NAVFAC
Naval Facilities Engineering Command
SOUTHWEST

Subfloor Tunnels and Floating Slabs in a 7-acre Building
The Case of the Accidental VI Mitigation System(s)

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Project Team

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Presentation Overview

1. Project Objective
2. Introduction and Background
3. 7-acre Building Construction
4. Contamination and VI Risk
5. Vapor Intrusion Mitigation Systems (VIMS) Design
6. VIMS Performance
7. Summary of Results and Lessons Learned

1.0 Project Objective

- *Concerns*:
  - Highly used building, critical to mission operations, occupants exposed to elevated cVOC levels in indoor air

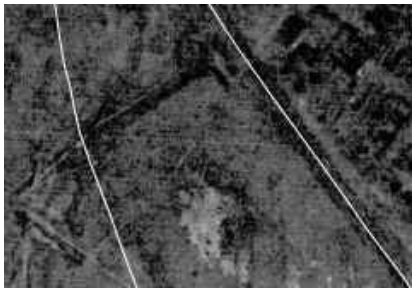
- *Challenges:*
  - Reducing cVOCs in subsurface while protecting building occupants without impacting operations

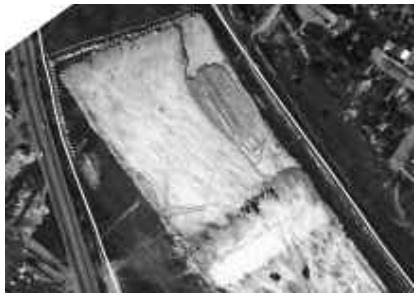
2.0 Background

- Large old industrial building (7-acres)
- Groundwater and soil gas contamination by cVOCs, primarily TCE
- Vapor intrusion (VI) issues

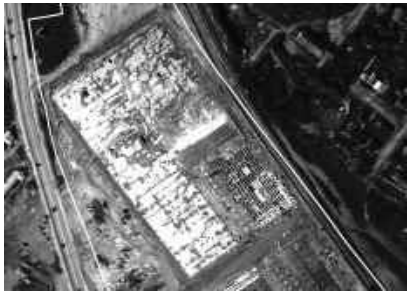
3.0 Construction of the 7-Acre Building

The land was formerly a floodplain of a nearby river and had to be stabilized with dredge and imported fill prior to construction from 1940 - 1941.


