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From:
Kristoffer Hinskey, Joe Quinnan

Date:
July 31, 2017

Arcadis Project No.:
MI001322.0001

Subject:
DEQ Information Request Regarding Ford LTP On site VI Investigation Plan

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This memo is provided in response to your email dated June 1, 2017 addressed to Todd Walton at Ford:

The DEQ is requesting additional information with respect to the chlorinated solvent release(s) at the plant. While information has been provided pertaining to the offsite issues the DEQ have limited information regarding onsite issues beyond some limited references from the Information Request response, dated April 22, 2016.

The following response to the Michigan Department of Environmental Quality (MDEQ) request for information is meant to complement information provided on the accompanying supplemental data package slide deck. The slides provide updated figures and information related to the conceptual site model (CSM) and additional remedial work completed since the submission of the CSM summary memo to the MDEQ on April 22, 2016. Some slides are duplicates from the April 2016 or other previous submissions, but are provided for clarity and context.

Comment #1: *Currently the DEQ is aware of existing on-site impacts to soil and groundwater from trichloroethene (TCE), cis-1,2-dichloroethane (DCE), and vinyl chloride (VC), but we do not have a solid understanding of the specific locations, extents, or typical concentrations of these extents. Does a working conceptual site model (CSM) of on-site impact exist? In addition to this, any soil-gas or indoor air samples would be necessary, as well as any interim response measures which Ford Motor Company has undertaken to comply with state or local laws.*

Response:

Ford and Arcadis have collected multiple rounds of data from the Livonia Transmission Plant (LTP), which have been used as lines of evidence to inform a working CSM for the Site. Lines of evidence include: soil, groundwater, light non-aqueous phase liquid (LNAPL), and soil vapor sampling. Limited indoor air samples have been collected for industrial hygiene monitoring. No indoor air samples have been collected to evaluate the indoor air vapor intrusion pathway. A pre-emptive sub-slab depressurization system is being designed to mitigate the potential for vapor intrusion.

Site Geologic Setting (Slides 3 through 7)

The current CSM incorporates existing site knowledge (such as geologic setting) with high-resolution permeability profiling and sampling. Borings completed as part of the Remedial Investigation (RI) are included on Slide 4. Exterior work has focused on permeability mapping with the Geoprobe™ Hydraulic Profiling Tool (HPT; Slide 5) and high-frequency vertical aquifer profile (VAP) groundwater sampling to characterize the hydrostratigraphy, contaminant distribution, and mass flux. Beneath the LTP building, high-frequency soil sampling was completed in lieu of VAP sampling to evaluate volatile organic compound (VOC) distribution through the LNAPL and within the saturated soil column. LNAPL delineation used a state-of-the-art laser-induced fluorescence (LIF) hydraulic profiling (LIF-HP) tool to simultaneously map LNAPL distribution and log the relative permeability of the soil. Based on LIF/LIF-HP results, LNAPL monitoring wells were installed for LNAPL sampling and mobility testing.

Slide 6 presents fence diagrams constructed with the HPT data. Shallow sediments at the Site are associated with a near-shore lacustrine setting and consist of varying amounts of fill material to depths between 0 and 5 feet below ground surface (ft bgs) followed by sandy outwash from approximately 5 to 12 ft bgs. From approximately 12 ft bgs to 25 ft bgs, a zone of interbedded fine sand and silt is encountered that transitions to a low-permeability clay. Groundwater is typically encountered at 6 to 8 ft bgs. Groundwater impacts at the Site are confined to these shallow sediments. Mass flux at the Site is isolated within the more permeable sand seams located within the top 20 feet of sediments.

Soils logged during deep monitoring well installation (Slide 7) around the perimeter of the Site indicate the clay extends to depths of 80 ft bgs followed by a gravelly unit above shale encountered at approximately 90 ft bgs. Groundwater samples collected from deep monitoring wells (MW-15-59D, MW-15-60D, and MW-15-61D) indicate that, although low levels of VOCs were detected in deep wells (e.g. April 2017 – part per trillion levels of benzene, carbon disulfide, cyclohexane, toluene and MTBE), the primary constituents of concern for the Site (i.e. CVOCs and 1,4-dioxane) were not detected in deep wells. Further, the compounds detected in deep wells are not present in shallow monitoring wells at the Site except for single detections of acetone (MW-69) and carbon disulfide (MW-40).

Soil & Groundwater Impacts (Slides 8 through 20)

Evaluation of data collected from monitoring wells (Slide 9) indicates that the primary constituents of concern at the Site are trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and vinyl chloride (VC), although three other compounds are present at concentrations that exceed either Non-residential Drinking Water (DW) or Groundwater-Surface Water Interface (GSI) Criteria at the Site including dichloromethane, styrene, and trans-1,2-dichloroethene.

Based on the isolated detections, styrene was not included as the primary constituents of concern for the Site. Styrene was detected in monitoring well MW-63 during routine performance well sampling. The styrene is attributed to storm sewer pipe rehabilitation work activities conducted at the Site. During rehabilitation of the storm sewers, cure and rinse water was recirculated within the manhole adjacent to monitoring well MW-63. The manhole had structural integrity issues and had not been rehabilitated. As a result, curing and rinse water containing styrene accumulated on the outside of the manhole and into the surrounding subsurface. The styrene is confined to the area around this well and is within the zone of capture created by the hydraulic containment system currently operating at the Site.

Slide 9 also includes a list of VOCs and polychlorinated biphenyls (PCBs) detected in the LNAPL samples collected at the Site. The compounds with the highest concentrations in LNAPL tend to be chlorinated ethanes (such as 1,1,1-trichloroethane [1,1,1-TCA], 1,1-dichloroethane [1,1-DCA], and chloroethane, as well as 2-methylnapthnalene and naphthalene); however, these compounds were not observed at significant concentrations in groundwater either below or downgradient of the LNAPL. Likewise, many of the less significant detections, such as those for benzene, toluene, ethylbenzene, xylene (BTEX) and trimethylbenzenes (TMBs) detected in the LNAPL were not observed at significant concentrations in soil or groundwater. Although, TCE, DCE, and VC were also detected in the LNAPL, the correlation of LNAPL to groundwater impacts is not consistent. This inconsistency suggests that separate sources for VOC impacts are present below the LNAPL, particularly beneath the southern portion of the LTP building where concentrations of TCE, DCE, and VC are highest. Additional detail regarding potential source areas is provided below in the response to Comment #3.

Slides 10 through 17 provide summary distribution maps for total chlorinated VOCs, TCE, DCE, and VC. The total VOC maps show the total chlorinated VOC results displayed as maximum values at each location normalized to drinking water criteria. The August 2016 maps include the HPT/VAP data collected up to that time, illustrating maximum concentrations observed at each boring location. The April 2017 maps include results from the most recent round of monitoring well groundwater samples. The August 2016 maps include saturated soil samples collected from beneath the buildings that were evaluated for “equivalent groundwater concentration” using the soil-to-groundwater partitioning equation (USEPA 1996). The VOC groundwater impacts extend from the LTP building to the east toward the site property boundary (Slides 10 through 17).

Samples collected from the LNAPL at the Site indicated the presence of 1,1,1-TCA. 1,4-dioxane was historically used as a stabilizer in 1,1,1-TCA. Consequently, VAP samples collected during the latter portion of the RI, as well as samples collected from monitoring wells as part of routine monitoring were evaluated for 1,4-dioxane. Slide 18 illustrates the most recent results from monitoring wells sampled for 1,4-dioxane. Currently, no monitoring wells exhibit constituent concentrations that exceed the 2016 proposed Non-Residential DW Criteria for 1,4-dioxane of 350 micrograms per liter (µg/L).

