ARCADIS Design & Consultancy for natural and built assets

# RACER LANSING 1Q 2017 QUARTERLY PROGRESS REPORT

Lansing Plants 2, 3 and 6

Lansing MI

April 14, 2017

ARCADIS Design & Consultancy for natural and built assets

# The information in this presentation is a combination of information shared with the MDEQ during the 1Q 2017, as follows:

- MDEQ In-Situ Taps Team Meeting on Jan. 3rd. This slide deck discusses bioremediation of 1,4-D and the biosparge pilot study
- Southern Plant 6 Boundary Metals presentation from Jan. 11th
- PFAs Investigation Summary presentation from March 2nd

ARCADIS Design & Consultancy for natural and built assets

# Additional 1Q 2017 activities include:

- The revised IGMP Monitoring Plan was submitted to the MDEQ in January 2017.
- The NE Lobe Lower 1,4-Dioxane Investigation Summary Report was submitted to the MDEQ in February 2017.
- The 2Q Investigation Work Plan was submitted to MDEQ in February 2017.
- The 1Q IGMP Sampling event was completed in March 2017.
- The Bioreactor Pilot Study continued throughout the 1Q 2017.

ARCADIS Design & Consultancy for natural and built assets

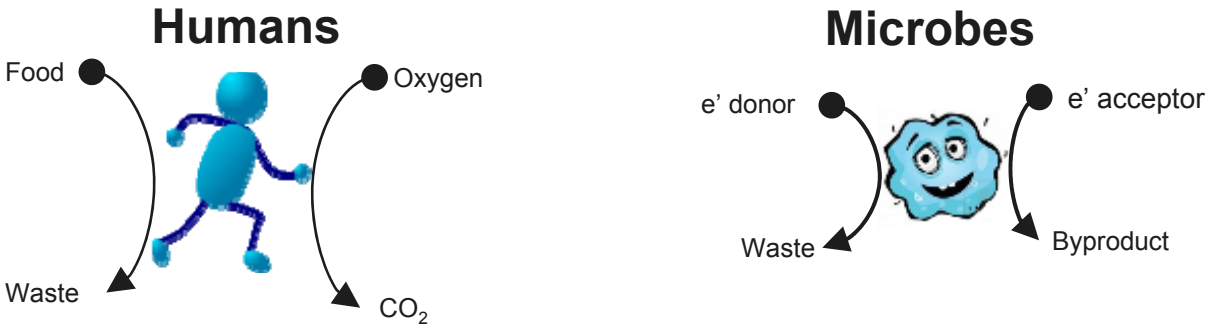
# MDEQ IN SITU TAPS TEAM MEETING

## 1,4- Dioxane Biosparge

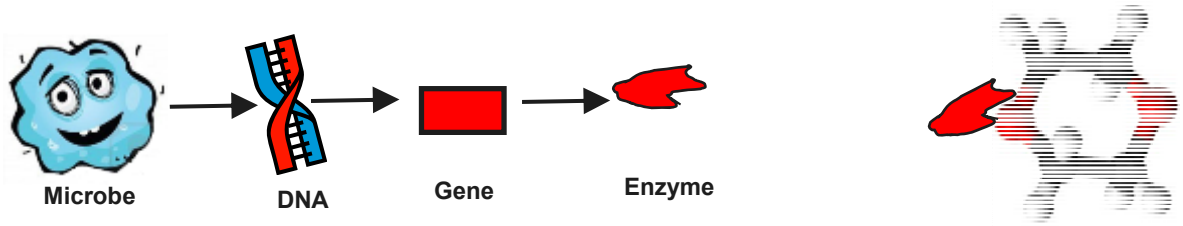
January 3, 2017

# Bioremediation
# Metabolism vs. Co-Metabolism

*Metabolism: the goal is to produce energy*

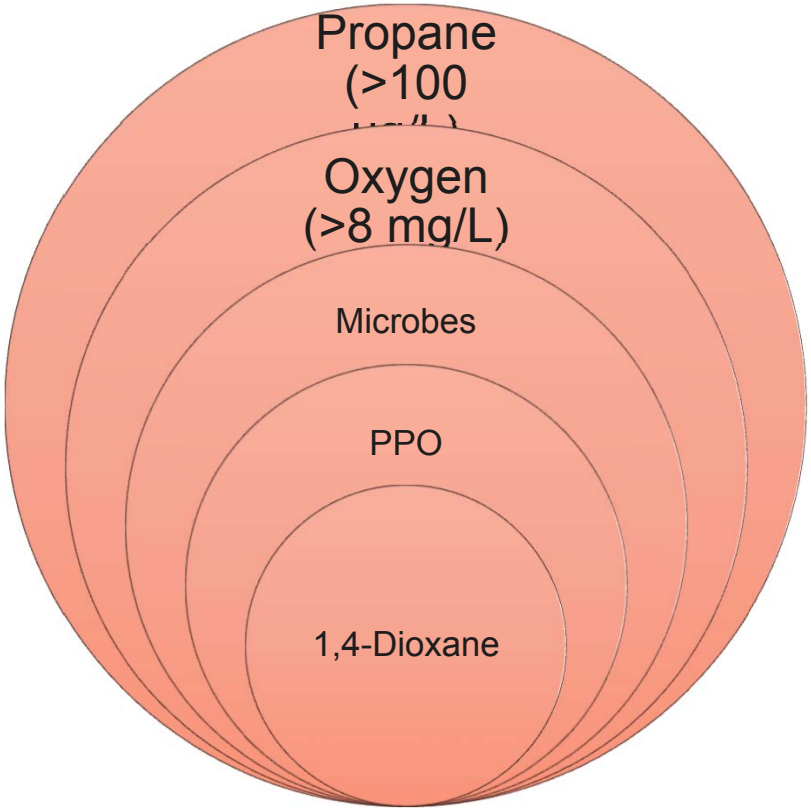



*Co-Metabolism: a fortuitous side reaction*




**DRAFT – For Discussion Purposes Only**

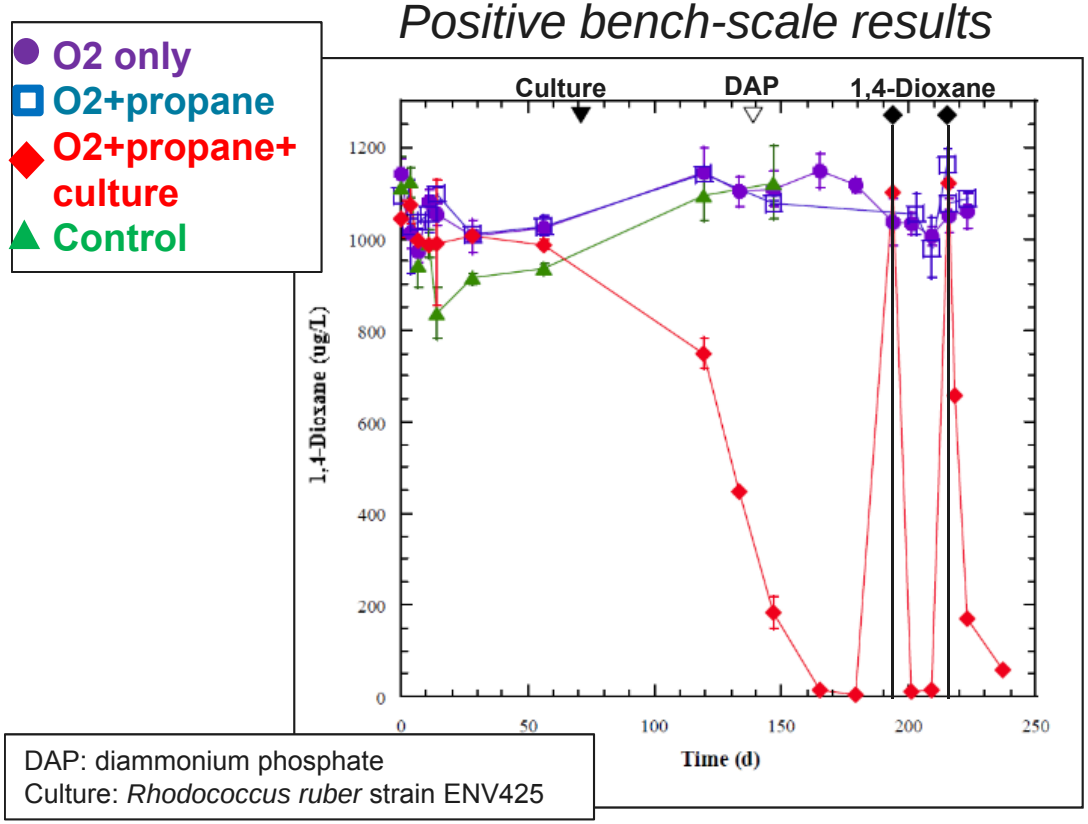
# Co-Metabolic Components




**DRAFT – For Discussion Purposes Only**

# Treatability Testing

*Positive bench-scale results*




DAP: diammonium phosphate
Culture: *Rhodococcus ruber* strain ENV425

*Also enriched propane-oxidizing cultures that degraded 1,4-dioxane as part of pre-field activities*

*Source: CB&I, July 2014*

**DRAFT – For Discussion Purposes Only**

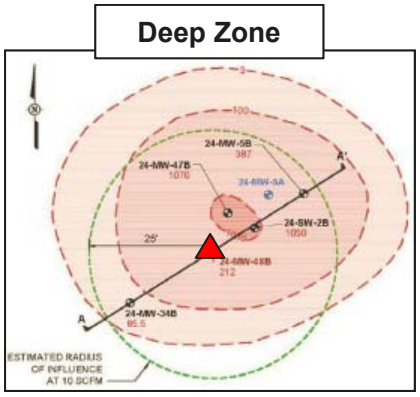
# Biosparging Pilot Testing – California

| Criteria | Deep Zone |
|---|---|
| Sparge points | 1 |
| Propane dosing | 0.65 lb/day/well |
| Sparge rate | 10 scfm/well, pulsed |
| Bioaugmentation | 37 L/well |
| Nutrient addition | 20 lb/well |
| Operational Period | Apr13-Dec13 |

