



CONESTOGA-ROVERS & ASSOCIATES

***IN SITU* CHEMICAL AND BIOLOGICAL TREATMENT OF TCE IN GROUNDWATER AT A LEGACY RAILROAD SITE**

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Overview

- Site Background
- Source Areas and VOC Concentrations
- Geology/Hydrogeology
- Historic Remedial Actions
- Current Remedial Approach/Activities
- Performance Monitoring
- Results
- Conclusions
- Subsidiary Challenges
- Future Actions
- Questions



Site Background

- Site Location – Mountain View, CA
- Operational History – Amusement park equipment manufacturing from 1960 to 1980
- Railroad Legacy – acquisitions and mergers
- Trichloroethene (TCE) used as degreaser in manufacturing process
- Active case since 1980s
- Part of regional Superfund groundwater VOC plume



Site Background - Location



Source Areas and VOC Concentrations

- Five source areas
- TCE impacts mainly in the top 20 feet bgs
- Soil concentrations as high as 16,000 $\mu\text{g}/\text{kg}$
- Groundwater concentrations as high as 300 $\mu\text{g}/\text{L}$

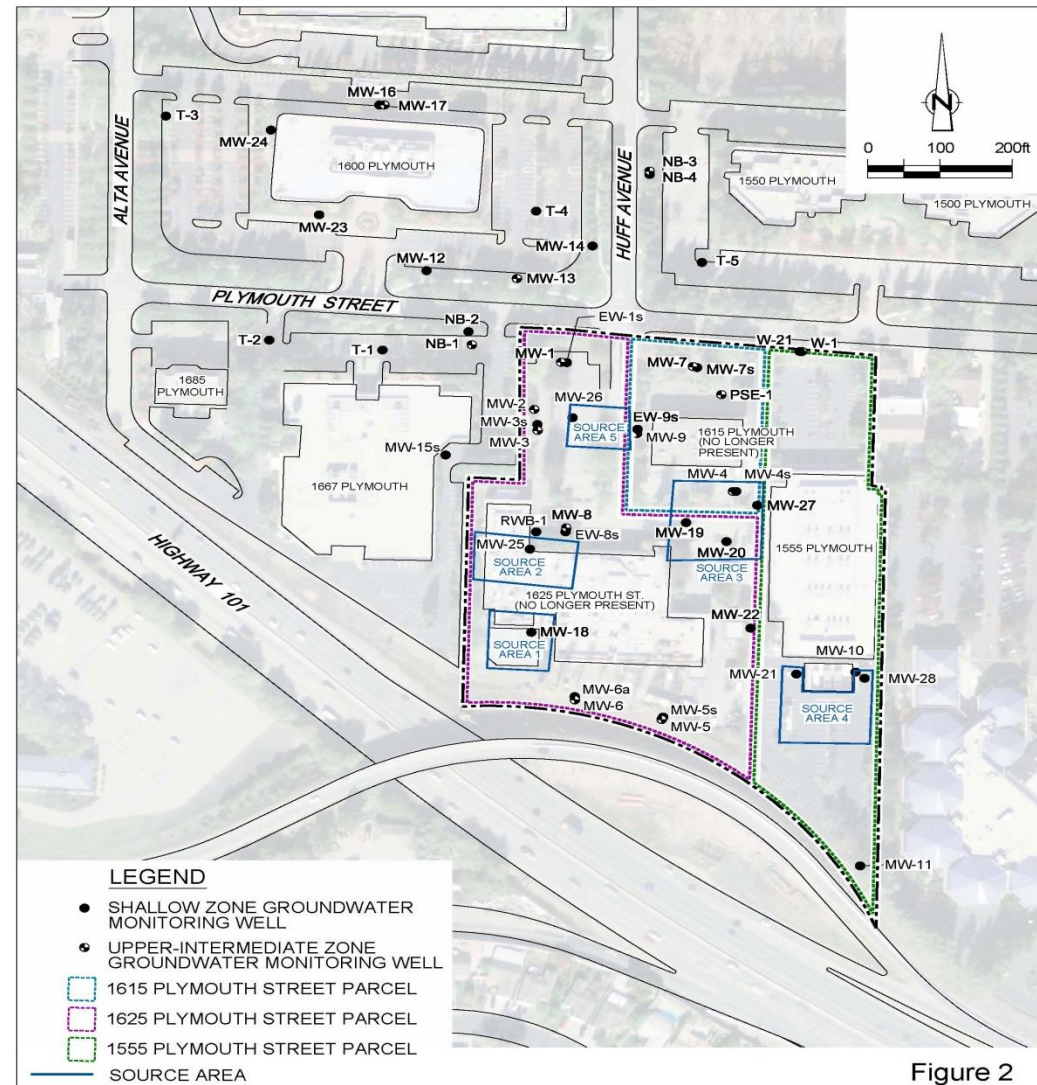
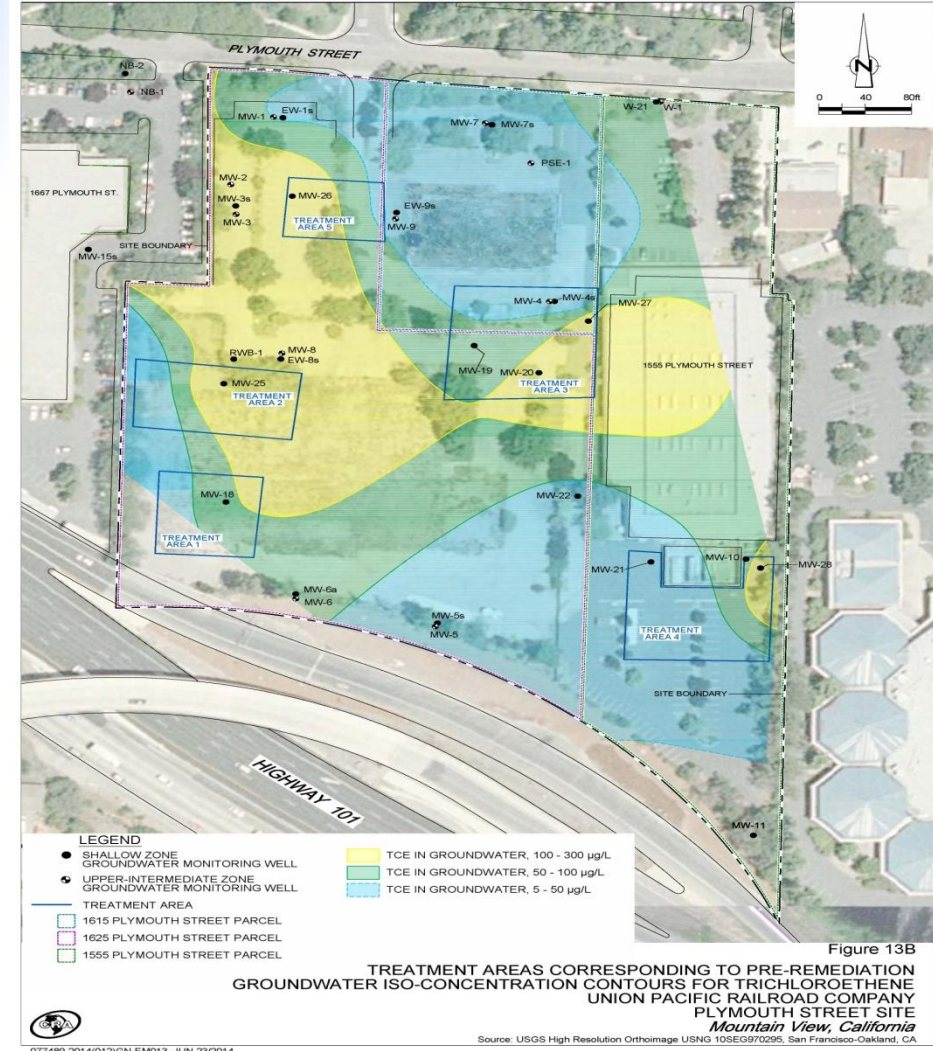
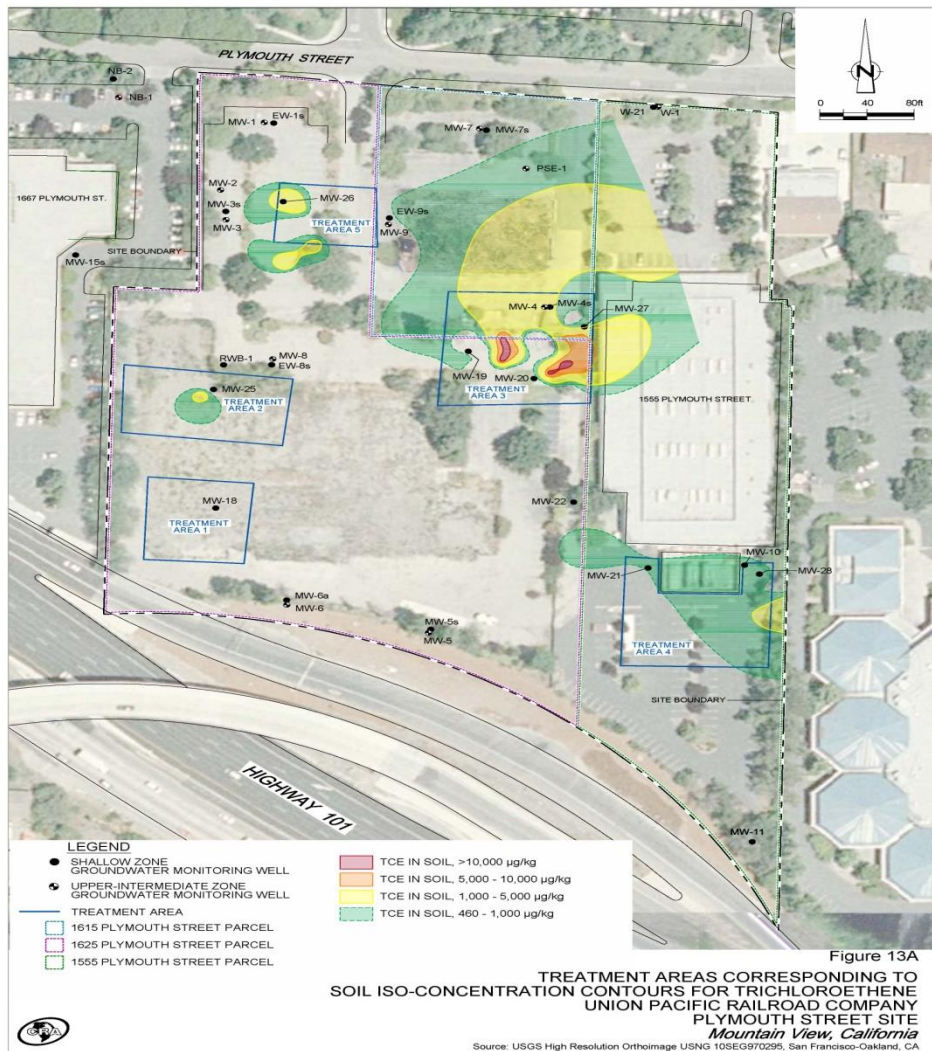


