Quantitative Assessment of Sustainable Remediation Options for the M-1 Air Stripper System at SRS

Introduction

The US Department of Energy (DOE) Savannah River Site (SRS) covers 310 sq. miles and is located south of Aiken, SC. The site produced materials used in the production of nuclear weapons from the 1950s to the 1980s.

Trichloroethylene (TCE) and tetrachloroethylene (PCE) were the main solvents used in degreasing and other industrial operations. These solvents are categorized as dense non-aqueous phase liquids (DNAPLs), semi-volatile, and hazardous chemical compounds.

In the 1980's, operations were initiated to remediate the contaminated soil and groundwater which continues today.

Problem Statement

The M-1 air stripper and well network has operated continuously since 1985 at an average electrical load of 150 kW and flow rate of 420 gpm. The influent TCE concentration to the air stripper has decreased exponentially from 25,200 ug/L in 1986 to 2,230 ug/L by the end of 2012, with the same energy consumption and water pumping rate.

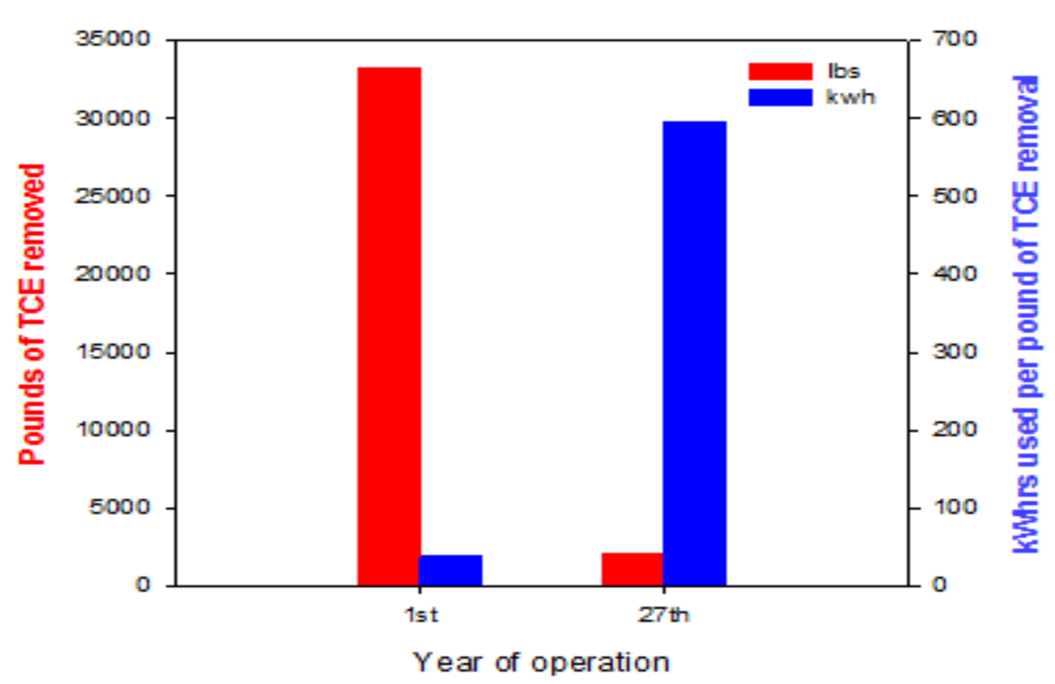

Figure 1: M-1 Stripper TCE removal During 1st and 27th Year of Operation

Purpose

To analyze the operation of the SRS A/M Area groundwater remediation system using state-of-the-art modeling tools to provide suggested engineering and operational improvements to expend less resources while still containing the contaminant plume.

Implementation of improvements will help DOE-EM apply sustainable remediation at its sites and help DOE achieve DOE-wide sustainability performance metrics.

A/M Area

- Located in the northern part of SRS within the lower reaches of the Tims Branch watershed (topographic elevation from ~420 ft to ~ 118 ft).
- Consists of facilities that fabricated reactor fuel and target assemblies (M-Area), and administrative and support facilities (A-Area).