*Source: CB&I, July 2014*

*Source: CB&I, June 2014*

*Source: CB&I, August 2014*

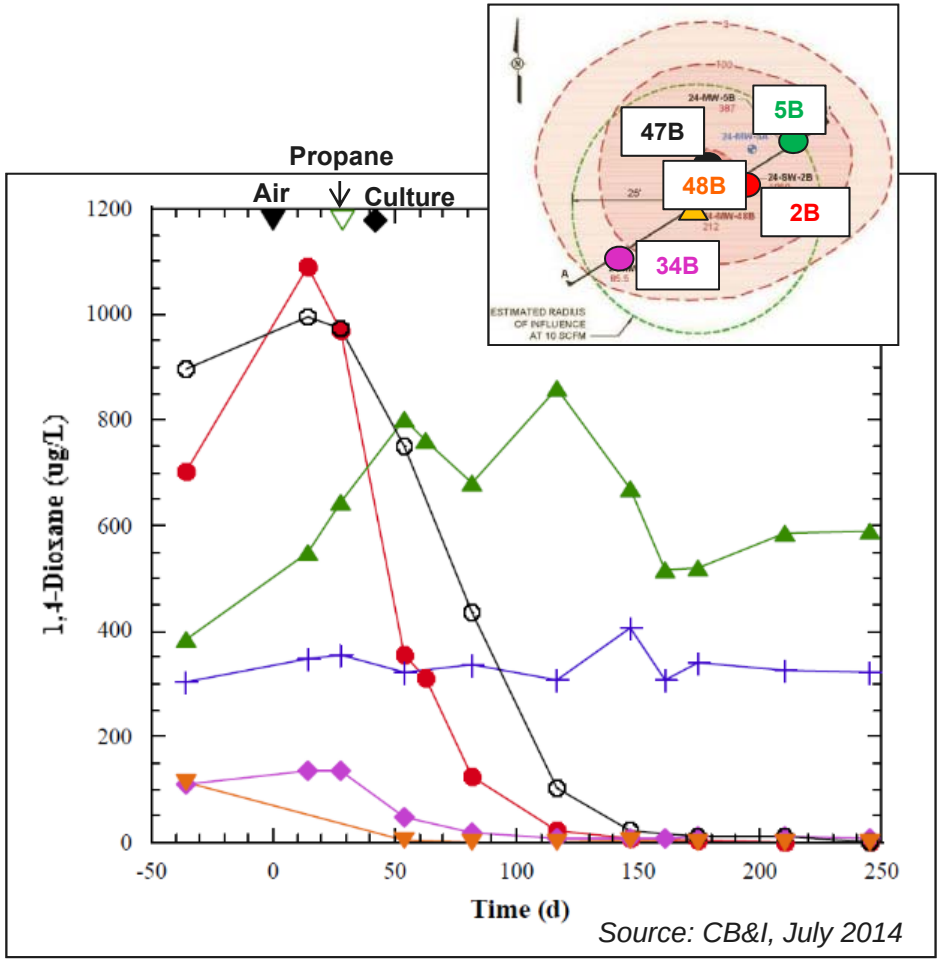



**DRAFT – For Discussion Purposes Only**

# Pilot Results – California

- 24-MW-47B
- 24-MW-34B
- 24-SW-2B
- 24-MW-5B
- 24-MW-48B (sparge)
- \+ 24-MW-5A (control)

| Location | 1,4-Dioxane Reduction (Day 245) |
|---|---|
| 47B | >99% |
| 34B | 91% |
| 2B | >99% |
| 5B | <1% |
| 48B | >99% |




*Source: CB&I, July 2014*

DRAFT – For Discussion Purposes Only

# Bioremediation Strategies

ARCADIS Design & Consultancy for natural and built assets

## Biosparging with Propane and Air:

- Direct injection of propane gas and air, in situ bio of 1,4-dioxane
- No groundwater extraction or injection
- Significantly less above grade infrastructure than recirculation options

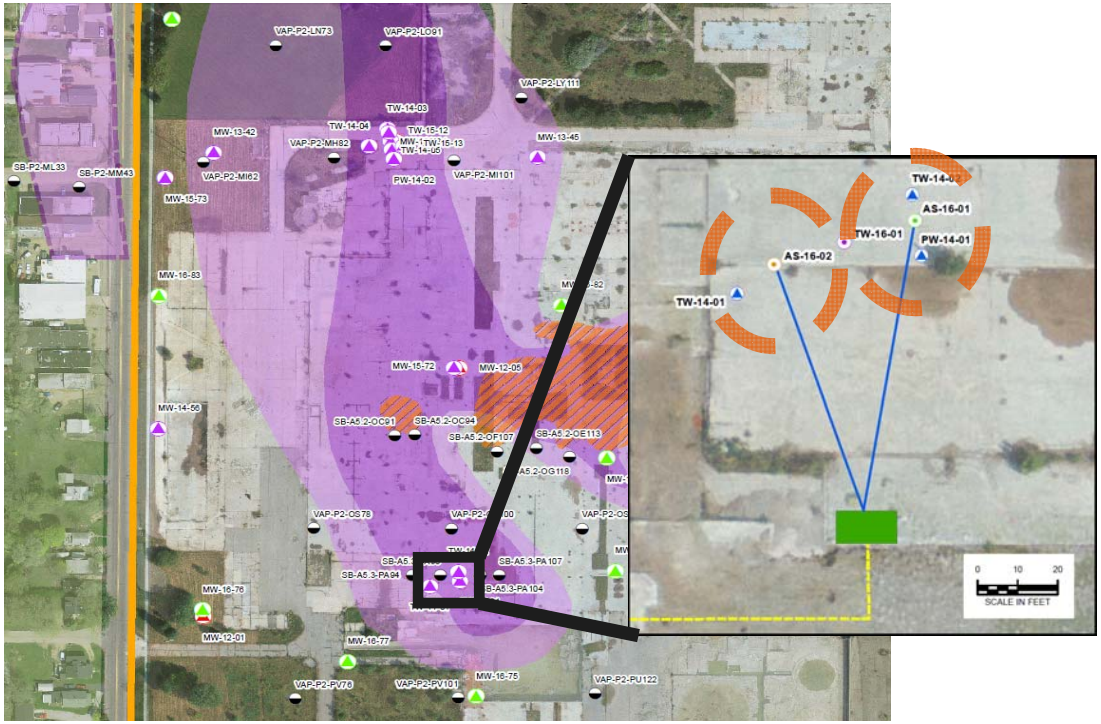
- Field application currently underway @ California site w/ good results
- Engineering cost estimate
  - ~25% less capital cost than bioreactor
  - ~50% cheaper to operate than bioreactor
- Maybe difficult to inject gas to weathered bedrock

**DRAFT – For Discussion Purposes Only**

# In Situ Biosparge Pilot Test

## Southern Plant 2:

- Phase 1 – sparge well install, short-term air-only sparge
- Phase 2 – If Phase 1 is successful, additional sparge wells and monitoring well installs, baseline monitoring, bioaugmentation, operation (~3 months) propane/air sparge

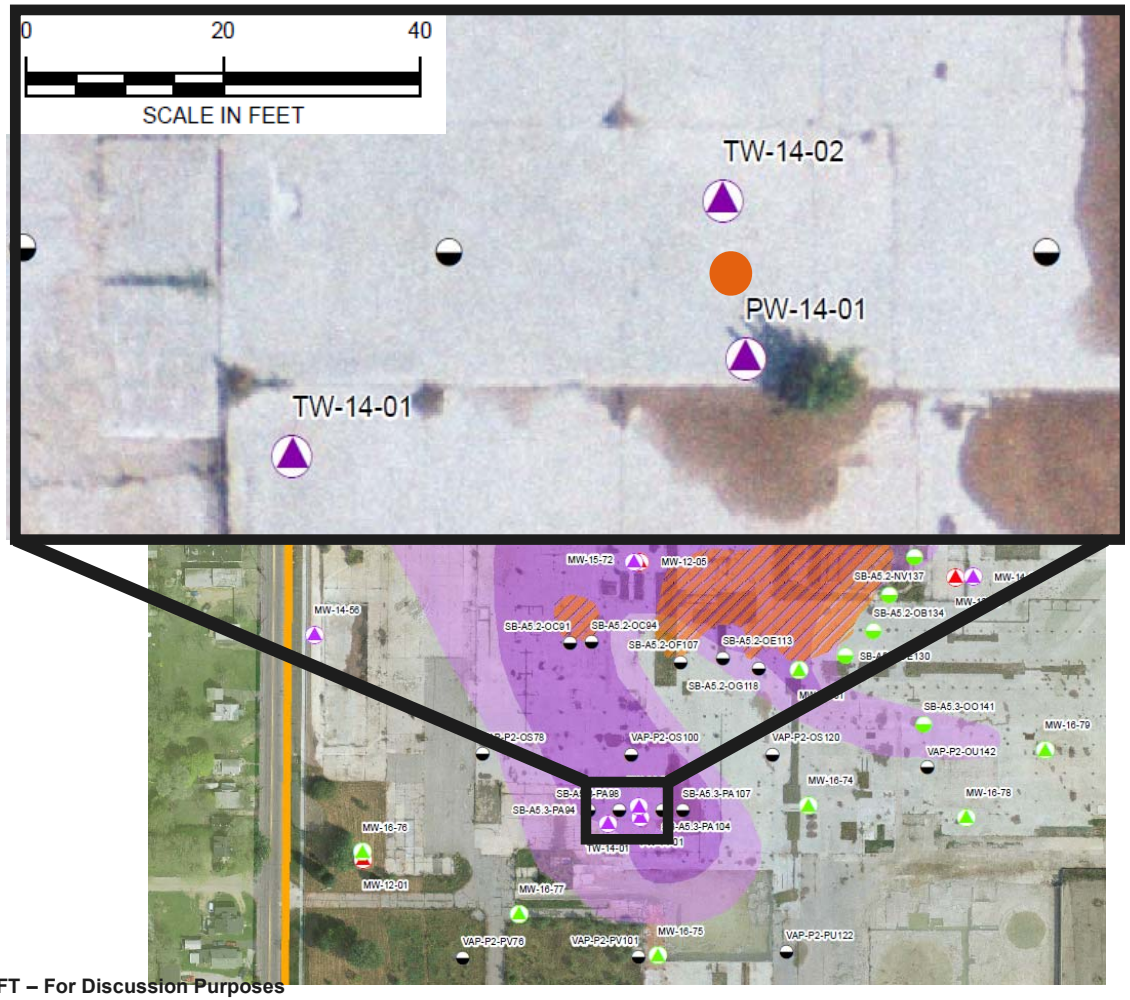



**DRAFT – For Discussion Purposes Only**

# In Situ Biosparge Pilot Test – Phase 1

- Phase 1 completed in June
  - High injection pressures, low flow rates as expected
  - Flow rates increased over time
  - Better then expected DO distribution
  - Water level increase in MWs
- Overall successful test that identified a new key objective for Phase 2:

**Must balance air injection and pressure in formation with increasing water levels**




DRAFT – For Discussion Purposes Only

# Biosparge Phase II

- System delivered on September 26, 2016
- Continuous operating began October 3, 2016

