In Situ Soil Mixing and Injection Using Large Diameter Auger

Joint Services Environmental Management Conference

May 21-24, 2007

Columbus, OH

In Situ Soil Mixing and Injection Using Large Diameter Auger

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Contents

- Objective
- Site Information
- Technology
- Data Collection
- Real Time Decisions
- Treatment Effectiveness
- Summary & Conclusion

Objective

- Present the technology for the treatment of a dense non-aqueous phase liquid (DNAPL) source area through "*in-situ soil mixing, with steam, hot air, and zero valent iron (ZVI) injection using large diameter auger (LDA)*"
- Evaluate the Effectiveness of the technology for the removal/treatment of VOC's/DNAPL from the subsurface

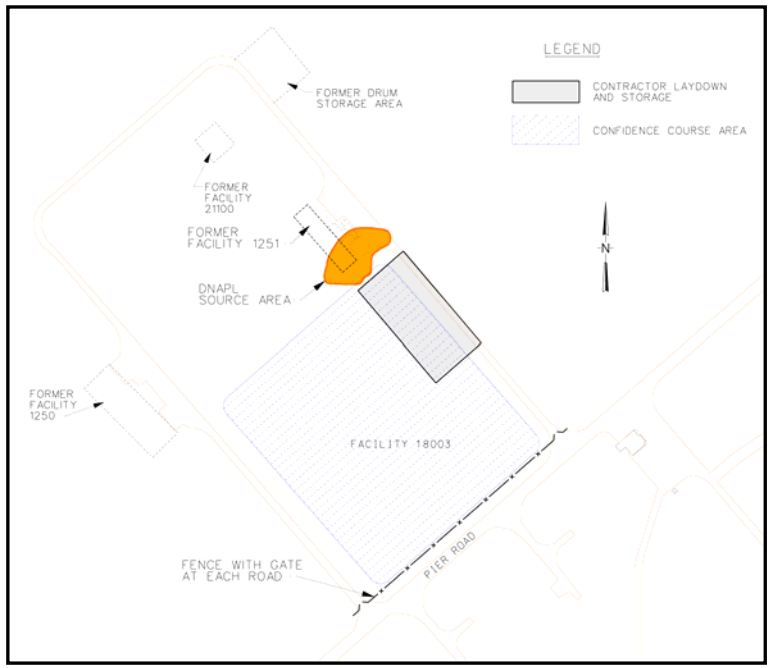
Site Information

- Location: Cape Canaveral Air Force Station, Florida
- Facilities
  - Security Police Confidence Course (SPCC)
  - Ordnance Support Facility (Facility 1381)

Site Information (cont.)

Security Police Confidence Course (SPCC)

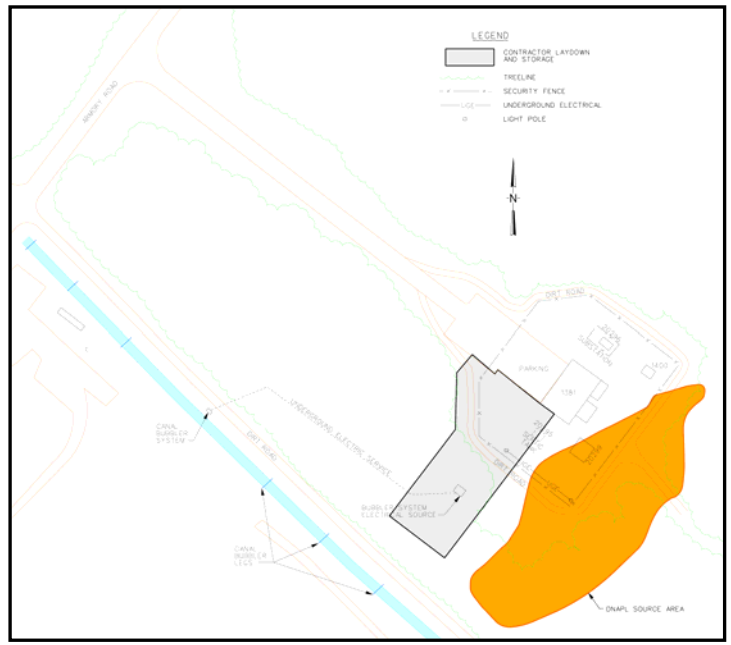
- Site currently used as an obstacle course for security forces.
- Disposal activities from former facilities /operations resulted in GW contamination.
  - Rocket Propellant and Chemical Storage
  - Rocket Assembly
  - Chemical Cleaning Lab
- Contaminants: TCE and breakdown products
- Estimated DNAPL Source Area is 0.2 acre



Site Information (cont.)

Ordnance Support Facility (Facility 1381)

- Since 1977 the facility was used as an ordnance support facility for the U.S. Coast Guard
- Disposal activities from past facility operations resulted in GW contamination
  - Metals Cleaning Lab
  - Tanker Truck Waste Disposal
- Contaminants of Concern: TCE and breakdown products
- Estimated DNAPL Source Area is 1.0 acre



Technology

- The technology consists of the following major elements:
  - Soil Mixing and Vapor Collection System
  - Off-gas Treatment System
    - Vapor Conditioning System
    - VOC Treatment System
  - Supervisory Control and Data Acquisition (SCADA) System

Technology (cont.)

Soil Mixing and Vapor Collection System

- Equipped with 8-foot diameter auger with ½-inch injection ports along two blades for a total of 14 ports
- Shears and mixes the soil as the auger advances below the ground surface while injecting hot air and steam
- Causes thermal desorption and volatilization of the VOCs from soil particles and interstitial spaces
- Hot air helps carry the volatilized contaminants to the surface
- Hot air and contaminants are captured in a containment shroud located at the surface operated under a vacuum

Treatment Effectiveness (cont.)

Auger

Crane

Technology (cont.)

Off-gas Treatment System

Vapor Conditioning System (VCS)

- Blower provides for the transport of vapor from the shroud to the VCS and through the treatment system
- The VCS consists of
  - Liquid Vapor knock-out (KO)/demister tank
  - Course particulate filter (20 microns)
  - Chiller (To cool the gas temperature from approximately 170^{o}F to less than 100^{o}F)
  - Reheater (To raise the temperature by 10^{o}F to 12^{o}F to reduce the relative humidity to 80% , and
  - Particulate filter (< 1 micron)

VOC mass in Performance Test Cell

Technology (cont.)

VOC Treatment System

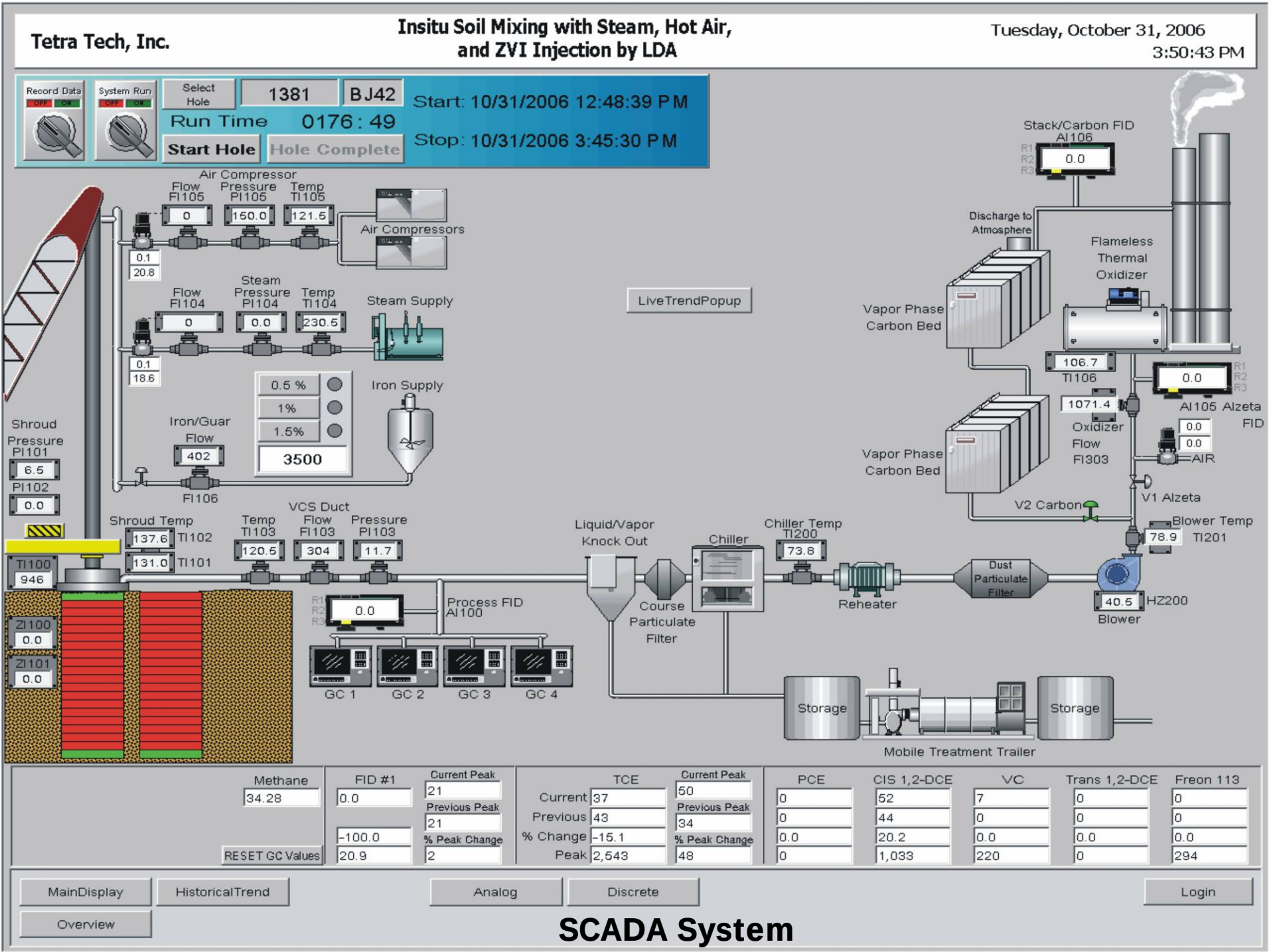
- The conditioned vapor stream consisting of VOC's is treated by the Flameless Thermal Oxidizer (FTO).
- The FTO primarily includes
  - The oxidizer (off-gas burns at 1700ºF)
  - Integral quench chamber (cool off-gas to 180°F)
  - Acid gas scrubber (remove the HCl gas from the vapor stream effluent prior to discharge into the atmosphere).
- GAC absorption vessels were used for backup treatment purposes when the FTO was shut down

Flameless Thermal Oxidizer

Technology (cont.)