Slide 19 provides a stratigraphic flux model that illustrates a relative measure of mass flux along each HPT transect. The stratigraphic flux is derived by multiplying the 3-D permeability field determined with HPT or LIF-HP, with the concentration field determined using VAP or saturated soil sampling. The result illustrates a five order-of-magnitude decrease in relative mass flux between the source area(s) located beneath LTP and the eastern property boundary. This result suggests that groundwater impacts attenuate rapidly between the source area and the eastern property boundary, likely due in part to anaerobic dechlorination of chlorinated VOCs (CVOCs) due to conditions created by the presence of LNAPL beneath the LTP building. In addition, migration of groundwater impacts on the southeastern portion of the Site were historically hindered by the presence of the eastern storm drain (Slide 20) as described further below.

LNAPL Characterization (Slides 21 through 26)

The lateral extent of LNAPL, based on the LIF and LIF-HP data, is illustrated on Slide 22. In general, the LNAPL consists of a mix of transmission, cutting, and hydraulic oils (Slide 24). Low concentrations of PCBs were detected in LNAPL, but at generally low concentrations (i.e., <5 parts per million). The specific PCB congeners detected suggest that all of the PCBs were released before 1971 (slide 25). There are some areas of elevated VOCs within the LNAPL; most notably at well LMW-15-05, where 1,1,1-TCA and cis-1,2-DCE were detected at concentrations greater than 100 parts per million (Slide 26).

Sub-Slab Soil Vapor and Methane Evaluation (Slides 27 through 44)

Sub-slab soil vapor samples were collected during multiple mobilizations at the Site between 2015 and 2017. All samples were collected following methods in compliance with the MDEQ 2013 Vapor Intrusion Guidance document. Samples have been collected from both temporary and permanent sample point installations. Prior to sampling each location, a water dam leak test and shut-in test was used to verify the integrity of both the sample point installation and the sample train. Samples were collected using both evacuated sample canisters (i.e., Summa cans) and sorbent tubes, with most of the sampling being conducted using sorbent tubes.

Using the known extents of LNAPL as a guide, initial sub-slab soil vapor samples for VOCs and methane were collected at 10 locations during December 2015 (Slide 28). Results of this initial sampling indicated methane detections higher than the MDEQ screening level (1.25%) at six of 10 locations. Cis-1,2-DCE was detected at concentrations above the since-rescinded 2013 non-residential vapor intrusion screening level at one location. Initial sub-slab soil vapor sampling indicated that further investigation was warranted.

Between June 7 and September 1, 2016, comprehensive soil vapor sampling for VOCs and methane was conducted at 81 locations (Slide 29). Sample locations were selected based on extents of LNAPL and previous sub-slab soil vapor sample results. Permanent vapor pins were installed at all locations to allow for multiple rounds of sampling as needed. VOC samples were collected using sorbent tubes (i.e., United States Environmental Protection Agency [USEPA] Method TO-17) from each location (Slide 30). During the sampling event, multiple additional lines of evidence were also collected in real time to support the CSM including: differential pressure, methane, CO_2, and O_2 (Slide 31). Field staff also looked for preferential pathways to indoor air during the sampling effort; no preferential pathways were noted.

Methane concentrations underneath the slab were verified in two ways: (1) laboratory samples collected from five locations and (2) resampling using the real-time instrument between December 27, 2016 and January 3, 2017. These verification samples (Slide 32) provided concurrence that field screening methods were adequate to characterize the presence of methane underneath the floor slab. Additional sampling for VOCs and methane was conducted between December 27, 2016 and January 3, 2017, as well as on April 11, 2017, to complete delineation in areas that had not previously been sampled.

Soil vapor data collected to date indicate that VOCs are present underneath the building slab at concentrations above the rescinded MDEQ 2013 non-residential sub-slab soil vapor screening levels (Slide 33). Separate, distinct areas of VOC exceedances have been noted. Data will be re-evaluated using the pending MDEQ vapor intrusion screening values when they become available. Chemicals present at concentrations that exceeded rescinded screening criteria include VC, cis-1,2-DCE, and TCE. Methane is present at concentrations above the MDEQ screening level of 1.25% in three distinct areas (Slide 33). Overall VOC and methane exceedances were in roughly the same locations, suggesting LNAPL as a source of soil vapor (Slide 33). VOC results were also evaluated using Michigan Department of Health and Human Services (MDHHS)/MDEQ interim consensus values. This re-evaluation expanded the areas where VOC concentrations exceed a screening level are present. Additional samples are proposed for late 2017 to complete delineation of methane in the western portion of the plant (Slide 34).

Although VOCs and methane are present beneath the building slab, multiple lines of evidence suggest that vapor intrusion is likely not currently occurring. These lines of evidence include:

- Indoor air sampling at six locations inside the plant in July 2015 (Golder) using industrial hygiene sampling methods (Slide 35). The detection limits of these samples (0.1 parts per million by volume [ppmv] for VOCs) limit the utility of the data for assessing the potential for vapor intrusion. VOCs were not detected in five of the six indoor air samples. At the sixth sample location, TCE was detected; however, a trench to the sub-grade was open during construction, skewing the sampling results high and not representing normal operating conditions.
- Ford plant staff have monitored indoor air near each vapor pin for methane multiple times with a portable instrument; methane has not been detected in any of these monitoring events.
- No significant pressure was noted beneath the floor slab during differential pressure measurements (Slide 31).
- The floor slab of the facility is 8 inches thick in most locations, and most of the plant is covered in an epoxy covering. Although the epoxy coating was added to enable smooth travel of carts and personnel inside the facility, it also likely provides some impediment to vapor movement.

In response to the presence of VOCs and methane beneath the building, Ford has started to design a pre-emptive sub-slab depressurization system to ensure that vapor intrusion cannot occur in the future. Initial steps towards building mitigation included a review of building construction (Slide 36) and completion of sub-slab depressurization pilot testing (Slide 37). Pilot testing was conducted December 28 through 30, 2016 at five areas of the plant where VOC and methane concentrations were present in the sub-slab and within areas constructed at different times to determine the parameters necessary for sub-slab depressurization (SSD) system design in each of these areas. Results of the pilot testing indicated vacuum propagation results across most of the plant (Slides 38 through 43).

- A 170-foot or greater radius of influence (ROI) of 0.004 inch of water column (” WC) was induced within the main plant area with approximately 60” WC applied at the extraction point and approximately 30 cubic feet per minute (cfm) flow rate.
- A smaller ROI of approximately 80 feet of 0.004” WC was induced within an eastern addition area (which was not epoxy-coated) with approximately 60” WC applied at the extraction point and less than 10 cfm flow rate (Slides 41 and 43).
- Calculated emissions rates for each extraction point during the pilot test ranged from 0.15 to 22.8 pounds per month (lbs./mo) for total VOCs and 0.0005 to 0.114 lbs./mo for carcinogens (Slides 38 and 42).

An SSD system is currently being designed to address areas of the plant with constituent concentrations that exceed rescinded MDEQ 2013 non-residential sub-slab soil vapor screening levels and MDEQ/MDHHS Interim Consensus Values for sub-slab soil vapor. The SSD system is being designed, based on the results of the pilot study, to apply approximately 60” WC at nine locations with the following ROIs:

- Six points with 170-foot ROI covering a total of approximately 136,000 square feet
- Three points with 80-foot ROI covering a total of approximately 15,000 square feet

Slide 44 presents a conceptual design of the SSD system. The performance of this system will be evaluated and used to further the design of any additional SSD coverage to be incorporated as applicable.

