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GEOTECHNICAL | ENVIRONMENTAL | ECOLOGICAL | WATER | CONSTRUCTION MANAGEMENT

A COMPREHENSIVE REMEDIAL DESIGN APPROACH TO A MULTICONTAMINANT MULTIRECEPTOR SITE

Prepared for:

remediation technologies symposium 2023

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Presentation Outline

- Project History
- Challenges
- Delineation of Contamination
- Findings & Results/Evaluation of Effectiveness
- Path Forward

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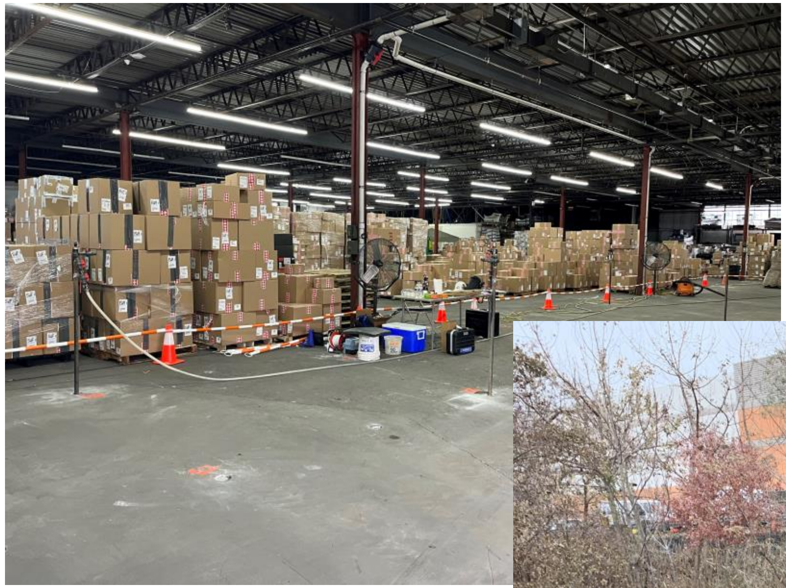
SITE LOCATION

The Site is a 3.52-acre parcel located in a commercial and industrial area of Elizabeth, New Jersey

Project History

- Former Safeguard Chemical Facility
  - Operated from 1964 to 2008, where operations included the manufacturing, filling (of aerosol containers), and distribution of aerosol products
  - Manufactured products including cleaners, polishers, pesticides/insecticides, disinfectants, lubricants, and adhesives
  - Stored chemicals including pesticides, solvents, and propellants in bulk quantities in ASTs in the rear side of the building in the vicinity of the Great Ditch
- Currently used as a warehouse distribution facility
- Remedial investigations identified cVOCs and pesticides as the primary contaminants of concern (COCs) in subsurface soil, groundwater, surface water, and sediments



Site Geology/Hydrology

0.0-0.5 ft: Asphalt, Concrete and/or Gravel

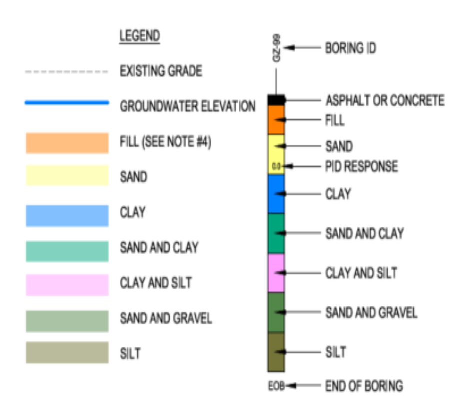
0.5-7.0 ft: Fill Material (Glass, Plastic, etc.)

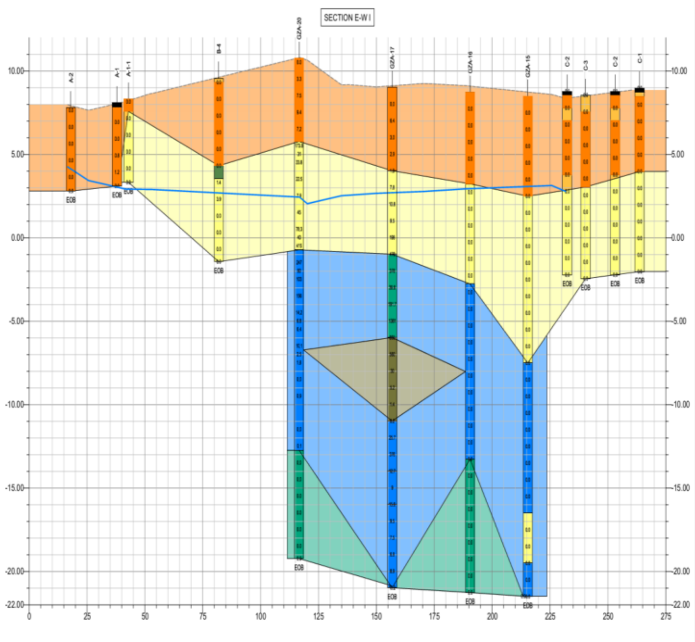
7.0-13 ft: Fine-Medium Sand and Silt

13-45 ft: Clay

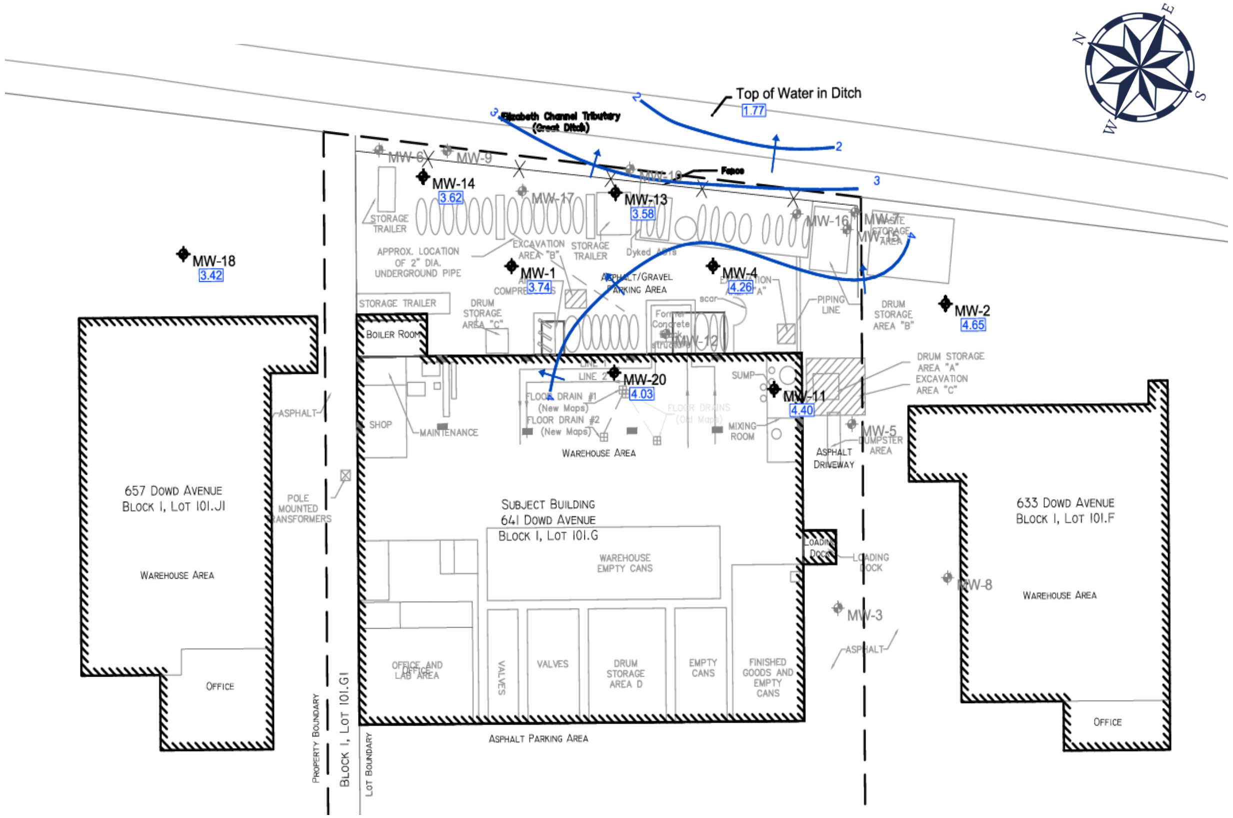
45-50 ft: Weathered Bedrock (Mudstone)

50+ ft: Bedrock (Mudstone)





- Depth to Groundwater ranges from 4 to 5 ft bgs
- Groundwater flows northeast toward the Great Ditch, bordering the Site to the east



Contamination Treatment Plan

Challenges:

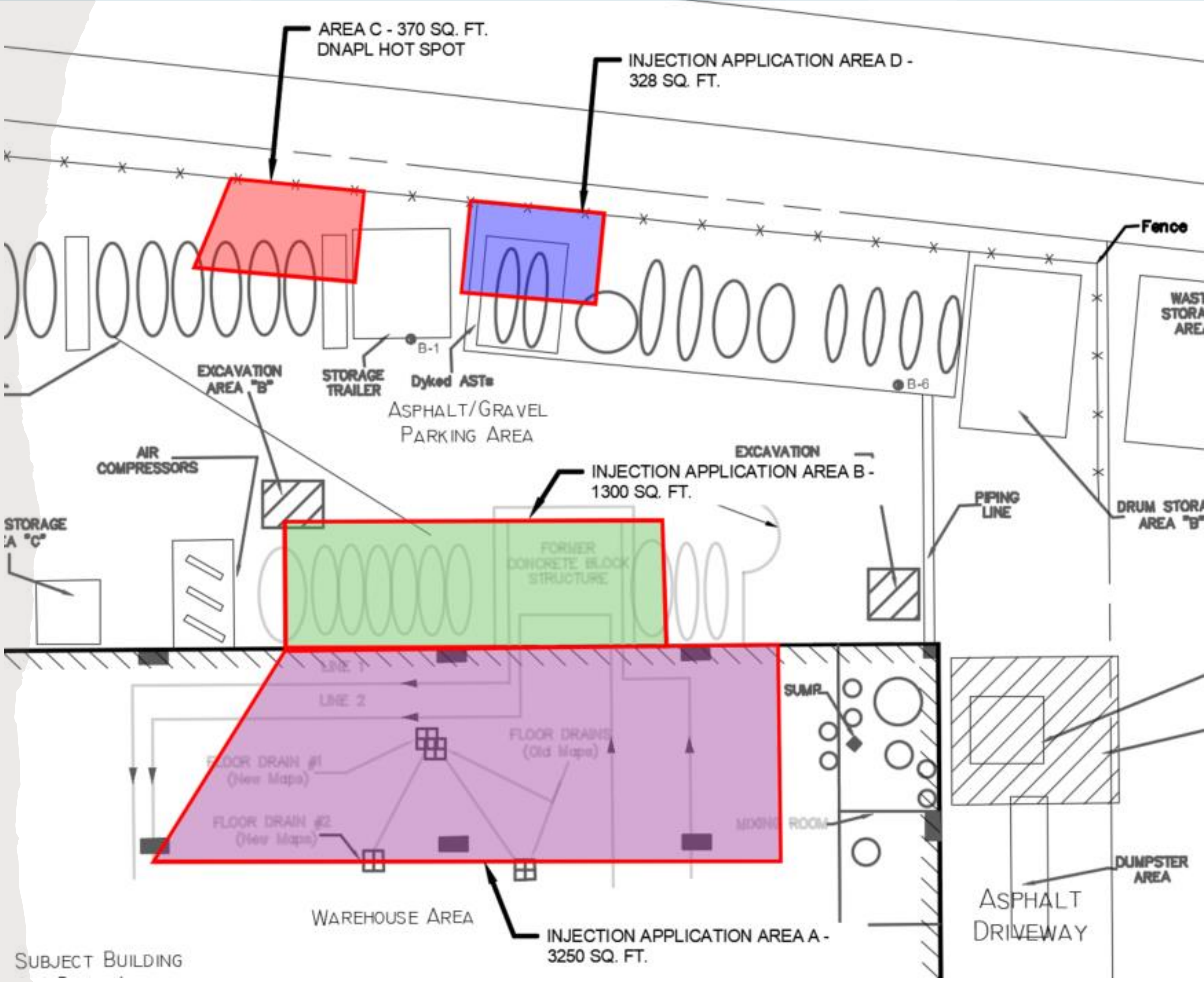
- VOC was detected in clay layer, therefore the removal would be challenging
- Highest levels of VOCs detected in the vicinity of Great Ditch a sensitive receptor
- Low levels of pesticides detected in groundwater
- Groundwater discharges into the Ditch
- Injections at high pressure may mobilize contamination and potentially impact the Ditch
- Select appropriate treatment technology (e.g., excavation, injections, or combination of both)
- Implementation of any remedial action was challenging because the contamination was detected within the building and the facility is an active warehouse so disruption to operations was not feasible
- Dig and haul not a feasible option due to extensive cost of disposal of soil and groundwater. An open cut excavation was not feasible due to limited area and shallow groundwater.
- Address DNAPL hotspot in the vicinity of The Great Ditch