Figure 2

Source Areas and VOC Concentrations



Geology/Hydrogeology

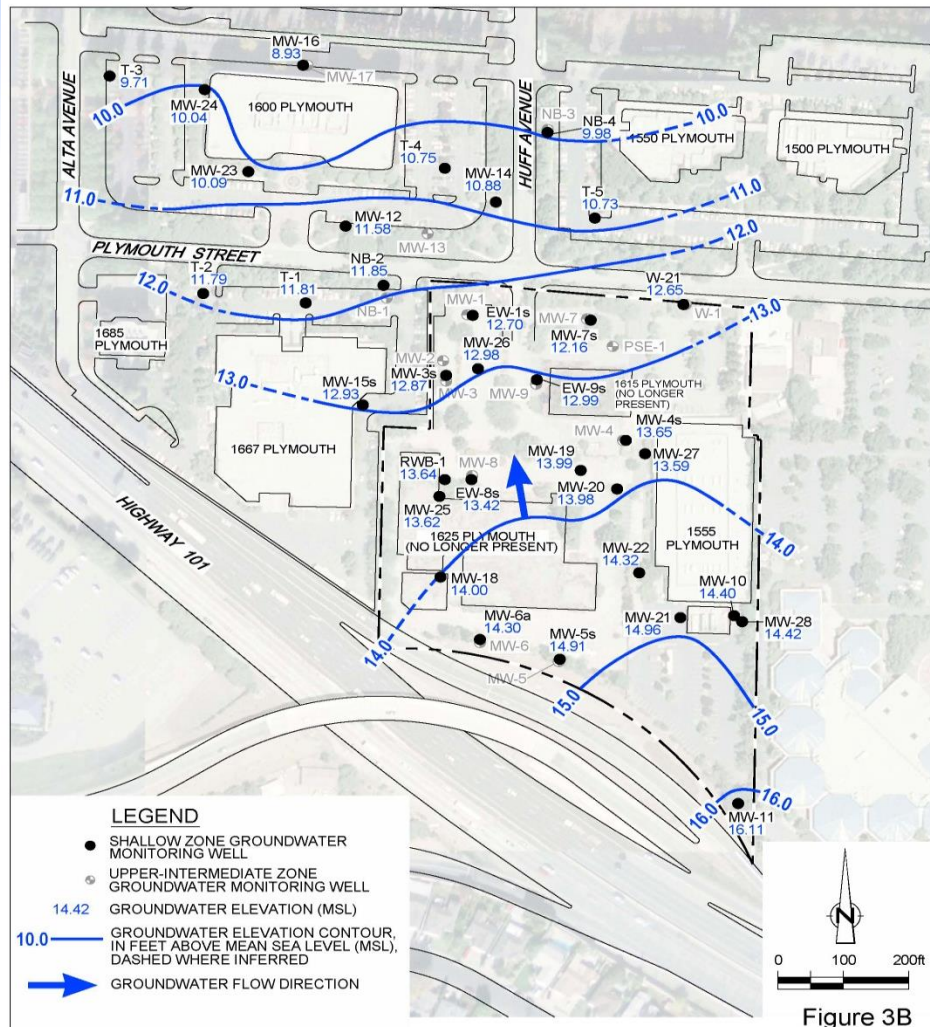
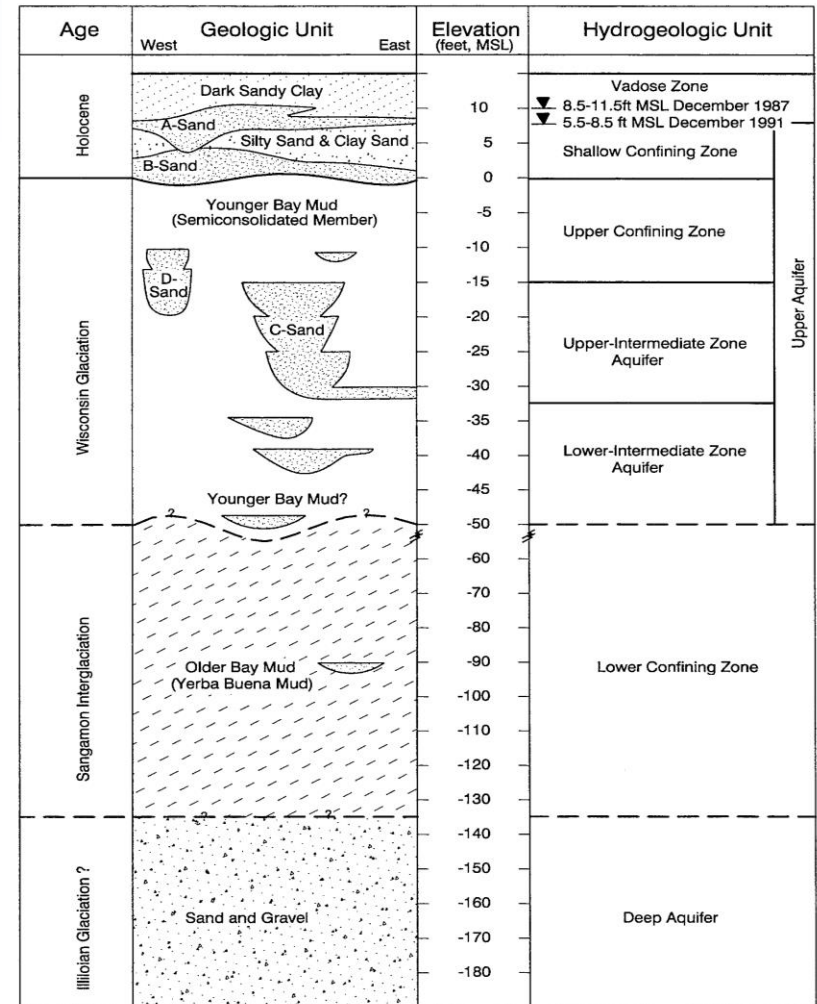
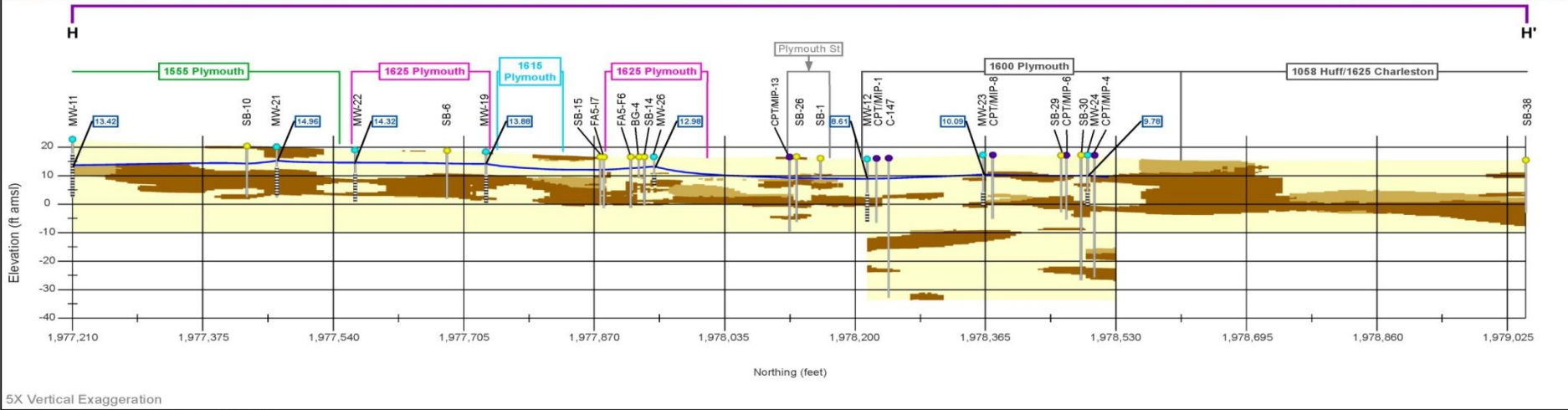
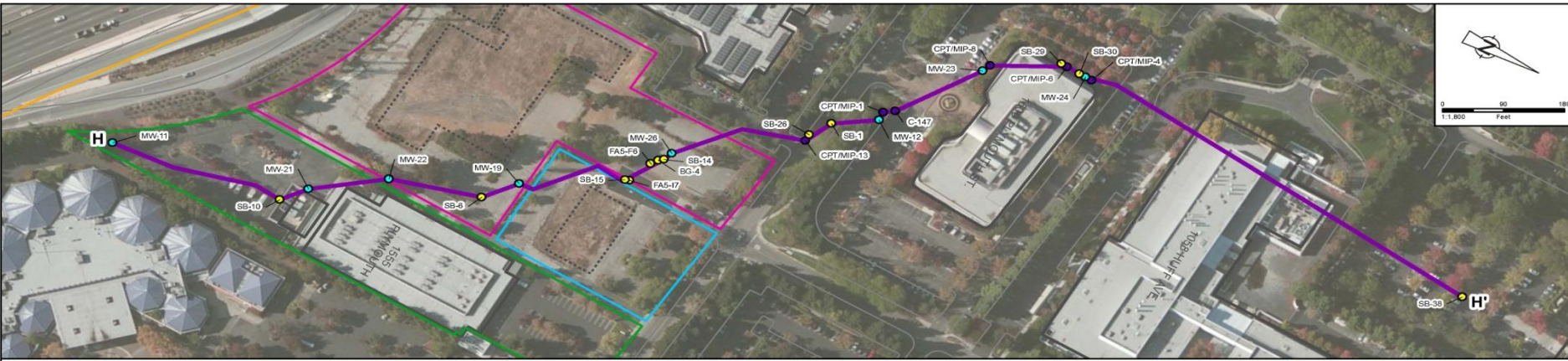


Figure 3B



Geology-Hydrogeology: Cross-Section



Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet
 Aerial Image Source: ESRI Imagery, accessed Jun 03/2014

