Full-Scale ISCR and EISB to Treat Chlorinated Solvents in Unsaturated Soils at a Former Chlorinated Solvents Manufacturing Plant

John Daniels, PG, CAPM
Mark Motylewski
Groundwater & Environmental Services, Inc.

John Daniels, PG, CAPM
Principal Hydrogeologist

- Based in GES' Stafford, Texas office
- 30+ years environmental consulting experience in US and internationally
- Project Manager: Coordinated & implemented the project

Project Partners:

Ethyl CORPORATION

SEMS Inc. Southern Environmental Management & Specialties

Presentation Content

01 Project Background

02 Site History

03 Project Approach

04 Feasibility Testing and Results

05 Lessons Learned

06 Question & Answer

Background

- Ethyl Corporation operated a former chlorinated-solvent manufacturing plant in Baton Rouge, LA.
- Site is managed under RCRA Corrective Action Program with oversight by LA Department of Environmental Quality (LDEQ).
- Active operations continue in one section of the property; most areas involved with the former mfg. plant have been decommissioned and demolished.
- Challenges to remediation included heterogeneous, tight, depositional soils, buried debris from former operations, and proximity to active operations.
- In-situ technology was sought to remediate unsaturated soil (upper 15-feet) in solid waste management unit (SWMU) #77 / AOC-E located within the active area of the site formerly occupied by aboveground chemical storage tanks.
- Shallow soils in the SWMU were impacted to ~15 feet bgs by carbon tetrachloride (CT), 1,2-dichloroethene (DCE), 1,1,2-trichloroethane (1,1,2-TCA), trichloroethene (TCE), and tetrachloroethene (PCE), with concentrations >100 ppm in multiple locations.
- The remedial objective is to achieve a no-further-action (NFA) determination for soil from LDEQ.

ETHYL REPORTER

VOL. I, NO. 1 JANUARY 1963

Social Security Tax Now Higher

If you, as a taxpayer, are wondering where your money is going these days, the answer in part is that it is going to pay higher taxes.

Effective January 1, social security taxes have been increased by one-half a percentage point. The new rate is 3⅝ on the first $4,800 of any employee's taxable income. This means that, if you earn $4,800 or more a year, you are now paying $174 a year in social security taxes. Last year you paid $150 (on $4,800 of income) and in 1961 you paid only $144.

The Company's social security tax payments—which are equal to each employee's contribution—have gone up by the same percentage. Counting the ½% increase in the rate, Ethyl will probably be paying somewhere around a million dollars this year in social security taxes for its employees. Employees also are paying around a million dollars out of their earnings for social security.

Significantly, this is the ninth time that social security taxes have been increased since the Social Security Administration was first established in 1937. At that time, the tax was only 1% for employee and employer alike on the first $3,000 of an employee's income. But since 1950, the rate has jumped from 1½% to the present 3⅝—and the income subject to tax has been increased from $3,000 to the present $4,800.

And the end is not in sight. Even without any increase in benefits—or without taking into account such new proposals as Medicare—present law calls for further increases in our social security taxes over the next five years. In 1966, the tax rate for employees and employers alike is scheduled to jump to 4⅛ and in 1968 it is due to go to 4⅜. This means that by 1968, on a covered wage of $4,800, you will be paying $222 a year as against the $174 you are paying in 1963. The company, of course, will be paying the same amount.

Vinyl Chloride Sales Set Company Record

Ethyl's Chemical Sales Group hit an all time sales high in vinyl chloride monomer during 1962. According to Harry Kuhe, Chemical Sales manager, sales volume for the year approximated plant capacity for the two Company installations where vinyl is produced, Baton Rouge and Houston.

Sales of chemical products other than antiknock compounds have gained an increasing percentage in the Company's total sales in recent years. From 3 percent of total sales in 1957, products other than antiknocks now account for 13 percent of Ethyl's total sales volume.

ANNOUNCEMENT

What you are reading is the first issue of Ethyl's new employee publication, a project that has been a full year in the planning and preparation. It replaces "Ethyl Bulletin Board" and, as you can see, is totally different from its predecessor in every way. It even has a new name.

