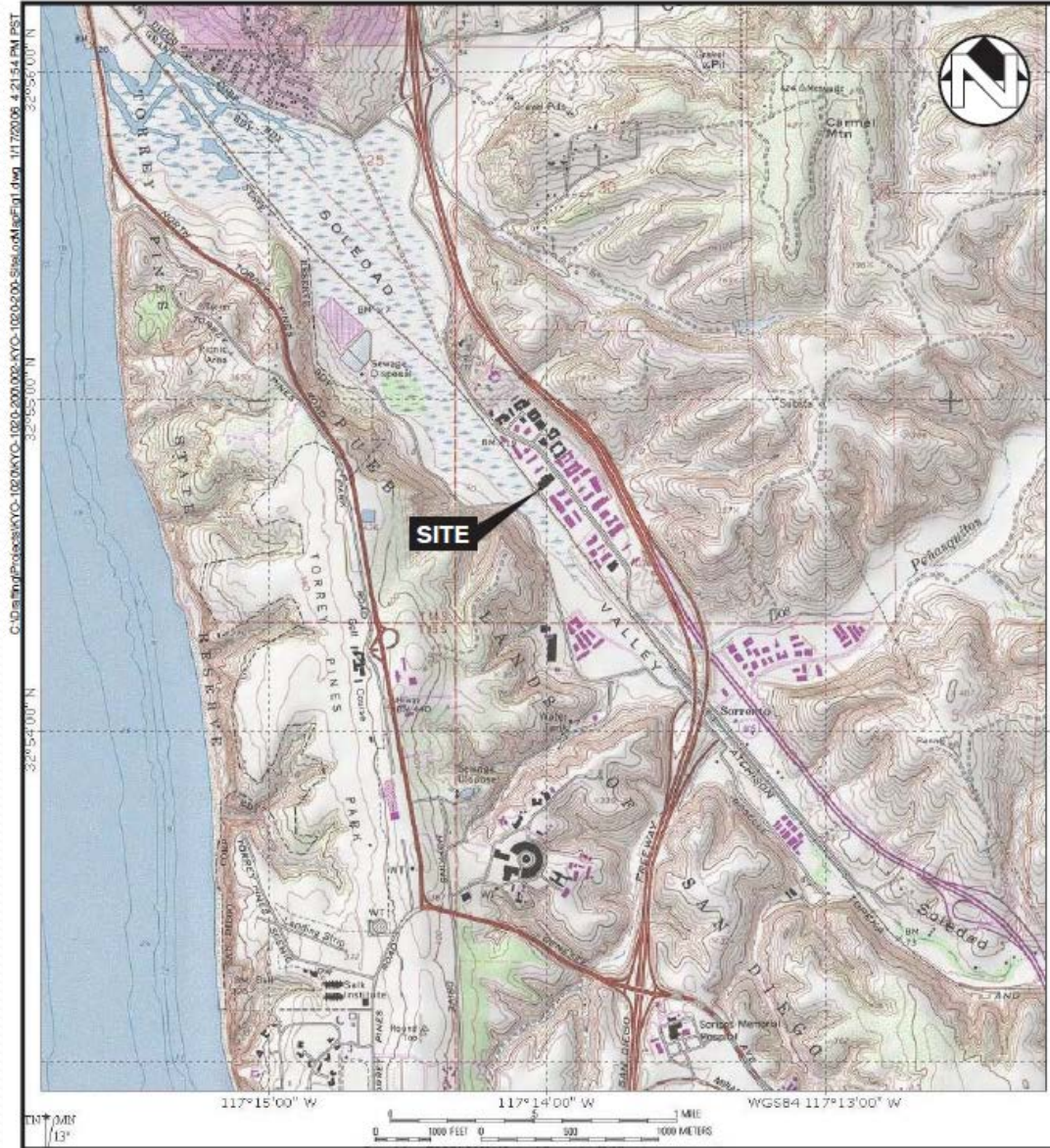




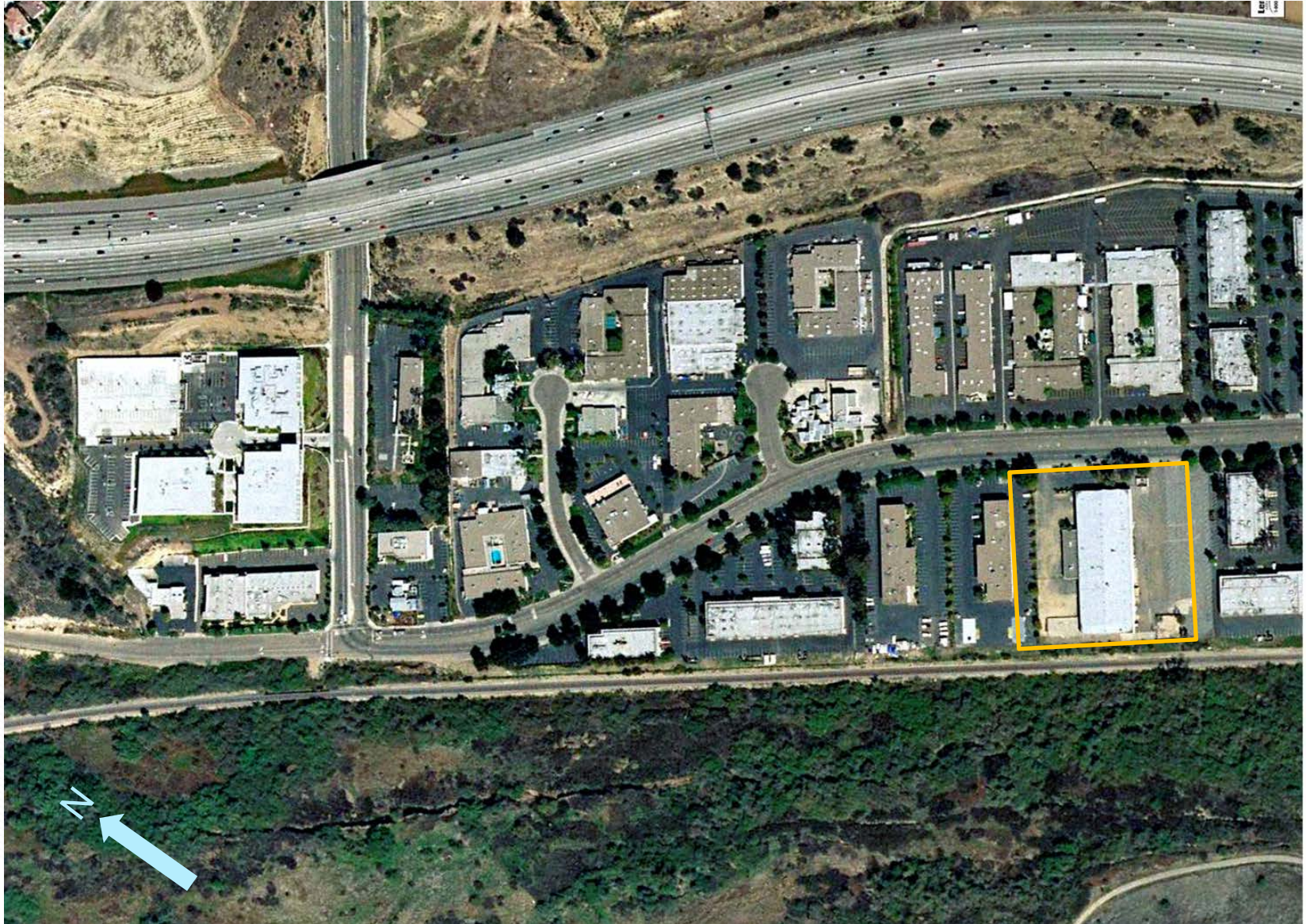
Sorrento Valley Site Electrical Resistance Heating (ERH) Remediation Overview

October 18, 2016

Site Location



Aerial Photo



Site History

- Ceramic capacitor manufacturing 1963-1986
- Vacant from 1986 until 1990
- Property remodeled and leased to a printing company in 1990
- Property sold to redevelopment group in 2004
 - Back portion of the building was demolished
 - Leased to US Army as a training facility
- Property sold in 2006 (leased to US Army as training facility)
- Property sold in 2012 (leased to US Army as training facility)