Proposed Treatment Train Approach:

Delineate hot spot extents → Treatability/bench scale study to select appropriate amendment(s) → Implementation of remedial action (ISCO) → Limited excavation using caisson rigs to address DNAPL

Delineation of Contamination

- Chlorinated/Volatile Organic Compounds (cVOCs and VOCs)
  - Highest concentrations of cVOCs were primarily detected in the clay layer (between 6 and 18 ft bgs), within and behind the building where the bulk chemicals were stored at the Site
  - PCE was detected at 3,000,000 ppm i.e. free product/DNAPL in the northeastern portion of the Site
- Pesticides
  - Pesticides were primarily identified in shallow soils (between 0 and 5.5 ft bgs) and low levels in groundwater in the northeastern and southeastern corners of the asphalt/gravel parking area



Treatability Study

Fenton's Reagent

- Reduced 95.9% to 98.5% of chlorinated ethenes
- Eliminated 1,1,1-TCA but not its daughter product 1,1-DCA
- Reduced BTEX by 91.3% to 96.6%
- Reduced concentrations of organochlorine pesticides by 60.2% to 75.3%

Sodium Persulfate Activated with Carbohydrate and Sodium Hydroxide

- Reduced 98.3% to 99.99% of chlorinated ethenes
- Eliminated 1,1,1-TCA at the highest loading, but not its daughter product 1,1-DCA
- Reduced BTEX by 97.9% to 98.5%
- Reduced concentrations of organochlorine pesticides by 0.3% to 58.9%

EZVI and Bioaugmentation

- Reduced 87.2% to 90% of chlorinated ethenes
- Eliminated 1,1,1-TCA at the highest loading, but not its daughter product 1,1-DCA
- Reduced BTEX by 99.7% to 100%
- Increased concentrations of organochlorine pesticides

Overview of In-Situ Chemical Oxidation

Injections Remedy Selection

Treatability study results showed that a combination of activated sodium persulfate with glucose and sodium hydroxide, along with Fenton's Reagent, are most effective at the Site

Based upon the treatability study results we decided to go with a combination of MFR, consisting of hydrogen peroxide and chelated iron to mobilize adsorbed contamination from the clay layer, this can be done without applying high pressure and Activated sodium persulfate (CHASP) was injected to treat the mass mobilized in the groundwater.

MFR is short lived however, CHASP has a longer shelf life, which will continue treating the groundwater.

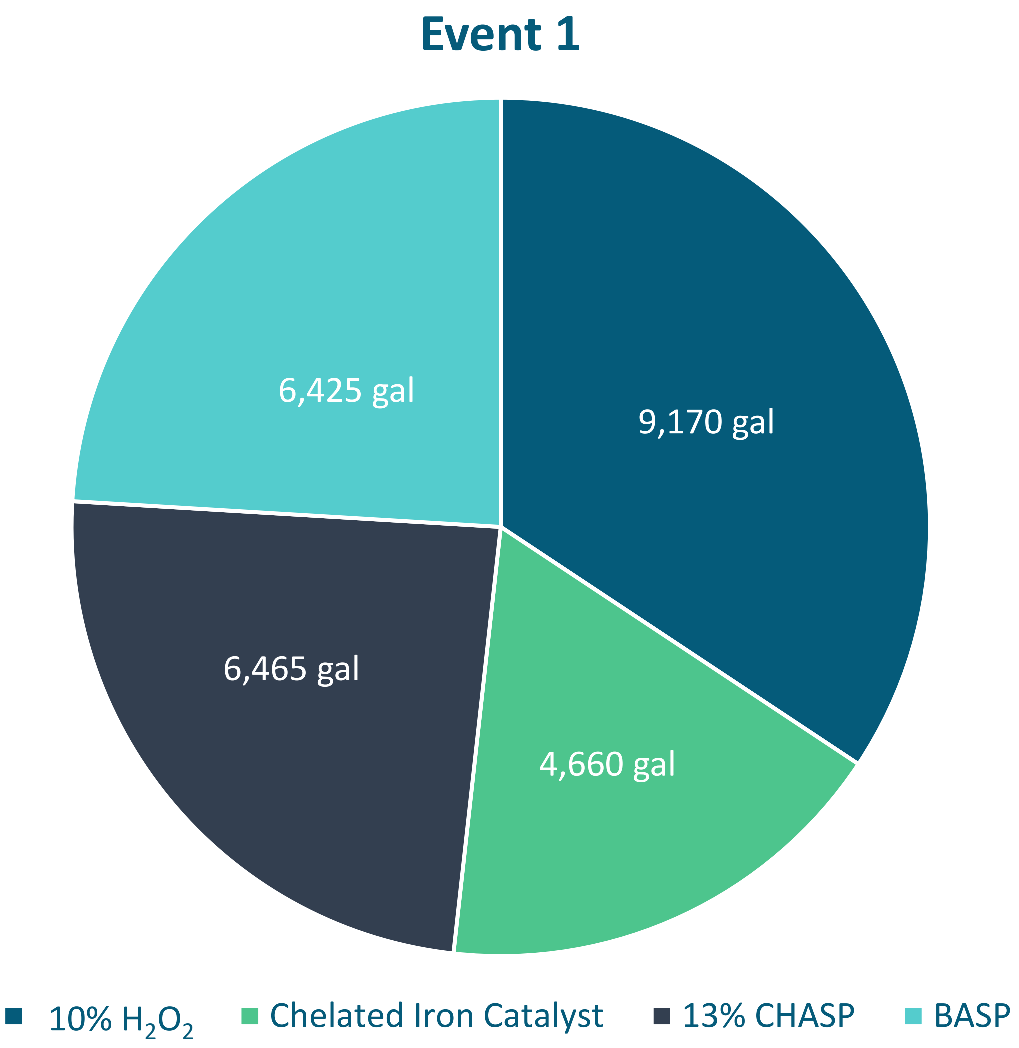
Based upon our design the volume of amendment required was too large to inject during one injection event, therefore it was split into two events. The target during each event was to replace 30% to 40% pore volume

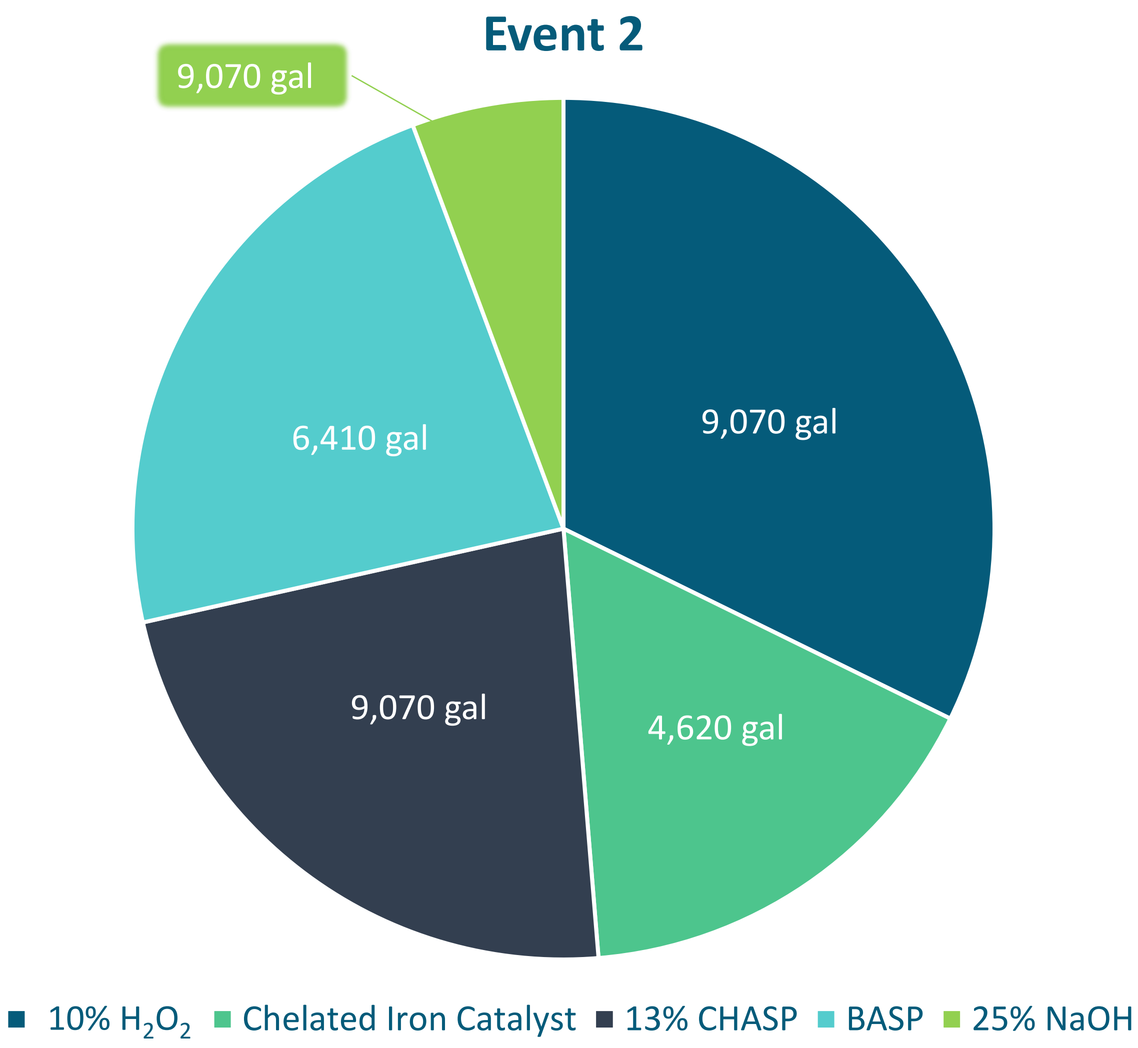
ISCO – Quantities

EVENT 1: November 15 through December 19, 2022				
	10% Hydrogen Peroxide	Chelated Iron Catalyst	13% CHASP	Base Activated Sodium Persulfate (BASP)
Area A (3,250 sq. ft.)	5,800 gal	2,900 gal	4,060 gal	4,020 gal
Area B (1,3000 sq. ft.)	2,720 gal	1,400 gal	1,925 gal	1,925 gal
Area D (328 sq. ft.)	650 gal	360 gal	480 gal	480 gal

EVENT 2: March 1 through March 30, 2023					
	10% Hydrogen Peroxide	Chelated Iron Catalyst	13% CHASP	Base Activated Sodium Persulfate (BASP)	25% Sodium Hydroxide
Area A (3,250 sq. ft.)	5,750 gal	2,900 gal	4,060 gal	4,060 gal	1,156 gal
Area B (1,3000 sq. ft.)	2,720 gal	1,360 gal	1,870 gal	1,870 gal	306 gal
Area D (328 sq. ft.)	600 gal	360 gal	480 gal	480 gal	137 gal

