NYSDEC - NYSDOH
Study of Temporal and Spatial Variability
of
VOCs in Soil Gas and Indoor Air

SUMMARY OF PROJECT:

Problem Statement

Although there has been a substantial effort over the past few years to sample and identify structures at which vapor intrusion mitigation systems are warranted, our understanding of the temporal and spacial variability in indoor, subslab and soil gas concentrations hinders our ability to know when and where to sample in order to reliably identify structures in need of mitigation.

Primary Objective

The primary objective of the sampling program is to develop empirical data that provide the Agencies (New York State Department of Environmental Conservation [NYSDEC] and the New York State Department of Health [NYSDOH]) with an improved understanding of the spatial and temporal variability of chlorinated VOCs in subslab soil gas and lowest level (typically, basement) indoor air at vapor intrusion sites. The sampling program will be structured to address the following questions:

1. How much do subslab concentrations of chlorinated VOCs vary over the course of a year?

2. How much do indoor air concentrations (lowest level) of chlorinated VOCs resulting from vapor intrusion vary over the course of a year?

3. Is there a significant difference in concentrations of chlorinated VOCs between subslab samples collected at the center of the structure as opposed to those collected near the perimeter?

The Agencies will assess the degree of temporal and spatial variability in the subslab and indoor samples to determine whether vapor intrusion sampling programs should be restricted to certain times during the year and certain locations within/beneath the structures being sampled. Data collected under this study should enable the Agencies to develop more efficient and effective vapor intrusion sampling programs, and to more reliably identify structures in need of mitigation.

Secondary Objectives

If a suitable site is available, the spatial and temporal variability of non-chlorinated VOCs (BTEX compounds) resulting from vapor intrusion will be studied to improve our understanding of the behavior of those compounds.

Talking Points for Figures

Figure 2 - Henry's Law

The key points that I take from the slide:

- Rethink your concept of what a source is when you shift from a groundwater paradigm to a vapor intrusion paradigm. In vapor intrusion 10 ppb is a source for 100-1000s of $\mu g/m^3$ of soil gas.

- Many of the soil gas samples fall within an order of magnitude of what Henry's Law would predict, but some soil gas samples are unexpectedly clean. Be careful when predicting (or modeling) soil gas concentrations from groundwater concentrations - you may be wrong.

Sub-slab vs Soil Gas Figure

The key point that I take from the slide:

- For most part, good near-slab to sub-slab correlation, but if you used EN04-14 and EN04-16 to predict sub-slab concentrations in structures near them, you could underestimate sub-slab concentrations by 2 orders of magnitude. Again, it highlights the difficulty in accurately modeling or screening sites based on groundwater or soil gas concentrations. You may do a reasonable job at representing conditions in general, but you may not do a satisfactory job of representing conditions at all locations.

Figure 1 - Depiction of Soil Gas Trends

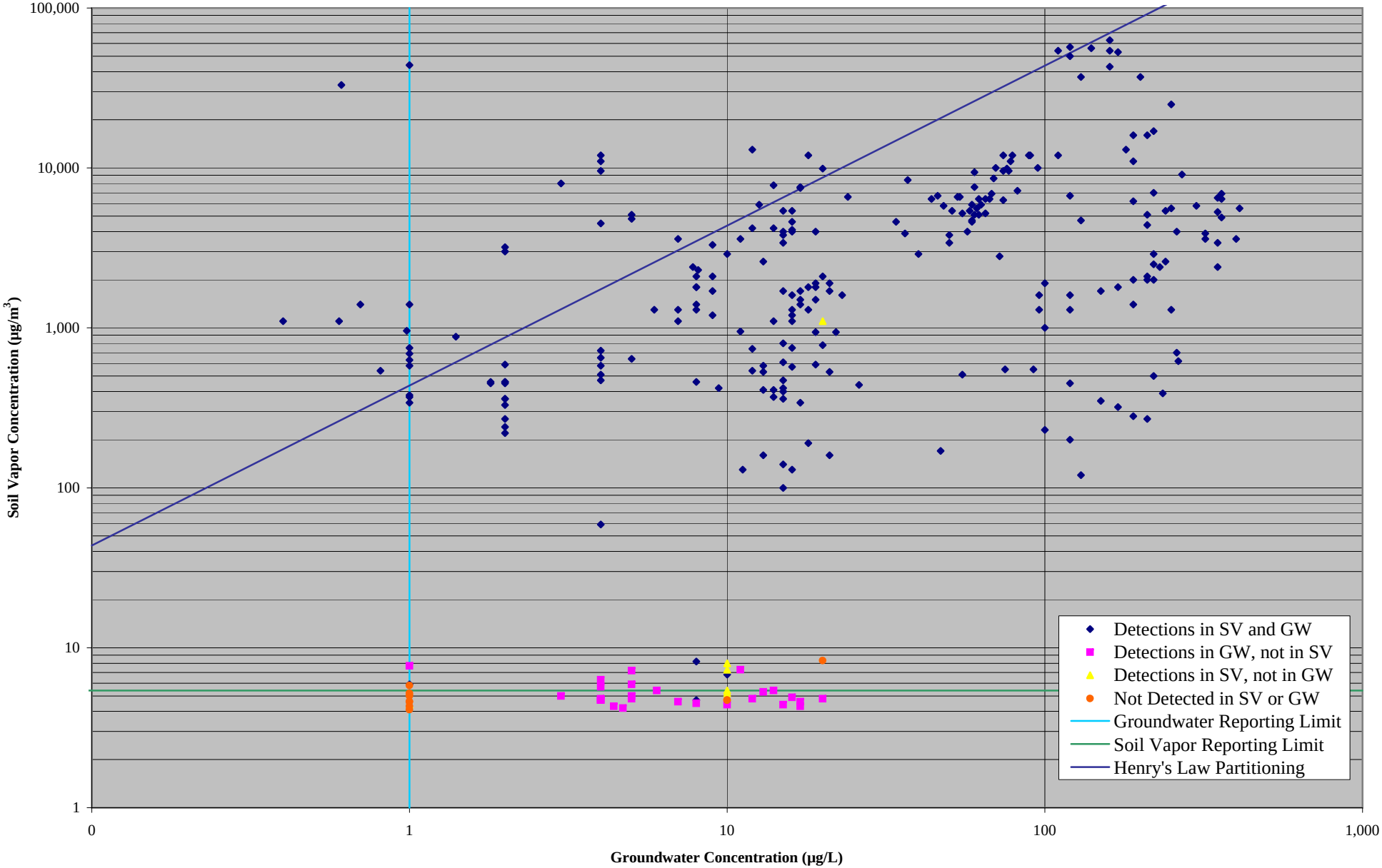
The key points that I take from the slide:

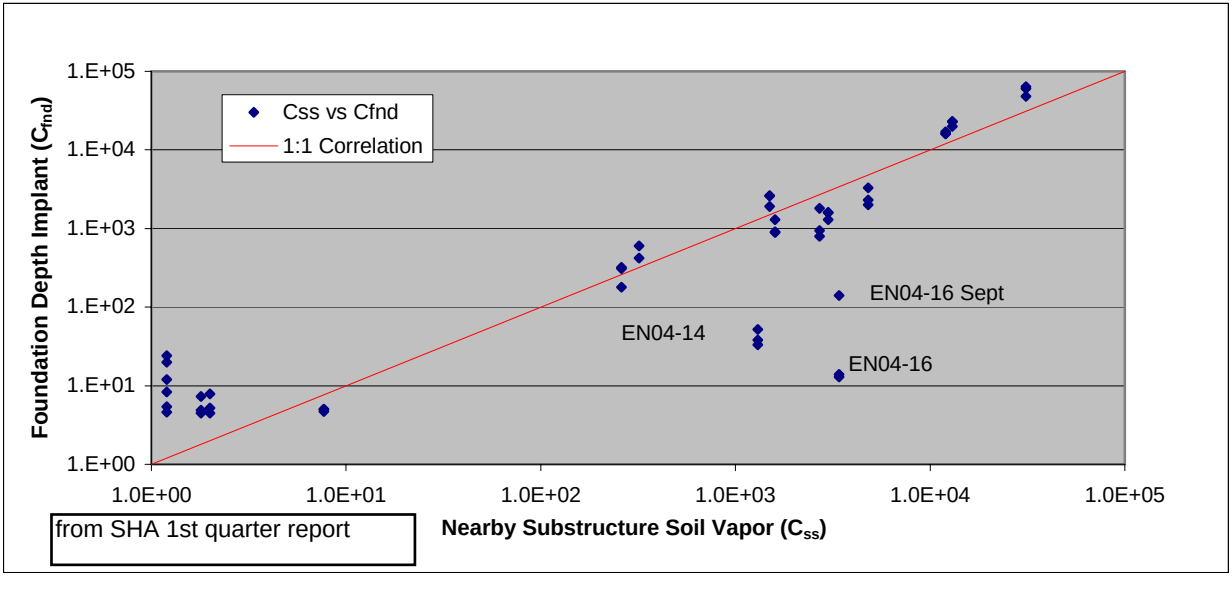
- Soil gas concentrations seem to be pretty constant (within an order of magnitude over time) at any one location. You can collect soil gas data at anytime during the year and come up with a reasonable estimate of the likely concentration at that location.

- Soil gas concentrations exhibit a wide degree of spacial variability that is difficult to predict from groundwater concentrations. The subsequent slides represent three distinct soil gas patterns that we've observed at locations with similar groundwater concentrations. Subtle changes in the site geology (i.e. thin lenses of high moisture content material) seem to have a significant impact on the concentration of TCE in the soil gas

Figure 2
TCE in Water Table Depth Soil Vapor and Groundwater

Quarterly Report - Soil Vapor Monitoring
Comprehensive Operations, Maintenance, & Monitoring Program
Endicott, New York




Foundation Depth Implant (C_{fnd})
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1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Css vs Cfnd
1:1 Correlation
EN04-16 Sept
EN04-14
EN04-16
1.0E+00
1.0E+01
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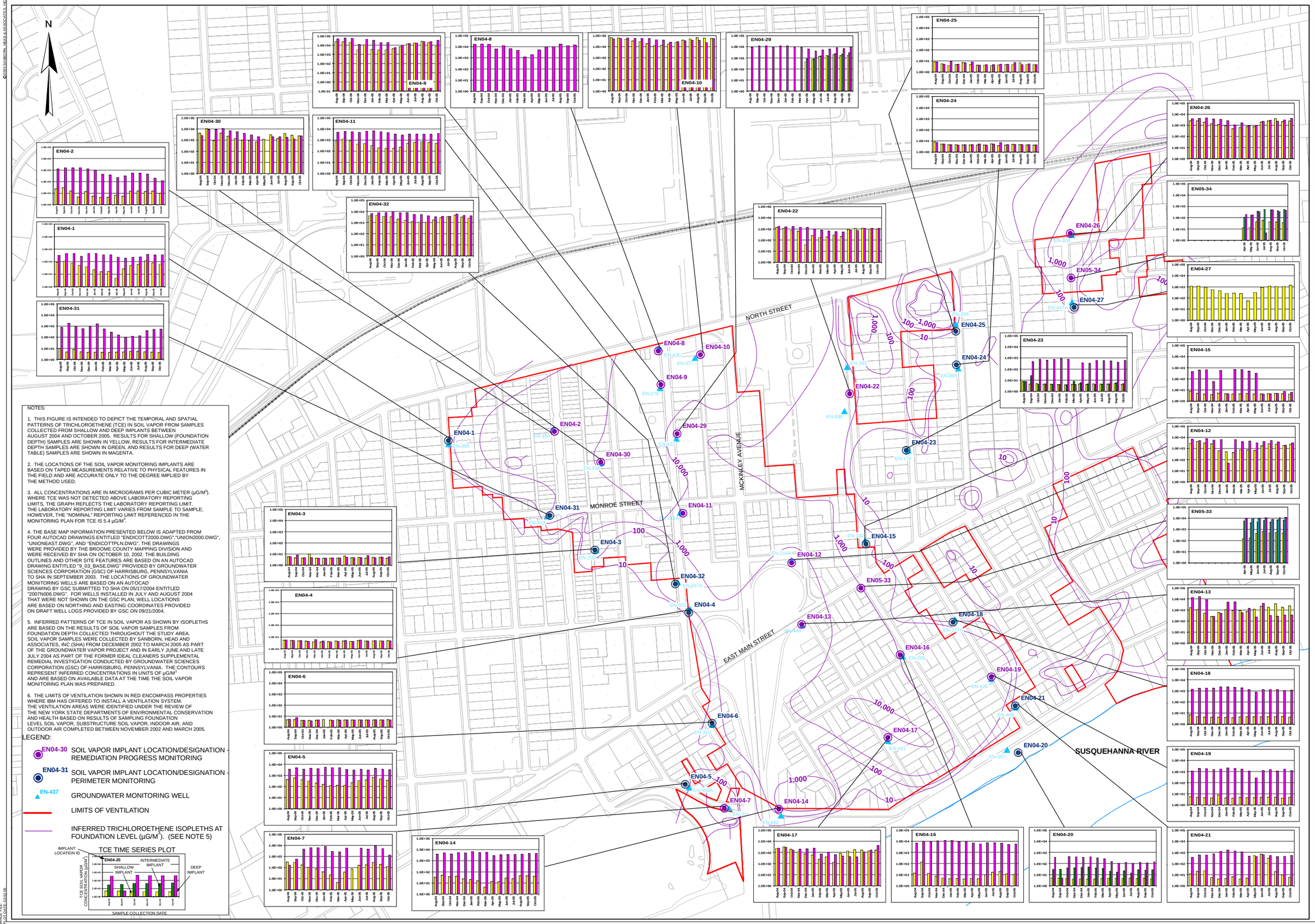
Nearby Substructure Soil Vapor (C_{ss})
from SHA 1st quarter report