11698

 MW-BMW.28 MVA-5MVA-29 NV-17R

$\text{MW} \cdot \text{EB} \cdot \text{B}$
 $\text{MW} \cdot 2 \cdot \text{PV}$

FORMER
DRUM STORAGE

 NV7

© MVA-1

MVA-30 20

5950

NW-25

Min 4.20

2000

← DRAINAGE

NPA-11 ■

10-1001-08-01 01-01-0000

MVA-9

MV-10

■ MVV-12

 MW-14

• **MTW-16**

MAN-15

WETLAND AREA

0 50 100 FEET
APPROXIMATE SCALE

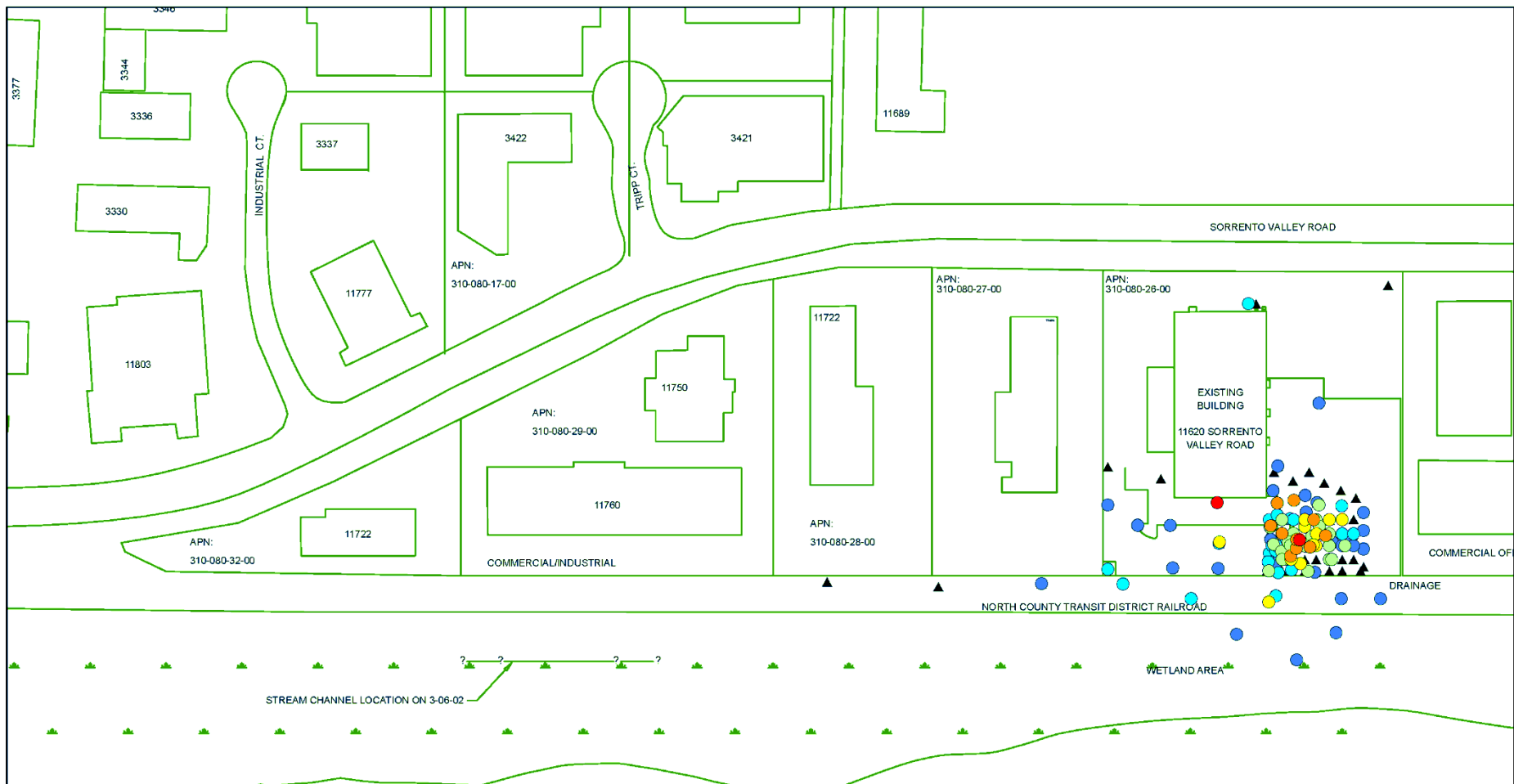






NO
PARKING

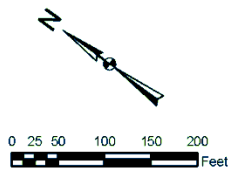


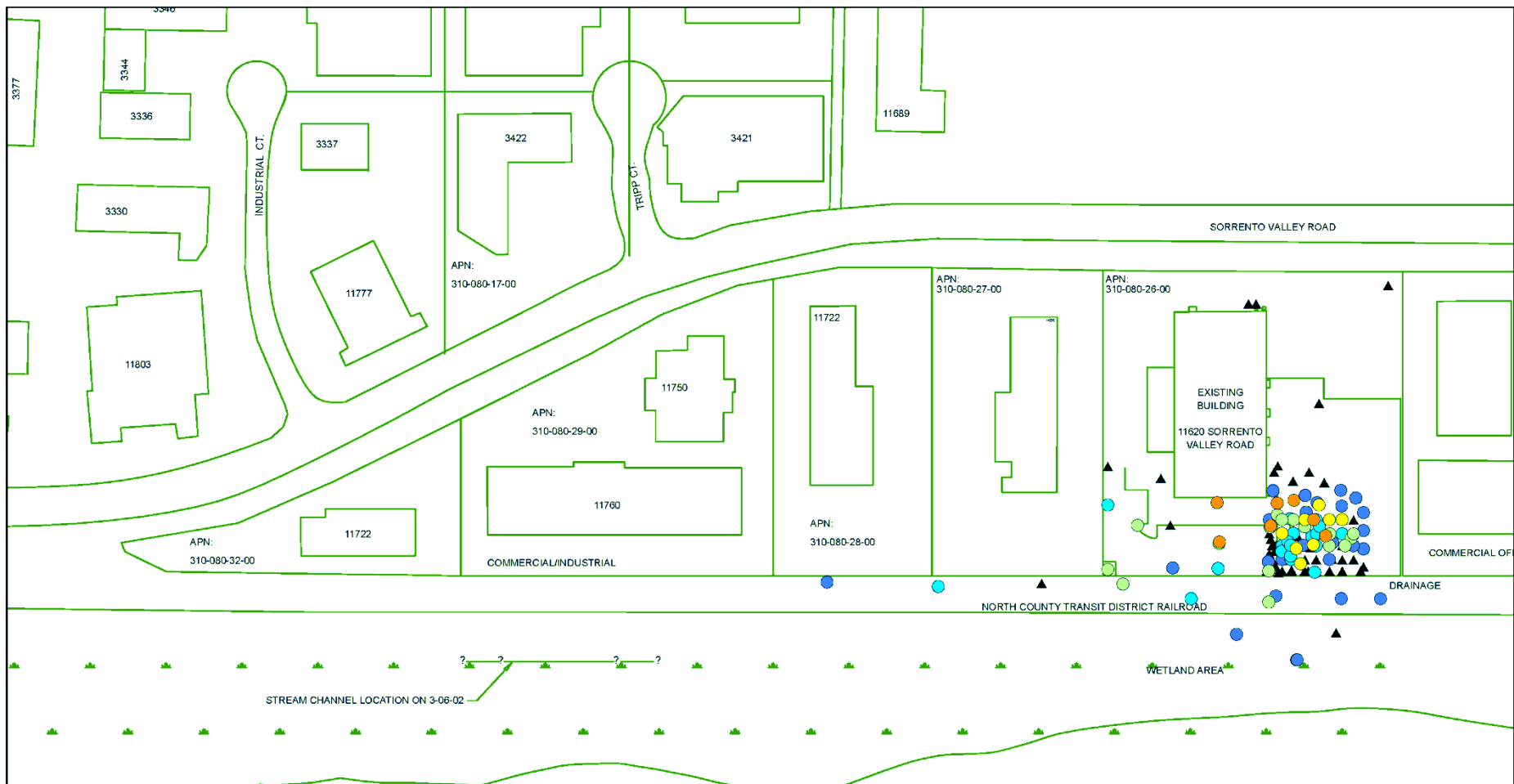


1,1,1-TCA in Soil (all depths)

RESULT

- ▲ Non-detect
- 0-1 mg/kg
- 1-10 mg/kg
- 10-100 mg/kg
- 100 - 1,000 mg/kg
- 1,000 - 10,000 mg/kg
- > 10,000 mg/kg

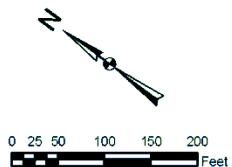




TCE in Soil (all depths)

RESULT

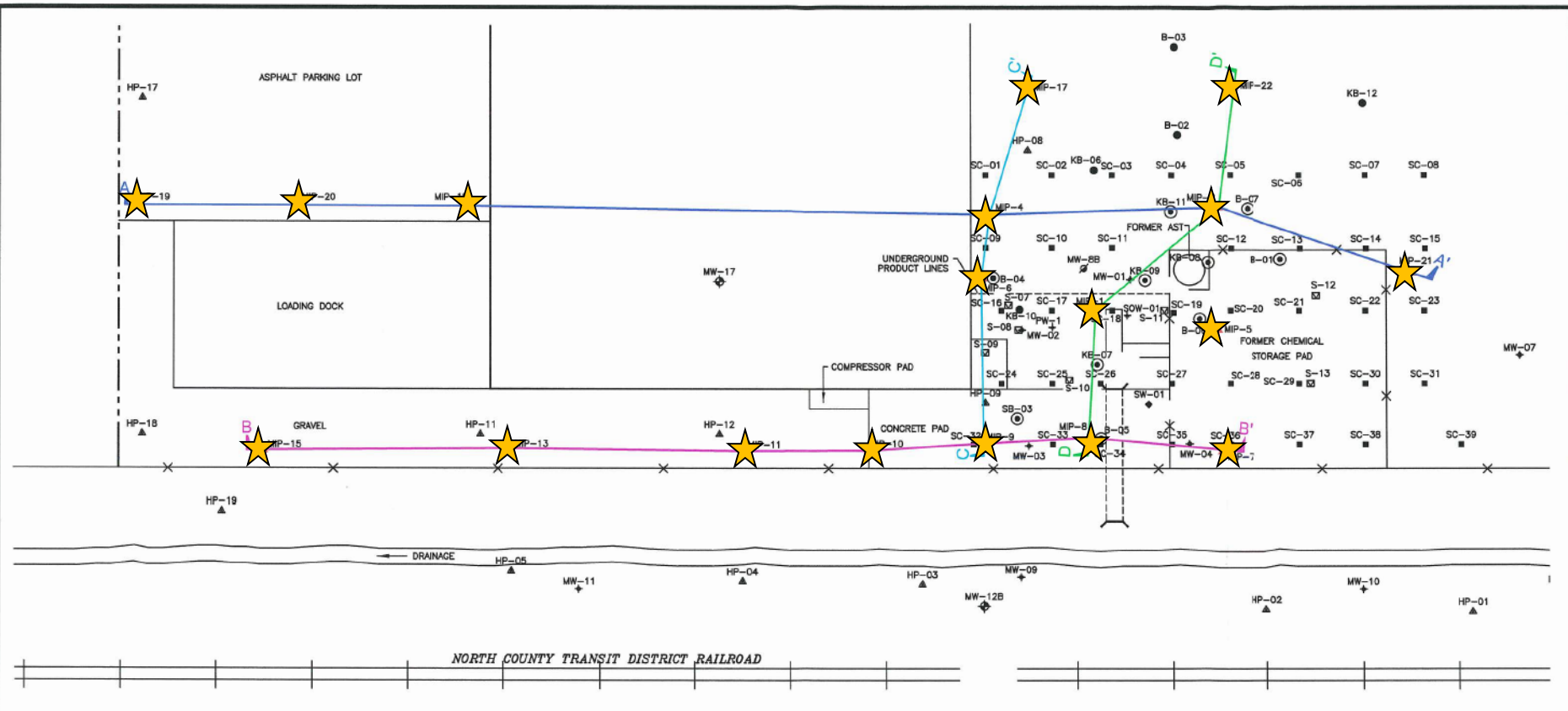
- ▲ Non-detect
- 0-1 mg/kg
- 1-10 mg/kg
- 10-100 mg/kg
- 100 - 1,000 mg/kg
- 1,000 - 10,000 mg/kg
- > 10,000 mg/kg



Investigations, Feasibility Studies, and Pilot Tests

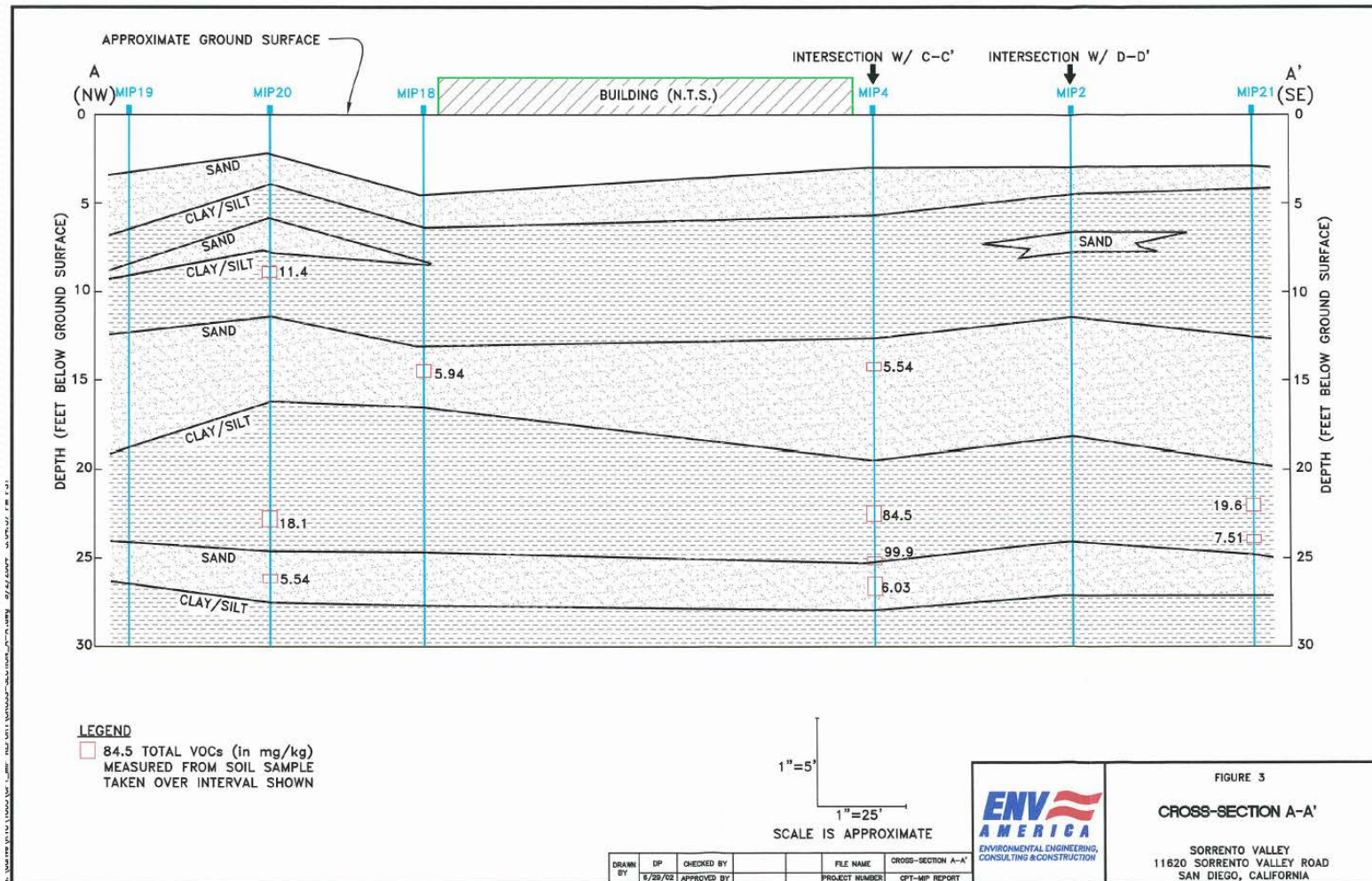
Delineation Investigations

- CPT-MIP Soil Investigation(ENV, 2004)
 - 18 soil borings to better delineate site lithology and map extent of VOCs
 - CPT borings used with Membrane Interface Probe (MIP)



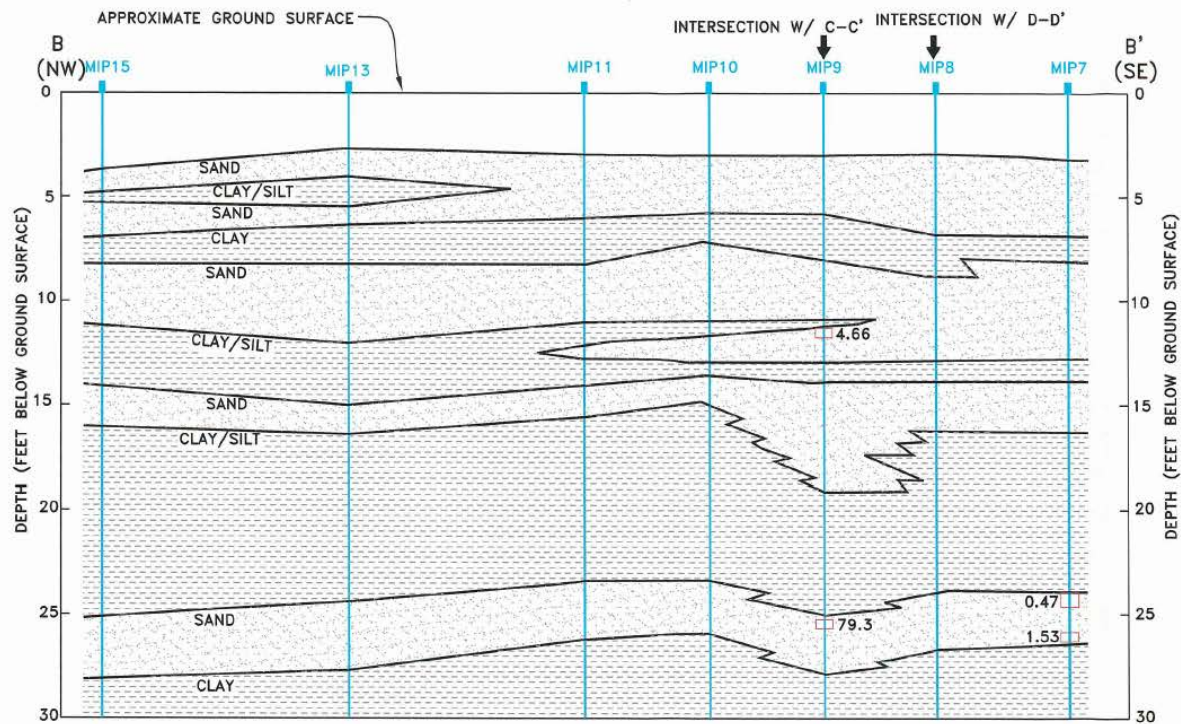
Investigations, Feasibility Studies, and Pilot Tests CPT