- | | | |
|---|---|--|
| <p>Legend</p> <ul style="list-style-type: none"> — CROSS-SECTION LINE — NORTH BAYSHORE AREA (NBA) — 1615 PLYMOUTH STREET PARCEL — 1625 PLYMOUTH STREET PARCEL — 1555 PLYMOUTH STREET PARCEL — EXISTING BUILDING - - - - PREVIOUS BUILDING | <p>SOIL PERMEABILITY</p> <ul style="list-style-type: none"> High Medium Low | <p>SAMPLE LOCATION</p> <ul style="list-style-type: none"> ● MONITORING WELL ● SOIL BORING / CPT MIP ● SOIL BORING — GROUNDWATER TABLE (JAN. 2014) 13.4 GROUNDWATER ELEVATION (FT AMSL) |
|---|---|--|

Figure 6H

GEOLOGIC CROSS-SECTION H-H'
 UNION PACIFIC RAILROAD COMPANY
 PLYMOUTH STREET SITE
 Mountain View, California

Historic Remedial Actions

- Groundwater extraction: between 1994 and 2007, removed 29M gallons of water and 84 pounds of VOCs
- In situ chemical oxidation with permanganate in 2004: concentrations rebounded after initial decline
- Excavation in 2010: removed approximately 800 tons of vadose zone soils from source area 5
- MNA 2007 to 2010: not accepted by the regulatory agency due to commingling with Superfund plume



Current Remedial Approach/Activities

- *In situ* chemical and biological reduction
- EHC[®] and SDC-9[™]
- Injected 23% EHC in 907 points by direct-push technique
- Target depth 7 to 18 feet bgs
- Bioaugmentation in 1 in 4 EHC injection points, for a total of 229 points
- Injected total 208,000 pounds of EHC and 916 liters of SDC-9



Current Remedial Approach/Activities

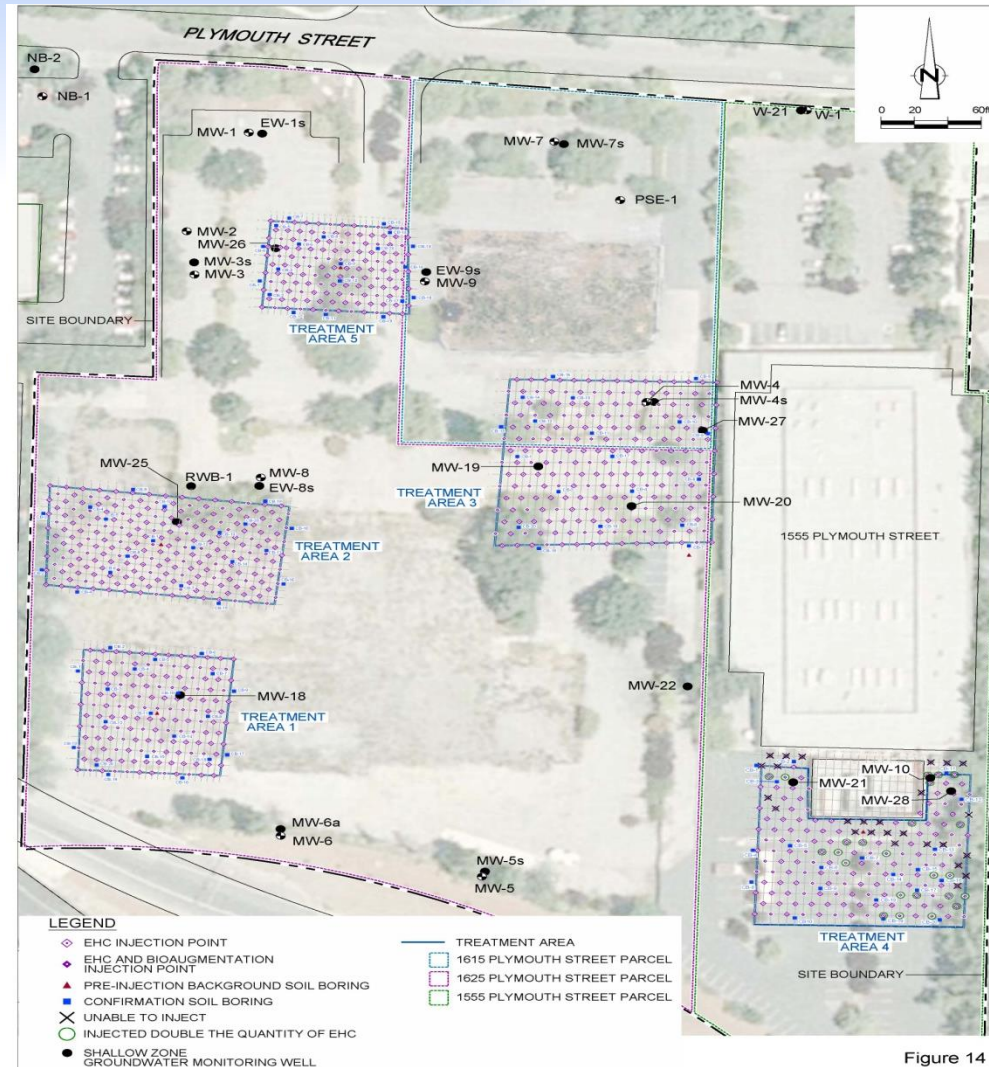


Figure 14

Performance Monitoring

- Focused on treatment area wells
- Quarterly monitoring over five years
- Samples analyzed for VOCs, geochemical parameters, and bacterial counts