NOTES:

1. THIS FIGURE IS INTENDED TO DEPICT THE TEMPORAL AND SPATIAL PATTERNS OF TRICHLOROETHENE (TCE) IN SOIL VAPOR FROM SAMPLES COLLECTED FROM SHALLOW AND DEEP IMPLANTS BETWEEN AUGUST 2004 AND OCTOBER 2005. RESULTS FOR SHALLOW (FOUNDATION DEPTH) SAMPLES ARE SHOWN IN YELLOW, RESULTS FOR INTERMEDIATE DEPTH SAMPLES ARE SHOWN IN GREEN, AND RESULTS FOR DEEP (WATER TABLE) SAMPLES ARE SHOWN IN MAGENTA.

2. THE LOCATIONS OF THE SOIL VAPOR MONITORING IMPLANTS ARE BASED ON TAPED MEASUREMENTS RELATIVE TO PHYSICAL FEATURES IN THE FIELD AND ARE ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

3. ALL CONCENTRATIONS ARE IN MICROGRAMS PER CUBIC METER ($\mu g/M^3$). WHERE TCE WAS NOT DETECTED ABOVE LABORATORY REPORTING LIMITS, THE GRAPH REFLECTS THE LABORATORY REPORTING LIMIT. THE LABORATORY REPORTING LIMIT VARIES FROM SAMPLE TO SAMPLE; HOWEVER, THE "NOMINAL" REPORTING LIMIT REFERENCED IN THE MONITORING PLAN FOR TCE IS 5.4 $\mu g/M^3$.

4. THE BASE MAP INFORMATION PRESENTED BELOW IS ADAPTED FROM FOUR AUTOCAD DRAWINGS ENTITLED "ENDICOTT2000.DWG","UNION2000.DWG", "UNIONEAST.DWG", AND "ENDICOTTPLN.DWG". THE DRAWINGS WERE PROVIDED BY THE BROOME COUNTY MAPPING DIVISION AND WERE RECEIVED BY SHA ON OCTOBER 10, 2002. THE BUILDING OUTLINES AND OTHER SITE FEATURES ARE BASED ON AN AUTOCAD DRAWING ENTITLED "9_03_BASE.DWG" PROVIDED BY GROUNDWATER SCIENCES CORPORATION (GSC) OF HARRISBURG, PENNSYLVANIA TO SHA IN SEPTEMBER 2003. THE LOCATIONS OF GROUNDWATER MONITORING WELLS ARE BASED ON AN AUTOCAD DRAWING BY GSC SUBMITTED TO SHA ON 05/17/2004 ENTITLED "2007N006.DWG". FOR WELLS INSTALLED IN JULY AND AUGUST 2004 THAT WERE NOT SHOWN ON THE GSC PLAN, WELL LOCATIONS ARE BASED ON NORTHING AND EASTING COORDINATES PROVIDED ON DRAFT WELL LOGS PROVIDED BY GSC ON 09/21/2004.

5. INFERRED PATTERNS OF TCE IN SOIL VAPOR AS SHOWN BY ISOPLETHS ARE BASED ON THE RESULTS OF SOIL VAPOR SAMPLES FROM FOUNDATION DEPTH COLLECTED THROUGHOUT THE STUDY AREA. SOIL VAPOR SAMPLES WERE COLLECTED BY SANBORN, HEAD AND ASSOCIATES, INC (SHA) FROM DECEMBER 2002 TO MARCH 2005 AS PART OF THE GROUNDWATER VAPOR PROJECT AND IN EARLY JUNE AND LATE JULY 2004 AS PART OF THE FORMER IDEAL CLEANERS SUPPLEMENTAL REMEDIAL INVESTIGATION CONDUCTED BY GROUNDWATER SCIENCES CORPORATION (GSC) OF HARRISBURG, PENNSYLVANIA. THE CONTOURS REPRESENT INFERRED CONCENTRATIONS IN UNITS OF $\mu G/M^3$ AND ARE BASED ON AVAILABLE DATA AT THE TIME THE SOIL VAPOR MONITORING PLAN WAS PREPARED.

6. THE LIMITS OF VENTILATION SHOWN IN RED ENCOMPASS PROPERTIES WHERE IBM HAS OFFERED TO INSTALL A VENTILATION SYSTEM. THE VENTILATION AREAS WERE IDENTIFIED UNDER THE REVIEW OF THE NEW YORK STATE DEPARTMENTS OF ENVIRONMENTAL CONSERVATION AND HEALTH BASED ON RESULTS OF SAMPLING FOUNDATION LEVEL SOIL VAPOR, SUBSTRUCTURE SOIL VAPOR, INDOOR AIR, AND OUTDOOR AIR COMPLETED BETWEEN NOVEMBER 2002 AND MARCH 2005.

LEGEND:

- EN04-30 — SOIL VAPOR IMPLANT LOCATION/DESIGNATION - REMEDIATION PROGRESS MONITORING
- EN04-31 — SOIL VAPOR IMPLANT LOCATION/DESIGNATION - PERIMETER MONITORING
- EN-437 — GROUNDWATER MONITORING WELL
- LIMITS OF VENTILATION
- INFERRED TRICHLOROETHENE ISOPLETHS AT FOUNDATION LEVEL ($\mu g/M^3$). (SEE NOTE 5)

TCE TIME SERIES PLOT

IMPLANT LOCATION ID — EN04-20 — SHALLOW IMPLANT — INTERMEDIATE IMPLANT — DEEP IMPLANT — TCE SOIL VAPOR CONCENTRATION (µG/M³) — SAMPLE COLLECTION DATE