Investigation Results, X-section A-A'



Investigations, Feasibility Studies, and Pilot Tests CPT

Investigation Results, X-section B-B'



LEGEND

- 79.3 TOTAL VOCs (in mg/kg) MEASURED FROM SOIL SAMPLE TAKEN OVER INTERVAL SHOWN

1"=5'

1"=25'

SCALE IS APPROXIMATE



FIGURE 4

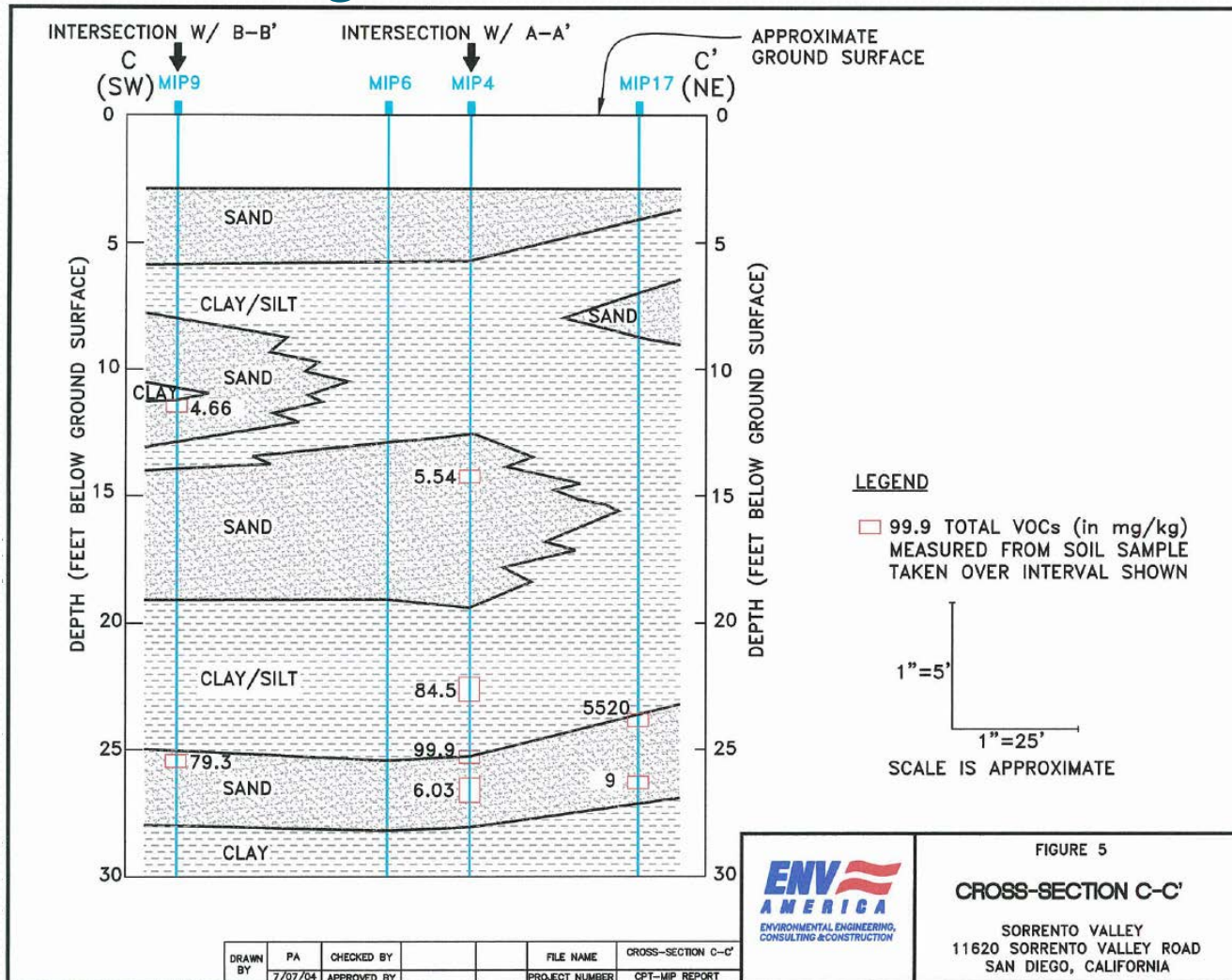
CROSS-SECTION B-B'

SORRENTO VALLEY
11620 SORRENTO VALLEY ROAD
SAN DIEGO, CALIFORNIA

DRAWN BY	DP	CHECKED BY	FILE NAME	CROSS-SECTION B-B'
6/23/02	APPROVED BY	PROJECT NUMBER	CPT-MIP-REPORT	

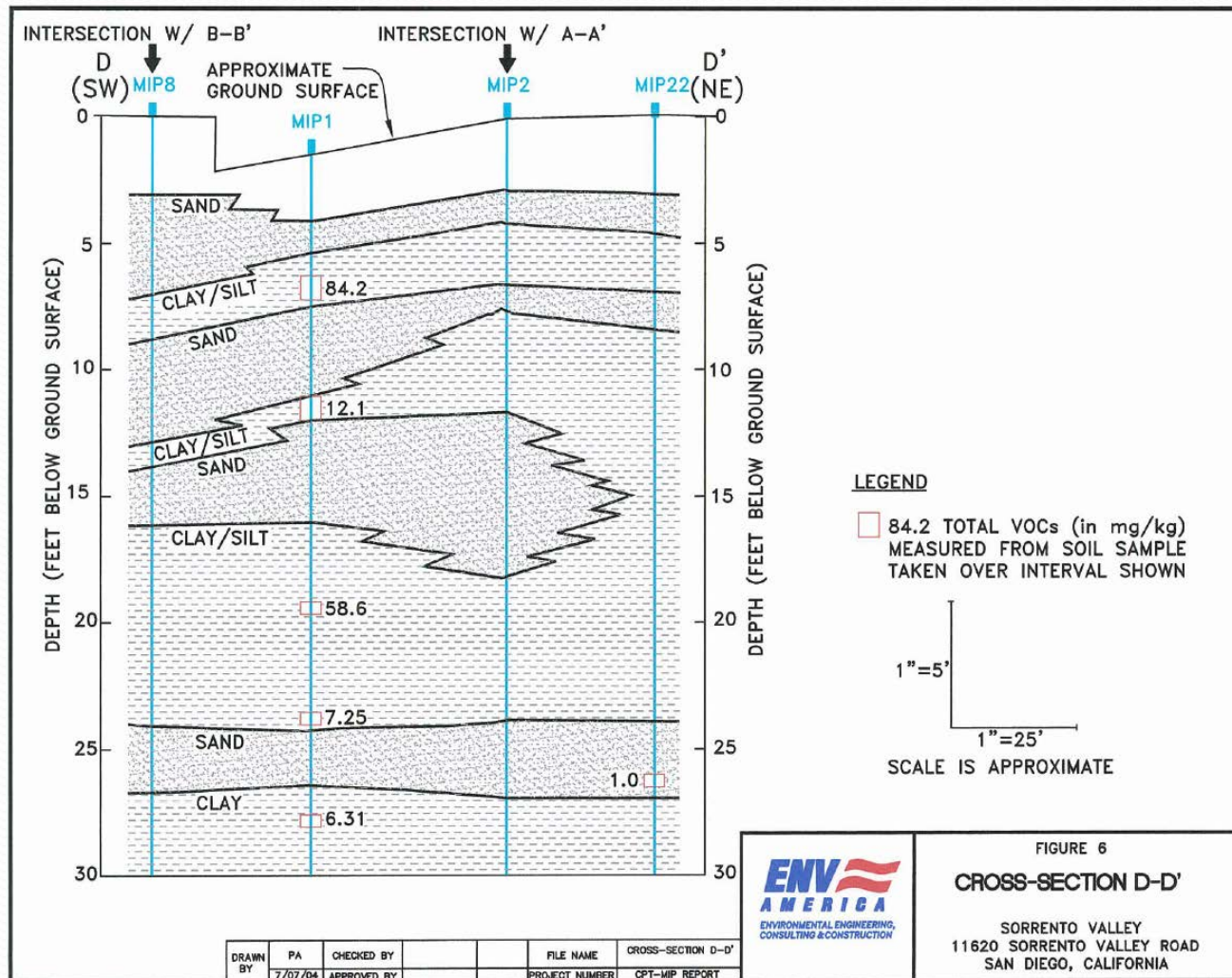
Investigations, Feasibility Studies, and Pilot Tests CPT

Investigation Results, X-section C-C'

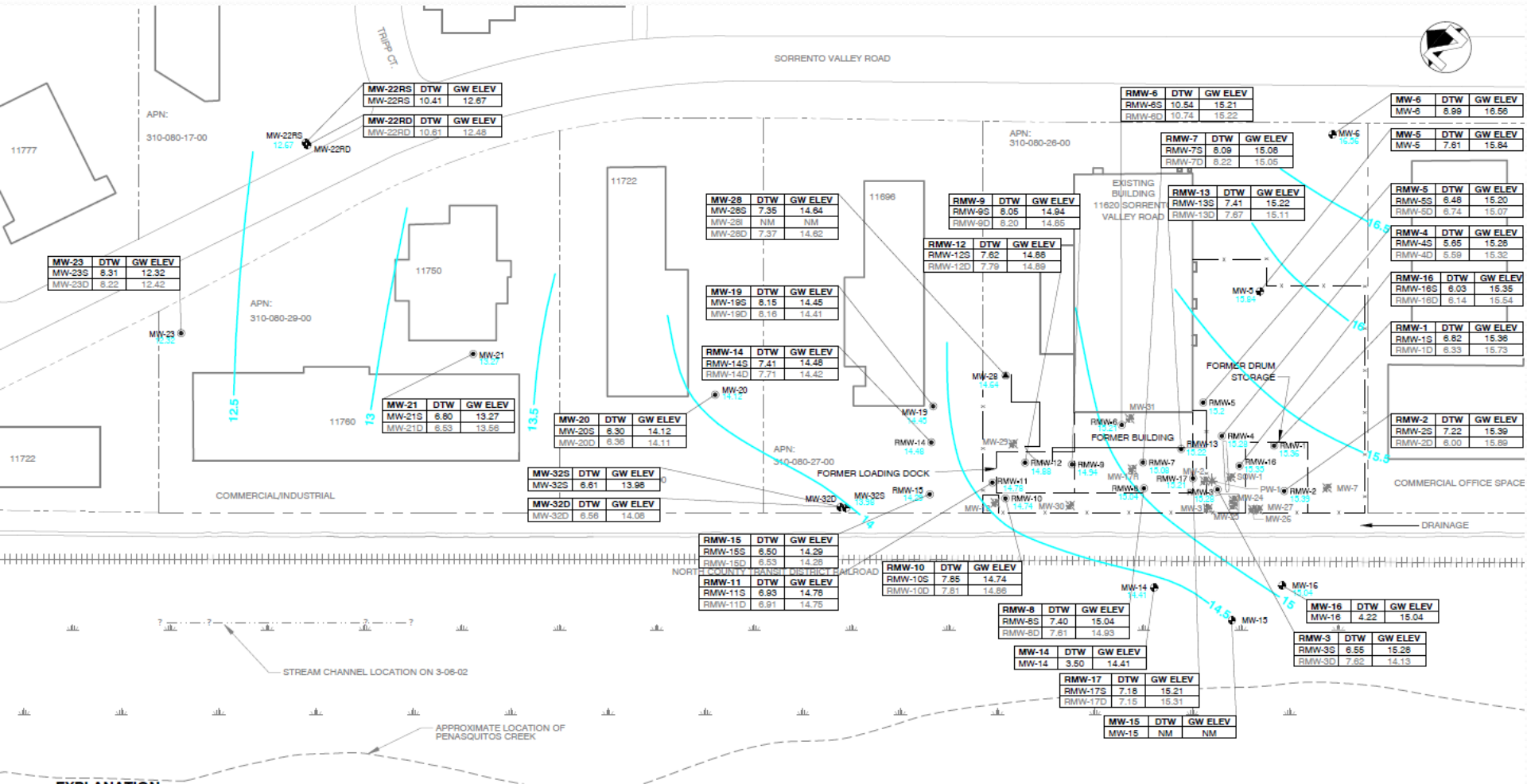


Investigations, Feasibility Studies, and Pilot Tests

CPT Investigation Results, X-section D-D'



Shallow Zone Groundwater Elevations



EXPLANATION

- SINGLE COMPLETION MONITORING WELL
- DOUBLE COMPLETION MONITORING WELL
- TRIPLE COMPLETION MONITORING WELL
- ABANDONED RECOVERY WELL
- ABANDONED MONITORING WELL
- 13.32 — GROUNDWATER ELEVATION IN FEET ABOVE ASSUMED MEAN SEA LEVEL (AMSL)
- 13.5 — GROUNDWATER ELEVATION CONTOUR IN FEET AMSL, DASHED WHERE INFERRED

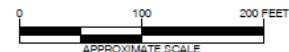
- WELL ID, S INDICATES SHALLOW, I INDICATES INTERMEDIATE, D INDICATES DEEP
- DEPTH TO GROUNDWATER MEASURED IN FEET FROM TOP OF CASING
- GROUNDWATER ELEVATION IN FEET ABOVE ASSUMED MEAN SEA LEVEL, NM INDICATES NOT MEASURED

NOTE:
GROUNDWATER GAUGED ON OCTOBER 1, 2014.