1928


December 20th, 1940


March 3rd, 1941


March 14th, 1941


March 27th, 1941


April 11th, 1941

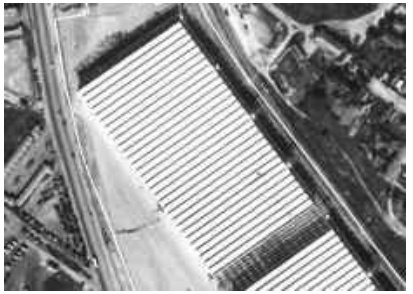

April 16th, 1941


April 21st, 1941

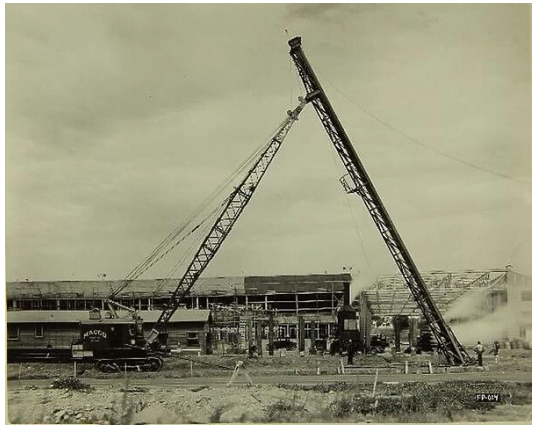

May 8th, 1941


May 20th, 1941

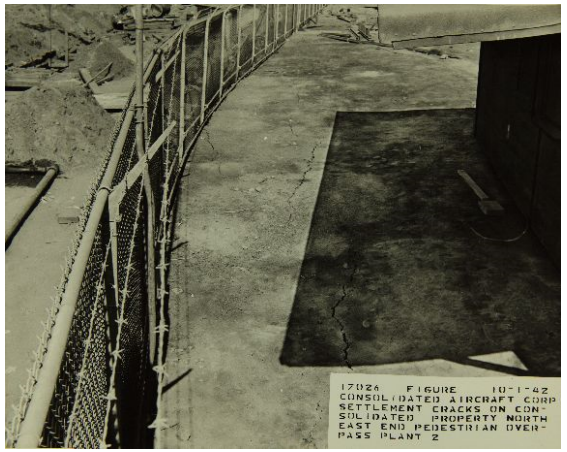

June 13th, 1941


July 30th, 1941

3.1 Building Design and Purpose



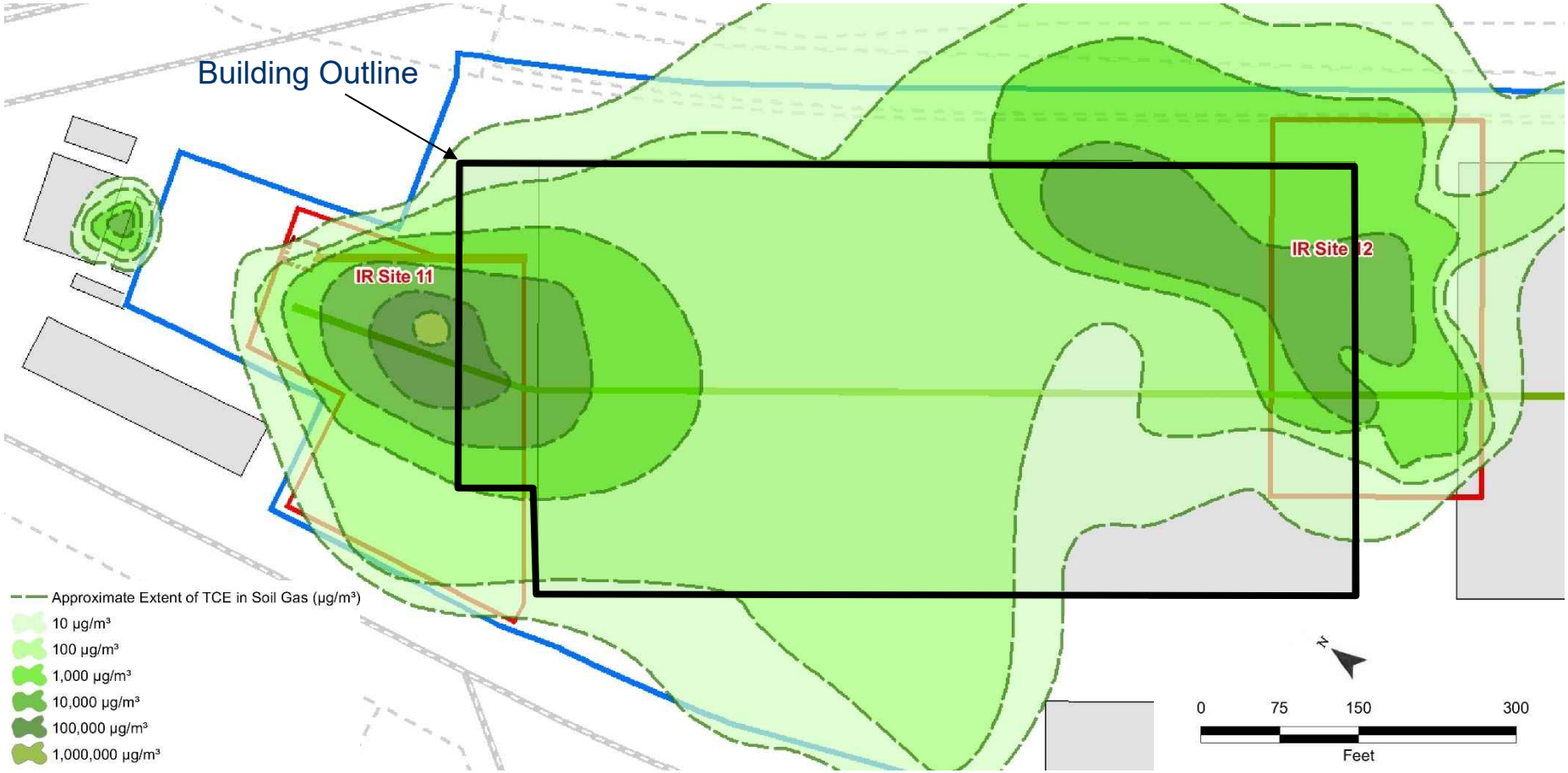
- Building footprint is ~ 300,000 Square Feet (~ 7 acres)
- Built during World War II
- Used for the manufacture of warplanes (production of 270 B-24 Liberator bombers per month during World War II)
- Steel I-beams used to frame and anchor the warehouse
- Multiple buried vaults, utility corridors throughout



4.0 Contamination and VIMS Timeline

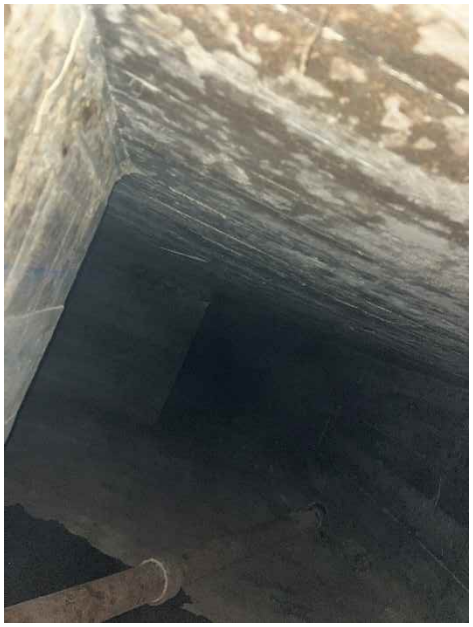
- 2008: Soil gas and groundwater contamination (cVOCs) just outside northern edge of building
- 2012: TCE detected in Indoor Air
- 2014: SVE Pilot Test in northern part of Building
- 2016: Vapor Intrusion Mitigation System (VIMS) in northern part of Building (North VIMS)
- 2021: Separate contamination area detected in the southern part of Building
- 2022: VIMS in the southern part of the building (South VIMS)

4.1 TCE in Soil Gas Pre-Remediation



Two cVOC releases exist on opposite ends of the large 7-acre building. The co-mingling of soil gas plumes subjects the entire building to VI risk.