Supervisory Control and Data Acquisition System

- The SCADA system allow effective coordination and control of various process parameters in the treatment train
- Collects and Stores data
- The SCADA system helps in making real time decisions


Tetra Tech, Inc.
Insitu Soil Mixing with Steam, Hot Air, and ZVI Injection by LDA
Tuesday, October 31, 2006
3:50:43 PM
Record Data
System Run
Select Hole
1381
BJ42
Run Time 0176 : 49
Start Hole
Hole Complete
Start: 10/31/2006 12:48:39 PM
Stop: 10/31/2006 3:45:30 PM
Air Compressor
Flow FI105
Pressure PI105
Temp TI105
0
150.0
121.5
Air Compressors
0.1
20.8
Steam
Flow FI104
Pressure PI104
Temp TI104
0
0.0
230.5
Steam Supply
0.1
18.6
0.5 %
1%
1.5%
3500
Iron Supply
Iron/Guar Flow
402
FI106
LiveTrendPopup
Shroud Pressure PI101
6.5
PI102
0.0
Shroud Temp
137.6 TI102
131.0 TI101
VCS Duct
Temp TI103
Flow FI103
Pressure PI103
120.5
304
11.7
TI100
946
ZI100
0.0
ZI101
0.0
R1
R2
R3
0.0
Process FID AI100
GC 1
GC 2
GC 3
GC 4
Liquid/Vapor Knock Out
Course Particulate Filter
Chiller
Chiller Temp TI200
73.8
Reheater
Dust Particulate Filter
Blower
40.5
HZ200
Blower Temp
78.9
TI201
Stack/Carbon FID AI106
0.0
Discharge to Atmosphere
Flameless Thermal Oxidizer
Vapor Phase Carbon Bed
Vapor Phase Carbon Bed
106.7
TI106
1071.4
Oxidizer Flow FI303
0.0
AI105 Alzeta FID
0.0
AIR
V1 Alzeta
V2 Carbon
Storage
Storage
Mobile Treatment Trailer
Methane
34.28
RESET GC Values
FID #1
0.0
-100.0
20.9
Current Peak
21
Previous Peak
21
% Peak Change
2
TCE
Current 37
Previous 43
% Change -15.1
Peak 2,543
Current Peak
50
Previous Peak
34
% Peak Change
48
PCE
0
0
0.0
0
CIS 1,2-DCE
52
44
20.2
1,033
VC
7
0
0.0
220
Trans 1,2-DCE
0
0
0.0
0
Freon 113
0
0
0.0
294
MainDisplay
HistoricalTrend
Analog
Discrete
Login
Overview
SCADA System

Data Collection

- Data Collection
  - Field Instruments
  - Process Equipment
  - Gas Chromatographs (GC's)
    - Used to speciate the contaminants for decision making in the field
    - Also used for post treatment mass removal estimates.
  - Flame Ionization Detectors (FID's)
    - FID is used to collect instantaneous total VOC measurements from the off-gas stream.
    - Gives an instant gross estimate of where and how much contamination is present at a certain depth.

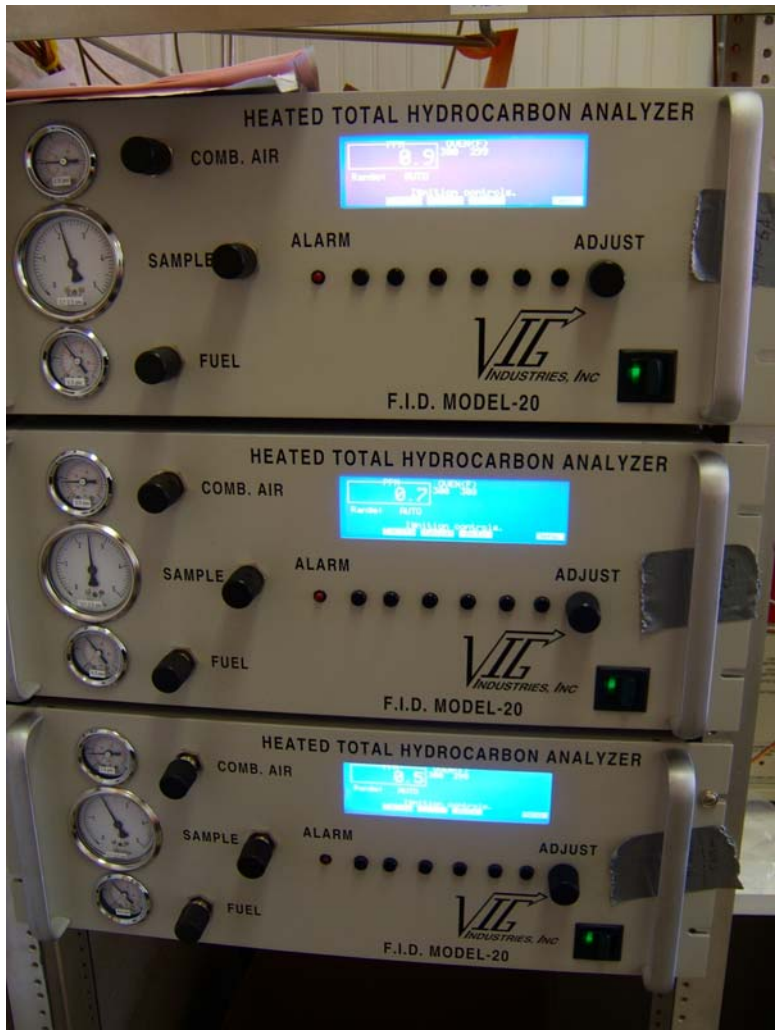
Data Collection

- The SCADA system integrates FIDs, GCs, and other instruments
- The SCADA system collects and stores data in SQL Server Database for
  - Reporting
  - Trending
  - Analysis

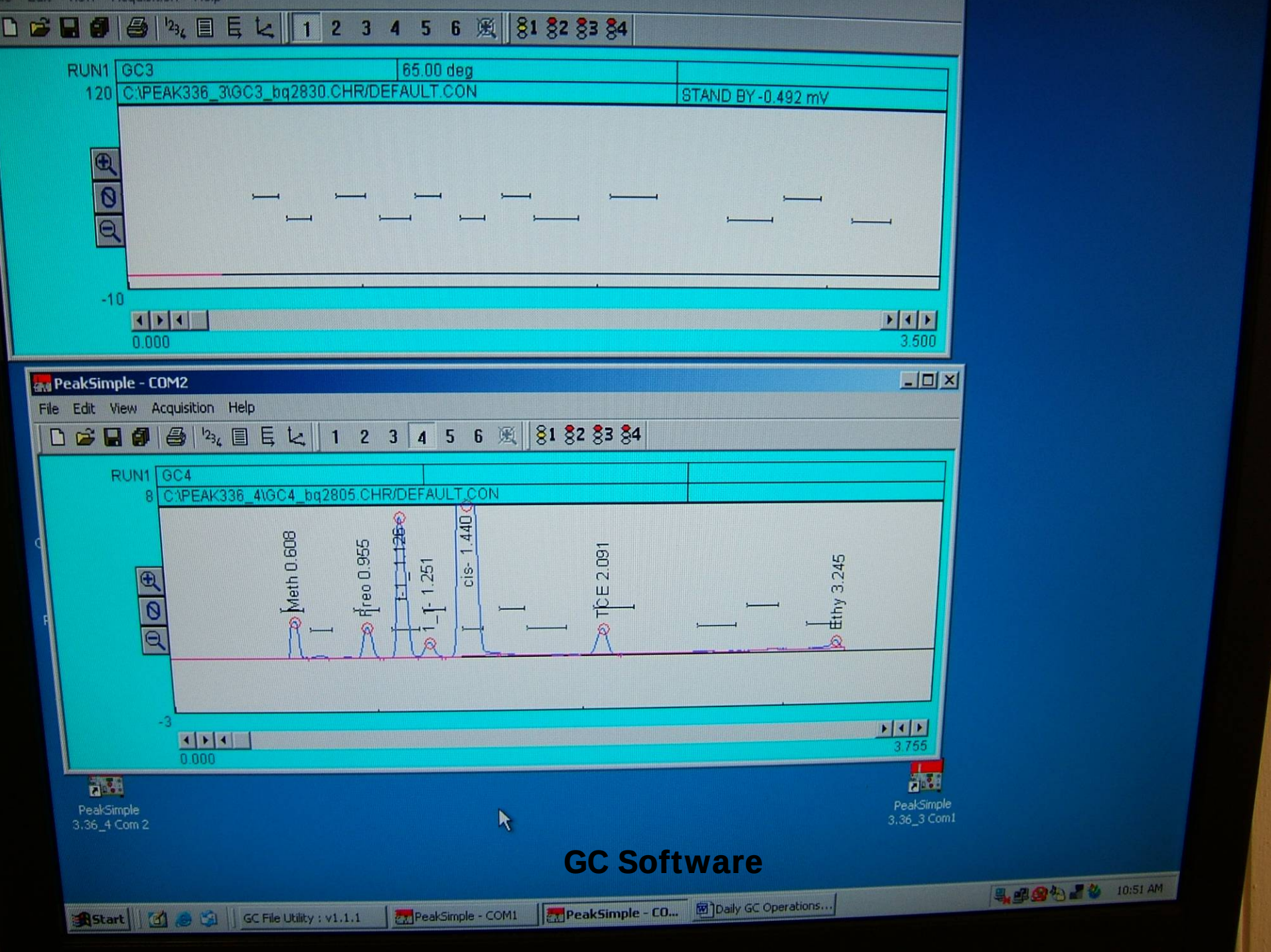
Sample Conditioning System

Gas Chromatographs

Data Collection (cont.)