NO.	DATE	DESCRIPTION	BY

GRAPHICAL SCALE — Feet: 250 125 0 250 500 750

Sanborn, Head & Associates, Inc.
CONSULTING ENGINEERS & SCIENTISTS

DRAWN BY: EMB
DESIGNED BY: EMB
CHECKED BY: JO
REVIEWED BY: DBC
PROJECT MGR: JO
PIC: DBC
DATE: DEC 05

QUARTERLY REPORT - SOIL VAPOR MONITORING

COMPREHENSIVE OPERATIONS, MAINTENANCE & MONITORING PROGRAM
ENDICOTT, NEW YORK

LOCATION PLAN AND SOIL VAPOR DATA SUMMARY

PROJECT NUMBER : 2200.00

1

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Figure B.18
TCE in Soil Vapor and Groundwater
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Comprehensive Operations, Maintenance, & Monitoring Program
Endicott, New York

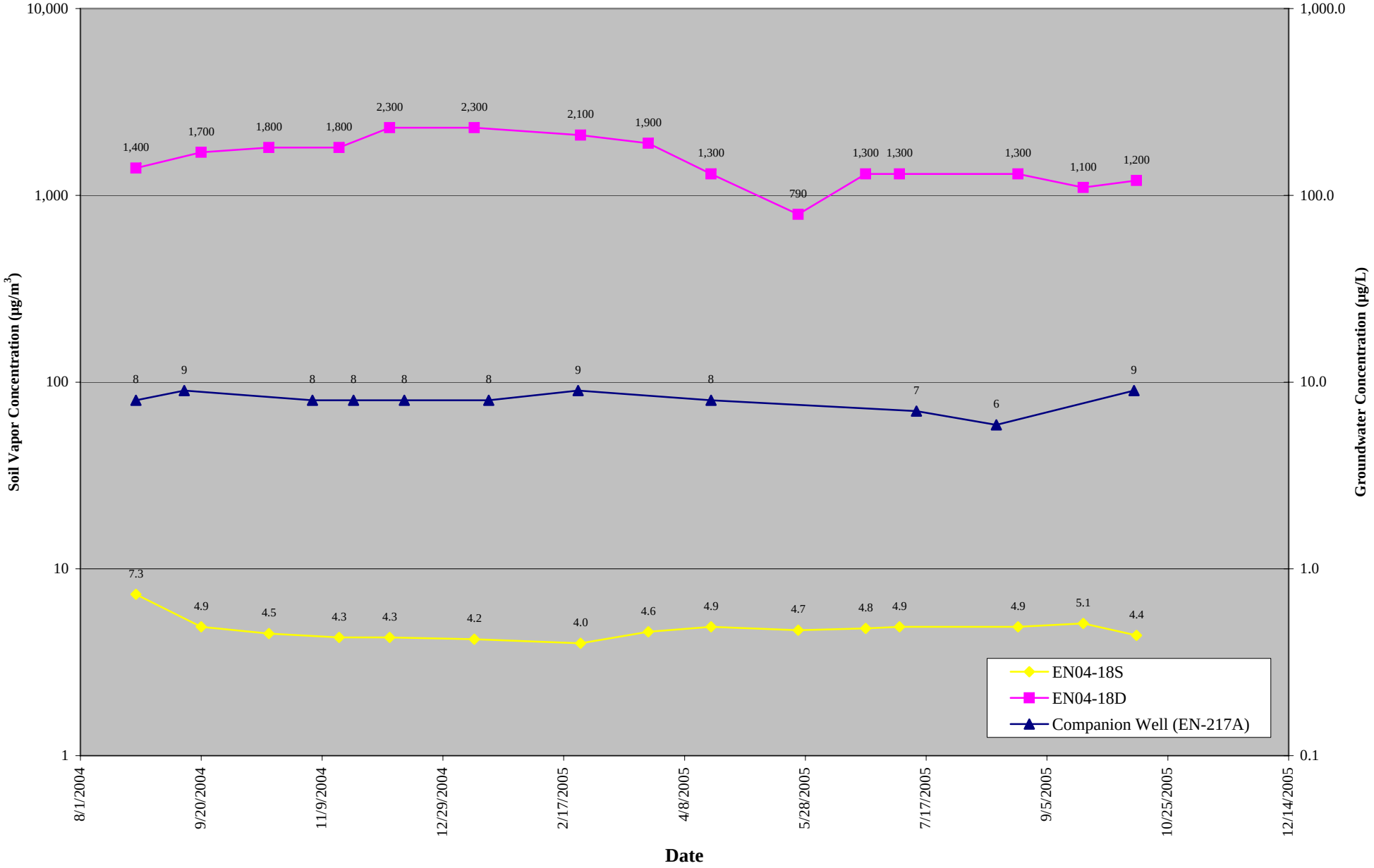

Figure B.24
TCE in Soil Vapor and Groundwater
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Comprehensive Operations, Maintenance, & Monitoring Program
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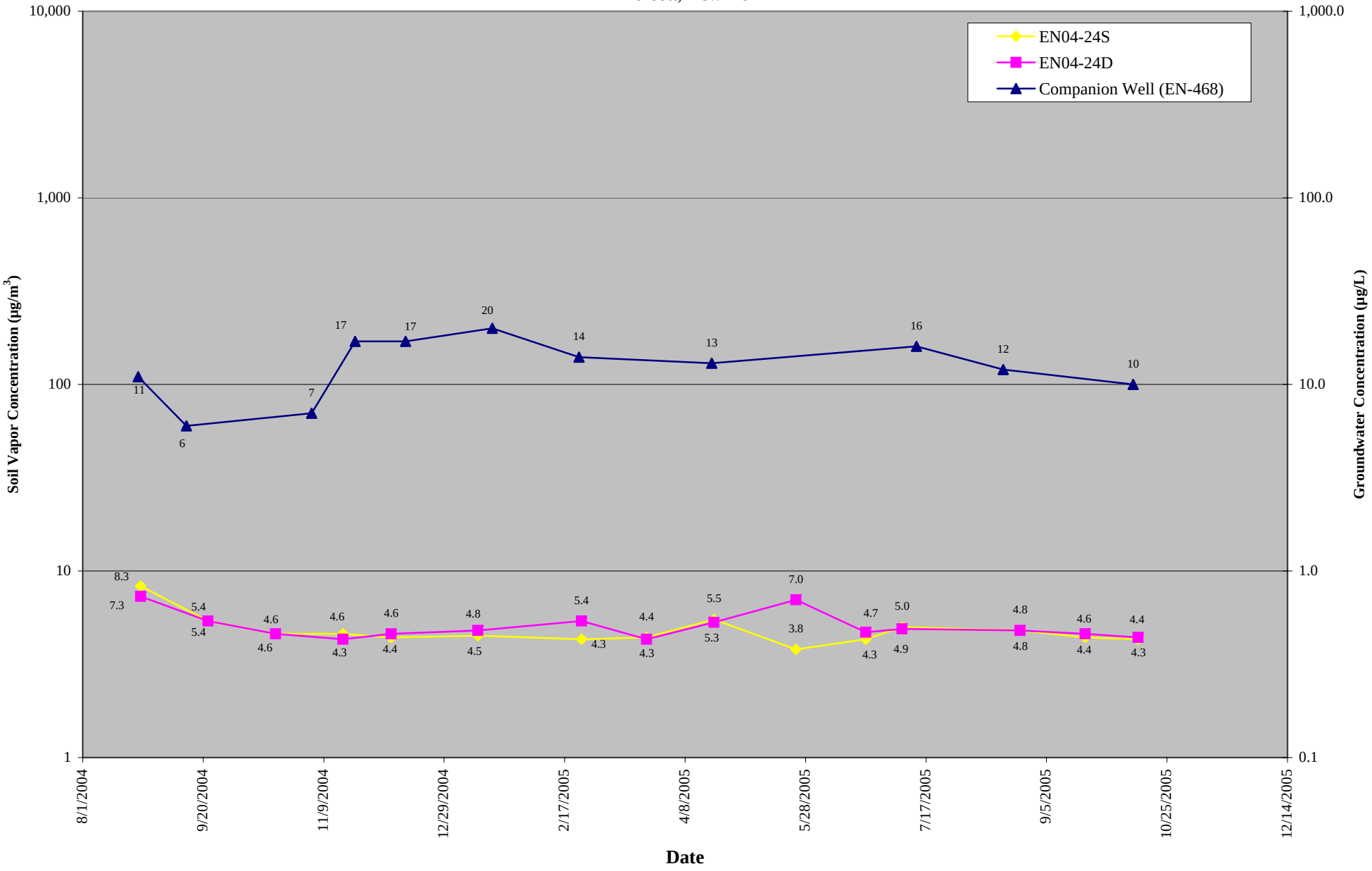