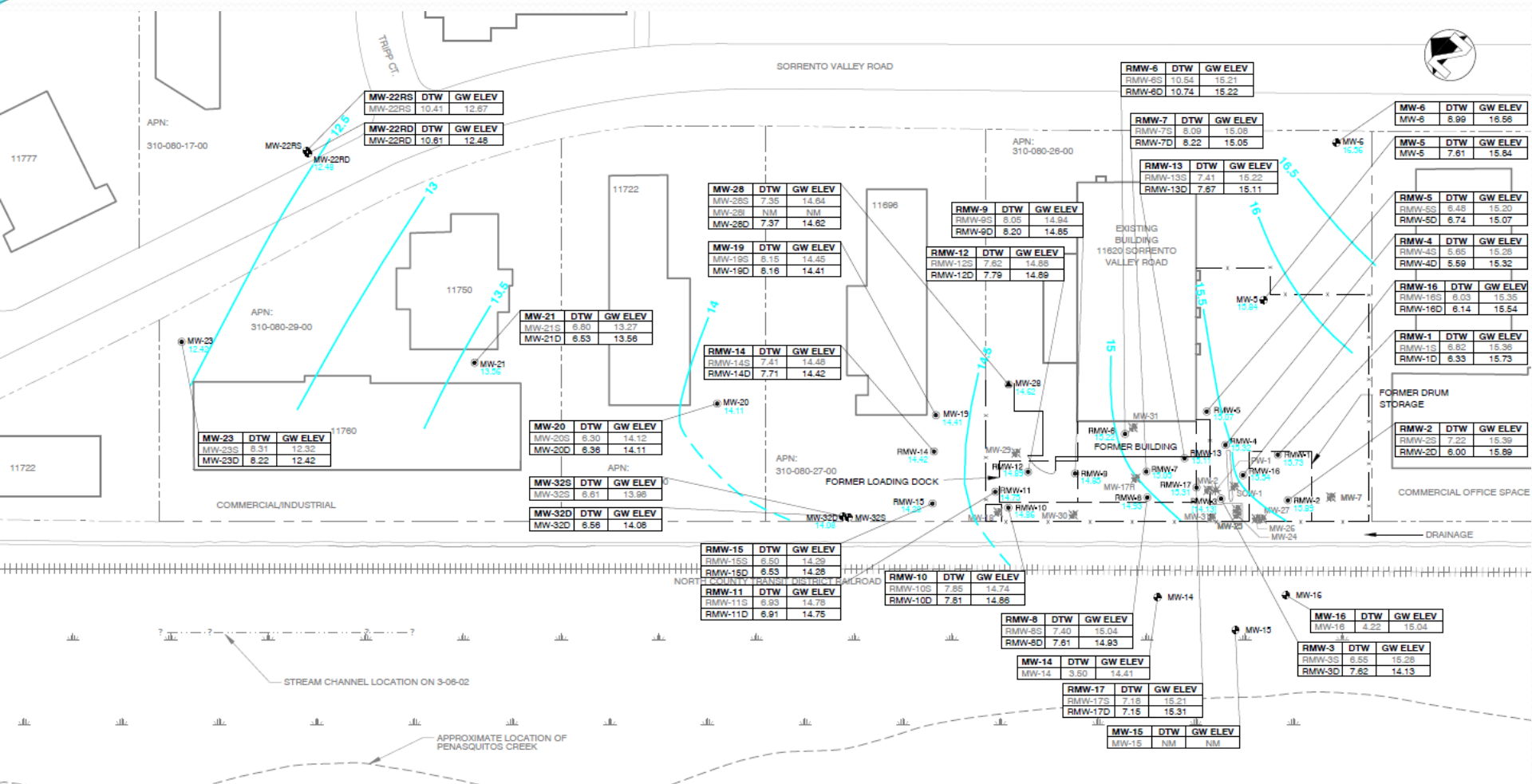
FIGURE 4
GROUNDWATER ELEVATION
CONTOUR MAP - SHALLOW ZONE
OCTOBER 2014

11620 SORRENTO VALLEY ROAD
SAN DIEGO, CALIFORNIA

TERRA PACIFIC GROUP
Environmental Engineering, Consulting, and Construction



Deep Zone Groundwater Elevations



EXPLANATION

- | | |
|---|-----------------------------------|
|  | SINGLE COMPLETION MONITORING WELL |
|  | DOUBLE COMPLETION MONITORING WELL |
|  | TRIPLE COMPLETION MONITORING WELL |
|  | ABANDONED RECOVERY WELL |
|  | ABANDONED MONITORING WELL |

- 13.59 GROUNDWATER ELEVATION IN FEET
ABOVE ASSUMED MEAN SEA LEVEL (AMSL)
- 5.5 — GROUNDWATER ELEVATION CONTOUR IN
FEET AMSL, DASHED WHERE INFERRED

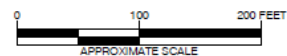
- WELL ID, S INDICATES SHALLOW,
I INDICATES INTERMEDIATE, D INDICATES DEEP
- DEPTH TO GROUNDWATER MEASURED
IN FEET FROM TOP OF CASING
- | MW-20 | DTW | GW ELEV |
|--------|------|---------|
| MW-20S | 8.30 | 14.12 |
| MW-20D | 8.38 | 14.11 |
- GROUNDWATER ELEVATION IN FEET
ABOVE ASSUMED MEAN SEA LEVEL,
NM INDICATES NOT MEASURED.

NOTES:
GROUNDWATER GAUGED ON OCTOBER 1, 2014.
[14.13] DATA NOT USED IN CONTOURING

FIGURE 5
GROUNDWATER ELEVATION
CONTOUR MAP - DEEP ZONE
OCTOBER 2014

11620 SORRENTO VALLEY ROAD
SAN DIEGO, CALIFORNIA

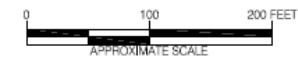
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Environmental Engineering, Consulting, and Construction



100-



TERRA PACIFIC GROUP
Environmental Engineering, Consulting, and Construction





- | MW-20 | DATE | TOTAL VOCs |
|--------|---------|------------|
| MW-20S | 9/30/10 | 7,971 |
| MW-20D | 9/30/10 | 14,679 |

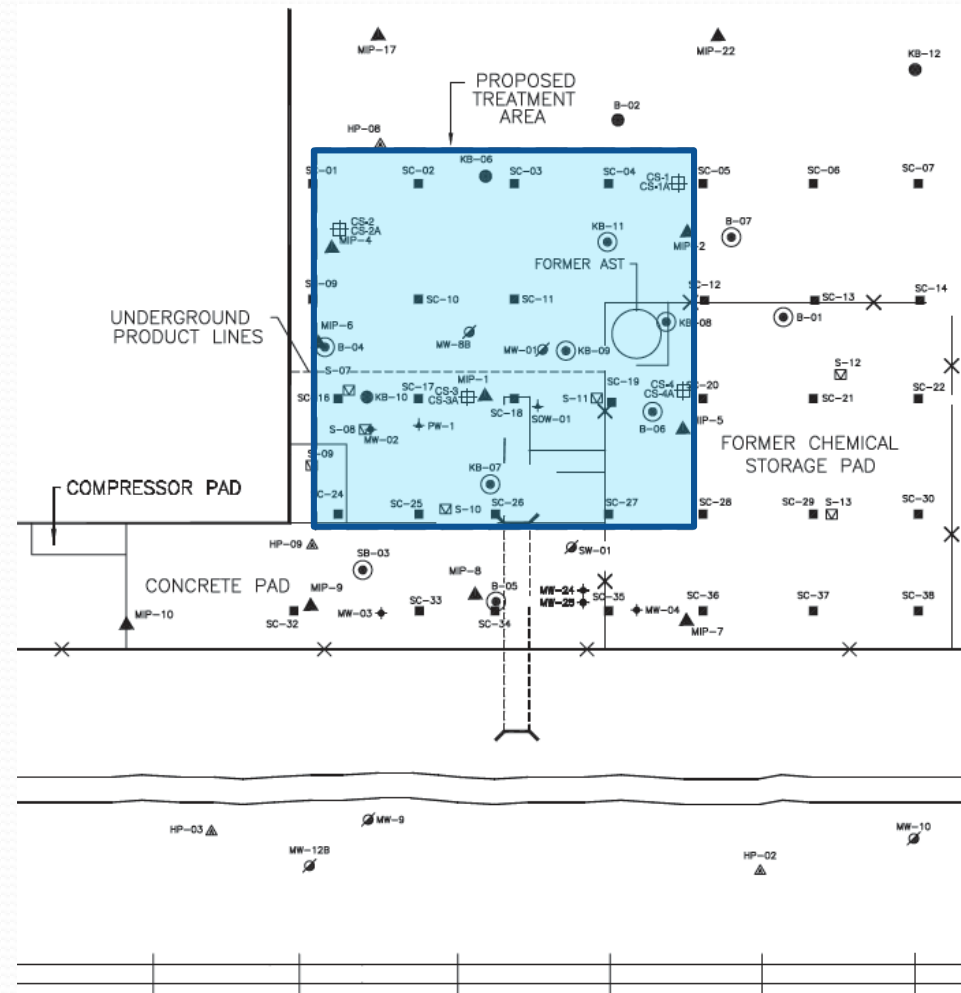
TERRA PACIFIC GROUP
Environmental Engineering, Consulting, and Construction



- 
- **Groundwater at the Site has been exempted from beneficial uses (California basin 906.10)**
 - **Site is located in the Penasquitos Hydrologic Unit (6.00), Miramar Reservoir Hydrologic Area (HA 6.10), west of the I-5**
 - **Page 2-65 of the Basin Plan indicates that beneficial uses do not apply westerly of the easterly boundary of the right-of-way of I-5 in HA 6.10 and this area is “exempted from the sources of drinking water policy”.**

In-Situ Chemical Oxidation Pilot Test

- Pilot Scale Test 2005
 - Isotec performed Pilot Study
 - 60 ft. x 60 ft. area
 - 48 direct push injection locations
 - 4 injection events during March through May 2005
 - Injection volumes ranged from 0 to 200 gallons per location
 - Surfacing of reagents
 - Rounds 1 and 2 – Modified Fenton's reagent
 - Round 3 and 4 – Modified Fenton's reagent, sodium persulfate, oxidizer, and catalyst



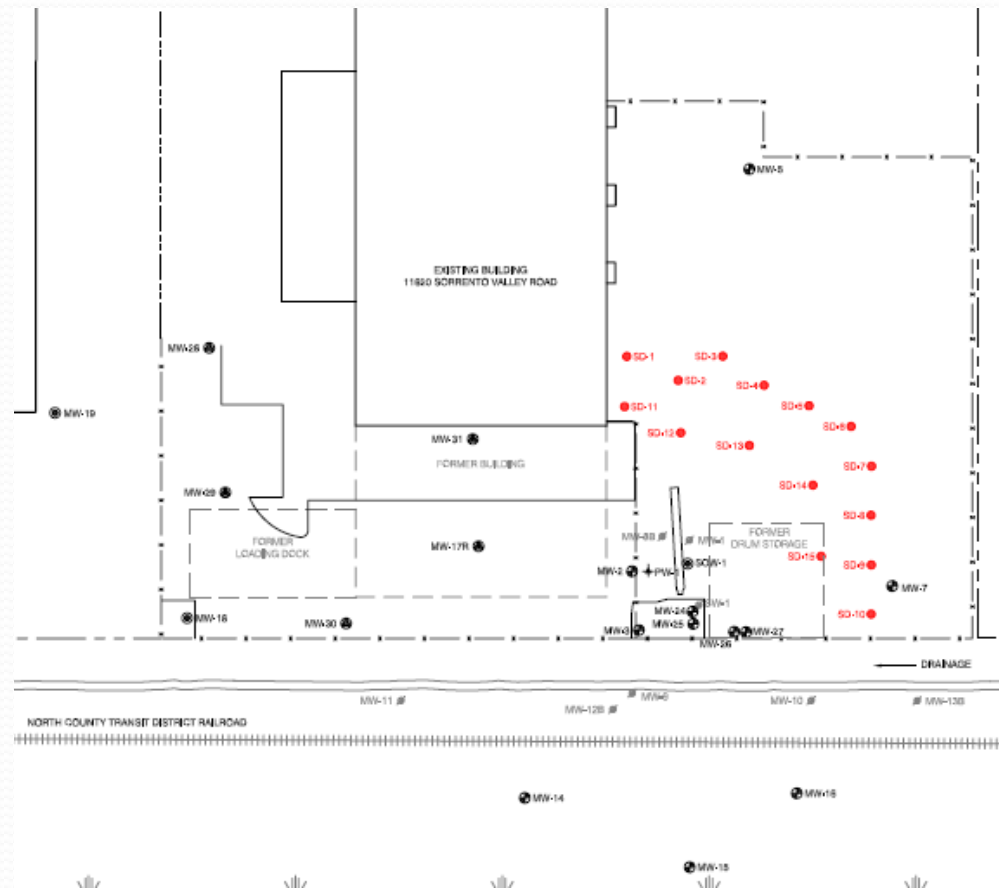
In-Situ Chemical Oxidation Pilot Test

- Pilot Scale Test 2005 results:
 - Partial treatment accomplished
 - Surfacing due to prior investigation activities and reactive nature of modified Fenton's reagent
 - Resealing required for boreholes from prior investigations
 - Limited ability to inject into finer grained sediments – silts and clays
- **Technology determined to be not feasible for Site conditions**

