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# **Use of In-Situ Bioremediation of Trichloroethene to Reduce Long-Term Monitoring and Life Cycle Costs**

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# Chlorinated Solvents as Contaminants

- Trichloroethene (TCE), tetrachloroethene (PCE), and methylene chloride were commonly used as solvents, degreasers, and possibly as de-icing liquids
- Many current and former DOD installations have chlorinated solvent plumes in the groundwater
- Chlorinated solvents difficult to remediate
- Remedial alternative evaluation
  - High initial capital cost - short LTM period
  - Low initial capital cost - long LTM period

# SS-32, Former Weapons Maintenance Area Columbus AFB, MS

- Site History
  - Maintenance activities
  - Approximately 1959 to 1969
- Chemicals of Concern in Groundwater
  - TCE
  - Vinyl chloride
- Maximum Contaminant Levels (MCLs)
  - 5 µg/L for TCE
  - 2 µg/L for vinyl chloride
- Remedial Action for contaminated groundwater

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**PRIVATE  
WELLS**

**PROPERTY  
BOUNDARY**

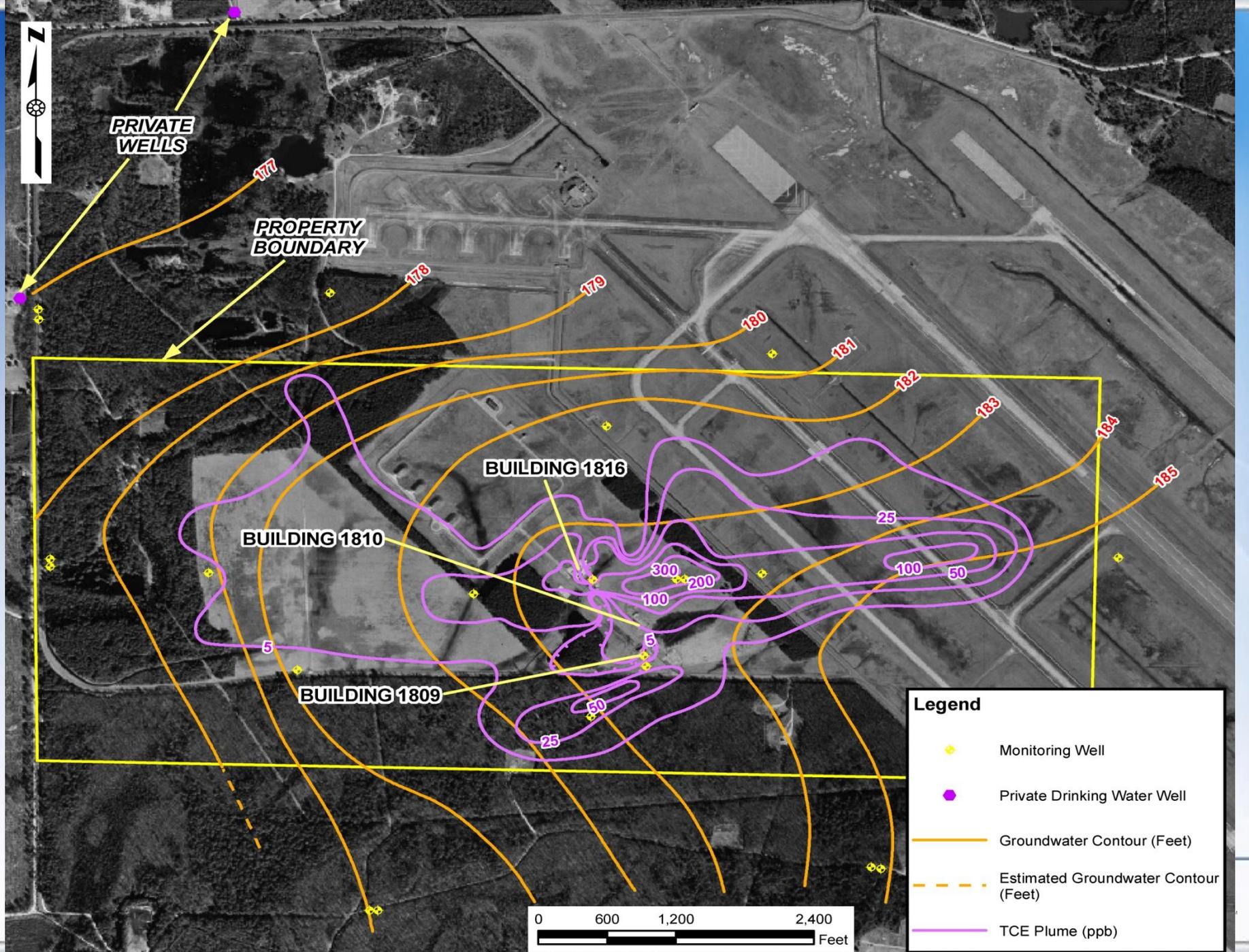
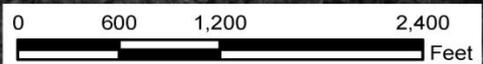
**BUILDING 1816**