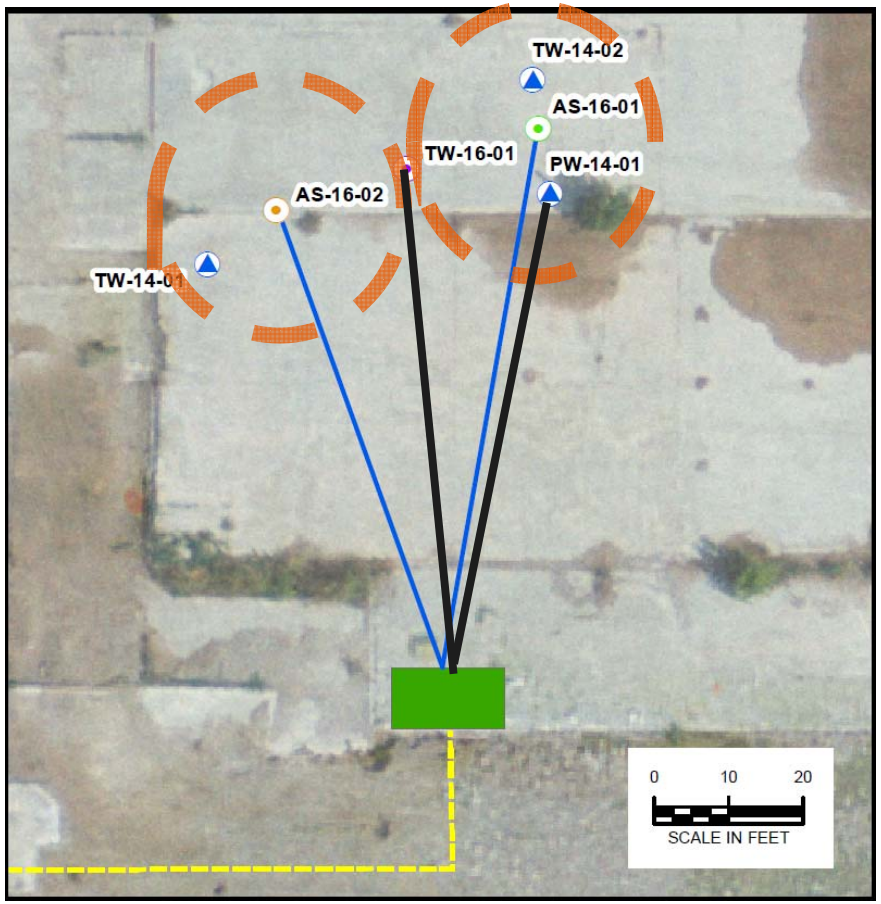
**DRAFT – For Discussion Purposes Only**

# Biosparge Phase II Start Up

- Continuous sparge (~7 hrs) to maximize DO and evaluate flow rates and water levels in each AS well
- AS-16-01 (Oct. 3rd)
  - DO up to 11 mg/L in TW-16-01, TW-14-02, and PW-14-01
  - Less water level rise than observed in Phase 1

| Well | Phase I | Phase 2 |
|---|---|---|
| TW-16-01 | NA | 8.2 feet |
| PW-14-01 | 34.1 feet | 10.2 feet |
| TW-14-01 | 2.2 feet | 2.7 feet |
| TW-14-02 | 7.0 feet | 1.5 feet |

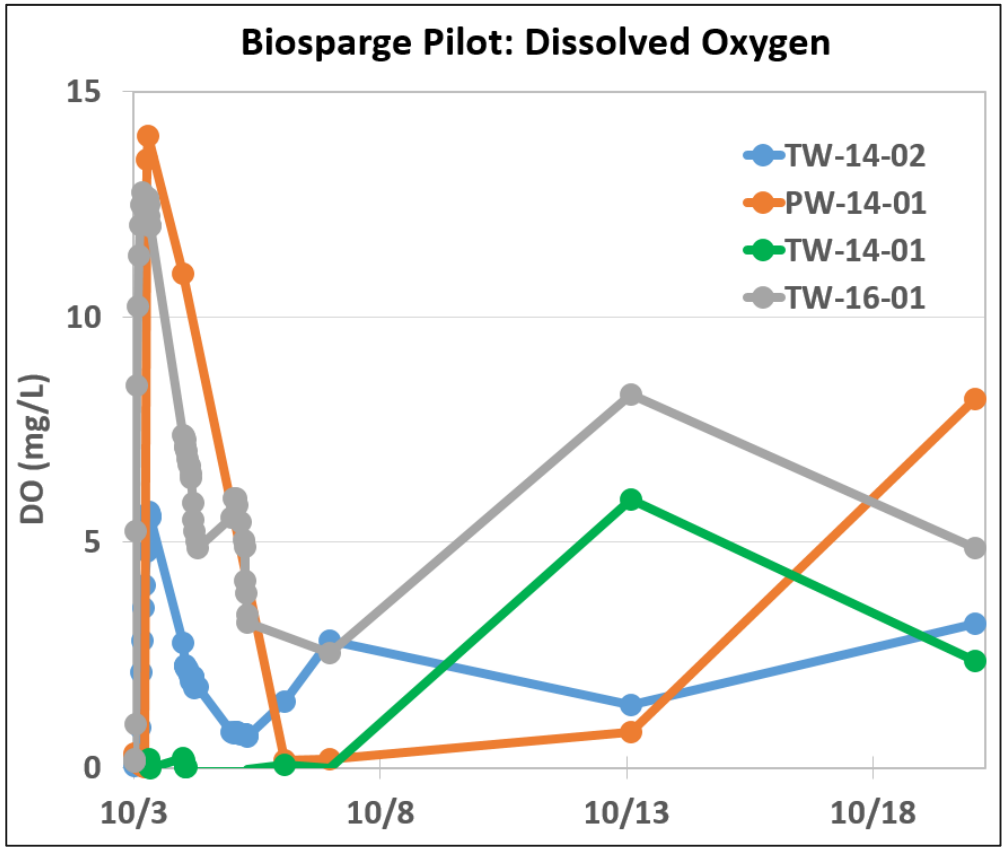
- AS-16-02 (Oct. 4th)
  - DO up to 11 mg/L in TW-16-01, no increase observed in TW-14-01 during start up
  - DO increase observed in TW-14-01 (~6 mg/L) two weeks post startup




**DRAFT – For Discussion Purposes Only**

# Biosparge Phase II Operation

- Currently injecting at 2 SCFM at one well at a time
- Propane injection concentration at ~16% of the LEL (3,360 ppm)
- Optimal DO observed in all 4 monitoring wells but not sustained
- Mechanical issues corrected Oct. 20, 2016
- Optimizing cycle times and injection flow rates to maintain DO of 6-8 mg/L




DRAFT – For Discussion Purposes Only

# Biosparge Phase II Schedule

- First round of samples for 1,4-dioxane and propane collected on October 13, 2016
- Second round of samples for 1,4-dioxane and propane collected on October 20, 2016
- Nutrient and microorganism additions scheduled for November 1, 2016 - delayed to allow more time for optimization
- Continued sampling – 2 more weekly events, biweekly for month 2, monthly for month 3
- Anticipated shut down end of December, may be adjusted depending on results

**DRAFT – For Discussion Purposes Only**

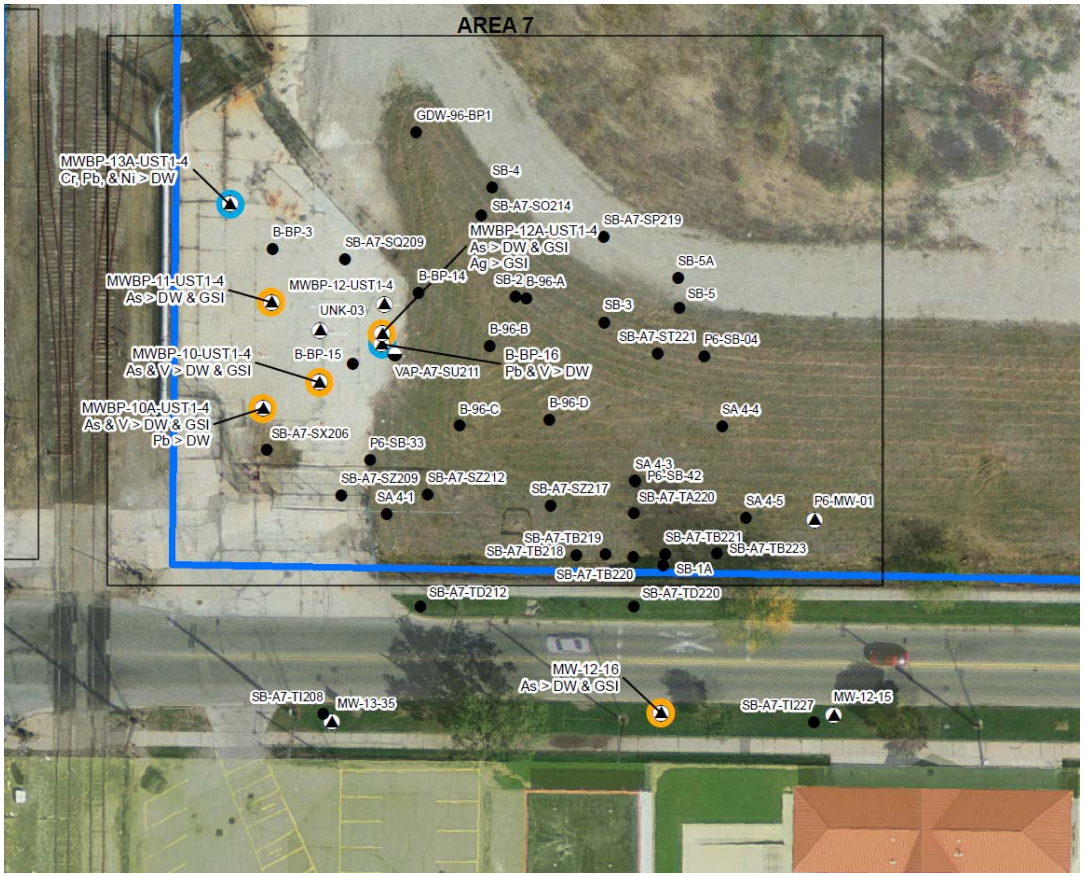
ARCADIS Design & Consultancy for natural and built assets