5.1 A Building that Floats



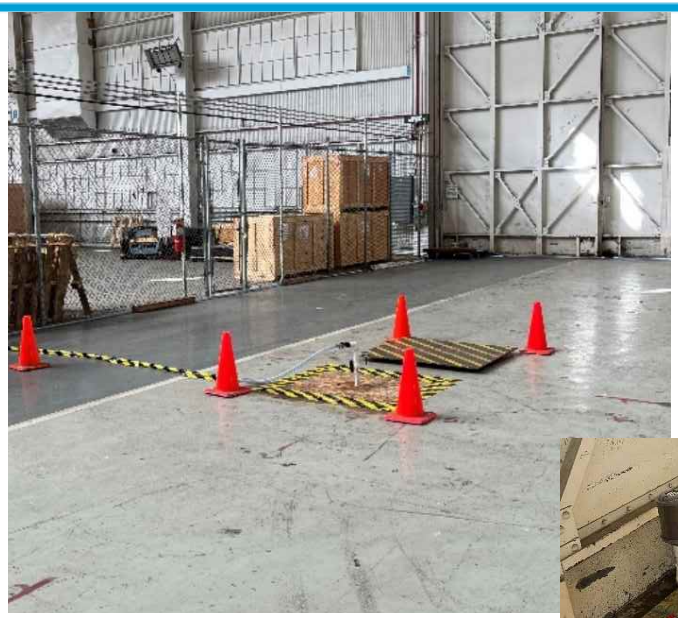
- SVE Pilot Test conducted in 2014
- None of the subfloor probes near the extraction well showed a vacuum response
- **The team realized that there was an air gap below the floor**
- The air gap was connected to multiple vaults and utility corridors; and was the key VI Pathway
- A helium tracer test was performed and established an ROI of at least 181 feet
- This confirmed the air gap is connected underneath the Building

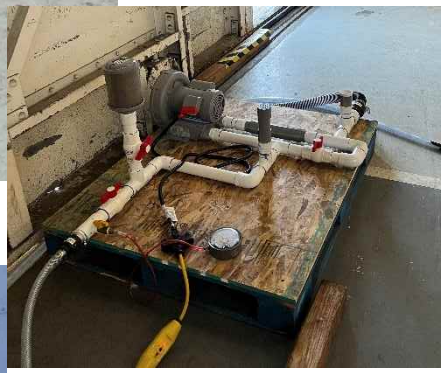
5.2 North VIMS Design (Installed February 2016)

- One of the closets near known soil gas contamination had an opening in the wall, leading to an apparent cavern
- The cavern was connected to the air gap
- Instead of using the SVE wells installed for the SVE Pilot Test, a slotted pipe was inserted into the opening, and a seal was placed around it
- The well was connected to a vacuum blower and VPGAC (at a fraction of the cost of a typical VIMS for an area this size)
- VIMS continues to operate as of 2024

5.5 South VIMS Design (Installed June 2022)

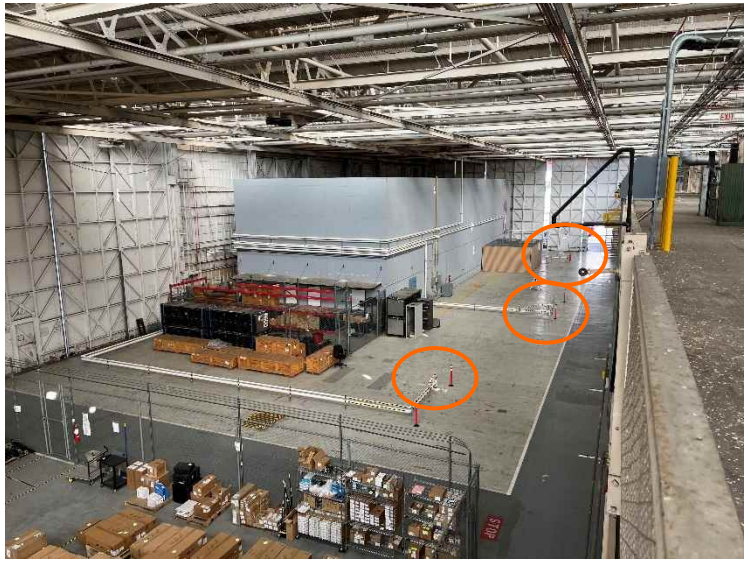
- In early 2022, TCE was detected in the air gap in the southern part of building at 140,000 µg/m^3
- Given the experience with the northern VIMS, the team found a vault close to the highest contamination
- A temporary VIMS was constructed in only a few days for an immediate response until full scale system could be implemented (parts were mostly sourced from a local Grainger)