Flame Ionization detector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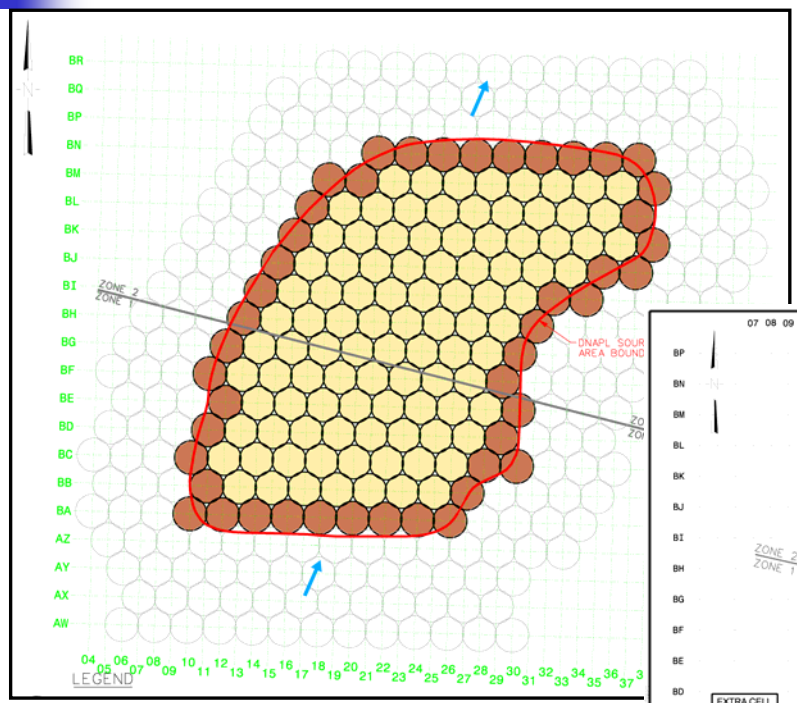
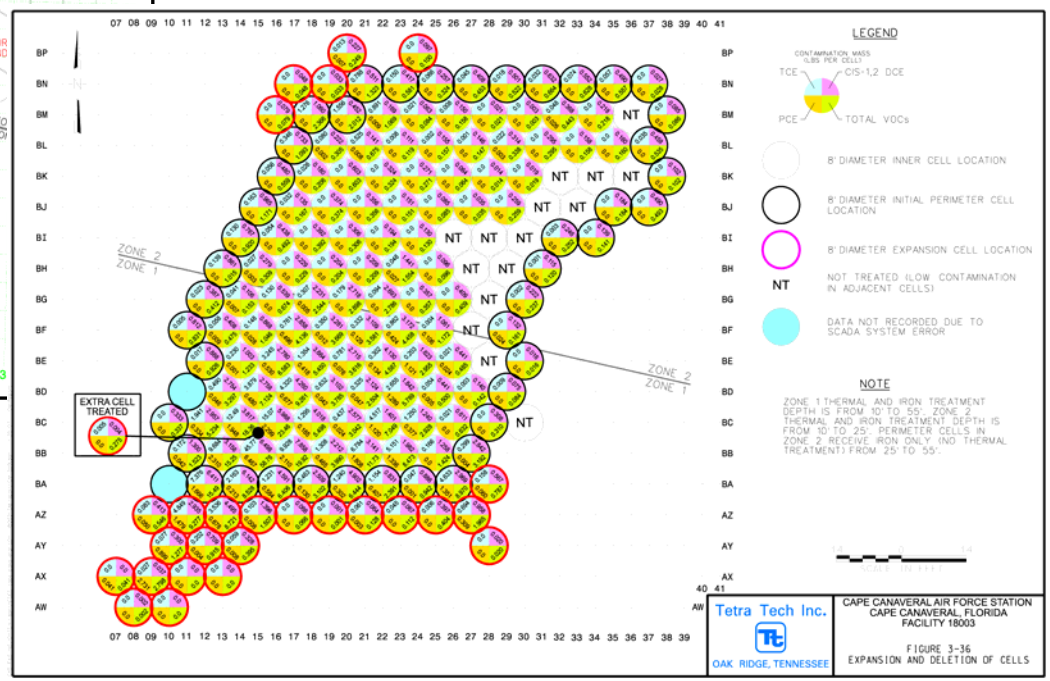
120 C:\PEAK336_3\GC3_bq2830.CHR/DEFAULT.CON STAND BY -0.492 mV
-10
0.000
3.500
PeakSimple - COM2
File Edit View Acquisition Help
RUN1 GC4
8 C:\PEAK336_4\GC4_bq2805.CHR/DEFAULT.CON
Meth 0.608
Freo 0.955
1,1-1.125
1,1-1.251
cis-1.440
TCE 2.091
Ethy 3.245
-3
0.000
3.755
PeakSimple 3.36_4 Com 2
PeakSimple 3.36_3 Com1
GC Software
Start
GC File Utility : v1.1.1
PeakSimple - COM1
PeakSimple - CO...
Daily GC Operations...
10:51 AM

Real Time Decisions

- Data from the FIDs and GCs were used to determine trends in depth, concentration, and location of contamination requiring treatment.
- Identified data trends in contamination and enabled on-site field personnel and managers to make real-time decisions on treatment.
- Real Time Decisions
  - Deeper Contamination Treatment
  - Expansion and Deletion of Cells
  - Additional Thermal Treatment Time

Real Time Decisions (cont.)





Planned and Modified SPCC Treatment Area

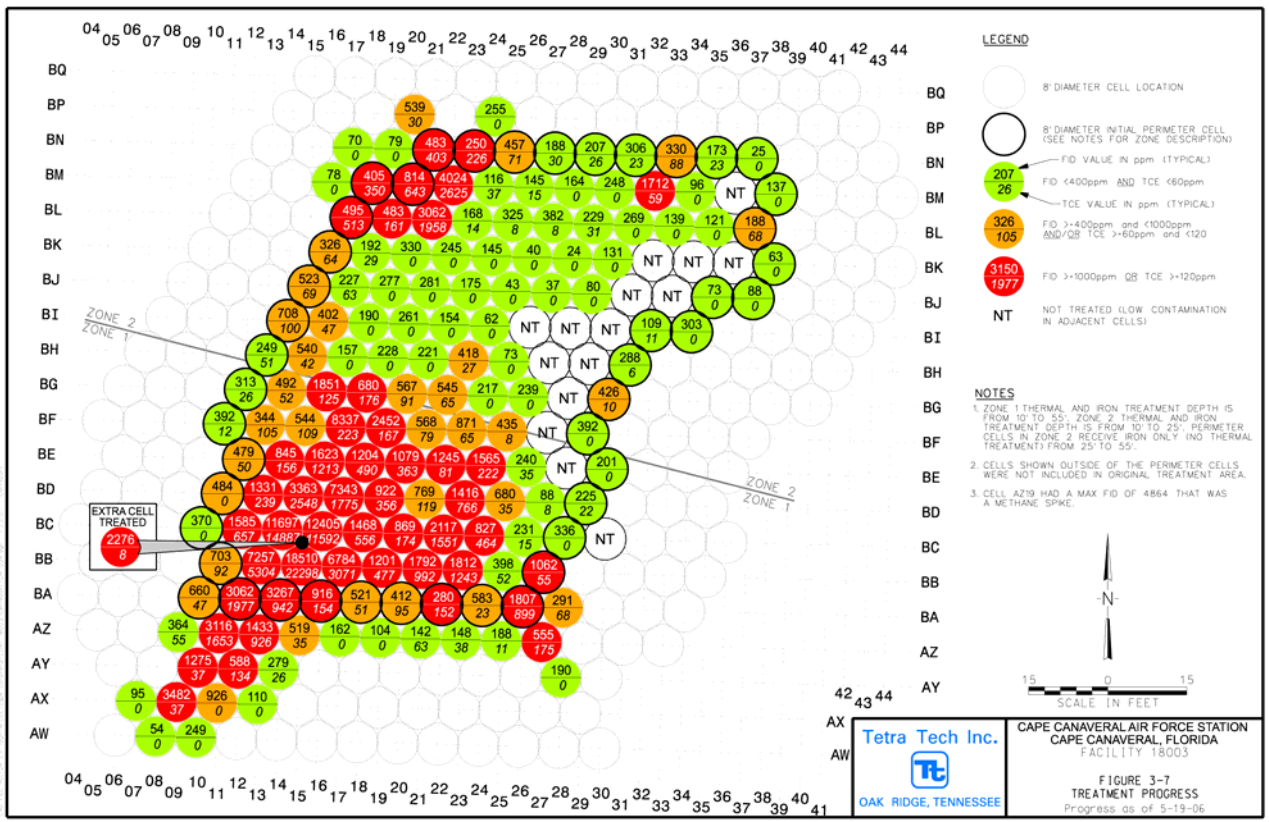
Treatment Effectiveness

- Used "Multiple Lines of Evidence" to evaluate Treatment Effectiveness
  - Evaluation of Several Re-Treated Cells
  - Total Mass Removed
  - Pre and Post Treatment Sampling Comparison.

Treatment Effectiveness (cont.)

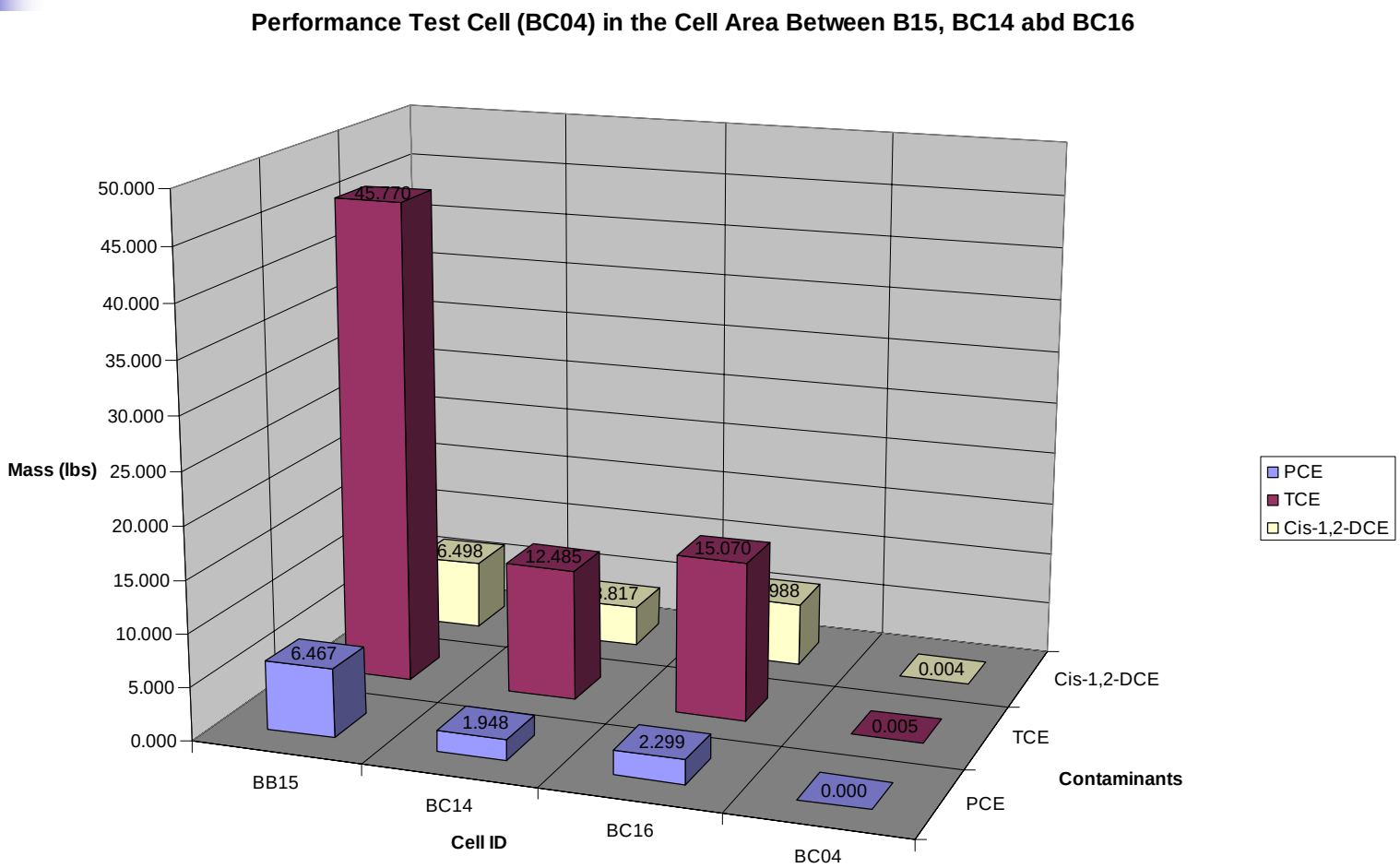
SPCC

Evaluation of VOC reduction in previously treated area



Performance Test Cell Location

Treatment Effectiveness (cont.)



VOC mass in Performance Test Cell

Treatment Effectiveness (cont.)

