

OPTIMIZING OPERATION OF A SOIL VAPOR EXTRACTION SYSTEM TO REMOVE CHLORINATED VOLATILE ORGANIC COMPOUNDS WHILE IMPACTED BY REGIONAL NATURAL GAS

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PROJECT BACKGROUND

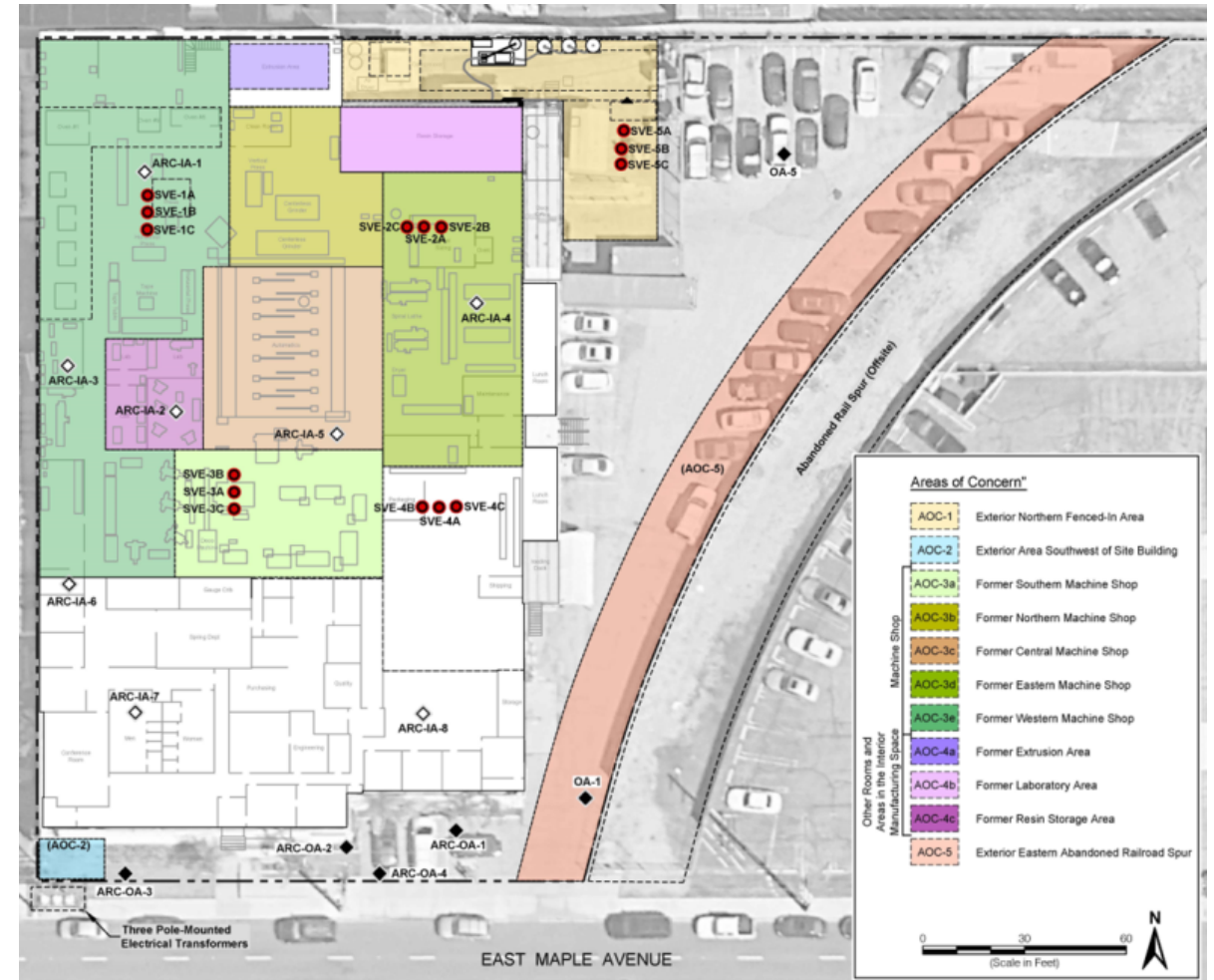