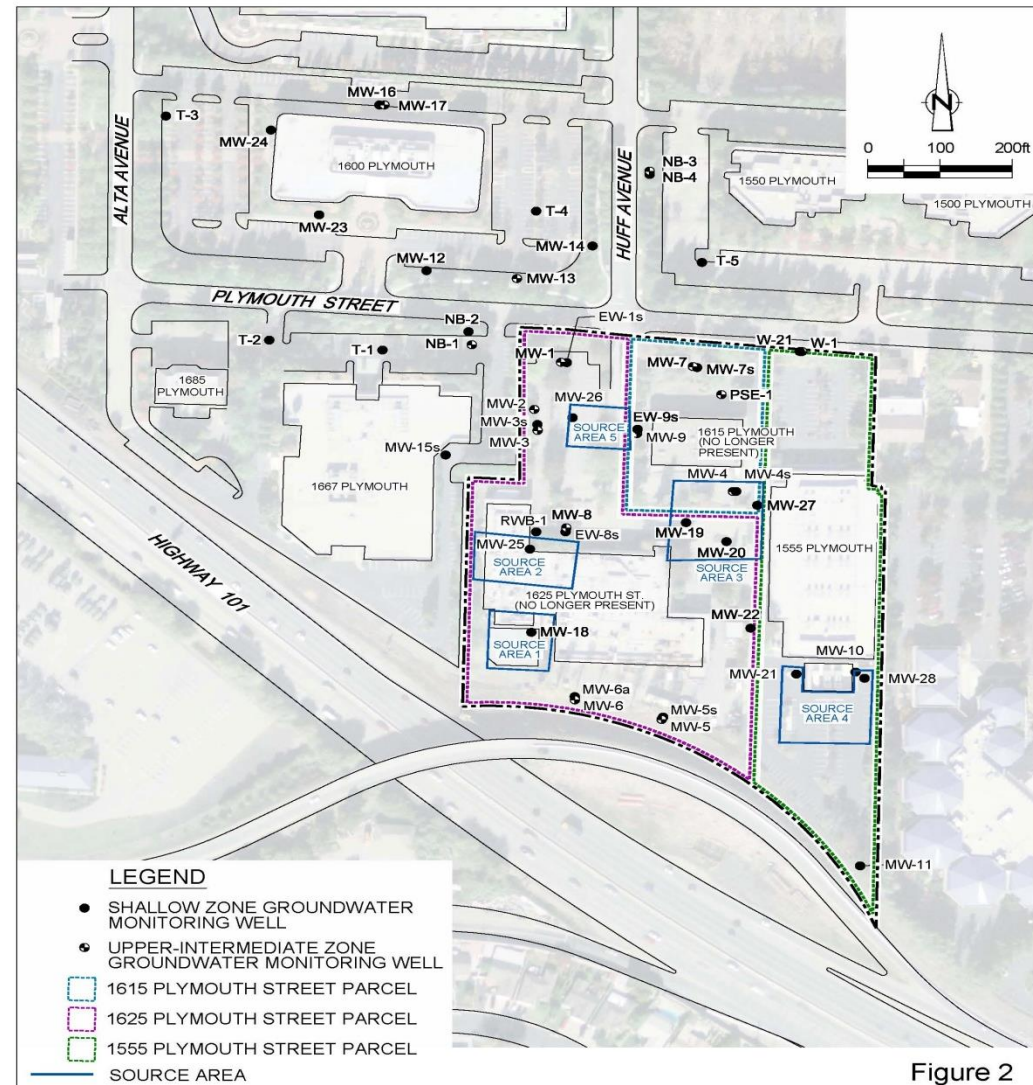
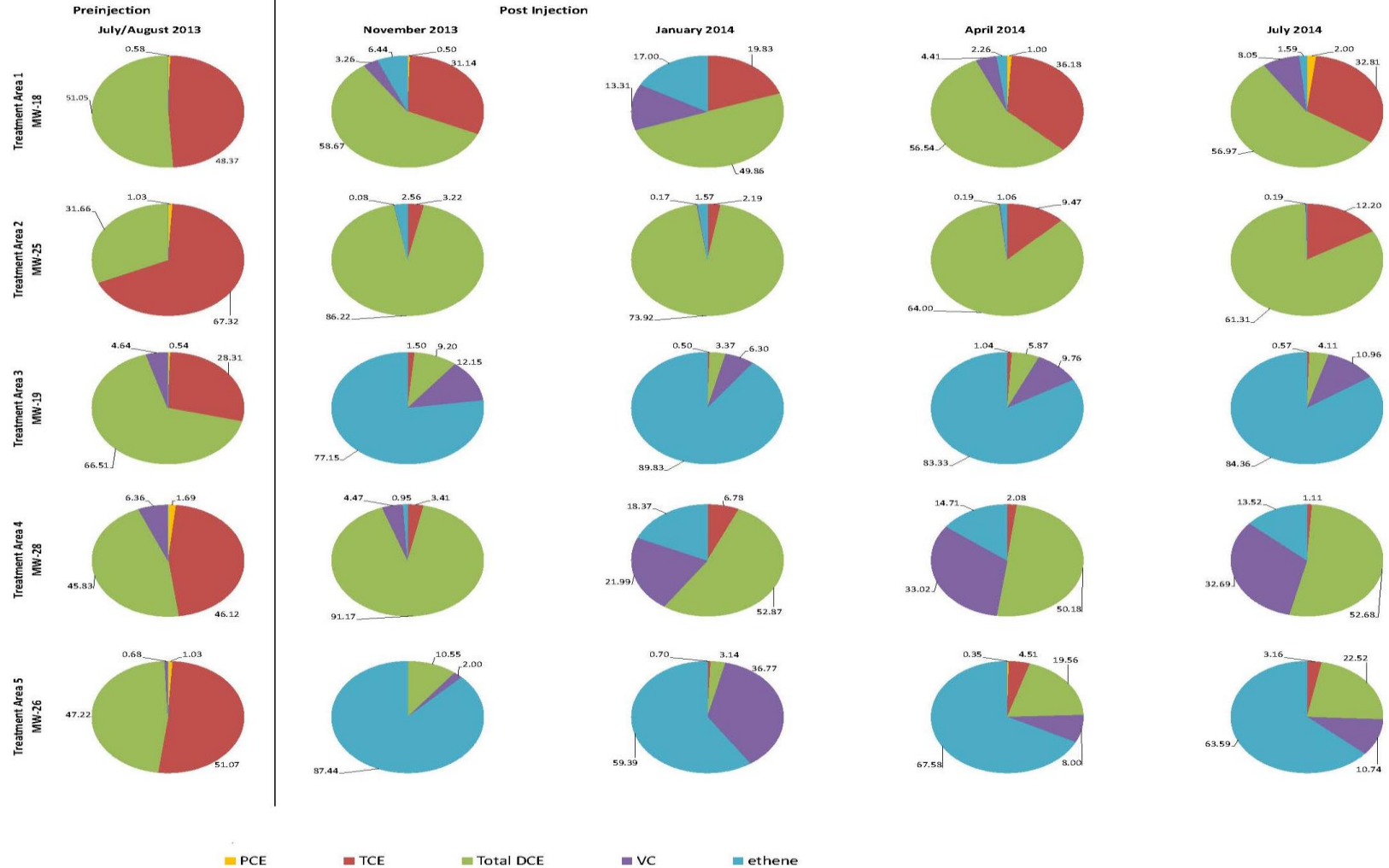