Our plants in Baton Rouge and Houston will continue to publish their own monthly newspapers for employees at those locations. ETHYL REPORTER will serve all other employees, including those of Ethyl Corporation of Canada Limited.

ETHYL REPORTER is by no means the result of a hasty decision. For the past year, the Public Relations department has been studying the entire field of employee communication. A score of other companies were surveyed to get their viewpoints, and members of the Public Relations staff also talked to many of our own people to learn their ideas. Always one fact stood out: Employees want as much company, industry and other timely and pertinent news as possible and—in this day of television and so many other demands upon their time—they want it quickly and concisely. The editors feel they can best satisfy this reading requirement with a newspaper rather than a magazine.

While giving you more news faster, ETHYL REPORTER will, at the same time, effect an economy in printing and production costs.

It is hoped that you and the members of your family will find this and all future issues of ETHYL REPORTER informative and interesting reading.

James S. Sheridan
Director of Public Relations

Directors Meet, Declare Dividend

The board of directors of Ethyl Corporation on December 11 declared quarterly dividends of $1.50 a share on each class of preferred stock and 12½ cents a share on each class of common stock. The dividends were payable January 1, 1963 to stockholders of record December 20, 1962.

The dividends represent the third quarterly payment to stockholders in Ethyl's fiscal year. The preferred stock dividends are $6 a year. Dividends on the common stock have been at the rate of 50 cents a year since 1958.

In a letter to stockholders accompanying the dividend payments, the Company explained that, because of necessity for development of accounting procedures and valuation of assets resulting from the recent merger, it is not feasible to publish a quarterly financial statement for the most recent three-month period. Complete financial information will be given in the annual report covering the fiscal year ending March 31, 1963.

FIVE REGIONAL MANAGERS GATHER—A regular quarterly meeting of Regional managers was held in New York recently. These periodic gatherings are held to give Ethyl's top Sales management from the field a chance to get together with home office personnel and to discuss results of past policy, assess the state of present business conditions and go over new plans. A highlight of this particular quarterly meeting was the chance afforded the Regional managers to meet Ethyl's new Board Chairman, Floyd D. Gottwald, and other newly elected Company officers. Above, left to right, are shown: Jack Pruitt, General Sales manager; Bob Douglass, Mid-Continent Regional manager; Bo Weill, Western Region's acting manager; Stu Forbes, Domestic Sales manager; M. P. Murdock, Vice President—Sales; Dan Flynn, Central Regional manager; Dick Murphy, Eastern Regional manager; and Ellis Locher, Gulf Coast Regional manager.

'62 WAS BUSY FOR ETHYL, ITS PEOPLE

While the sale of Ethyl Corporation was the outstanding corporate event of 1962, the Company and its people made news on many other fronts during the year just completed.

In brief, 1962 was a year that:

–Ethyl was merged with the former Albemarle Paper Manufacturing Company, ending 38 years of joint ownership by Standard Oil (N. J.) and General Motors.

–Three new products were added to the line of more than 50 chemical products already sold under the "Ethyl" banner.

–Our Louisiana manufacturing plant, the second largest employer in Baton Rouge, marked its 25th anniversary, and the Houston Ship Channel plant observed its 10th year of operation.

–The Ethyl Savings Plan made its first short-term payments and issued its first annual report.