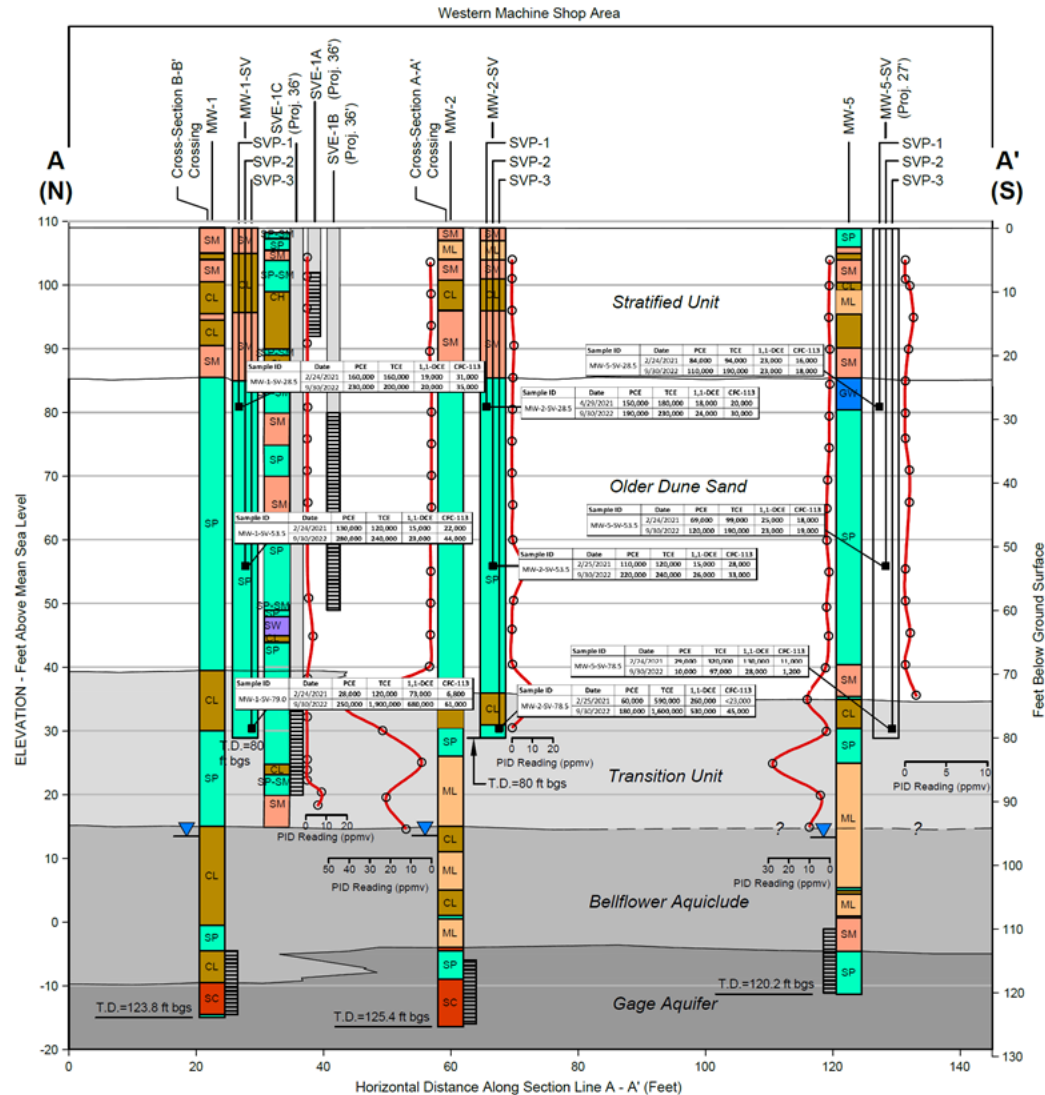
- Site Located in El Segundo, California
- Impacted by Chlorinated Volatile Organic Compounds (CVOCs)
 - PCE, TCE, and their degradation products
 - 12-month SVE pilot test started in October 2022
 - SVE system under a SCAQMD various locations air permit