<u>Comment #2</u>: *What other chemicals related to and comingled with the TCE/DCE/VC issue are present onsite? Is the LNAPL plume comingled or is this definitely a separate issue? We have been apprised of* *the issue with 1,4-Dioxane, but do not know the extent of this issue or if this issue is directly related to the aforementioned plume. Are other compounds such as (but not limited to) PCE or Ethene detected in other environmental samples? If so, at what extent and concentrations are these observed and what is their association to indoor working spaces on the plant.*

Response:

As noted above and summarized on Slide 9, an evaluation of data collected from monitoring wells indicates that the primary constituents of concern at the Site are TCE, DCE, and VC, although three other compounds exceed either DW or GSI Criteria at the Site: dichloromethane, styrene, and trans-1,2-dichloroethene.

The compounds present at the highest concentrations in LNAPL tend to be chlorinated ethanes (such as 1,1,1-TCA, 1,1-DCA, and chloroethane) as well as 2-methylnapthnalene and naphthalene (Slide 26); however, these compounds were not observed at significant concentrations in groundwater either beneath or downgradient of the LNAPL. Likewise, many of the less significant detections (such as BTEX and TMBs detected in the LNAPL) were not observed at significant concentrations in soil and groundwater. Although, TCE, DCE, and VC were also detected in the LNAPL, the correlation of LNAPL to groundwater impacts is not consistent. This inconsistency suggests that separate sources for VOC impacts are present below the LNAPL, particularly beneath the southern portion of the LTP building, where concentrations of TCE, DCE, and VC are highest. Additional detail regarding potential source areas is provided below in the response to Comment #3.

As described above, styrene is not considered as part of this evaluation or any calculation, as the isolated presence is based on pipe rehabilitation work as indicated above, and described further below.

Samples collected from the LNAPL at the Site indicated the presence of 1,1,1-TCA. The compound 1,4-dioxane was historically used as a stabilizer in 1,1,1-TCA. Consequently, VAP samples collected during the latter portion of the RI, as wells as samples collected from monitoring wells as part of routine monitoring, were evaluated for 1,4-dioxane. Slide 18 illustrates the most current results from monitoring wells sampled for 1,4-dioxane. Currently, no results from monitoring wells exceed the proposed 2016 non-residential DW Criteria for 1,4-dioxane (350 µg/L).

Comment #3: *In 2016, the specific source of the contamination had not yet been determined. Has this since been determined? Is the source estimated to be from a single point/catastrophic release, or is there more likely a history of substance mismanagement which lead to multiple nearby sources which have over time formed to create the greater issue which created the effects now being observed offsite? Does any information exist indicating whether this was one substance or multiple? We understand this may be difficult to nail down, but if any determinations have been made beyond the hypotheses outlined in the April 2016 memo, please let us know.*

Response:

Potential Historical Source Areas (Slides 45 through 52)

Based on historical operations, there are multiple potential historical sources beneath the LTP building (Slide 46). As shown on Slide 46, numerous pits, tanks, and pipe runs were historically present beneath the building that may have contributed to the release of LNAPL and solvent compounds. In particular, the waste conveyance lines may have contributed to impacts at the Site from potential leaks. However, the results of the sampling data have suggested several areas that may be contributing to soil, groundwater, and vapor impacts at the Site. Based on the occurrence of VOCs in sub-slab soil gas samples, as well as the distribution of VOC impacts observed in soil, groundwater, and LNAPL samples, six areas have been identified as potential source areas (PS-1 through PS-6) beneath or adjacent to the LTP building. These potential source areas are presented on Slides 48 through 50 and discussed below:

- PS-1: In addition to elevated soil gas results, the highest concentrations of VOCs in groundwater were identified beneath the LNAPL, downgradient of the former broach machine in the southern portion of the LTP building. A transect completed downgradient of this area has indicated zones of high VOC mass flux. This source area appears to contribute 95% or more of the VOCs mass flux observed in groundwater at the Site. The former broach pit is currently located beneath a "clean-room," making access to the area difficult.
- PS-2: Soil gas results identified high concentrations of VOCs beneath the northwestern portion of the LTP building. There are no additional sampling data available in the area, although downgradient groundwater samples suggest that VOC impacts in the area of PS-2 are confined to the vadose zone or entrained within the LNAPL.
- PS-3: Elevated soil gas results suggest a source of VOCs in this area. Saturated soil samples at one location indicate high concentrations of DCE and VC in groundwater at depths of 13 to 20 feet below grade (LMW-15-02). However, the LNAPL samples from this area indicate only nominal concentrations of VOCs (1 ppm TCE). These results suggest that the potential for an upgradient source of dissolved-phase VOCs may be present.
- PS-4: Sampling at one location has indicated high concentrations of VOCs in soil gas and high concentrations of VOCs (i.e., TCA, DCA, and DCE) in LNAPL (LMW-15-05). Saturated soil sampling indicates high concentrations of DCE in groundwater at 9 to 10 feet below grade.
- PS-5: Soil gas results suggest a potential source of VOCs (mainly TCE) beneath the northeast portion of the building; however, downgradient groundwater sampling does not suggest impacted groundwater in this area.
- PS-6 (Slides 51 and 52): Investigation was completed around the wastewater pre-treatment facility to help identify a potential source of TCE impacts along the northern property boundary. Historical use of the area for waste storage (1960s and 70s) and detections of VOCs in groundwater suggest that a potential source could be present east of the facility; however, impacts are likely commingled with VOCs emanating from beneath the LTP building.

<u>Comment #4</u>*: We understand the pump and treat system has been in operation since late March 2017. What volume of water is being treated and what are the concentrations of chlorinated solvents which are being removed from the groundwater? Additionally, the DEQ would like to obtain copies of any final system designs and information related to the O&M being completed on the system.*

Response:

The hydraulic control system commenced operations in late March 2017. Arcadis provided the MDEQ with the hydraulic control system operation and maintenance (O&M) manual to the MDEQ on July 14, 2017. The manual provides detailed construction information of the hydraulic system and regular O&M guidance for the system.

Hydraulic Control System (Slides 53 through 61)

The horizontal extraction wells were installed from November 2016 to February 2017 (Slide 54). The system operates at an average daily flow rate of 30 to 40 gallons per minute (gpm) with 5.6M gallons treated through July 28, 2017. The extraction wells were configured to intercept impacted groundwater migrating from west to east via the natural hydraulic gradient (Slide 55). The intent of the system is to provide a hydraulic barrier to migration of VOCs. The four extraction wells are constructed of 4-inch high-density polyethylene (HDPE) set 16.5 to 22.5 feet below grade surface, screened in high conductivity (K) zones, creating an approximate 2,000-foot-long hydraulic barrier (Slide 54).

The groundwater treatment system was designed for treatment of TCE, DCE, and VC. The system was designed to handle the highest concentrations observed on site. The liquid treatment consists of air stripping and a carbon polish. A catalytic oxidizer treats the air stripper vapor before discharge (Slide 56). O&M visits are conducted weekly to collect pressure and flow data from the system, as well as perform routine maintenance (bag filter replacement, air stripper inspection, and cleaning; Slide 57). Effluent samples are currently collected monthly for compliance with the Great Lakes Water Authority (GLWA) sanitary discharge permit. Influent and system samples are collected as needed to document influent concentrations and monitor both air stripper performance and carbon usage rates (Slide 58).

