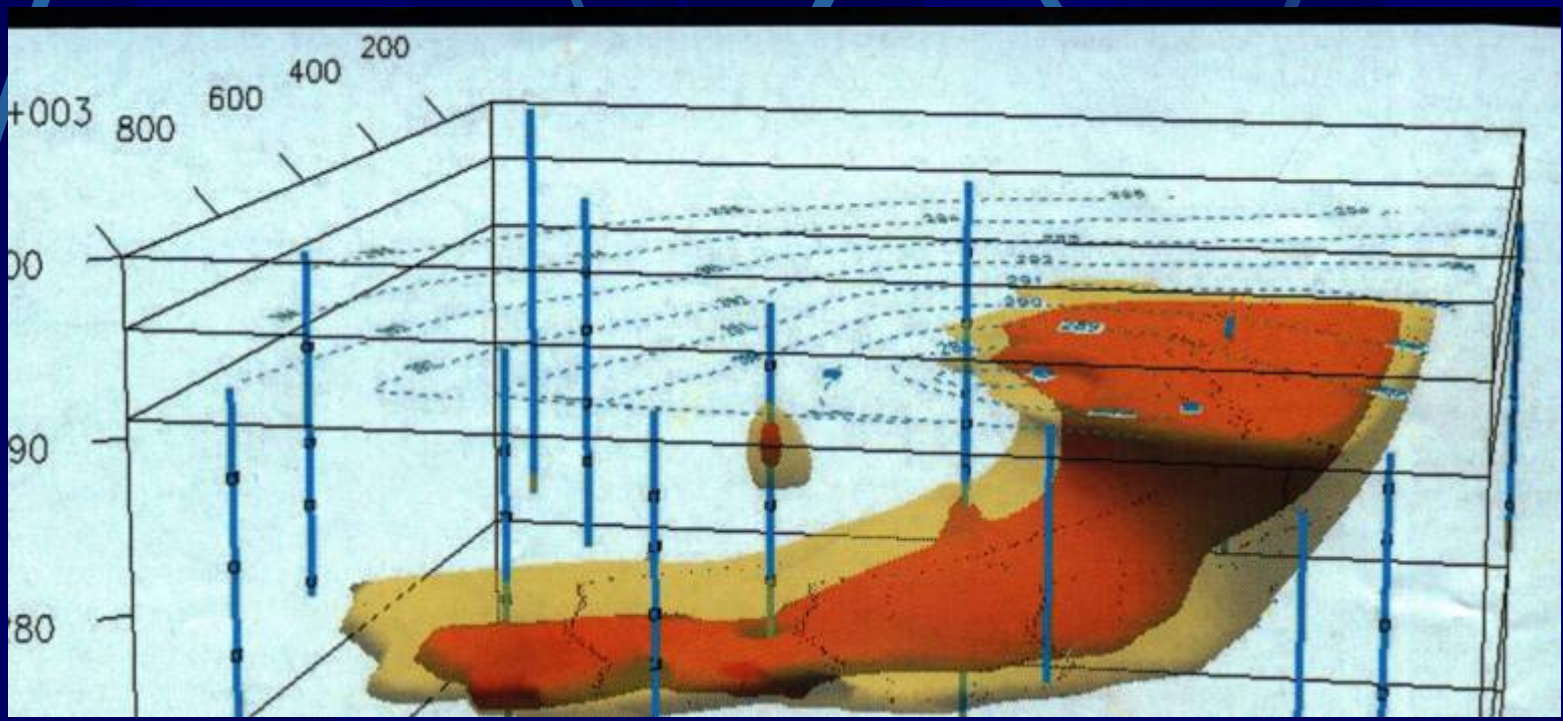
REMEDIAL PROCESS OPTIMIZATION

- DEFINITION
- ORIGIN
- EXAMPLE



What is RPO ?

Definition:

- The systematic evaluation and enhancement of site remediation processes to ensure that human health and environment are protected over the long term at minimum risk and costs. (ITRC, 2004)

Origin of RPO

INTERSTATE TECHNOLOGY AND REGULATORY COUNCIL:

A National coalition of U.S. state-led Environmental Regulatory Agencies, U.S. federal agencies, public and industry stakeholders.

OBJECTIVE:

“Reducing barriers to, and speeding development of, better and more cost-effective environmental techniques”.

Why RPO ?

