



CTI and Associates, Inc.

IPEC 2013
San Antonio, Texas

Presented by :

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Use of Innovative Soil Vapor Extraction System for
Delineation and Remediation of Vadous Zone
Impacted with Chlorinated Hydrocarbons

The SITE: A third party operated Manufacturing Facility



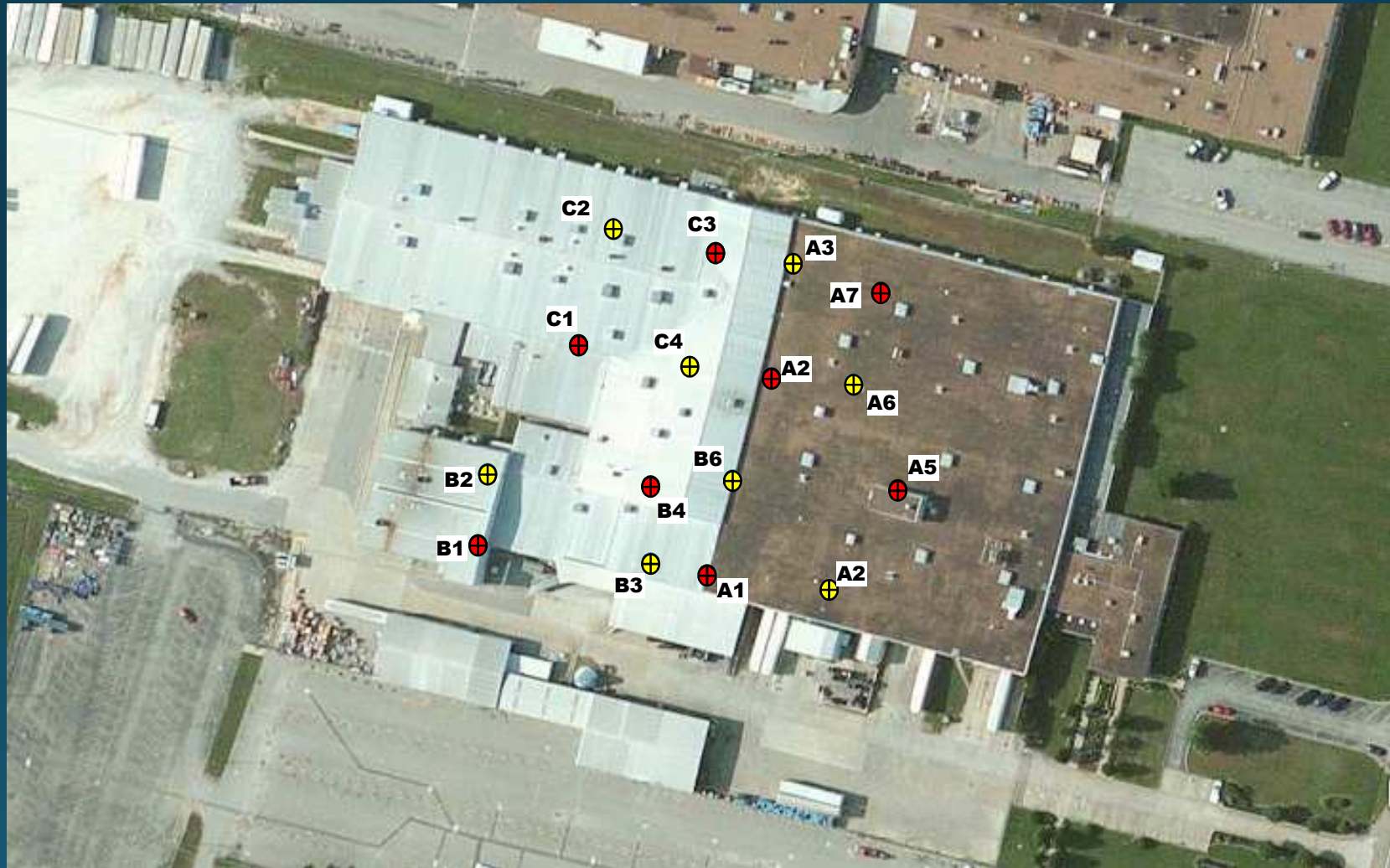
Site Characteristics

- **5-10 feet of Clay beneath concrete slab**
- **125+ feet of Sand and siltly-sand below the clay becoming finer with depth**
- **40 feet to the water table**
- **30-35 foot vadous zone**

Concept

- Install a flexible Soil Vapor Extraction (SVE) system to:
 - Characterize soils
 - Remediate Soils
 - In less time for less money!
- System
 - Must be able to run individual or banks of wells to maximize removal.
 - It must be expandable in case estimated radius of influence is too small.
 - Adjustable remotely due to site being in remote location.
 - Compare to characterization to traditional methods.
 - Eliminate the need for full characterization and design.
- Can be used to recover off gas from GW Sparge if pursued for GW Remediation.