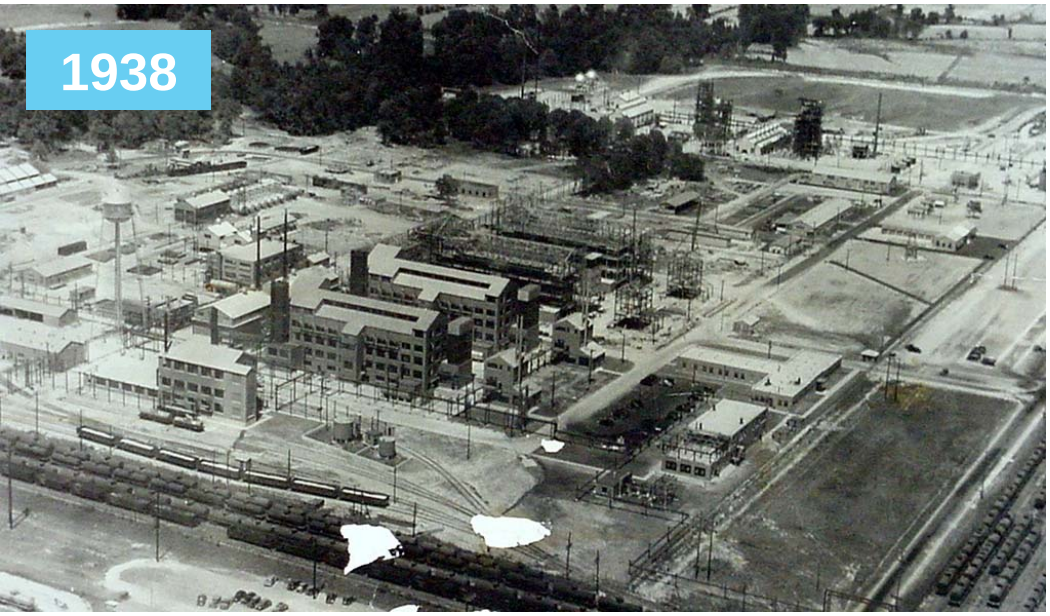
–An Ethyl Merit Scholarship, to be held by the qualified son or daughter of an Ethyl employee, was created.

Taking a closer look at some of these areas of achievement, new products announced during 1962 were "Ethyl" Combustion Improver 2 (improves combustion characteristics of heating oil and improves oil burner efficiency), "Ethyl" Multi-Purpose Additive–Diesel (improves diesel engine performance) and "Ethyl" Automate Liquid Dyes (offering several advantages over dry dyes for mixing with petroleum products).

Some of last year's key job promotions were Bill Sabin to be director of the Refinery Technology division and Hans Wolfe to succeed him as chief refinery technologist for the Central Region, Charlie Manore to be Employee Relations manager of Ethyl of Canada, Chris Bruhl to be director of the newly-formed Marketing Research and Analysis division, Ed Dailey to be assistant manager of the Yonkers Gasoline Testing Laboratory, Doug King to be assistant manager of Product Services and Safety, Walter Cosgrove to be assistant director of Employee Relations and Ralph Hutchinson to succeed him as Employee Benefits manager.

On the safety front, the Detroit Laboratories were cited by the National Safety Council for having completed one million man-hours of work without a disabling injury.

The foregoing are but a sampling of the people, places and events that made news throughout Ethyl Corporation during the year just past. There is every indication that 1963 will be just as newsworthy for both the Company and the thousands of Ethyl people everywhere.