Figure B.32
TCE in Soil Vapor and Groundwater
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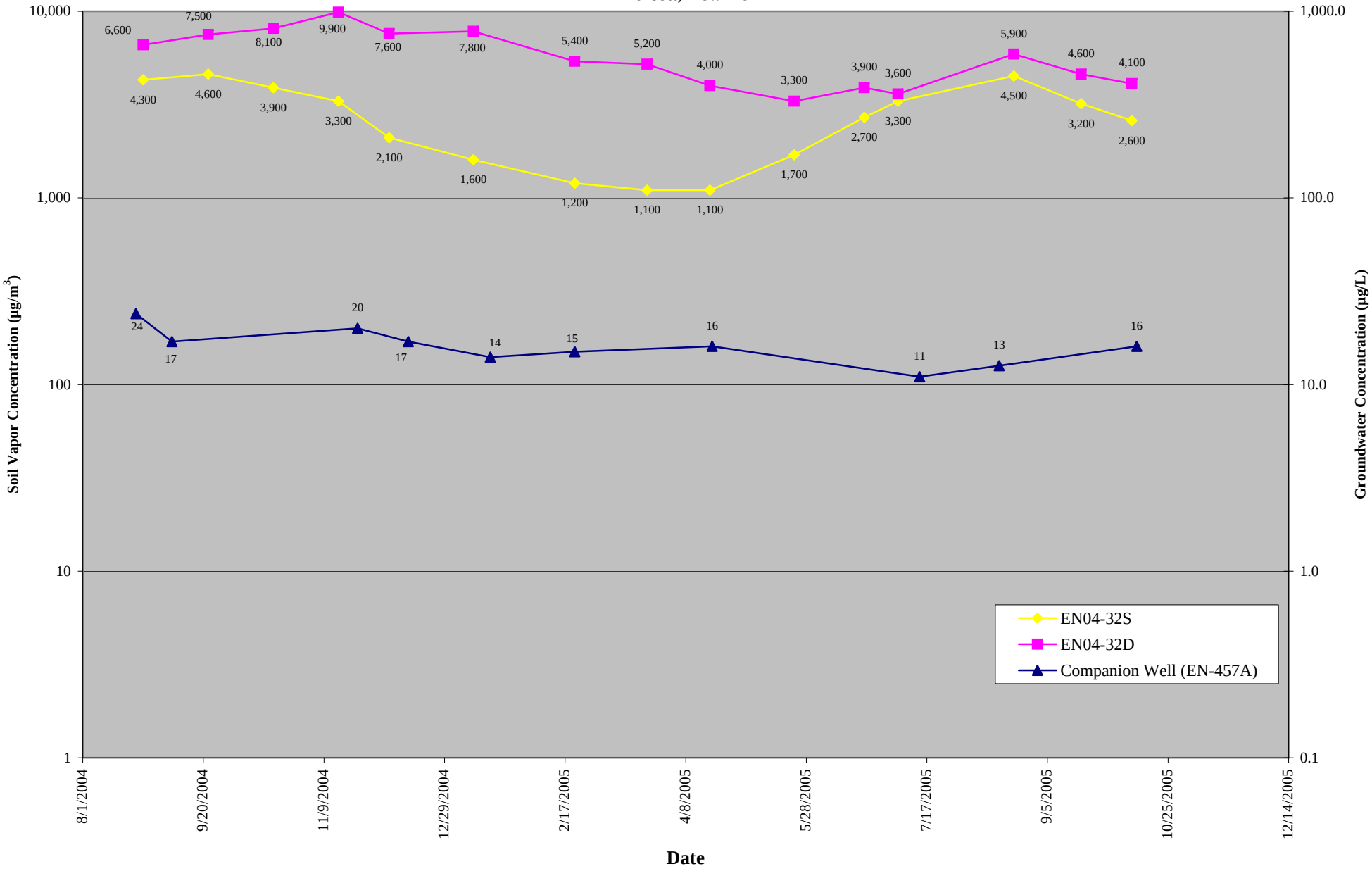
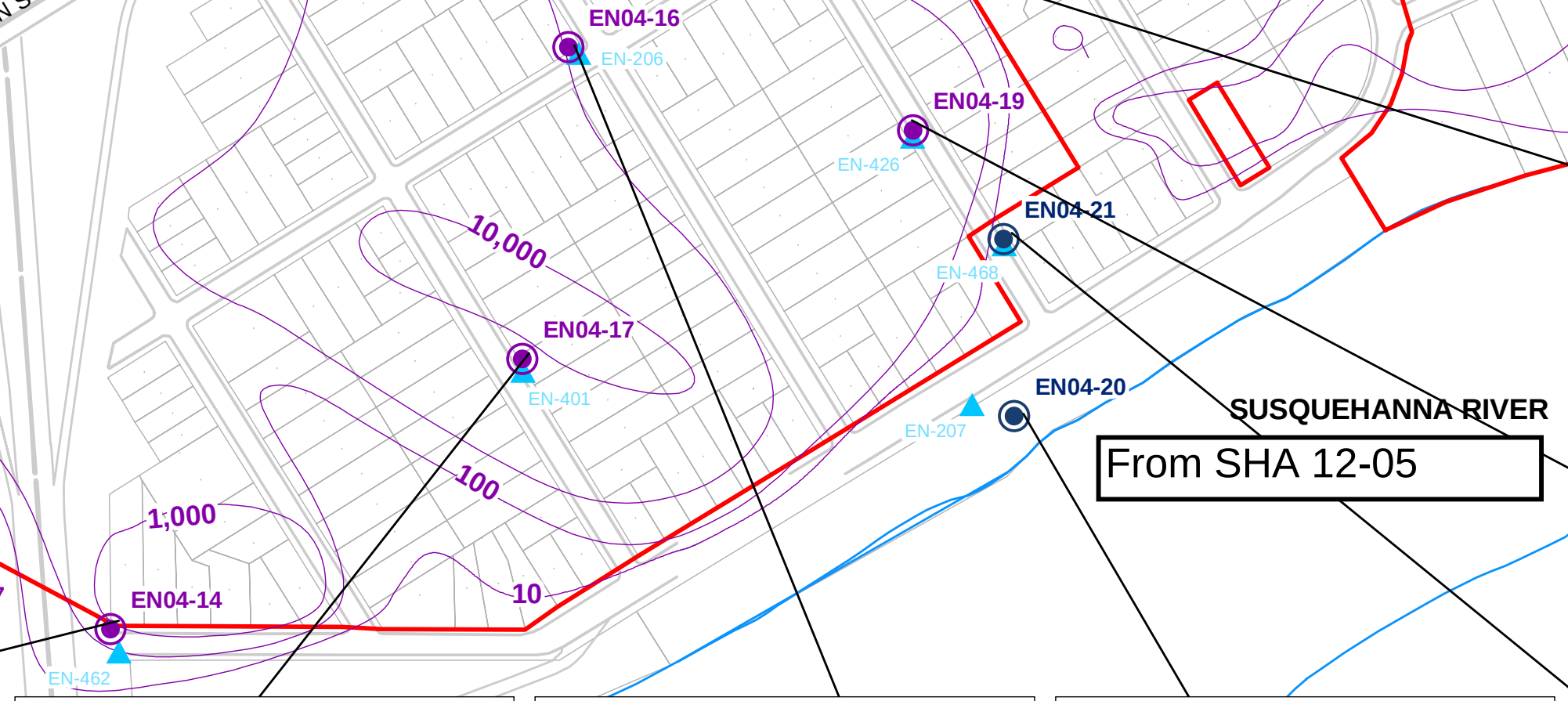
Comprehensive Operations, Maintenance, & Monitoring Program
Endicott, New York