Investigations, Feasibility Studies, and Pilot Tests

Delineation Investigations - continued

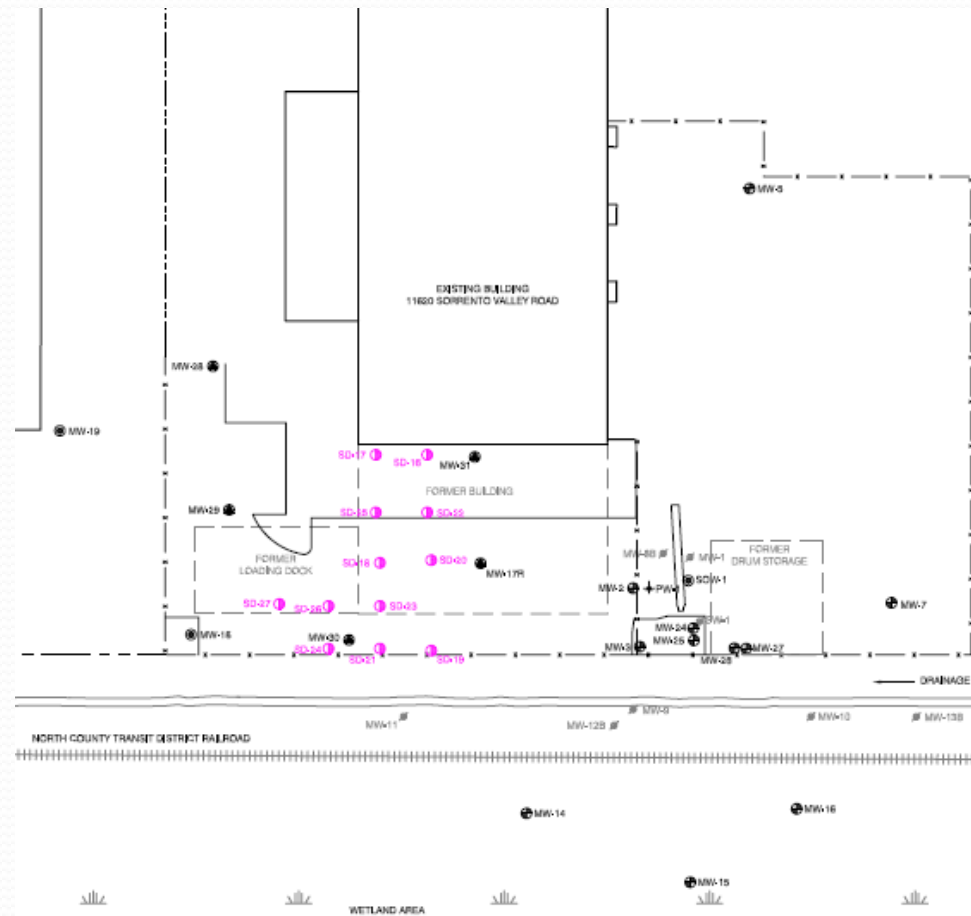
- Source Area Delineation Field Investigation (TPG, 2006)
 - Investigation conducted to delineate upgradient extent of impacts
 - 15 soil borings were drilled with detailed evaluation of lithology and screening for VOCs
 - 60 soil samples collected
 - 43 groundwater samples collected
 - **Investigation successfully delineated upgradient and east of the former drum storage area**



Investigations, Feasibility Studies, and Pilot Tests

Delineation Investigations - continued

- Pre-Design Investigation, 2007
 - Delineate downgradient extent of source area
 - 12 soil borings - detailed evaluation of lithology and screening for VOCs
 - 1 dual completion MW installed on adjacent property
 - 43 soil samples collected
 - Field screening tests for NAPL
 - **Successfully delineated downgradient source area and used to define treatment area**





Example of positive DNAPL screening test – center vial positive, others negative

Location of sample collected from SD-21 at 25.5 feet –
note that there is no visual evidence of contamination



SD-21
25 → 30'

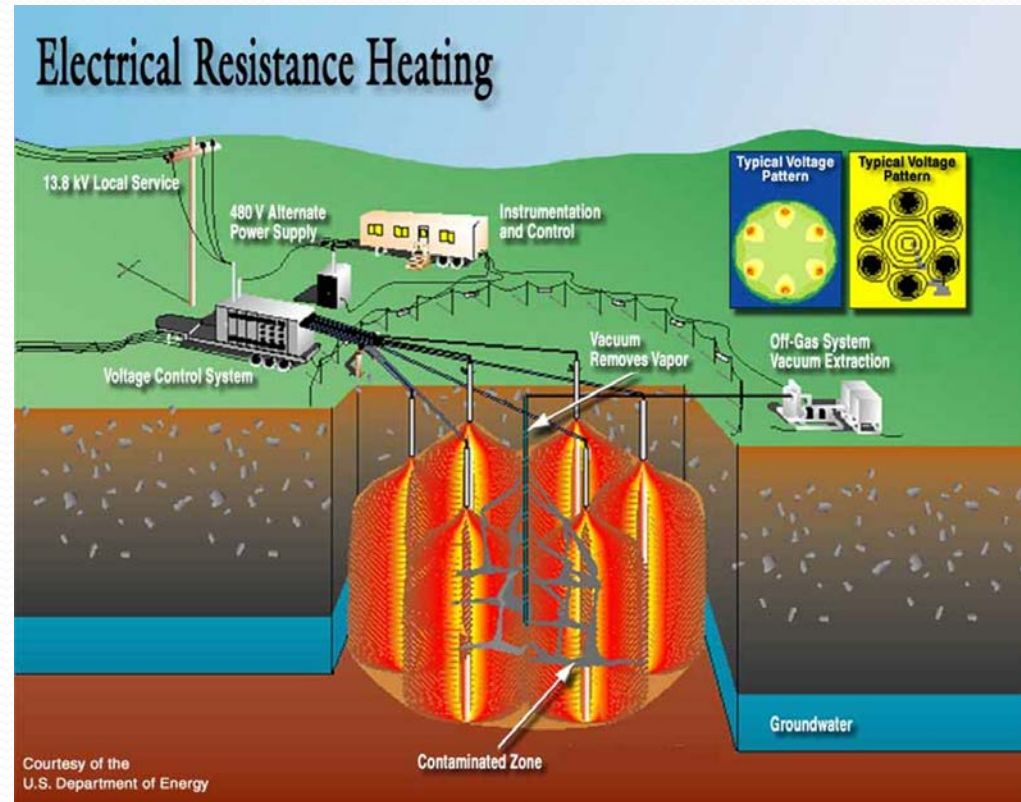
Summary of Investigations, Feasibility Studies, and Pilot Tests

- Multiple investigations conducted since 1988
 - More than 1,000 groundwater samples
 - More than 300 soil samples
- Feasibility Studies conducted to evaluate remedial technologies
- Pilot tests conducted to evaluate applicability of potential remedial technologies
 - Soil Vapor Extraction
 - Air Sparging
 - Groundwater Extraction
 - High Vacuum Dual Phase Extraction
 - In situ Chemical Oxidation
- **Conclusion: Electrical Resistance Heating was the best technology to treat the DNAPL source area**
- **Worked closely with County DEH to select ERH and establish remediation objectives for the Site**
 - Met in September 2006 to discuss ERH technology and criteria necessary for Site closure (TPG letter, October 5, 2006)
 - Met in March 2011 to discuss proposed ERH remediation, and the criteria required to obtain a “letter of concurrence” (TPG letter, May 23, 2011)

Electrical Resistance Heating (ERH) Project

ERH Technology

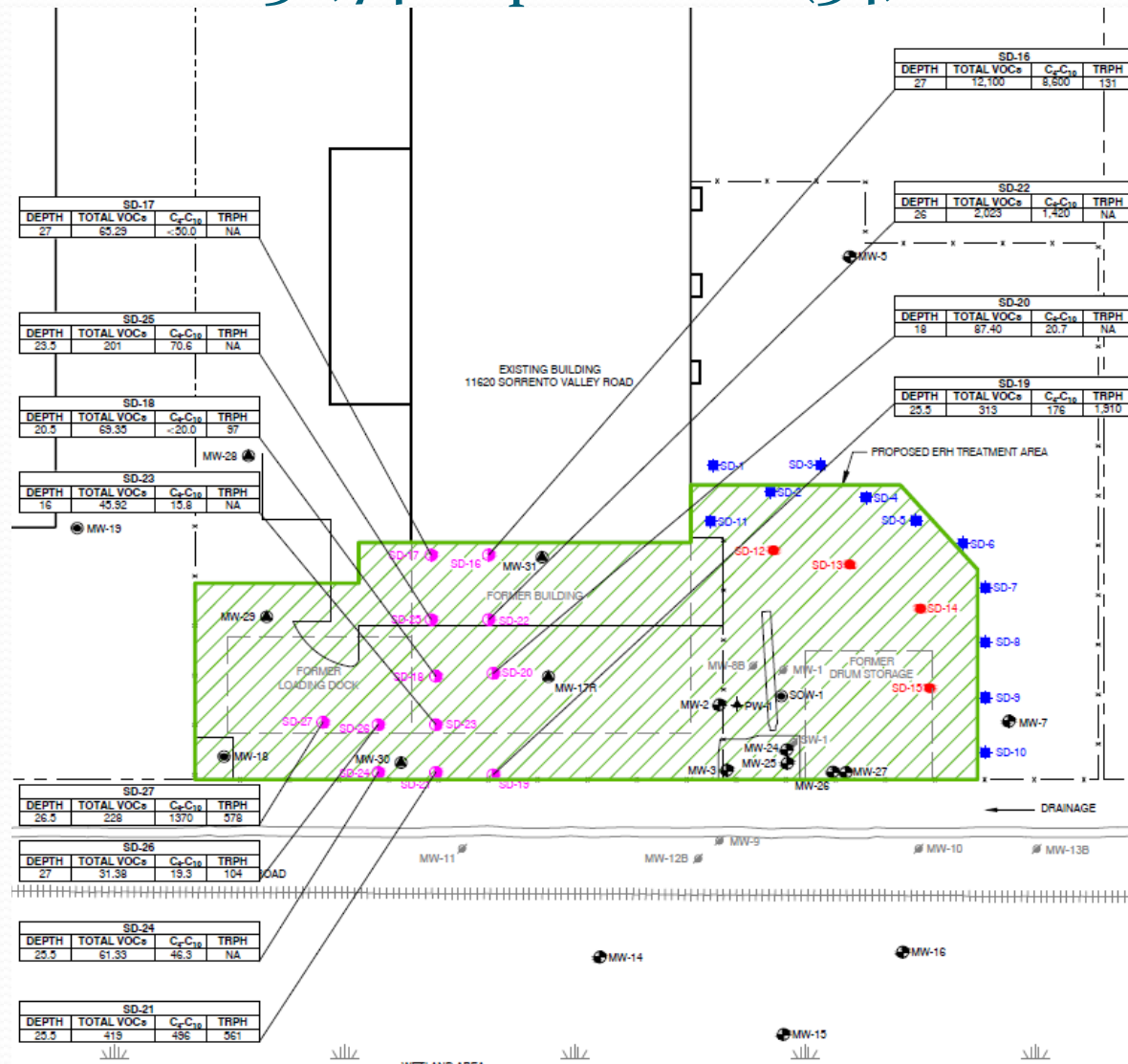
- Electricity flows between subsurface electrodes and heats the subsurface
- Steam is produced in situ
- Preferentially heats tight soil lenses and DNAPL hot spots
- Mass is extracted in vapor phase and treated by steam regenerated carbon



Electrical Resistance Heating

- Multiple vendors solicited for design of ERH system
- TRS Selected based on their experience and approach to treating DNAPL
 - Operating since 1997
 - 100% safe working record
 - Performed ERH at more than 70 Sites nationwide
 - Performed on US Department of Defense and Private Sector Sites

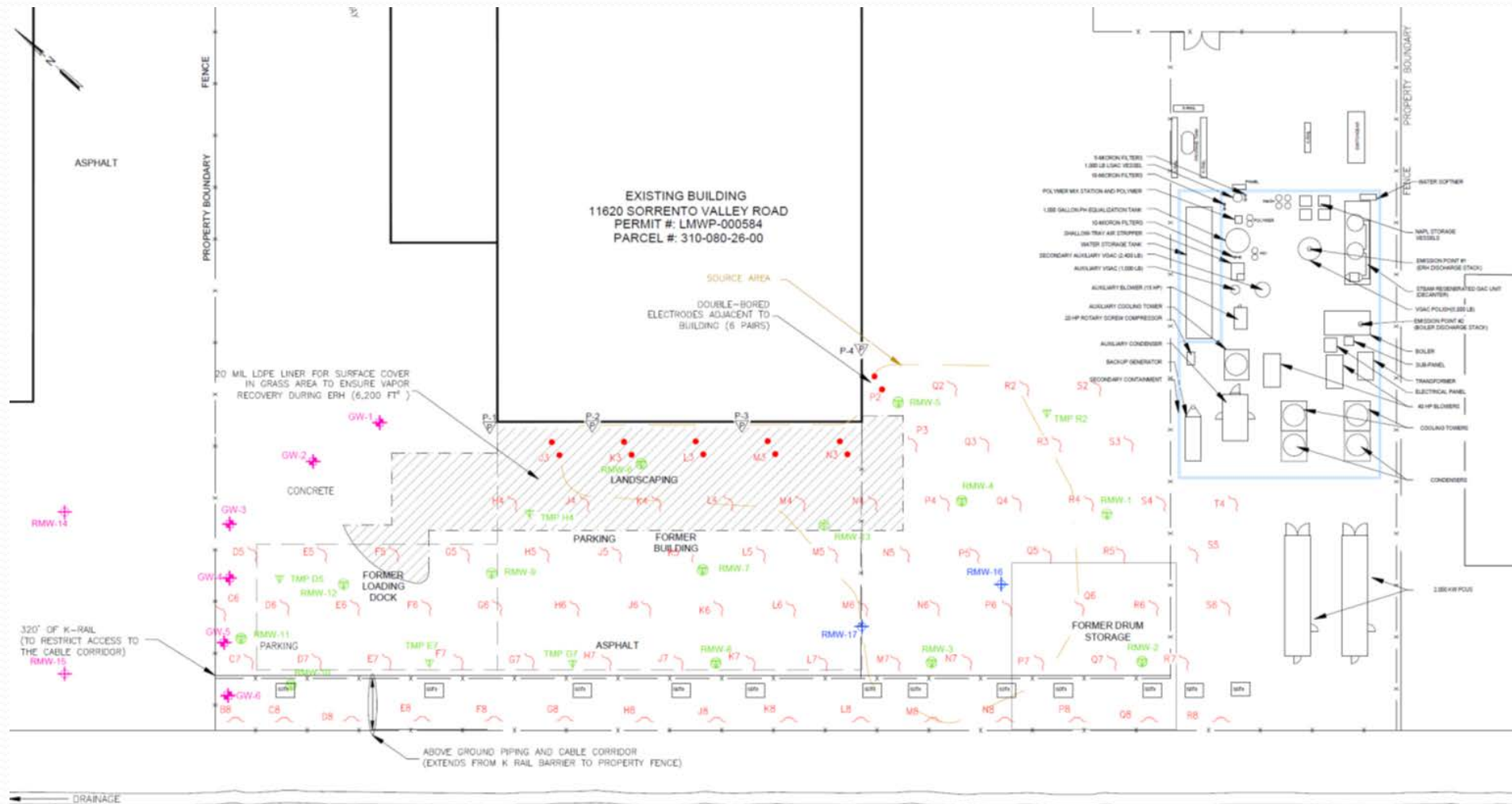
Treatment Area 36,740 square feet (34,018 cubic yards)



