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Guaranteed Remediation Certainty
Our Word Is Who We Are

TRS won the Silver Design Excellence Award in 2006 for the Fort Lewis Project from the Society of American Military Engineers

Project Example - Electrical Resistance Heating Remediation
East Gate Disposal Yard, Fort Lewis Army Base, Tacoma, WA

The size of the treatment areas, the types of contaminants, the high energy depositional environment and the in depth studies of the effects of heat on in situ biotic and abiotic degradation make this the ***largest and most complex Electrical Resistance Heating project ever implemented****.*

Client Reference: Ms. Kira Lynch, Project Director, Seattle District, ACOE, (206) 764-6918
TRS Project Manager: Tom Powell, Operations Manager, (360) 693-6301, tpowell@thermalrs.com
Contracting Terms and Number*:* Performance Based Guaranteed Fixed Price, #DACA67-02-C-0218
Contract Award: $25M of which ~$12M has been released.
Performance Period: Winter 2003 through 2006.
Contaminants*:* Chlorinated Hydrocarbons and Petroleum, Oil, and Lubricants.
Technologies*:* Electrical Resistance Heating and Multi-Phase Extraction.
Geology*:* Glacial deposits of sand, gravel, clay, silt.
Contaminant Levels*:* LNAPL and DNAPL.
Site Constraints: Groundwater flow velocities as high as 20 feet per day.
Area 1 Cleanup: >99% average reduction of targeted contaminants in groundwater.
Area 2 Cleanup: Presently reducing final data.
Area 3 Cleanup: Presently installing.

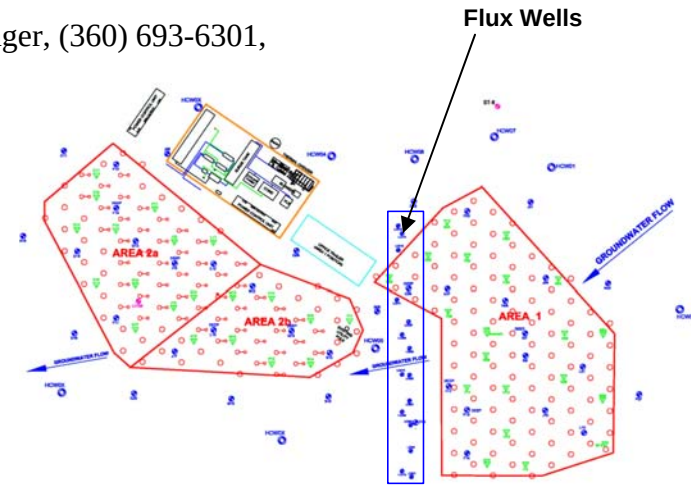

Figure 1. Site Layout for NAPL Areas 1 and 2

Background:

Thermal Remediation Services, Inc. (TRS) has designed and operated Electrical Resistance Heating (ERH) systems for the *in situ* thermal remediation of LNAPL and DNAPL from two source areas at the Ft. Lewis, East Gate Disposal Yard (EGDY). Contaminants of concern include chlorinated solvents, primarily trichloroethene (TCE), and petroleum products, oil and lubricants (POLs). The complete project will involve the thermal remediation of three separate source areas (NAPL Areas 1, 2 and 3) within the EGDY.

Key participants in this complex, multi-agency project include:

- Mr. Richard Wilson – Installation Restoration Program Manager
- U.S. Army Corps of Engineers, Seattle District – Project Manager
- Ft. Lewis Public Works – EGDY Site Manager
- Thermal Remediation Services, Inc. – Prime Remediation Contractor
- AMEC – Thermal Remediation Services Subcontractor
- CDM - Thermal Remediation Services Subcontractor
- Gary Struthers and Associates - Thermal Remediation Services Subcontractor
- U.S. Environmental Protection Agency (EPA)
- U.S. Army Environmental Center (AEC)
- Pacific N.W. National Laboratory (Battelle/PNNL)
- Strategic Environmental Research and Development Program (SERDP)
- Environmental Security technology Certification Program (ESTCP)

Site Characteristics and Design Parameters

The NAPL Area 1 measured approximately 25,400 square feet and the remediation system included 106 ERH electrode and MPE locations. Treatment depth in Area 1 extended from 2 feet to approximately 38 feet below grade (bg), producing an estimated treatment volume of 31,040 cubic yards. In NAPL Area 2, a total of 22,390 square feet of subsurface was heated to a depth of 43 feet bg, cleaning a total volume of 36,500 cubic yards.