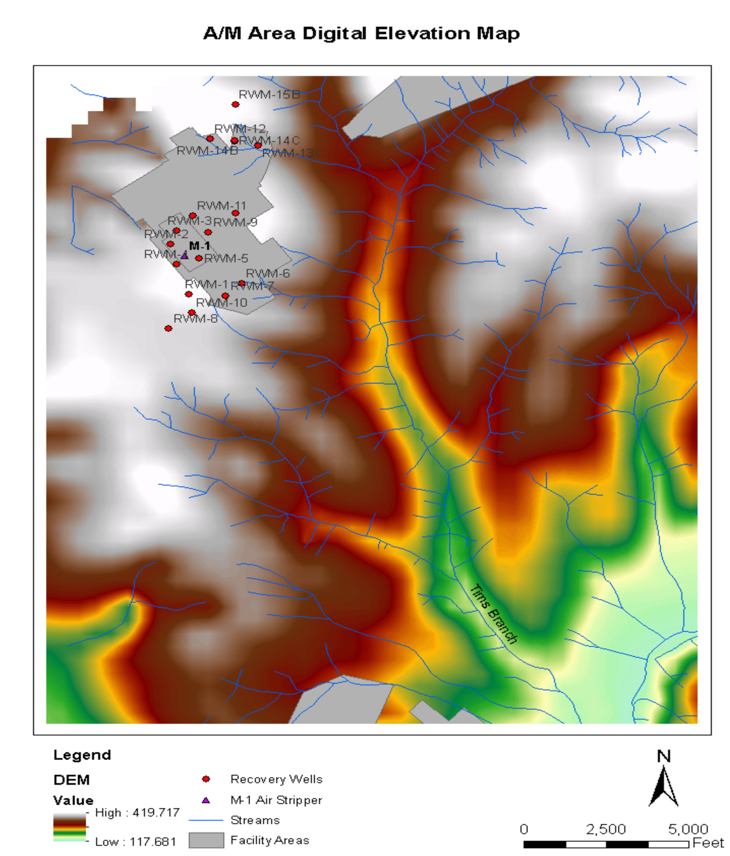

Figure 2: SRS A/M Area Digital Elevation Map

M-1 Air Stripper & Recovery Well Network

- Installed in 1985 to treat groundwater in order to reduce chlorinated solvent concentrations.
- 17 recovery wells have been installed over the years. Currently recovery wells 1-12 feed the M1 air stripper.
- The treated groundwater is discharged to a stream in Tims Branch.

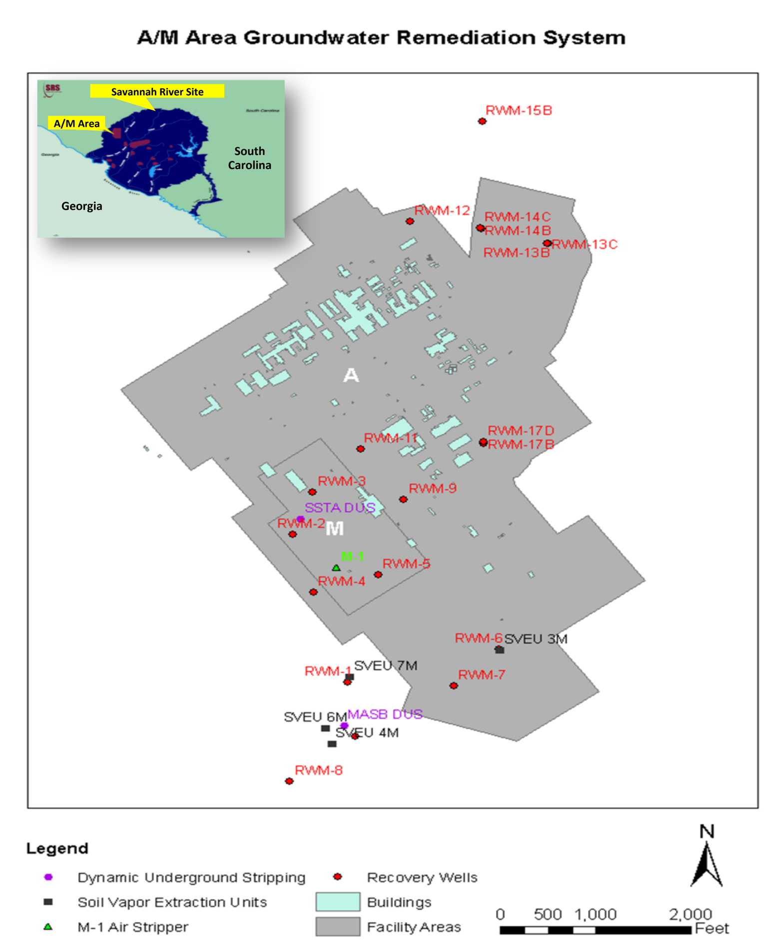

Figure 3: SRS A/M Area Remediation Network

Preliminary Results

The monthly removal rate and the cumulative mass removed for TCE and PCE in the 12 recovery wells was analyzed for 1985-2012. Removal from well RWM-1 is plotted below.