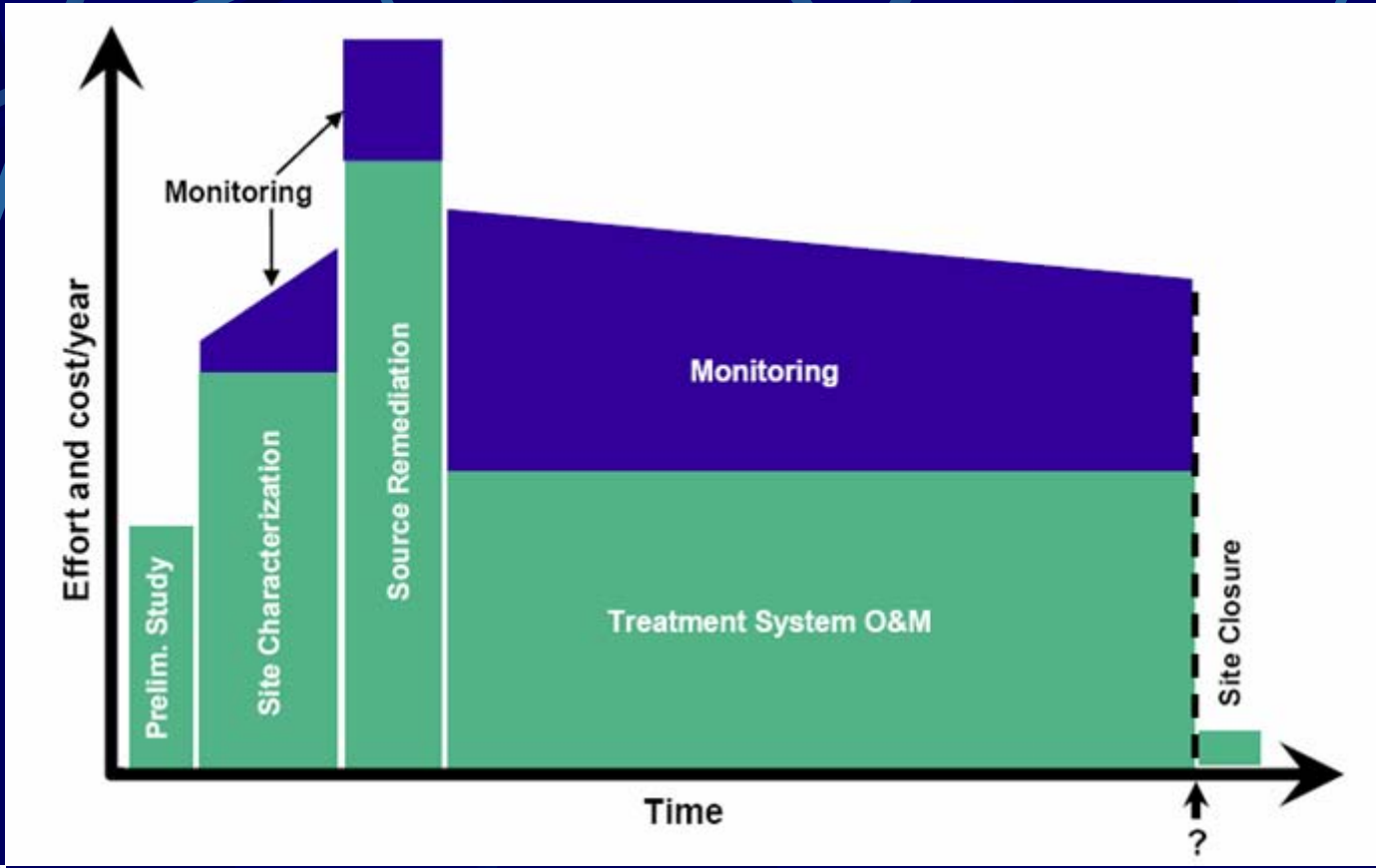
- Uncertainties in Environmental Remediation require more flexible, iterative approaches that manage these uncertainties (e.g. time to closure, cost).

- New mechanisms required for systematic reevaluation of initial objectives and continuous improvement/optimization of remediation technologies : “RPO”.