ISCO – Quantities





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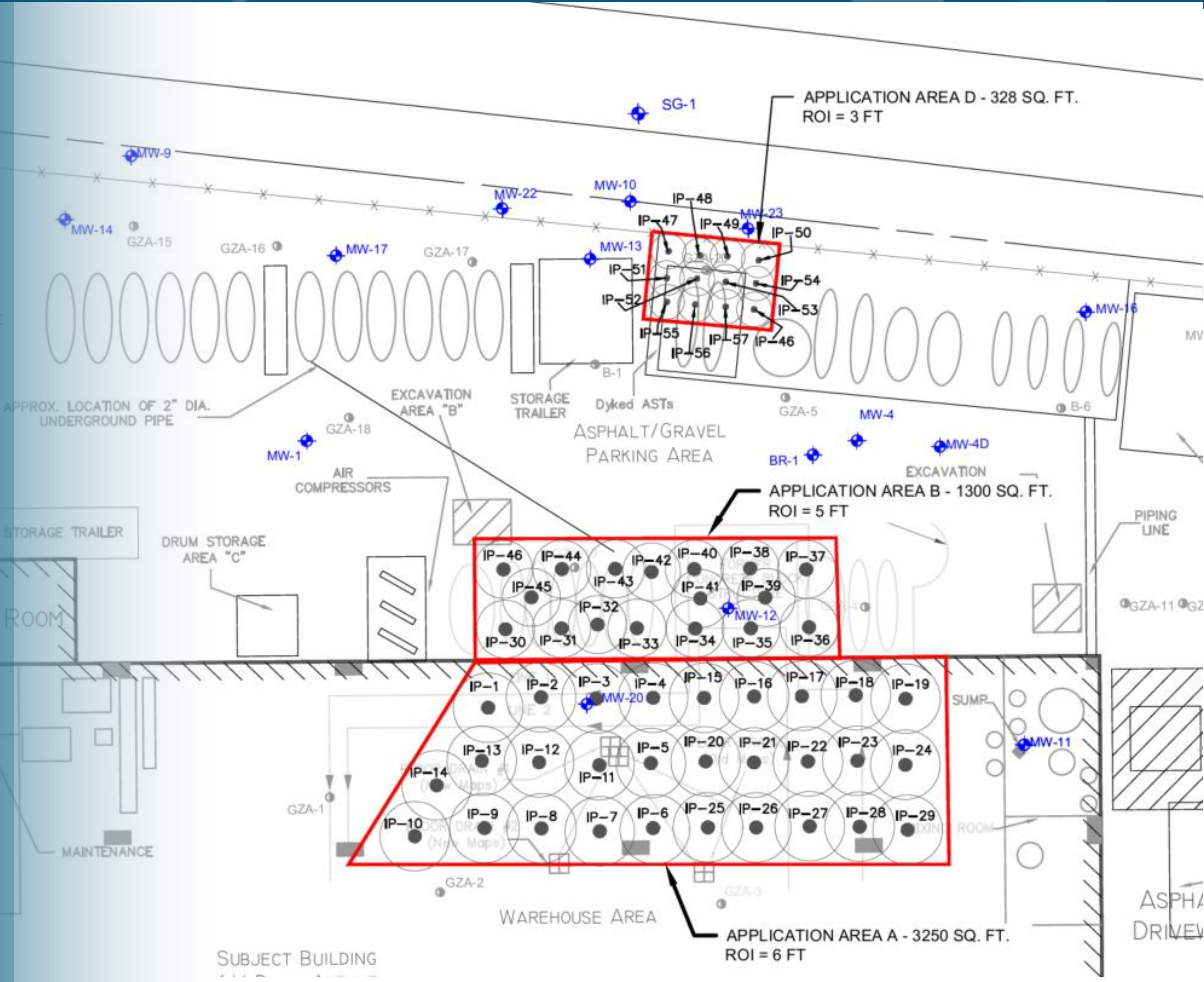
ISCO – Field

- GZA implemented two different injection events, each event lasting approximately 4-5 weeks in duration and separated by 2 months
- MFR and CHASP were injected in a sequential and manner at minimal pressure in the three injection areas, via direct push technology (DPT) at target depths of 6-to-16 ft bgs
- Field observations include surfacing in limited areas, pressure monitoring, measurement of geochemical parameters, and modification of injection quantities based on subsurface acceptance of reagents



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Findings

Criteria for evaluating effectiveness includes the monitoring of groundwater concentrations and geochemical parameters

Groundwater Monitoring:

- **Baseline:** prior to injections
- **Interim:** between the 2 injection events
- **30-60-90 Day:** conducted after the injections in May, July and October 2023

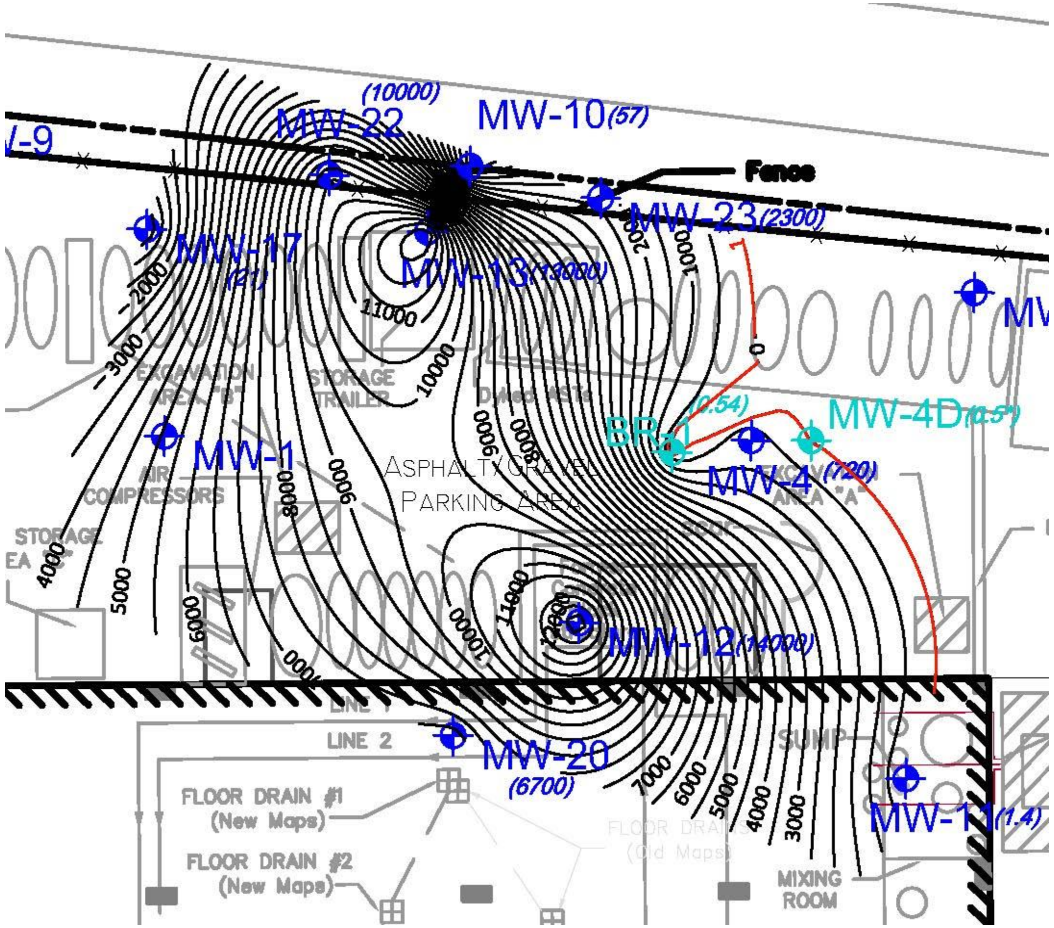
Geochemical Parameters:

- Geochemical parameters behaved as expected with increases in DO and ORP, as monitored through sampling events and daily during the injections

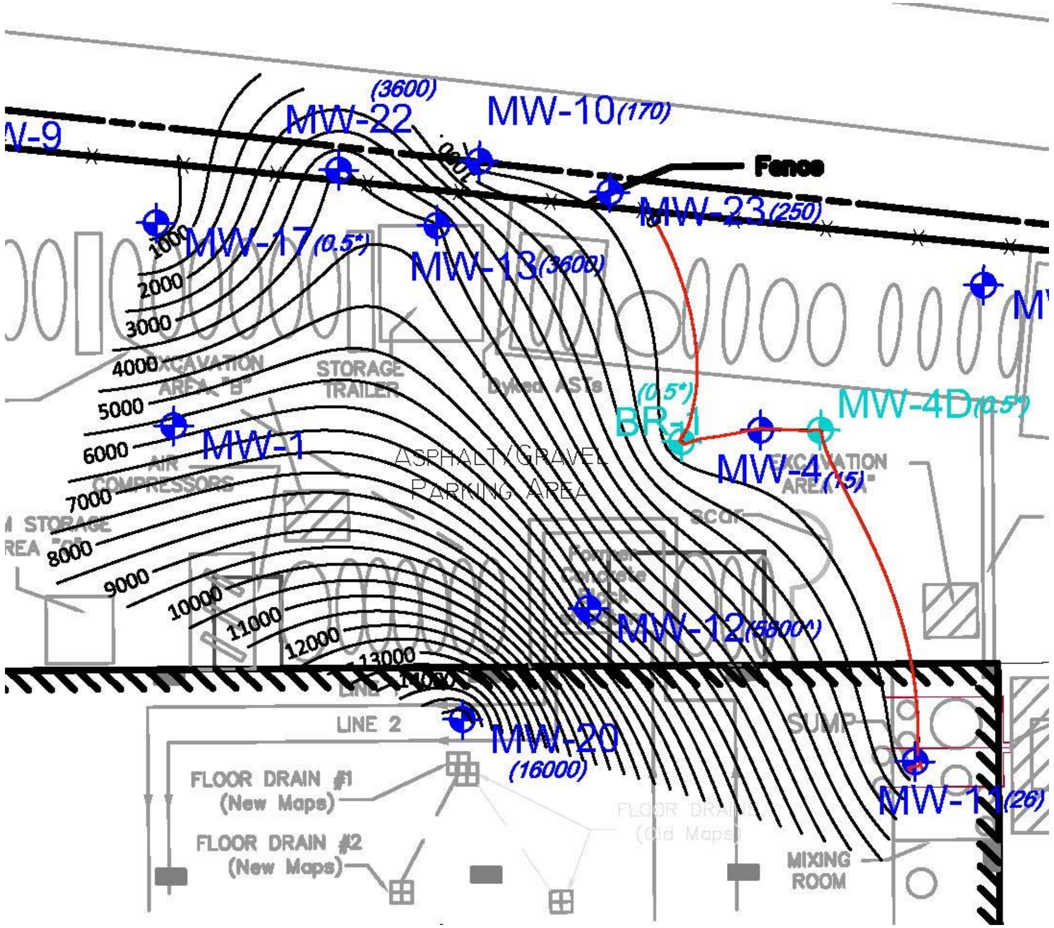
ISCO – Groundwater Monitoring

Tetrachloroethene

BASELINE SAMPLING EVENT (OCT/NOV 2022)



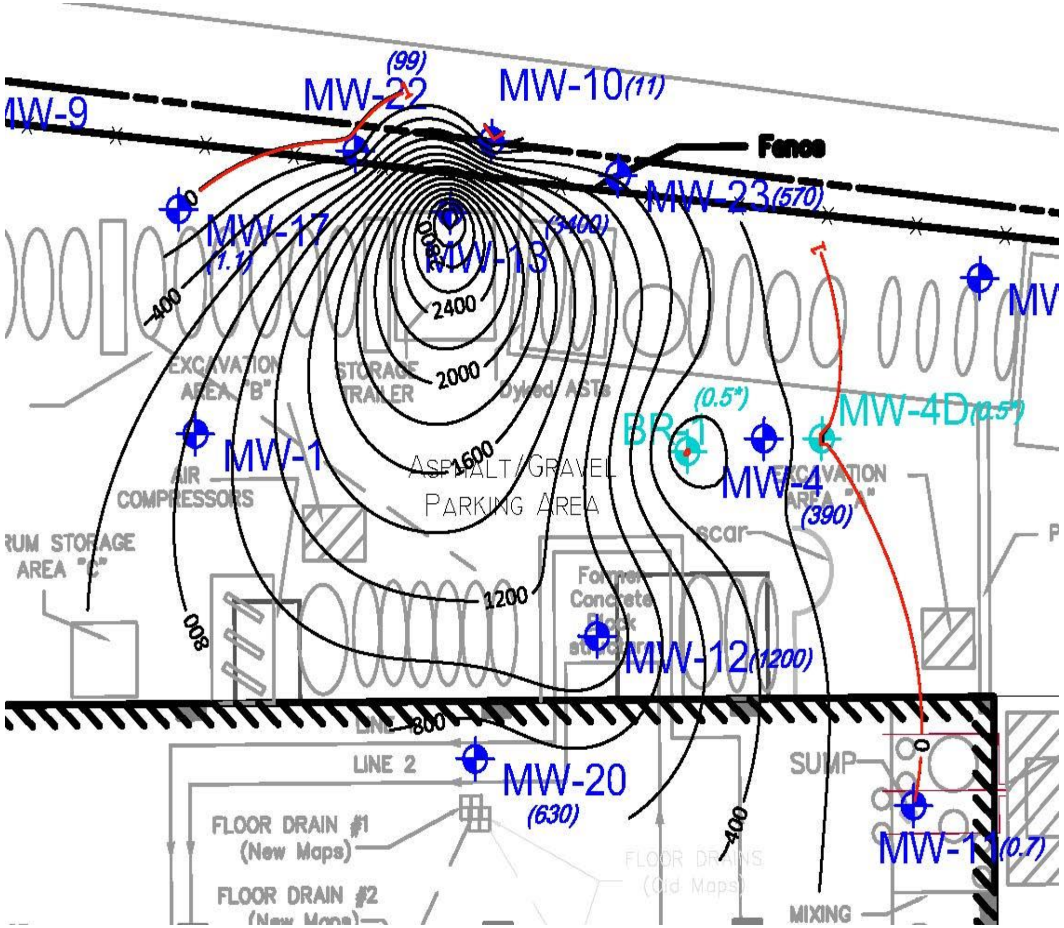
60-DAY MONITORING SAMPLING EVENT (JULY 2023)



