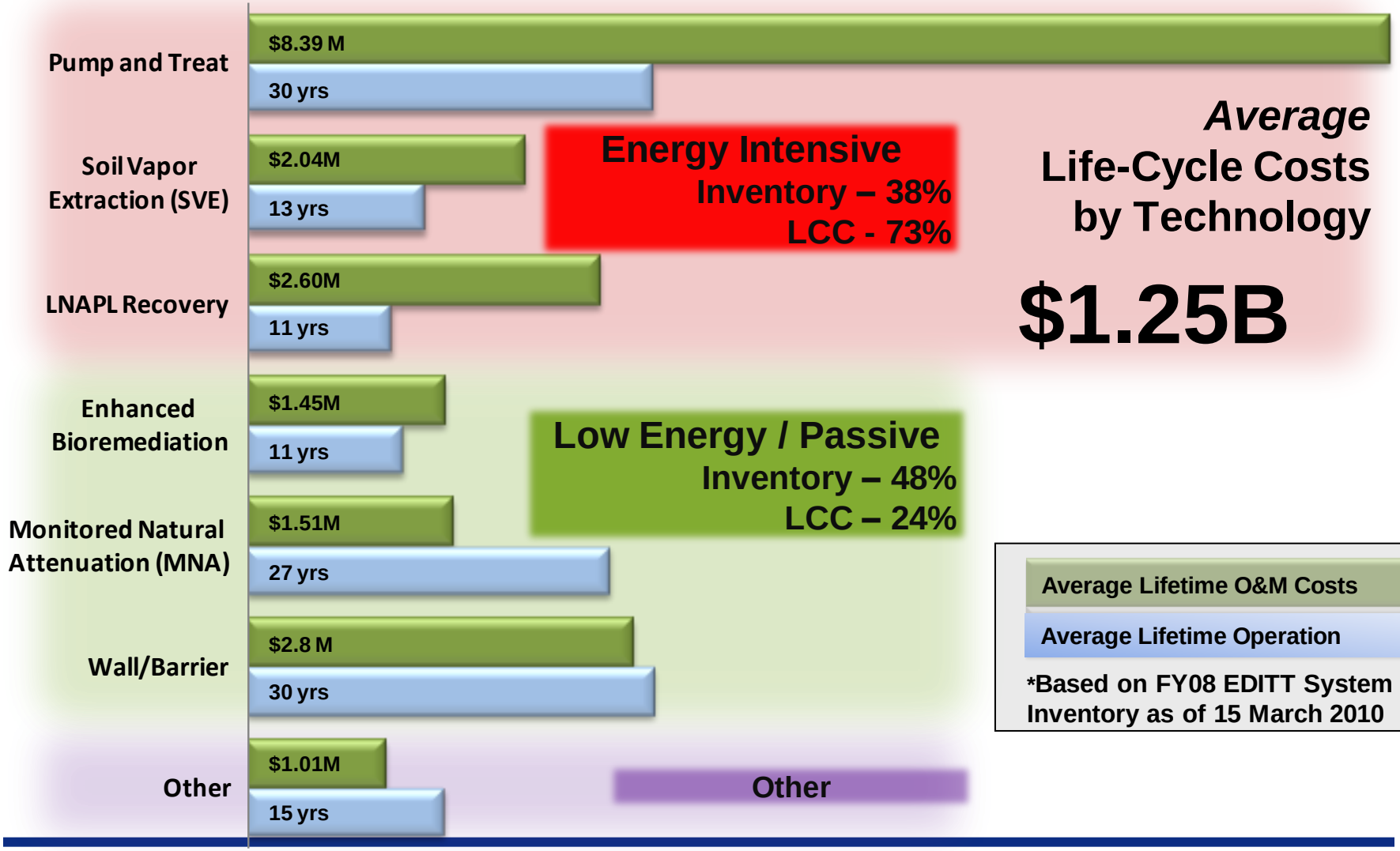
Energy Intensive (66% annual costs)

Low Energy / Passive (28% annual costs)



*Based on FY08 EDITT System Inventory as of 15 March 2010

AF ERP


Pump and Treat
$8.39 M
30 yrs
Soil Vapor Extraction (SVE)
$2.04M
13 yrs
LNAPL Recovery
$2.60M
11 yrs
Enhanced Bioremediation
$1.45M
11 yrs
Monitored Natural Attenuation (MNA)
$1.51M
27 yrs
Wall/Barrier
$2.8 M
30 yrs
Other
$1.01M
15 yrs
Energy Intensive
Inventory – 38%
LCC - 73%
Low Energy / Passive
Inventory – 48%
LCC – 24%
Other
Average Life-Cycle Costs by Technology
$1.25B
Average Lifetime O&M Costs
Average Lifetime Operation
*Based on FY08 EDITT System Inventory as of 15 March 2010

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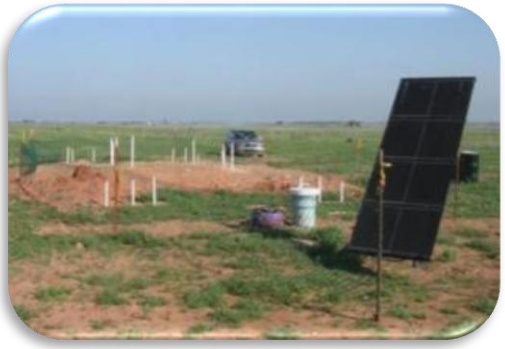
Green and Sustainable Remediation (GSR) in AF ERP

- US EPA defines Green Remediation
  - Practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprint of a cleanup