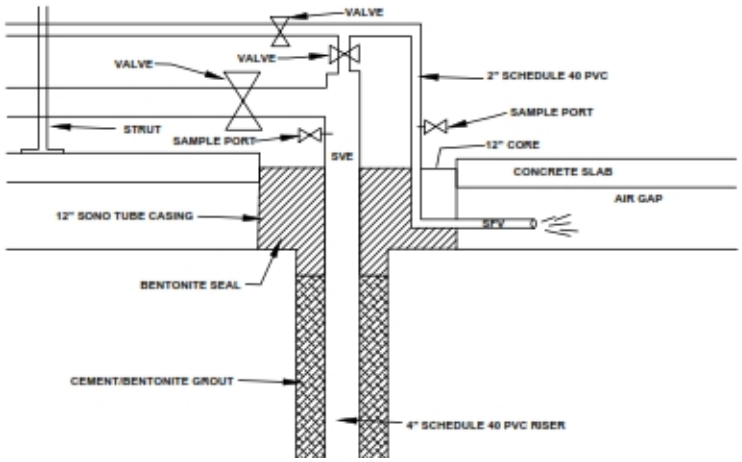




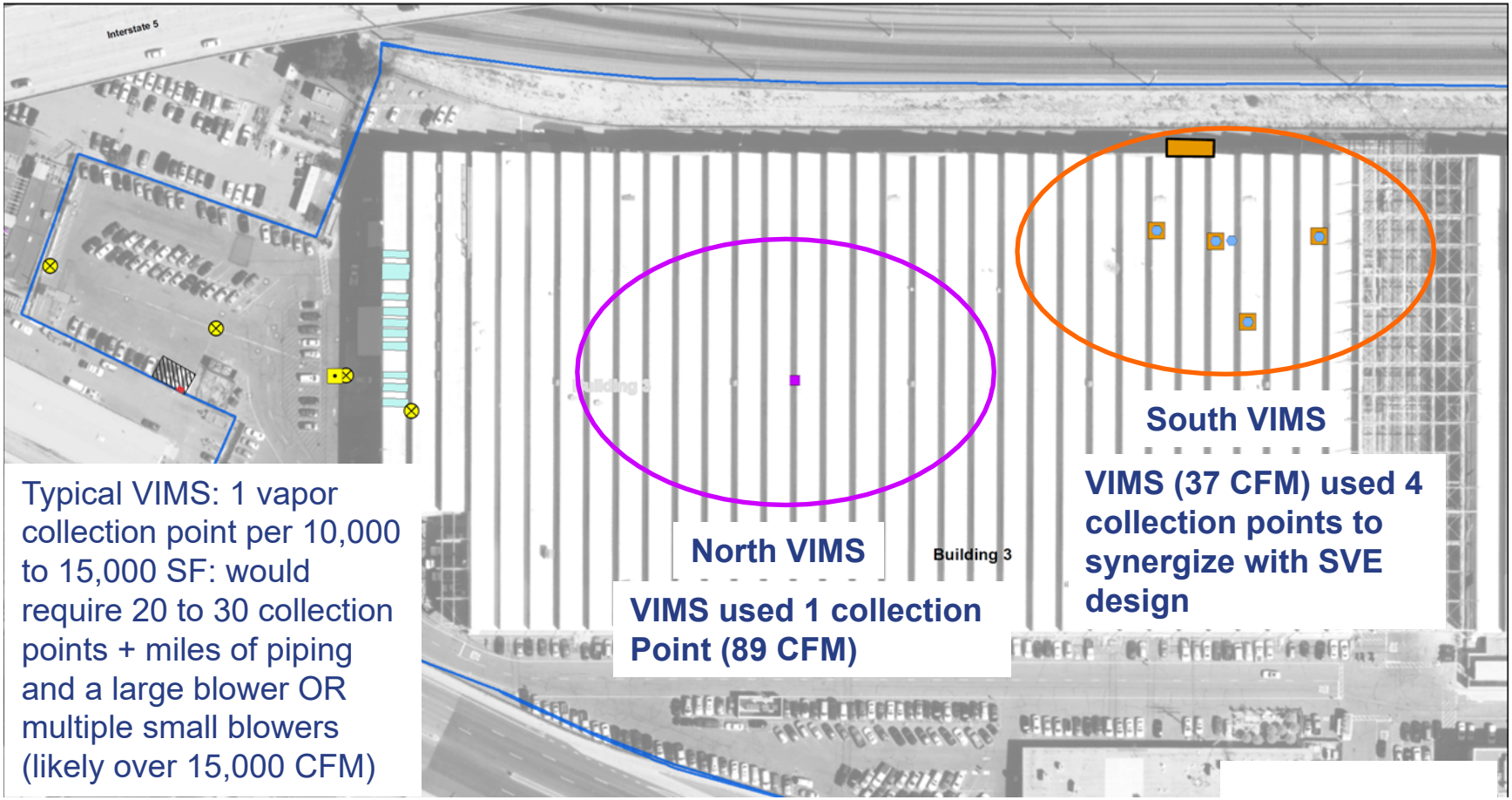
5.6 South VIMS and SVE Design (Installed May 2023)

- Permanent South VIMS constructed
- Soil gas contamination addressed with SVE system – SVE wells co-located with VIMS extraction points (isolated from air gap using seal)