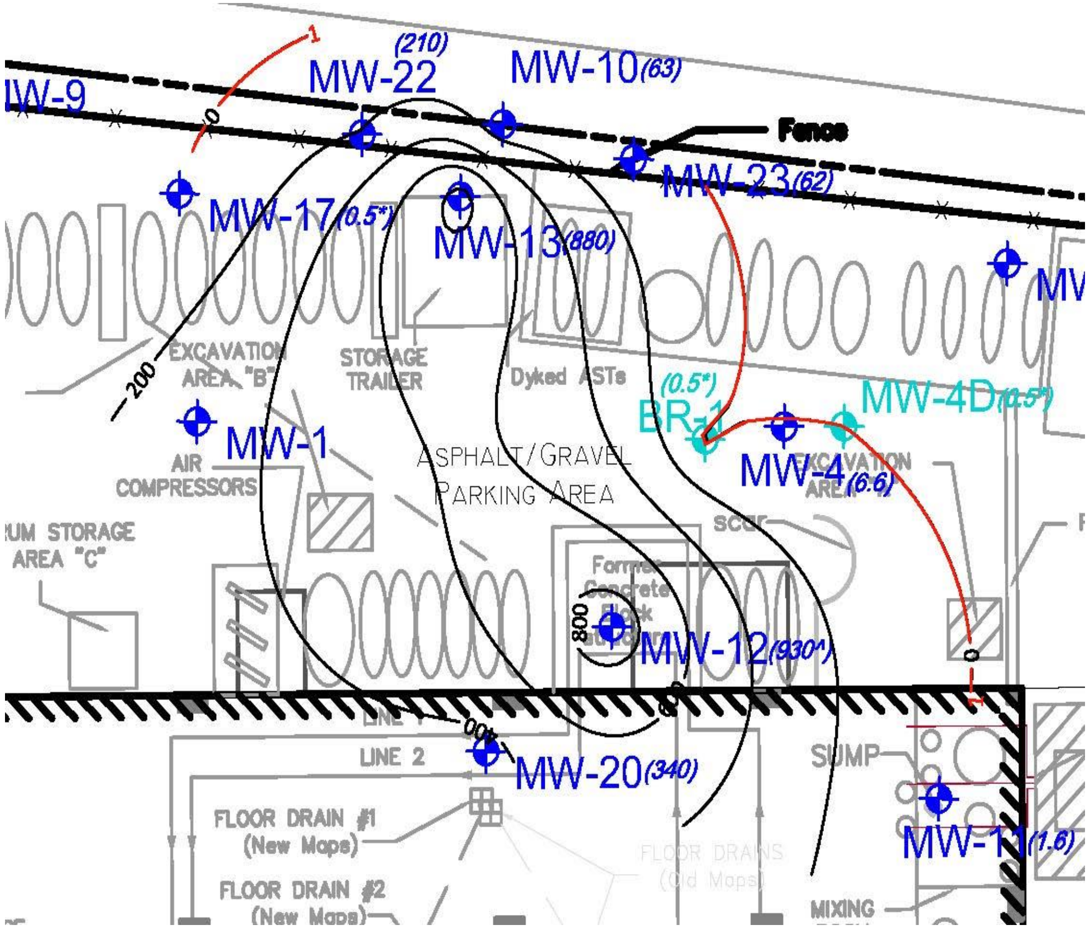
ISCO – Groundwater Monitoring

Trichloroethene

BASELINE SAMPLING EVENT (OCT/NOV 2022)

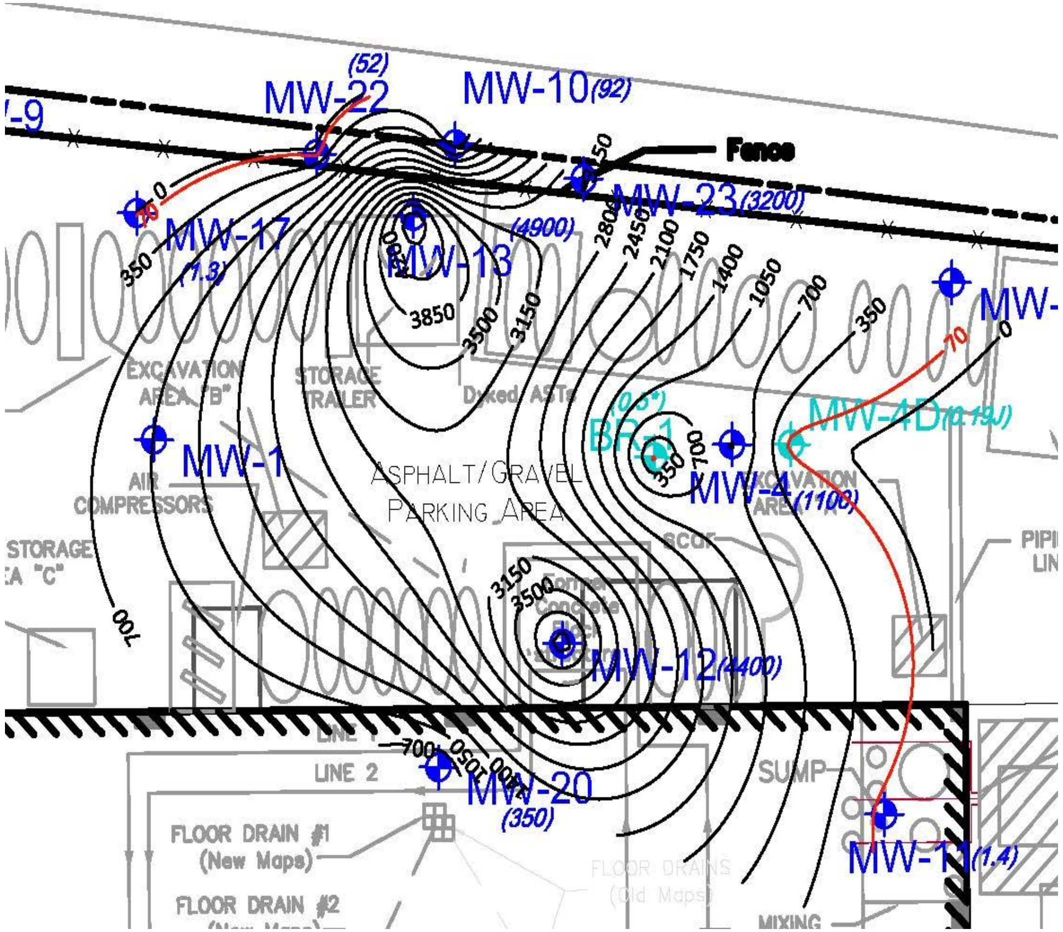


60-DAY MONITORING SAMPLING EVENT (JULY 2023)



Cis-1,2-Dichloroethene

BASELINE SAMPLING EVENT (OCT/NOV 2022)