# SOUTHERN PLANT 6 BOUNDARY METALS

## RACER Lansing Plant 6

January 11, 2017

# Plant 6 Metals Exceedances




Note: results exclude Fe & Mn

**LEGEND**

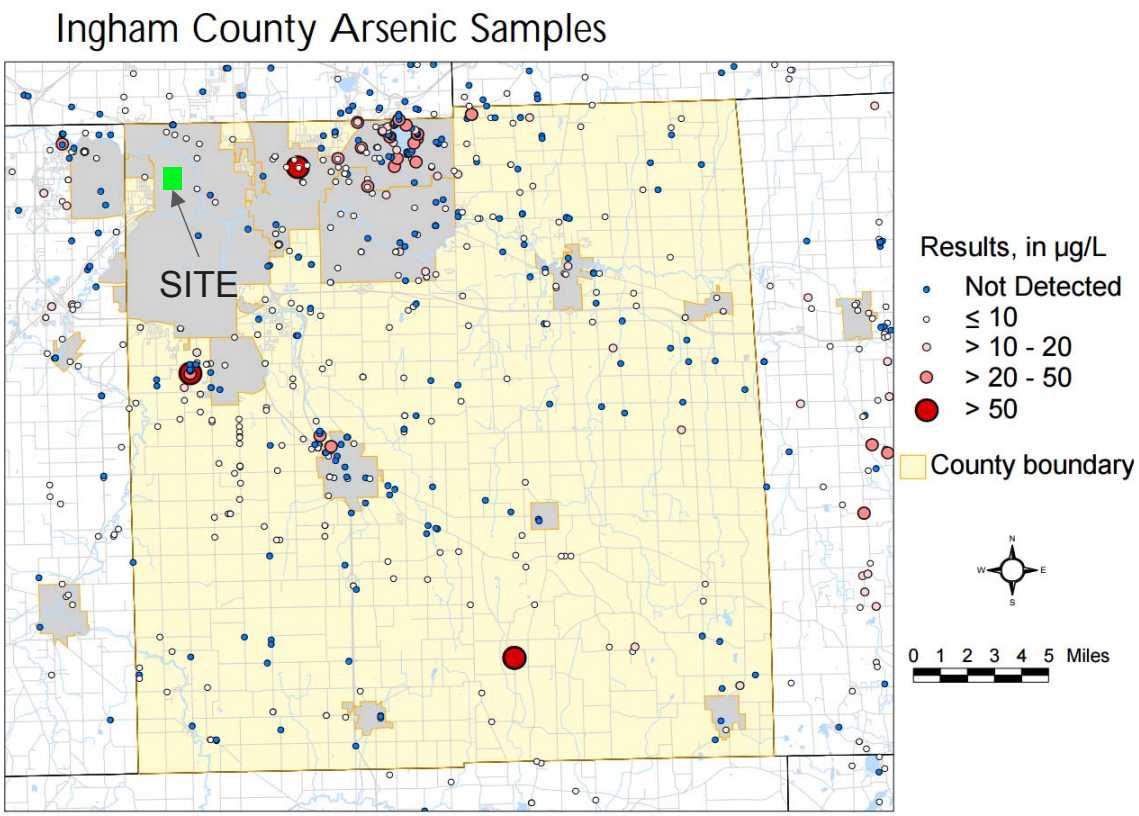
- VAP BORING LOCATION
- MONITORING WELL
- SOIL BORING
- EXCEEDS 2016 DW CRITERIA
- EXCEEDS 2016 DW AND GSI CRITERIA
- WORK PLAN AREAS
- PLANT 6 BOUNDARY

NOTES:

DW: DRINKING WATER
GSI: GROUNDWATER SURFACE WATER INTERFACE
VAP: VERTICAL AQUIFER PROFILE

| Location ID: / Date Collected: / Sample Name: | Units | MI GW (DEQ2013) RES DW | MI GW (DEQ2013) GSI |
|---|---|---|---|
| Iron | mg/L | 0.3 | - - |
| Arsenic | mg/L | 0.01 | 0.01 |
| Lead | mg/L | 0.004 | 0.044 |
| Nickel | mg/L | 0.1 | 0.12 |
| Vanadium | mg/L | 0.0045 | 0.027 |

# Arsenic Background



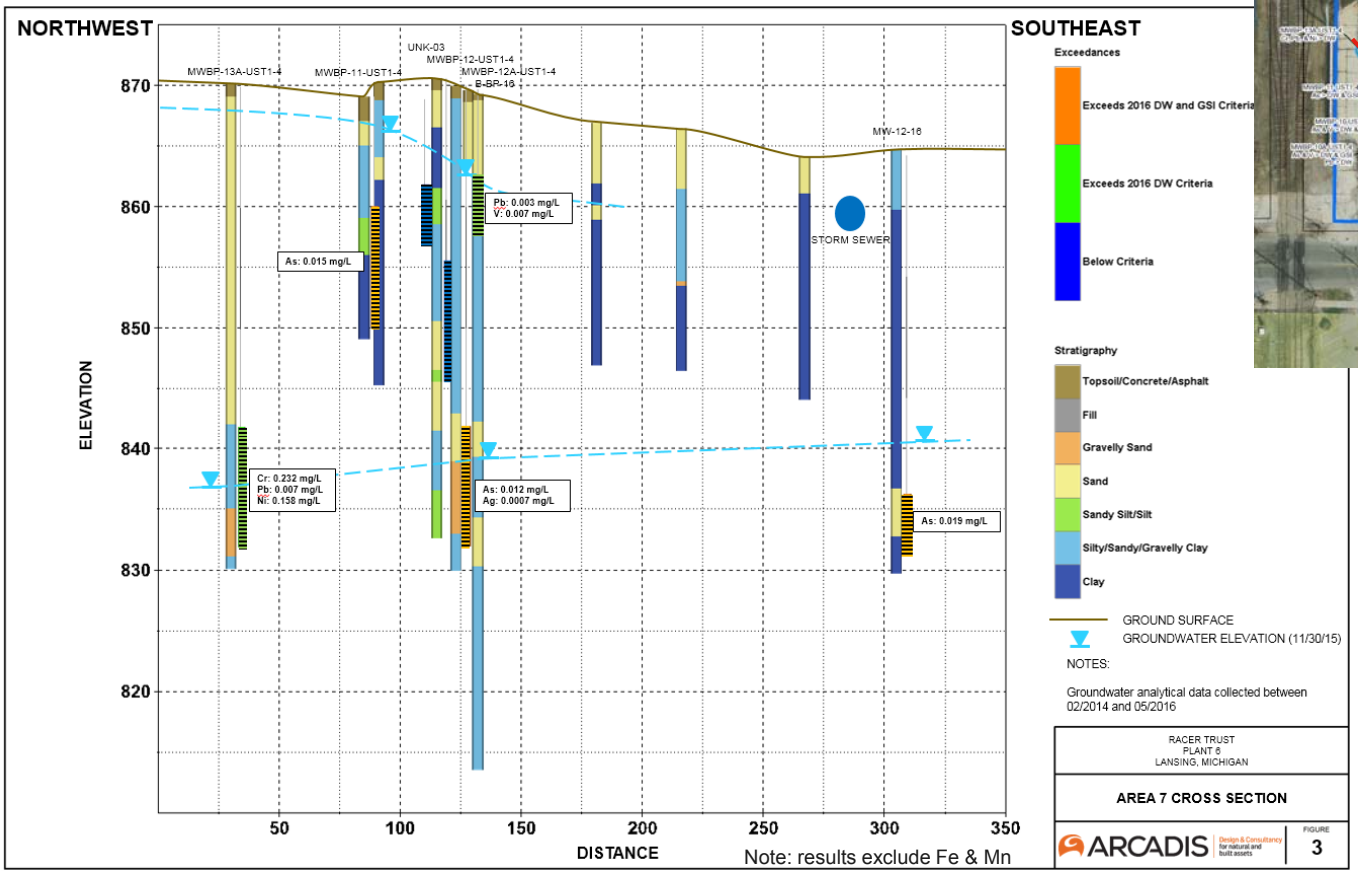

- Available information indicates arsenic concentrations in excess of drinking water criteria (10 µg/L) have been detected across the county (MDEQ 2013, MDEQ 2014, Welch 2000).
- Mean concentrations of the metals at the site are within the range of regional concentrations recorded in this study, with the exception of nickel (i.e. Plant 3)
- Regional groundwater is under reducing conditions, leading to iron and manganese dissolution and mobilization of iron and manganese as well as metals associated with iron bearing minerals; arsenic, copper, cobalt, lead, nickel, vanadium, and zinc.

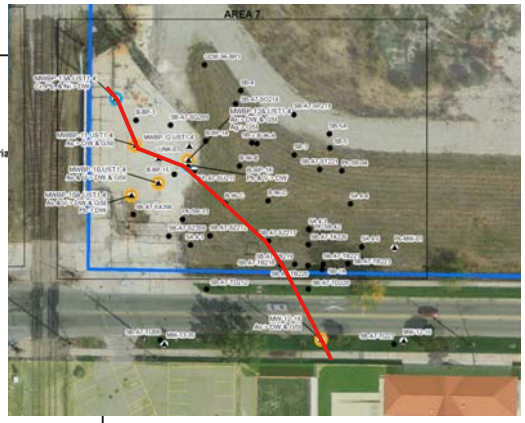
# Geochemistry

| Location ID: | Date Collected: | Zone | Current | Previous | Justification for difference | CH4 | DO | ORP | Fe total | Mn total | Fe dissolved | Mn dissolved | NO3- | SO42- |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-12-15 | 06/10/15 | Perched | strongly reducing | reducing | elevated methane, negative ORP, depleated sulfate | 280 O | 0.11 | -74.20 | 8.29 [a] | 0.324 [a] | 7.67 [a] | 0.309 [a] | <0.5 | <10 |
| MW-12-16 | 06/09/15 | Perched | strongly reducing | reducing | elevated methane, negative ORP | 130 O | 0.38 | -55.80 | 6.94 [a] | 0.429 [a] | 6.74 [a] | 0.417 [a] | <0.5 | 178 |
| P6-MW-01 | 06/09/15 | Perched | reducing | reducing | -- | 39 O | 0.47 | 58.2 | 2.75 [a] | 0.573 [a] | 1.93 [a] | 0.594 [a] | <0.5 | 321 [a] |

- Reducing conditions prevalent at the Site causing mobilization of arsenic and other iron related metals, particularly in areas impacted by VOCs.
- Monitoring wells without VOC impacts also show mildly reducing conditions suggesting regional groundwater in the perched zone is mildly reducing and conducive to the occurrence of mobile metal species even under ambient conditions.