SPCC

VOC Mass Removal (389 lbs)

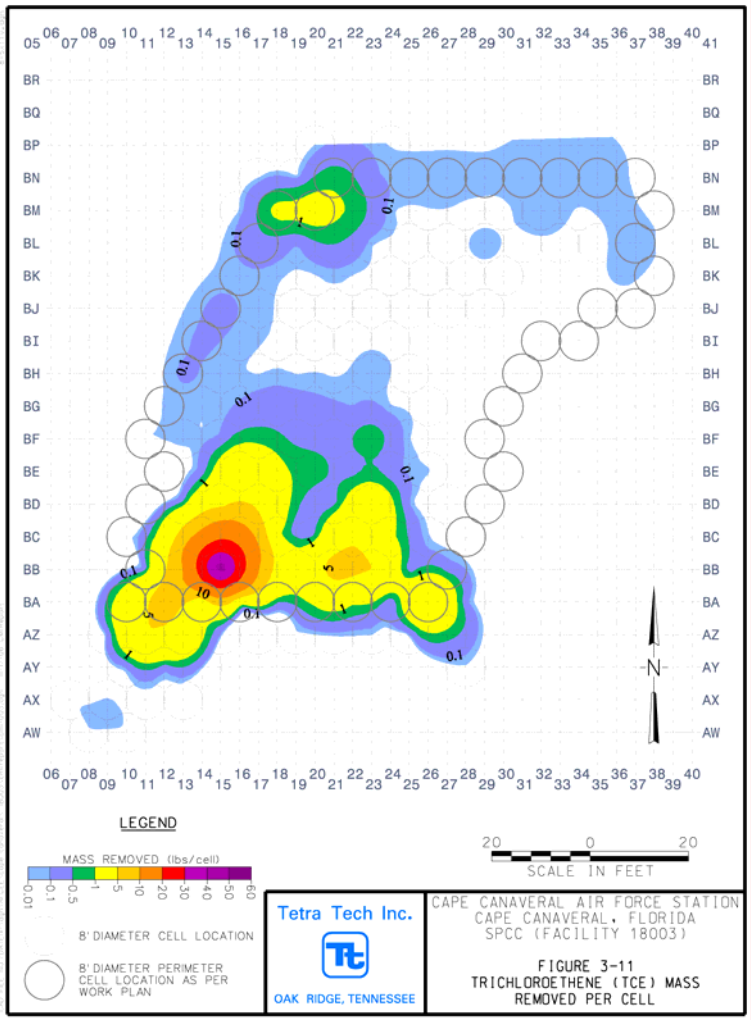
Contaminants	PCE	TCE	Cis-1,2DCE	Trans-1,2-DCE	VC	Freon 113	Benzene	Toluene	Ethyl benzene	1,1-DCA	1,1,1-TCA
Mass (lbs)	37.97	173.05	176.52	0.427	0.47	0.38	0.000	0.001	0.000	0.093	0.088
Percent of Total Mass for SPCC	9.76	44.49	45.38	0.11	0.12	0.10	0.00	0.00	0.00	0.02	0.02

Total Mass Removed From SPCC

Treatment Effectiveness (cont.)

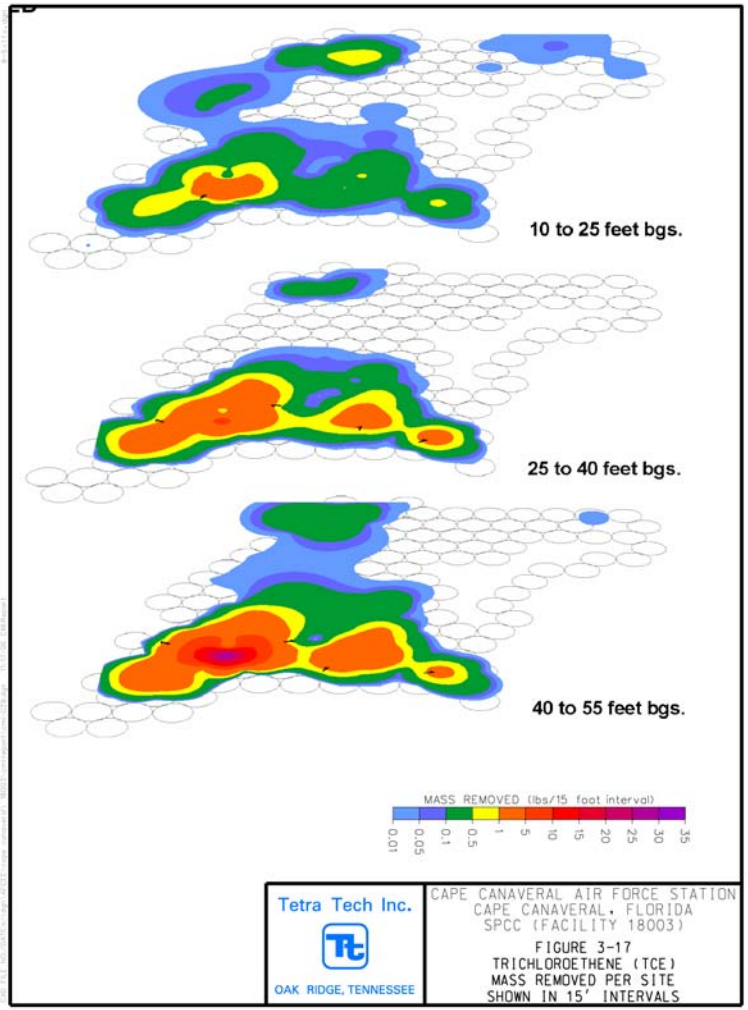
SPCC

Mass and Concentration Profiles



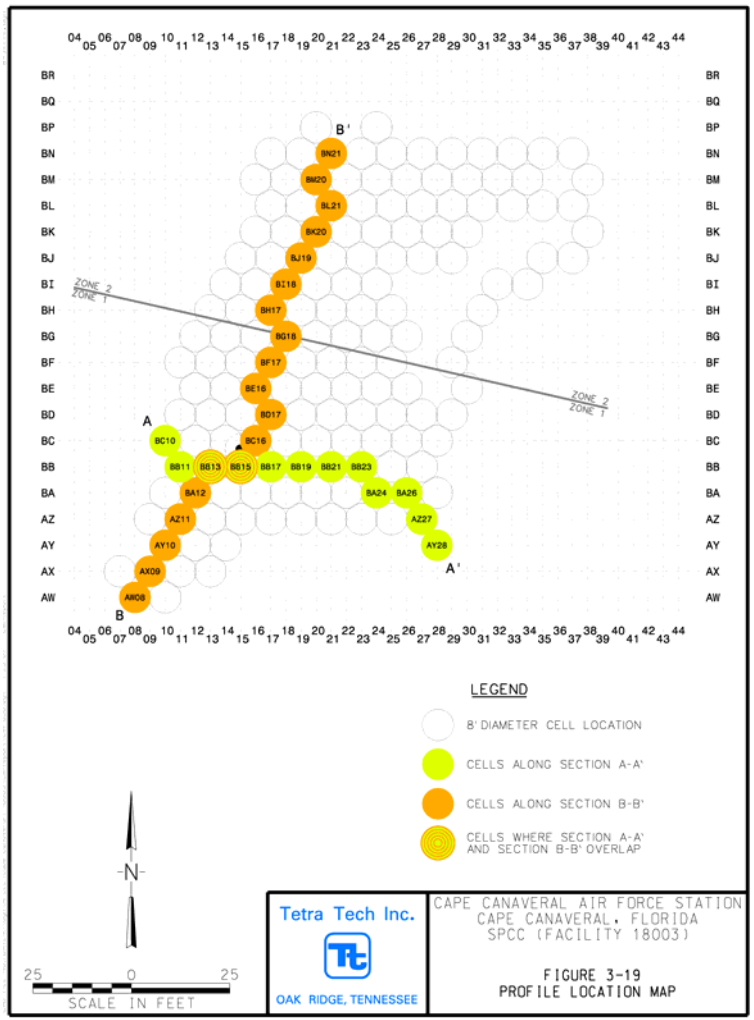
TCE Mass Removed Per Cell

Treatment Effectiveness (cont.)



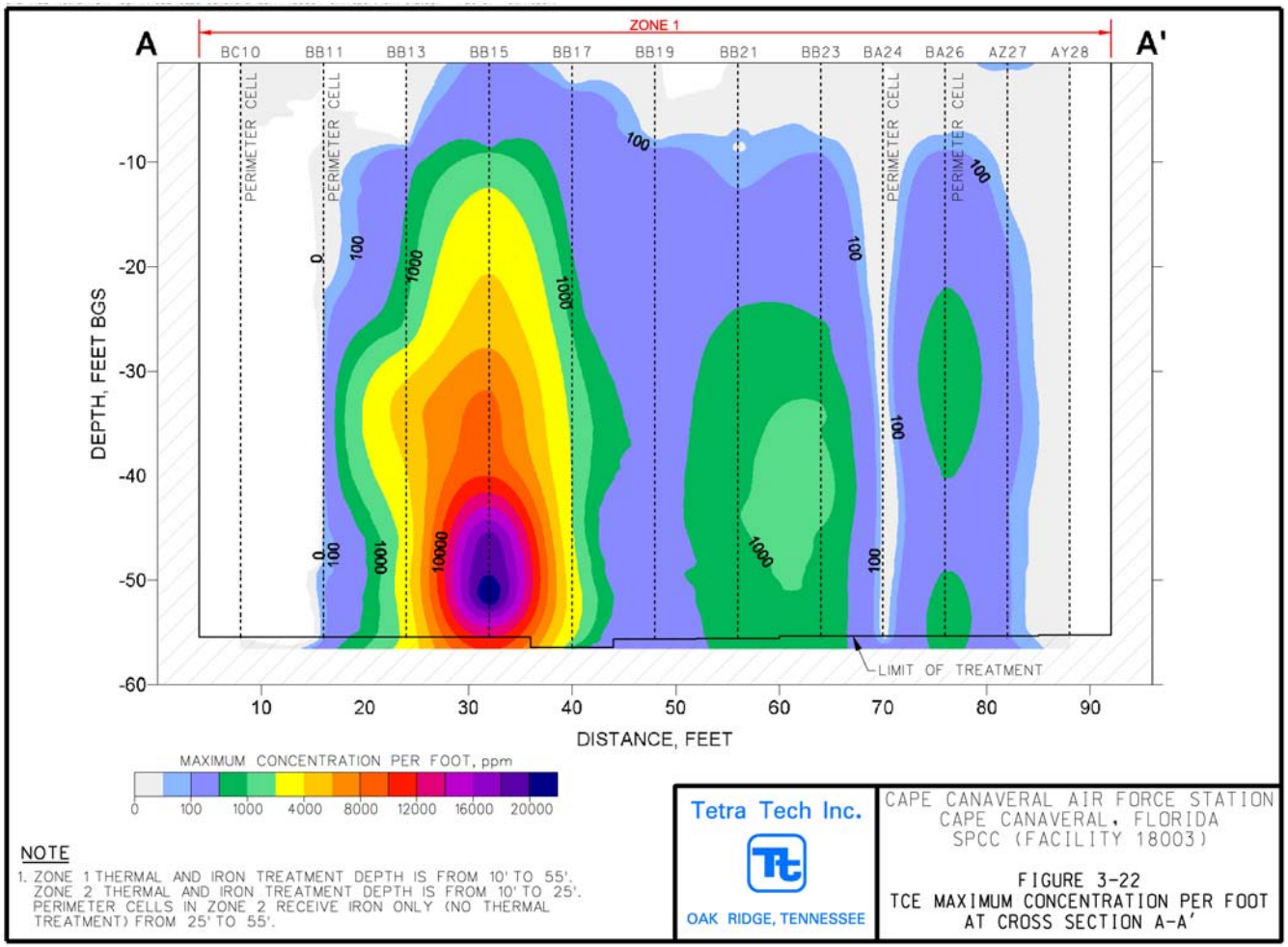
TCE Mass Removed in 15 Feet Intervals

Treatment Effectiveness (cont.)