Figure 2

Results



Results

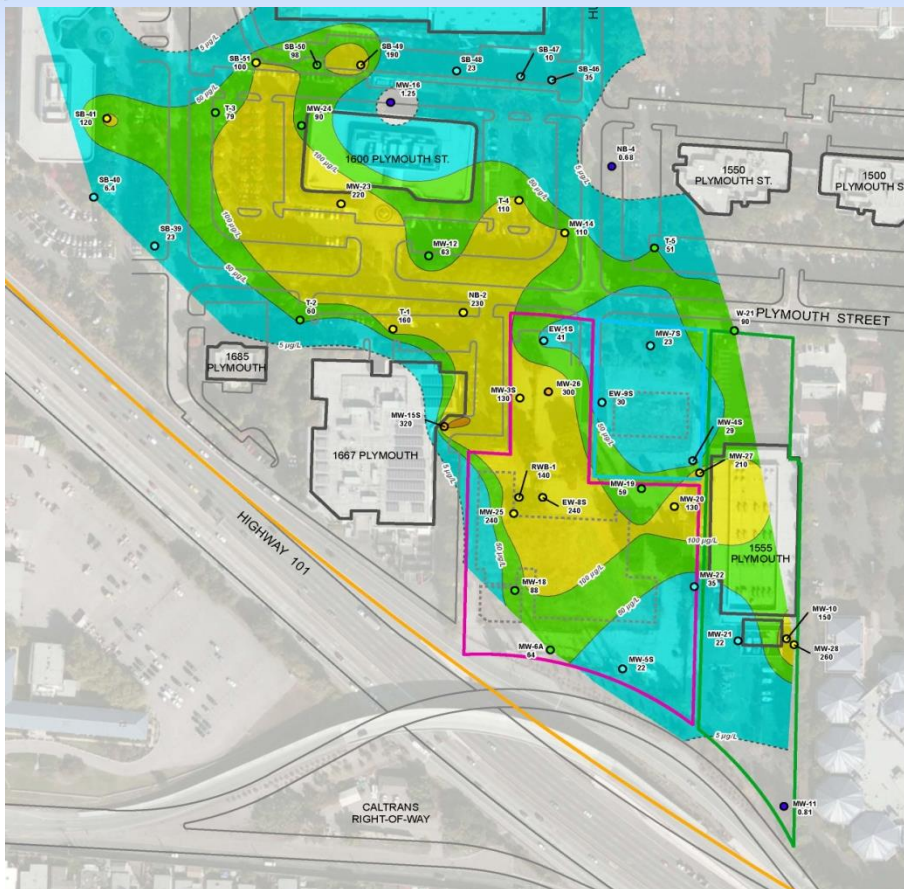


Figure 10

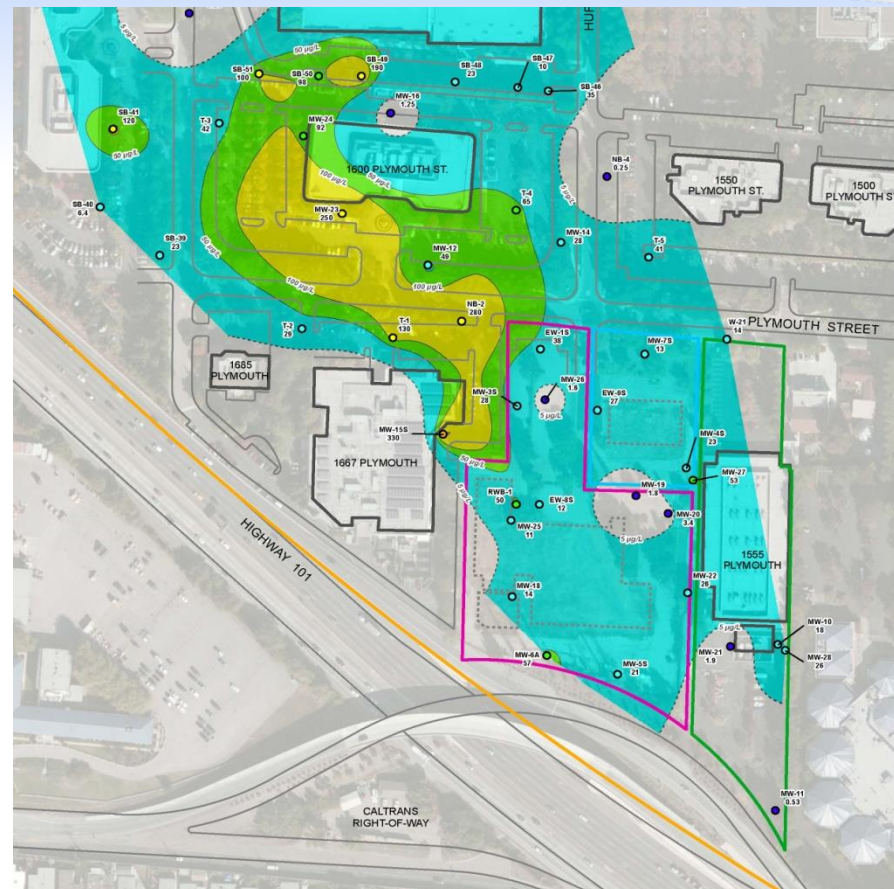


Figure 16

1 StatePlane California III FIPS 0403 Feet, Aerial Image Source: ESRI Imagery Service, accessed May 15, 2014.

nd
 NORTH BAYSHORE AREA (NBA)
 1615 PLYMOUTH STREET PARCEL
 1625 PLYMOUTH STREET PARCEL
 1555 PLYMOUTH STREET PARCEL
 EXISTING BUILDING
 PREVIOUS BUILDING

µg/L
 > 500
 300 - 500
 100 - 300
 50 - 100
 5 - 50
 < 5

PLUME EXTENT AT 5 MICROGRAMS PER LITER

NOTES:
 1. MAXIMUM RESULT AT LOCATION
 2. CONTOUR LINES DOTTED WHERE INFERRED.

GROUNDWATER ISO-CONCENTRATION CONTOURS FOR TRICHLOROETHENE PRE-REMEDIATION UNION PACIFIC RAILROAD COMPANY PLYMOUTH STREET SITE Mountain View, California

GW_TCE_v01_Pre-Remediation_Jan2009-Jul2013 May 15, 2014

1 StatePlane California III FIPS 0403 Feet, Aerial Image Source: ESRI Imagery Service, accessed May 16, 2014.

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 NORTH BAYSHORE AREA (NBA)
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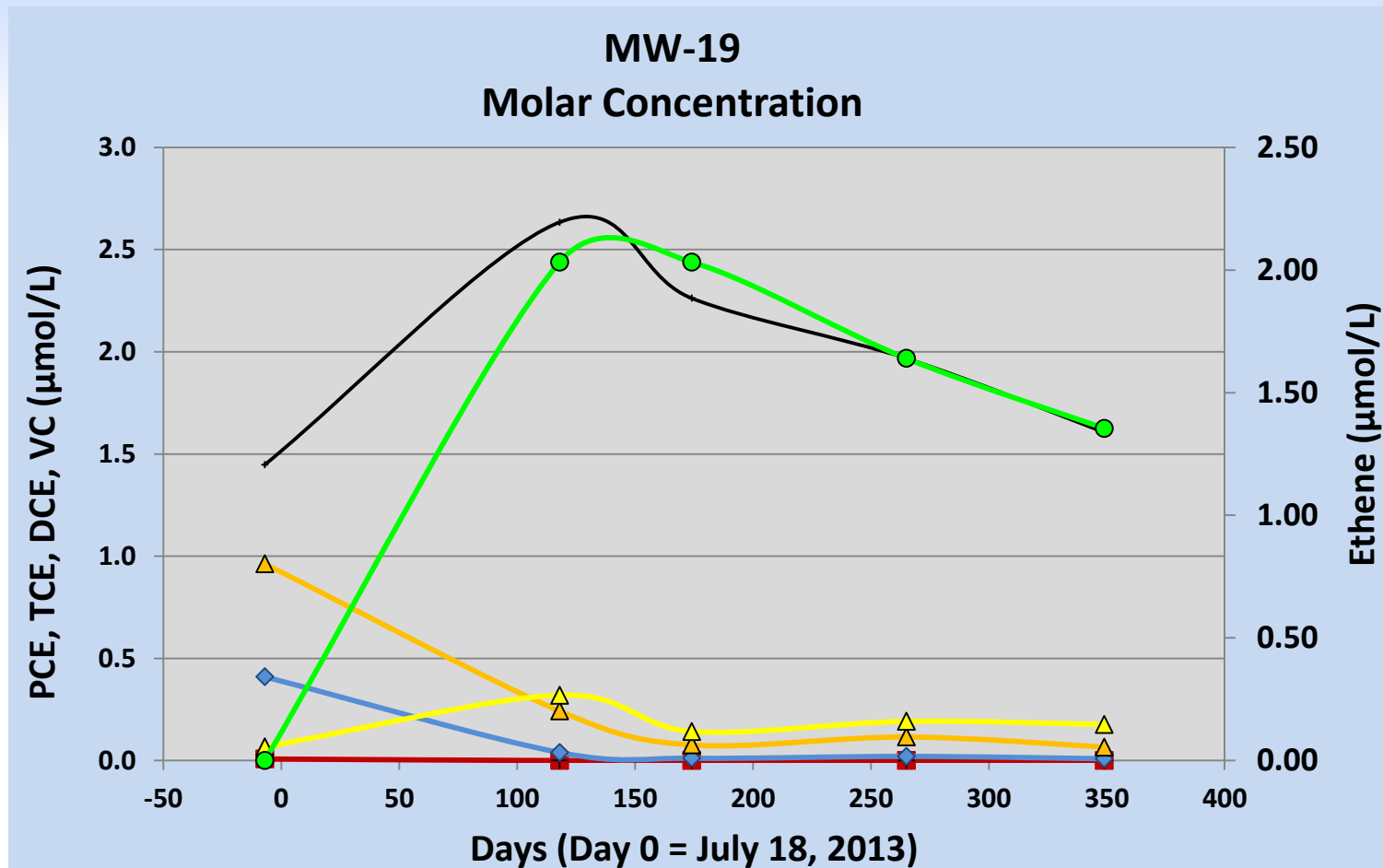
PLUME EXTENT AT 5 MICROGRAMS PER LITER