RPO Features

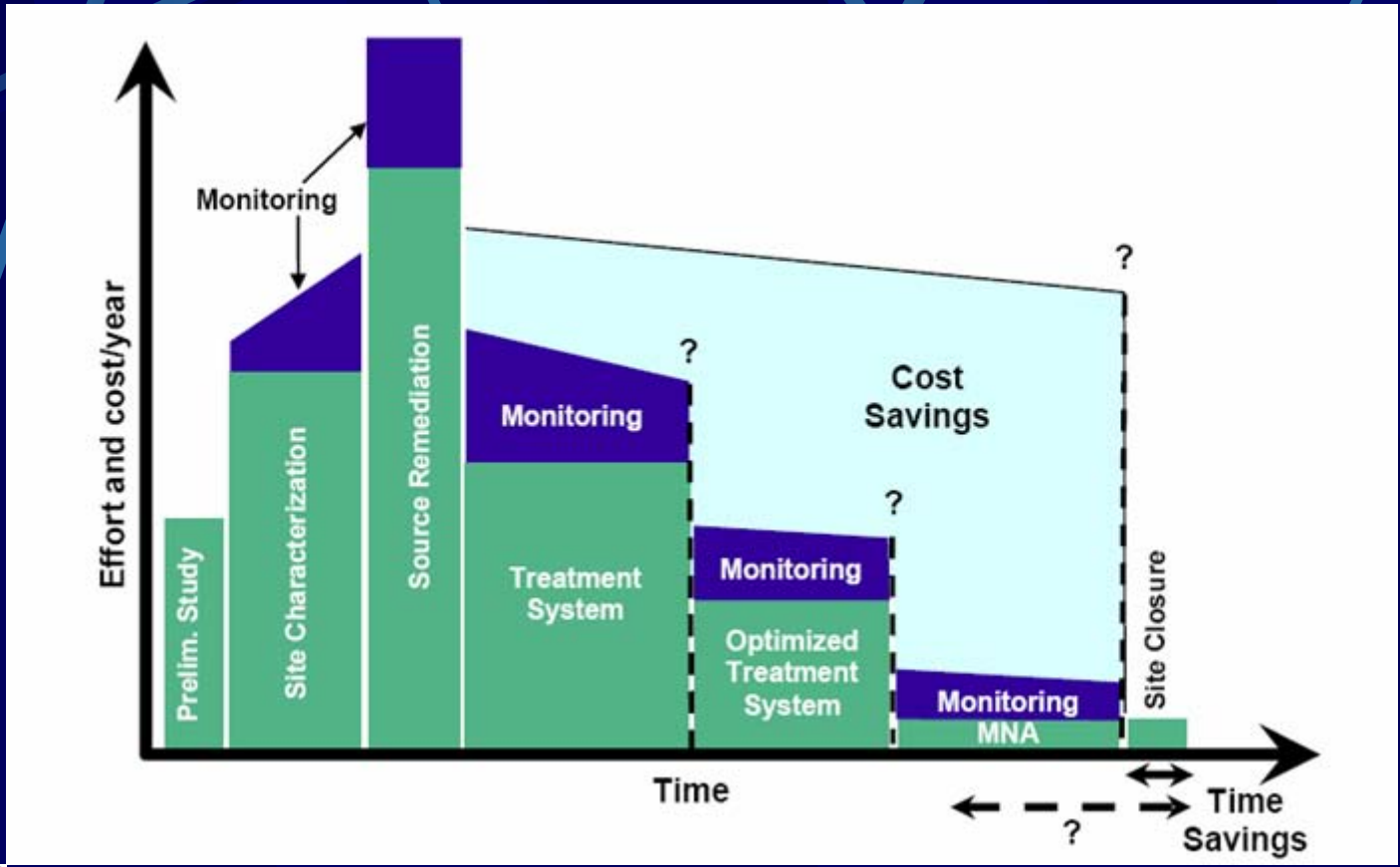
- Flexible, Iterative, Integrated approach
- Uses “Best Available Technologies”
- Sustainable Remediation
- Seeks Endpoint to Remediation
- Reduce Cost