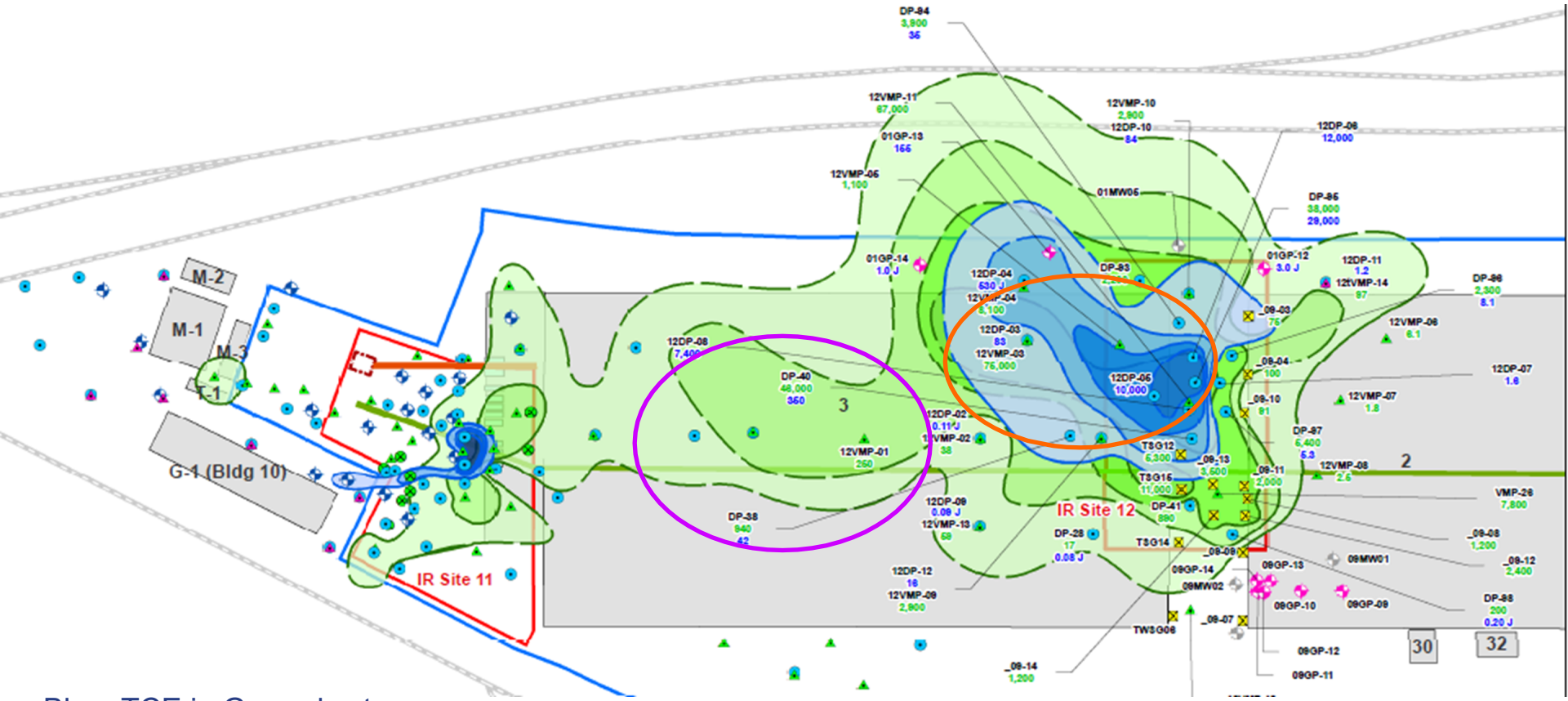




5.7 VIMS Locations/Details

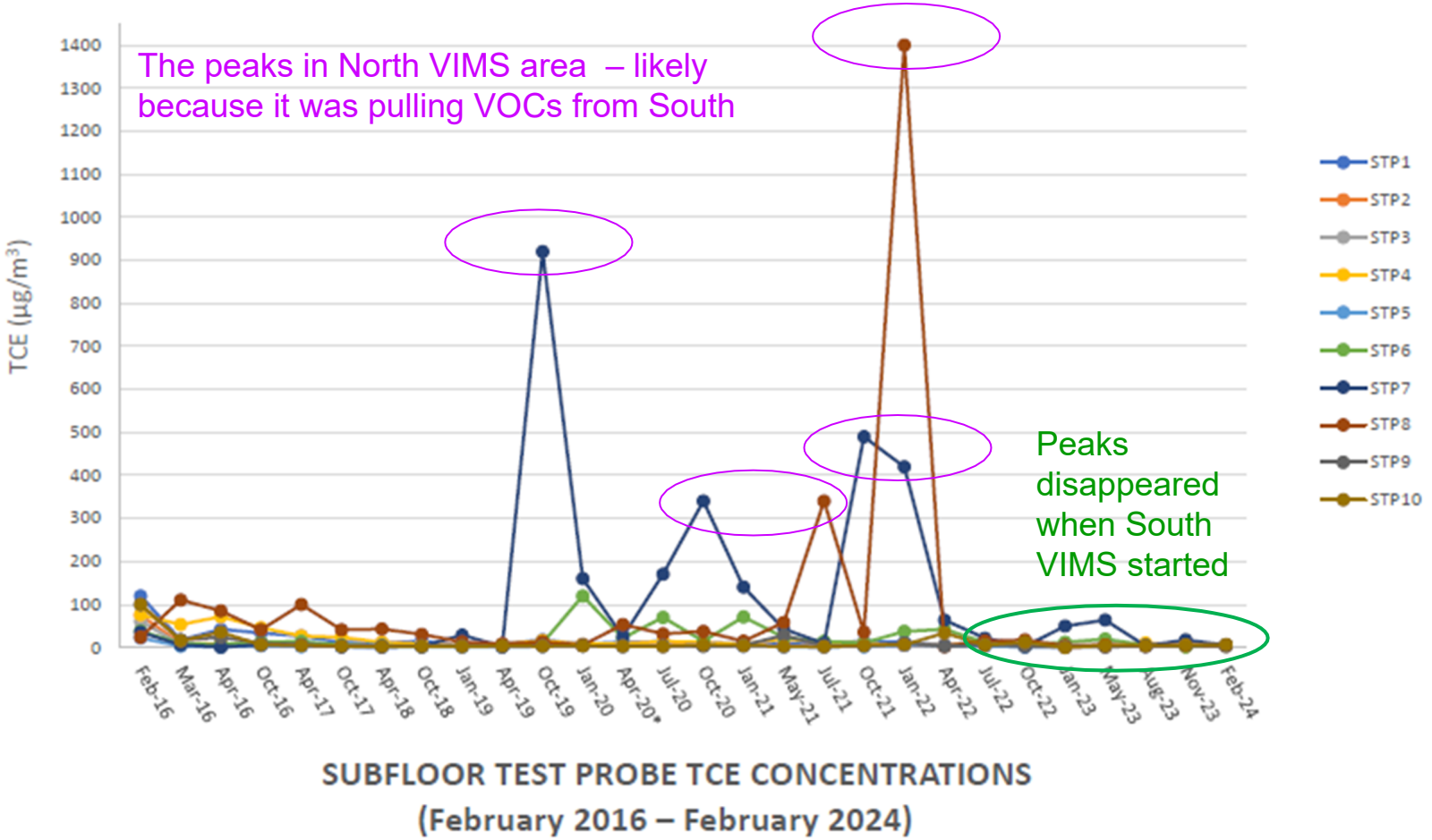