Figure 2. ERH Equipment & Electrode Layout in NAPL Area 2

Heating of NAPL Area 1 started in late December 2003 and was completed in August 2004. Energy was first applied to NAPL Area 2 in January 2005 and remediation was complete by early August 2005. Results for Area 1 are presented in this case history, while data from Area 2 is presently being compiled. The ERH system is presently being installed in NAPL Area 3 and is scheduled to begin operations this fall.

In addition to the ERH/MPE components, the remediation system includes hydraulic control wells to help depress the groundwater table within the treatment area and limit groundwater migration, a liquid waste management system (LWMS) to remove NAPL from and to treat recovered groundwater, and a 1,000 scfm thermal oxidizer to treat vapors recovered from the subsurface.

In order to evaluate the performance of the ERH project, the USACE Seattle District set forth the following performance criteria:

- Minimize the time to implement the remedy while maximizing mass removal,
- Establish, maintain, and verify control of contaminant migration in groundwater, vapors, and air emissions,
- Establish and verify subsurface temperatures of 90ºC in the vadose zone and 100ºC in

the saturated zone,

- Maintain target subsurface temperatures for set time intervals, and
- Provide a system for near real time data delivery, performance and compliance monitoring, and project communications.

Figure 3. Solid NAPL in the Bottom of the Vapor/Liquid Separator

Near real time project management was achieved by the use of daily, weekly, and monthly reports regarding daily sample and process monitoring data. Reports were presented in electronic format on a dedicated project website, enabling the Army, USACE, EPA, AEC, and the TRS remediation team to analyze and monitor the progress of the remediation in near real time.

The project team managed the site using a Triad approach that combined flexible design and work plans, rapid data turnaround times, and the web based communication system. This project management approach allowed the team to incorporate nationally recognized research programs on the *in situ* biological and abiotic destruction of TCE into the project. The Triad management approach also helped the project team successfully handle a series of challenges related to site conditions at the EGDY.

Because the site lithology is complex, final electrode depths were determined in the field based upon actual site conditions. To maintain an aggressive production schedule, TRS used air rotary drilling methods to place most of the electrodes, but utilized sonic drilling and continuous sampling at selected locations to allow further delineation of the contaminant plume. The result was that an unexpected area of DNAPL impact in Area 1 was discovered during electrode installation. The project team was able to rapidly expand the ERH and monitoring systems to include this DNAPL area without delays in schedule and with very little impact to the project budget.

During the final stages of the design process, two improved methods to treat and dispose of liquid effluents were evaluated. The Army accepted both alternatives and TRS implemented them without delays in schedule and at an overall savings to the project. During operations in NAPL Area 1 significant quantities of NAPL were recovered to the surface. Figure 3 shows a mass of NAPL collected at the bottom of the vapor/liquid separator before it reached temperature. Once the separator reached temperature, the NAPL continued to flow through the recovery equipment as a liquid until it was treated in the liquid waste management system.

Results of ERH Remediation

Figure 4 shows the propagation of subsurface temperatures at the 16-foot depth interval in NAPL Area 1. The data is from July 2004, several weeks before the ERH system was shut

down. Figure 5 shows the subsurface temperatures in NAPL 2 in June 2005, again several weeks before subsurface heating was ceased.