The primary objective of the hydraulic control system is to prevent the migration of impacted groundwater off site. This objective is currently being evaluated via capture zone analysis following the USEPA Guidance Evaluation of Capture Zone for Pump and Treat (USEPA 1996). Initial capture zone evaluation depicts an inward gradient. Removal of contaminant mass remains a secondary objective, with concentrations observed in the range of 0 to 30 parts per billion (ppb) for DCE and 0 to 100 ppb for VC. TCE has remained largely non-detect, with only intermittent 0 to 5 ppb detections (Slide 59).

Initial capture zone evaluation using USEPA-approved methodology depicts a hydraulic gradient toward the groundwater treatment system extraction wells. This analysis demonstrates hydraulic capture preventing the off-site migration of impacted groundwater (Slide 60). Following startup in late March, the optimization phase will continue for the first 6 months of operation (April through September) to normalize and refine system operation, with the primary objectives of observing and evaluating capture, and maintaining compliance with discharge permitting (Slide 61).

<u>Comment #5</u>: *Is the storm drainage condition which is believed to have helped slow down the migration of this contamination to the south still present? Is this still being addressed for a more appropriate long-term solution in which the contaminated groundwater is not being intercepted by the storm sewer, or is a long-term solution now in place?*

<u>Response:</u>

The 48-inch corrugated metal pipe (CMP) that infiltrated the southern groundwater impacts was successfully rehabilitated on March 30, 2017. As stated above, the hydraulic control system became operational in March 2017. Ford successfully installed the hydraulic control system prior to the rehabilitation of the 48-inch line to limit any potential migration of impacted groundwater to the east. The hydraulic control system offers a long-term remedy to control water migration, and the rehabilitation of the 48-inch line with the cured-in-place liner also provides a long-term remedy to prevent impacted groundwater infiltration.

<u>Storm Sewer System Rehabilitation (Slides 62 through 71)</u>

On January 15, 2016, Trimatrix collected storm water samples from the eastern diversion chamber, western diversion chamber, and compliance point SL-2, which is located along Plymouth Road (Slide 63). The sample results collected identified concentrations of DCE, TCE, and VC above the discharge requirements for individual compounds (20 ppb) regulated by the GLWA. Based on videos collected as part of the new programs facility upgrades in December 2015, it was determined that the structural integrity of the of 48-inch CMP that leads to the eastern diversion chamber was not structurally sound and potentially allowing groundwater infiltration.

On April 21, 2016, Arcadis began the review of closed-circuit television (CCTV) files previously collected by Ford Motor Company in 2015. Some of videos were of poor quality or certain pipes were not included in the CCTV footage. In July 2016, Arcadis provided oversight of the CCTV inspection of approximately 6,657 linear feet of storm sewer piping. Review of the videos collected by Ford and Arcadis determined that 17,030 linear feet of storm sewer pipe would be manually tested for structural integrity and/or rehabilitated. In addition to the storm sewer pipes, 31 manholes required rehabilitation (Slide 64).

In assessing the technologies to be implemented at the Ford Livonia Transmission Plant, many considerations were made to reduce disruption to an active plant while meeting the objective of reducing impacted groundwater infiltration. The following technologies were chosen for this project to rehabilitate storm pipes and manholes (Slides 66and 68):

- Cured in Place Pipe Lining (CIPPL)
- Test and Seal (T/S)
- Cementitious or Polymer Coating
- Man Entry Injection Grouting (MEGI)

On October 10, 2016, a pipe rehabilitation contractor mobilized to the Site. Activities focused on cleaning an assessment of the 48-inch CMP that resides between the test track and the Automatic Transmission New Products Center. The 48-inch CMP was targeted first for rehabilitation to reduce the infiltration of impacted groundwater into the Eastern Diversion Chamber and compliance point SL-2.

On November 4, 2016, Ford received an extension to the GLWA discharge permit and the deadline was extended to March 31, 2017. The 48-inch CMP rehabilitation was postponed until the hydraulic control system could be installed and operating. Ford recognized that both the 48-inch CMP and the hydraulic control system had to be implemented at the same time to reduce any potential migration of impacted groundwater.

From November 4, 2016 through March 2017, Arcadis provided oversight for the following rehabilitation activities: CIPPL, T/S, Manhole Rehabilitation, and MEGI. Below is a list of the of storm pipes and manholes rehabilitated to date (Slides 66 through 71):

- CCTV and cleaned 15,852 linear feet of storm sewer
- CIPPL of 3,588 liner feet of storm sewer including the 48-inch CMP (Slides 67 and 69)
- Test and Seal of 1,435 joints; 345 joints needed to be sealed due to water infiltration
- Rehabilitated 31 manholes
- Completed two MEIG locations in a 60-inch reinforced concrete pipe
- Installed seven clean outs to allow for test and seal to be completed
- Installed one manhole to allow for additional CIPPL.

Post-construction CCTV indicated that the 48-inch CMP was successfully rehabilitated (Slide 71)

Currently, Arcadis is overseeing the remainder of the rehabilitation, which includes 1,178 linear feet of storm sewer pipe. Rehabilitation is expected to be completed by August 2017. The remaining pipes to be rehabilitated show no evidence of groundwater infiltration and are believed to be above the current water table.

References

U.S. Environmental Protection Agency (EPA) (1996). *Pump-and-treat ground-water remediation: a guide for decision makers and practitioners*, office of Research and Development, Washington, D.C.

Design & Consultancy
for natural and
built assets

SUPPLEMENTAL DATA PACKAGE

Response to MDEQ Request for Information

Ford Livonia Transmission Plant

July 2017

Comment #1, Comment #2, & Comment #3
On-Site Impacts
Methane and VOC Vapor Assessment
Source Areas

Site Geologic Setting

Borings Completed to Date

LEGEND

- ● HPT-VAP BORING (78)
- ▲ LIF BORING (57)
- ▲ LIF-HP BORING (11)
- ▲ LIF-HP-WCSS BORING (9)
- ◉ MONITORING WELL (69)
- ◉ LNAPL MONITORING WELL (10)
- ◉ SOIL BORING (28)
- ▭ FORD PROPERTY BOUNDARY