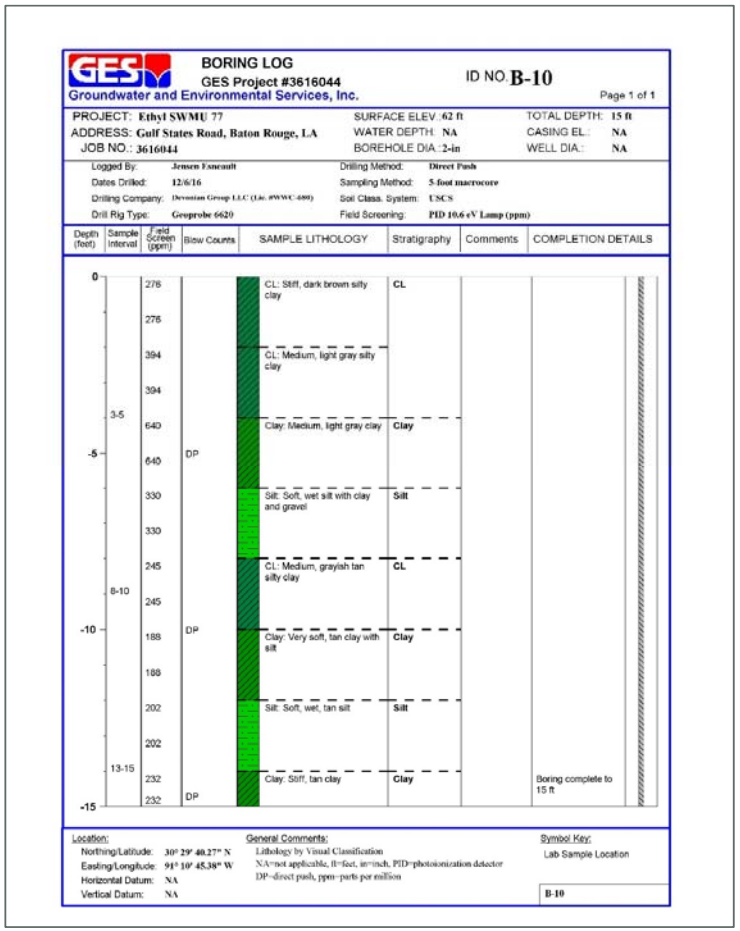


Site History and Conditions

Project Approach

- GES and SEMS collaborated with Ethyl Corp. to develop a comprehensive feasibility test plan. This included technology evaluation and selection, implementation plan, and sampling and analysis plan.
- Review of historical data led the team to identify in-situ chemical reduction (ISCR) and enhanced in-situ bioremediation (EISB) as potentially appropriate technologies to meet project goals.
- A pre-design investigation (PDI) strategy was developed to obtain baseline soil quality and assess soil microbial population.
- PDI microbial assay indicated that aerobes were the dominant microbes, which is not the most favorable condition for degradation of the contaminants.

Site soils- tight depositional, mostly silt & clay



BORING LOG
GES Project #3616044
Groundwater and Environmental Services, Inc.
ID NO. B-10
Page 1 of 1

PROJECT: Ethyl SWMU 77 | SURFACE ELEV.: 62 ft | TOTAL DEPTH: 15 ft
ADDRESS: Gulf States Road, Baton Rouge, LA | WATER DEPTH: NA | CASING EL.: NA
JOB NO.: 3616044 | BOREHOLE DIA.: 2-in | WELL DIA.: NA

Logged By: Jensen Fancault | Drilling Method: Direct Push
Dates Drilled: 12/6/16 | Sampling Method: 5-foot macrocore
Drilling Company: Devonian Group LLC (Lic. #WWC 488) | Soil Class. System: USCS
Drill Rig Type: Geoprobe 6620 | Field Screening: PID 10.6 eV Lamp (ppm)

Depth (feet)	Sample Interval	Field Screen (ppm)	Blow Counts	SAMPLE LITHOLOGY	Stratigraphy	Comments	COMPLETION DETAILS
0		276		CL: Stiff, dark brown silty clay	CL		
		276					
		394		CL: Medium, light gray silty clay			
	3-5	394					
		640		Clay: Medium, light gray clay	Clay		
-5		640	DP				
		330		Silt: Soft, wet silt with clay and gravel	Silt		
		330					
		245		CL: Medium, grayish tan silty clay	CL		
	8-10	245					
-10		188	DP	Clay: Very soft, tan clay with silt	Clay		
		188					
		202		Silt: Soft, wet, tan silt	Silt		
		202					
	13-15	232		Clay: Stiff, tan clay	Clay		Boring complete to 15 ft
-15		232	DP				

Location:
Northing/Latitude: 30° 29' 40.27" N
Easting/Longitude: 91° 10' 45.38" W
Horizontal Datum: NA
Vertical Datum: NA

General Comments:
Lithology by Visual Classification
NA=not applicable, ft=feet, in=inch, PID=photoionization detector
DP=direct push, ppm=parts per million

Symbol Key:
Lab Sample Location
B-10

Feasibility Test (Dec. 2015 / April 2016)