15 SVE WELLS

- Three stratigraphic units, up to 120 feet deep

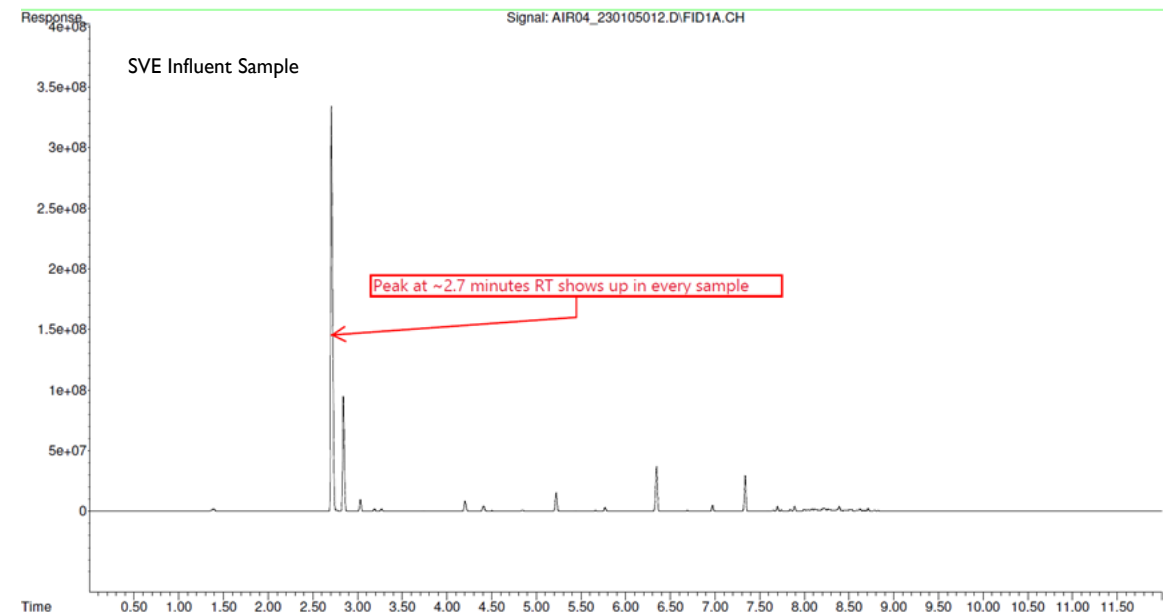
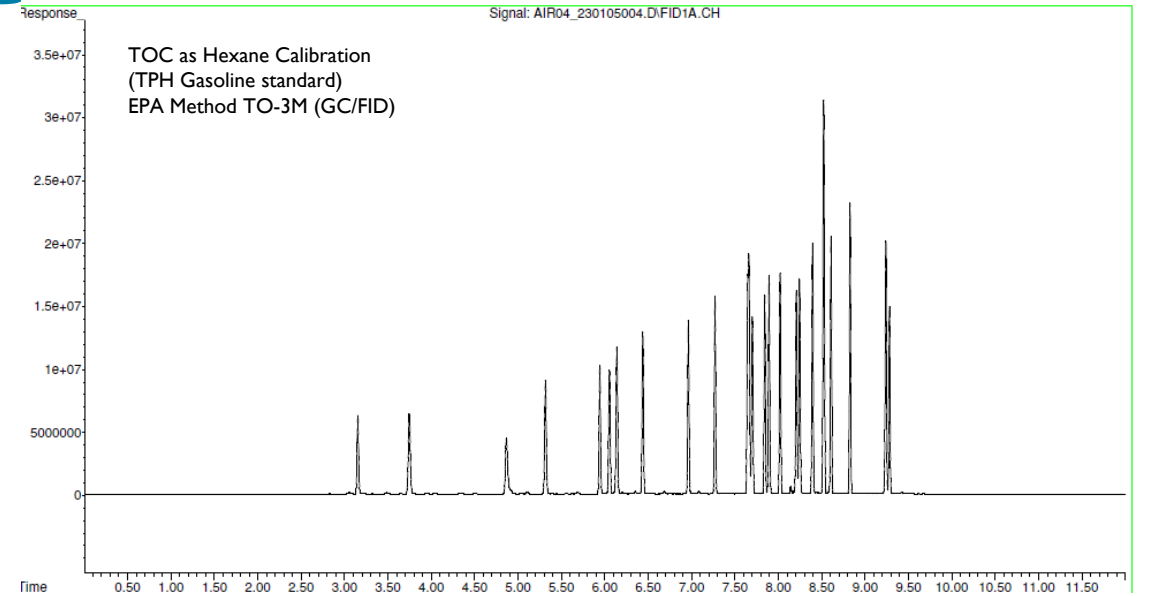
- 5 SVE wells in each unit



HERE IS WHAT HAPPENED

“TOC as hexane” air permit limit = 18 ppmv

- Field PID readings were consistently below limit
 - PID effectively detected the chlorinated VOCs
- Lab result for TOC as hexane by EPA method TO-3M (GC/FID) surprisingly exceeded permit limit in emissions sample 4 months after startup
- First, SVE system off
- Then, investigate:
 - TOC as hexane method (EPA TO-3M, GC/FID) quantifies total organic compounds detected in C2-C10 range
 - TOC as hexane lab result was more than 20x the sum of individual VOCs measured by EPA method TO-15
 - Review TO-3 chromatograms: “mysterious” peak at ~2.7 RT



INVESTIGATION CONTINUED

- Lab suspected the early elution might be formaldehyde; field-tested, not detected
- Samples sent to a different lab to analyze for total C2-C10 as hexane. Ethane was the major contributor
- Additional samples sent to two different labs to speciate C1-C4 hydrocarbons by EPA Method 18