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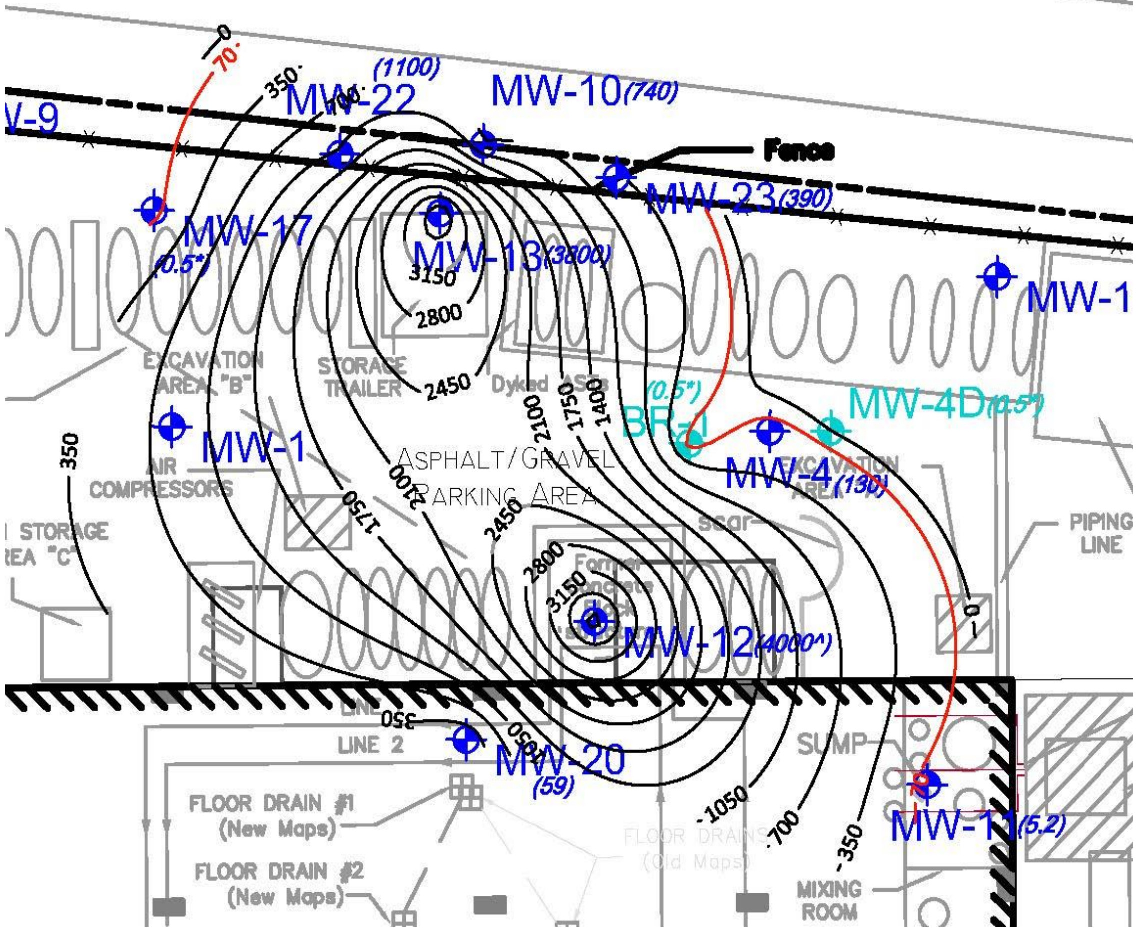
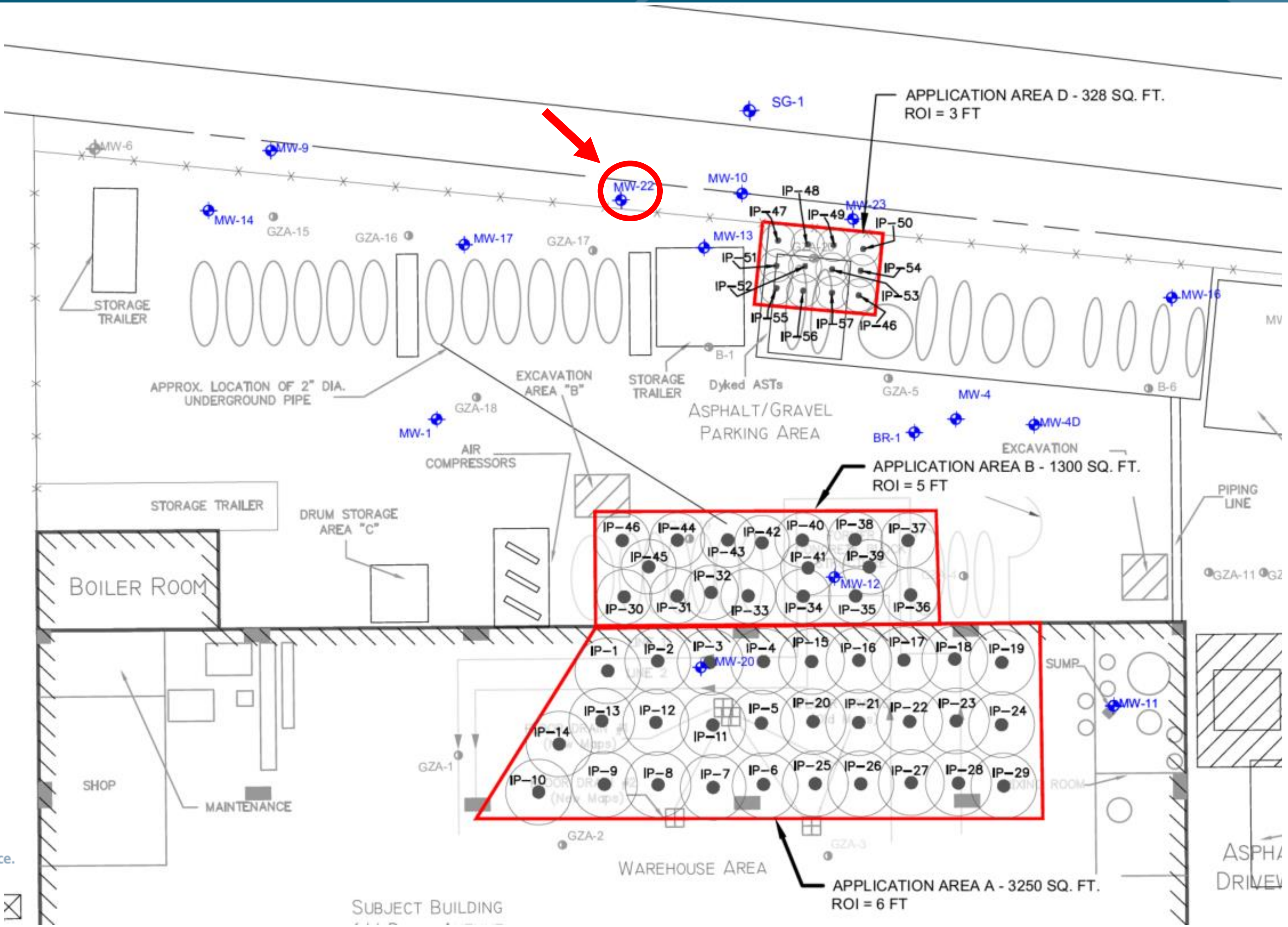
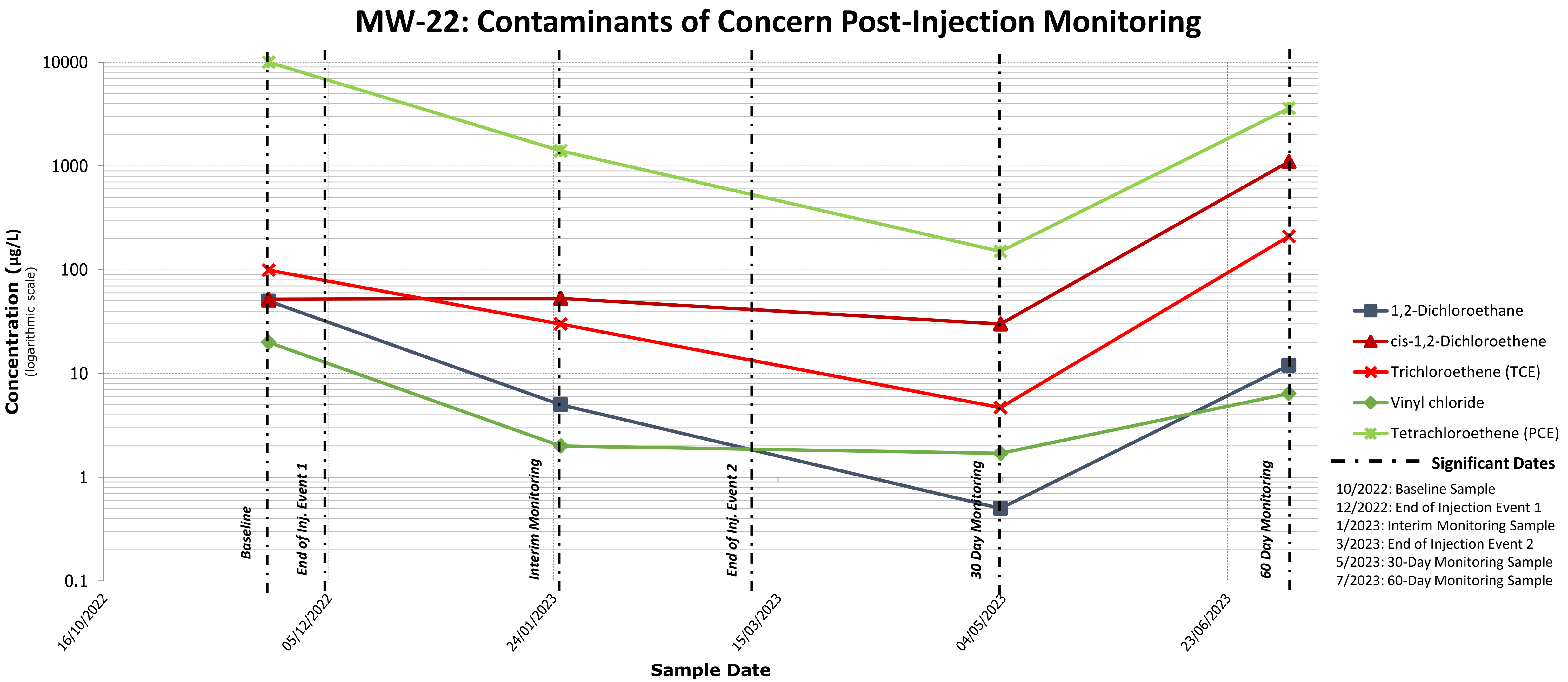


ISCO – Groundwater Trends



ISCO – Groundwater Trends



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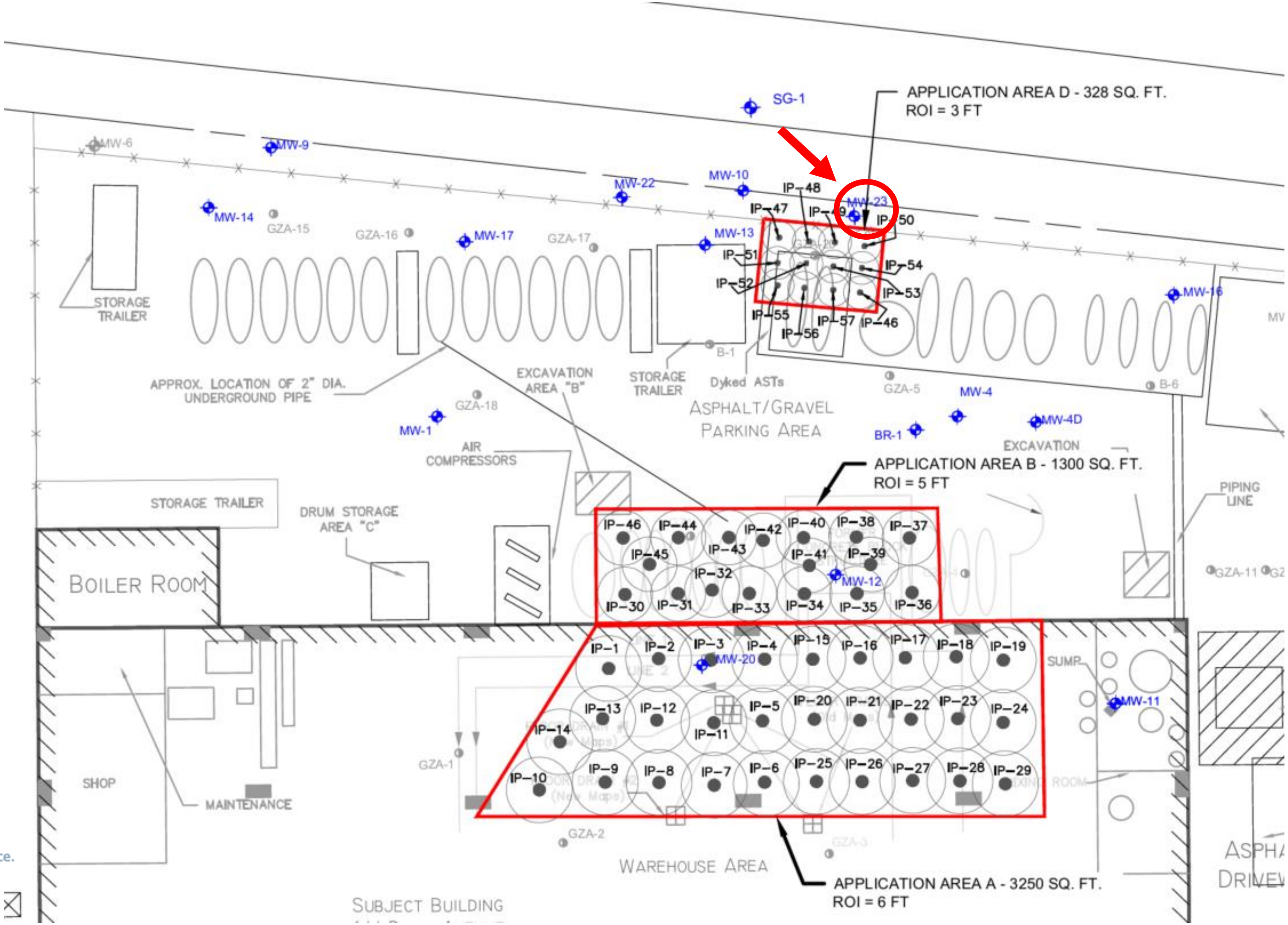
ISCO – Groundwater Trends



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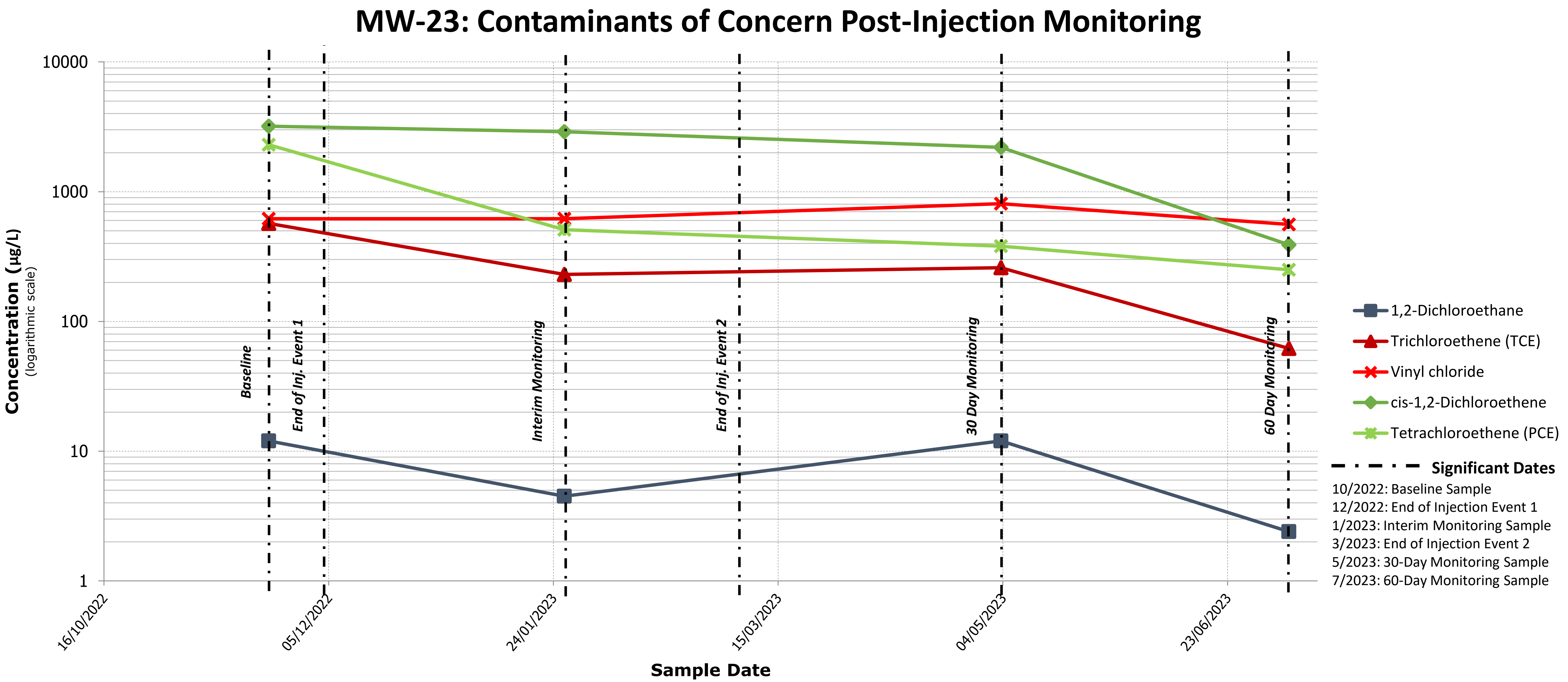