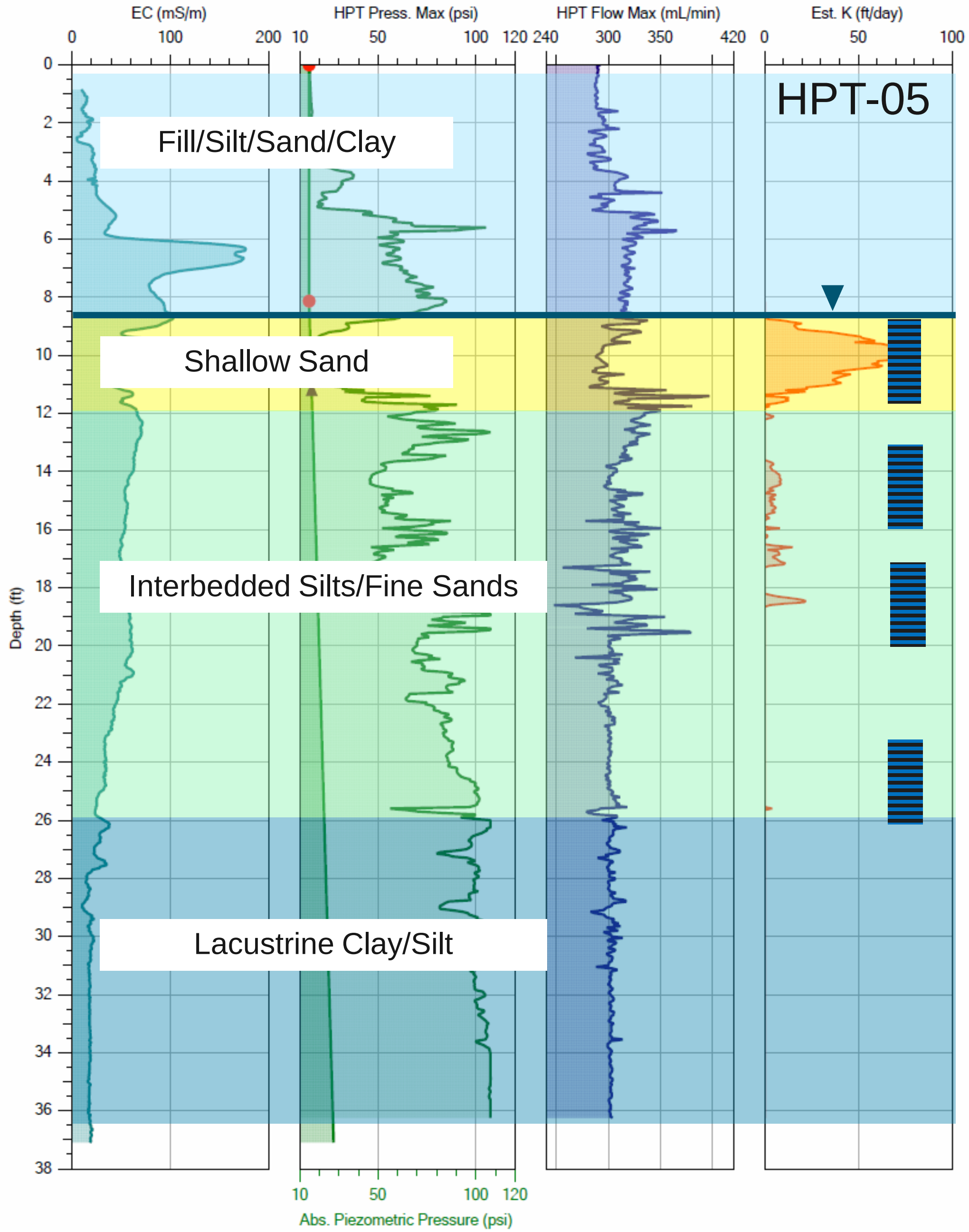
HPT Characterization

Geoprobe® Hydraulic Profiling Tool

- Direct push probe that injects small amount of water into the formation and records pressure response

Flow (Q) / Pressure (P) = Est. K (Q/P)

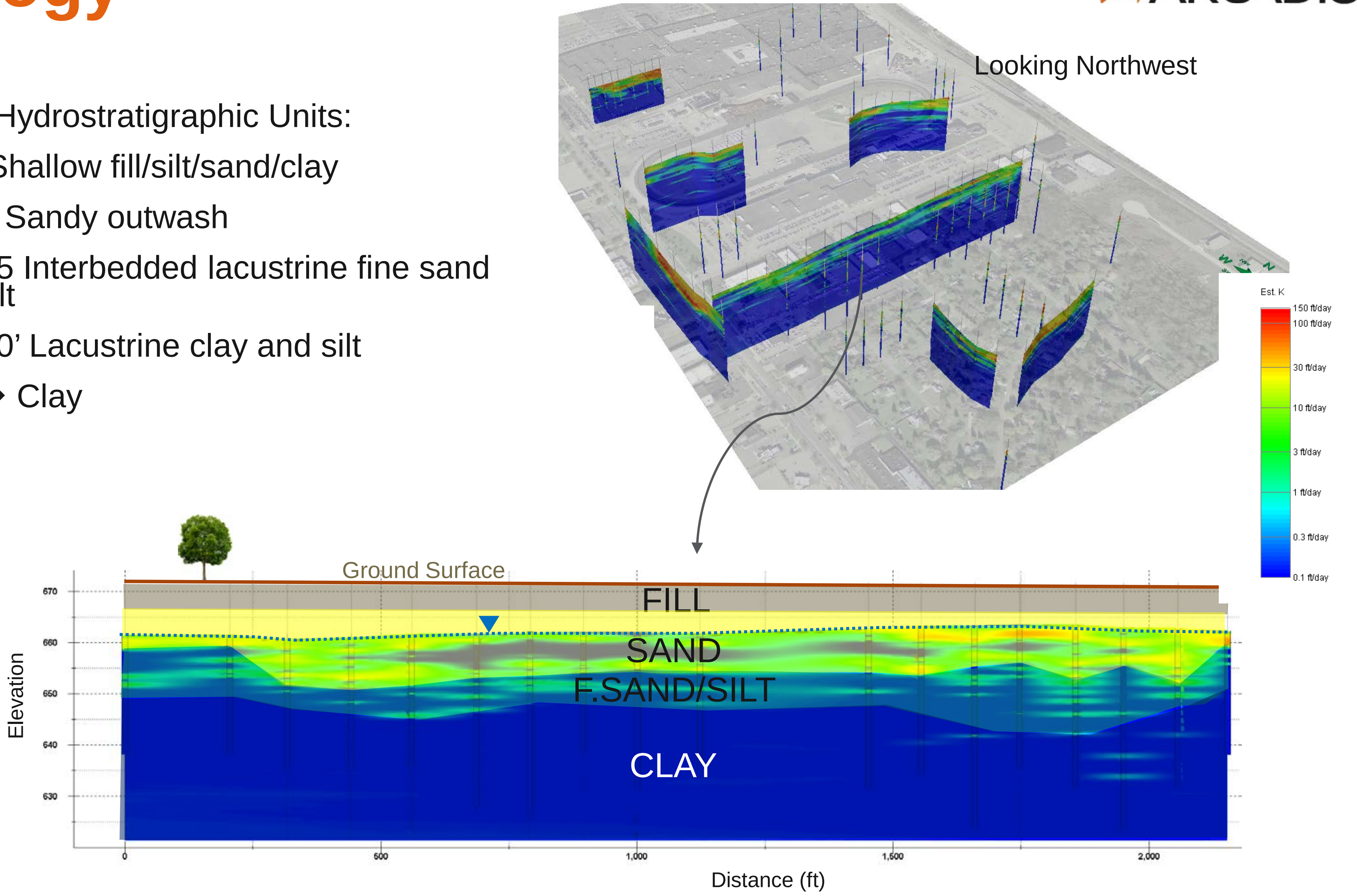
- Est. K is Q/P corrected by an empirical relationship developed by Geoprobe



Geology

General Hydrostratigraphic Units:

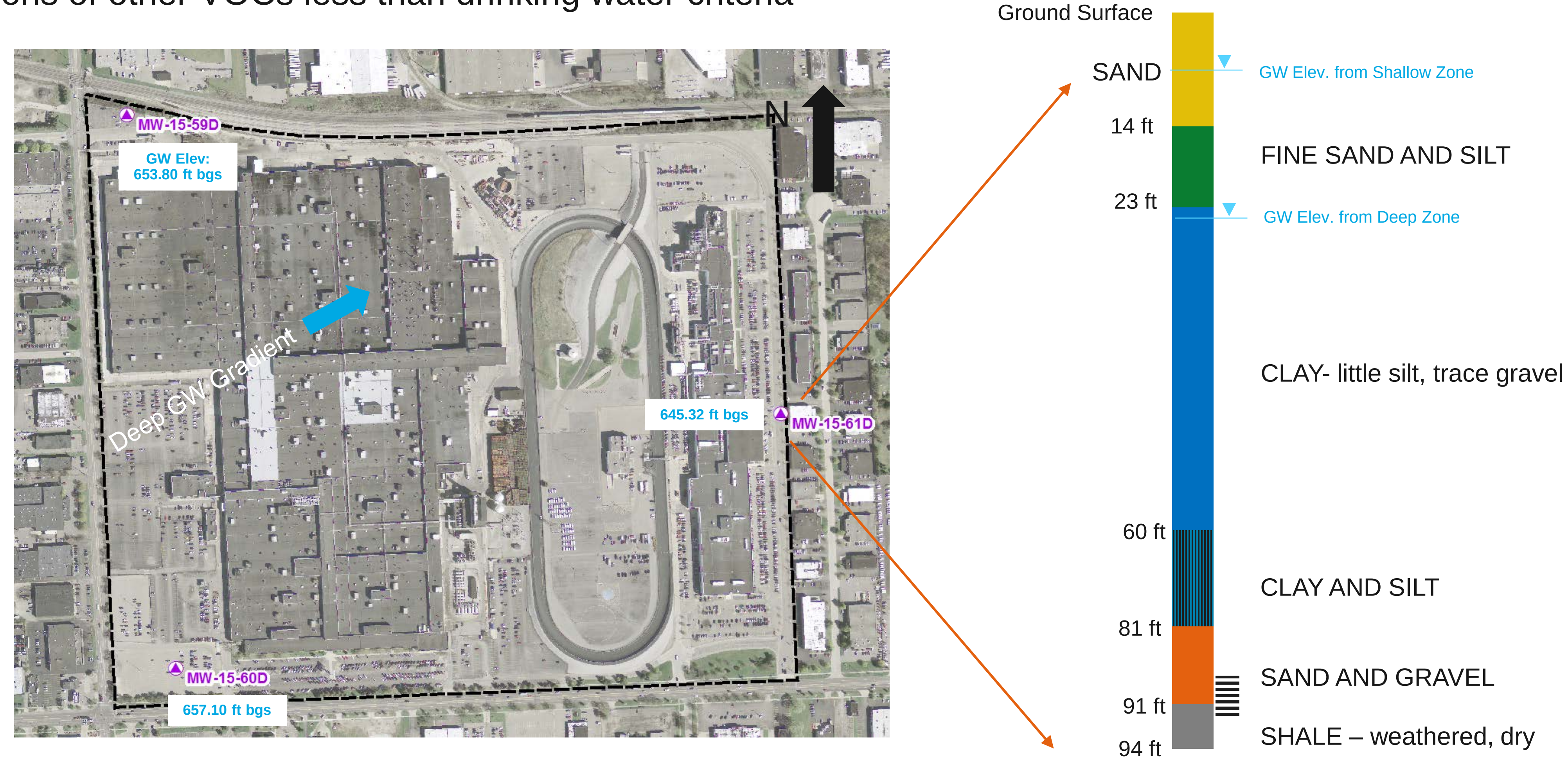
- ~0-5 Shallow fill/silt/sand/clay
- ~5-12 Sandy outwash
- ~12-25 Interbedded lacustrine fine sand and silt
- ~25-30’ Lacustrine clay and silt
- ~30 → Clay



Deep Groundwater Conditions

April 2017 Monitoring Results

- Groundwater elevation ~10-15 ft lower within deep sand and gravel vs perched zone indicating hydraulic separation
- Primary COCs not detected in deep monitoring wells
- Minor detections of other VOCs less than drinking water criteria



Soil and Groundwater Impacts

Constituents of Concern

April 2017 on-site monitoring well data:

Non-Residential Drinking Water or GSI Criteria Exceedances:

VOCs	General and Geochemical Parameters
cis-1,2-Dichloroethene	Chloride
Dichloromethane	Total Dissolved Solids
Styrene (Monomer)	Aluminum, Total
trans-1,2-Dichloroethene	Iron, Total
Trichloroethene	Manganese, Total
Vinyl chloride	

Detections in LNAPL (2015):

LNAPL VOC Constituents	
>10 PPM	<10 PPM
1,1,1-Trichloroethane	1,2,3-Trimethylbenzene
1,1-Dichloroethane	1,2,4-Trichlorobenzene
2-Methylnaphthalene	1,2,4-Trimethylbenzene
Chloroethane	1,3,5-Trimethylbenzene
cis-1,2-Dichloroethene	1,3-Dichlorobenzene
Naphthalene	1,4-Dichlorobenzene
	Ethylbenzene
	o-Xylene
	p,m-Xylene
	p-Isopropyltoluene
	Toluene
	Trichloroethene
	Vinyl chloride
	PCB-1242
	PCB-1248
	PCB-1260

Groundwater Normalized Chlorinated VOC Impacts:

RI Data – August 2016

ARCADIS Design & Consultancy for natural and built assets

LEGEND

TOTAL CVOC NORMALIZED - GROUNDWATER

- 🔵 ≤ DW CRITERIA
- 🟢 1 - 100 X DW CRITERIA
- 🟡 100 - 1000 X DW CRITERIA
- 🔴 >1000 X DW CRITERIA

TOTAL CVOC NORMALIZED - EQUIVALENT GROUNDWATER

- 🟦 ≤ DW CRITERIA
- 🟩 1 - 100 X DW CRITERIA
- 🟨 100 - 1000 X DW CRITERIA
- 🟥 >1000 X DW CRITERIA

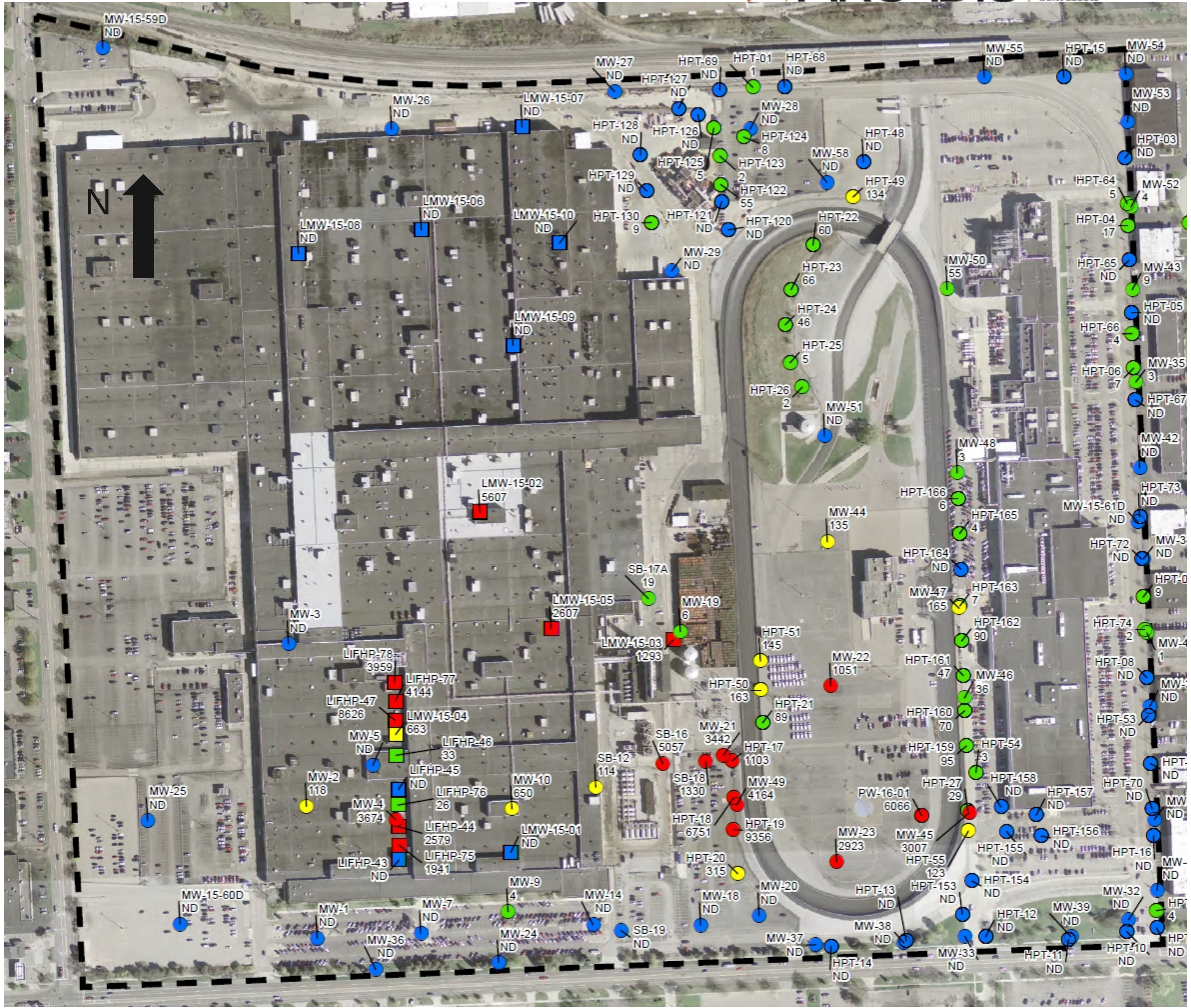
NOTE:

TOTAL CVOCS INCLUDE TCE, 1,1-DCE, CIS-DCE, TRANS-1,2-DCE, 1,1,1-TCA, 1,2-DCA AND VINYL CHLORIDE

NORMALIZATION OF DATA IS COMPLETED BY DIVIDING EACH COMPOUND BY THE RESPECTIVE NR DRINKING WATER CRITERIA AND ADDING THE RESULTS TOGETHER (VALUES LESS THAN 1 ARE IGNORED)

EQUIVALENT GROUNDWATER CONCENTRATIONS ARE DETERMEINED FOR SATURATED SOIL SAMPLES BY CALCULATIING THE SOIL TO GROUNDWATER PARTITIONING VALUE FOR EACH COMPOUND (USEPA,1996) AND NORMALIZING AS ABOVE.

HPT BORINGS INCLUDE UP TO 5 VERTICAL AQUIFER PROFILE GROUNDWATER SAMPLES. ONLY THE MAXIMUM DETECTED VALUE IS PRESENTED ON THE FIGURE. LIKEWISE ONLY THE MAXIMMUM VALUE FOR SATURATED SOIL/EQUIVALENT GROUNDWATER ARE PRESENTED FOR EACH SOIL BORING COMPLETED BENEATH THE LTP BUILDING.



Groundwater Monitoring Event
Total Normalized Chlorinated VOCs – April 2017

ARCADIS Design & Consultancy for natural and built assets

LEGEND

- 🔵 0 - 1 X DRINKING WATER CRITERIA
- 🟢 1 - 100 X DRINKING WATER CRITERIA
- 🟡 100 - 1,000 X DRINKING WATER CRITERIA
- 🔴 >1,000 X DRINKING WATER CRITERIA
- ● WELL NOT SAMPLED
- ▣ VAULT (2 FT x 2 FT)
- ▣ VAULT (4 FT x 6 FT)
- - - - WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)
- ― WELL BLANK CASING (4-INCH SDR-11 HDPE)
- ― WELL BLANK CASING (6-INCH SDR-11 HDPE)
- ▭ FORD PROPERTY BOUNDARY

NOTES:
µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

TOTAL CHLORINATED VOLATILE ORGANIC COMPOUNDS (CVOCs) INCLUDE: 1,1,1-TRICHLOROETHANE, 1,1-DICHLOROETHENE, 1,2-DICHLOROETHANE, CIS-1,2-DICHLOROETHENE, TRANS-1,2-DICHLOROETHENE, TRICHLOROETHENE, AND VINYL CHLORIDE

NORMALIZATION OF DATA IS COMPLETED BY DIVIDING EACH COMPOUND BY THE RESPECTIVE DRINKING WATER CRITERIA AND ADDING THE RESULTS TOGETHER (VALUES LESS THAN 1 ARE IGNORED).

RESULTS ARE COMPARED TO STATE OF MICHIGAN PART 201 NONRESIDENTIAL DRINKING WATER CRITERIA (SEPT. 2016).