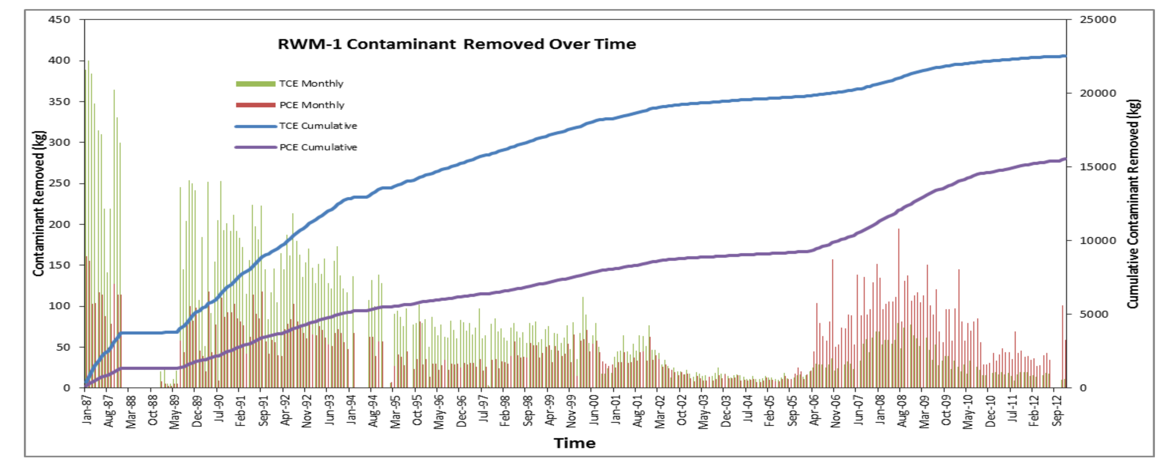

Figure 4: RWM-1 Cumulative and Monthly TCE and PCE Mass Removed

- 7 of 12 recovery wells have transitioned to more PCE than TCE removed. This is an expected result since TCE was initially used and then replaced by PCE.
- The rate of recovery in some wells was affected by the Dynamic Underground Stripping process.
- 7 wells exhibit exponential decay in contaminant removal while 5 exhibit steady concentrations, and 2 exhibit linear decreases.

Table 1: Comparison of Contaminant Removal 1987 to 2012

Comparison of Contaminant Removal 1987 to 2012

Well ID RWM	TCE Jan. '87 removal (kg/mo.)	TCE Dec. '12 removal (kg/mo.)	TCE Jan. '87 H_2O Intensity, kg/Mgal	TCE Dec. '12 H_2O Intensity, kg/Mgal	PCE Jan. '87 removal (kg/mo.)	PCE Dec. '12 removal (kg/mo.)	PCE Jan. '87 H_2O Intensity, kg/Mgal	PCE Dec. '12 H_2O Intensity, kg/Mgal
1	389.00	10.57	243	26.9	161.35	58.76	101	149
2	89.09	3.00	98.2	3.24	29.43	8.68	32.4	9.39
3	341.37	8.94	116	3.89	66.55	7.53	22.7	3.27
11	180.52	2.18	69.6	.931	49.59	0.16	19.1	0.0665
4	12.96	19.64	23.1	10.0	0.00	8.13	0.00783	4.15
5	5.29	13.35	5.32	6.57	1.43	8.26	1.44	4.07
7	3.48	40.15	7.32	23.8	2.90	48.72	6.10	28.9
8	0.09	5.20	0.129	2.66	0.22	3.67	0.305	1.88
10	101.16	24.89	52.0	18.5	111.05	70.67	57.1	52.4
6	105.00	2.90	73.7	2.70	95.94	7.58	67.3	7.04
12	91.76	6.39	39.3	3.11	0.05	0.06	0.0196	0.03.13
9	3.77	1.73	3.23	9.08E-07	0.67	0.53	.571	.278