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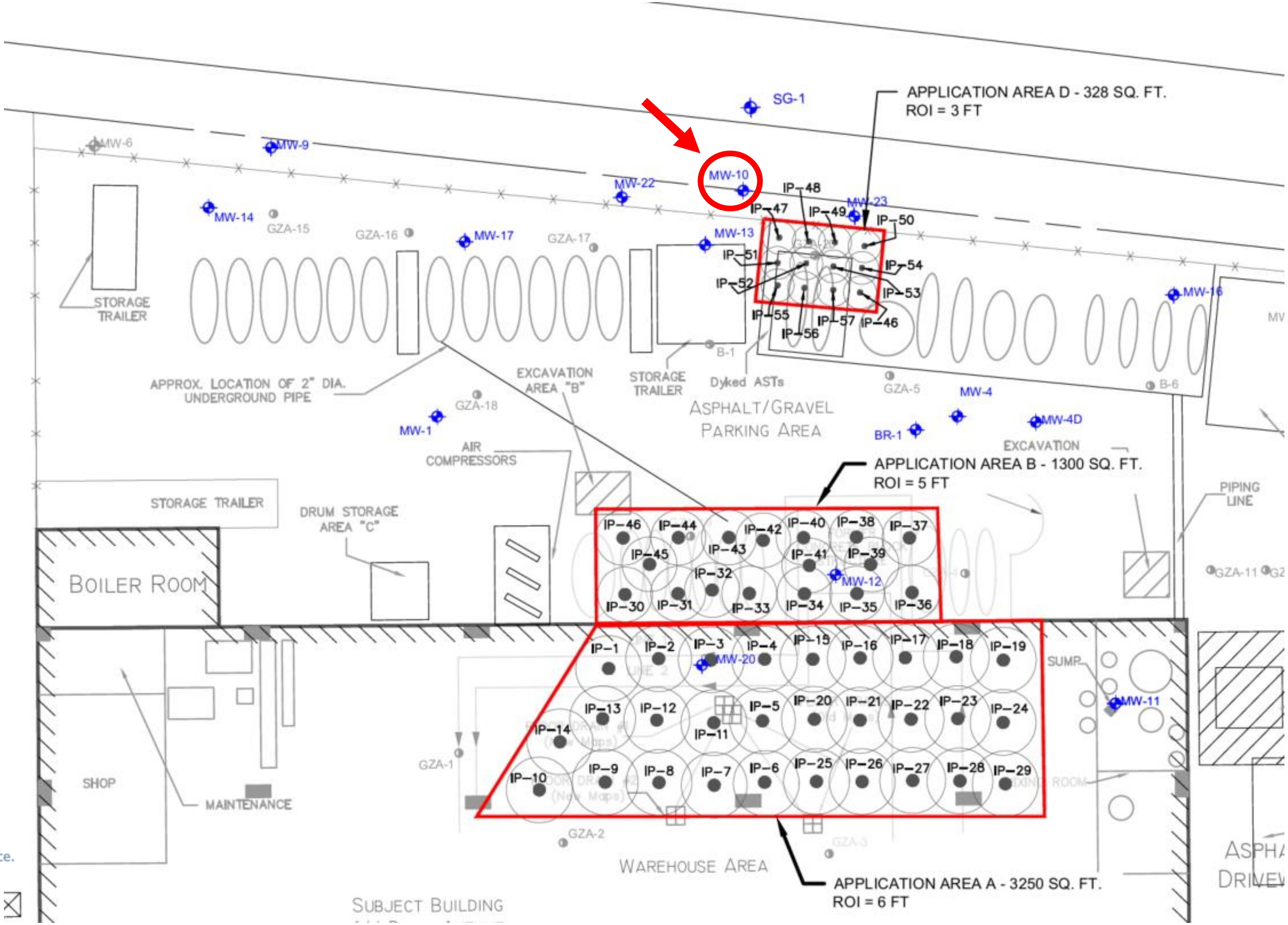

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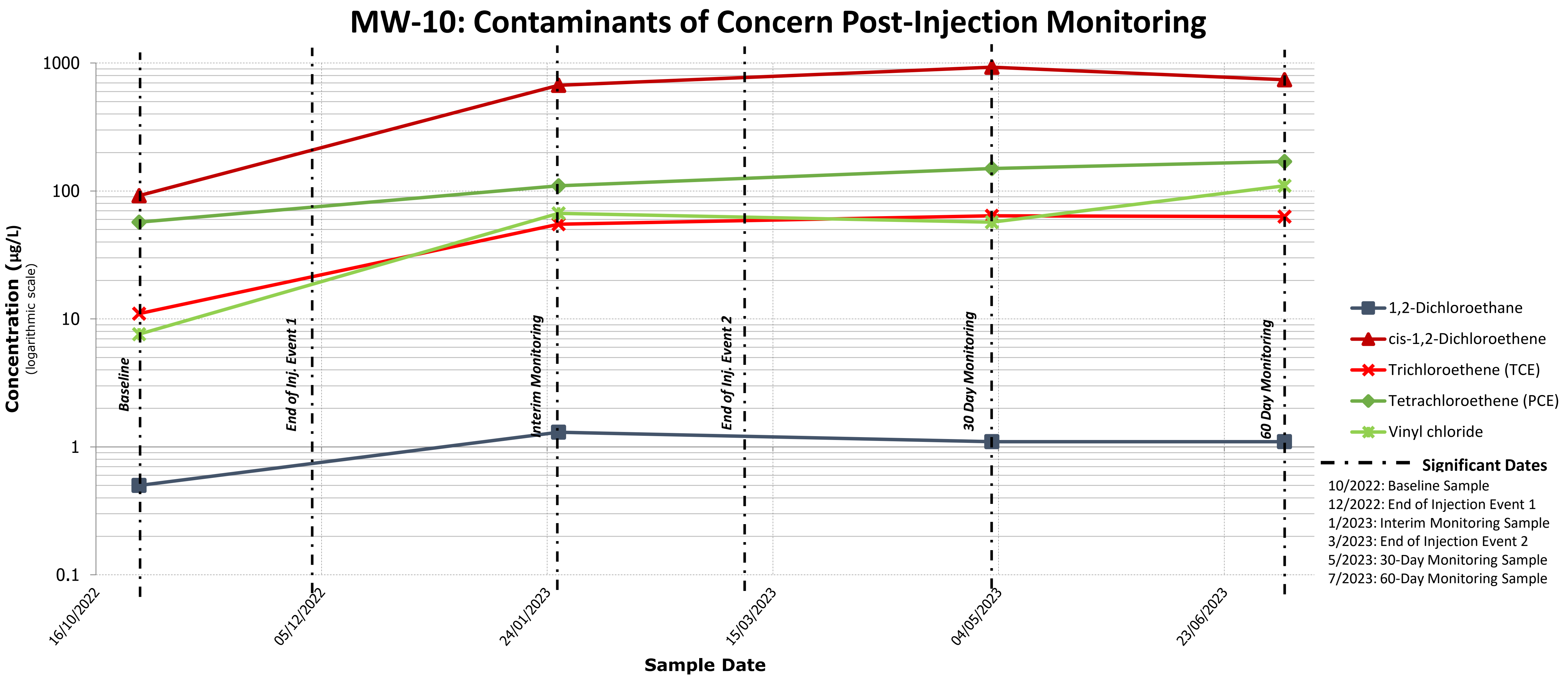

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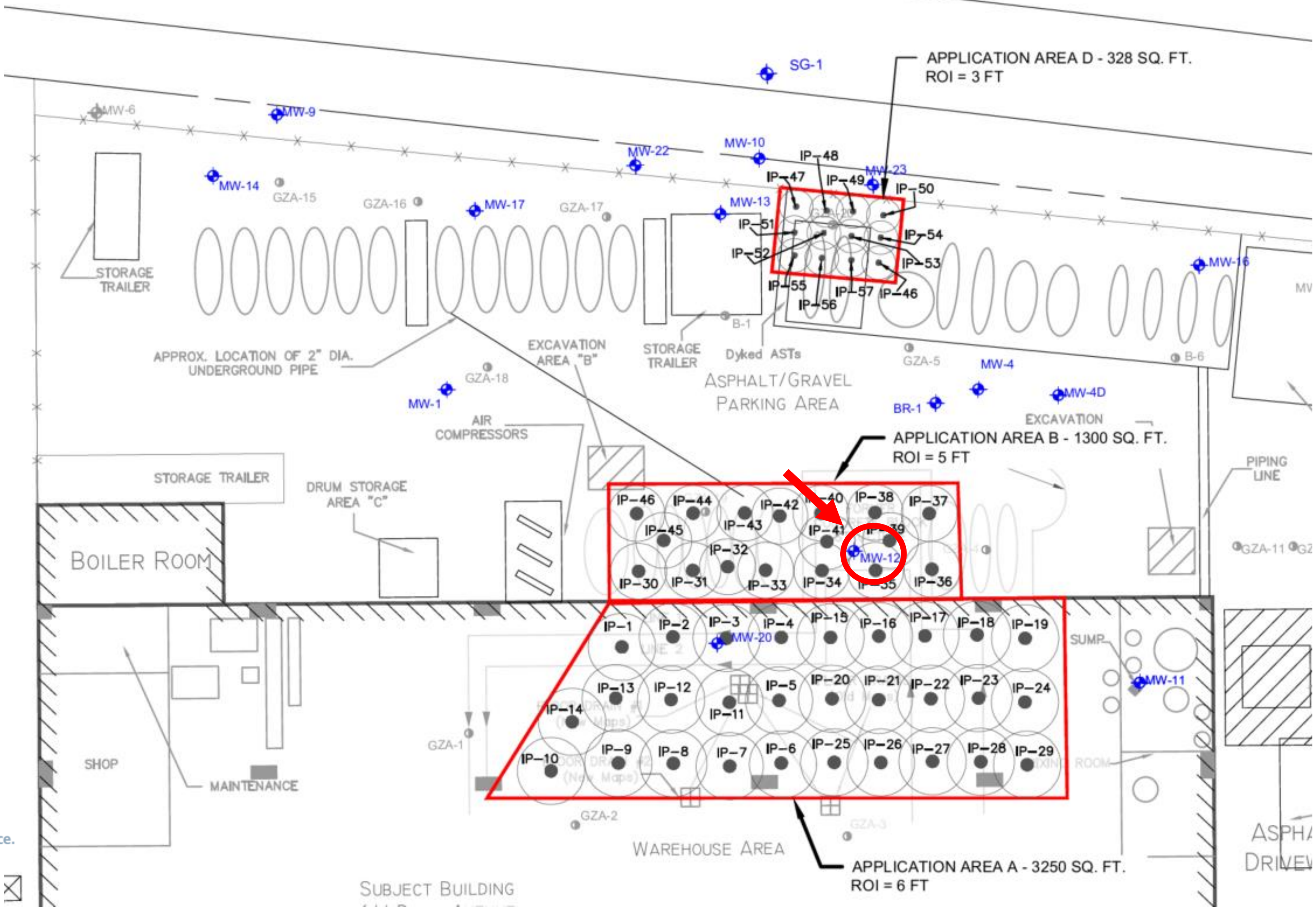

