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

Natalia Duque
DOE Fellow
(Graduate Student, Environmental Engineering)

Florida International University

Presentation Overview

- Project description
- Methodology
- Area characterization
- Preliminary results
- Discussion
- Future work
- Acknowledgments

Project Description

Background on Sustainable Remediation

- ***Definition:*** the abatement, cleanup, or use of methods to contain, remove, or destroy contaminants ***while*** seeking to minimize the environmental, economic, and social costs of the remediation.

Project Description

Process

1. Develop/update Conceptual Site Model
2. Establish goals
3. Evaluation level selection
4. Metric selection
5. Tool selection
6. Boundary identification
7. Implementation

Project Description

Project Background

- This research is the preliminary phase of a sustainable remediation analysis of the M-1 air stripper at the A/M Area GW remediation system at Savannah River Site (SRS).
- SRS 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. They are categorized as dense non-aqueous phase liquids (DNAPLs), semi-volatile, and hazardous chemical compounds.

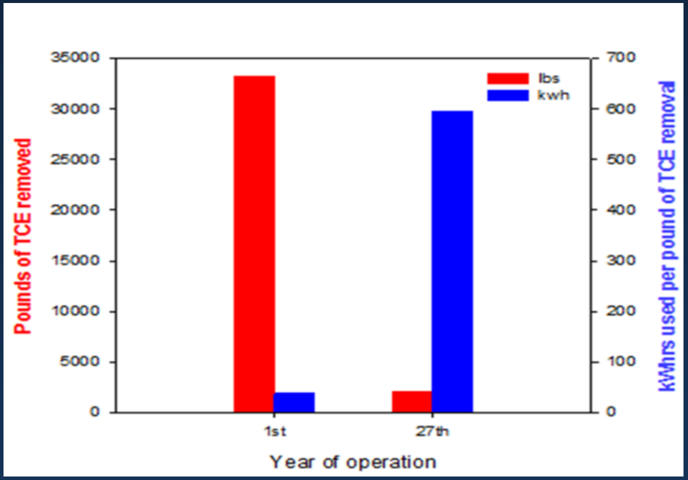
Project Description

FIU Applied Research Center

Problem Statement

- The M-1 air stripper and well network have 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.



Project Description

Objectives

- 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 in order 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.

Methodology

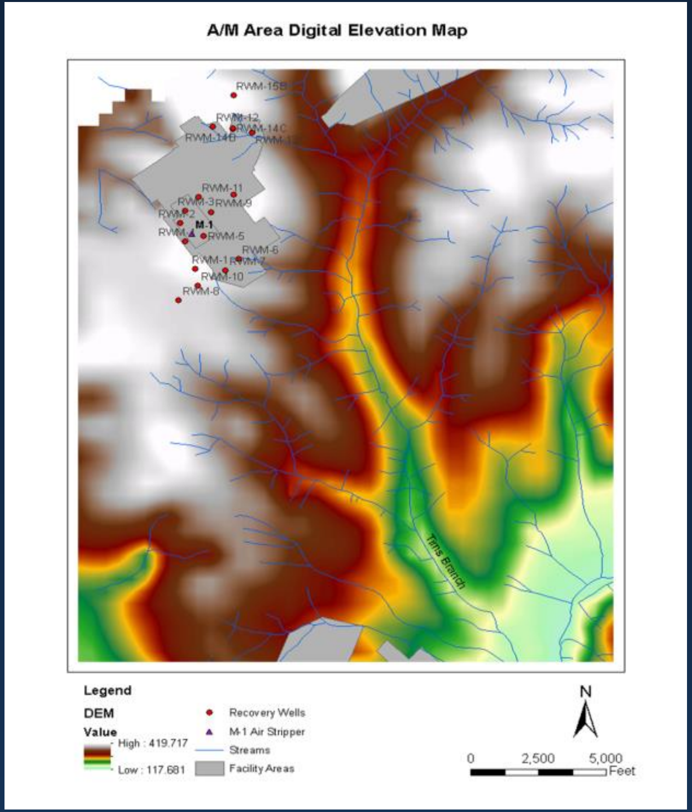
- Literature review
- Data collection
- Contaminant recovery study
- Mechanical design study
- Use of GIS (Geographical Information System) to aid analysis

Area Characterization

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).