- USAF would change it slightly to:
  - Practice of considering all environmental effects of remedy implementation and operation incorporating options to minimize the environmental footprint of a cleanup



Solar-powered in situ bioreactor at Altus AFB, OK

… thereby ensuring operational performance is sustainable

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GSR in AF ERP

- **Overarching goal – protect human health and environment**
- **Key elements of the GSR initiative to <u>minimize</u>:**
  - ***Energy use for treatment systems***
  - ***Water use/impacts on water resources***
  - ***Material consumption/waste generation***
  - **Impacts on *land* and *ecosystem***
  - ***Air* emissions**
- **Objective – Incorporate GSR *technologies* as part of holistic approach to *optimize* cleanup**
  - **Technology-driven (green)**
  - **Process-centric (sustainment)**

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GSR through Technology

Goals

- Accelerate greener Remedy-in-Place (RIP)
- Augment current remedies to achieve Response Compete (RC)
- Lower capital and O&M costs
- Move from energy-consumptive to energy-efficient technologies
- Promote education and transfer of successful solutions and lessons learned

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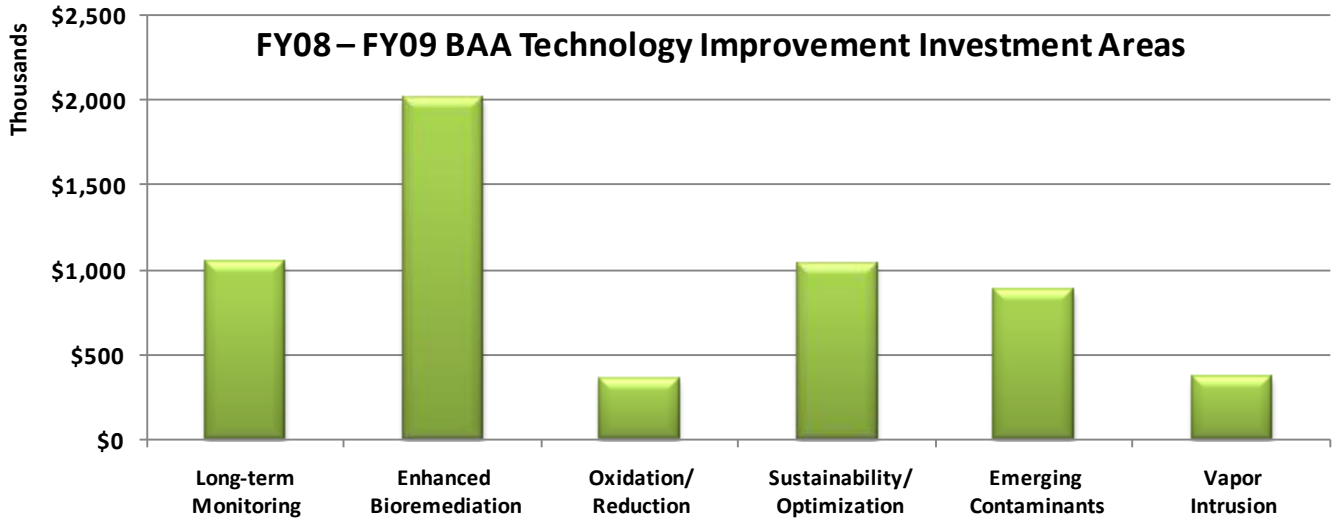
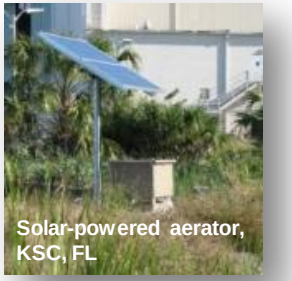
GSR through Technology

Broad Agency Announcement (BAA) for USAF Environmental Restoration Program Innovation

- **Contract mechanism for dem/val of innovative technologies**
  - **Identify BETTER, FASTER, CHEAPER, & GREENER solutions**
  - **Appears in FedBizOps**
  - **Awards based on: technical merits and broad spread application**
  - **$3M-$4M/yr AFCEE -- leveraged -- $36M (total) SERDP/ESTCP**




Solar-powered aerator, KSC, FL


Vegetable oil injection, Dover AFB, DE


Biowall, Altus AFB, OK


Solar-powered extraction well, Travis AFB, CA

GSR through Optimization

Environmental Restoration Program Optimization (ERP-O)

- A *comprehensive and systematic* review of an installation's cleanup activities
- Return natural infrastructure resources to *beneficial use*
- Promote and incorporate *sustainability principles*
- Ensure remedy *effectiveness,* first
- Optimize remedy *efficiency*, second

Focus is on PERFORMANCE … which drives COSTS

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Case Study: Travis AFB

Goals

- **Out of necessity**
- **Reduce energy consumption, air emissions, material consumption and waste generation**
- **Improve performance of existing remedial technologies**
- **Improve cost effectiveness**
- **Reduce impacts on water resources, land and ecosystems**
- **Reach RIP and RC in a more sustainable manner as decreasing concentrations will allow**
- **Multiple reasons for selecting or transitioning to sustainable technology**