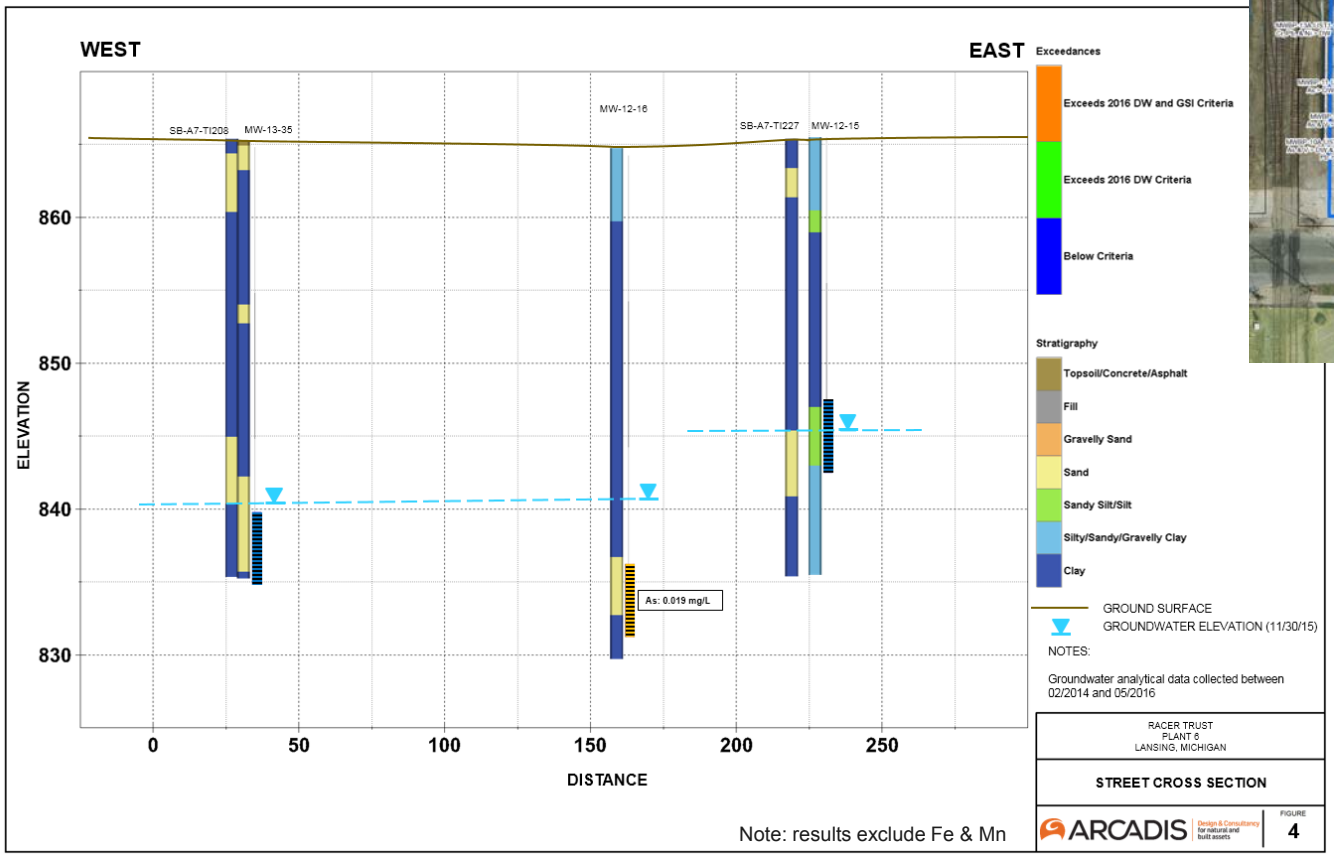
# NW-SE Cross-Section

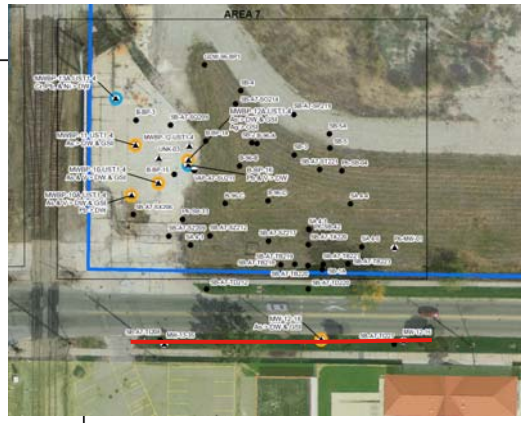



- Arsenic at MW-12-16 in deeper zone off-site
- Groundwater elevation suggests northerly horizontal gradient in deeper wells
- Variability in water levels shallow to deep indicates hydraulic isolation of deeper zone

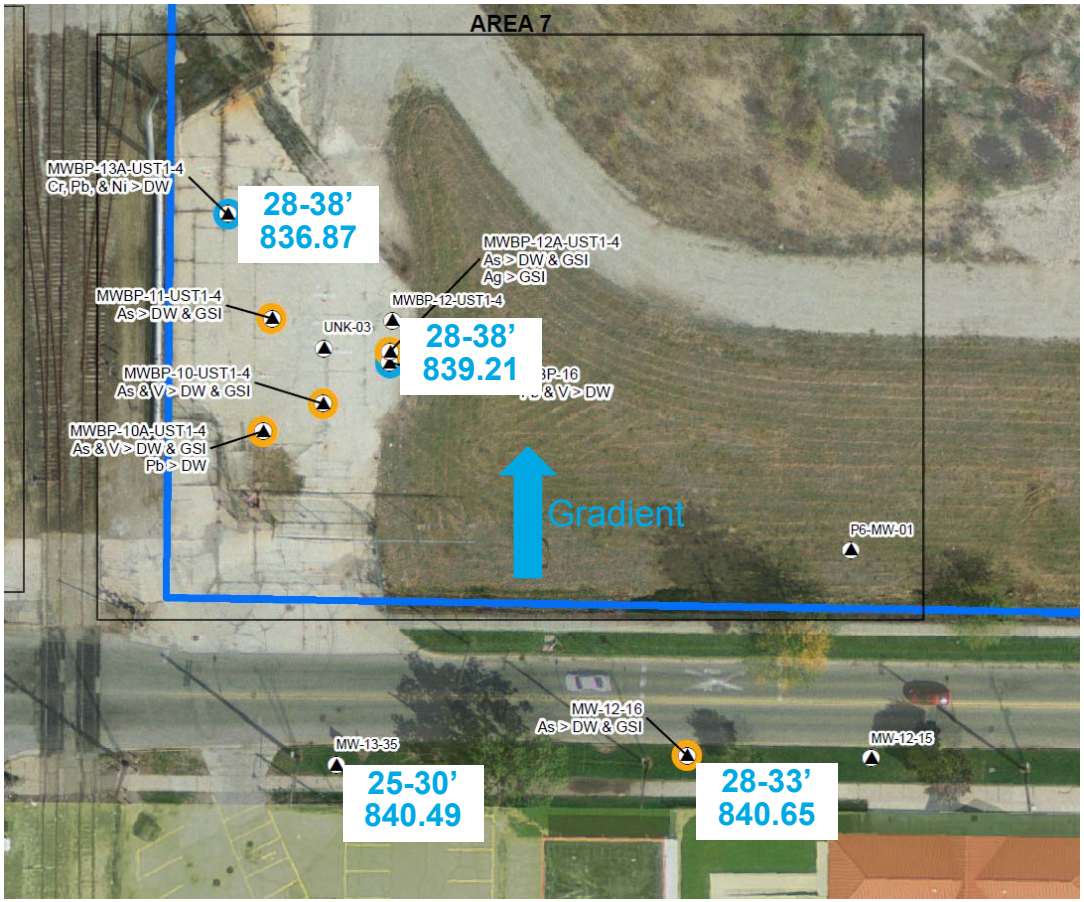
# E-W Section




- Arsenic at MW-12-16 in deeper zone off-site
- Metals do not exceed in other off-site monitoring wells

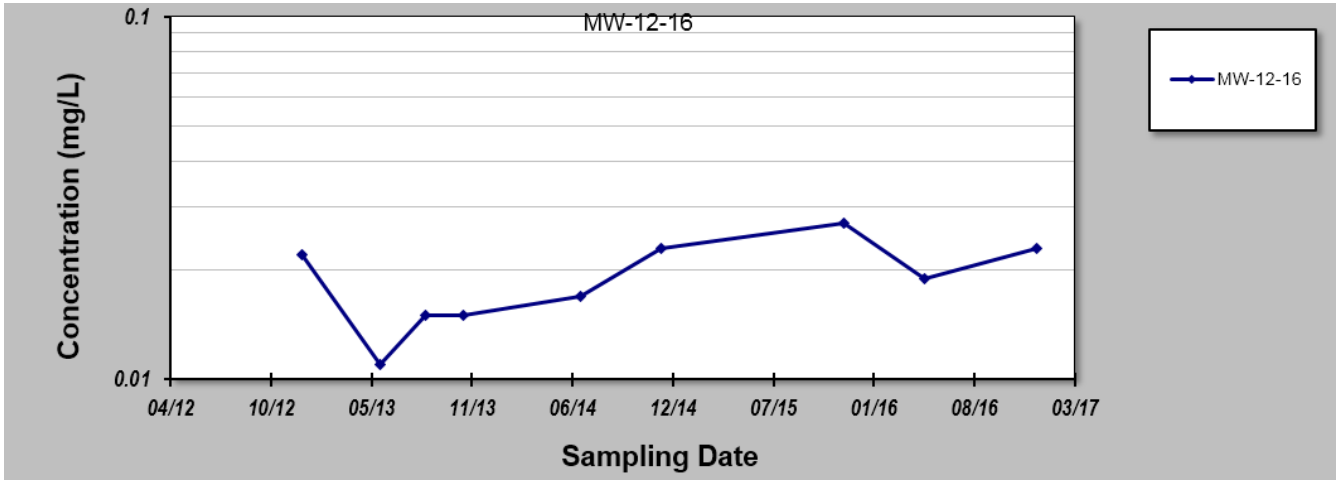
# Deeper Groundwater Elevation




Note: results exclude Fe & Mn

- Horizontal gradient in deeper zone is to the north

# MW-12-16 Trends




- Arsenic concentrations at MW-12-16 initially increasing, stable the last two events.
- Xylene impacts in shallow perched removed in Spring 2016
  - Continue to monitor geochemical parameters biannually

# Summary

- No risk associated with off-site arsenic concentrations
- Arsenic within deeper zone, isolated from utility corridors and perched impacts at Plant 6
- Arsenic occurrence in deeper zone may be related to geochemical conditions associated with the Plant 6, or related to regional reducing conditions
- Horizontal gradient within deeper zone is northerly
- Arsenic concentration stable over last two sampling events