**BUILDING 1810**

**BUILDING 1809**

**Legend**

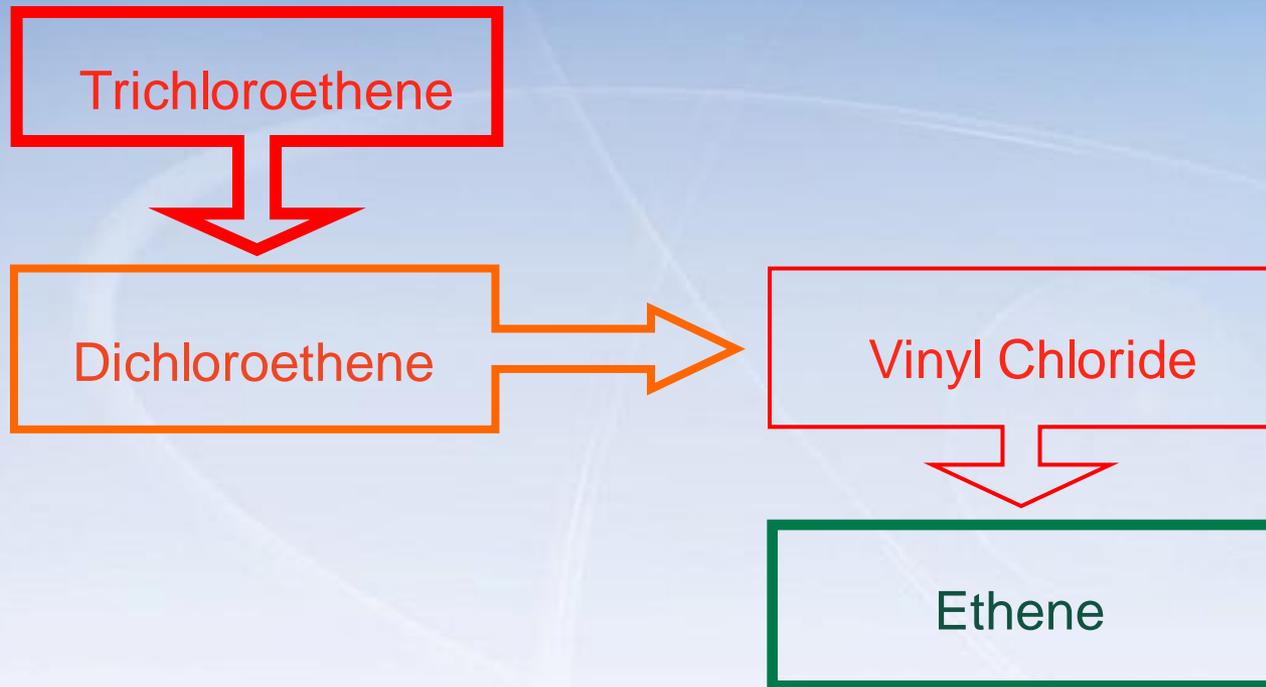
-  Monitoring Well
-  Private Drinking Water Well
-  Groundwater Contour (Feet)
-  Estimated Groundwater Contour (Feet)
-  TCE Plume (ppb)



# Evaluation of Remedial Alternatives

Option	Time	Cost	Other Considerations	Conclusion
<b>Monitored Natural Attenuation</b>	Time to reach MCL approx. 60 years	Lifecycle costs: \$1.5-2.5 million	<ul style="list-style-type: none"> <li>• Abiotic conditions prevalent</li> <li>• Biotic degradation limited</li> <li>• LUCs required for prolonged time</li> <li>• Threat to offsite receptors remains unmitigated</li> <li>• Regulatory acceptance?</li> </ul>	Not feasible by itself
<b>Complete Remediation of Plume (Treatment of &gt;5 ppb of TCE)</b>	Time to reach MCL approx. 5 years	High lifecycle cost: (approx. \$30 million)	<ul style="list-style-type: none"> <li>• Feasible but may be difficult to achieve due to the large size of the plume</li> <li>• In situ bioremediation or oxidation may be used</li> </ul>	Not cost effective
<b>Source Reduction (Treatment of &gt;100 ppb TCE)</b>	Reduces LTM period to 5-10 years	Lifecycles costs: \$1.5 – 2.0 million	<ul style="list-style-type: none"> <li>• Feasible and easily implemented</li> <li>• Highly likely to be accepted by the regulators because of source reduction and short LTM period</li> </ul>	<b>Best Value Approach</b>

# Selected Remedy: Source Reduction by In Situ Enhanced Bioremediation (ISEB)



**ISEB is implemented by creating a reducing environment in the contaminated groundwater with amendments (lactate, emulsified oil and microbes)**