- Injected via direct-push over two days
- Two injection locations (Test Area #1 and #2)
- Injected liquid reagents / dechlorinating microbes into vadose zone:
  - 3’ – 5’ ft. / 8’ – 10’ ft. / 12’ – 15’ ft. intervals
  - 89-gal of emulsified vegetable oil (EVO)
  - 20-gal mixture of reactive ceramic reductants, buffers, & nutrients in glycol
  - 7.5-liters of microbes via nitrogen carrier gas
  - 1 – 2.5 gpm flow rate
  - 25 – 50 psi injection pressure
- Post-injection soil data collected 120-days after injection
- Significant reductions in CT, PCE, & TCE
- More successful on ethenes than ethanes
- Report submitted to LDEQ / Received Authorization for Full-Scale Implementation

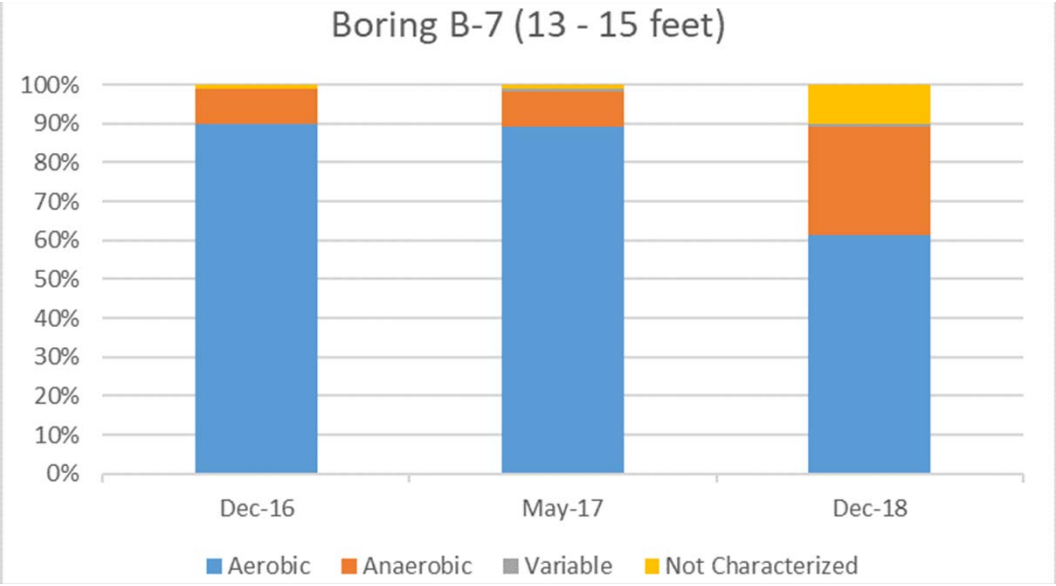
Full-Scale (Dec. 2016 / Feb. 2017)

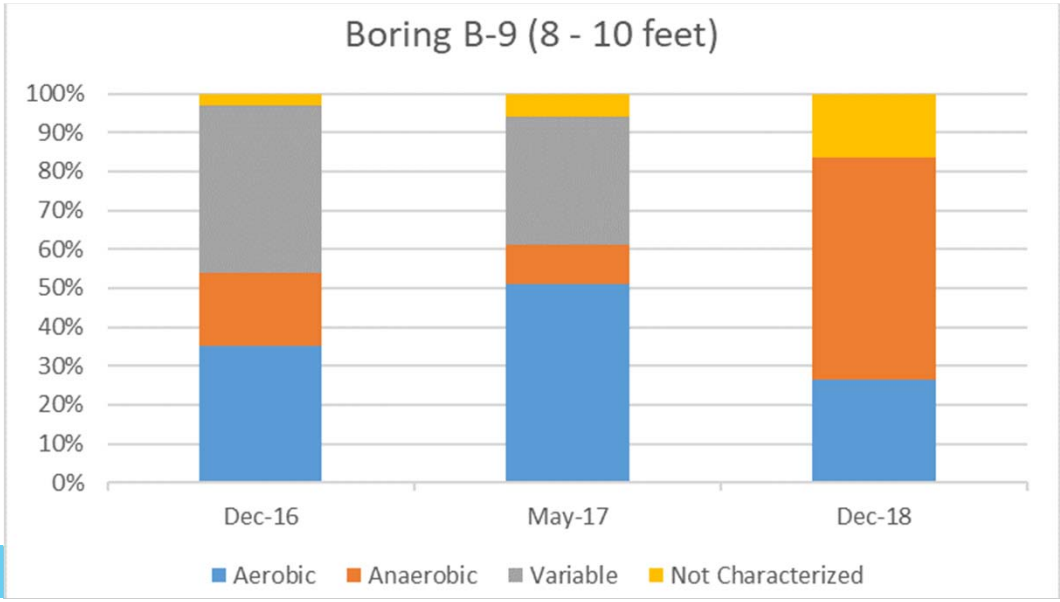
Application	30 Injection Points	Notes
Targeted Injection Depths	3'-5' / 8'-10' / 12'-15'	Distribute reagents through vadose zone
Reagent Liquids	6,530 gal: Mix of Dilution Water (76%), EVO (20%), & Reactive Metal Particles/Calcium Carbonate/Nutrients in Glycol (4%)	3-5 ft.: 992 gal 8-10 ft.: 2,034 gal 13-15 ft.: 3,504 gal
Microbes	76.4 liters: 50-50 Mixed Bio-Augmentation of *Dehalococcoides / Dehalobacter*	3-5 ft.: 14.6 liters 8-10 ft.: 26 liters 13-15 ft.: 35.8 liters
Flow Rate	0.5 – 2.0 gpm	Varied by depth and location