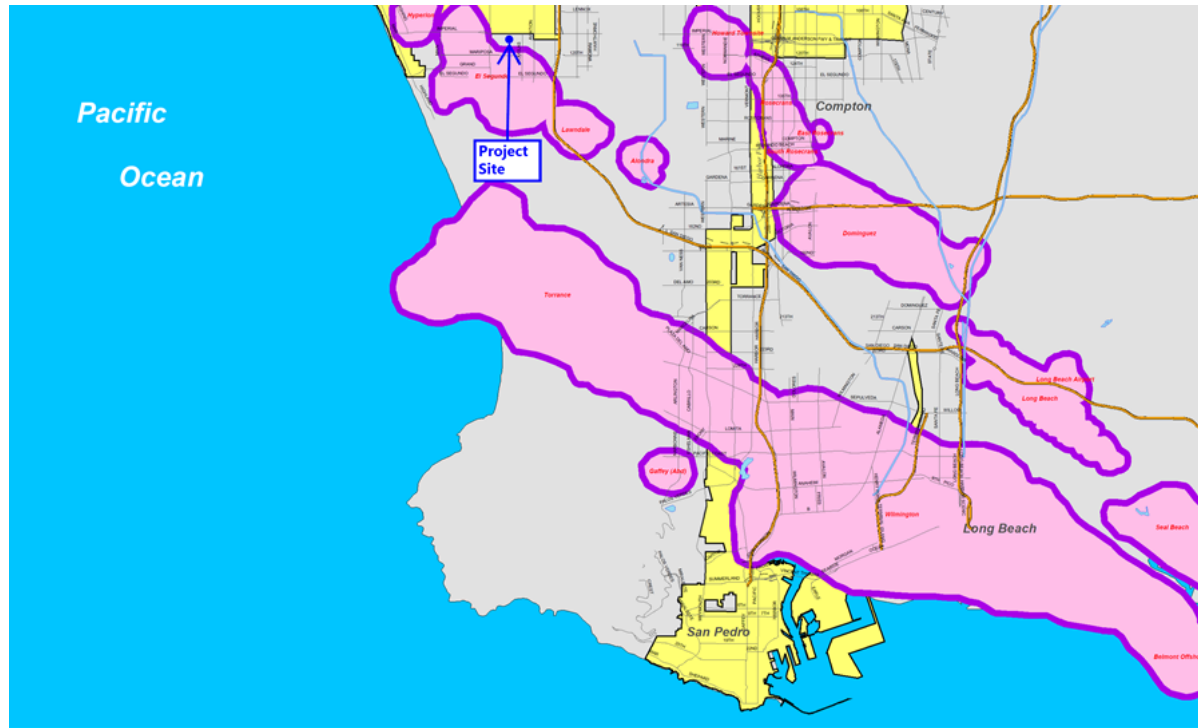
Draeger Formaldehyde
Detector Tubes

INVESTIGATION CONTINUED

- 12,400 ppmv methane (~25% LEL) in the influent sample, with ethane and propane
 - Methane/ethane/propane combination is a clear signature of natural gas
 - Ethane was causing the elevated TOC as hexane lab result
- Gas leak? SoCal Gas technician said, “No”
- Naturally-occurring natural gas
 - Regional “stray gas”
 - Nearby hotel development site (<1,000 ft away) showed 190,000 ppmv of methane and installed passive methane venting system during construction