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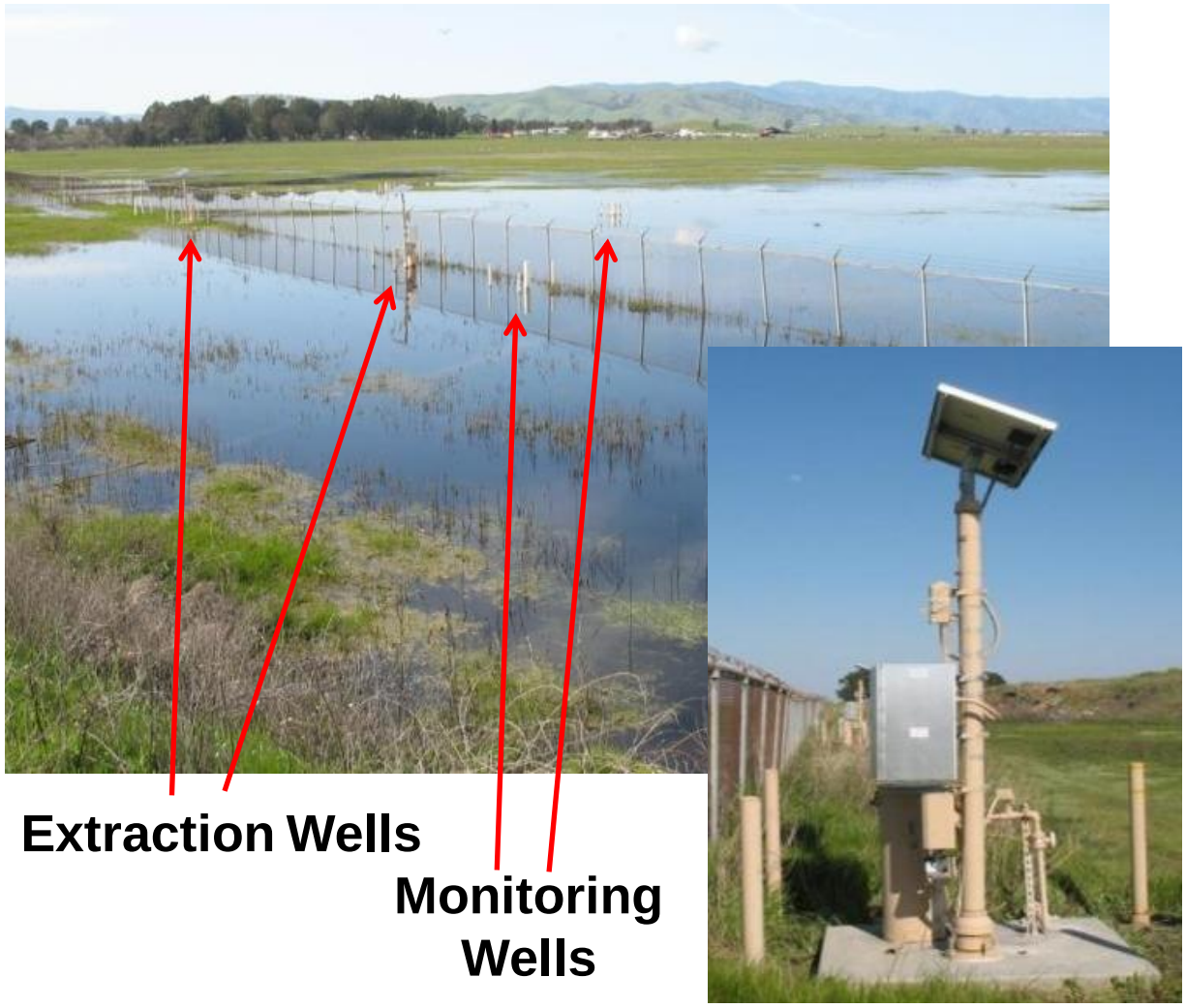
Solar Powered Well at Base Boundary



- Example of GSR out of necessity
- Vernal pool covers most of on- and off-base site boundary
- Solar solution avoided regulatory hurdles and reduced impact on sensitive ecosystem

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Transition to Low Conc/ Low Vol Operations

- At start of base GW remediation, plumes large and heavily contaminated
- Centralized GW treatment offered economy of scale and easier O&M
  - >1.17 billion gals of GW treated
  - >12 thousand lbs of solvents removed
- Over time, extraction systems effectively removed contaminant mass-plumes shrank-hot spots “cooled”
- Over time, influent concentrations and volumes decreased and maintenance/repair costs increased
- ERP-O helped with transition to more sustainable technology
  - “Time to trade in the old SUV for a new Prius”

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North Treatment Plant Before Optimization

- 82 M gal water treated since 2000
- $100K/lb VOC removed
- 10K kWh of electricity consumed monthly
- 13K lbs of CO_2 generated monthly

- NGWTP removed over 500 lbs of VOCs from 2000-2007
- In 2008 NGWTP removed ½ lb of VOCs!

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North Treatment Plant After Optimization

- 80k gals of water will be treated monthly
- Significantly reduced cost/lb VOC removed
- No off grid electricity used for treatment
- No CO_2 generated by solar powered treatment

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Central Treatment Plant Before Optimization

- UV Oxidation primary treatment technology
- Max plant capacity 300 GPM
- Plant usage 80 GPM
- O&M costs significant
  - UV bulbs $2k/ea
- Treated water previously used for irrigation, stopped as DERA funding could not be used beyond treatment

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Central Treatment Plant After Optimization

- Turned off electricity intensive UV/Ox system
- Utilized two existing 20K lb canisters
- Significant reduction in electricity consumption and O&M costs