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SUSQUEHANNA RIVER
From SHA 12-05
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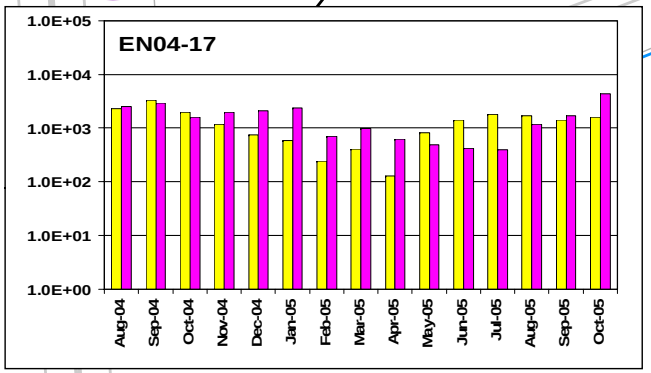
EN04-14
EN-462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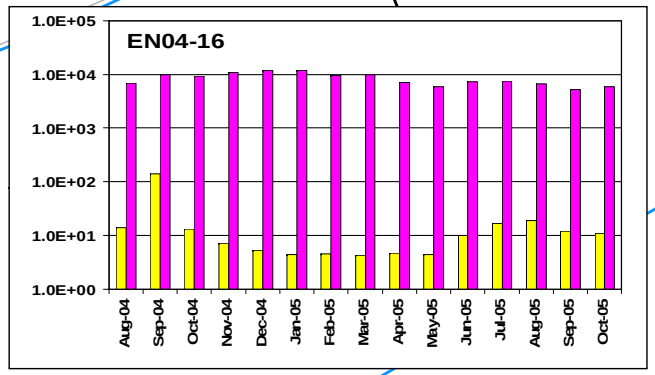
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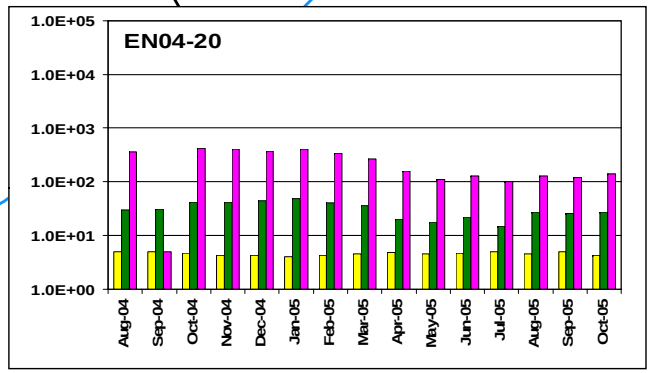
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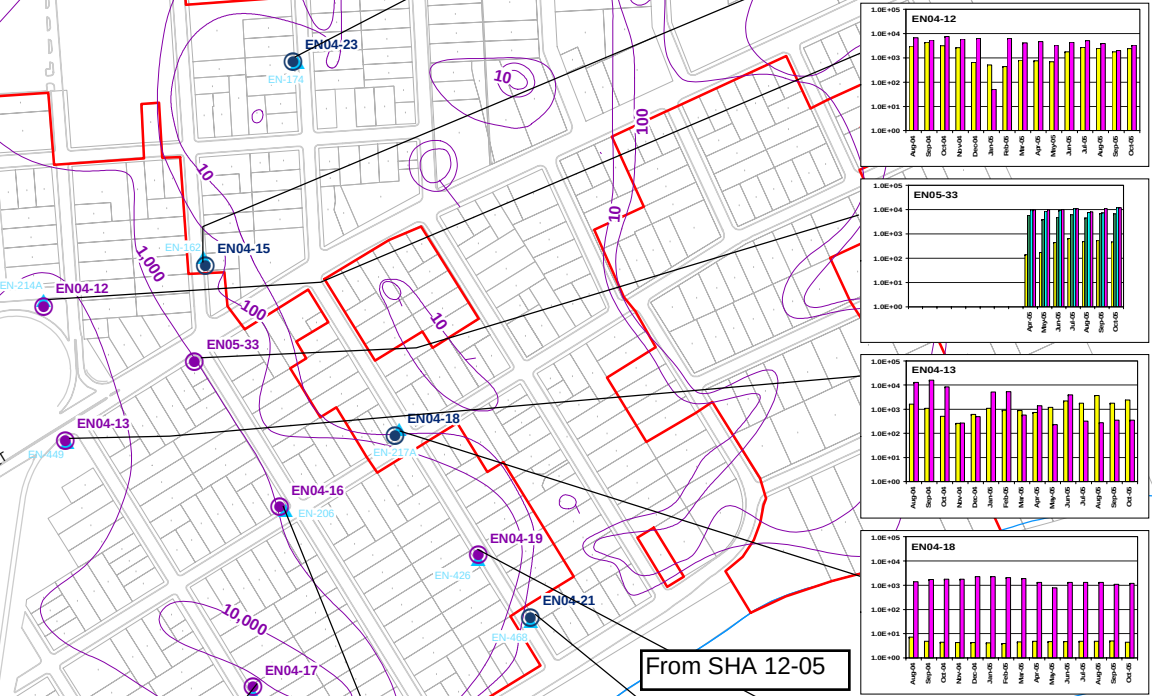
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10,000
EN04-17
EN04-12
EN05-33
EN04-13
EN04-18
From SHA 12-05