5.8 VIMS Influence (circa 2022)



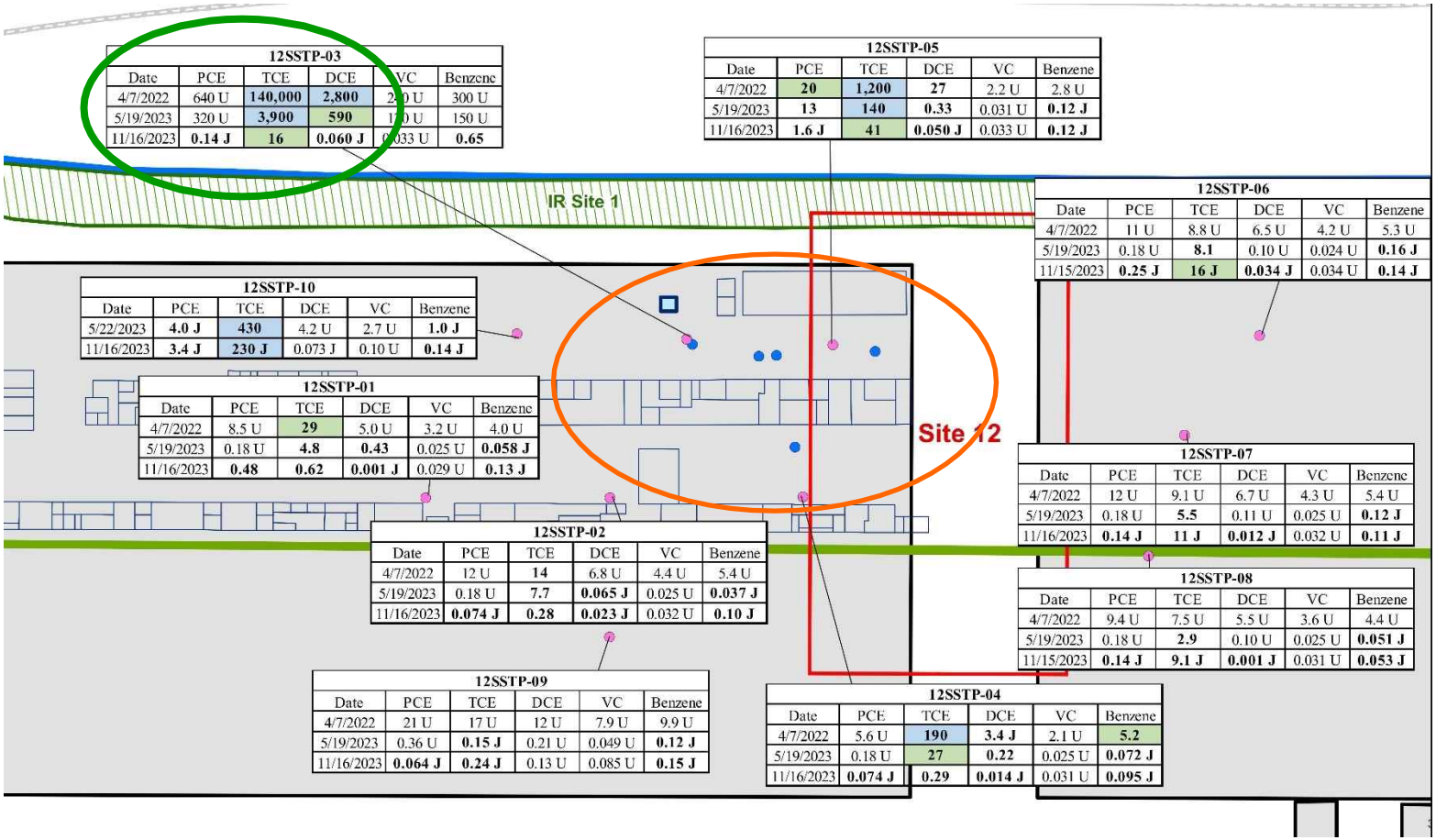
Blue: TCE in Groundwater
Green: TCE in Soil Gas