# Options

1. Continue monitoring to evaluate the effect of the Area 7 soil excavation
   - Stabile or decreasing trend may continue
2. Attempt to delineate the extent of arsenic off-site and restrict off-site school property
   - Access problematic
   - If reducing conditions prevalent off-site, delineation of arsenic may be difficult
3. Request RC for MDEQ approved area of Lansing Sexton school property

ARCADIS Design & Consultancy for natural and built assets

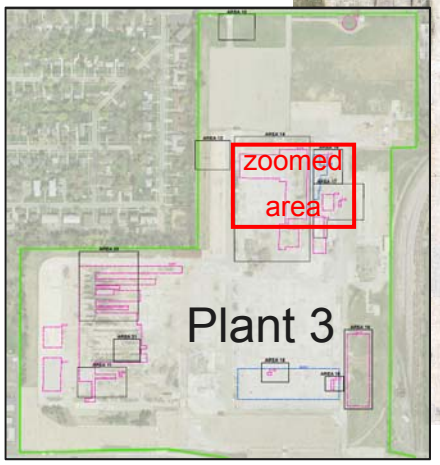
# PFAS INVESTIGATION SUMMARY

## RACER Plant 3, Lansing MI

March 2, 2017

# PFAS Sampling

- Groundwater samples analyzed (EPA method 537) from four monitoring locations near former plating line:
  - CH-14-RO and P3-SB-07 from the perched zone
  - MW-91-2 and MW-13-41 from the deep overburden
- CH-14-RO: PFOS and PFOA exceed proposed DW and GSI criteria
- P3-SB-07: PFOS exceeds proposed GSI criteria





**LEGEND**

- NAPL MONITORING WELL
- PERCHED ZONE MONITORING WELL
- DEEP OVERBURDEN MONITORING WELL
- BEDROCK MONITORING WELL
- PFAS SAMPLING LOCATIONS
- APPROXIMATE EXTENT OF LNAPL
- APPROXIMATE PROPERTY BOUNDARY

NOTES:

RED TEXT INDICATES AN EXCEEDANCE OF PROPOSED GSI CRITERIA.
BOLD TEXT INDICATES AN EXCEEDANCE OF PROPOSED DW CRITERIA.

PFOS - PERFLUOROOCTANESULFONIC ACID
PFOA - PERFLUOROOCTANOIC ACID
ppt - PARTS PER TRILLION

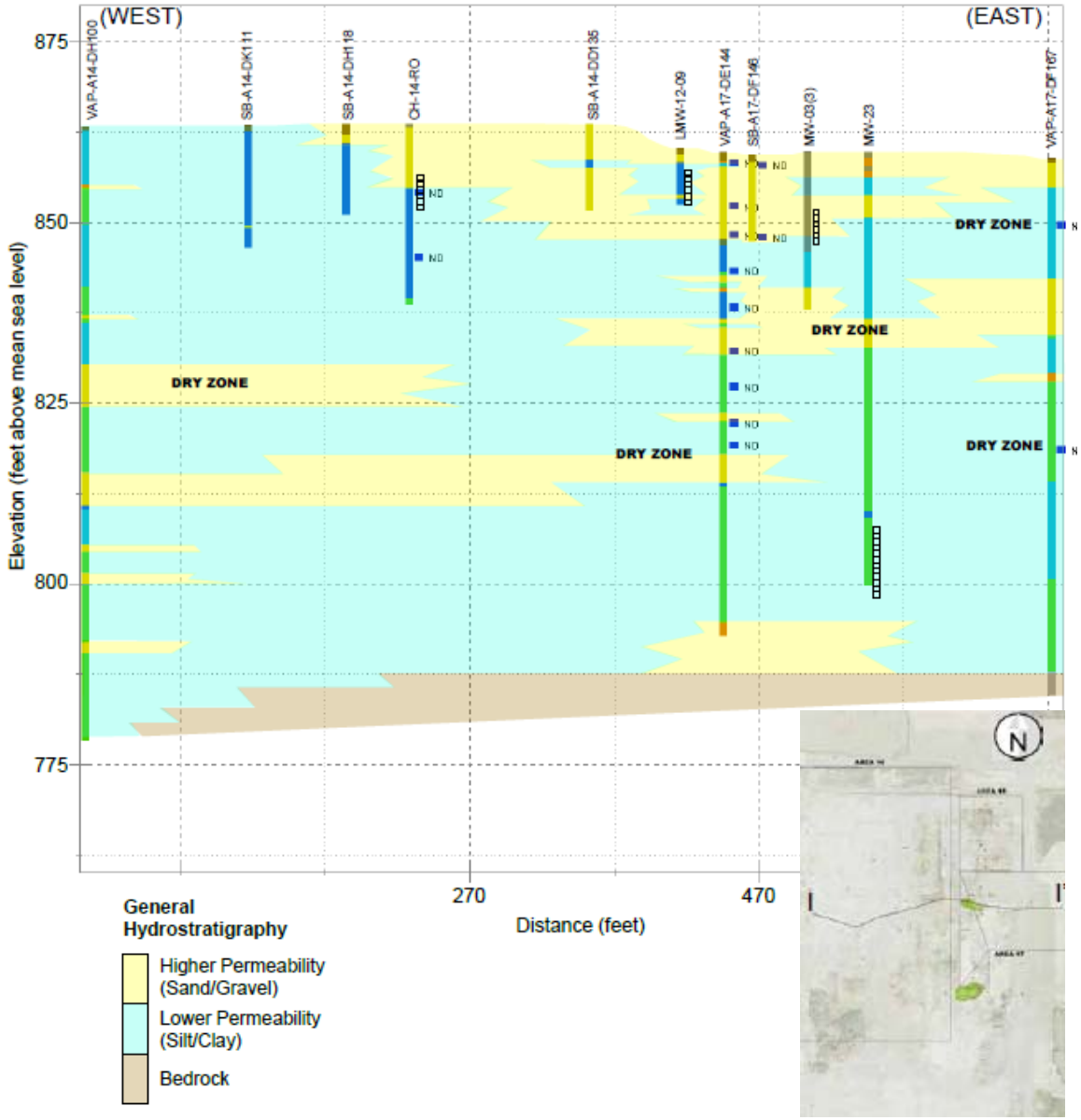
PROPOSED 2016 MDEQ PART 201 CRITERIA:
DW - DRINKING WATER
GSI - GROUNDWATER SURFACE WATER INTERFACE

PFOS DW: 80 ppt
PFOS GSI: 12 ppt
PFOA DW: 89 ppt
PFOA GSI: 12,000 ppt

# Plant 3 Geology

Water bearing zones:

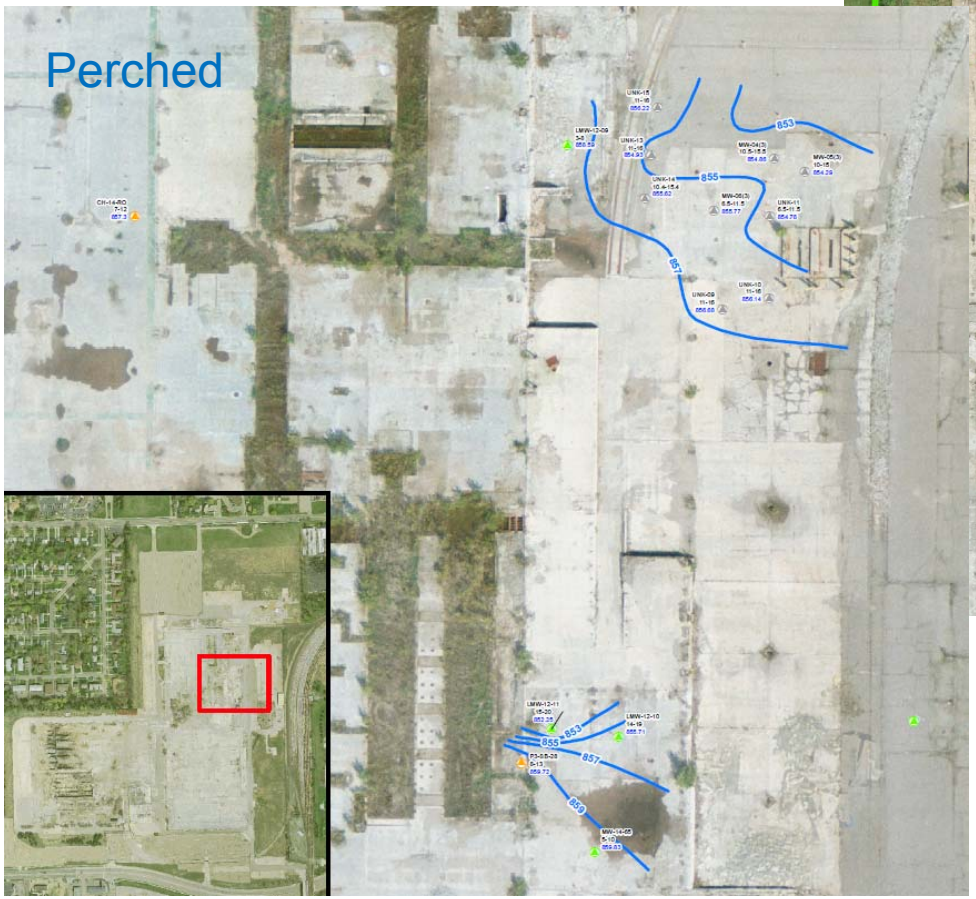
- Perched - shallow fill material and sand seams within shallow clay
- Deep overburden - separated from the perched zone by a dense glacial till
  - Saturation where bedrock surface greater than 65 ft bgs
  - Connected to weathered bedrock
- Bedrock - Grand River Formation sandstone overlying Saginaw Formation sandstone and interbedded shale