REGIONAL NATURALLY-OCCURRING NATURAL GAS



METHANE AND METHANE BUFFER ZONES

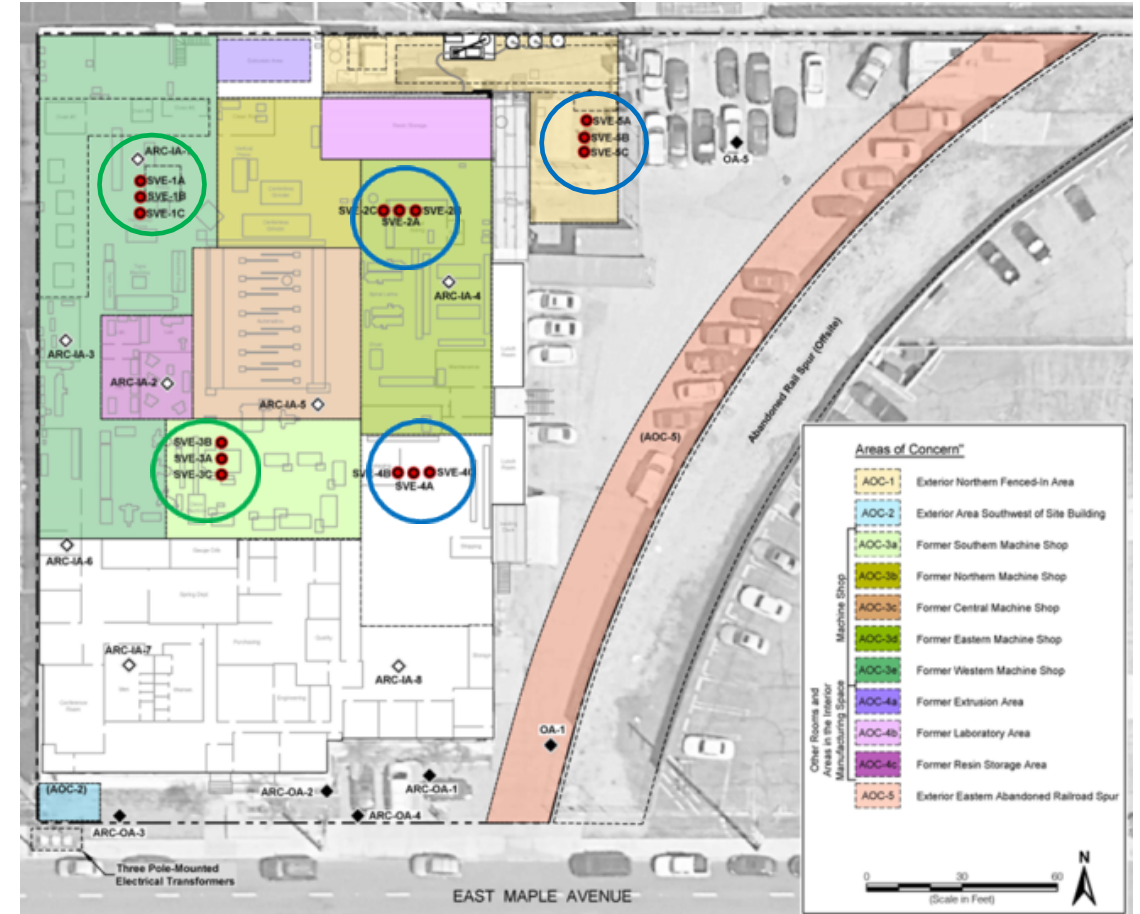
PRODUCTIVE BOUNDARIES OF OIL FIELDS

LA DPW
ENGINEERING
BRADLEY M. ANDERSON, P.E.
DISTRICT CITY ENGINEER

190,000 ppmv at 20 feet bgs

METHANE IN SVE WELLS

- Field measurements
- Elevated methane in the 3 SVE well clusters on the eastern portion of the site
- Indicated SVE system was pulling in stray natural gas from east of site
- >100% LEL in several wells



 SVE Wells without Elevated Methane

 SVE Wells with Elevated Methane

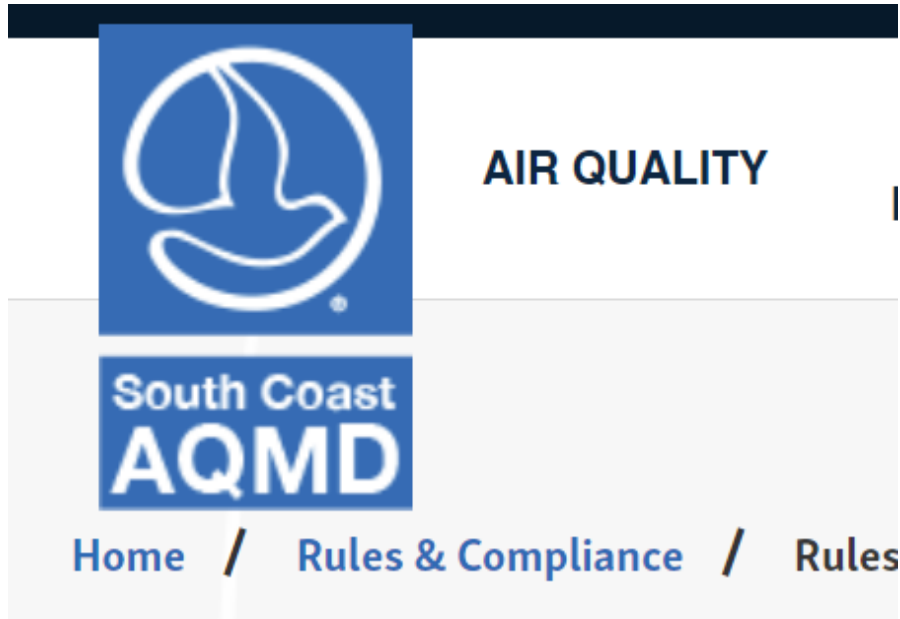
PERMIT REQUIREMENTS OF TOC BY HEXANE



<https://www.aqmd.gov/home/rules-compliance/rules>

- VOLATILE ORGANIC COMPOUND (VOC) is any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds
- “Exempt” compounds are listed in two groups (SCAQMD Rule 102). Ethane is in Group I
 - “Exempt” compounds are not ozone precursors
- SCAQMD has NO definition of “Organic Compounds” or “Total Organic Compounds” (TOC)

PERMIT REQUIREMENTS OF TOC BY HEXANE



<https://www.aqmd.gov/home/rules-compliance/rules>

- Discussed with a senior permit engineer at SCAQMD
 - Purposes of “TOC as hexane” permit limit are:
 - Limit emissions of ozone precursor organics
 - Screen for VOC breakthrough of carbon treatment
 - Neither methane or ethane is toxic or an ozone precursor, both are exempt from definition of VOCs
 - Both methane and ethane pass through carbon quickly, and are not good indicators of breakthrough for the target VOCs
- The senior permit engineer agreed they can both be excluded from TOC for the purposes of this permit
 - Adjust “TOC as hexane” lab analysis (EPA TO-3M) to quantify only C3+ hydrocarbons
 - Excludes methane (C1) and ethane (C2)
 - Still include C2 chlorinated VOCs (PCE, TCE, etc.)