# Project Status

- Remedial Action Construction - Completed July 5, 2008
- Remedial Action Operations (RA(O))- Ongoing
  - Completed 1<sup>st</sup> Year Quarterly Monitoring in July 2009
  - ISEB GOAL ATTAINED July 2009**
  - 2nd Year RA(O) Monitoring through July 2010
  - 3rd Year RA(O) Monitoring through July 2011
  - 5-10 years of LTM beyond 2011

# Remedial Action

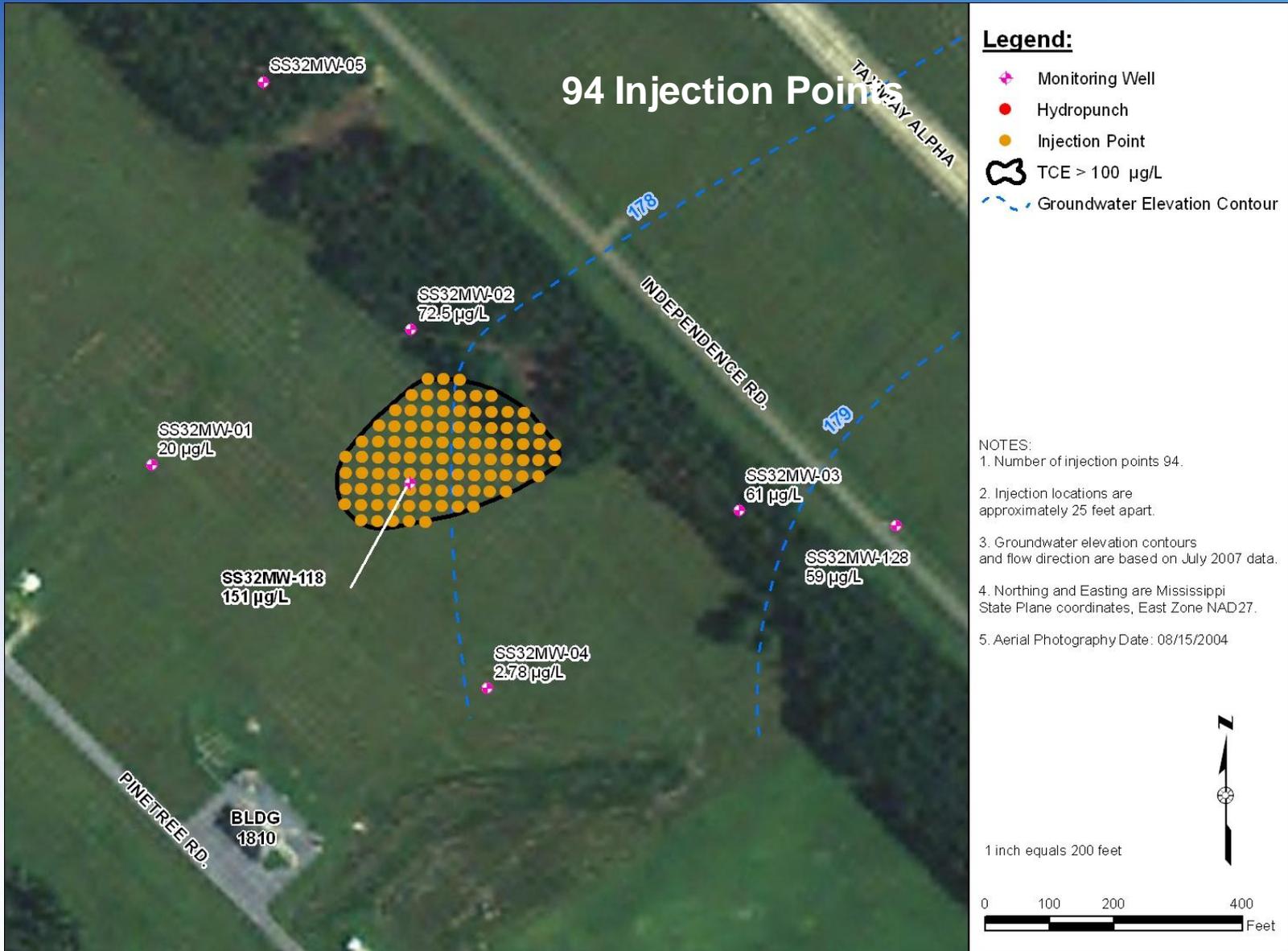
- Mobilized June 2, 2008
  - Two Track Mounted DPT Rigs
  - Injection Trailer
  - Four Water Pillows
  - Water Truck
  - Fork Lift
  - Connex Box
  - Vehicles



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# West Target Area Injection Points