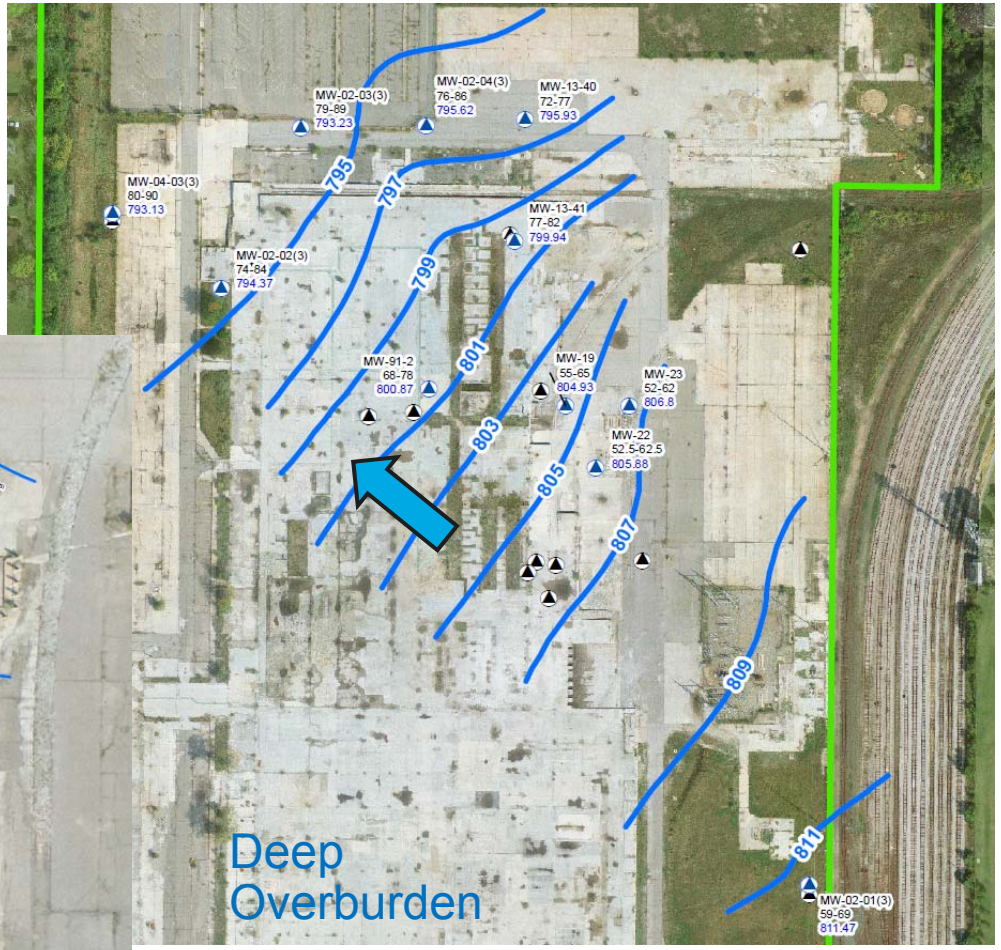


# Plant 3 Saturated Zones

Groundwater Contours

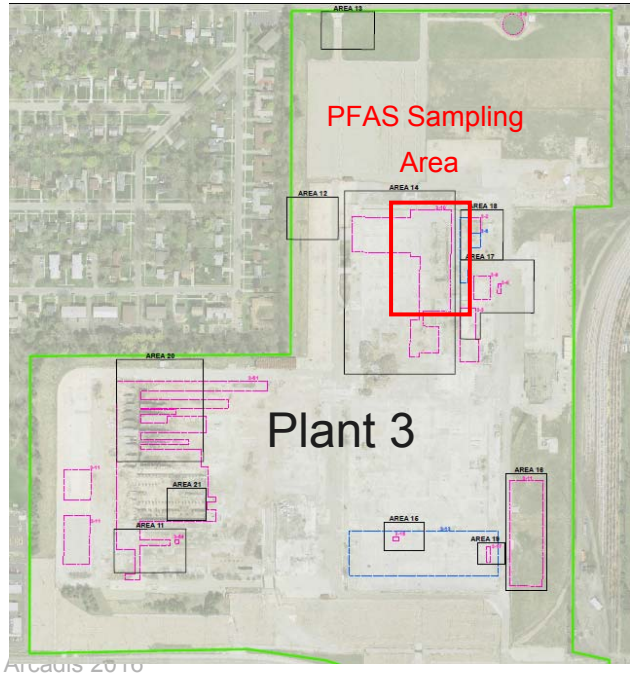
- Perched water sporadic flow not discernable
- Deep overburden – flow by gradient or gravity toward the bedrock valley

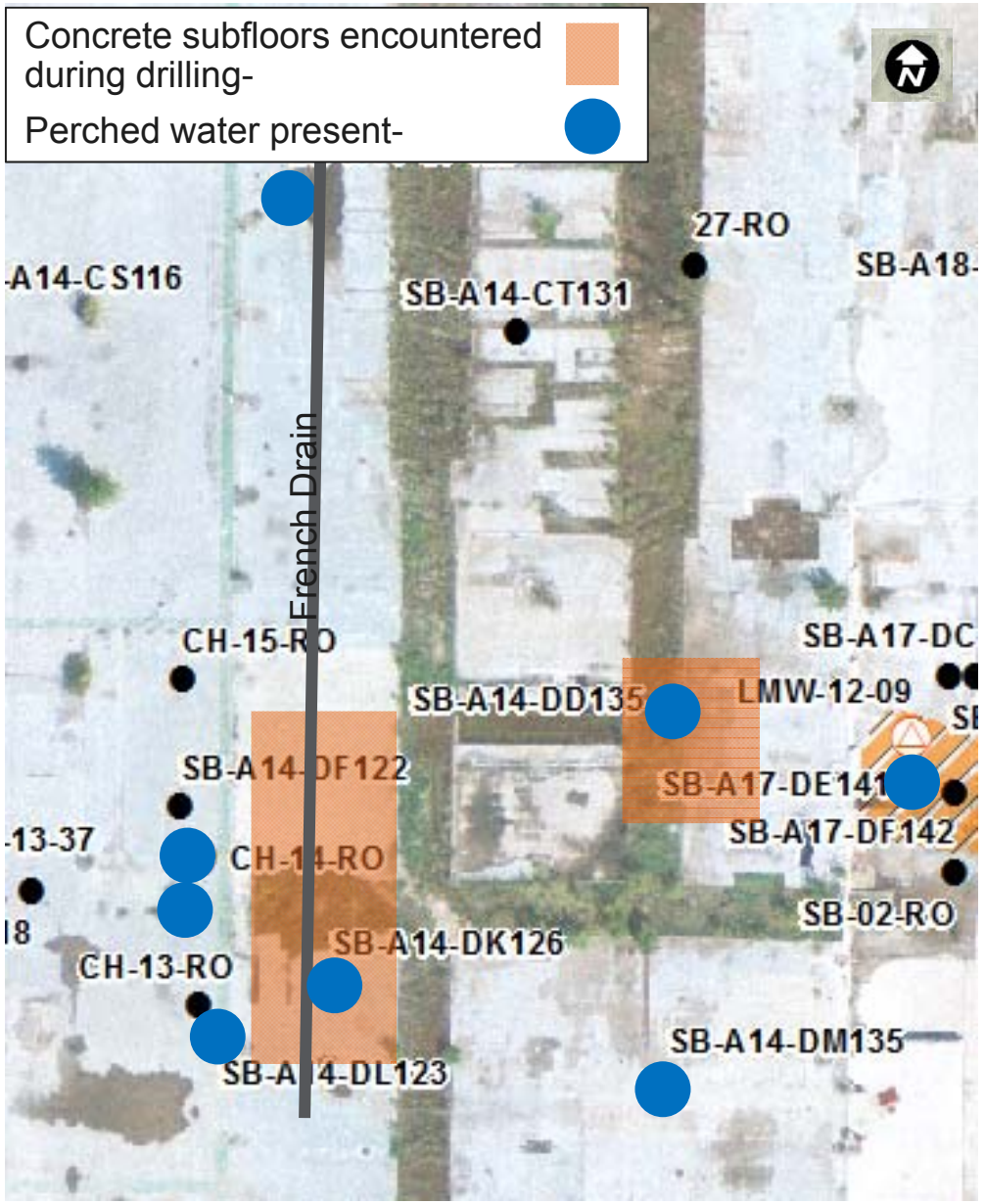


# Background

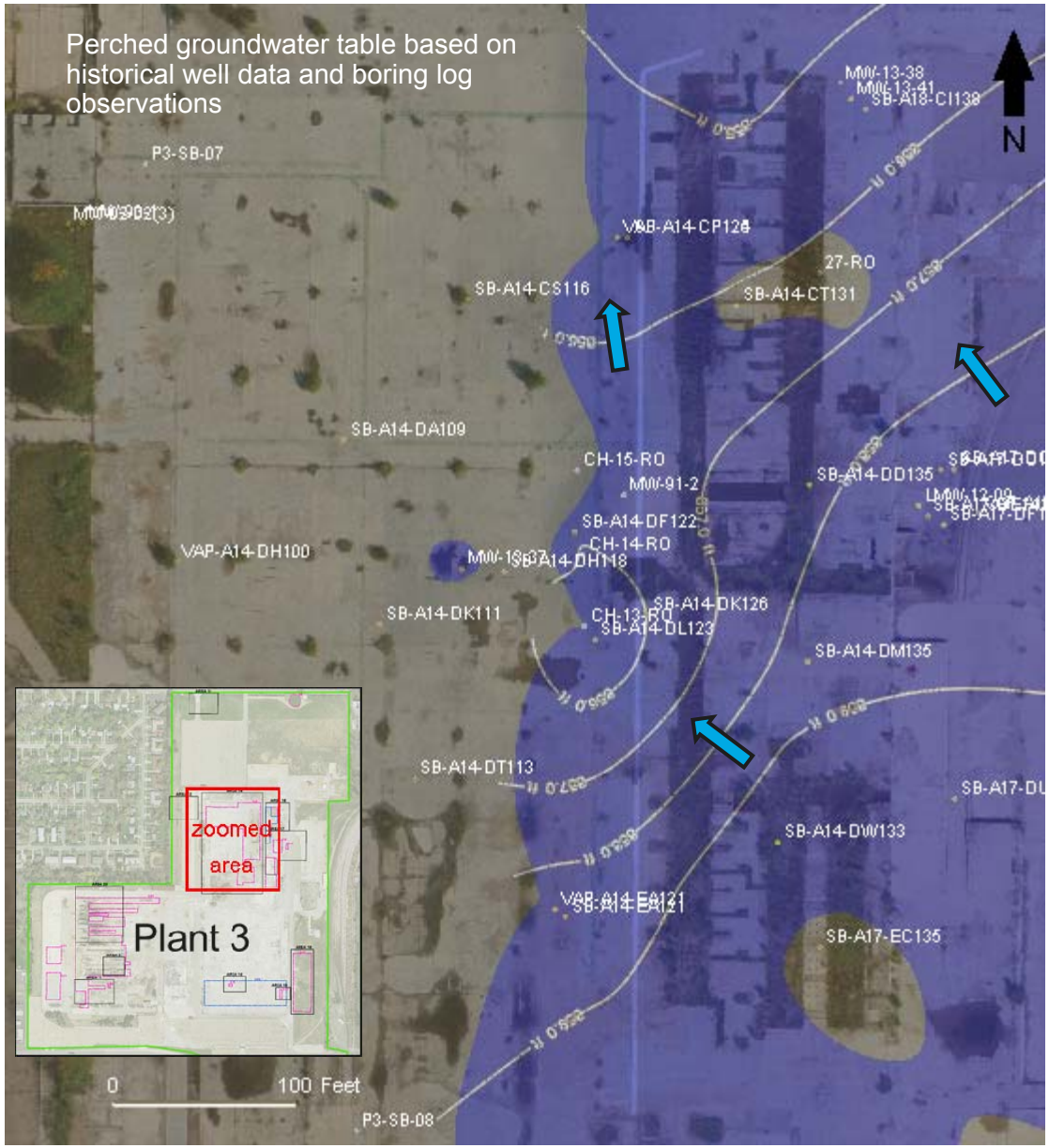
- Electroplating operations (AOI 3-10) were housed in former building 301 at Plant 3 prior to 1988
- PFAS used as vapor suppressants for plating tanks