OPERATION OPTIMIZATION

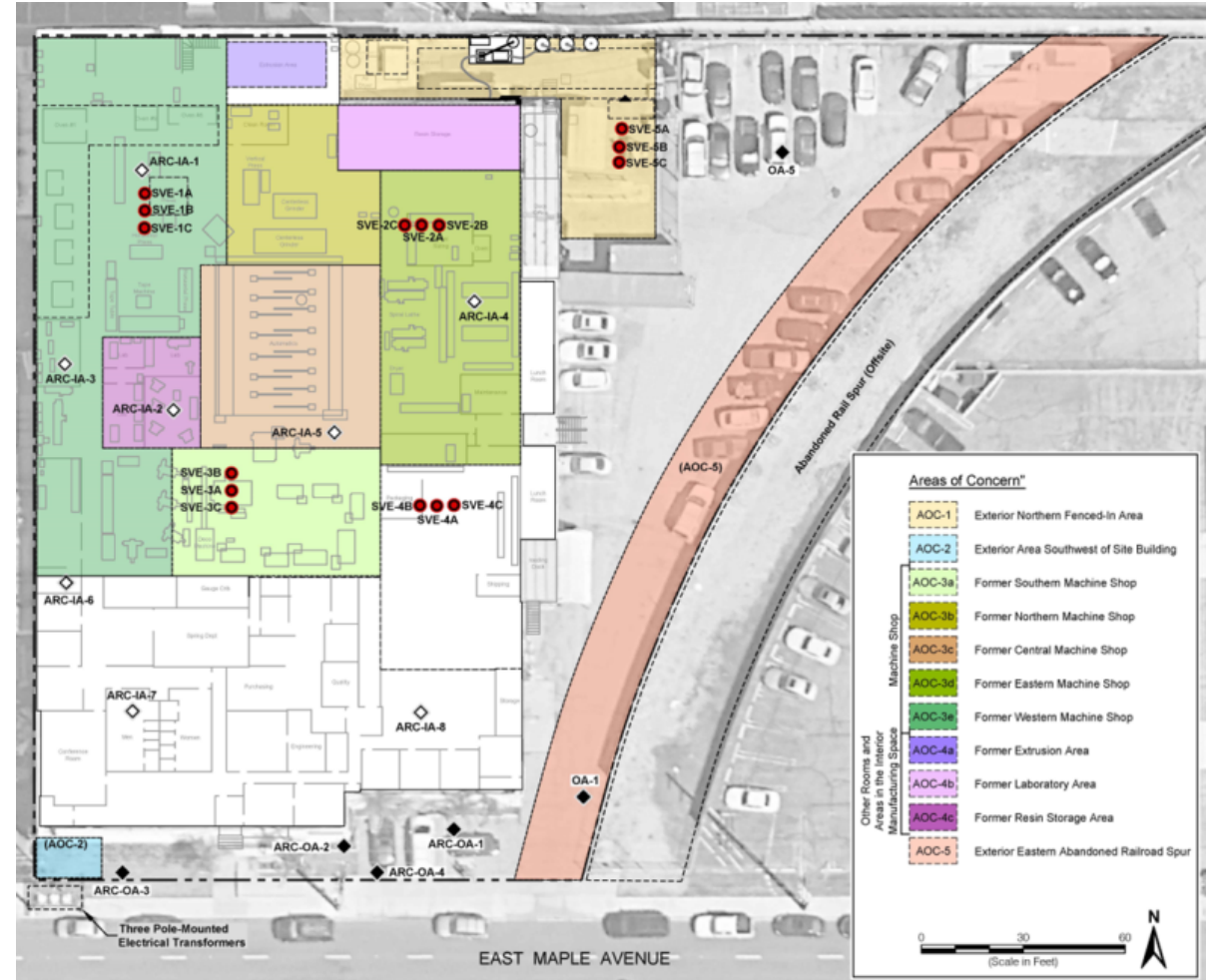
ALL THINGS TO CONSIDER :

- Safety: methane concentrations in system influent, <60% LEL
- Permit requirement: system flow rate, <1,000 scfm
- Remediation:
 - System vacuum > 70 in-WC
 - VOC concentrations in A-, B-, and C-zone SVE wells



OPERATION OPTIMIZATION (CONT.)

- General approach:
 - Close or reduce flow for B-zone SVE wells on eastern part of site with elevated methane (LEL) and high flow rates
 - Open SVE-1B (0% LEL) in northeast of site, used as “dilution air” for LEL, while treating highest VOCs in the Older Dune Sands unit
 - Maintain flow and 70 in-WC vacuum in most A- and C-zone wells, where flows are lower and VOCs elevated, requiring most remediation
 - Adjust to operating conditions where dilution air valve is closed (to maximize flow from SVE well field) yet LEL is stable in a safe range
 - Operated at ~40% to 60% LEL



OPERATION OPTIMIZATION (CONT.)