Initial Concept



Reduced Phase 1 Installation SVE Well Estimated ROI Range



Traditional Characterization Performed

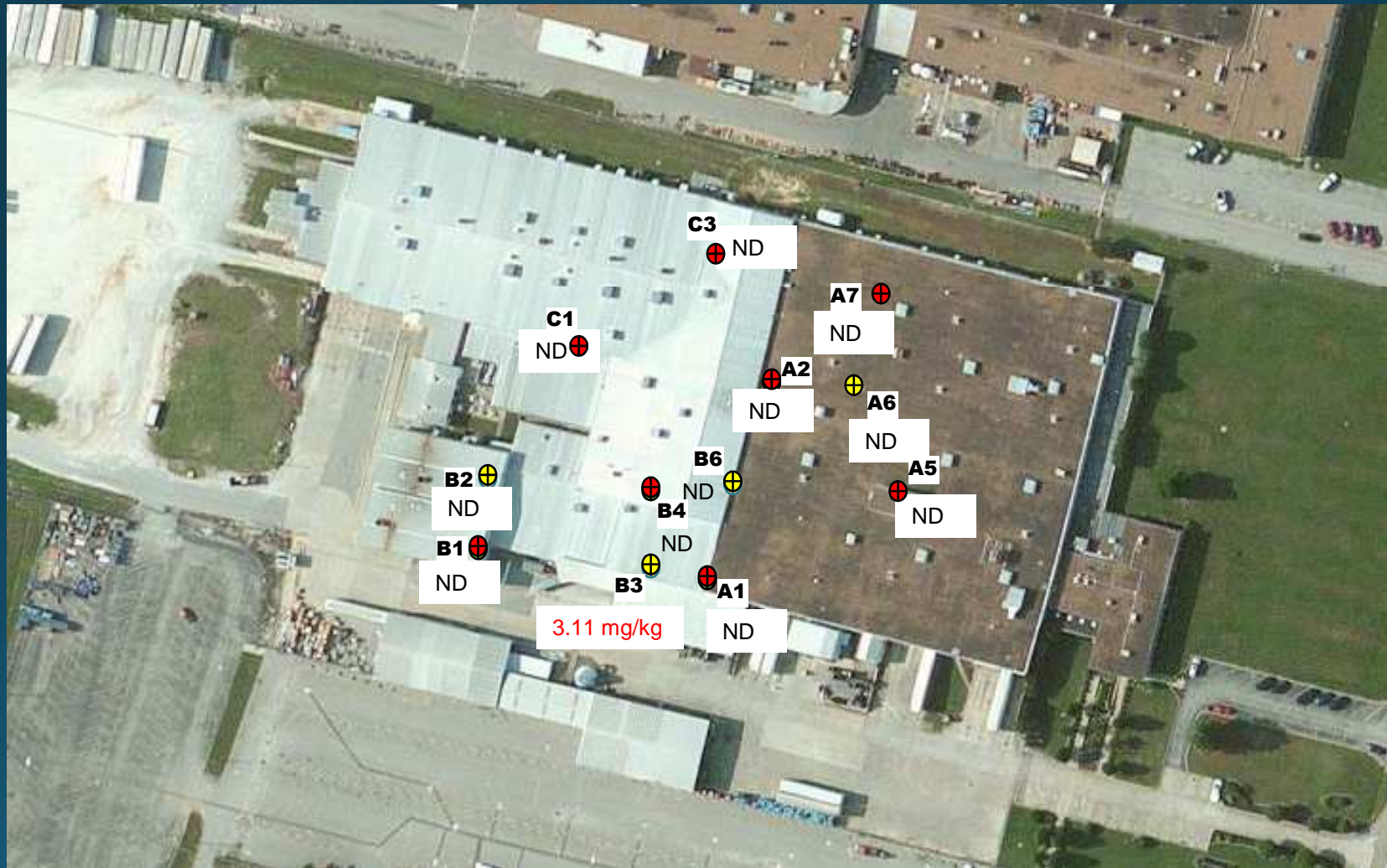
- As a part of the SVE and Monitoring point well installation
 - Soil Samples were collected
 - Water Samples were collected

Traditional Investigation and SVE well and Monitoring Point locations



Soil Samples

(Total Chlorinated Hydrocarbons)



Groundwater Samples (Total Chlorinated Hydrocarbons)



Characterization

- Based on the groundwater (GW) concentrations from installation
 - the Henry's constant was used to calculate the steady state concentrations of vapors as a result of impacted GW.
 - 131.5 mg/m³ Vapor Concentration

SVE Well Estimated ROI Range



System Design

- Oversized manifold piping balances flow when multiple wells are run at the same time. (Negligible Losses)
- Running individual compressed air hose from system to each pneumatic valve.
 - Allows for individual and bank well operation
 - Hose can be run by mechanical contractor installing the manifold piping.
- The vacuum blower operated by a variable frequency drive (VFD).
 - Allows for individual well testing and multiple well zones (banks)
 - Allows for step testing of individual wells locally and remotely
 - PLC operation provides modular flexibility.

System Design (cont.)

- System installed in 8x10 ft. shipping container.
 - Was built off-site and hauled to site for easy installation
 - The system can be used again at new site to provide additional value to the client.
- Based on site conditions utilized a 5 HP Regenerative blower.
 - Flexible operations with low maintenance requirements
- Knock-out tank with progressive cavity pump to evaporator tank.
- Evaporator tank utilizes a fan and a small recirculation pump with swamp matting to evaporate accumulated water.