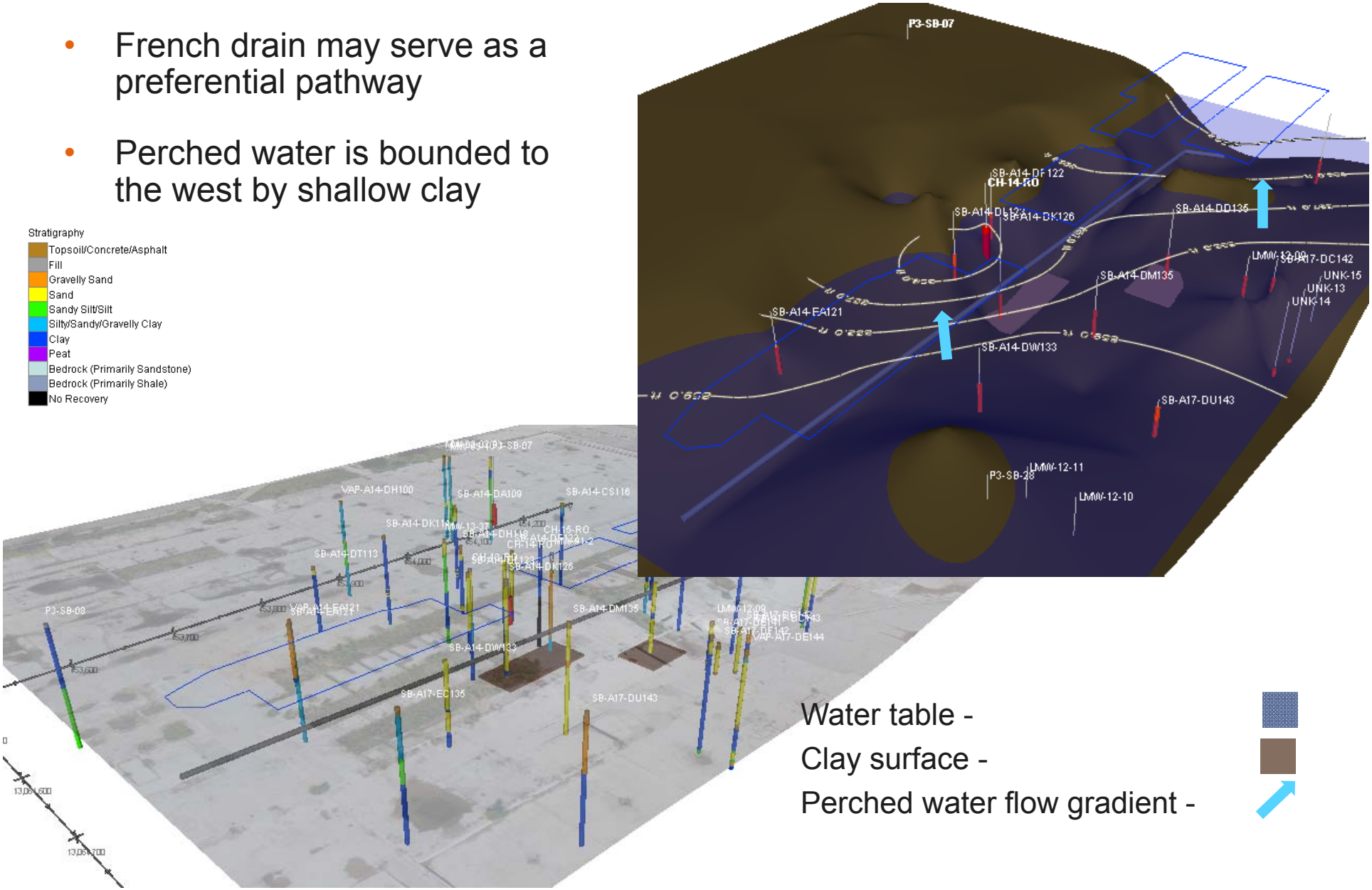
# Hydrostratigraphy

- Perched groundwater:
  - Discontinuous in eastern part of Area 14
  - Confined to sand seams within clay to the west
  - Potentially up to 16 ft of saturated thickness in former excavations and along french drain
- P3-SB-07 - screened in saturated silt 11-16 feet bgs



# Hydrostratigraphy

- French drain may serve as a preferential pathway
- Perched water is bounded to the west by shallow clay



# Additional Evaluation

Collect data to evaluate:

- extent of PFAS in perched water near former plating line
  - Determine if french drain is a potential a migration pathway
- PFAS mass potentially present in soils
- Potential connection of sand seams to the west (P3-SB-07) to perched water along the plating line
- potential sources for PFAS at P3-SB-07
  - Related to CH-14-RO impacts?
  - Potential spills at loading dock?
- Storm water discharge

# Path Forward

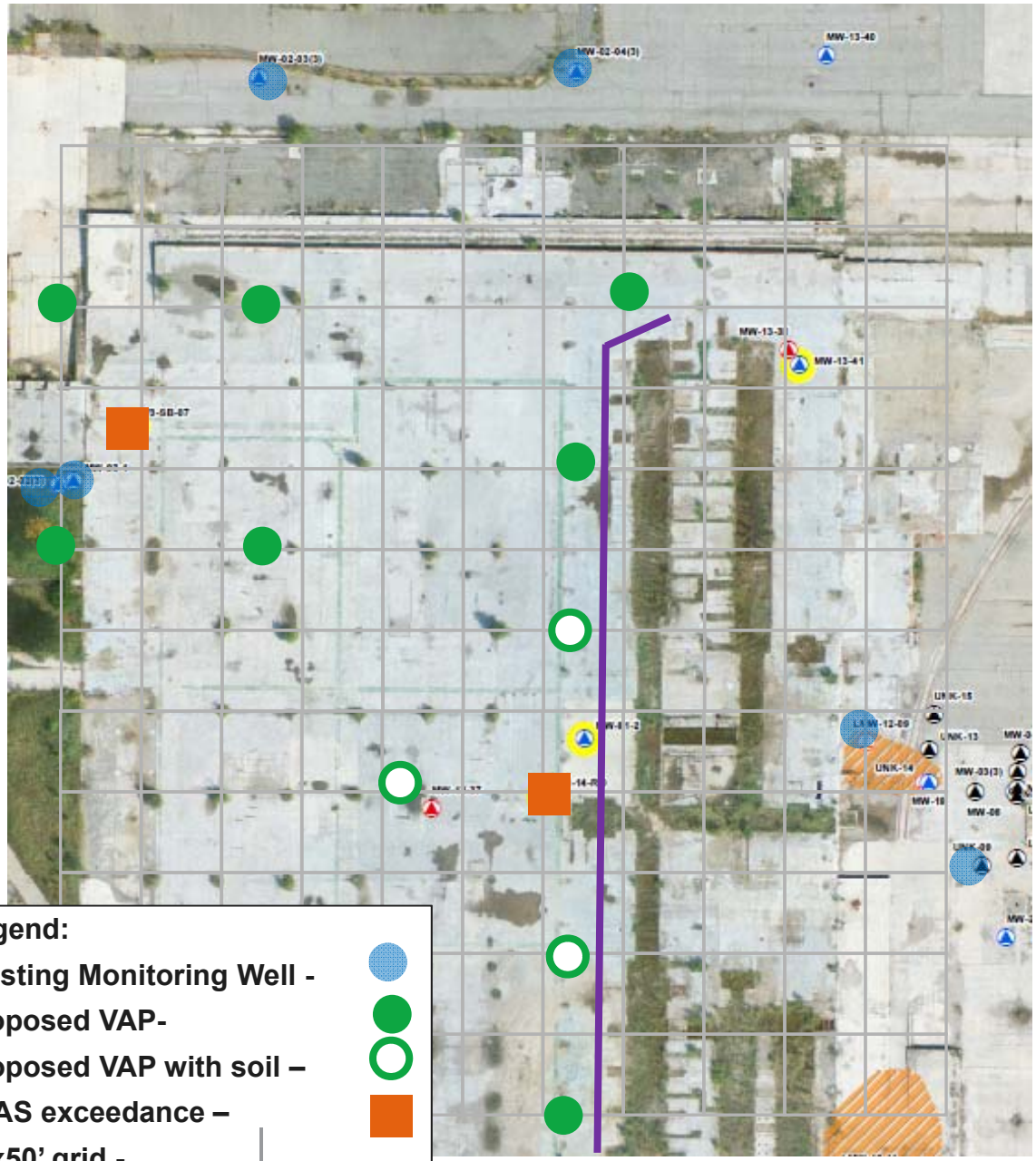
**Phased approach**:

Phase 1:

- 10-12 Geoprobe borings to ~20’ bgs.
- 1-2 VAP intervals per boring
- Up to 2 soil samples each from select soil borings for PFAS
- Sample two perched monitoring wells to the east
- Sample four additional deep overburden monitoring wells to northwest
- Sample Plant 3  storm sewer outfall for PFAS

Phase 2:

- Based on results, install additional monitoring wells or expand investigation area, as appropriate



# Extra Info

- 6:2 fluorotelomer sulfonate (FTS) and 8:2 FTS were added to the USEPA Method 537 analysis (associated with metal plating operations)
- CH-14-RO impacts likely the result of vapor suppressants used in plating operations
- Proximity of P3-SB-07 to loading dock suggests minor spill as a potential source rather than continuous use.
- PFOA not as likely a soil source. PFOS and 8:2 FTS can leach from soils for decades.
- PFOS Kd increases with Ca, the same way VOCs Kd increases with TOC
- TA can run soil analysis

# Previous Investigations

- 1989 – Decommissioning/ excavation of plating line. French drain installed in excavation to collect perched water near impacted soils.
- 1990 – metals exceedances in/near French drain
- Soil and GW investigations continue until Plant 3 closed in 2006
- 2011- hexavalent chromium detected in CH-14-RO during RFI Phase I investigation
- 2012- hexavalent chromium delineated to a small perched zone at CH-14-RO during the RFI Phase II investigation.