NOTES:
 1. MAXIMUM RESULT AT LOCATION
 2. CONTOUR LINES DOTTED WHERE INFERRED.

GROUNDWATER ISO-CONCENTRATION CONTOURS FOR TRICHLOROETHENE POST-REMEDIATION UNION PACIFIC RAILROAD COMPANY PLYMOUTH STREET SITE Mountain View, California

GW_TCE_v02_Post-Remediation_Jan2014 May 16, 2014

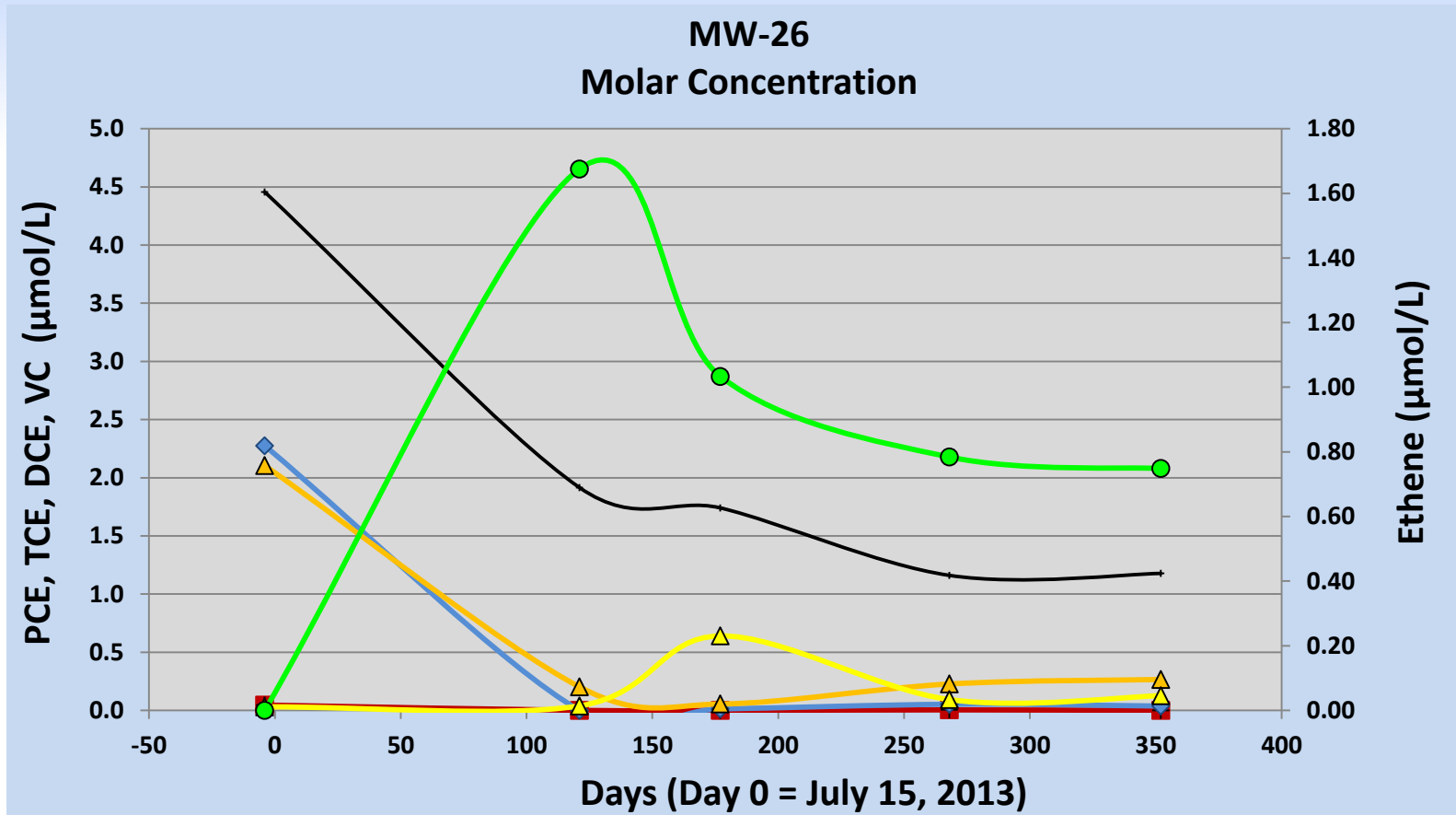
Results



■ PCE ◆ TCE ▲ Total DCE ▲ VC — Total ● ethene



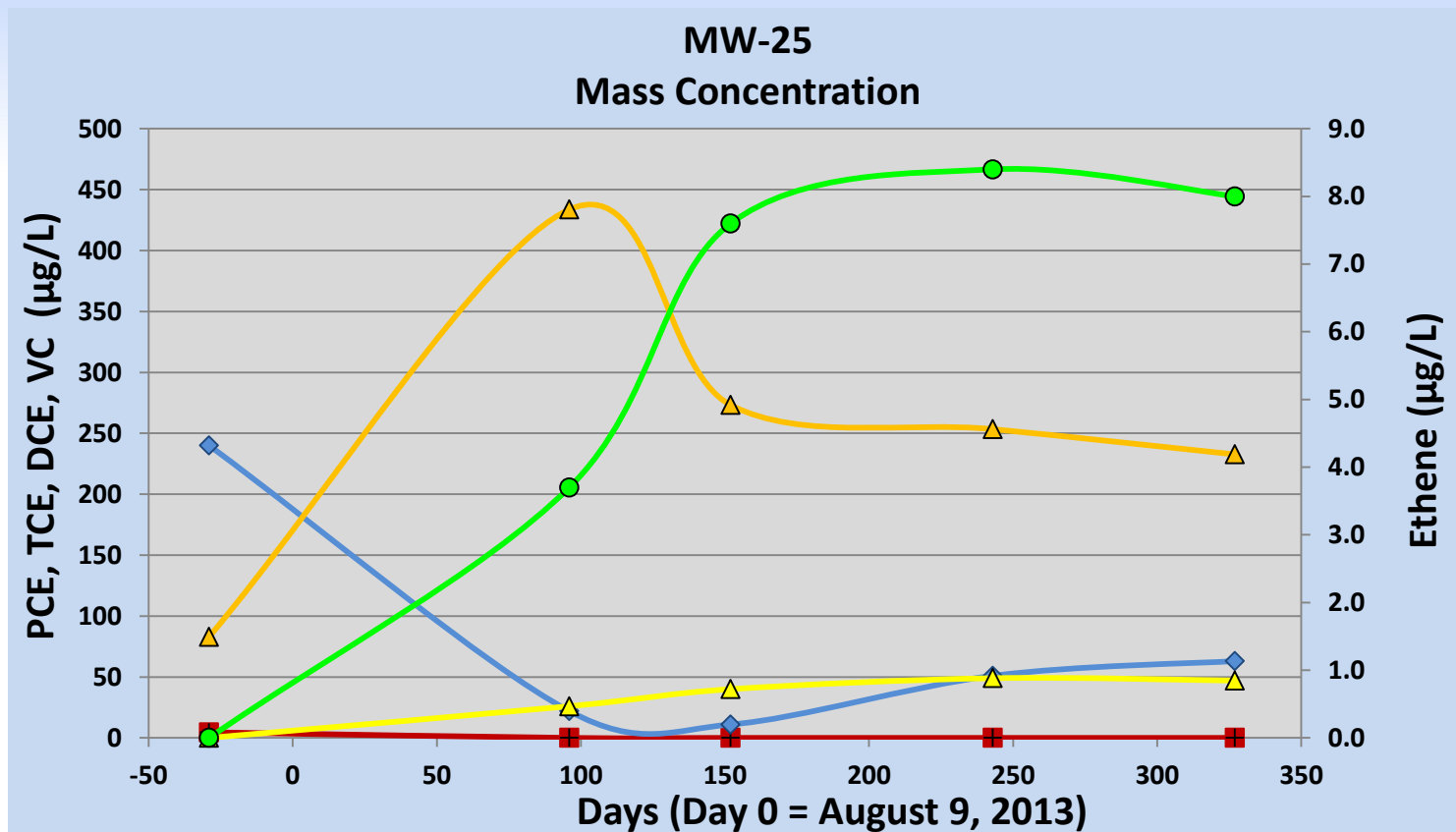
Results



■ PCE ◆ TCE ▲ Total DCE ▲ VC — Total ● ethene



Results



■ PCE ◆ TCE ▲ Total DCE ▲ VC — Total ● ethene

Conclusions

- A 75 to 99 % reduction in TCE concentrations