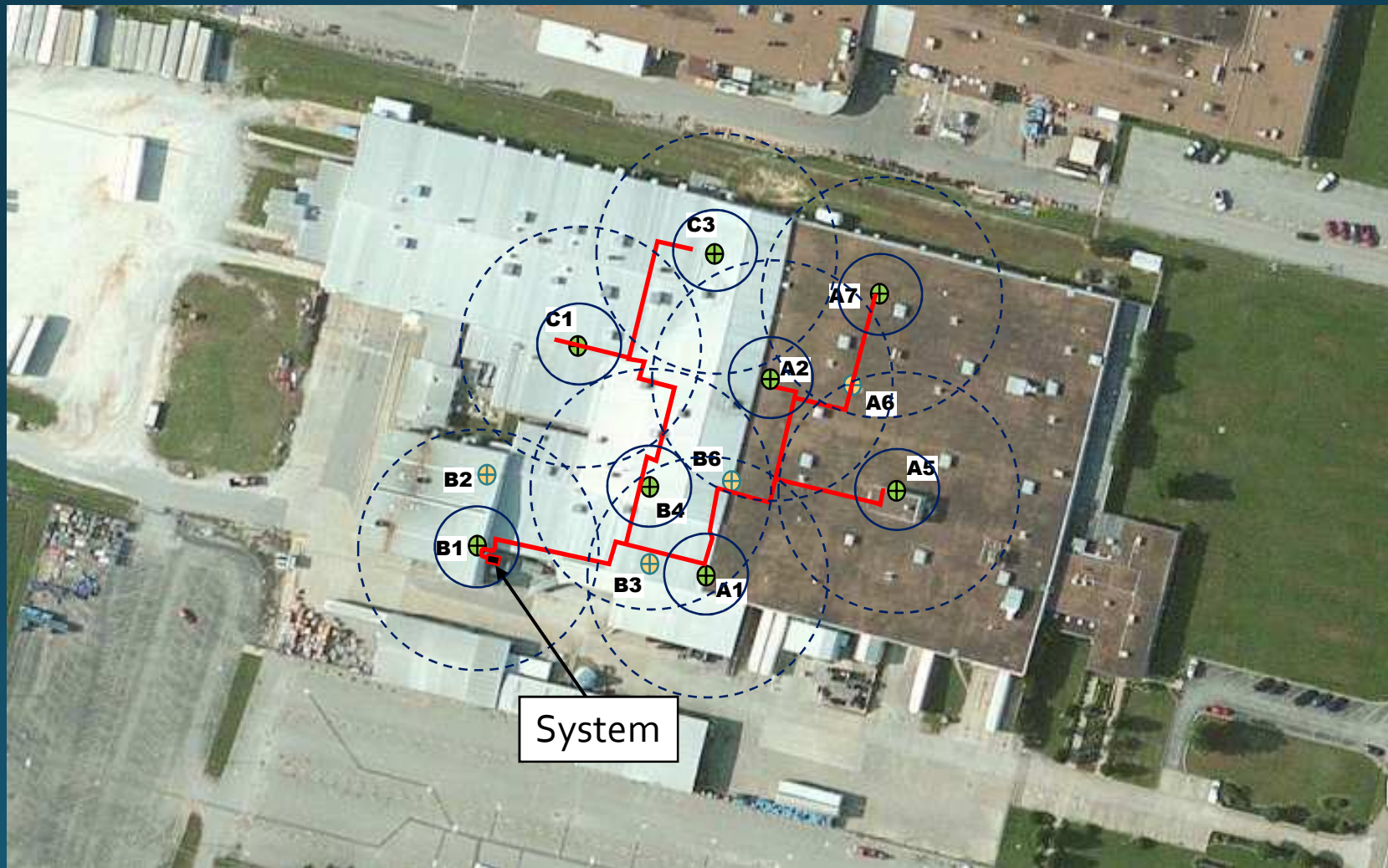
System Design (cont.)

- Equipped with 16 self venting solenoid valves with air hose quick connect fittings for valve actuation.
- Small compressor with air dryer and auto drain to evaporator tank feeds dry air to the solenoid valves.
- Self Averaging Pitot tube with vacuum, velocity head and process temperature sensors.
 - PLC calculates and displays air flow in SCFM.
- Heating and cooling provided by small heater and exhaust fan with door louvers.

Construction

- All construction took place on 3rd Shift
 - To not interfere with Plant Operations
 - Wells and Monitoring Points Installed out of Isles and production areas to minimize impacts.
 - Work performed in winter months inside plant

Location of the 8-inch Manifold Piping and System



SVE System



SVE Well and Monitoring Points

- Screened from 25-35 below ground surface
 - Screen stops 5 feet above the water table
 - 2-inch PVC screen and casing
 - 10-slot PVC screen and sand packs
-
- Monitoring points identical to SVE well and can be piped to the manifold if needed.

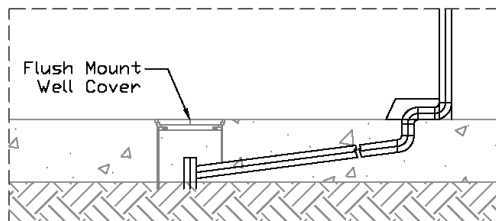
Sub-Slab Vents (contingent item)

- 1-1/5 foot long 2-inch 10 slot screen embedded in gravel.
- Installed in pipe run trench to SVE well head.