Full-Scale Test Results (May / Dec. 2017)

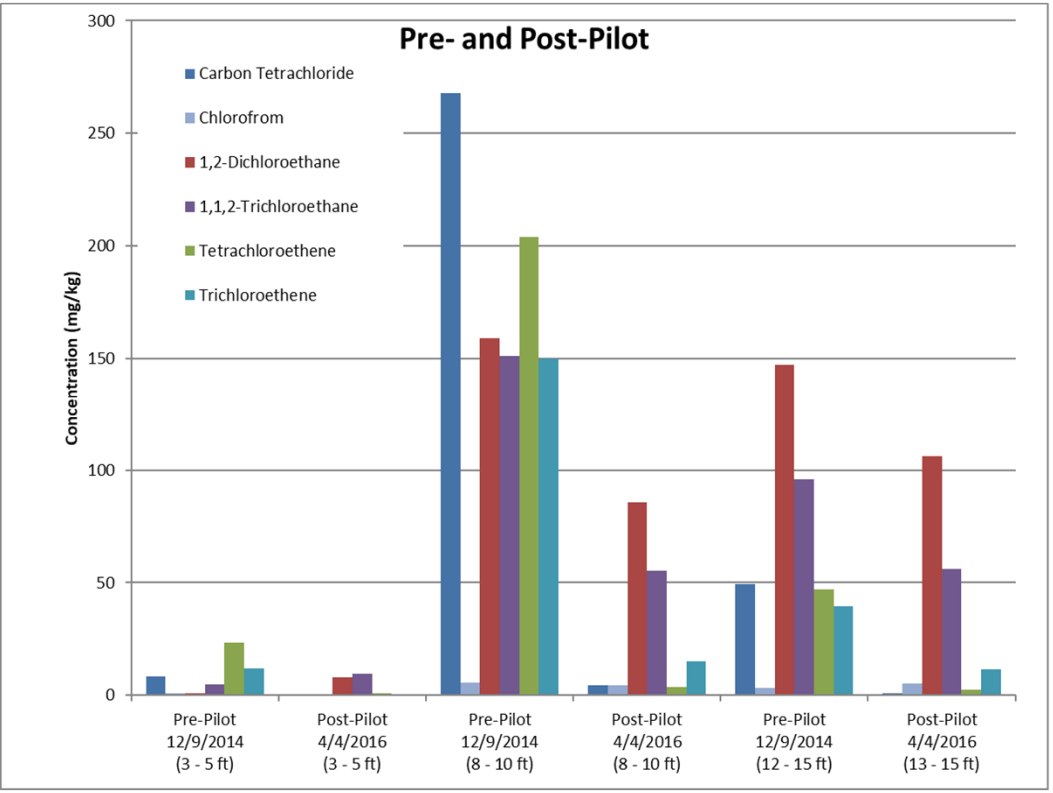
- CVOC concentration reductions have occurred at several locations
- Overall microbial population stable to increasing
- Anaerobic and fermenting microbes have increased
- Conditions favorable for continued biodegradation