Figure B.33
TCE in Soil Vapor and Groundwater
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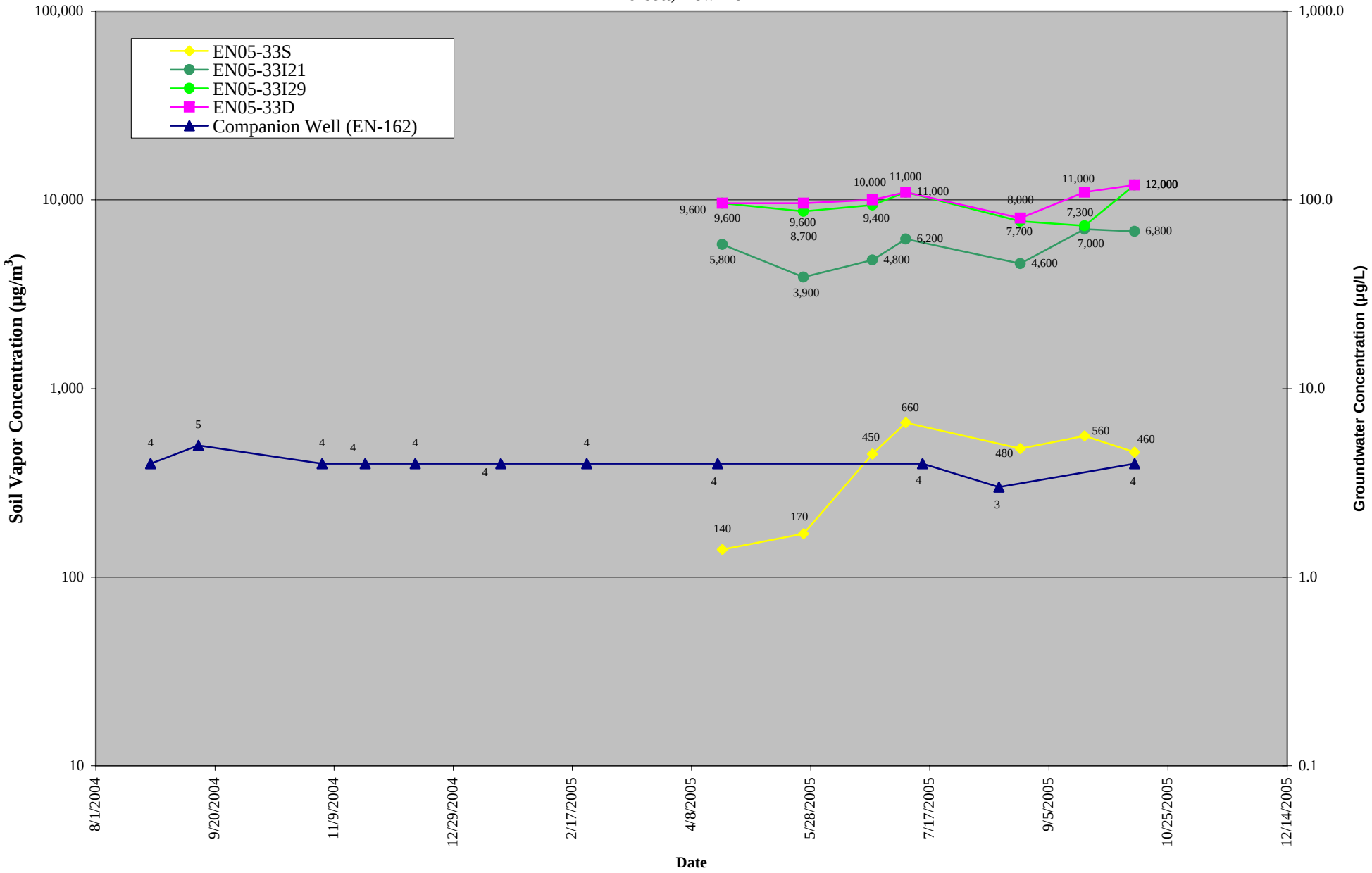
Comprehensive Operations, Maintenance, & Monitoring Program
Endicott, New York