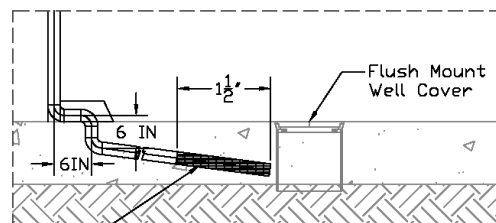
Typical Completion and Riser Details

CROSS SECTION VIEWS

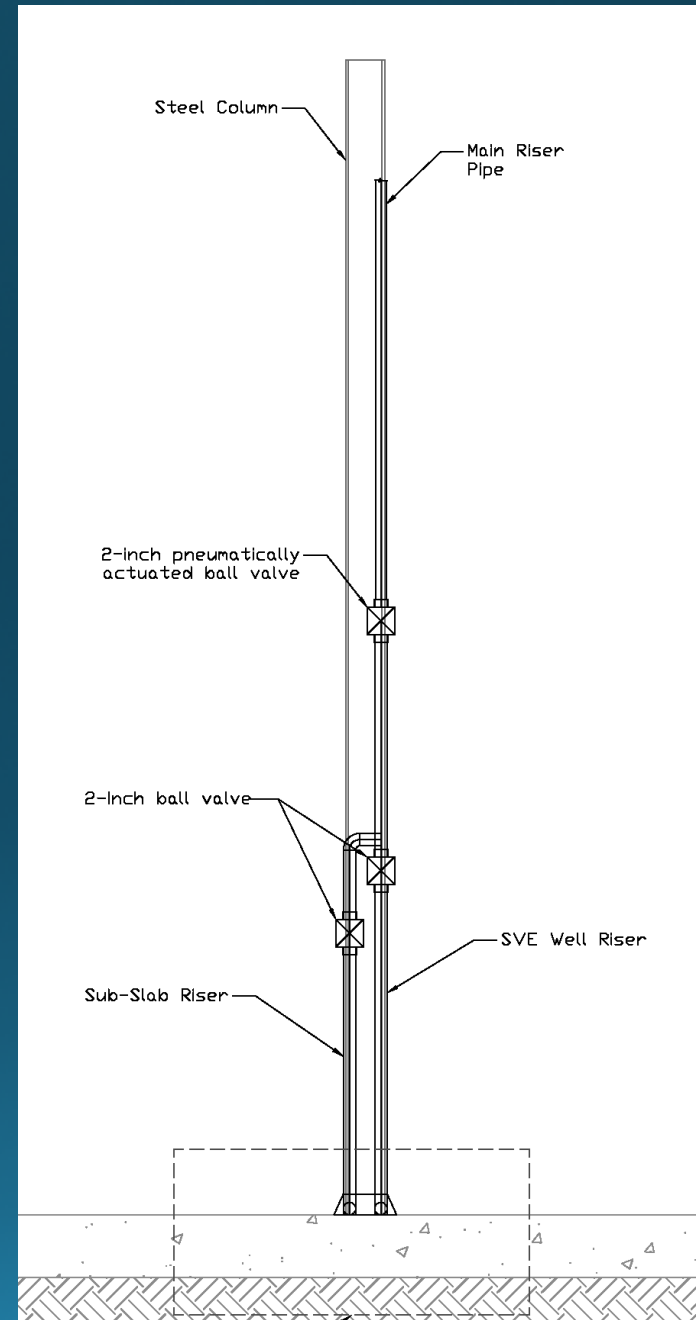
(1) SVE Well Connection



(2) Sub-Slab Connection



Sub Slab screen
is embedded
in peagravel



Pneumatically actuated valve
(Air open spring return)



PLC Totalizer and Alarm Screen

FactoryTalk ViewPoint - Windows Internet Explorer

http://192.168.1.20:5120/FTVP/ViewPoint.aspx?area=&cmd="ALARMS"&prev=DIRECTORY

FactoryTalk ViewPoint

FactoryTalk@ ViewPoint About

OZONology INC. ALARMS & STATUS

BACK

| | | |
|---------------------------------|--|---|
| PROCESS TEMP °F 70.0 | ROOM TEMPERATURE HIGH <input type="radio"/> | SPARE WARNING <input type="radio"/> |
| VAC PRESSURE WC" 39.1 | ROOM TEMPERATURE LOW <input type="radio"/> | SPARE SHUTDOWN <input type="radio"/> |
| DIFF PRESSURE WC" 6.0 | SOLENOID OPEN TIME (MINUTES) | |
| ROOM TEMP °F 78.0 | SOL 1: 0 | SOL 6: 12243 |
| | SOL 2: 0 | SOL 7: 18225 |
| | SOL 3: 6088 | SOL 8: 0 |
| | SOL 4: 0 | SOL 9: 0 |
| | SOL 5: 24314 | SOL 10: 0 |
| | | SOL 11: 0 |
| | | SOL 12: 0 |
| | | SOL 13: 0 |
| | | SOL 14: 0 |
| | | SOL 15: 0 |
| | | SOL 16: 0 |
| | RESET RUN TIMES | FAULT RESET |