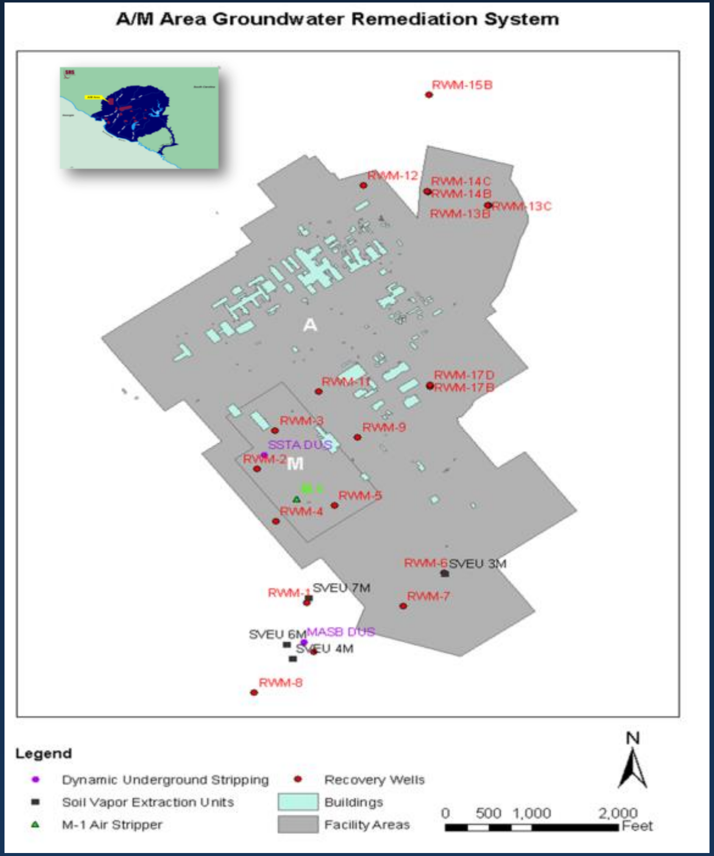


Area Characterization

FIU Applied Research Center

M-1 Air Stripper & Recovery Well Network

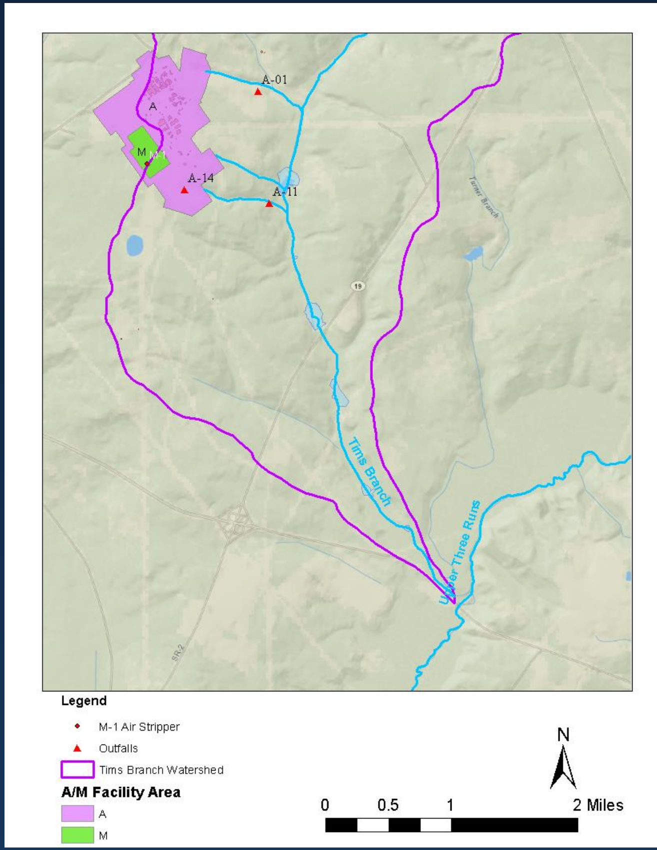
- Installed in 1985 to treat groundwater in order to reduce chlorinated solvent concentrations.
- 17 recovery wells have been installed over the years. Currently recovery wells 1-12 feed the M1 air stripper.
- The treated groundwater is discharged to a stream in Tims Branch.