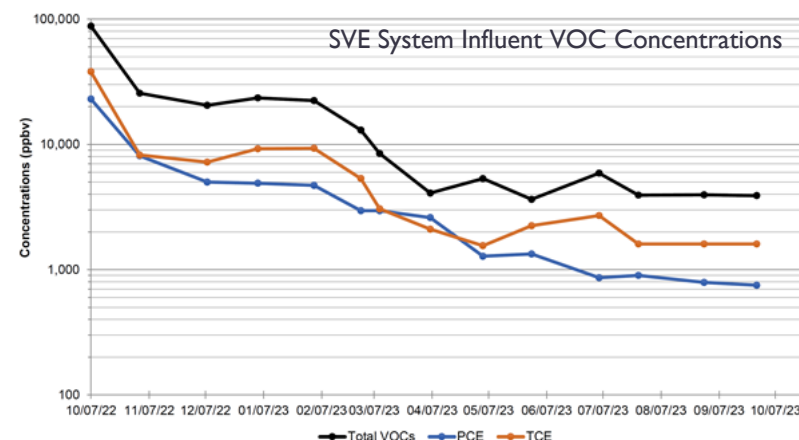
- Field staff recorded field measurements in MS Teams for senior engineers to review real-time data and adjust system operational parameters
- Adjusted field plans based on monthly system sampling and quarterly SVP sampling results.



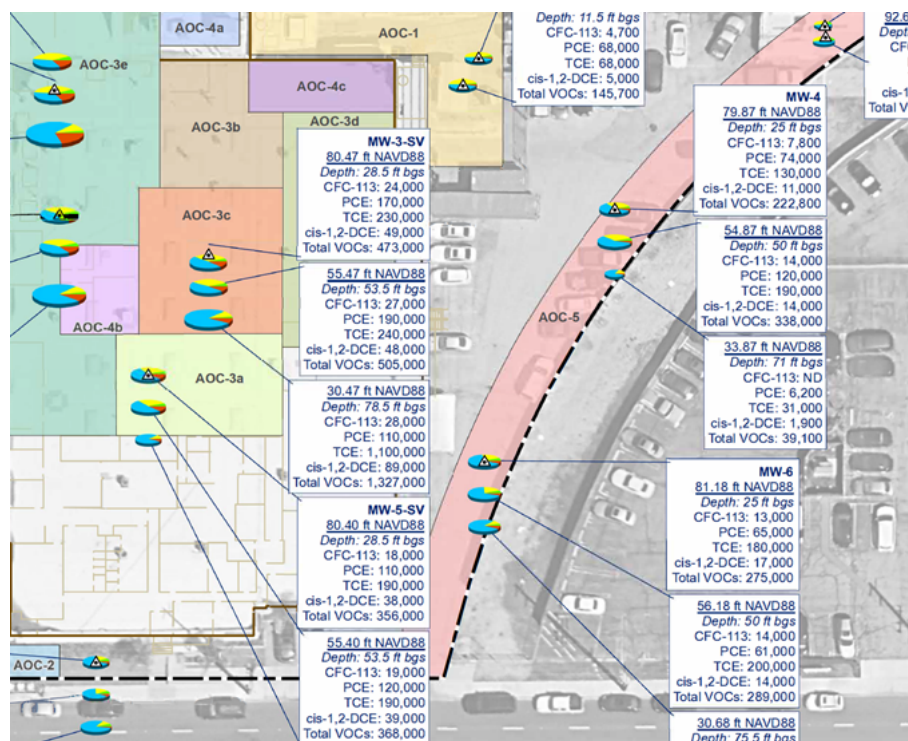
RKI EAGLE 2 Portable
Multi-Gas Detector

PILOT TEST RESULTS

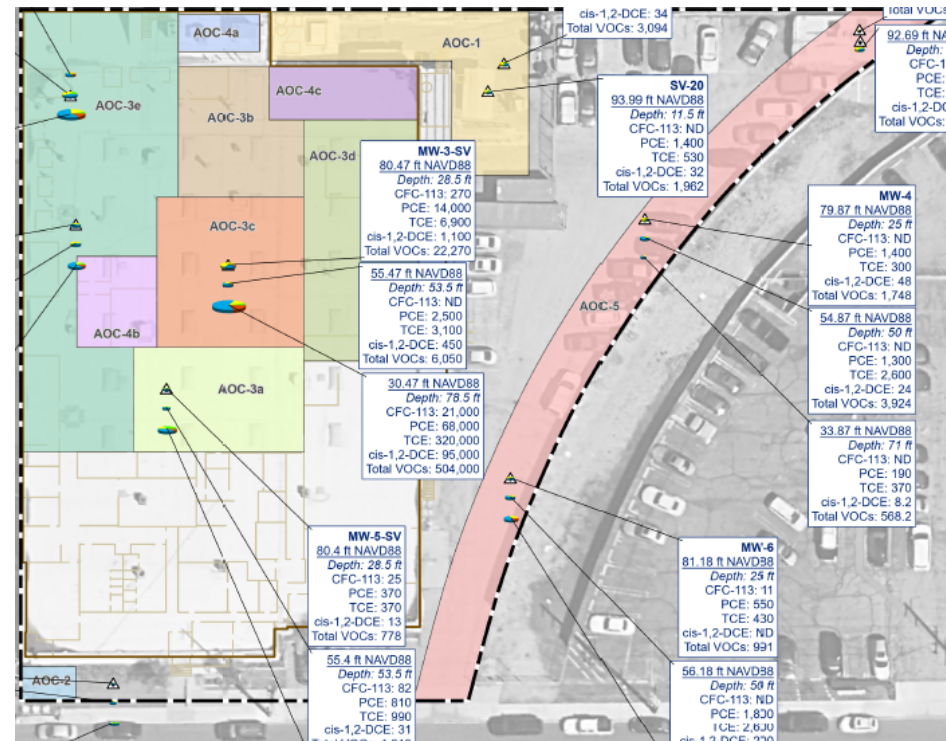
- Operated full 12 months while safely adjusting for stray gas
- Removed ~1,600 pounds of chlorinated VOCs
- Reduced VOC concentrations in soil vapor 1-2 orders of magnitude