Conventional Remediation



Effort vs. Time

Remedial Process Optimization



Effort vs. Time

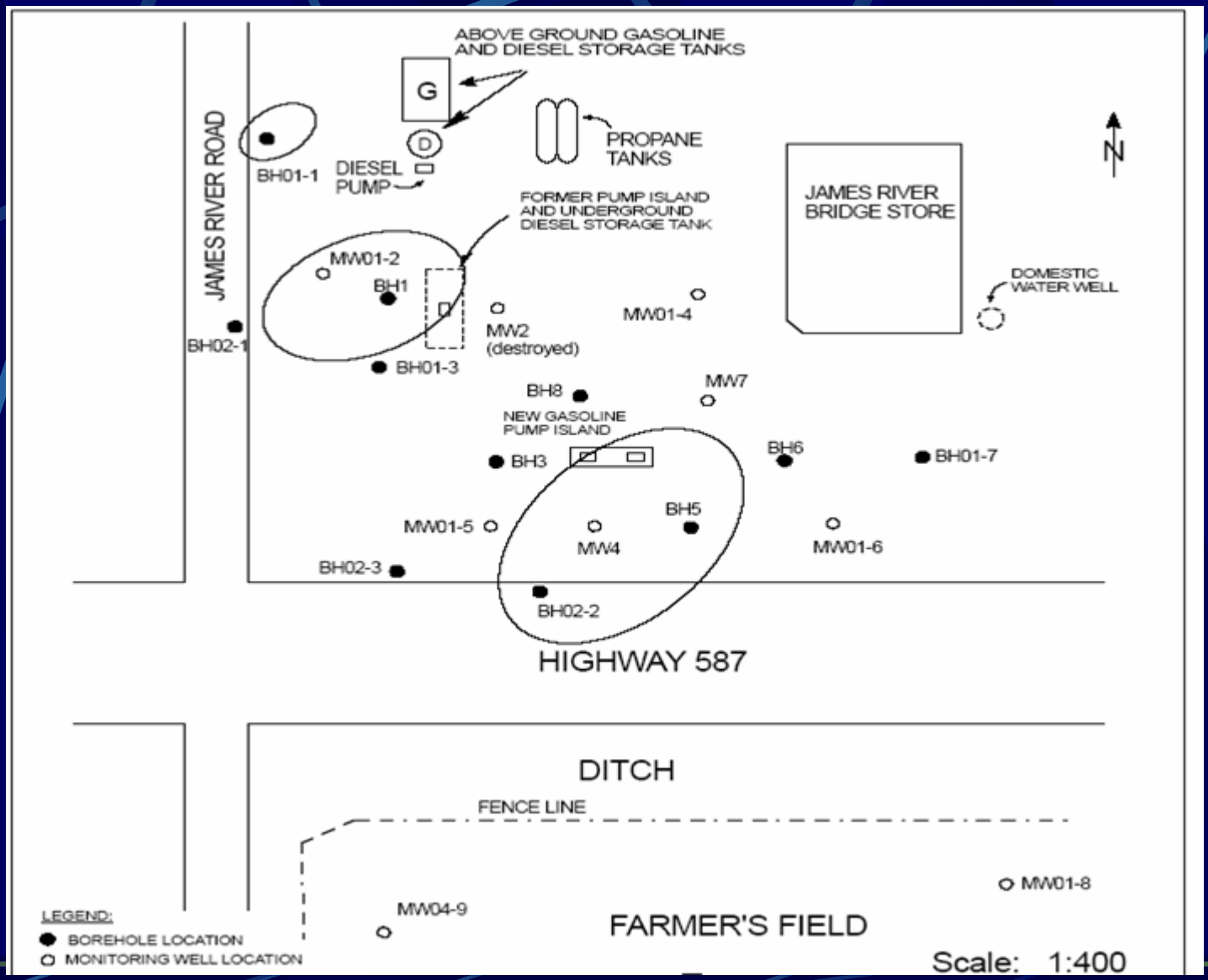
RPO Case Study

- Independent Fuel Retailer has residual HC contamination in soil & GW on property.
- Option to excavate contamination rejected by owner due to cost ($290,000) and disruption to business operations.
- Alternate option required to remediate contamination and manage HC vapours.

RPO Approach

- Additional investigations determined contamination localized, not extensive
- No threat to on site domestic water well
- Applicable criteria: Generic Residential for fgs – GW ingestion criteria unwarranted
- Off-site contamination under Highway
- Innovative approach req'd to remediate low permeability clays in situ and off-site.