- CVOC decreases and microbial growth not consistent across area
  - Dense clay inhibited reagent distribution

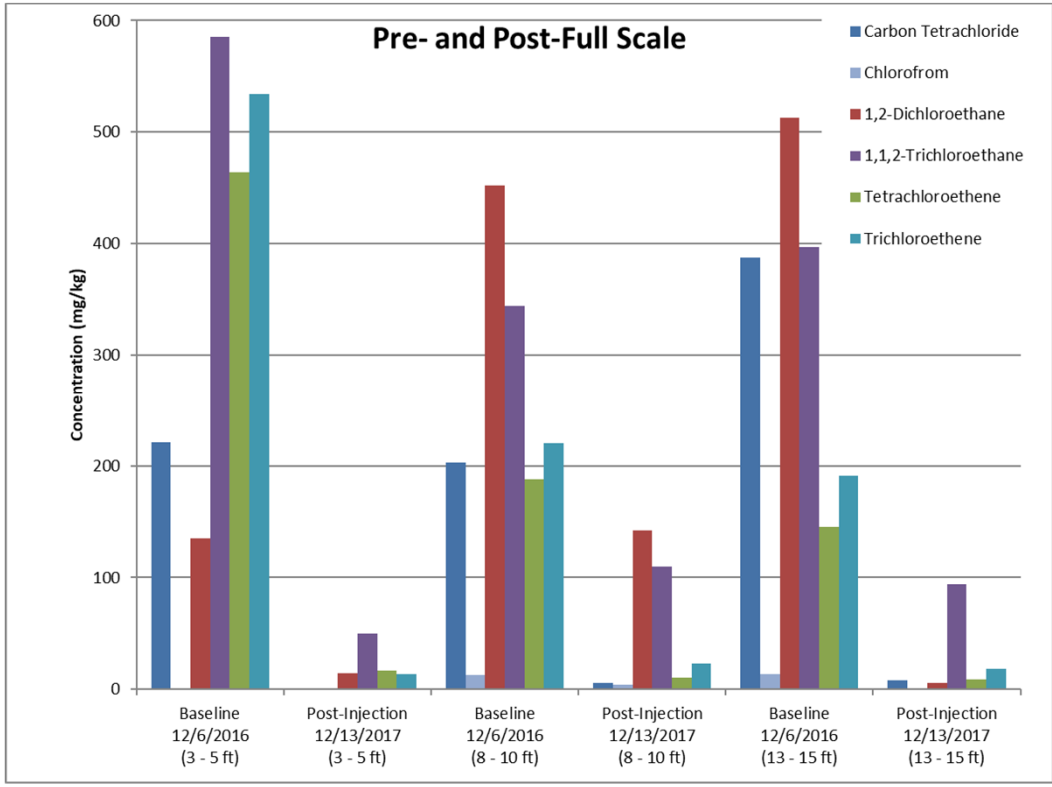




CVOC Results



Borings B-1/B-3



Boring B-9

SWMU 77 / AOC-E Full-Scale Injection Locations

What Did We Learn?

- Injection of ISCR/EISB reagents was possible with low flow rates and pressures within targeted ranges
- Influence of injected chemistry was not as great as anticipated based on feasibility test results
- Reductions in targeted CVOC concentrations were evident with greatest reductions of CT, PCE, and TCE at several locations
- Alternative chemical delivery methods warrant consideration if future injections are proposed

Question & Answers

Thank You!

John Daniels, PG, CAPM
Principal Hydrogeologist

T. 888.540.0804 ext. 3205
E. jdaniels@GESonline.com

Groundwater & Environmental Services, Inc.
12705 South Kirkwood Road, Suite 220
Stafford, TX 77477


GES
Groundwater & Environmental Services, Inc.