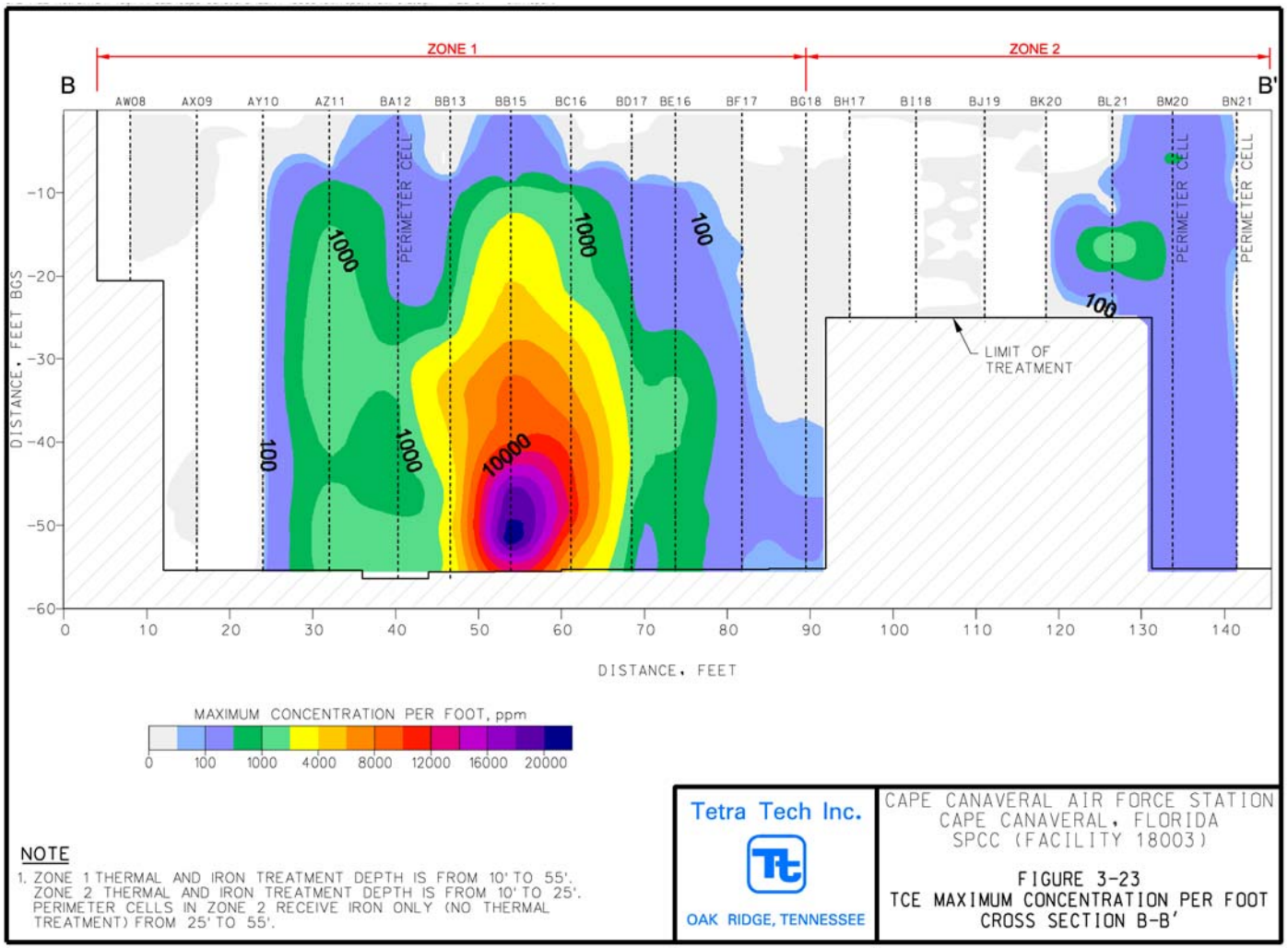
Profile Location

Treatment Effectiveness (cont.)



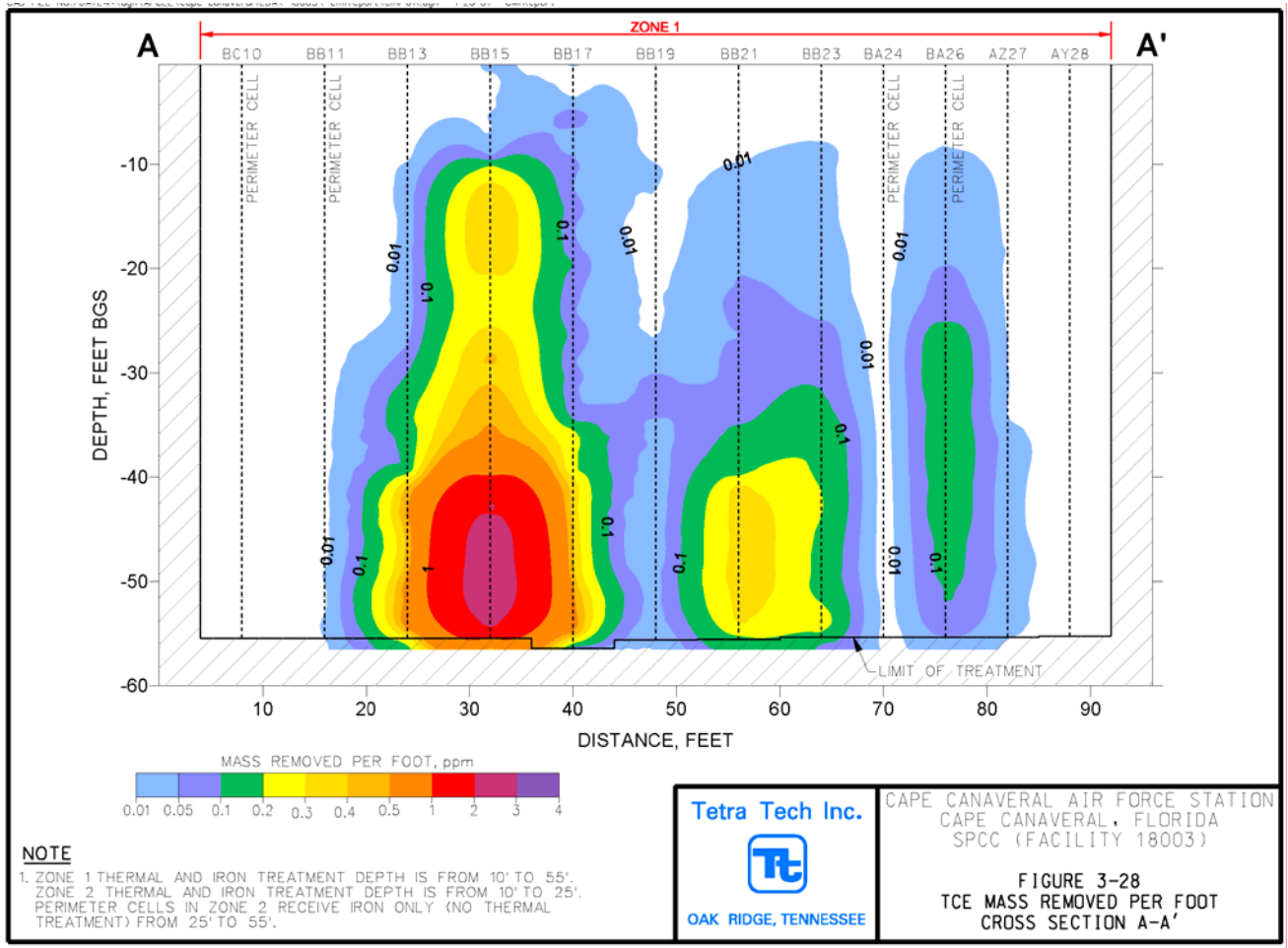
TCE Max Concentration Per Foot (A-A')

Treatment Effectiveness (cont.)



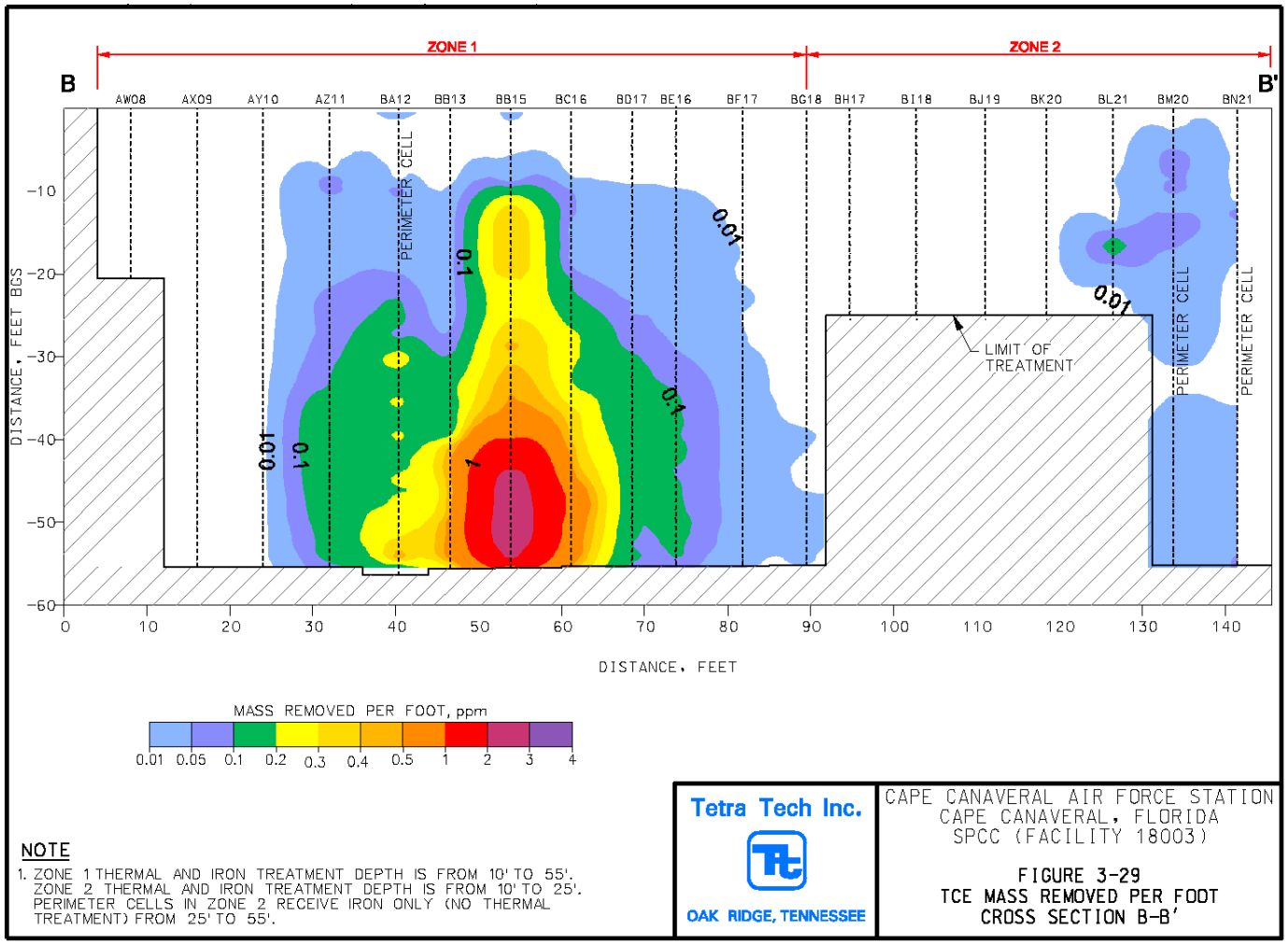
TCE Max Concentration Per Foot (B-B')

Treatment Effectiveness (cont.)