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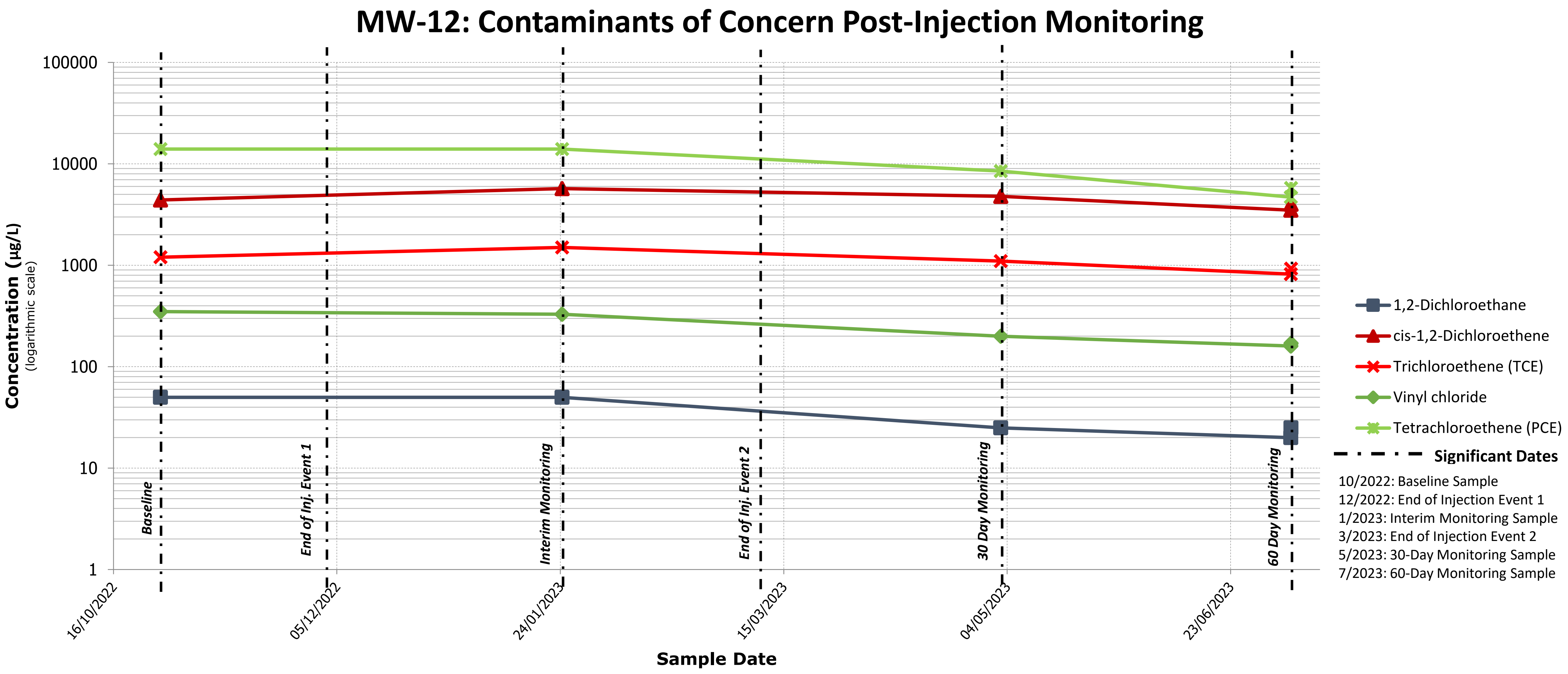

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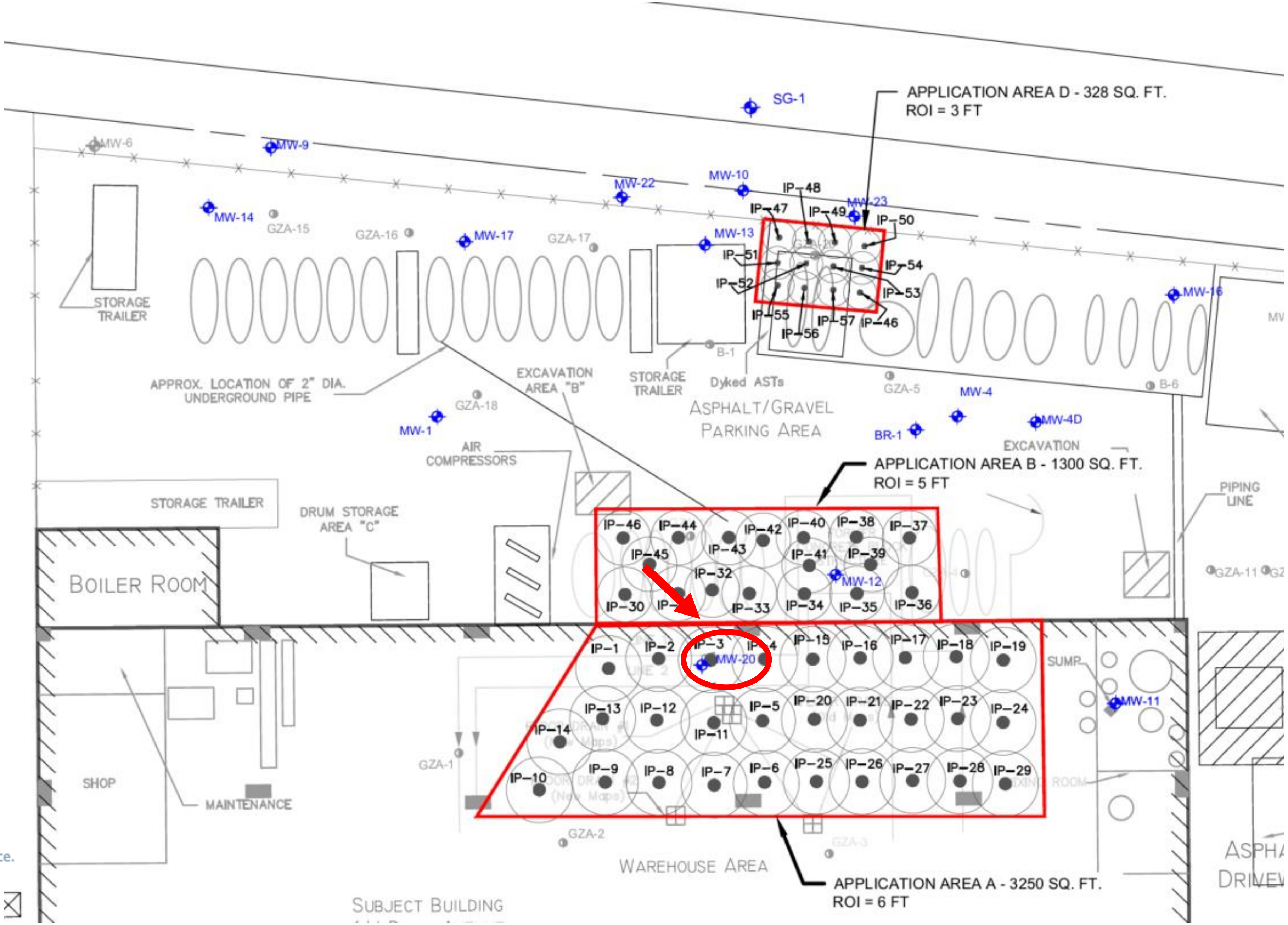

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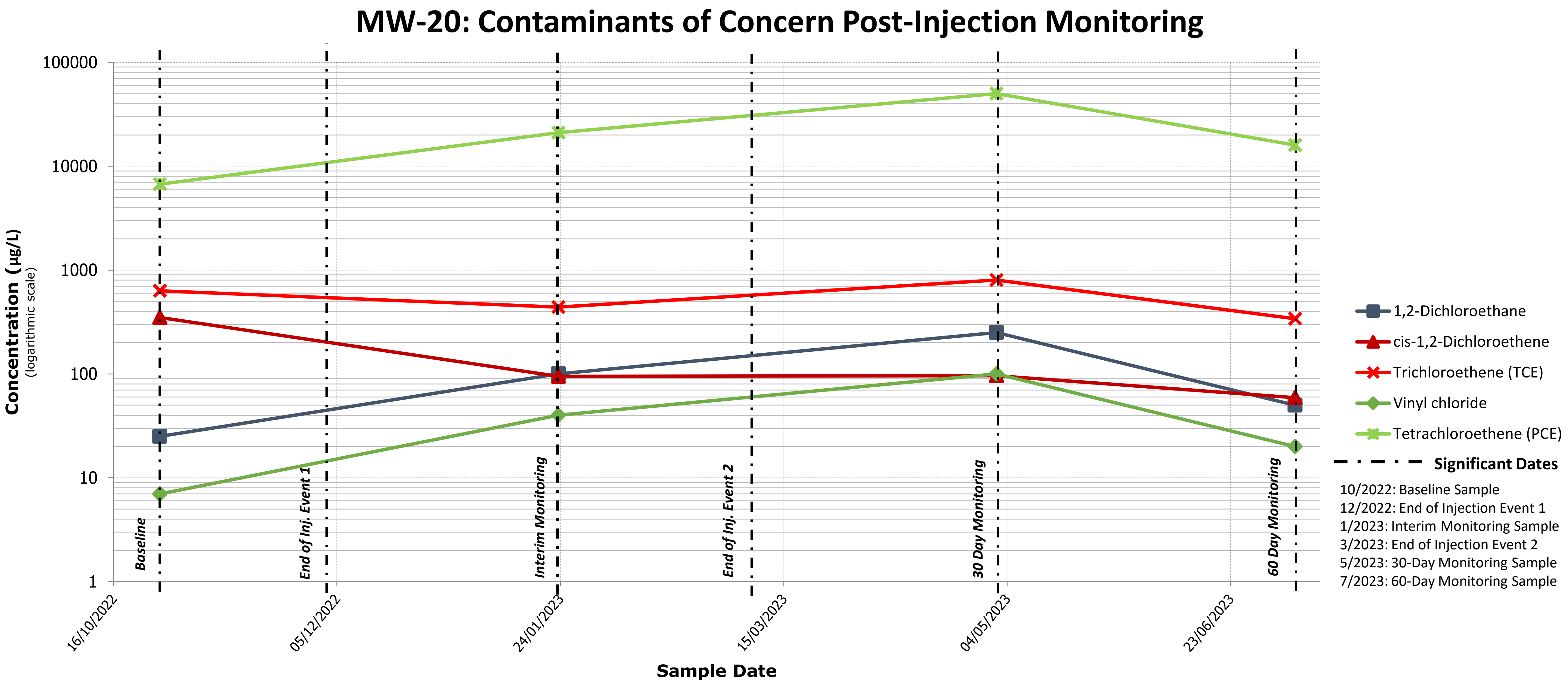

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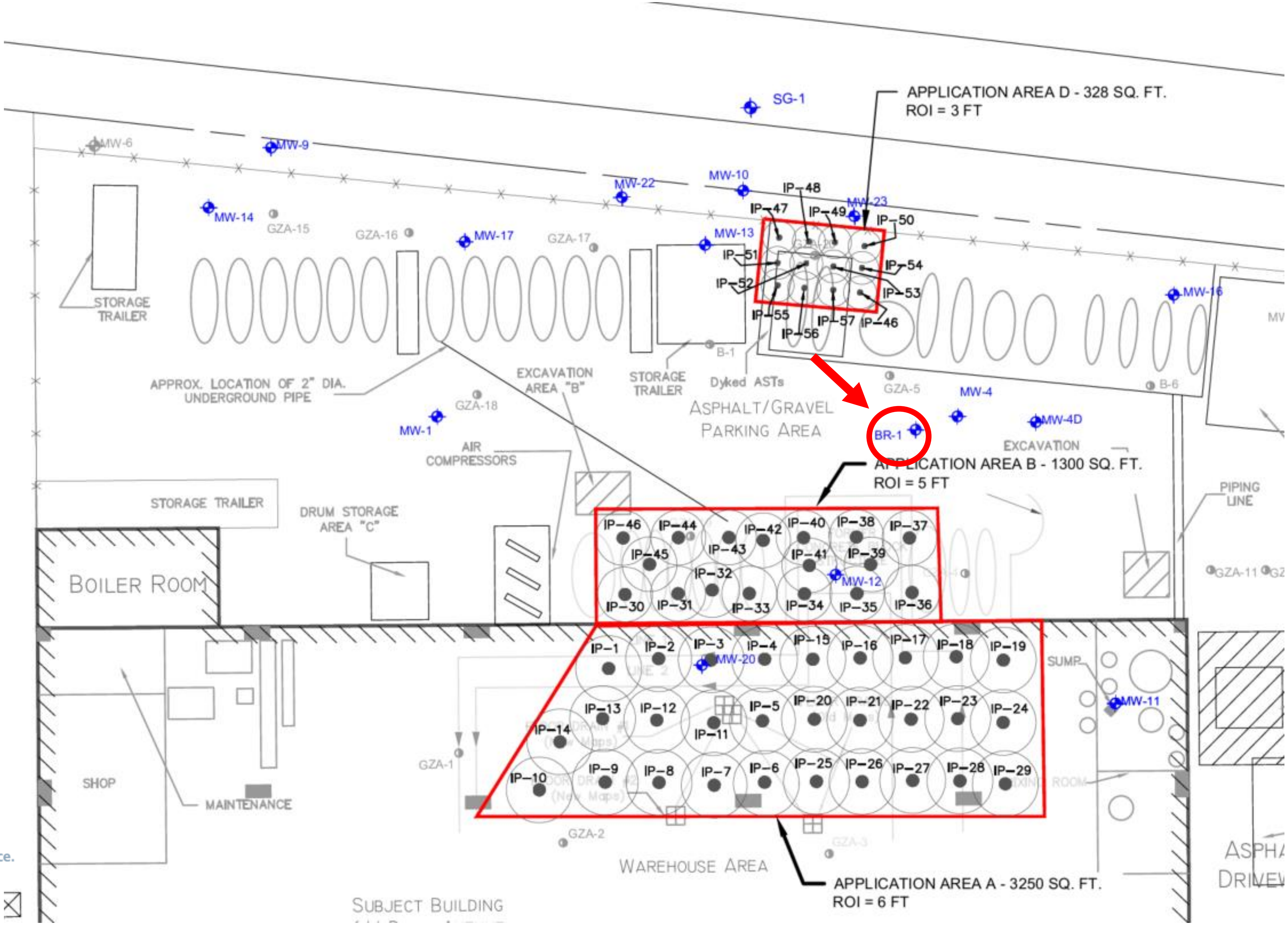