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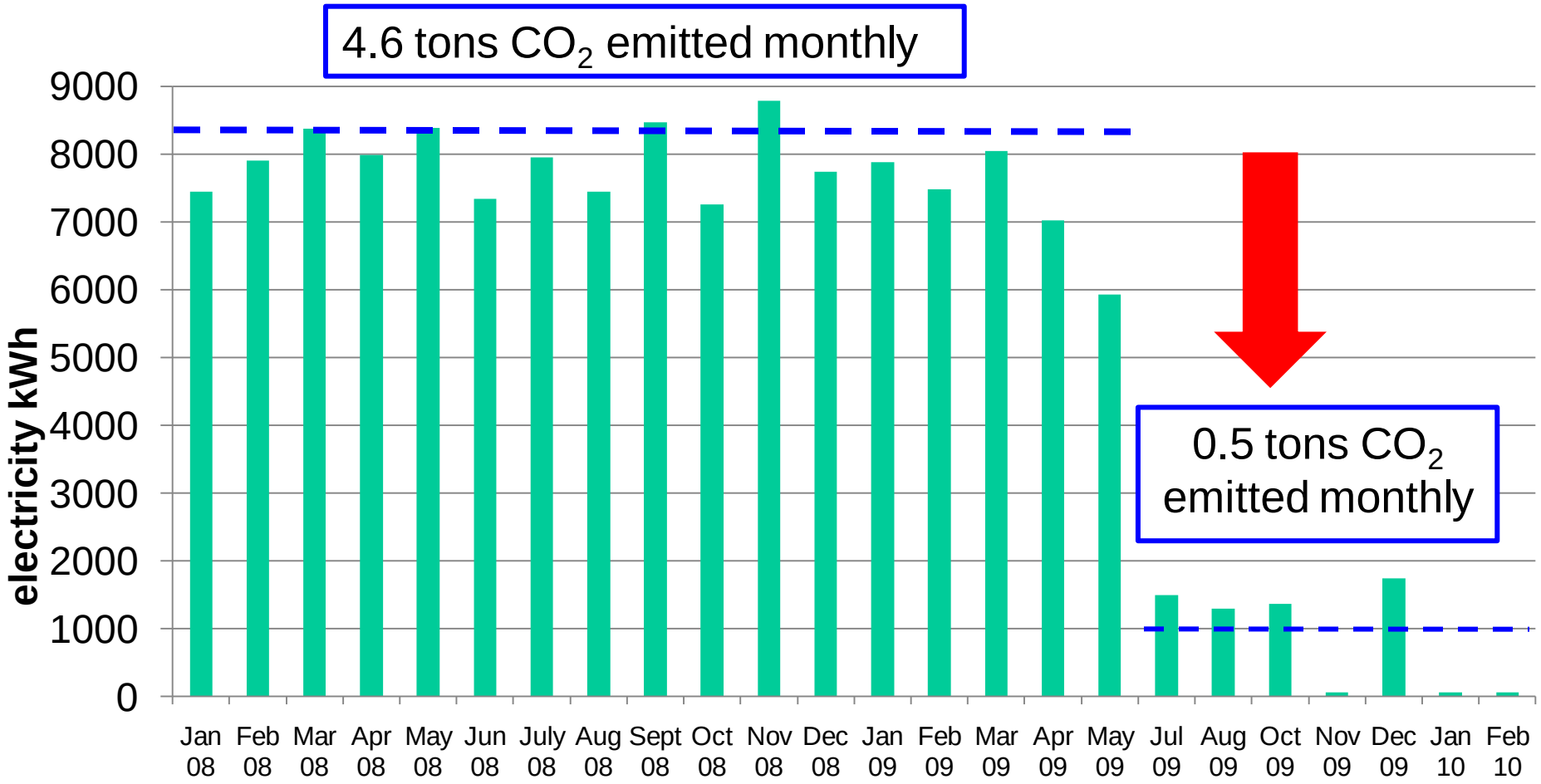