TCE Mass Removed Per Foot (A-A')

Treatment Effectiveness (cont.)

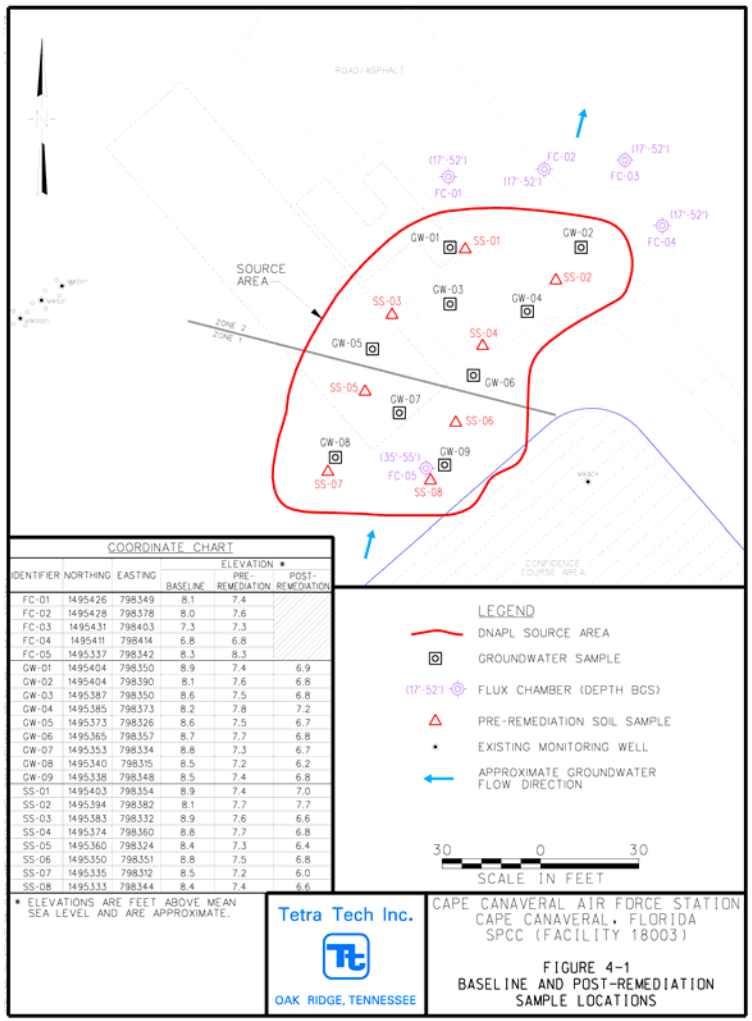


TCE Mass Removed Per Foot (B-B')

Treatment Effectiveness (cont.)

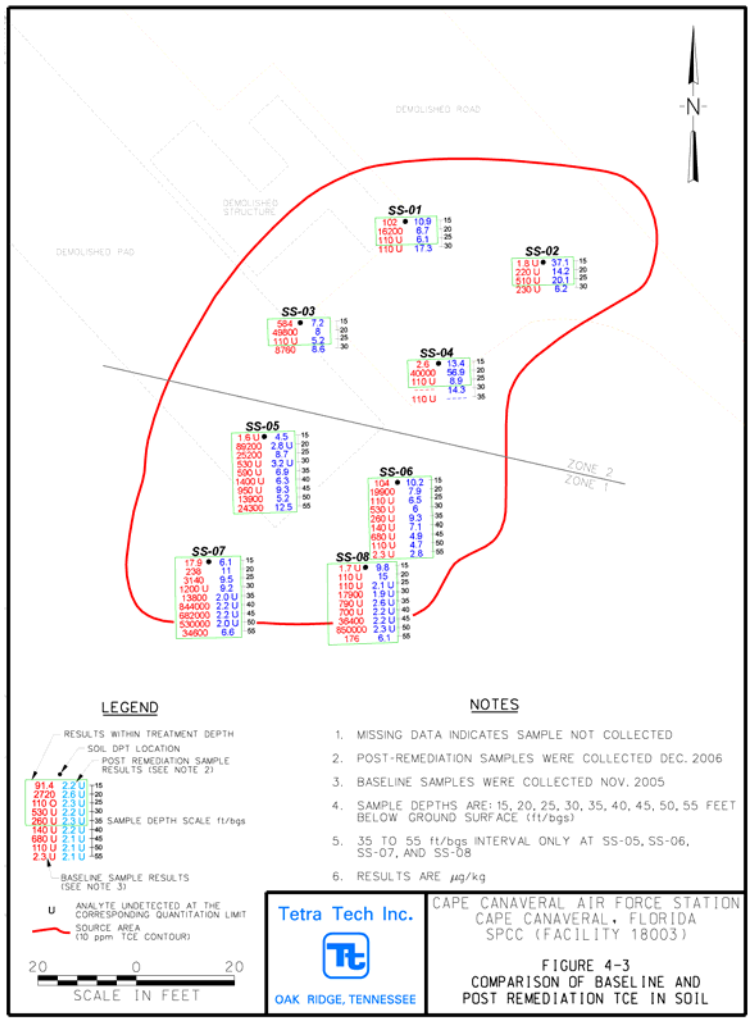
SPCC

Comparison of baseline and post-remediation concentrations in soil & GW



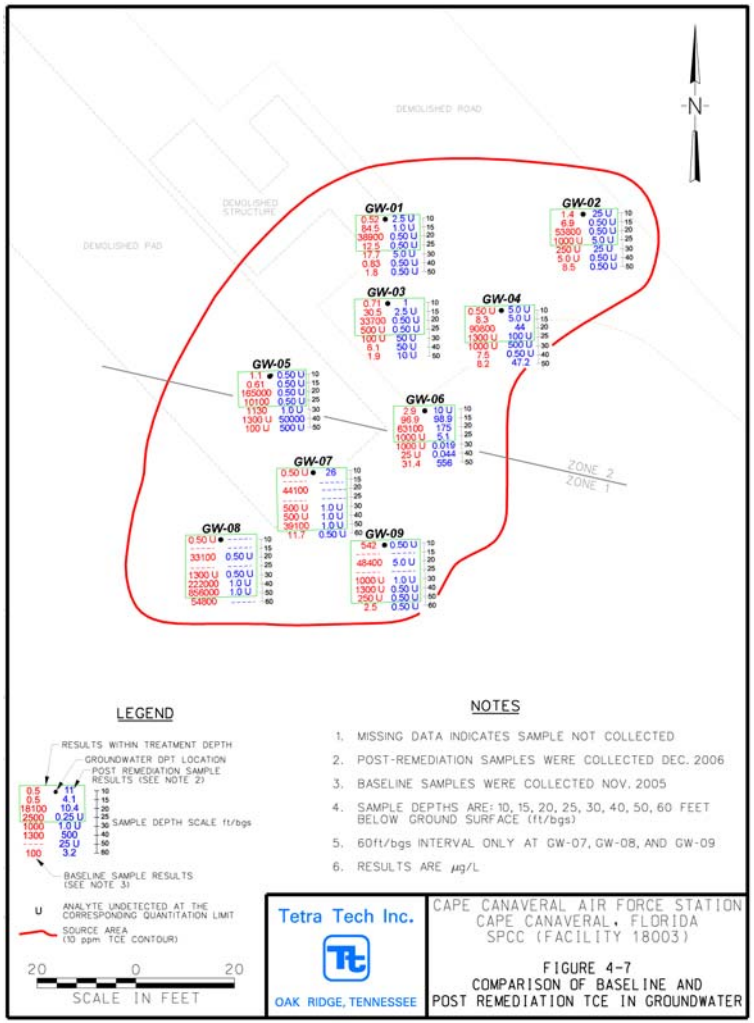
Baseline and Post-remediation Sample Locations

Treatment Effectiveness (cont.)



Comparison of Baseline and Post-remediation TCE in Soil

Treatment Effectiveness (cont.)

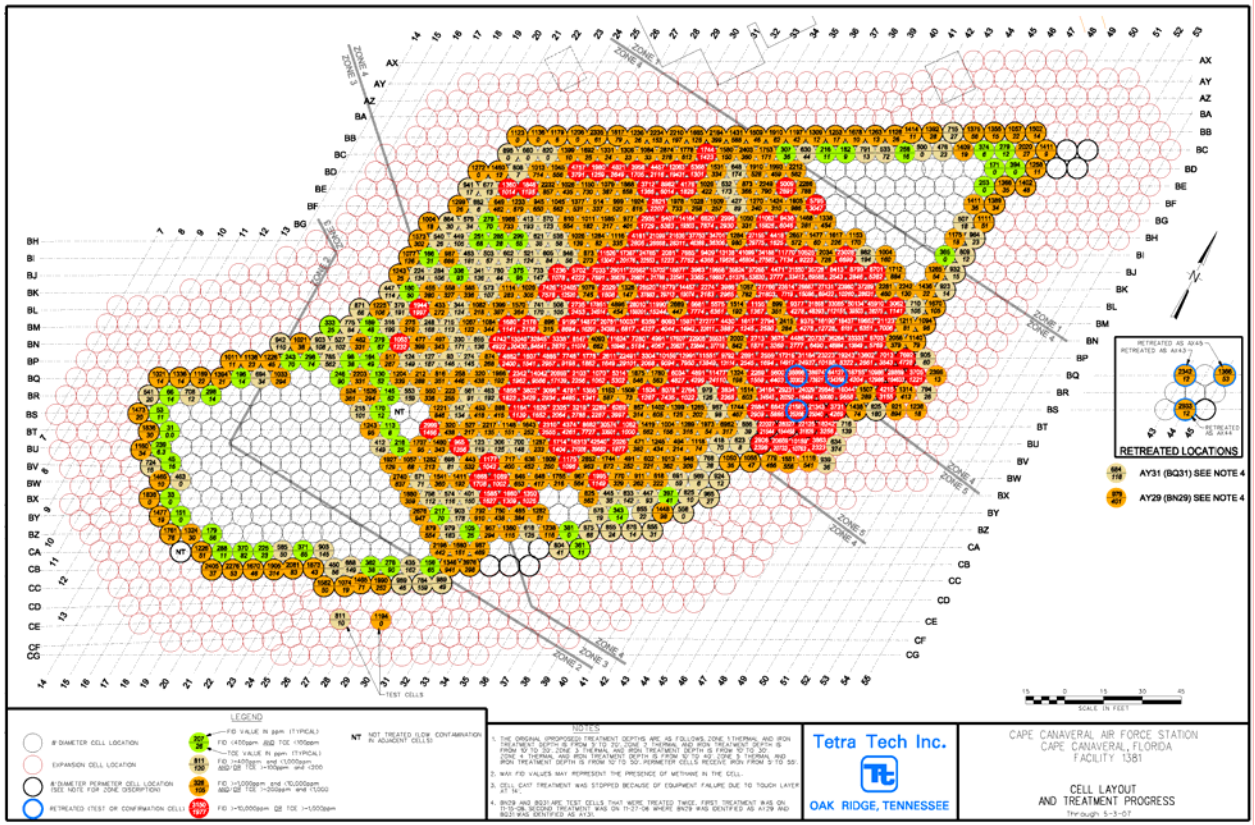


Comparison of Baseline and Post-remediation TCE in GW

Treatment Effectiveness (cont.)