# W-118 Sample Results

## West Target Area

Parameter	Units	Sep-07	July-08	Oct-08	Apr-09	Apr-10
		Baseline	Injection	3 months	9 months	21 months
Trichloroethene	µg/L	151		4.2	0.369	0.25
cis-1,2-Dichloroethene	µg/L	72.6		178	0.668	0.25
Vinyl chloride	µg/L	5.4		7.67	0.652	0.25
Ethene	µg/L	1		1	2	1
Dissolved Oxygen	mg/L	1.40		0.79	0.78	0.56
ORP	mV	66.1		-62.5	-228.5	-78.5
pH	-	5.05		6.13	6.42	6.58
TOC	µg/L	-		75,000	20,600	15,800
Dehalococcoides	cells/ml	-		120	19,000	770

cells/mL – cells per milliliter

*Dehalococcoides* sp. (bacteria)

J – The analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed

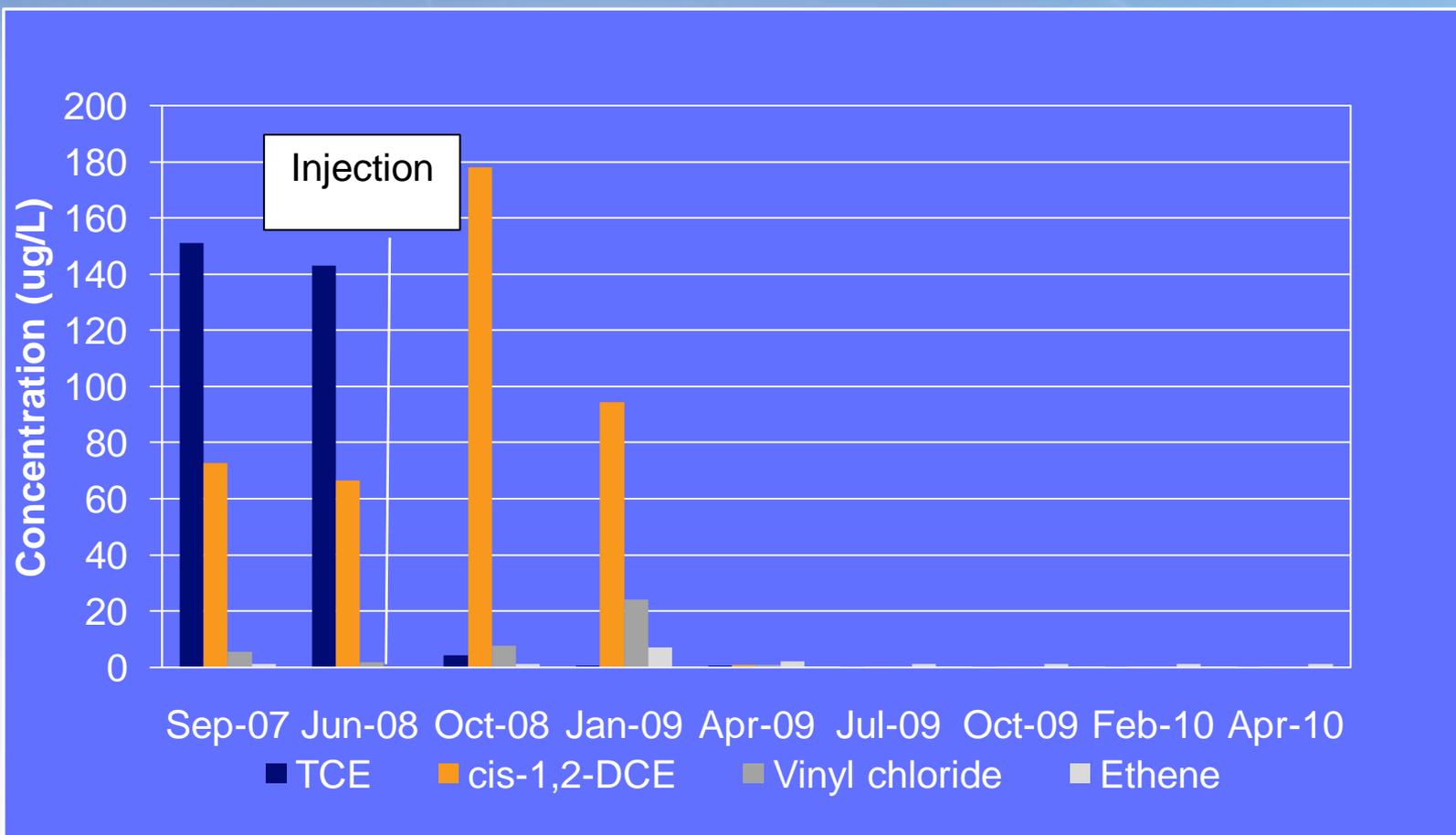
mg/L - milligrams per liter

ORP - oxidation-reduction potential

U - Not detected. The analyte was analyzed for, but not detected above the associated reporting limit.