6.0 North VIMS – Subfloor Concentrations



SUBFLOOR TEST PROBE TCE CONCENTRATIONS
(February 2016 – February 2024)

6.1 South VIMS and SVES – Subfloor Concentrations



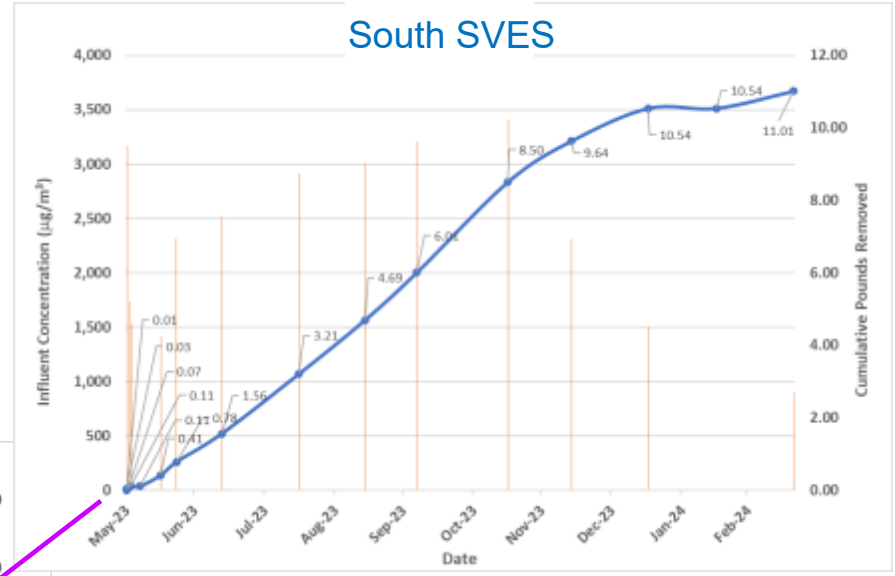
Timeline

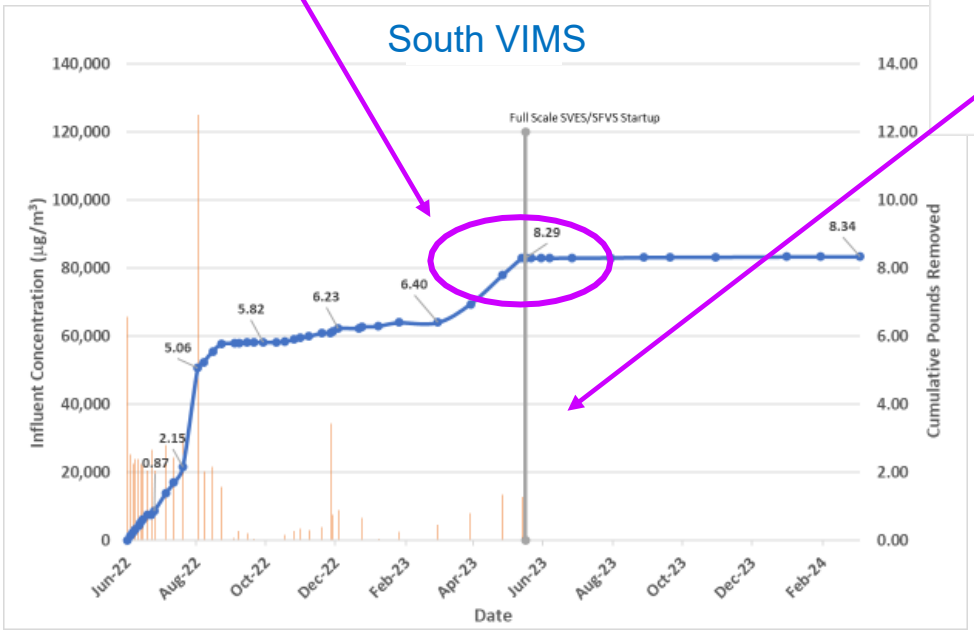
- 4/2022: Before VIMS
- 5/2023: VIMS Only
- 11/2023: VIMS and SVE

All subfloor test probes show a significant decrease in concentrations across the southern portion of the building