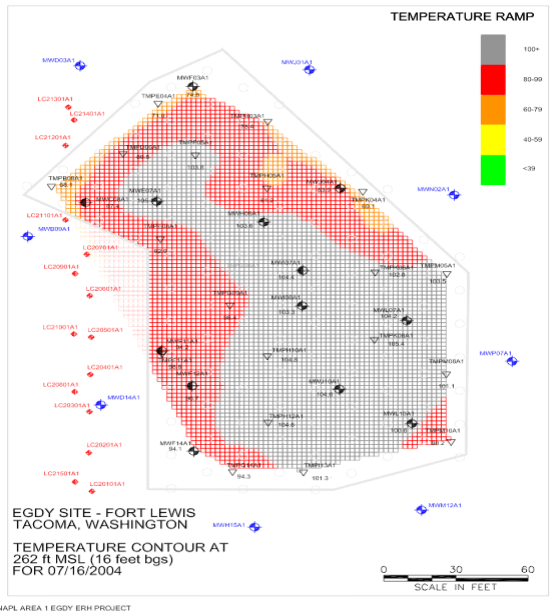

Figure 4. Subsurface Temperatures in NAPL Area 1, 2004

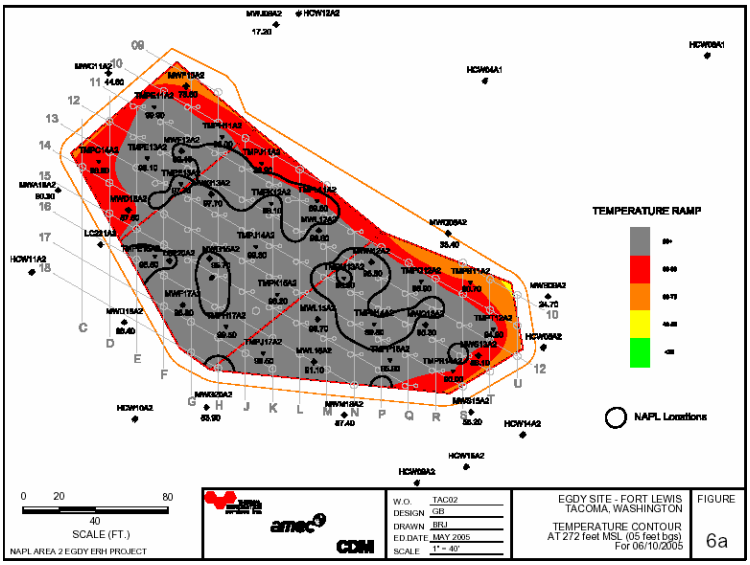

Figure 5. Subsurface Temperatures in NAPL Area 2, 2005

Figures 6 and 7 present the TCE concentrations in groundwater in NAPL Area 1 interior and exterior monitoring wells before, immediately after, and 10 months following heating. Ten months following the ERH remediation in NAPL Area 1, average TCE concentrations in groundwater continued to decline significantly from approximately a 89% reduction post ERH to >99% reduction in the interior monitoring wells.