Remediation Goals for Site

- Stable or shrinking groundwater plume
 - Confirmed through post-treatment down gradient monitoring
- No health risks to humans or ecological receptors
 - Post-remediation Health Risk Assessment for Buildings
 - Point of Compliance groundwater monitoring for wetlands
- Source reduction
 - Mass reduction demonstrated by confirmation sampling of soil and groundwater
 - Documented mass removal by treatment system

Electrical Resistance Heating (ERH) Project System Layout



Electrical Resistance Heating (ERH) Project Permitting

- Agency Permits
 - Building Permit – San Diego Development Services Department (SDDSD)
 - October 29, 2012
 - Seismic and wind shear constraints
 - Stress and load calculations for power control units
 - Strict property setbacks
 - Drilling Permits (5)
 - Abandonments (pre-ERH) – May 22, 2012
 - Chimney Wells Installation – May 23, 2012
 - Monitoring and System wells – June 18, 2012
 - Confirmatory Sampling – August 22, 2013
 - Abandonments – February 28, 2014

Electrical Resistance Heating (ERH) Project Permitting

- Agency Permits (cont'd)
 - Air Permit
 - Authority to Construct – March 8, 2012
 - Start-up Authorization - February 28, 2013
 - Final Permit to Operate Modification – January 10, 2014
 - Notification Operations Ceased – January 21, 2014
 - Wastewater Discharge (POTW) Permit
 - Issued March 11, 2013
 - San Diego Water Reclamation requirements
 - pH: 5 – 12.5
 - PCE: <700 ug/L
 - TCE: <500 ug/L
 - Vinyl chloride: <200 ug/L
 - Manganese: <0.05 mg/L

Electrical Resistance Heating (ERH) Project Permitting

- Agency Permits (cont'd)
 - Remediation Permit – San Diego Fire-Rescue Department
 - March 3, 2013
 - Security Alarm User permit – San Diego Police Department
 - March 16, 2013
 - Permit-by-Rule – San Diego Department of Environmental Health Hazardous Materials Division (DEH HMD)
 - June 10, 2013
 - Air Stripping for CVOC removal from groundwater

Installation of Sheet Pile Electrode



After Installation of Electrodes



Vapor Recovery Header



ERH - Cable Corridor



ERH - Condensers and Blowers



ERH – PCUs and Vapor Recovery Header



ERH – SRGAC and Polishing Carbon



VOC Liquid Storage Totes

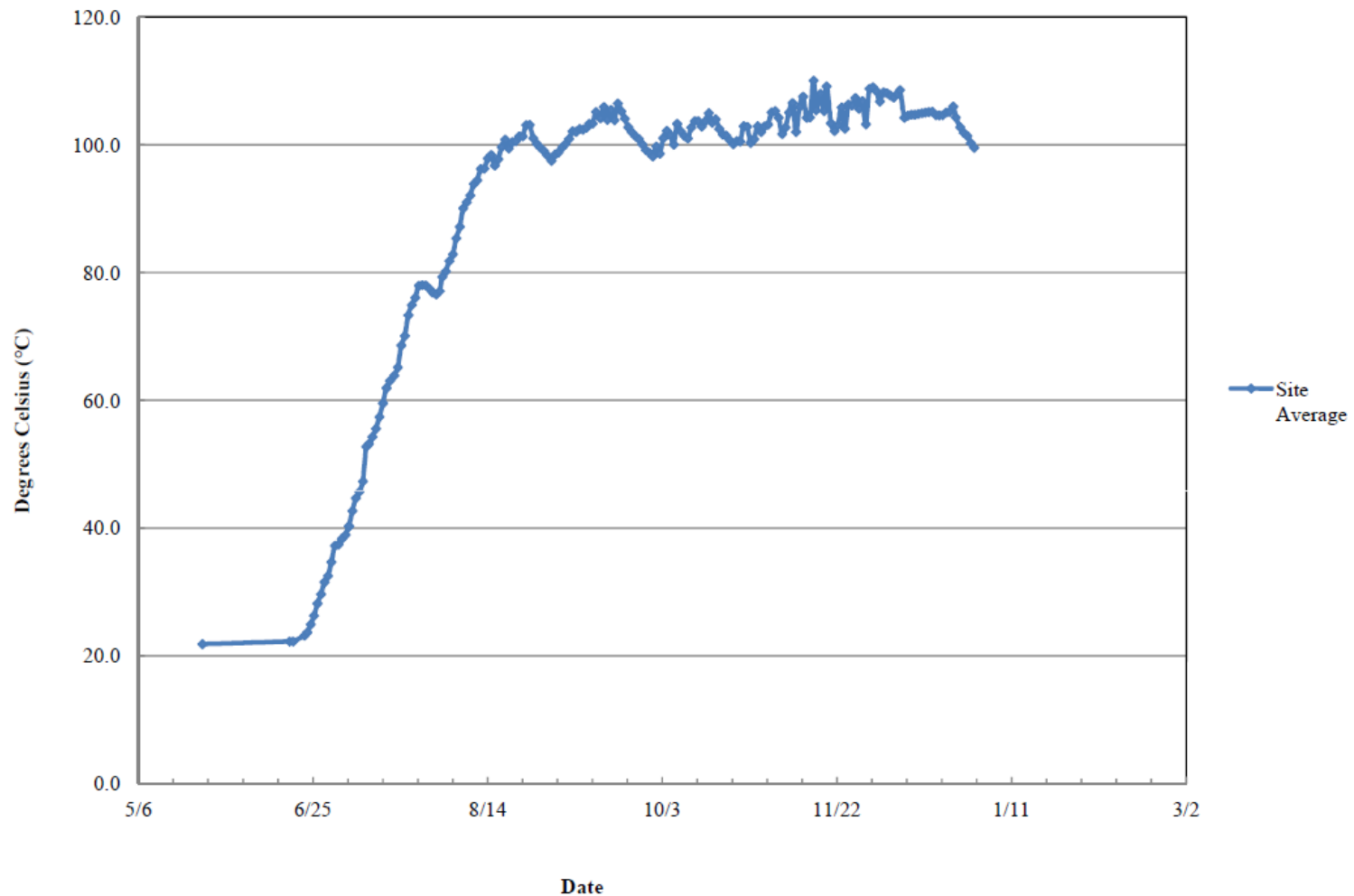


ERH – Treatment Compound



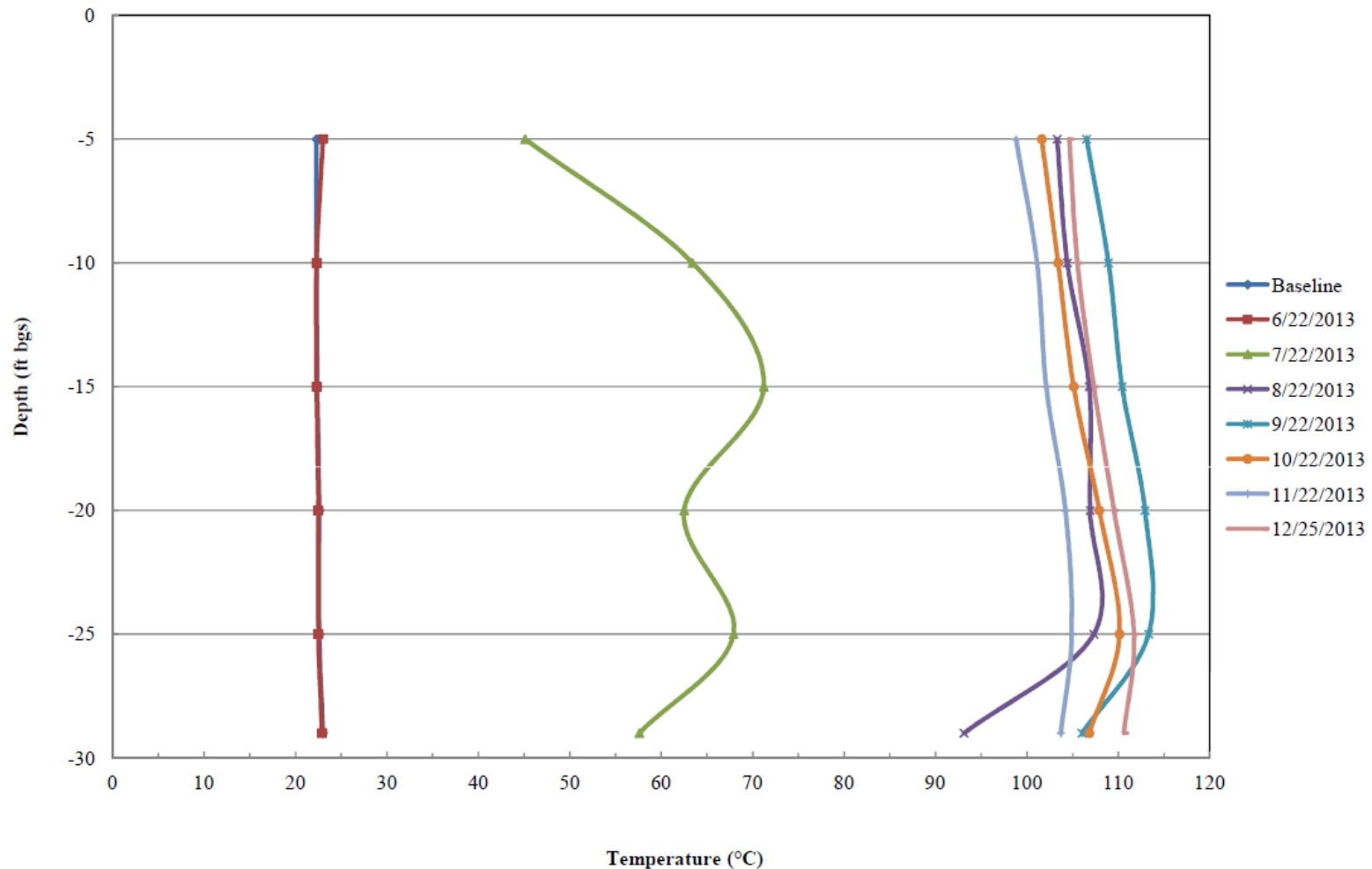
Electrical Resistance Heating (ERH) Project