Area Characterization

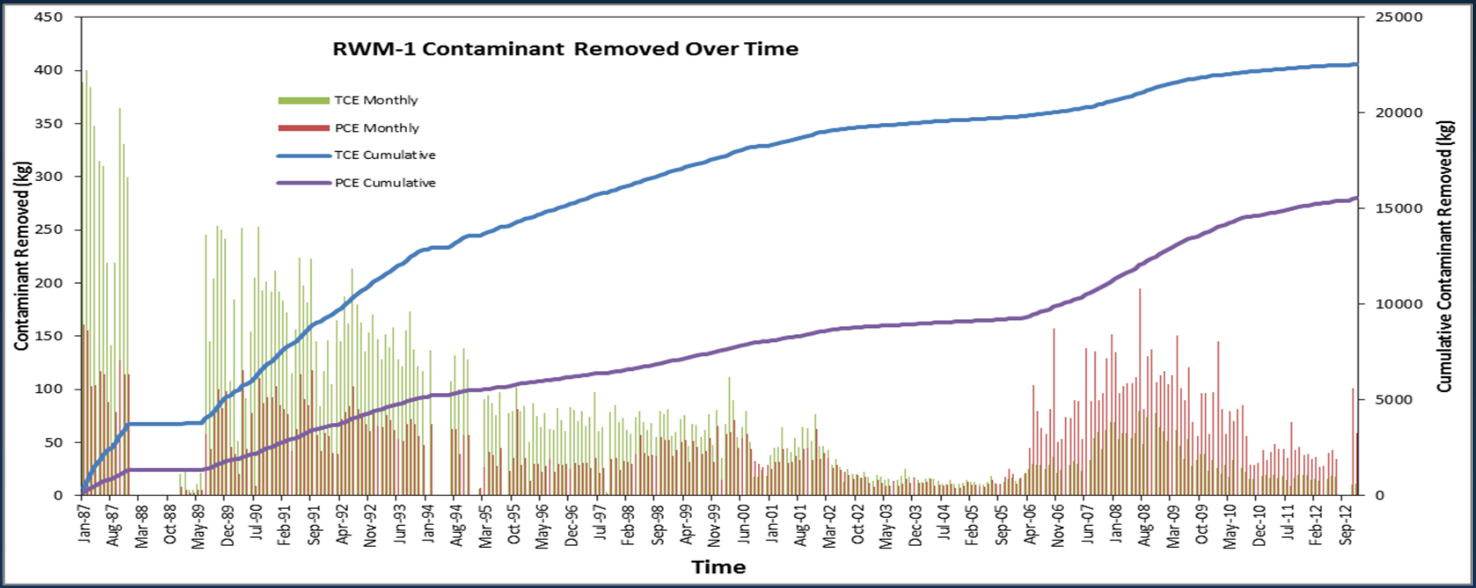
M-1 Air Stripper & Recovery Well Network

- The treated groundwater is discharged to streams connected to Tims Branch.
- Approximately 1.3 million lbs of chlorinated solvents were discharged from A-14 Outfall to Tims Branch.



Preliminary Results

- The monthly removal rate and the cumulative contaminant removed for TCE and PCE in the 12 recovery wells was analyzed for 1985-2012.