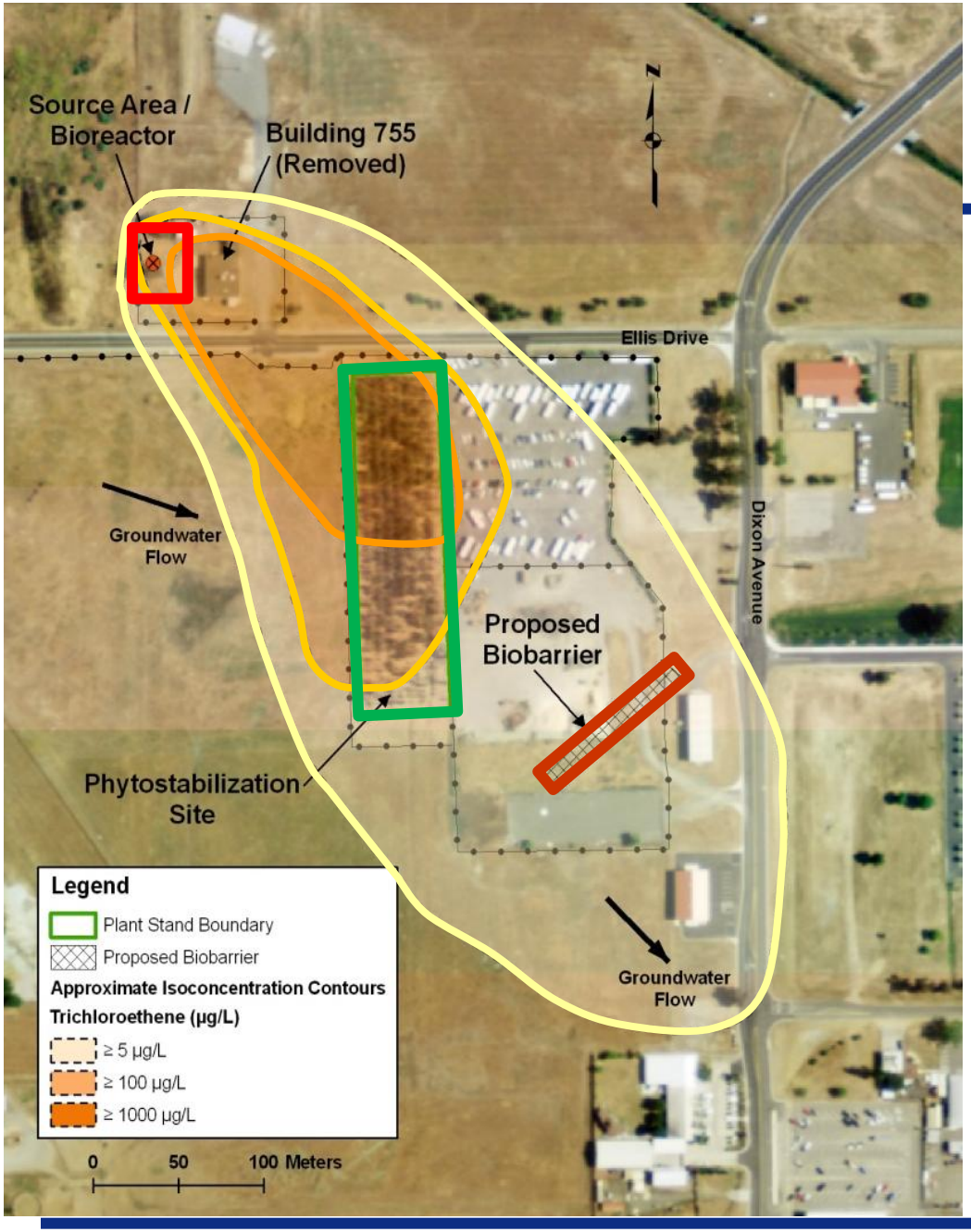
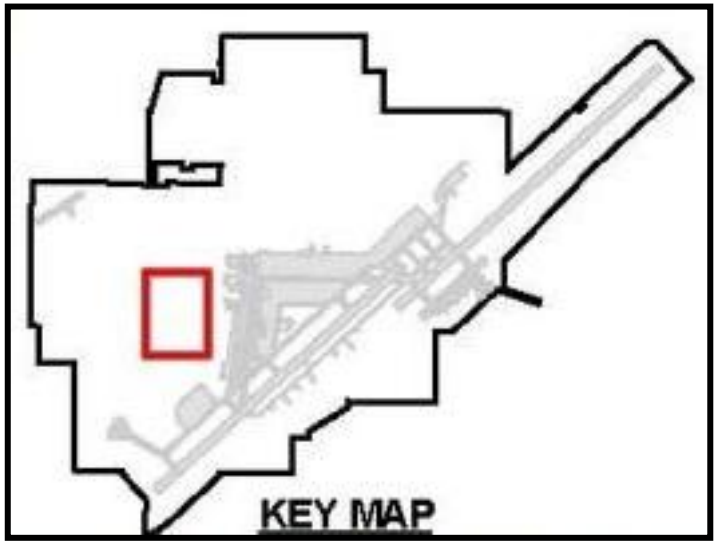
Central GW Treatment Plant
Ultra-Violet Oxidation