Average subsurface temperature during treatment



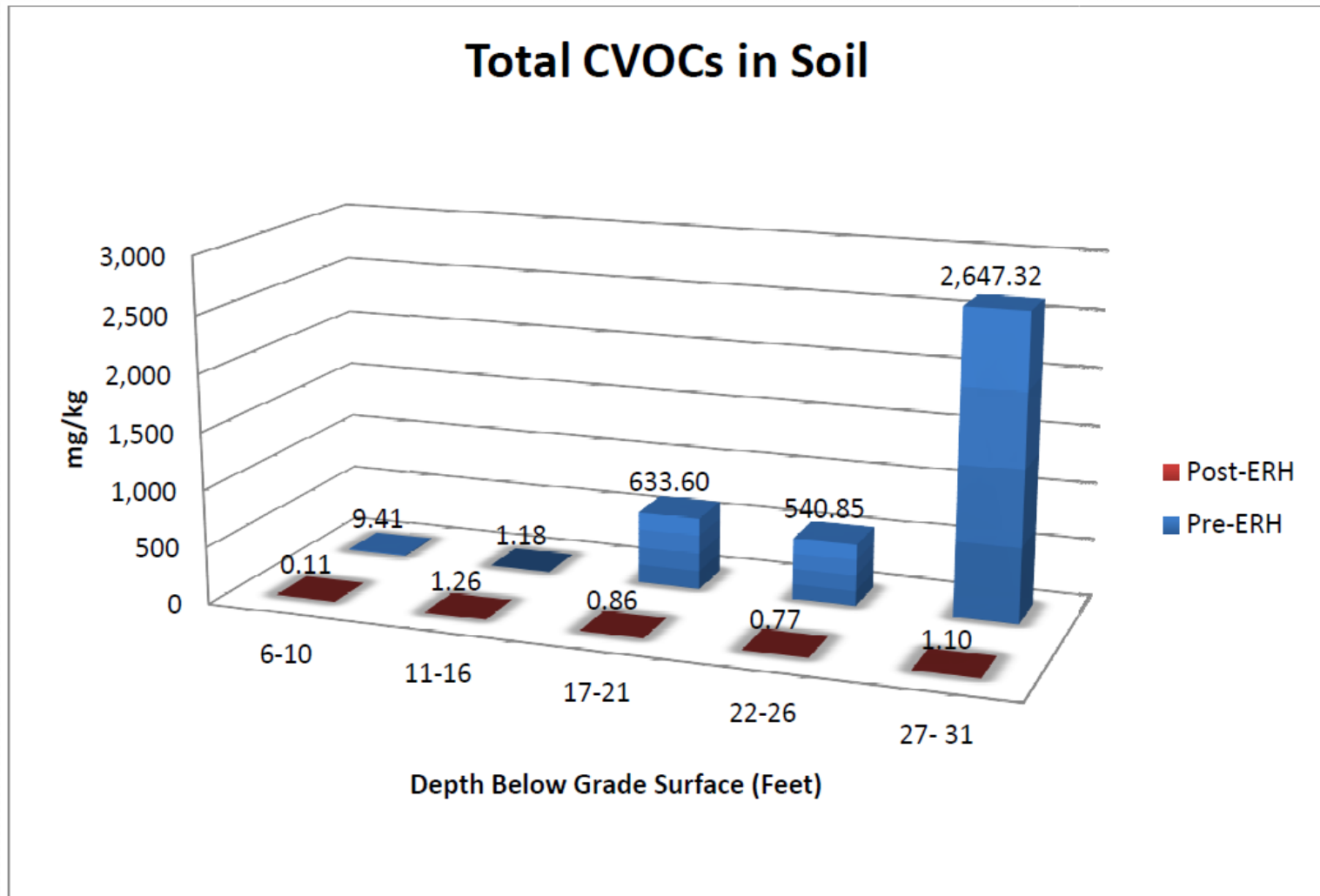
Electrical Resistance Heating (ERH) Project

Vertical temperature profile during treatment



Electrical Resistance Heating (ERH) Project

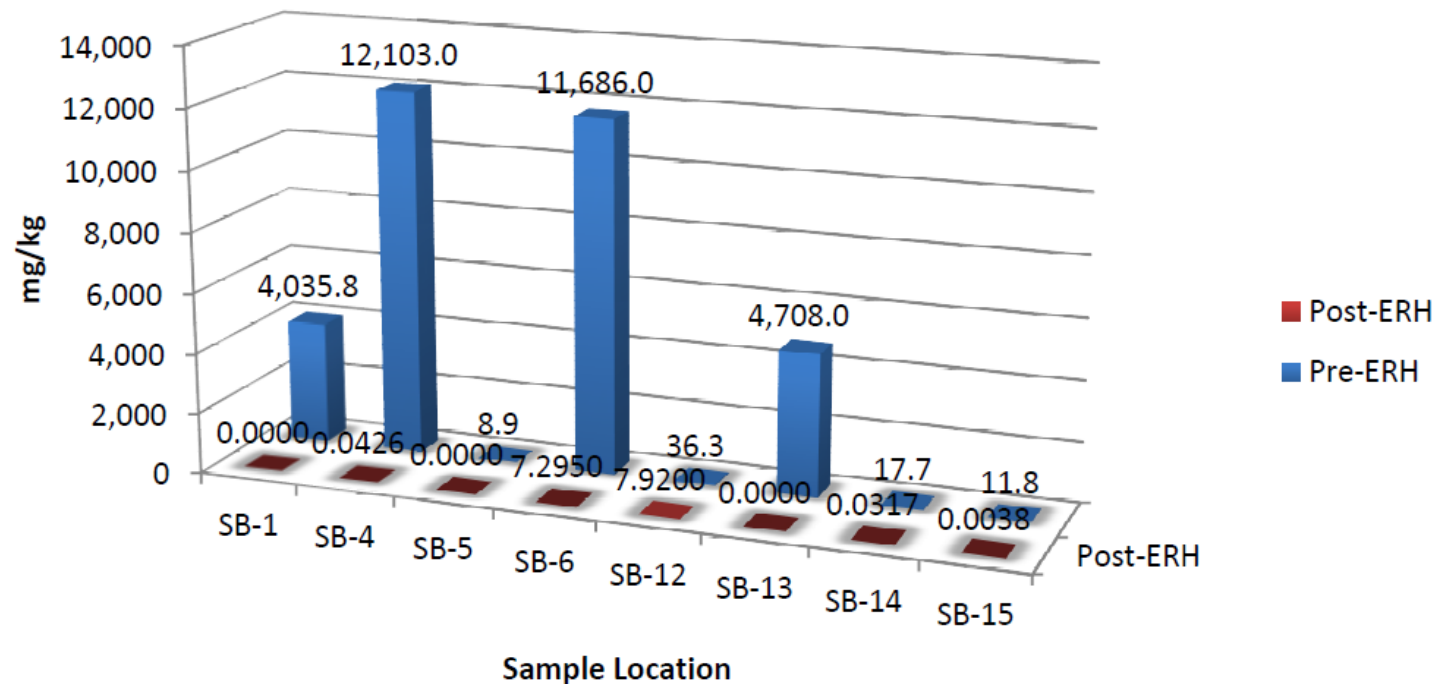
Concentration reduction in soil with depth



Electrical Resistance Heating (ERH) Project

Concentration reduction within source area

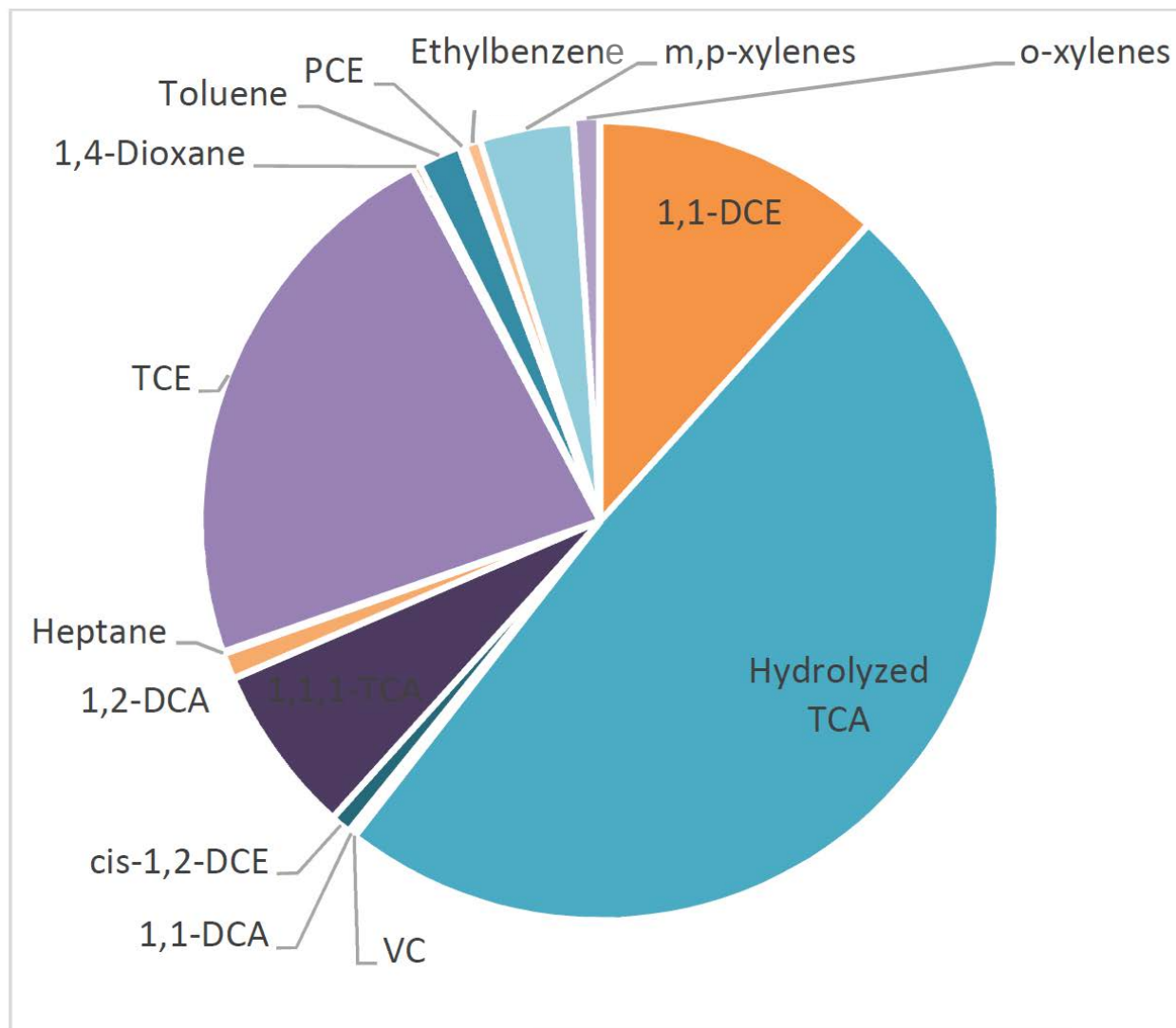
CVOCs in Soil - Source Area



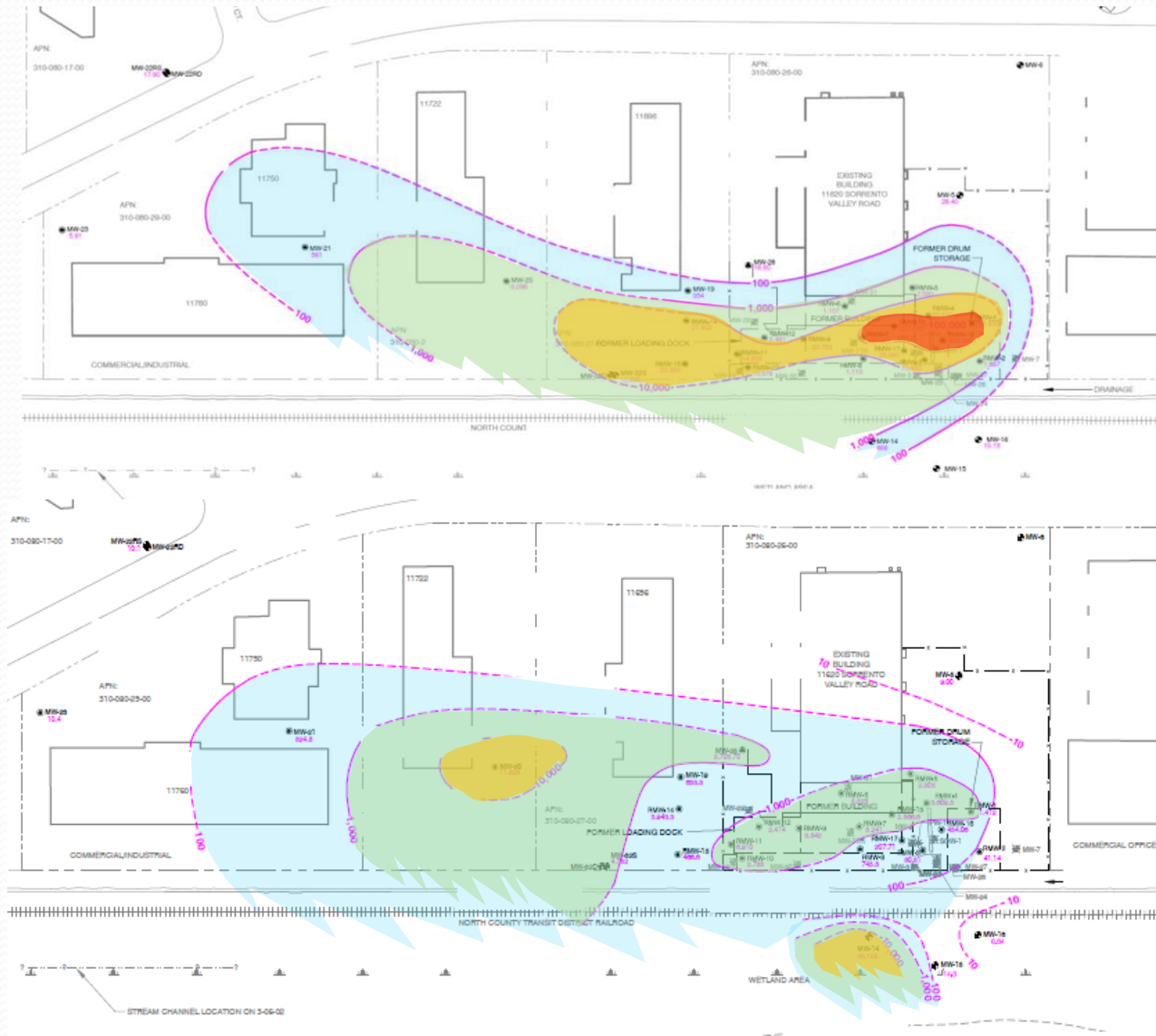
Electrical Resistance Heating (ERH) Project Results

- Design energy milestone was achieved on November 27, 2013
- System operation extended by 28 days to further reduce concentrations
- Mass removal became asymptotic indicating that further treatment using this technology was not feasible
- TRS estimated a minimum of 47,105 pounds of mass recovered or destroyed in situ via hydrolysis
 - **99.9 percent CVOC mass reduction in soil**
 - **99.5 percent CVOC mass reduction in groundwater**
- Average daily mass removal rate 113 pounds per day