6.2 South VIMS and SVES – Influent Concentration Trends

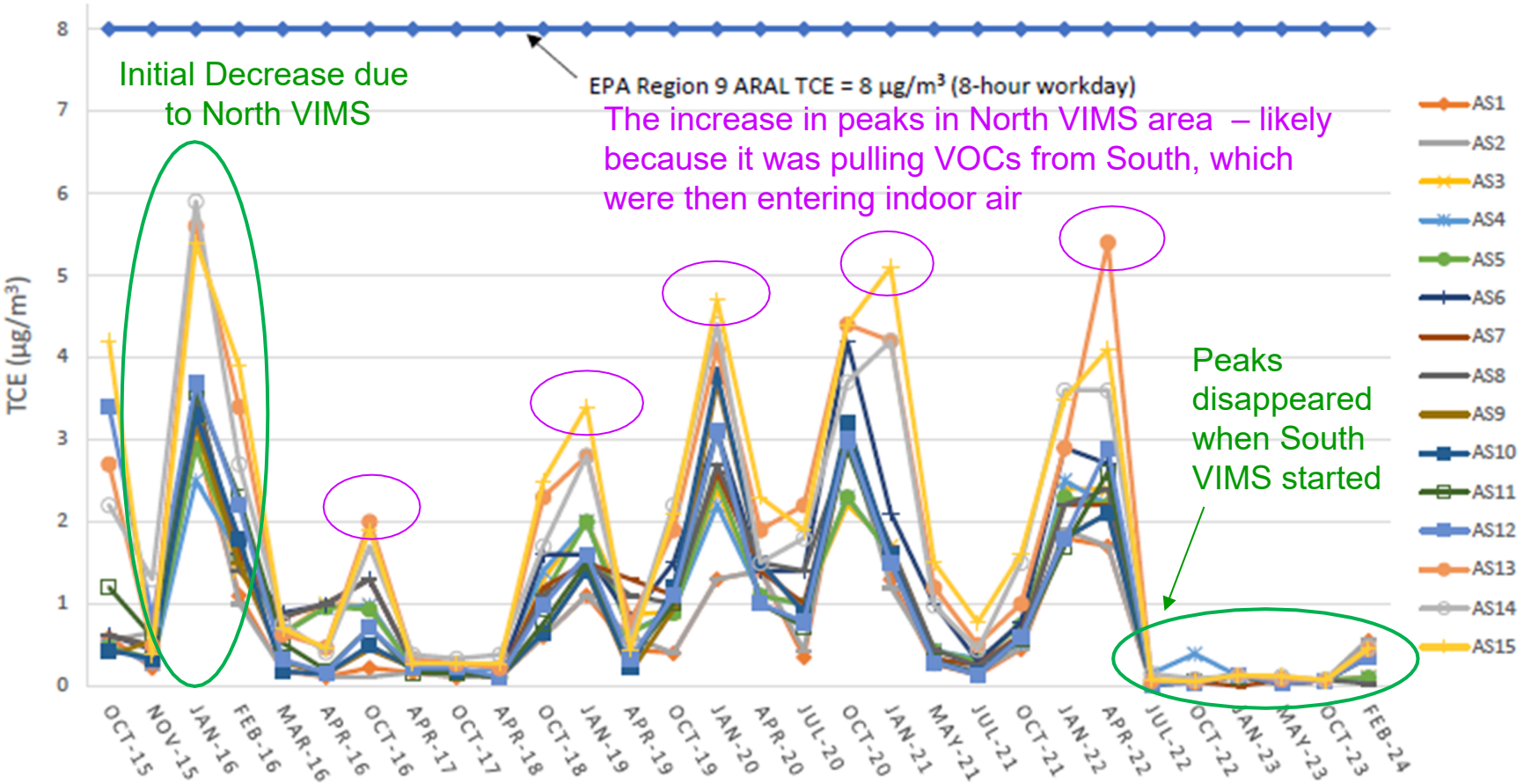
Mass Removed of South VIMS decreased when SVES was started





- Operation of South VIMS likely provides a pneumatic barrier by keeping air gap under vacuum (thereby minimizing short-circuiting of SVE wells)

6.3 Indoor Air Concentrations



INDOOR AIR TCE CONCENTRATIONS
(October 2015 – February 2024)

6.4 Typical VIMS Design vs. Actual

Parameter	Unit	Standard Value	Actual
Building Area	SF	~300,000	~300,000
**Collection Points - Design Coverage per Point (Typical)	SF	15,000	
**Number of Collection Points (Minimum)		20	2
**Number of Collection Points (Conservative)		30	
**Flow Needed (200 CFM / 4000 SF)	CFM/SF	0.05	0.00042
Flow Needed	CFM	15,000	126
Piping Length Needed	LF	30,000	~1,000

**NAVFAC VI Mitigation Fact Sheet:

https://clu-in.org/download/contaminantfocus/vi/vi_mit_new_bldg_fs.pdf

7.0 Lesson Learned and Results

Understanding the nuances of a site can lead you to the best solution

- Technical: Two small blowers effectively solved a complex VI problem
- Risk Mitigation: Indoor air detections now very low or non detect to occupants
- Cost Savings: Leveraging the air gap significantly reduced the overall project cost to mitigate VI
- Schedule: Rapid design and deployment of VIMS yielded immediate results