GSR Demo Site





Train Treatment Design

- **Bioreactor**
- **Phytoremediation**
- **Biobarrier**

GSR Demo Site: *In situ Bioreactor*

- **Battery acid neutralization sump**
- **Chlorinated solvents discharged to sub-surface resulted in TCE DNAPL**
- **TCE concentrations initially ranged from 5 - 240,000 ppb**

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GSR Demo Site: *In situ Bioreactor*

- Solar-powered biogeochemical source area treatment system
- Mix mulch, gravel, iron and gypsum promote reductive dechlorination both by biotic and abiotic processes
- Selected as GSR case study by EPA Region 9

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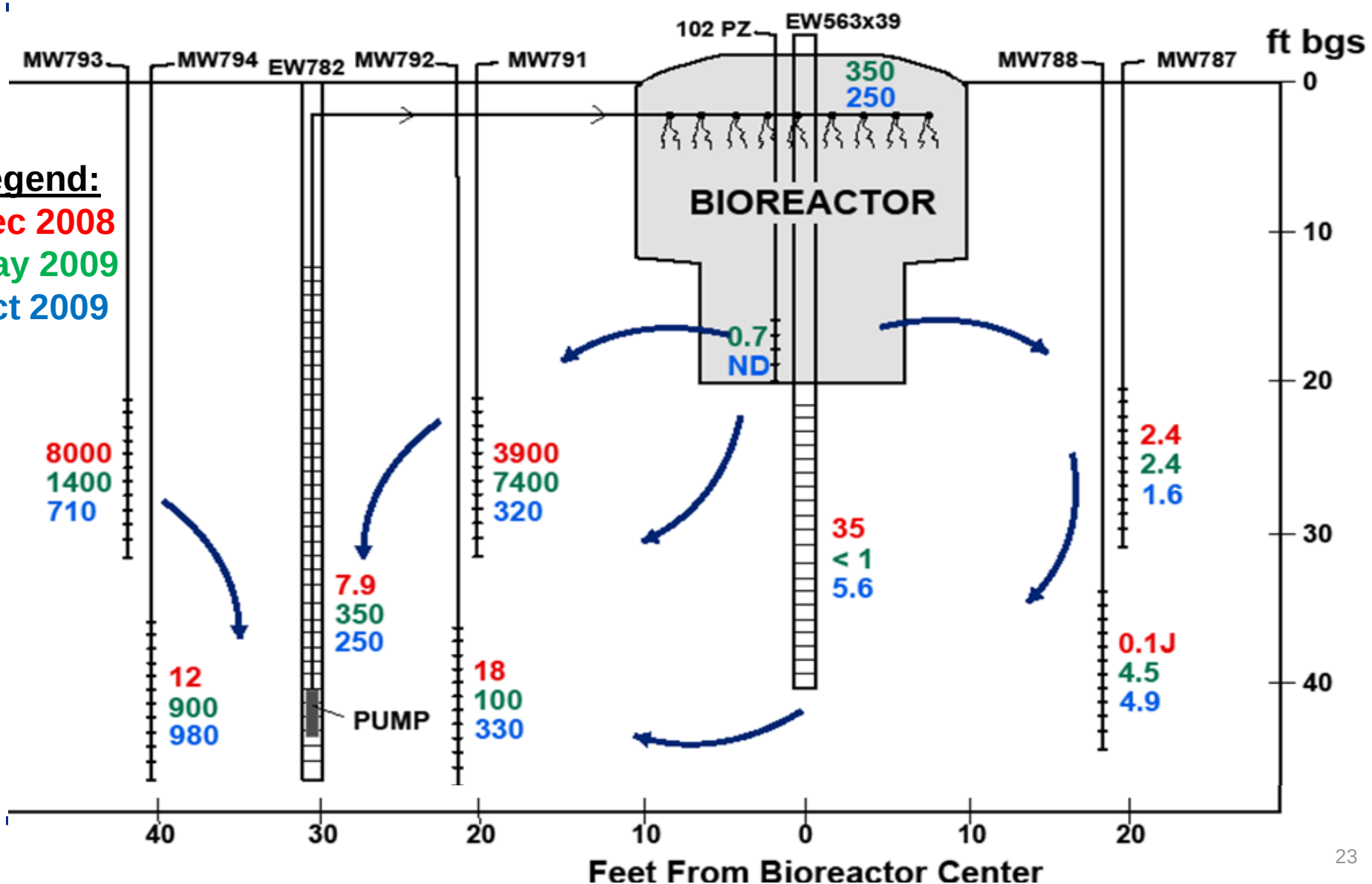
GSR Demo Site:
In situ Bioreactor - TCE µg/L in GW



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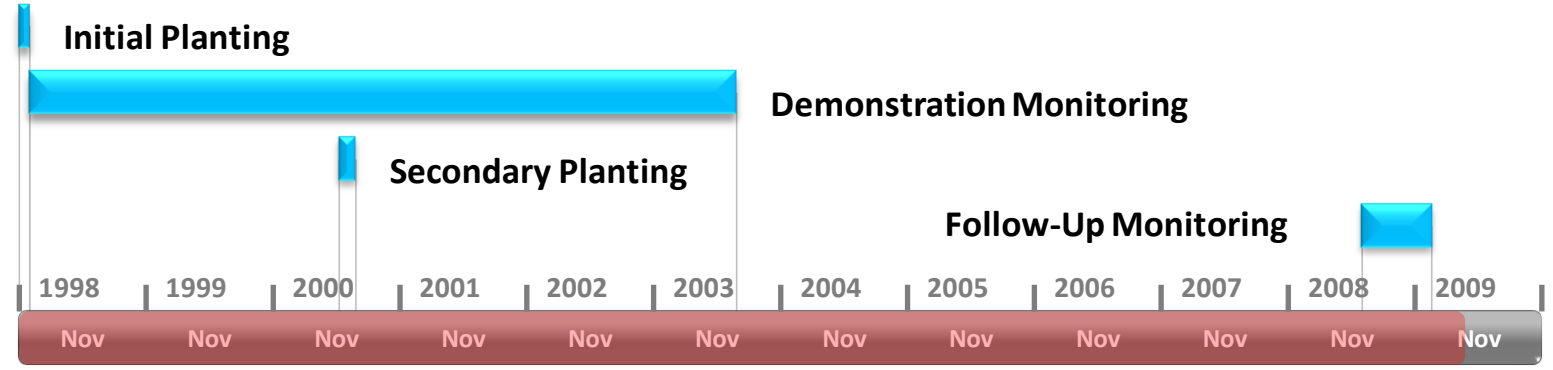
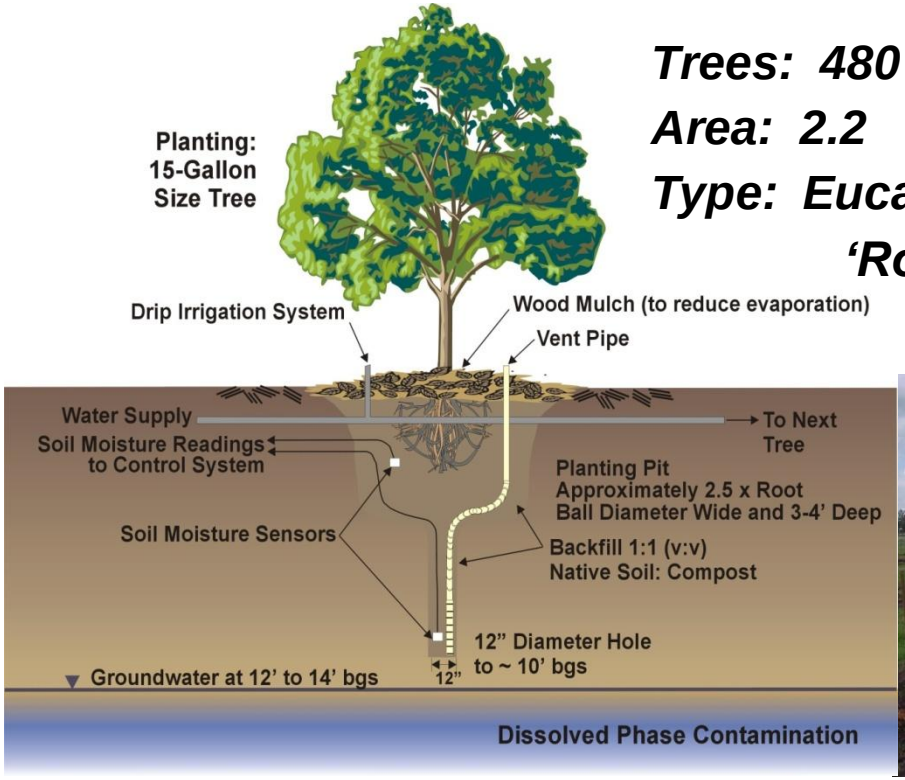
GSR Demo Site: Phytoremediation