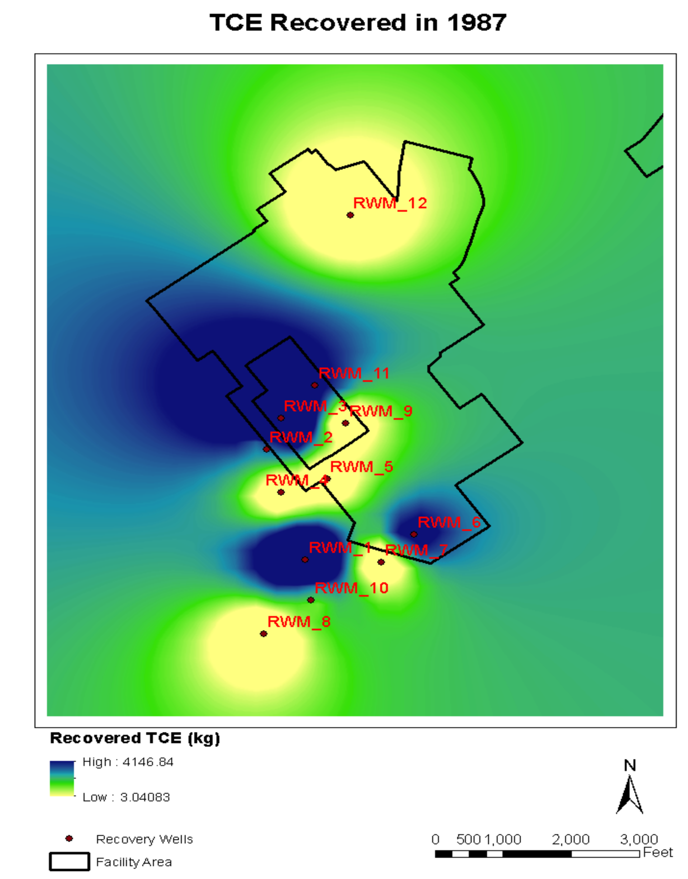

Figure 5: TCE (kg) Recovered per Well in 1987.

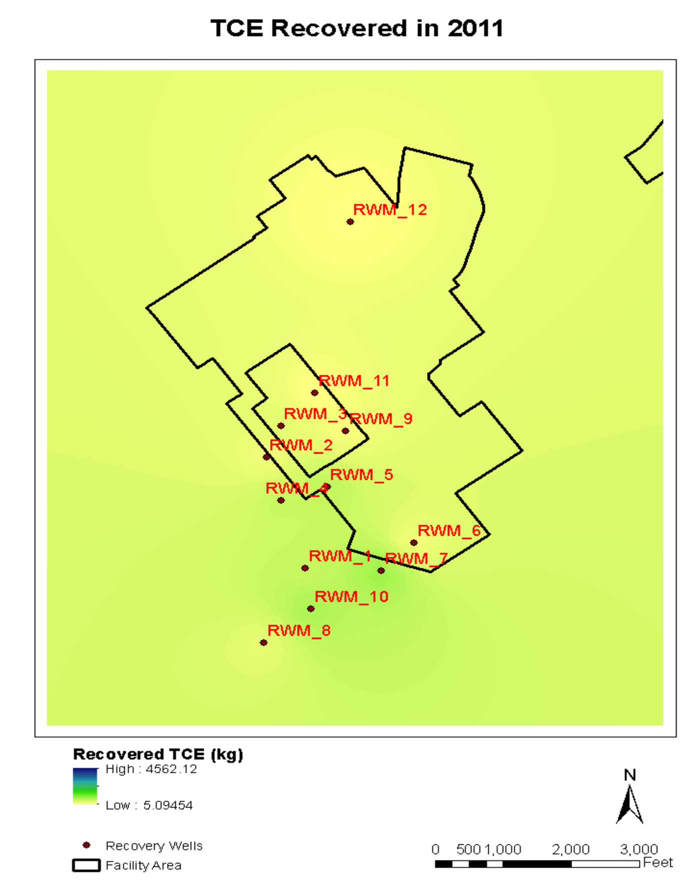

Figure 6: TCE (kg) Recovered per Well in 2011.

Future Work

- Identify opportunities to improve efficiencies related to electrical energy, water usage, and the use of other resources, beginning with mechanical design modifications.
- Investigate operational strategies to increase system performance by optimizing the hydraulic loads, pumping rates, contaminant mass flow rates and well drawdown levels.
- Determine a set of metrics which will correlate the pumping rates, the cone of depression, and the interaction between the wells with the contaminant mass flow rates.

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