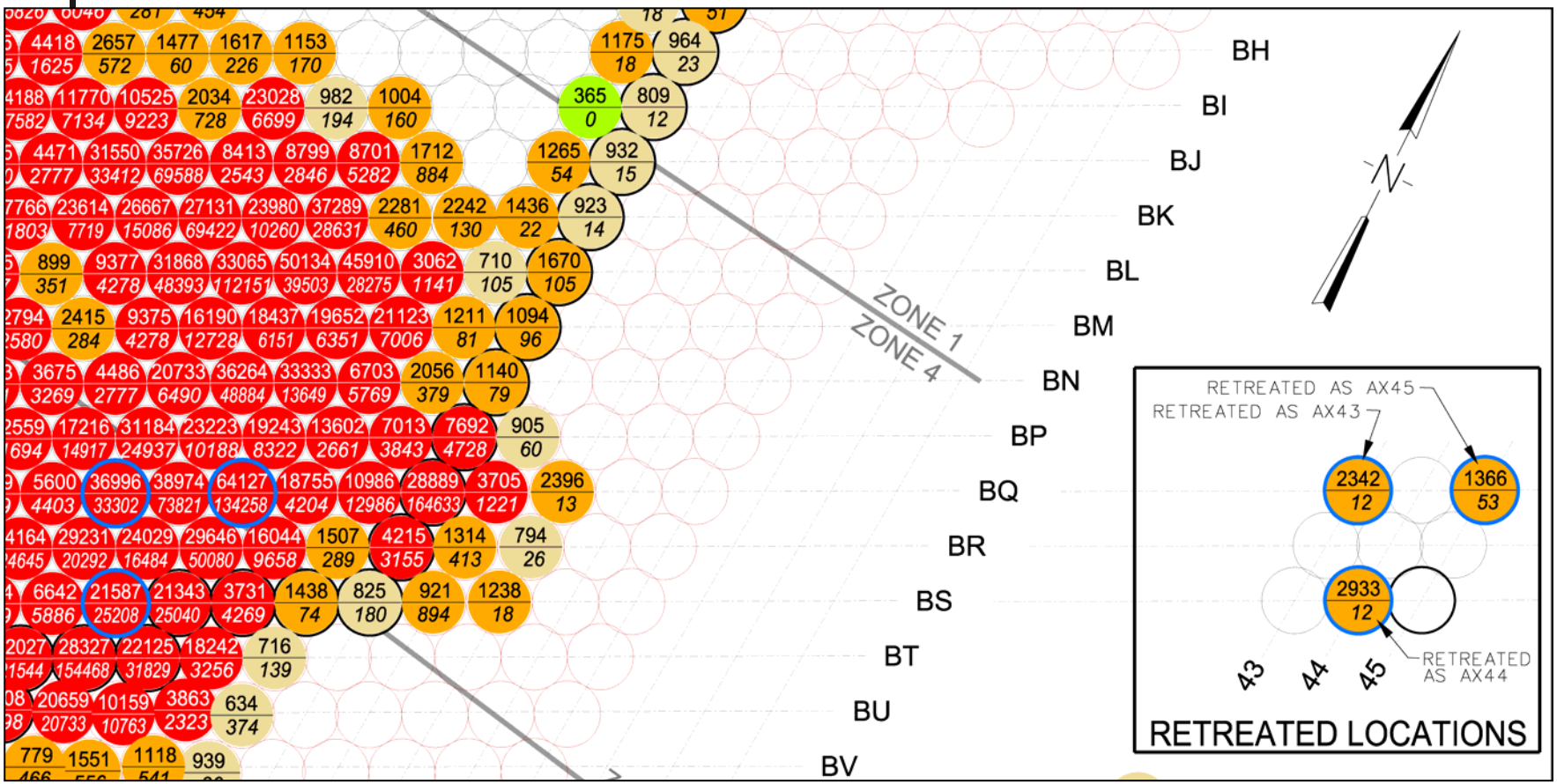
Facility 1381

Evaluation of VOC reduction in previously treated area



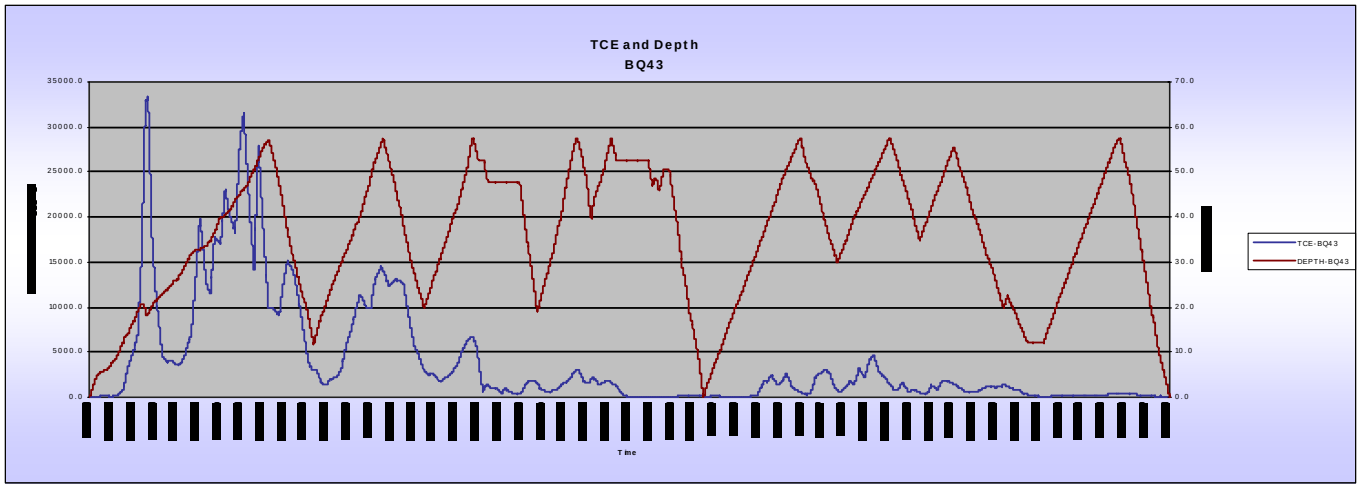
Performance Test Cell Location

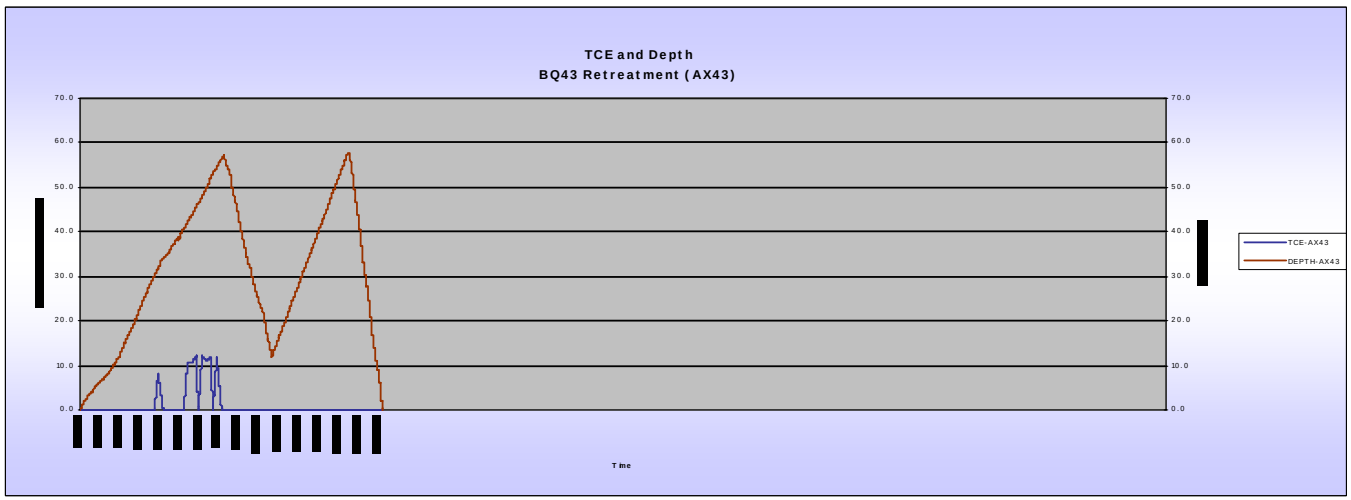
Treatment Effectiveness (cont.)



Performance Test Cell Location

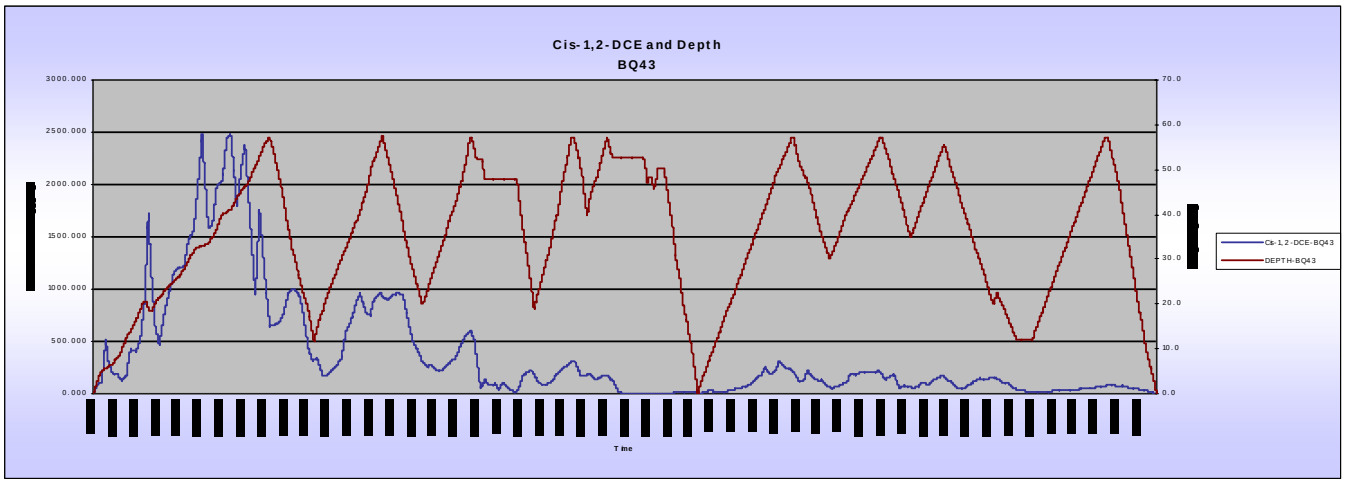
Treatment Effectiveness (cont.)