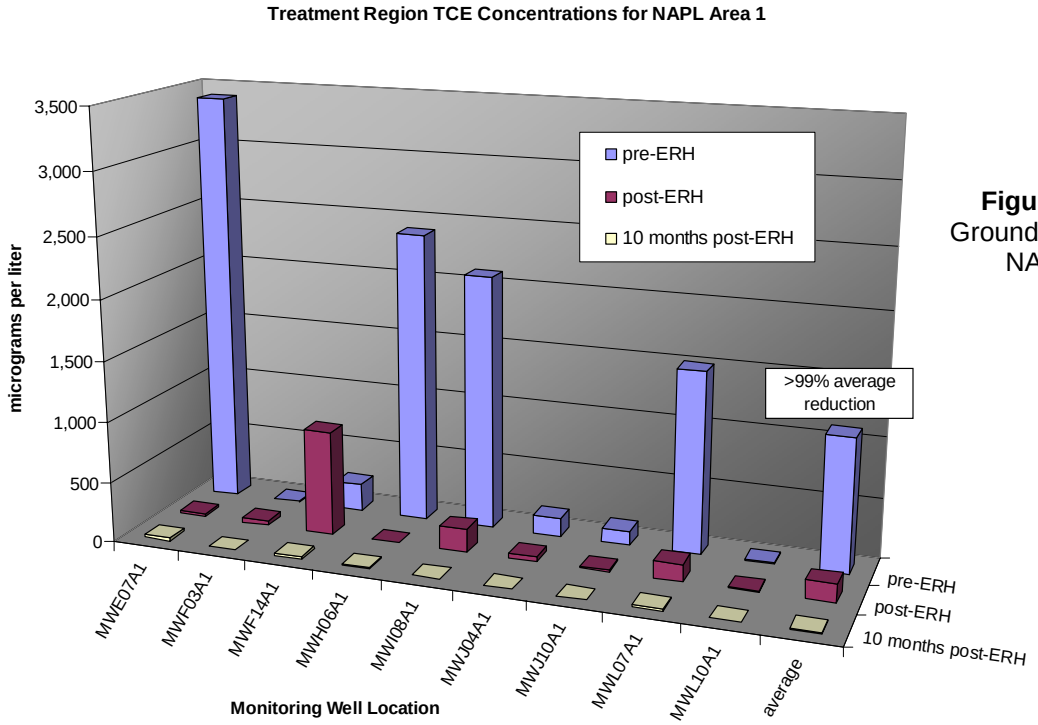

Figure 6. Pre and Post heating Groundwater TCE Concentrations in NAPL Area 1 Interior Wells

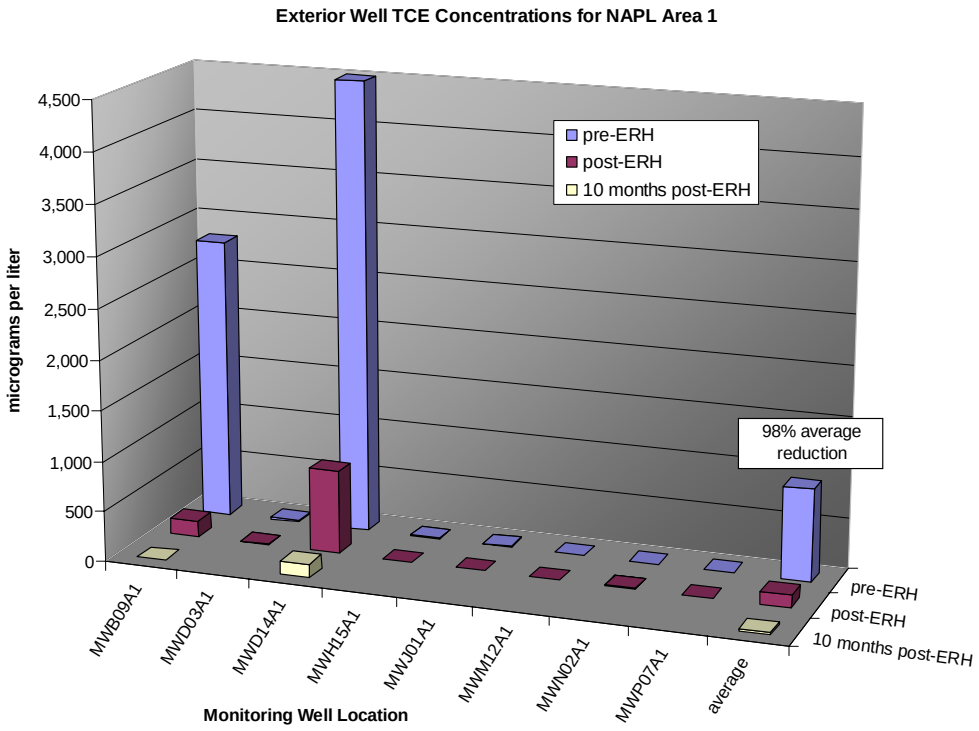

Figure 7. Pre and Post heating Groundwater TCE Concentrations in NAPL Area 1 Exterior Wells

Other Concurent Project Activities

During the course of the ERH remediation at NAPL Areas 1 and 2, and in preparation for treating NAPL Area 3, the following concurrent project activities have been accomplished in order to better understand the site, better quantify the effectiveness of the ERH process, and to investigate the effects of biological and abiotic reactions on the *in situ* destruction of TCE:

Project Activity	Primary Team Members
EGDY Phase II Remedial Investigation	USACE and PNNL
Area 1 TCE Flux Well Construction and Monitoring	ESTCP/SERDP
Post ERH Monitoring and Soil Sampling	USACE
Pump & Treat System Optimization and Operations	PNNL
In Situ Reaction Tests	PNNL, TRS, USACE
Area 3 TCE Flux Well Construction and Monitoring	ESTCP/SERDP
In Situ Biological Reaction Tests	North Wind, USACE

Work in Progress

Approximately 74 electrodes and co-located multi-phase extraction wells are presently being installed in NAPL Area 3. Figure 9 is a site plot plan showing NAPL Areas 1, 2 and 3. Figure 10 is a picture of the current drilling and electrode installation in NAPL Area 3.

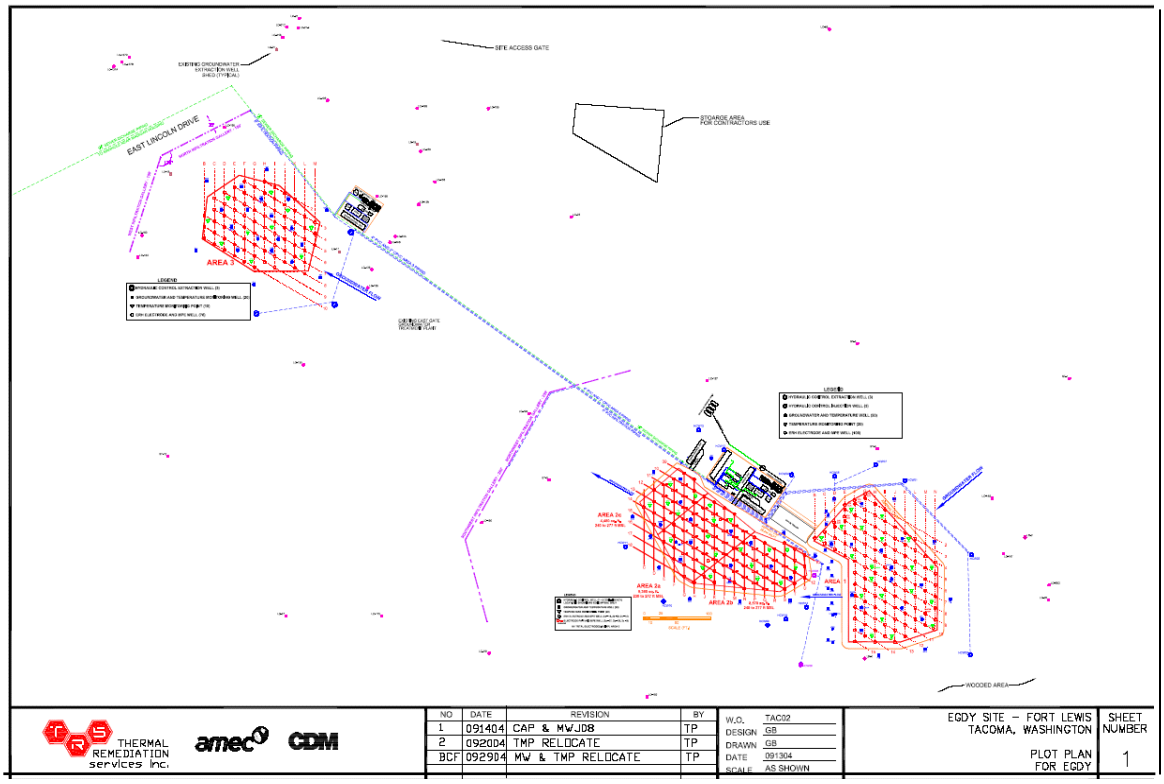

Figure 9. Site Plot Plan of NAPL Areas 1 (far right), 2 and 3 (far left)

Figure 10. Electrodes Installed in NAPL Area 3