COMP AIR LOW PRESSURE

COND TANK H2O HIGH

COND TANK H2O HIGH HIGH

KO TANK H2O HIGH

KO TANK H2O HIGH HIGH

VACUUM SWITCH FAIL

ROTRON BLOWER VFD FLT

Status Area

Internet 150%

Automatic PLC Screen

The screenshot shows a web browser window titled "FactoryTalk ViewPoint - Windows Internet Explorer". The address bar displays the URL: `http://192.168.1.20:5120/FTVP/ViewPoint.aspx?area=&cmd="AUTO"&prev=DIRECTORY`. The browser's menu bar includes "File", "Edit", "View", "Favorites", "Tools", and "Help". The page content features the "OZONology INC." logo and the title "AUTOMATIC OPERATION". A "BACK" button is located in the top right corner.

| Zone Status | Minutes of | Minutes of | Minutes Remaining |
|-------------|------------|------------|-----------------------|
| ZONE 1 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 2 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 3 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 4 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 5 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 6 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 7 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 8 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 9 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 10 ON | 57 | MINUTES OF | 60 MINUTES REMAINING |
| ZONE 11 OFF | 0 | MINUTES OF | 60 MINUTES REMAINING |
| ZONE 12 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 13 OFF | 0 | MINUTES OF | 180 MINUTES REMAINING |
| ZONE 14 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 15 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |
| ZONE 16 OFF | 0 | MINUTES OF | 0 MINUTES REMAINING |

On the right side of the screen, there are three buttons: "START IN AUTO" (grey), "STOP IN AUTO" (red), and "SKIP TO NEXT ZONE" (blue).

At the bottom right, there are two data fields: "BLOWER SPEED SETPOINT SCFM" with a value of 240.0, and "ACTUAL SCFM" with a value of 156.7.

A green box at the bottom left indicates "ROTRON BLOWER RUNNING".

The status area at the bottom of the page is currently empty.

PLC Parameter and Setting Screens (Zone Duration)

The screenshot shows a web browser window titled "FactoryTalk ViewPoint - Windows Internet Explorer" with the URL <http://192.168.1.20:5120/FTVP/ViewPoint.aspx?area=8&cmd='SETTING52'&prev=DIRECTORY>. The page content includes the "Ozonology Inc." logo, a "PARAMETERS & SETTINGS" title, and a "BACK" button. The settings are organized into two main sections: "ZONE ON TIME SETPOINTS (MINUTES)" and "ALARM DELAY SETPOINTS (SECONDS)".

| ZONE ON TIME SETPOINTS (MINUTES) | | ALARM DELAY SETPOINTS (SECONDS) | | | |
|----------------------------------|----|---------------------------------|-----------------------|------------------------|----|
| ZONE 1 | 0 | 60 | ZONE 9 | SPARE WARNING | 2 |
| ZONE 2 | 0 | 60 | ZONE 10 | SPARE SHUTDOWN | 2 |
| ZONE 3 | 0 | 60 | ZONE 11 | COMP AIR LOW PRESSURE | 5 |
| ZONE 4 | 0 | 0 | ZONE 12 | COND TANK H2O HIGH | 15 |
| ZONE 5 | 0 | 180 | ZONE 13 | COND TANK H2O HIGH HI* | 15 |
| ZONE 6 | 0 | 0 | ZONE 14 | KO TANK H2O HIGH | 15 |
| ZONE 7 | 0 | 0 | ZONE 15 | KO TANK H2O HIGH HIGH | 15 |
| ZONE 8 | 0 | 0 | ZONE 16 | VACUUM SWITCH FAIL | 60 |
| ZONE OVERLAP DELAY (SEC) | 30 | | ROTRON BLOWER VFD FLT | 15 | |
| BLOWER START DELAY (SEC) | 60 | | | | |

At the bottom right, there is a "NEXT" button. The status area at the bottom of the browser shows "Internet" and a zoom level of "150%".

Parameter and Setting Screens (Zone Solenoid Selection and Blower Speed Set Points)

The screenshot displays the FactoryTalk ViewPoint web interface in Internet Explorer. The browser address bar shows the URL: `http://192.168.1.20:5120/FTVP/ViewPoint.aspx?area=8&cmd="SETTINGS55"&prev=SETTINGS54`. The page title is "FactoryTalk ViewPoint".

The main content area is titled "PARAMETERS & SETTINGS" and includes a "BACK" button. It contains four solenoid selection tables for zones 13, 14, 15, and 16, each with 16 numbered buttons. Selected buttons are highlighted in green:

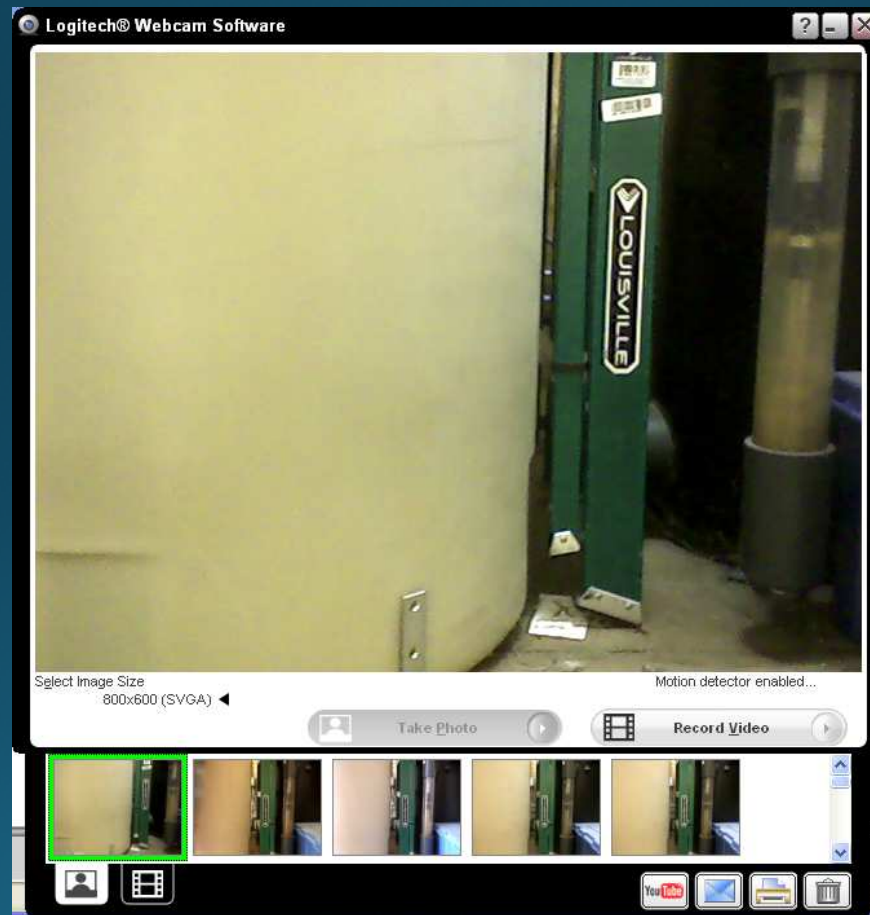
- ZONE 13 SOLENOID SELECTION TABLE: Buttons 5 and 7 are selected.
- ZONE 14 SOLENOID SELECTION TABLE: Buttons 1, 3, and 7 are selected.
- ZONE 15 SOLENOID SELECTION TABLE: Buttons 1, 4, 5, and 8 are selected.
- ZONE 16 SOLENOID SELECTION TABLE: Buttons 2, 3, 6, and 7 are selected.

Below these tables is a section titled "ROTRON BLOWER VFD SPEED SETPOINTS (SCFM)" with a grid of 16 zones and their corresponding speed values:

| ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 |
|--------|---------|---------|---------|---------|---------|---------|---------|
| 240.0 | 240.0 | 240.0 | 240.0 | 240.0 | 240.0 | 240.0 | 240.0 |
| ZONE 9 | ZONE 10 | ZONE 11 | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 |
| 190.0 | 240.0 | 190.0 | 240.0 | 240.0 | 210.0 | 240.0 | 240.0 |

At the bottom of the main content area, there are "MAIN" and "NEXT" buttons. A "Status Area" is located at the very bottom of the page.

Webcam Tank Monitoring



Initial Testing

- Upon Startup, gas samples were collected from each well head tested and analyzed by on-site gas chromatograph every 10-15 minutes.
 - Gas samples collected at the well riser pipe by syringe via a septa.
 - Vacuum and flow data were collected at each well head.
- Vacuum was measured at adjacent monitoring points and wells to determine actual radius of influence. (100 feet was observed)
- Upon completion of initial testing split samples were collected and sent to the laboratory for T-015 analysis.
- Based on Individual GC data the initial banks (zones) were configured to maximize removal while remaining below the maximum allowable discharge under the SVE exemption.

Typical Monitoring Point (Vacuum Testing)



Pitot tube and vacuum, velocity head and temperature measurements



Field Gas Chromatograph (Initial Testing)



Field GC Sample collection by syringe



September 2011 (Initial Testing) (>132 mg/m³ Soil Contamination)