µg/L - micrograms per liter

# W-118



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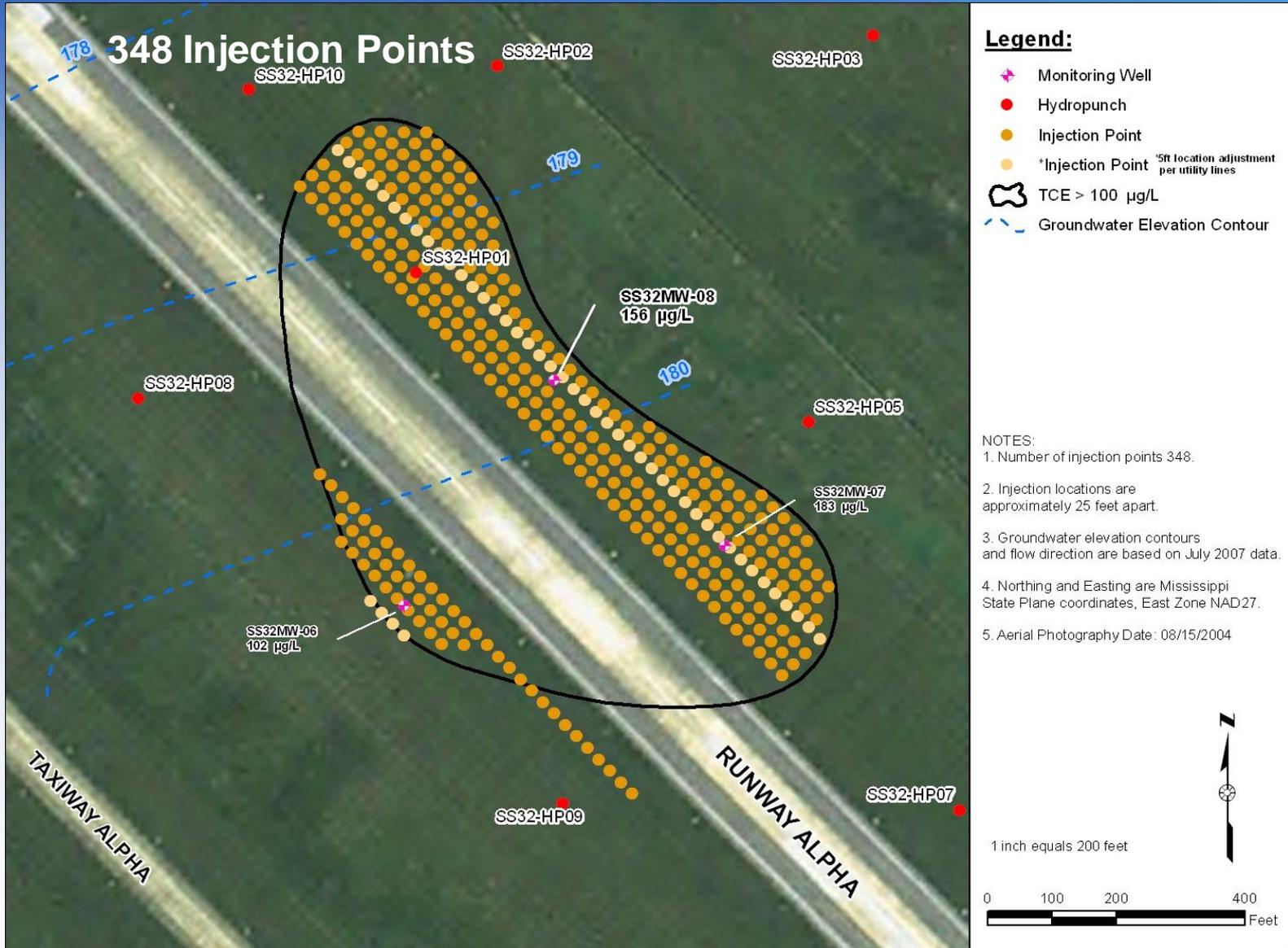
# ISEB Goal

Individual TCE values are  
25 µg/L or less  
for two most recent quarters  
AND  
average TCE for most recent quarter  
is 10 µg/L or less

Goal Attained for West Target Area



# East Target Area Injection Points



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# Injection Activities in East Area Near Runway



07/01/2008

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# SS32-MW06 Sample Results

## East Target Area

Parameter	Units	Sep-07	July-08	Oct-08	Apr-09	Apr-10
		Baseline	Injection	3 months	9 months	21 months
Trichloroethene	µg/L	102		107	3.51	26.6
cis-1,2-Dichloroethene	µg/L	204		488	38.7	54
Vinyl chloride	µg/L	84.2		302	24.6	141
Ethene	µg/L	1		2	72	41
Dissolved Oxygen	mg/L	1.14		0.93	1.05	0.52
ORP	mV	49.7		-93.4	-260.4	-14.1
pH	-	5.24		6.02	6.13	6.21
TOC	µg/L	-		5,000	25,900	9,310
Dehalococcoides	cells/ml	-		4,200	8,400	2,700

cells/mL – cells per milliliter

*Dehalococcoides* sp. (bacteria)