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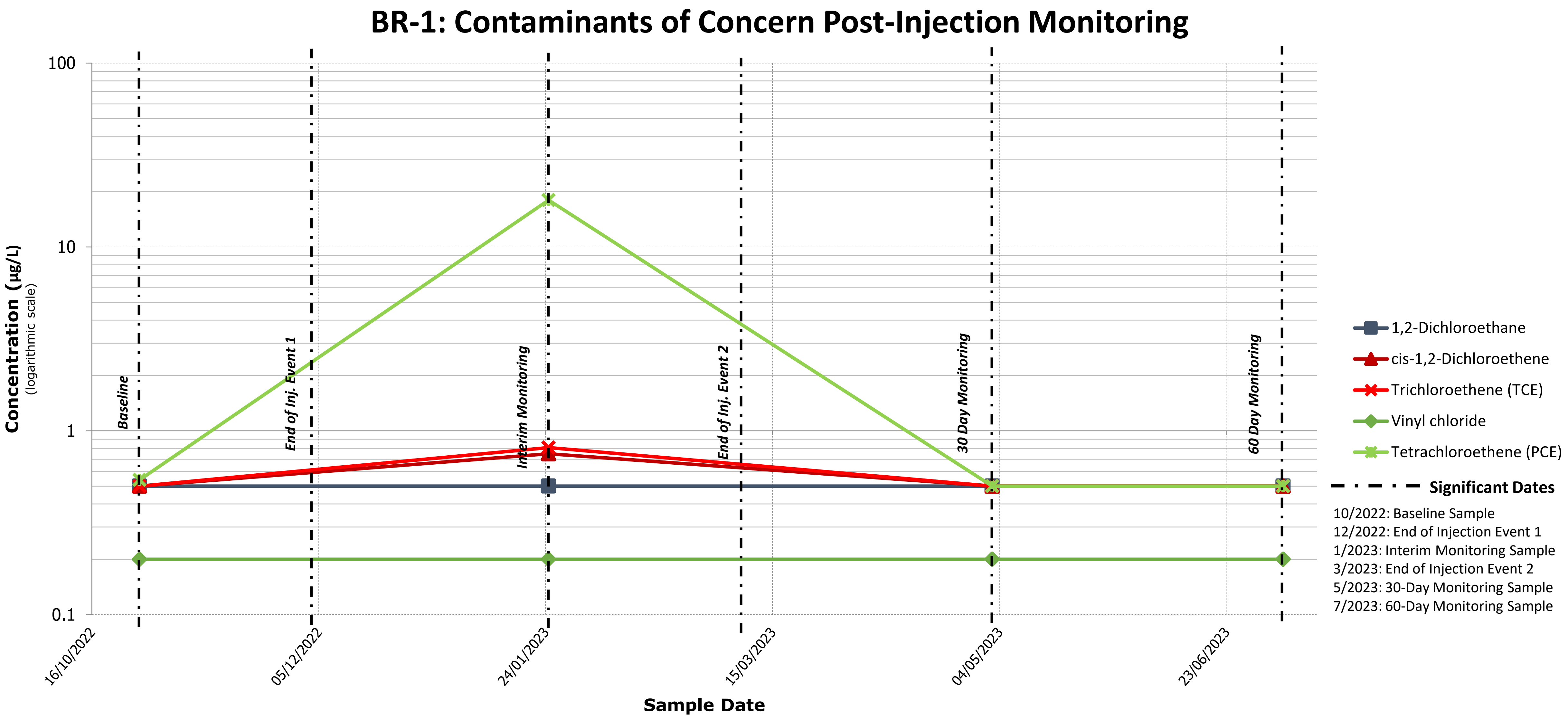

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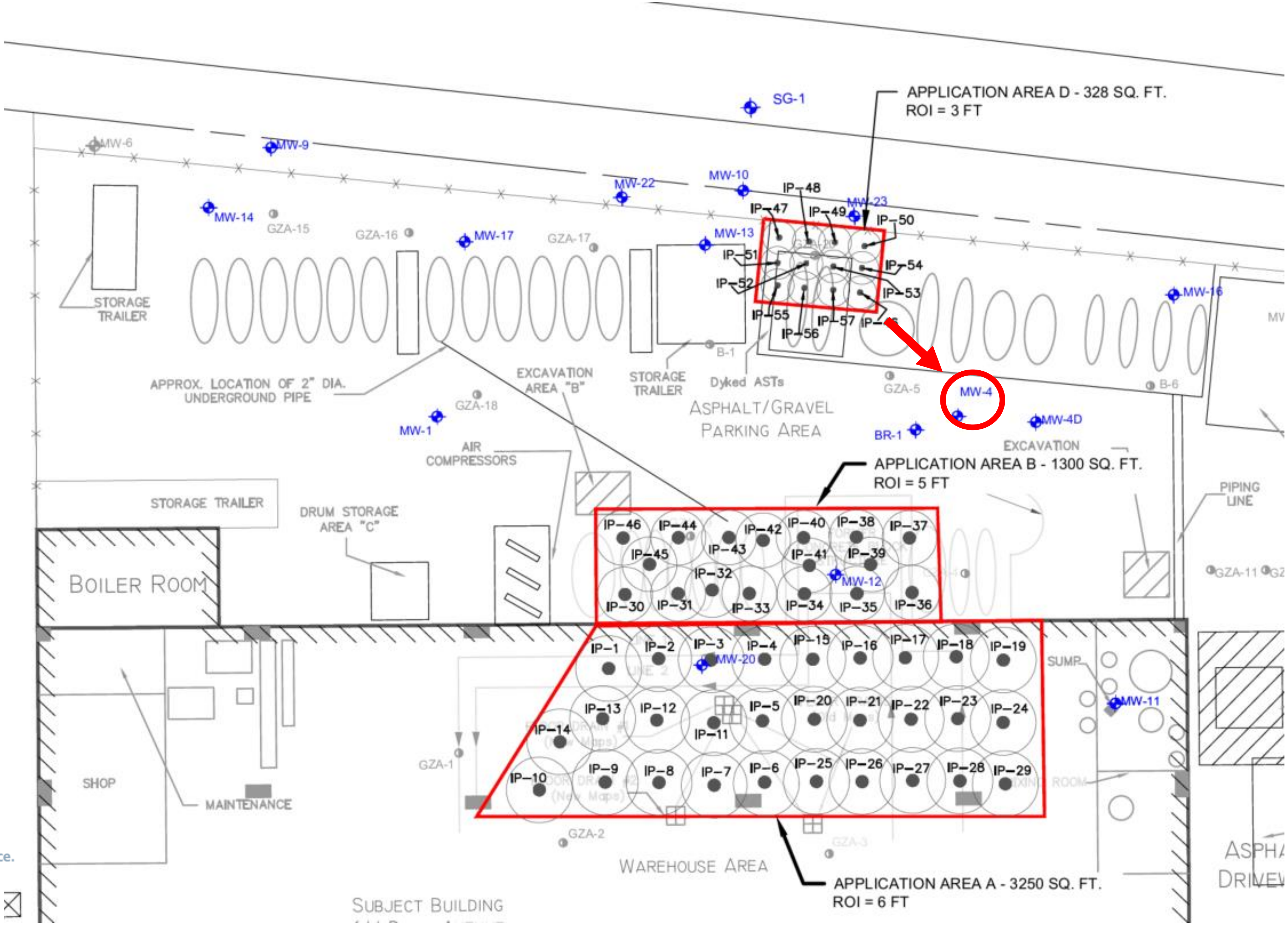

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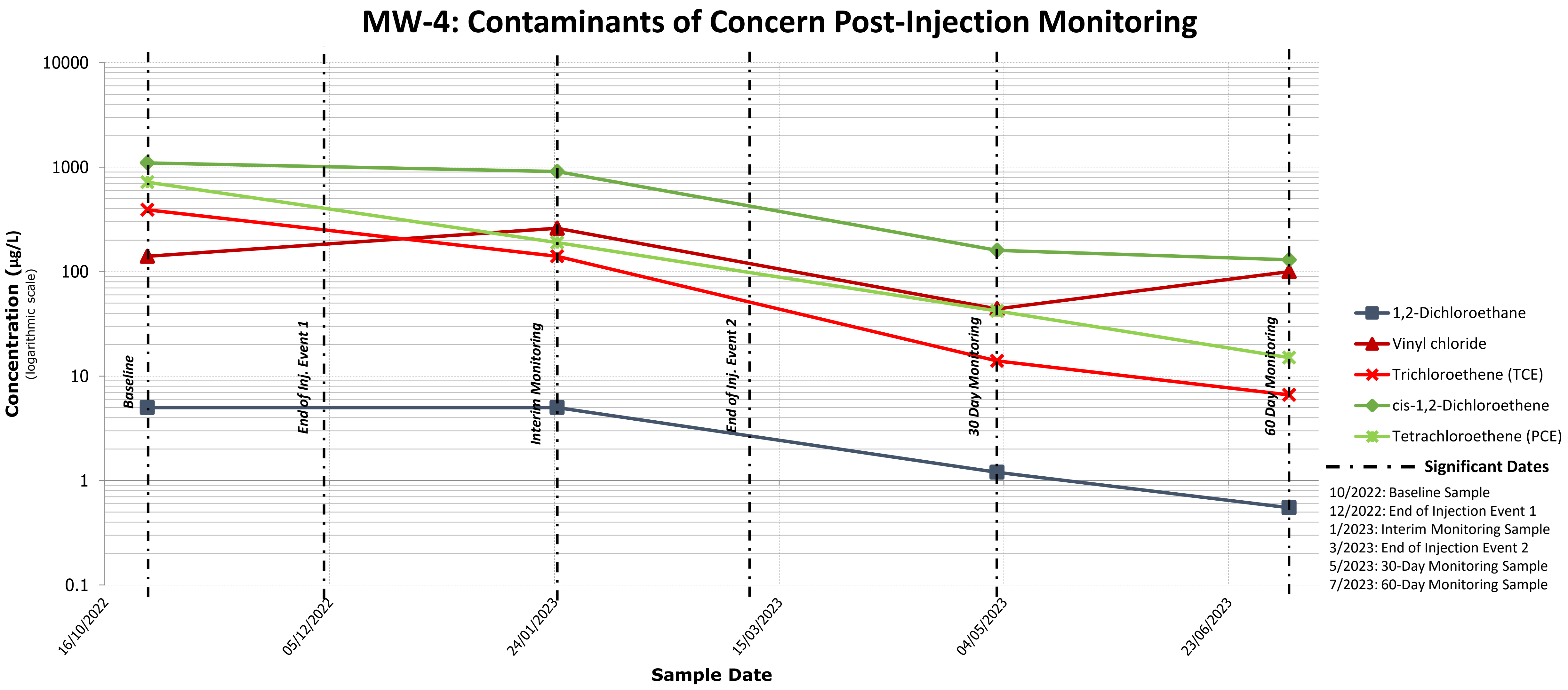

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Conclusions/Summary of Findings

- **Groundwater analytical results** typically followed the expected trend, with increases immediately after the injections followed by a general decreasing trend in contamination
- **Plume modeling** shows that a large mass of cVOCs has been liberated from the clay layer and mobilized into the groundwater
- **Overall results from the two injection events** demonstrated that the selected reagents are effective at reducing groundwater contamination at the site by mobilizing absorbed contamination and subsequently oxidizing the remnants
- **After further confirming the trends from the latest round of groundwater results, we anticipate an additional round of injections to reduce levels further**

Path Forward

Polishing round of injections targeting to be conducted in hotspots based upon the latest groundwater results

Conduct limited removal of DNAPL contaminated soils followed by in-situ stabilization (ISS)

Establish a decreasing trend of COCs and switch to Long Term Monitoring (LTM) to monitor the contamination and show consistent naturally degradation

Thank You and Questions?

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