Preliminary Results

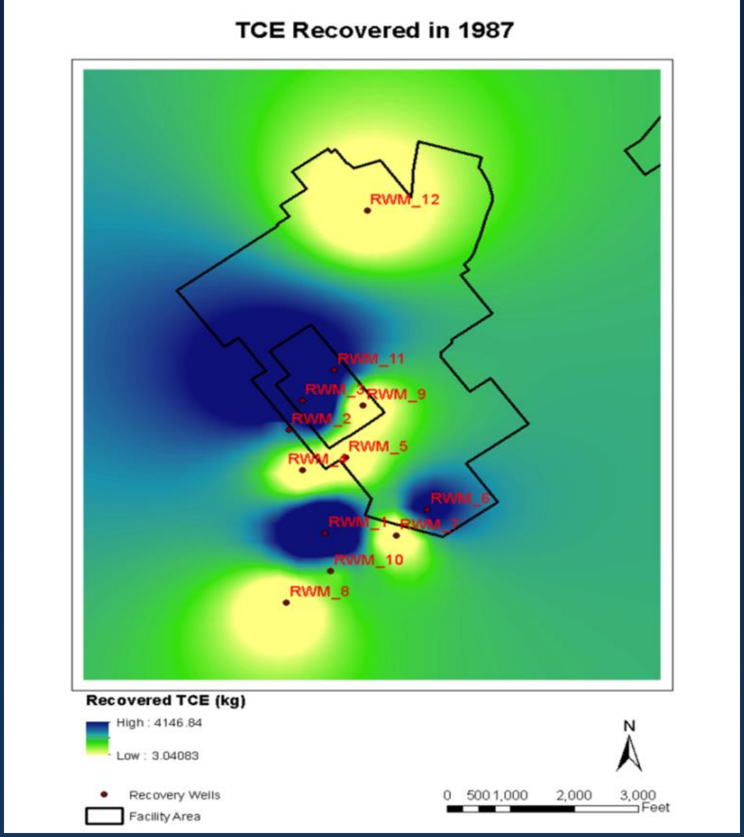
FIU Applied Research Center

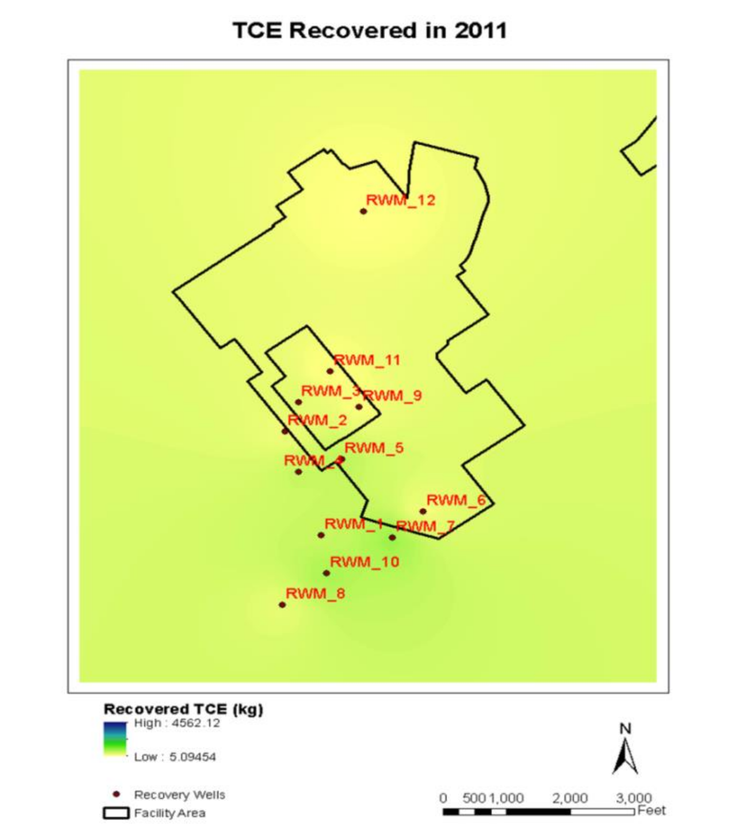
Comparison of remediation progress

Well ID RWM	TCE				PCE			
	Jan. '87 removal (kg/mo.)	Dec. '12 removal (kg/mo.)	Jan. '87 H2O Intensity, kg/Mgal	Dec. '12 H2O Intensity, kg/Mgal	Jan. '87 removal (kg/mo.)	Dec. '12 removal (kg/mo.)	Jan. '87 H2O Intensity, kg/Mgal	Dec. '12 H2O Intensity, kg/Mgal
1	389.00	10.57	243.00	26.90	161.35	58.76	101.00	149.00
2	89.09	3.00	98.20	3.24	29.43	8.68	32.40	9.39
3	341.37	8.94	116.00	3.89	66.55	7.53	22.70	3.27
11	180.52	2.18	69.60	0.93	49.59	0.16	19.10	6.65E-02
4	12.96	19.64	23.10	10.00	0.00	8.13	7.83E-03	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	23.80	2.90	48.72	6.10	28.90
8	0.09	5.20	0.13	2.66	0.22	3.67	0.31	1.88
10	101.16	24.89	52.00	18.50	111.05	70.67	57.10	52.40
6	105.00	2.90	73.70	2.70	95.94	7.58	67.30	7.04
12	91.76	6.39	39.30	3.11	0.05	0.06	1.96E-02	0.03
9	3.77	1.73	3.23	9.08E-07	0.67	0.53	0.57	0.28

Preliminary Results

Difference in TCE recovered in 1987 and 2011





Discussion

- The pumping and overall electrical energy efficiency has decreased to 6%. It now requires 15.9 times more energy and groundwater to remove 1 pound of TCE in the 26th year of operation than it did in the first year of operation.
- 7 of 12 recovery wells have transitioned to more PCE than TCE removed. This is an expected result since TCE is more soluble and volatile than 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.

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.

Acknowledgements

- **Mentors**
  - Angelique Lawrence, Dave Roelant, and Albes Gaona
- **DOE-FIU Science and Technology Workforce Development Program**
  - Sponsored by the U.S. Department of Energy, Office of Environmental Management, under Cooperative Agreement #DE-EM0000598.