J – The analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed

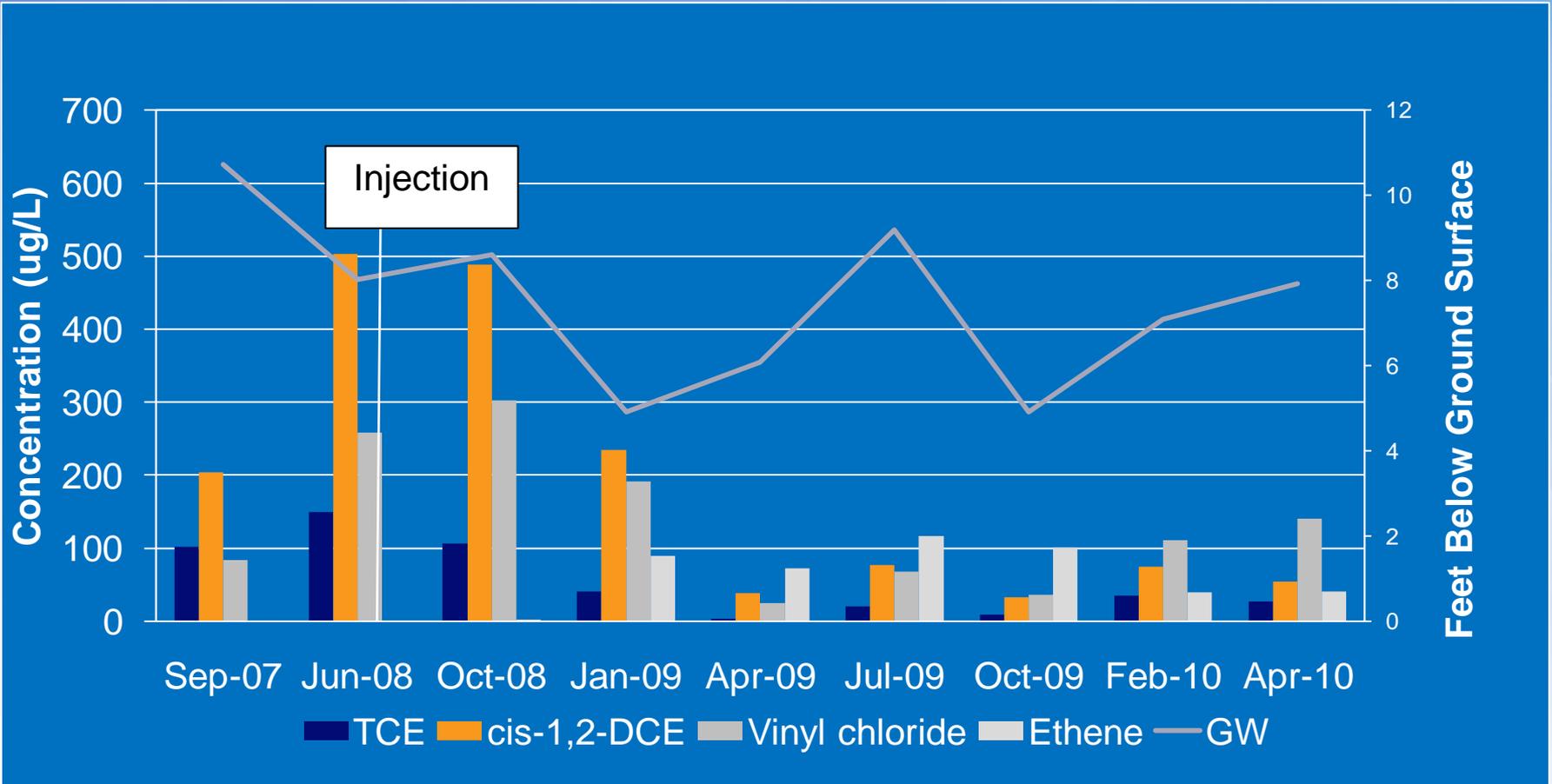
mg/L - milligrams per liter

ORP - oxidation-reduction potential

U - Not detected. The analyte was analyzed for, but not detected above the associated reporting limit.

µg/L - micrograms per liter

# SS32-MW06



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# SS32-MW07 Sample Results

## East Target Area

Parameter	units	Sep-07	July-08	Oct-08	Apr-09	Apr-10
		Baseline	Injection	3 months	9 months	21 months
Trichloroethene	µg/L	183		0.625	0.339	0.25
cis-1,2-Dichloroethene	µg/L	642		333	21.6	2.81
Vinyl chloride	µg/L	237		130	12.1	4.98
Ethene	µg/L	1		3	45	17
Dissolved Oxygen	mg/L	0.39		3.07	0.86	47.1
ORP	mV	-369.2		-98.0	-168.0	-62.3
pH	-	5.39		6.26	6.38	6.46
TOC	µg/L	-		52,900	59,300	25,200
DHE	cells/ml	-		11,000	180	10

cells/mL – cells per milliliter

*Dehalococcoides* sp. (bacteria)