Trees: 480

Area: 2.2

Type: Eucalyptus sideroxylon 'Rosea'

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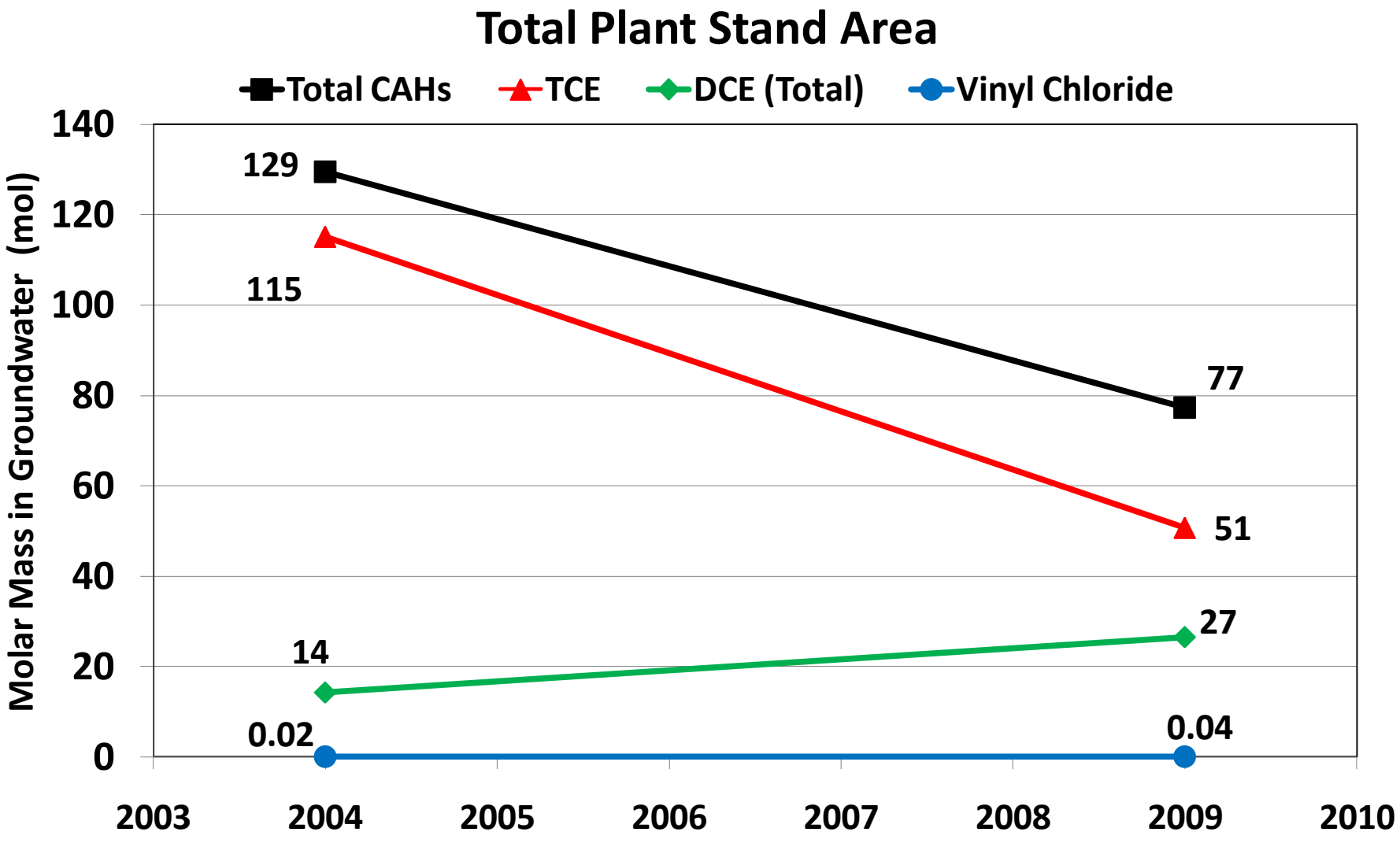
GSR Demo Site: Phytoremediation



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GSR Demo Site: Biobarrier

- Total 13 injection wells are being installed
- Inject emulsified vegetable oil
- After 3-4 rounds of sampling to validate the technology
- Travis AFB will propose the train treatment design as a ROD to EPA Region 9

Demonstrations DO NOT work every time!!

- Installation permeable treatment wall using jet grout applicator
- Zero valent iron slurry pumped across solvent plume
- Grout stopped flow of GW through reactive media:
  - "Successful" failure

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Travis AFB Wrap-Up: Think Big Picture!