Select VOCs in Soil Vapor Probes



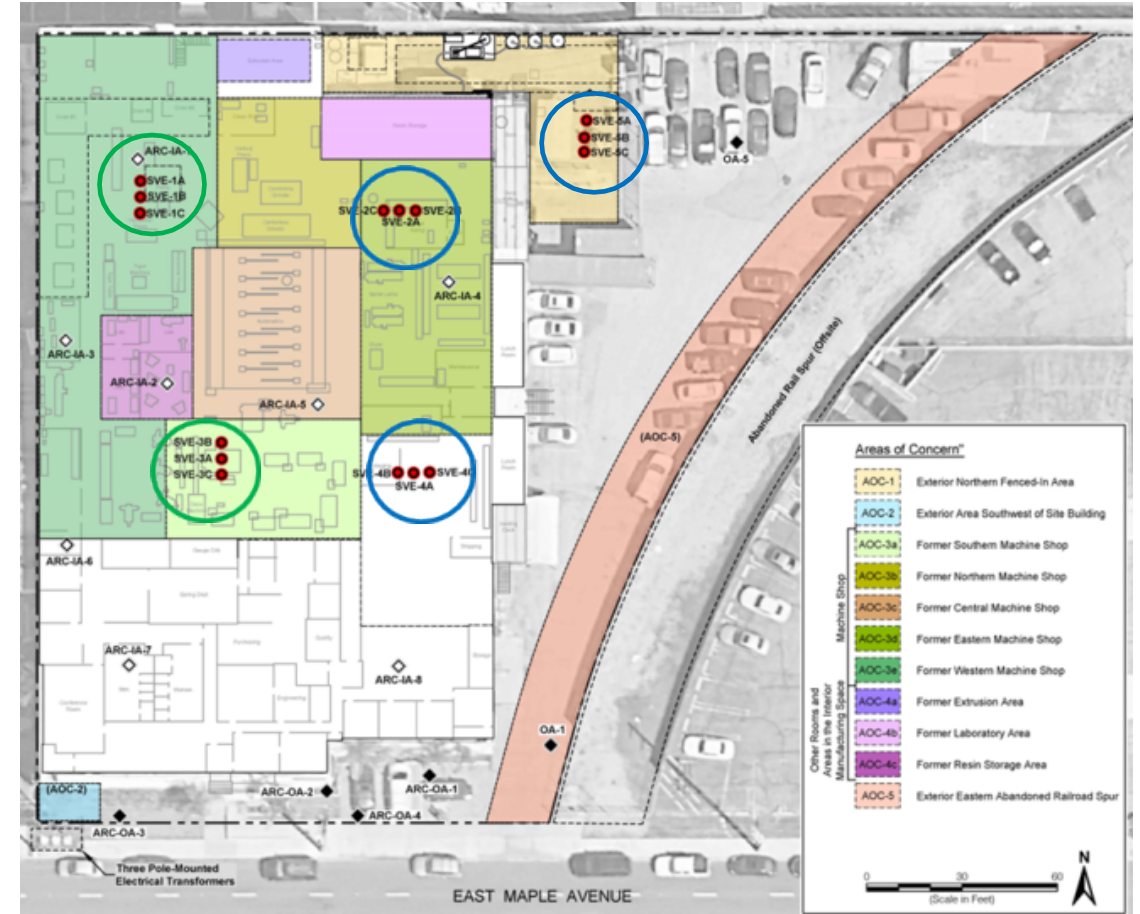
Pre-SVE Pilot Test



Post-SVE Pilot Test

LESSONS LEARNED

- For future SVE projects in the LA area, check the methane map and test for methane in soil vapor
- Understand the analytical results
- Understand the basis for air permit emissions limits
- Clear communication with regulatory agencies is essential for compliance



SVE Wells without
Elevated Methane

SVE Wells with
Elevated Methane

QUESTIONS