- Transient increases in cis-1,2-DCE and vinyl chloride
- Presence of ethene in all five treatment areas indicates complete reductive dechlorination
- Strong reducing conditions with sulfate reduction and methane production
- EHC and bioaugmentation were found to be effective for site-specific treatment of TCE



Subsidiary Challenges

- Property redevelopment
- Methane vapor intrusion

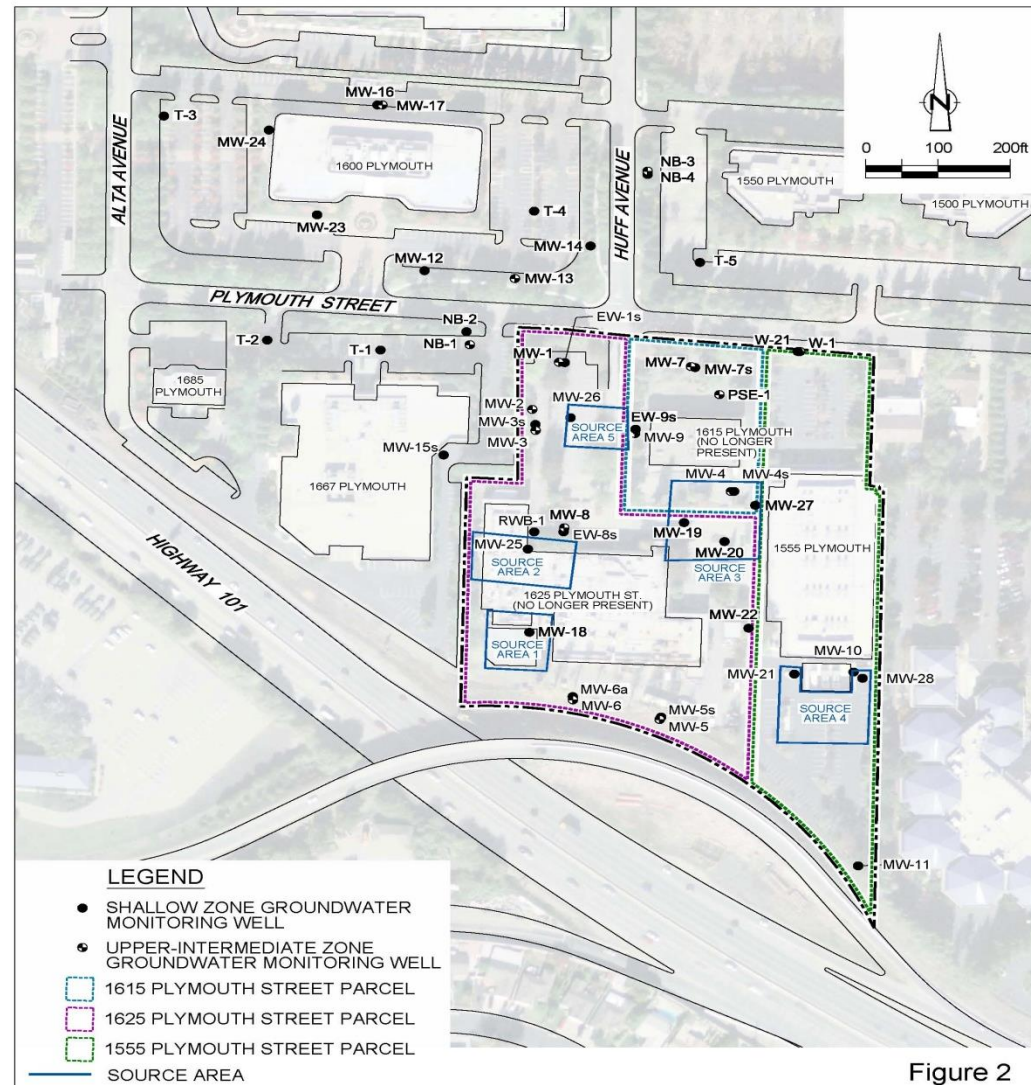


Figure 2

Future Actions

- Continue groundwater monitoring and treatment evaluation
- Continue to evaluate vapor intrusion risk from methane
- Potential additional injections



Questions