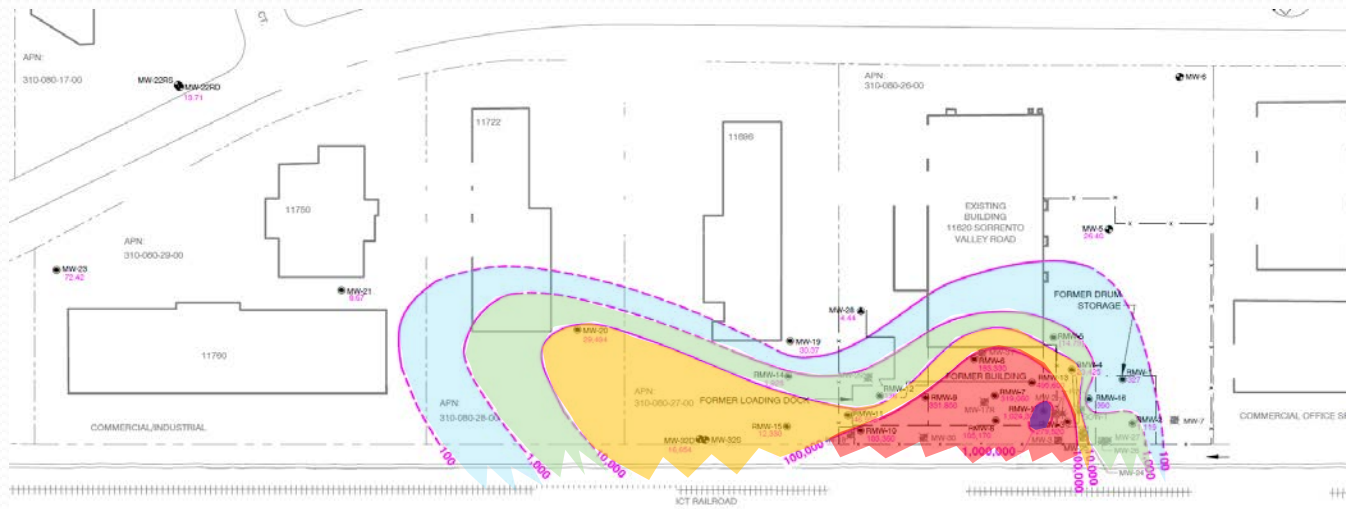
Mass Recovered or Destroyed During ERH Remediation



Shallow Zone Groundwater Results



Deep Zone Groundwater Results

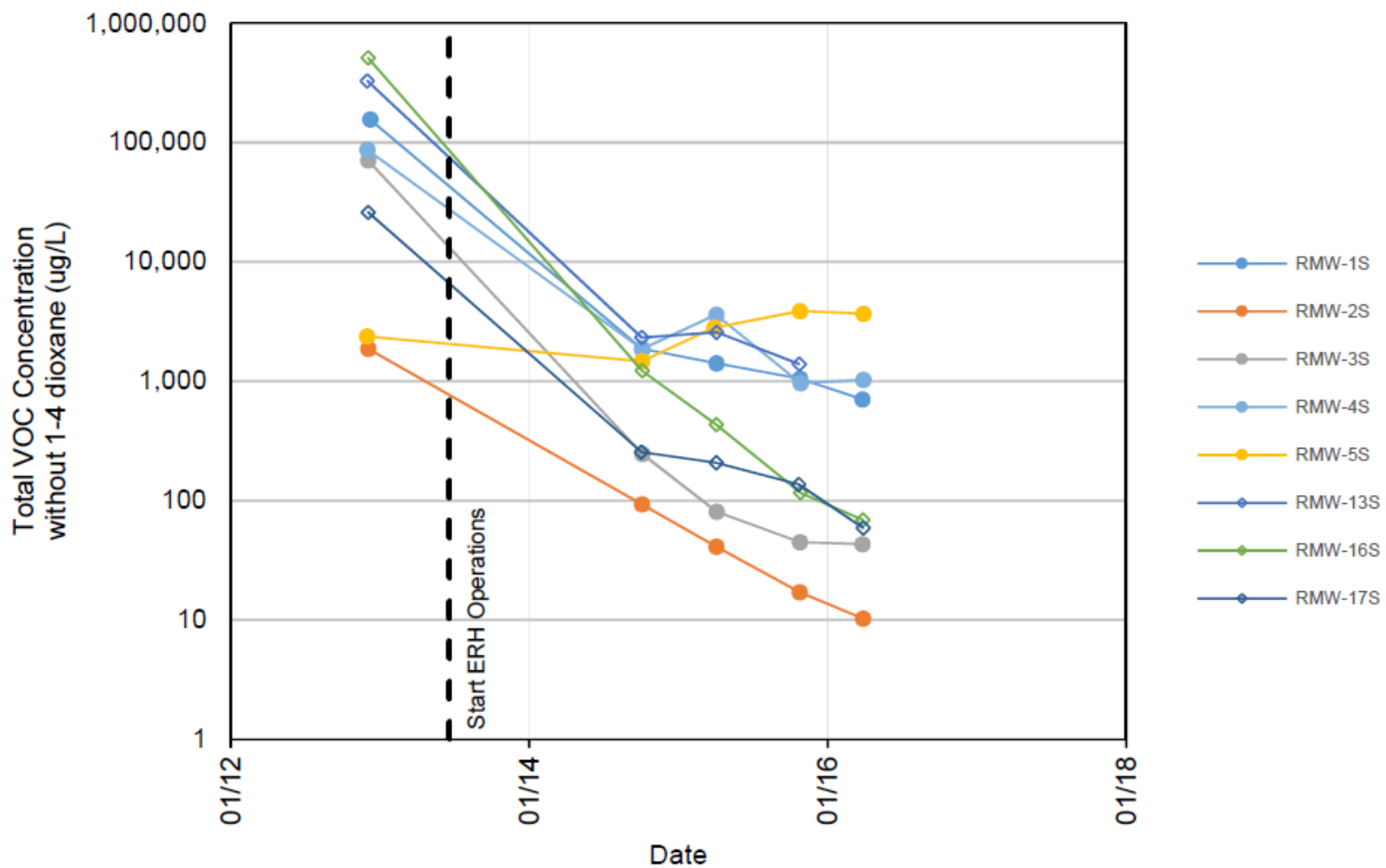


Pre-Remediation
November 2012

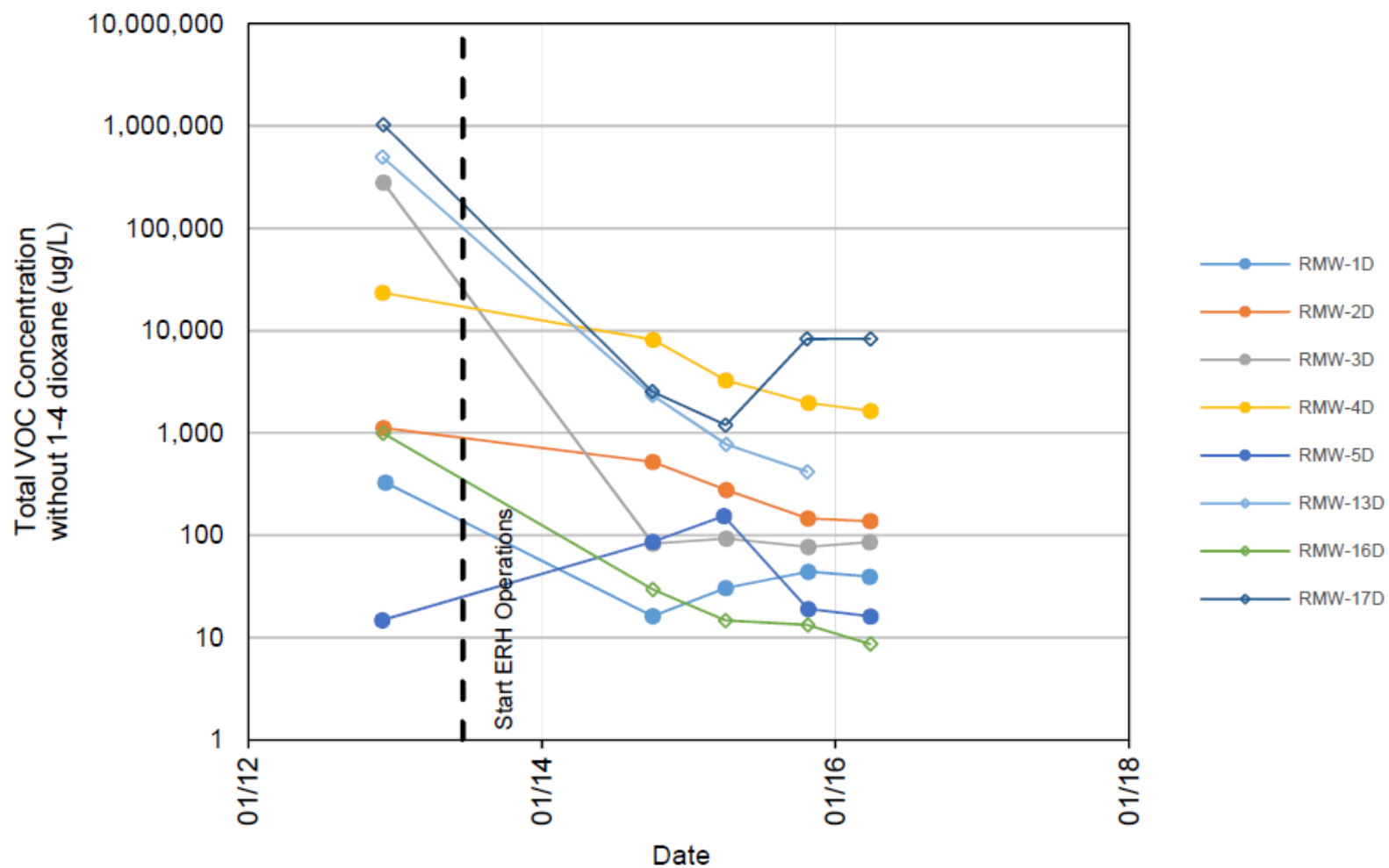


Post-Remediation
October 2014

Shallow : On Site - Source Zone Wells (2012-2016)



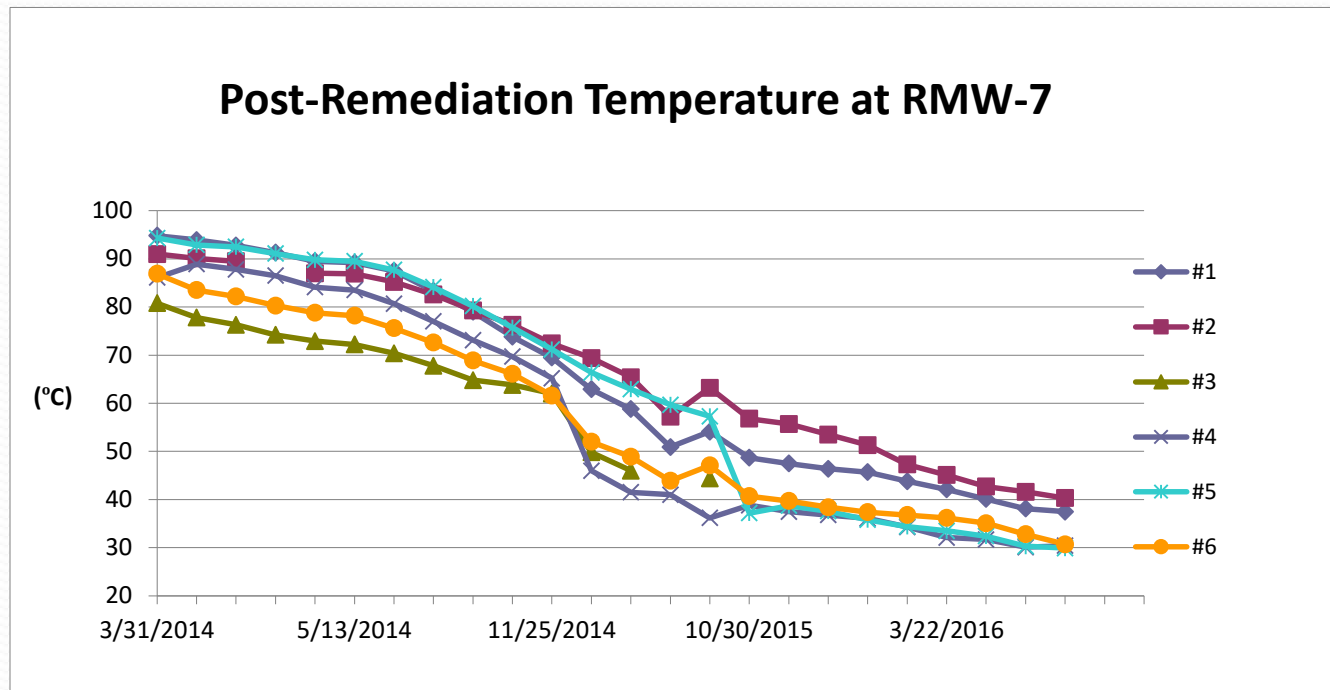
Deep : On Site - Source Zone Wells (2012-2016)



Electrical Resistance Heating (ERH) Project

Post-remediation mass degradation

- Hydrolysis of TCA, 1,1-DCA, and 1,2-DCA will continue to degrade residual mass
- Degradation rates significantly higher with elevated subsurface temperature (Arrhenius equation)
 - Rule of thumb: reaction rates double for each 10 degree C increase in temperature





Questions?