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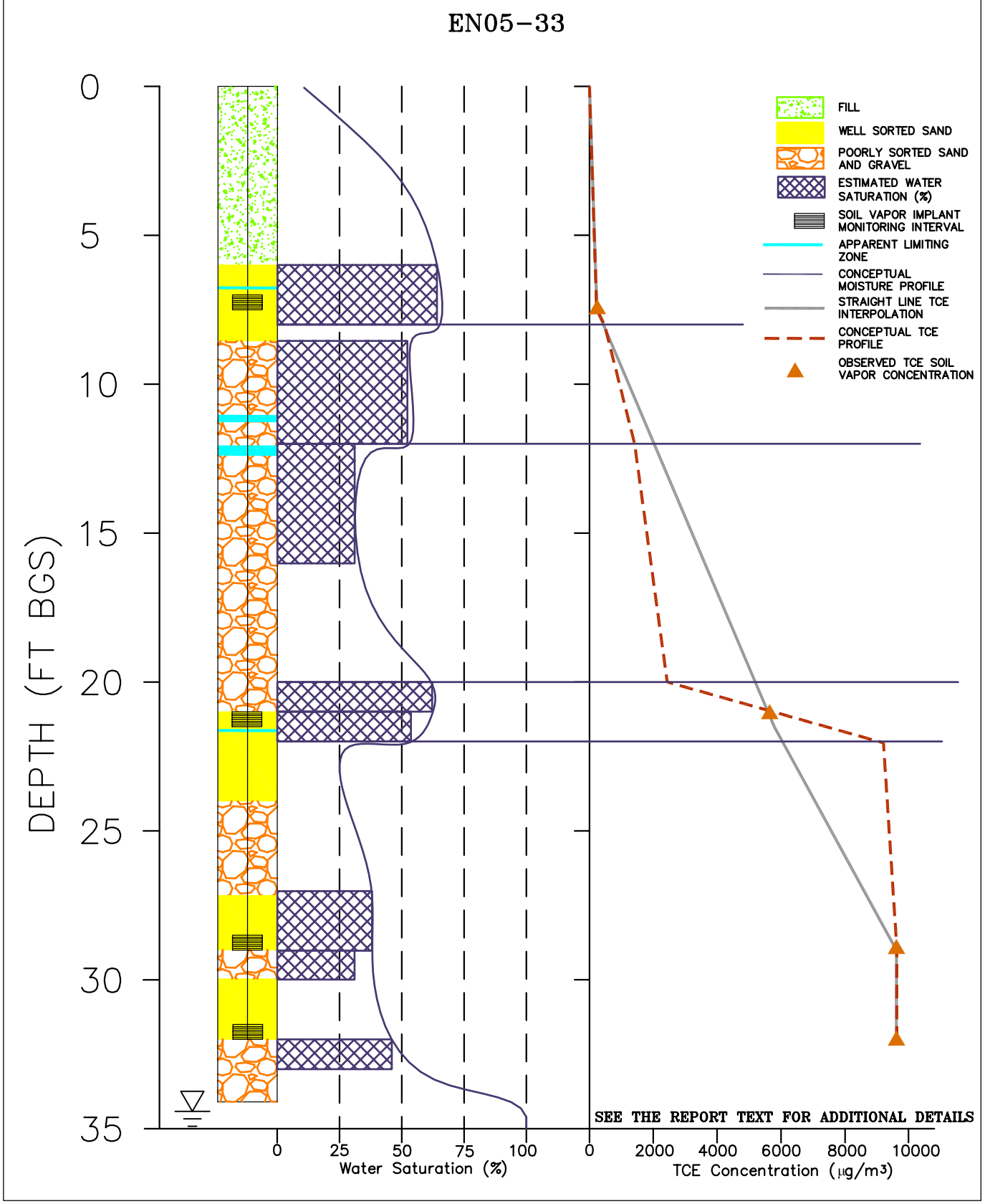

QUARTERLY REPORT – SOIL VAPOR MONITORING
COMPREHENSIVE OPERATIONS, MAINTENANCE & MONITORING PROGRAM
ENDICOTT, NEW YORK

SOIL AND SOIL VAPOR PROFILE

SHA
Sanborn, Head & Associates
Consulting Engineers & Scientists

NOT TO SCALE	DRAWN BY: EMB	FILE NO. 2200
DATE: JUNE 05	CHECKED BY: DBC	FIGURE NO. 2

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TABLE 2
Moisture Content and Gradation Analyses
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Comprehensive Operations, Maintenance and Monitoring Program
Endicott, New York

Implant Name	Sample ID	Depth (feet)	Gravimetric Moisture Content (%)	Assumed Bulk Density (lb/ft^3)	Assumed Porosity	Estimated Water Saturation (%)	Grain Size Distribution			Generalized Formation Designation
							% Gravel	% Sand	% Silt & Clay	
EN05-29	S-2	4 to 8	7	115	0.3	43	0	92.7	7.3	Well Sorted Sand w/ Silt Seam
EN05-33	S-2B	6 to 8	11	115	0.3	68	2.7	74.9	22.4	Well Sorted Sand w/ Silt Seam
	S-3B	8.5 to 12	7	120	0.25	54	62.6	33.9	3.5	Poorly Sorted Sand & Gravel w/ Silt Seam
	S-4	12 to 16	4	120	0.25	31	54.8	31	14.2	Poorly Sorted Sand & Gravel w/ Silt Seam
	S-6B	20 to 21	8	120	0.25	62	32.5	49.8	17.7	Poorly Sorted Sand & Gravel
	S-6C	21 to 22	9	115	0.3	55	0	84.4	15.6	Well Sorted Sand w/ Silt Seam
	S-8B	27.2 to 29	5	120	0.25	38	24	60.8	15.2	Poorly Sorted Sand & Gravel
	S-9A	29 to 29.9	4	120	0.25	31	37	42.8	20.2	Poorly Sorted Sand & Gravel
	S-10	32 to 33	6	120	0.25	46	59.9	29.4	10.7	Poorly Sorted Sand & Gravel
EN05-34	S-2B	7.5 to 8	10	115	0.3	61	0.7	79.9	19.4	Well Sorted Sand
	S-4A	8 to 10	4	120	0.25	31	60	39.4	10.6	Poorly Sorted Sand & Gravel
	S-4B	10 to 10.7	8	115	0.3	49	1.5	81.1	17.4	Well Sorted Sand
	S-4C	11.7 to 12	16	115	0.3	98	0	62.1	37.9	Well Sorted Sand
	S-5A	12 to 13	4	120	0.25	31	35.9	45.4	18.7	Poorly Sorted Sand & Gravel
	S-5B	13 to 14.5	13	115	0.3	80	9.6	62.7	27.7	Well Sorted Sand w/ Silt Seam

Notes:

1. This table provides a summary of grain size distribution and moisture content analyses completed by GeoTesting Express of Boxborough, Massachusetts, estimates of water saturation made based on assumed bulk density values, and generalized formation descriptions made by SHA based on field observations. See the soil vapor implant logs and laboratory data reports in Appendix B for additional information.

2. Implants EN05-29, EN05-33, and EN05-34 were installed by Parratt-Wolff, Inc. of East Syracuse, New York on April 18 and 19, 2005. Soil samples were documented, field screened, and classified by SHA.