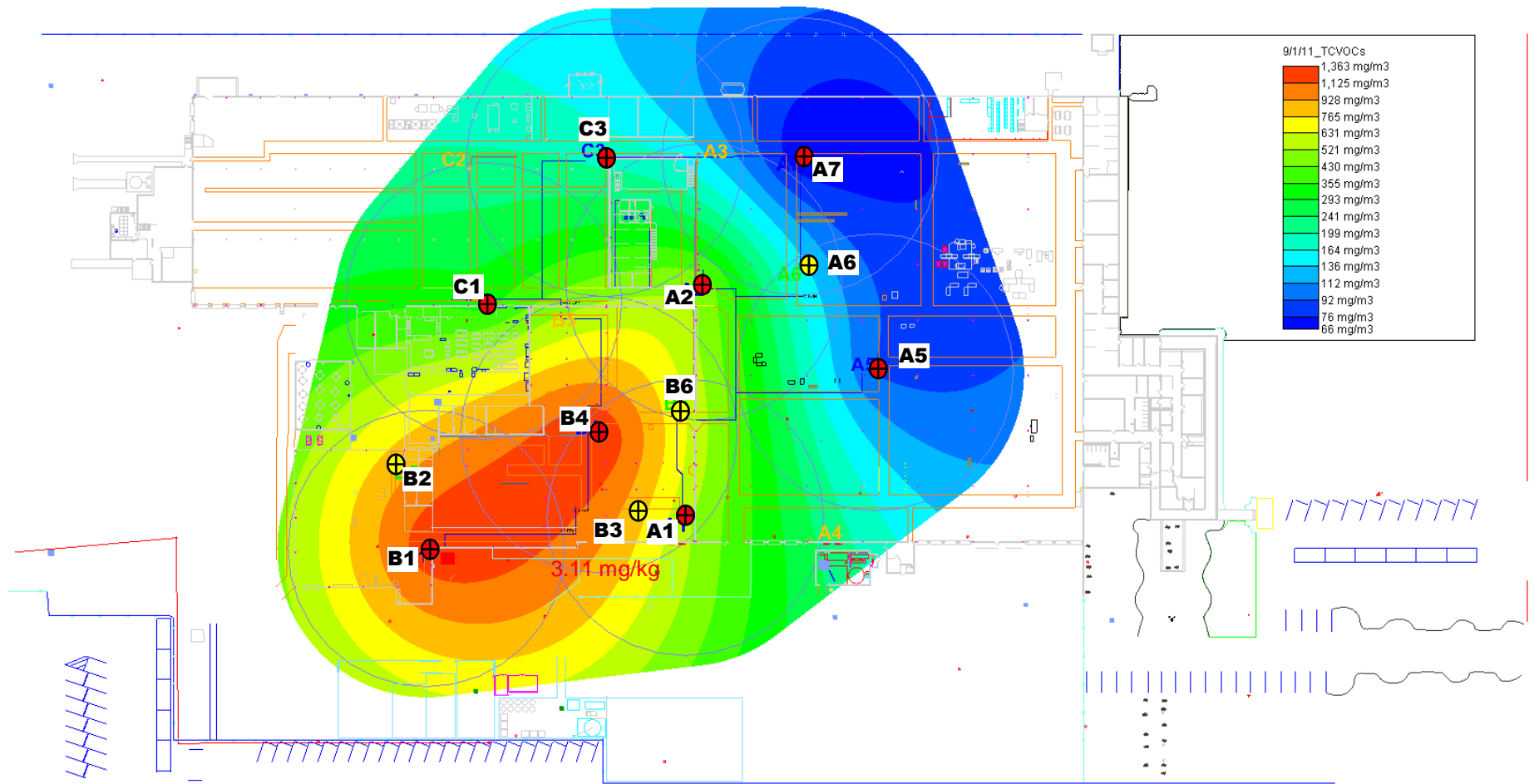
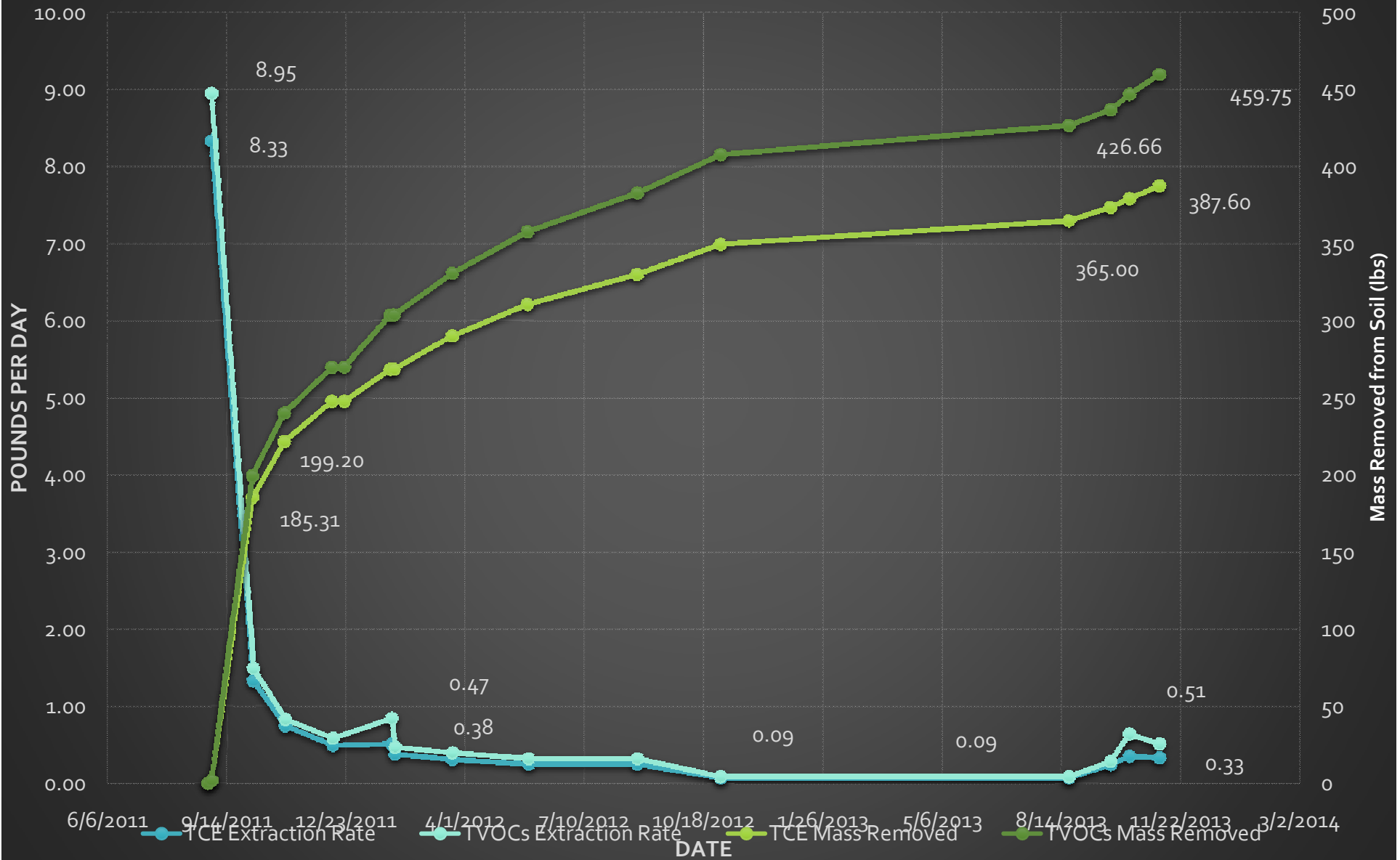
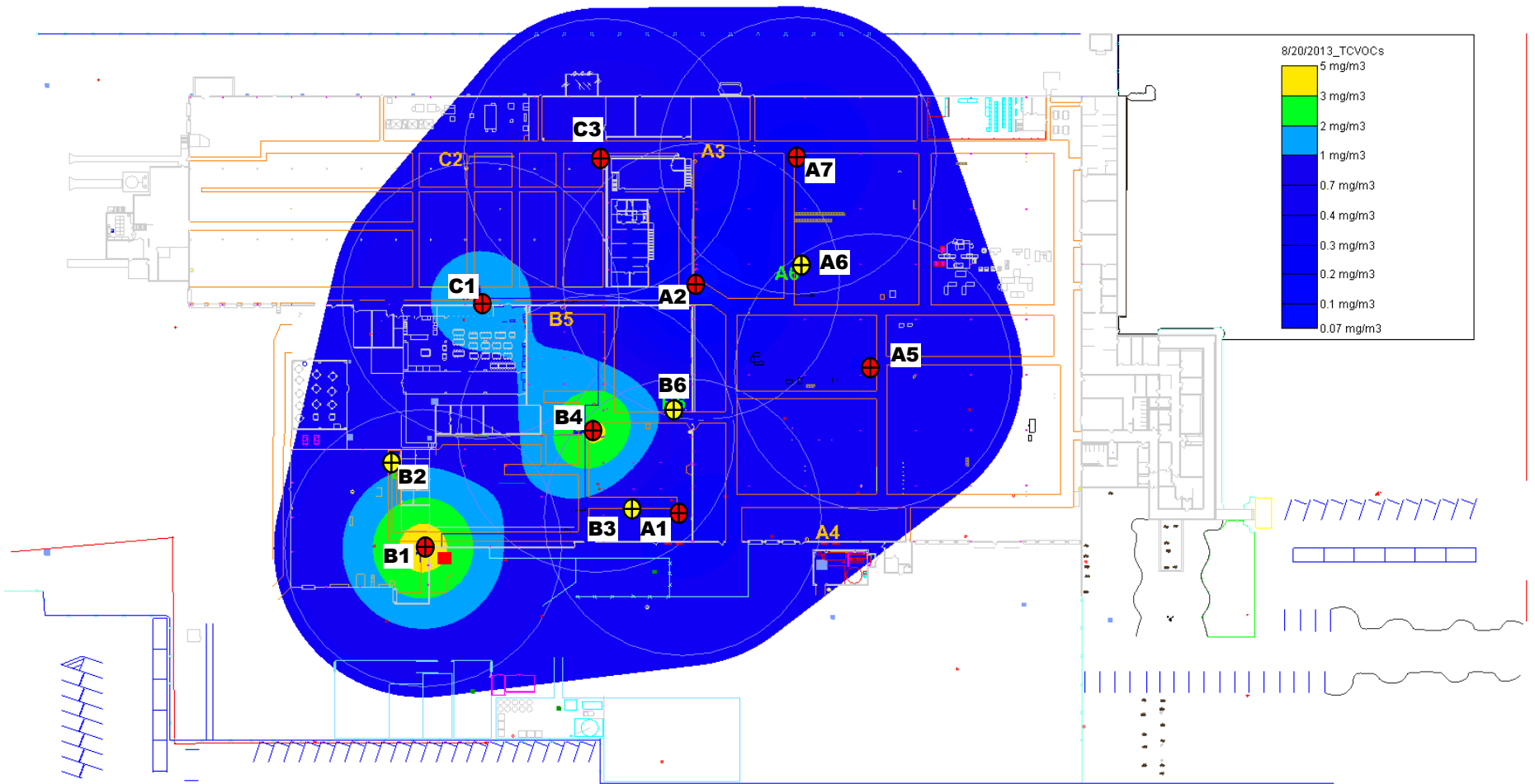


Chart of System Performance

TCE and TVOC Removal by SVE System



September 2013 (Last Characterization Event)



Conclusions

- Traditional Methods
 - Soil Sampling- Only 1 hit detected out of 12 samples
 - GW Sampling – Significant groundwater impacts observed
- SVE Characterization/Treatment
 - GW contribution to Vapor Results calculated.
 - Characterization with SVE resulted in $\frac{3}{4}$ of the area with impacted soils within well ROI (>131.5 mg/m³) all but 2 wells.
 - All discernable soil impacts removed within 3 months.
 - No further impacts to GW from source soils.
 - GW being further treated by SVE from Volatilization
 - Could be enhanced by Air Sparge

Resulted in Streamlined Characterization and Cleanup within a 2 year window at reduced cost. (Site is RAP ready with SVE as a contingency)

Questions

- Thanks for your attention!