J – The analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed

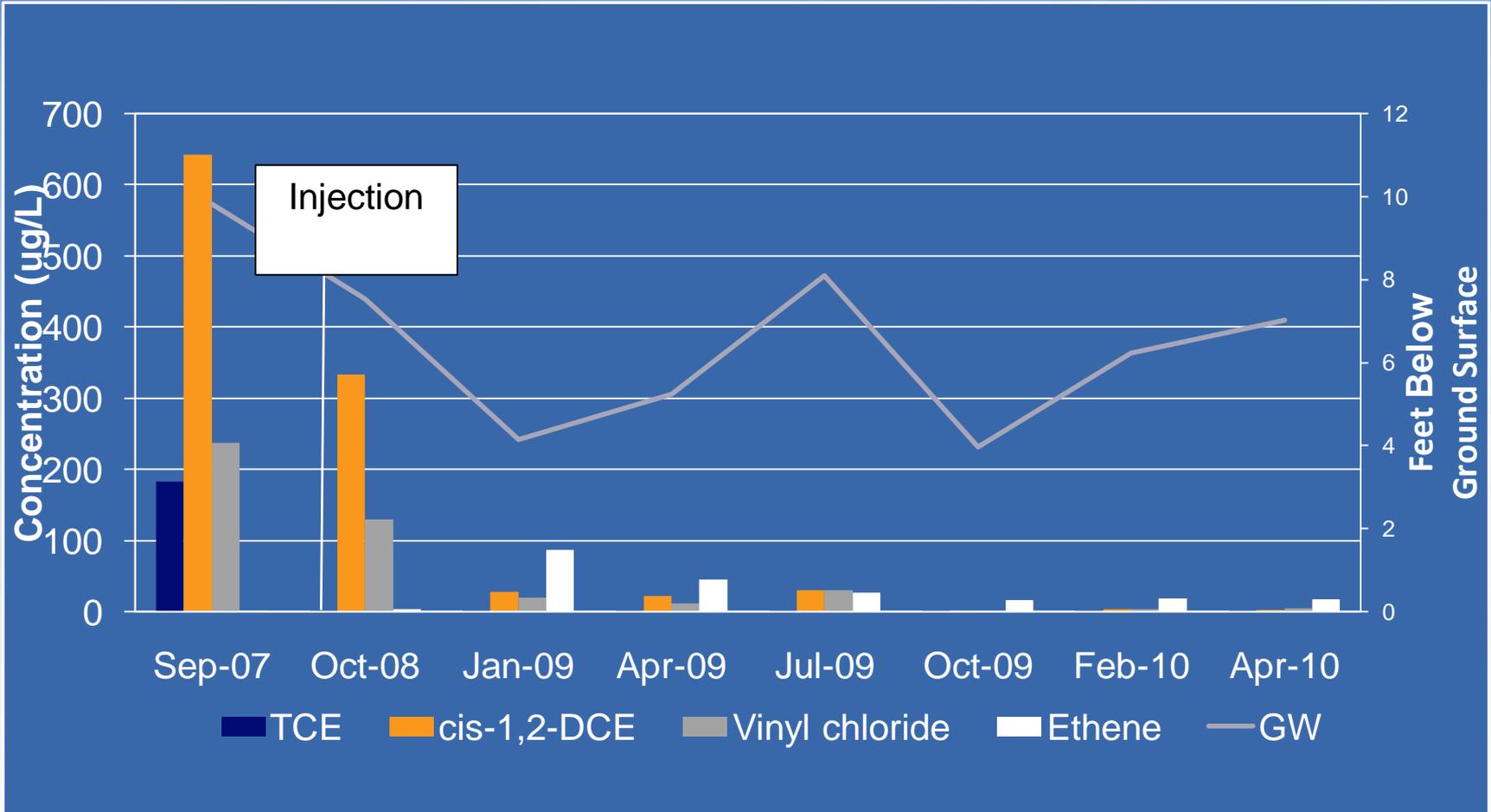
mg/L - milligrams per liter

ORP - oxidation-reduction potential

U - Not detected. The analyte was analyzed for, but not detected above the associated reporting limit.

µg/L - micrograms per liter

# SS32-MW07



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# SS32-MW08 Sample Results

## East Target Area

Parameter	Units	Sep-07	July-08	Oct-08	Apr-09	Apr-10
		Baseline	Injection	3 months	9 months	21 months
Trichloroethene	µg/L	156		13.7	0.259	0.25
cis-1,2-Dichloroethene	µg/L	468		615	2.38	0.25
Vinyl chloride	µg/L	186		222	2.81	0.749
Ethene	µg/L	1		2	57	17
Dissolved Oxygen	mg/L	0.74		0.82	0.90	0.6
ORP	mV	49.1		-25.4	-165.7	-76.2
pH	-	5.35		5.82	6.25	6.48
TOC	µg/L	-		59,200	72,000	49,800
DHE	cells/ml	-		360	16,000	10

cells/mL – cells per milliliter

*Dehalococcoides* sp. (bacteria)