- GSR really just common sense and BMPs
- Energy consumption reports along with resulting CO_2 generation from treatment plant operation at monthly regulatory meetings – A real "Eye Opener"
- AFCEE BAAs energize GSR selection process
- Regulatory agencies can be very receptive to GSR initiatives
- Performance-based contracts build GSR into your ERP

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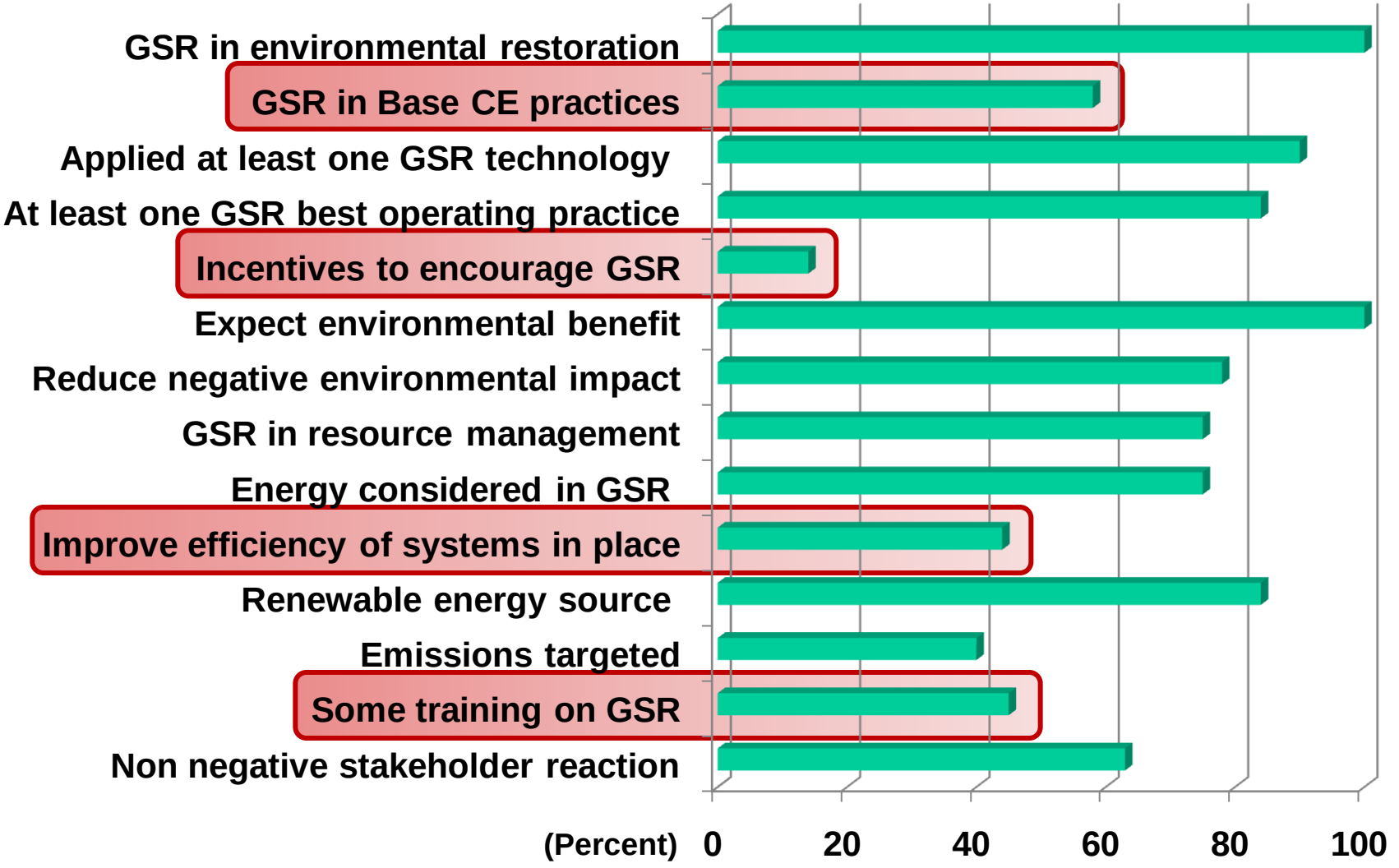
GSR – Future Direction



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GSR – Future Direction

Contract language

- **Develop sample contract language for GSR considerations**
- **Regionalize RAO/LTM contracts to optimize monitoring programs and eliminate high energy engineered remediation systems**
  - **Incentivized through PBC**
- **Considering award program to incentivize contractors to incorporate sustainable practices into environmental projects/contracts**

Partnerships

- **Interstate Regulatory & Technology Council (ITRC)**
- **American Society for Testing and Materials (ASTM)**
- **Sustainable Remediation Forum (SuRF) – Industry-led**
- **US EPA**
- **Services and agencies**

AF GSR policy

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GSR – Future Direction

Outreach

- More than $7M BAA investment since 2008 ERA transformation
  - Current projects: www.afcee.af.mil/resources/technologytransfer/baa
  - Solicitation: www.afcee.brooks.af.mil/pkv/baa/
- AFCEE Green and Sustainable Remediation Website
- Developing fact sheets and decision framework within context of ERP-O
- Web-based training in development
- 2010 and 2011 AF Restoration Technology Transfer Workshop and other training
- AFCEE Technology Transfer Newsletter

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GSR

Fore more information

AFCEE Technology Transfer:

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AFCEE ERP-O Website
www.afcee.af.mil/resources/restoration/erp-o/index.asp

AFCEE Sustainable Remediation Website
www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremeditation/index.asp

EPA on Green Remediation
www.clu-in.org/greenremediation/

ITRC on Green Sustainable Remediation
www.itrcweb.org/teampublic_GSR.asp

Questions?