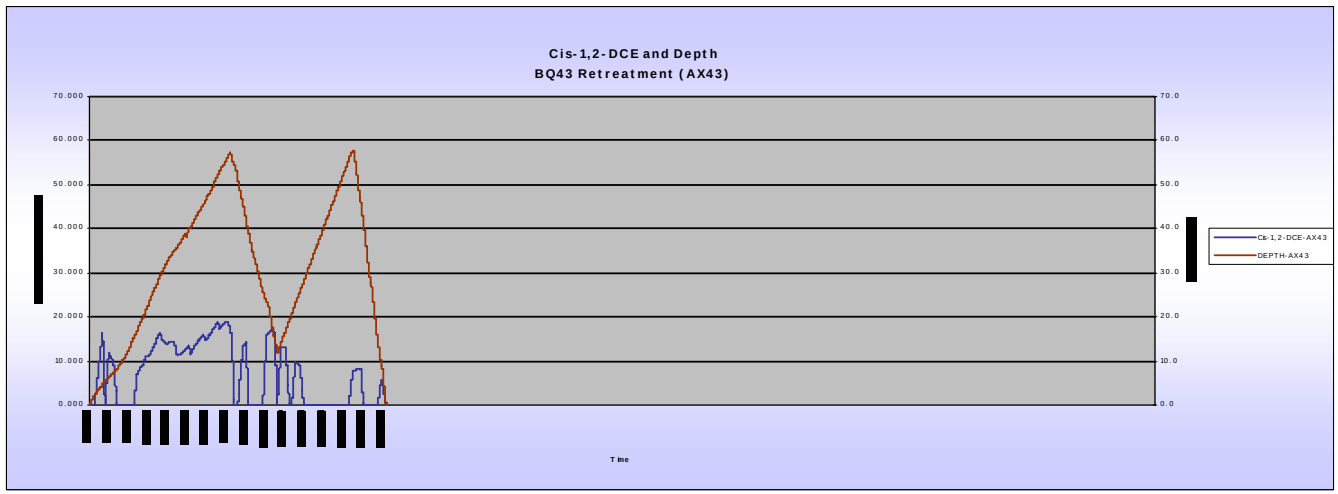




BQ43 and BQ43 Retreatment-TCE Concentration vs. Depth

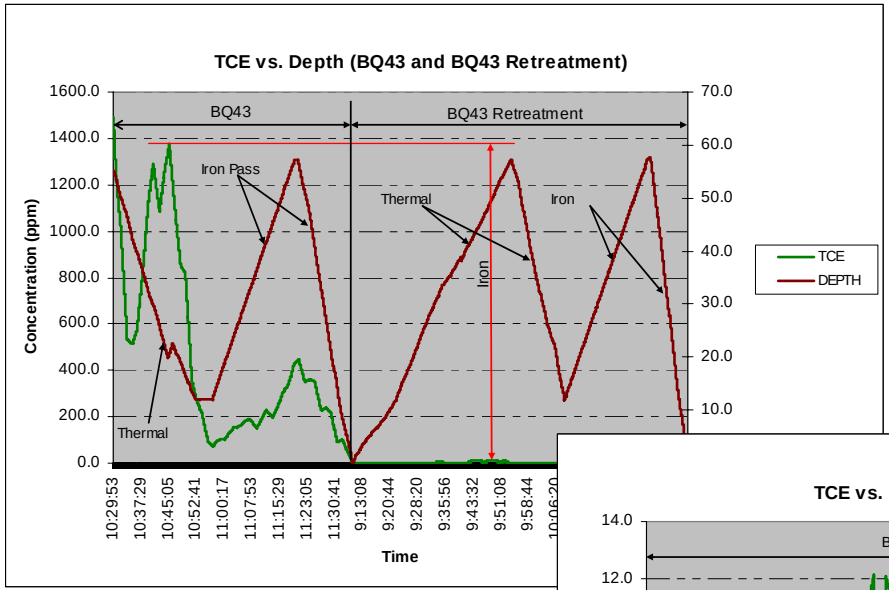
Treatment Effectiveness (cont.)

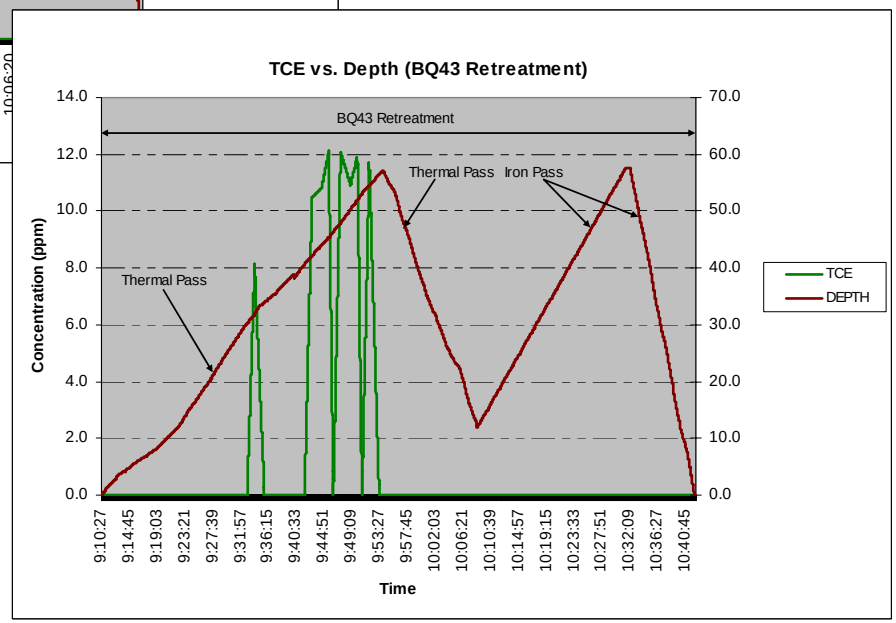




BQ43 and BQ43 Retreatment-Cis-1,2-DCE Concentration vs. Depth

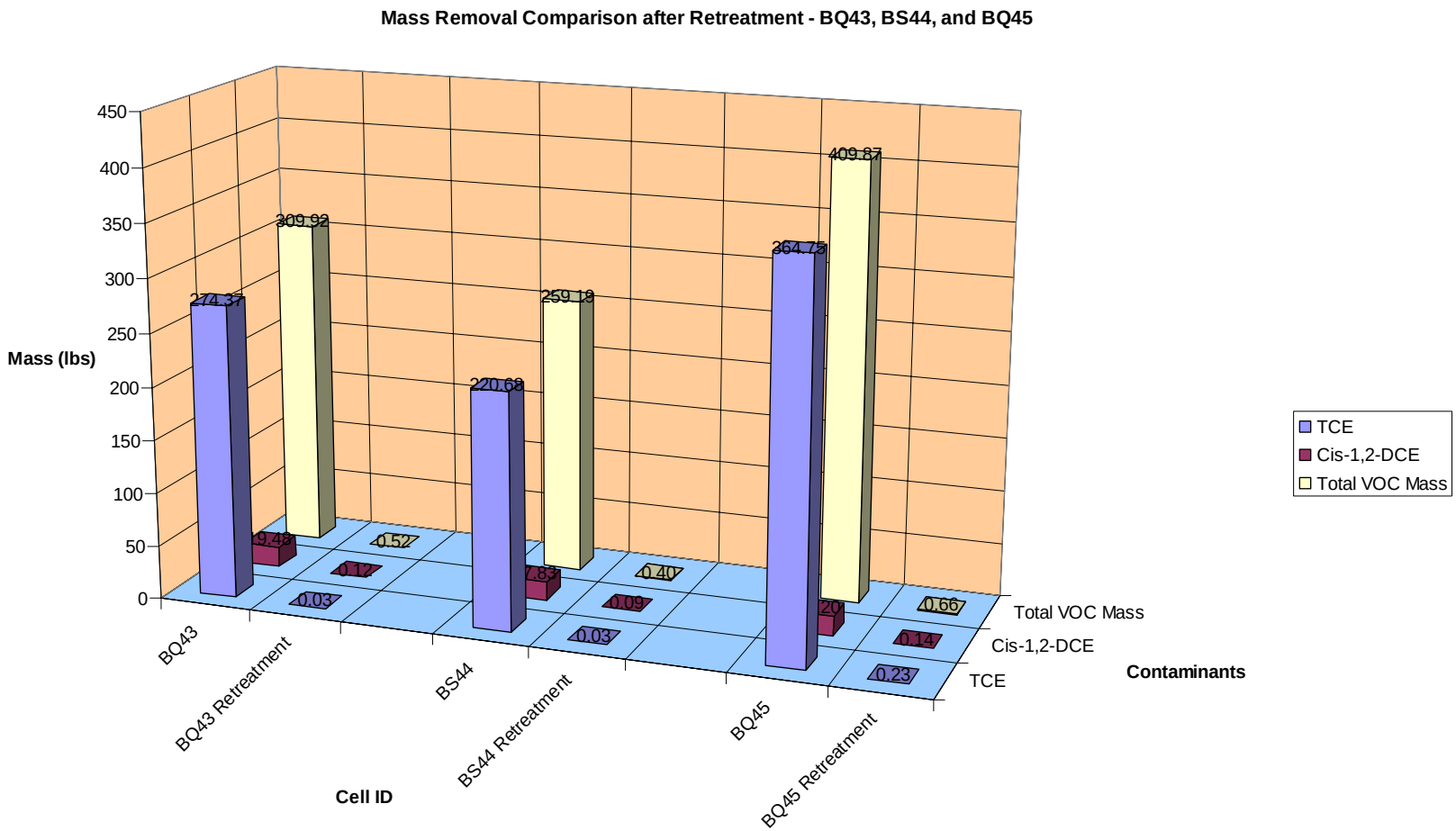
Treatment Effectiveness (cont.)





BQ43 and BQ43 Retreatment-TCE Concentration vs. Depth

Treatment Effectiveness (cont.)



VOC mass in Performance Test Cells (BQ43, BS44, and BQ45)

Treatment Effectiveness (cont.)

Facility 1381

VOC Mass Removal (Up to 05/03/2007 - 11,401 lbs)

Contaminants	PCE	TCE	Cis-1,2DCE	Trans-1,2-DCE	VC	Freon 113	Benzene	Toluene	Ethyl benzene	1,1-DCA	1,1,1-TCA
Mass (lbs)	1.318	9400.23	1229.51	2.72	108.38	616.46	0.00	0.88	0.003	9.489	31.71
Percent of Total Mass for SPCC	0.01	82.45	10.78	0.02	0.95	5.41	0.00	0.01	0.00	0.08	0.28

Total Mass Removed From Facility 1381

Treatment Effectiveness (cont.)

- Treatment at Facility 1381 is ongoing
- Treatment expected to be complete at the end of May

Summary & Conclusions

- In-situ soil mixing, with steam, hot air, and zero valent iron (ZVI) injection using large diameter auger (LDA) is an effective technology for the removal/treatment of VOCs/DNAPL from Subsurface
- SPCC
  - Number of Cells Treated – 157
  - Total Volume - 9,000 cu. yds.
  - Total VOC Removed – 389 lbs.
- Site 1381 (Up to May 03, 2007)
  - Number of Cells Treated – 659
  - Total Volume – Approximately 36,000 cu. yds.
  - Total VOC Removed– 11,401 lbs.

Acknowledgements

Project Team

- United States Air Force, Installation Restoration Program, 45 CES/CEVR, PAFB, FL
- Air Force Center For Environmental Excellence, Brooks City-Base, TX
- Environmental Protection Agency
- Florida Department of Environmental Protection

Subcontractors

- CORE Engineering & Construction, Inc.
- Florida Environmental Compliance Corporation
- KB Labs