J – The analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed

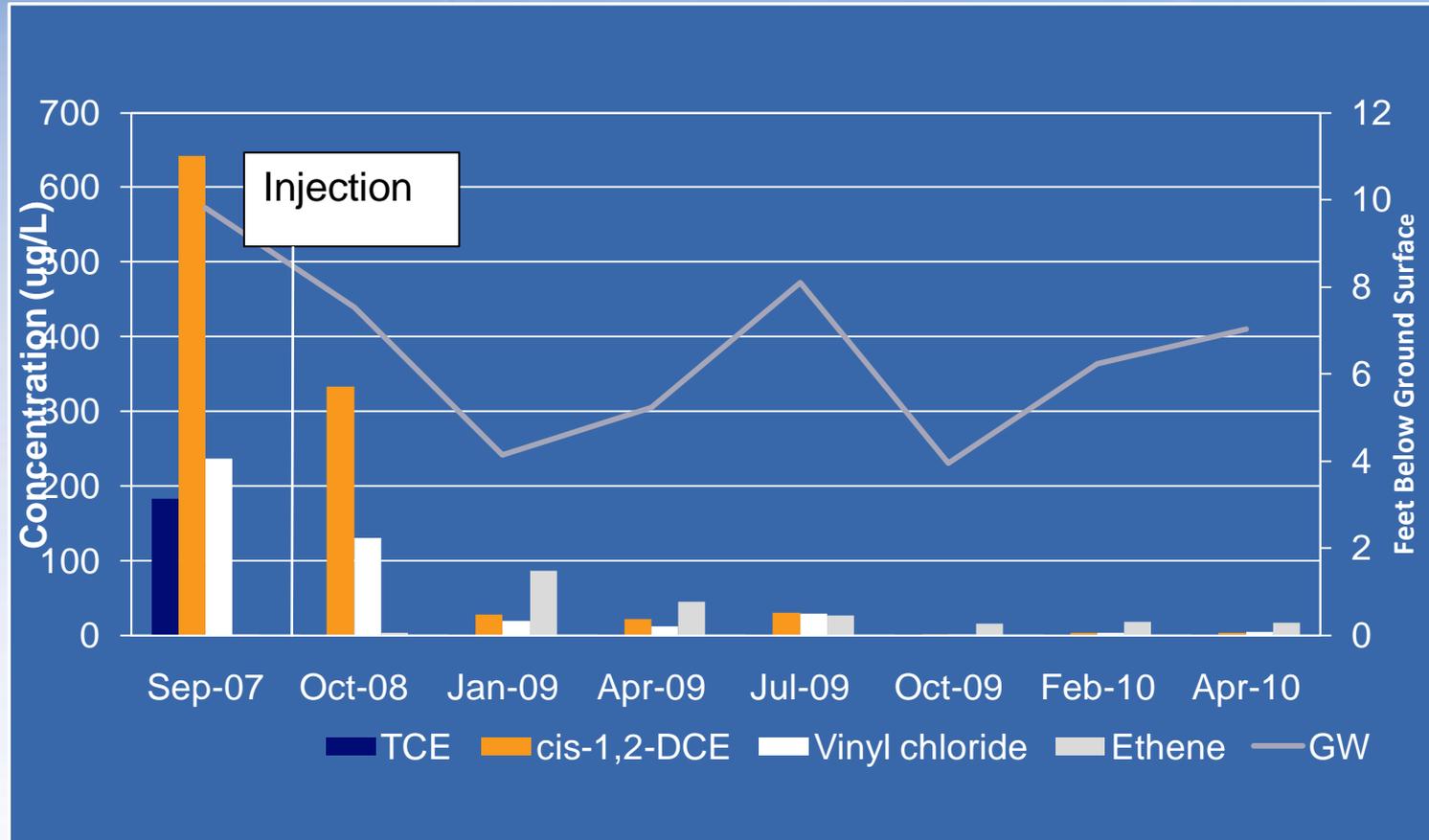
mg/L - milligrams per liter

ORP - oxidation-reduction potential

U - Not detected. The analyte was analyzed for, but not detected above the associated reporting limit.

µg/L - micrograms per liter

# SS32-MW08



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# East Target Area ISEB Goal Attainment

As of April 2010 SS32-MW06, SS32-MW07 and  
SS32-MW08 were near or below the  
25 µg/L TCE goal  
AND  
Average TCE for most recent quarter is  
less than 9.0 µg/L,  
below the 10 µg/L average goal.

## Goal Attained for East Target Area

# Path Forward

- ISEB goal has been met. Last RA(O) monitoring was conducted in April 2010
- RA(O) Monitoring : Currently quarterly as required by ROD
- Reduce RA(O) monitoring frequency to semi-annual.
- Future LTM frequency - annual

# Questions?



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