HC Delineation



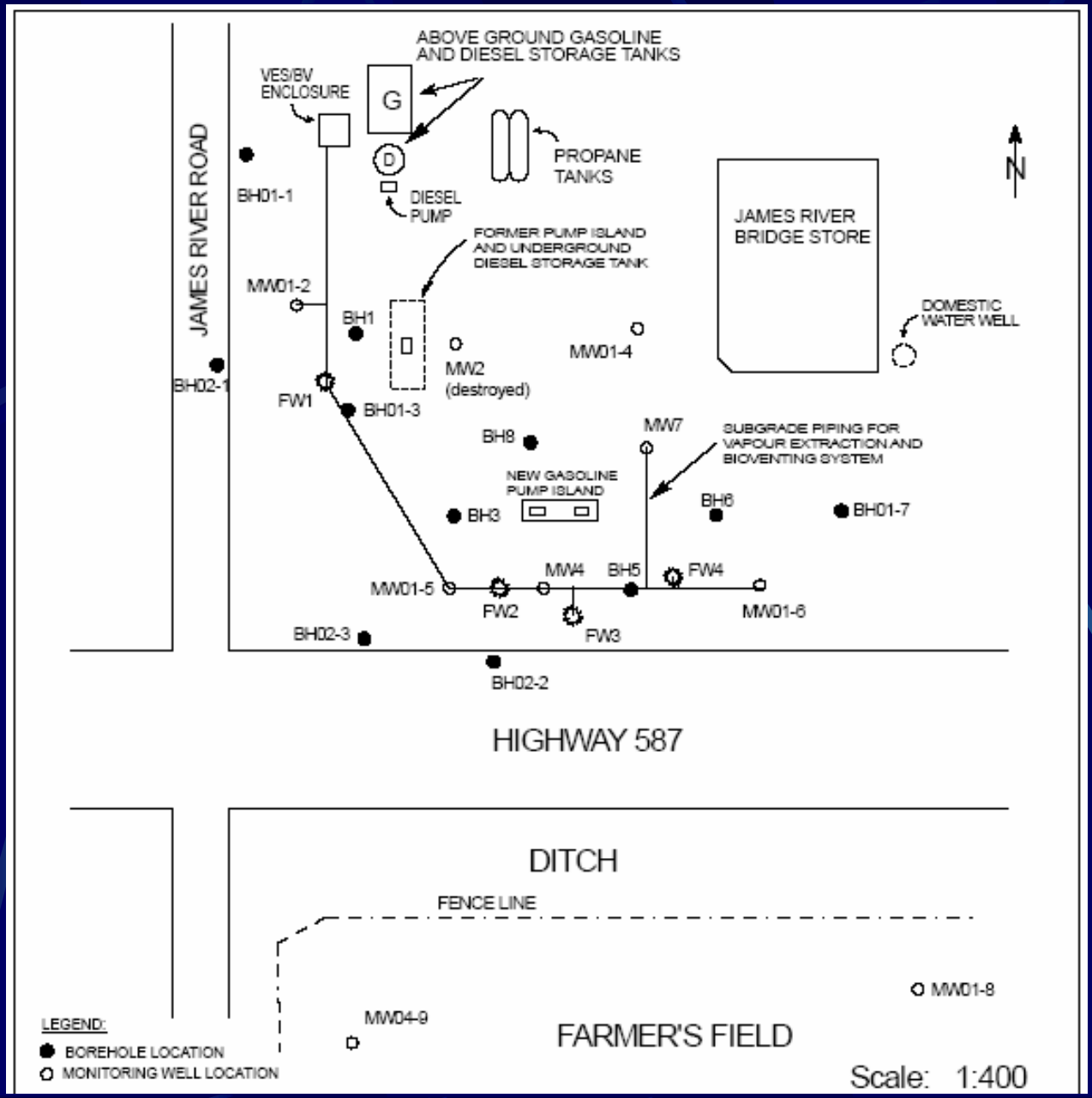
RPO Strategy

- Implement conventional and innovative, low cost *in situ* technologies.
- Technologies should serve multiple functions – integrated approach.
- Non-disruptive to owner's business operation: "light footprint".
- Needs to be effective in clays.

Technologies Used

- Permeability enhancement (HSF).
- Soil vapour extraction & Bioventing.
- Slow release oxygen (passive and injected).
- Monitoring and periodic “re-inoculation” with calcium peroxide containing nutrients and surfactants.

REMEDIAL SYSTEM SCHEMATIC



Frac-enhanced SVE/BV system with in situ peroxide injection (SRO).

Permeability Enhancement

SAND FRACTURES

VES/BV Piping Installation

System Monitoring

PRELIMINARY RESULTS:

- Increase in K from 10^{-9} to 10^{-7} m/s
- SVE HC removal rate increased by fivefold
- Benzene in GW reduced from high of 19.0 mg/L to 7 mg/L

Summary

- Owner needed cost-effective remediation
- Owner wants solution in his lifetime

  i.e. NO MNA; 3 to 5 years acceptable
- Minimal disruption to operations = NO DIG
- RPO determined site not extensively contaminated – localized contamination
- RPO initiated at site using innovative and multi-functional technologies in difficult soil
- RPO will result in cost saving of $190,000.

Ongoing work

- Switch SVE to Bioventing mode
- Re-inoculate site by subsurface injection of slow release oxygen peroxides and surfactants into fracture network
- System monitoring to optimize remediation
- Anticipated RPO endpoint: 2 to 3 years

Benefits of RPO

- Remedial endpoint w/i reasonable time frame
- BAT = Sustainable Technologies = “Green”
- Reduces risk (health & environment)
- Reduces liability
- Small footprint, non-disruptive, in situ
- Positive perception among public stakeholders
- Effective tool for managing uncertainty
- Cost-advantaged