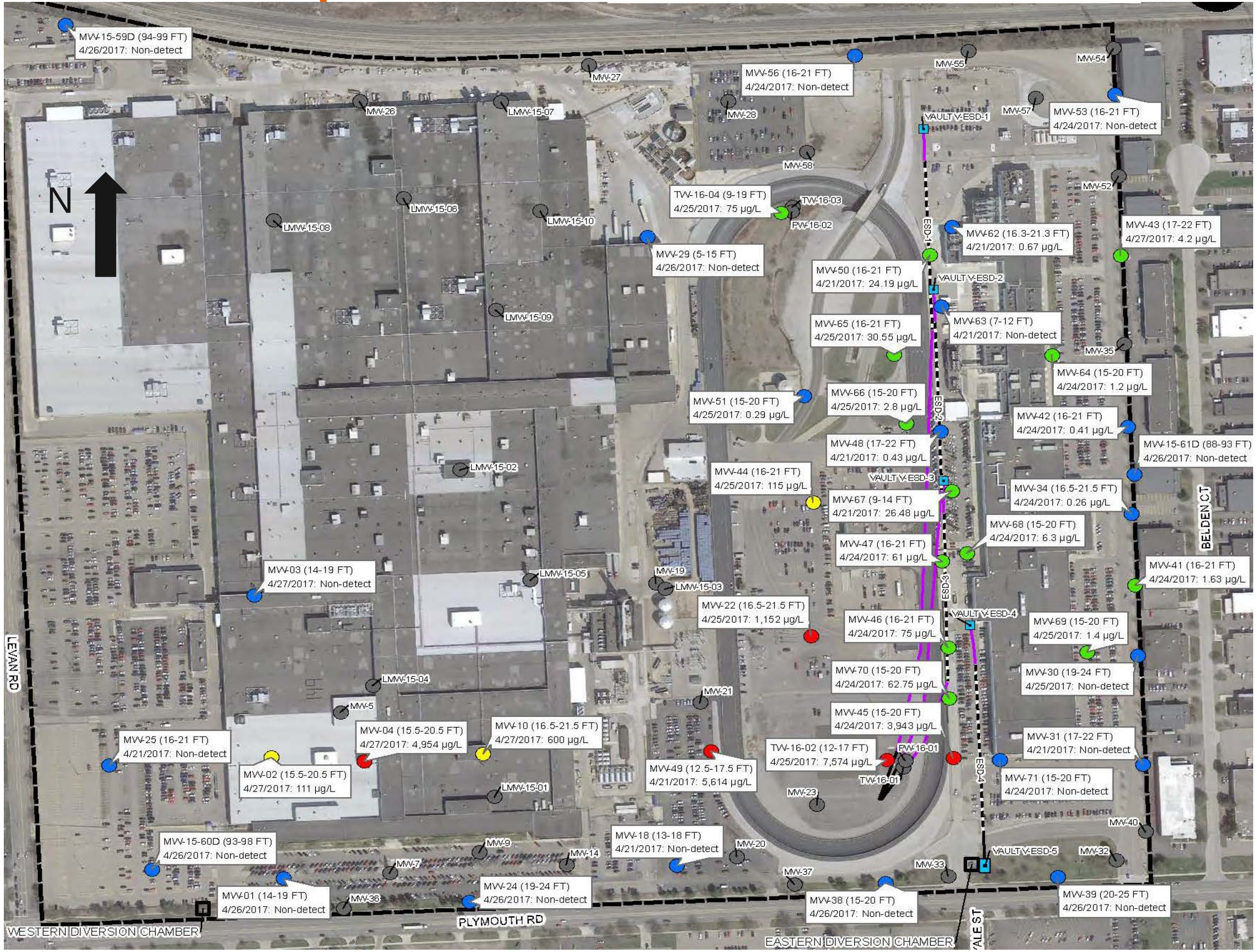
FT = FEET BELOW GROUND SURFACE

LMW = LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

MW = MONITORING WELL

NON-DETECT INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT, RANGING FROM <1.0 - 10 µg/L, FOR ALL CVOCs.

RESULTS COLLECTED DURING APRIL 2017 SAMPLING EVENT. ONLY WELLS SAMPLED ARE PRESENTED.



Groundwater TCE Impacts
RI Data – August 2016

LEGEND

TCE - GROUNDWATER

🔵 ND - 5 µg/L

🟢 5 - 100 µg/L

🟡 100 - 1000 µg/L

🔴 >1000 µg/L

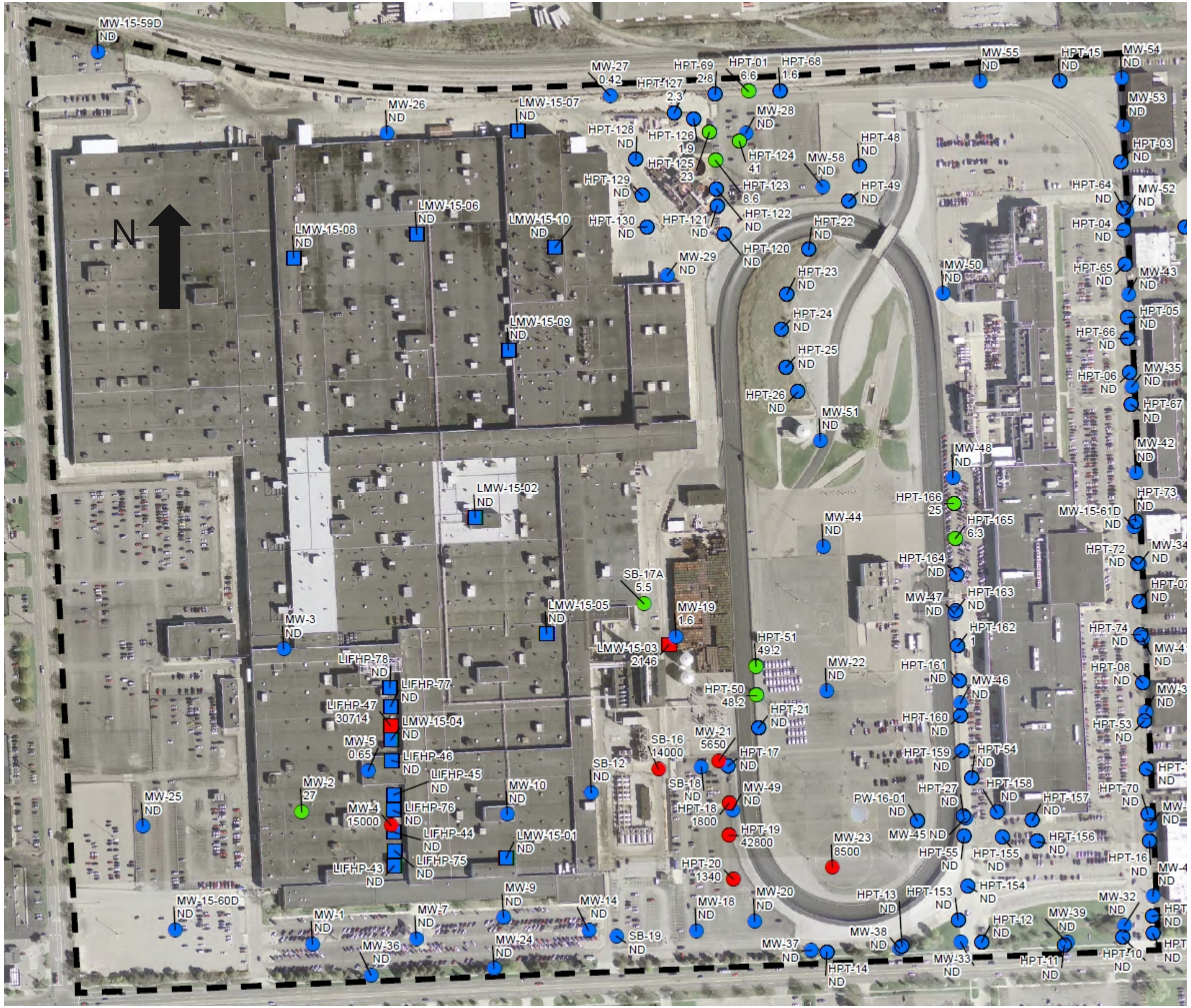
TCE - EQUIVALENT GROUNDWATER

🟦 ND - 5 µg/L

🟩 5 - 100 µg/L

🟨 100 - 1000 µg/L

🟥 >1000 µg/L



NOTE:

VALUES PROVIDED IN MICROGRAMS PER LITER (µg/L)

EQUIVALENT GROUNDWATER CONCENTRATIONS ARE DETERMINED FOR SATURATED SOIL SAMPLES BY CALCULATIING THE SOIL TO GROUNDWATER PARTITIONING VALUE FOR THE SPECIFIC COMPOUND.

HPT BORINGS INCLUDE UP TO 5 VERTICAL AQUIFER PROFILE GROUNDWATER SAMPLES. ONLY THE MAXIMUM DETECTED VALUE IS PRESENTED ON THE FIGURE. LIKEWISE ONLY THE MAXIMMUM VALUE FOR SATURATED SOIL/EQUIVALENT GROUNDWATER ARE PRESENTED FOR EACH SOIL BORING COMPLETED BENEATH THE LTP BUILDING.

Groundwater Monitoring Event

TCE – April 2017

LEGEND

🟢 ON-SITE MONITORING WELL TRICHLOROETHENE ≤ 5 µg/L

🔵 ON-SITE MONITORING WELL TRICHLOROETHENE > 5 µg/L

● WELL NOT SAMPLED

▪ VAULT (2 FT x 2 FT)

▪ VAULT (4 FT x 6 FT)

- - - - WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)

— WELL BLANK CASING (4-INCH SDR-11 HDPE)

— WELL BLANK CASING (6-INCH SDR-11 HDPE)

▭ FORD PROPERTY BOUNDARY

NOTES:

µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

THE NONRESIDENTIAL DRINKING WATER CRITERIA FOR TRICHLOROETHENE IS 5.0 µg/L.

THE GROUNDWATER-SURFACE WATER INTERFACE CRITERIA FOR TRICHLOROETHENE IS 200 µg/L.

FT = FEET BELOW GROUND SURFACE

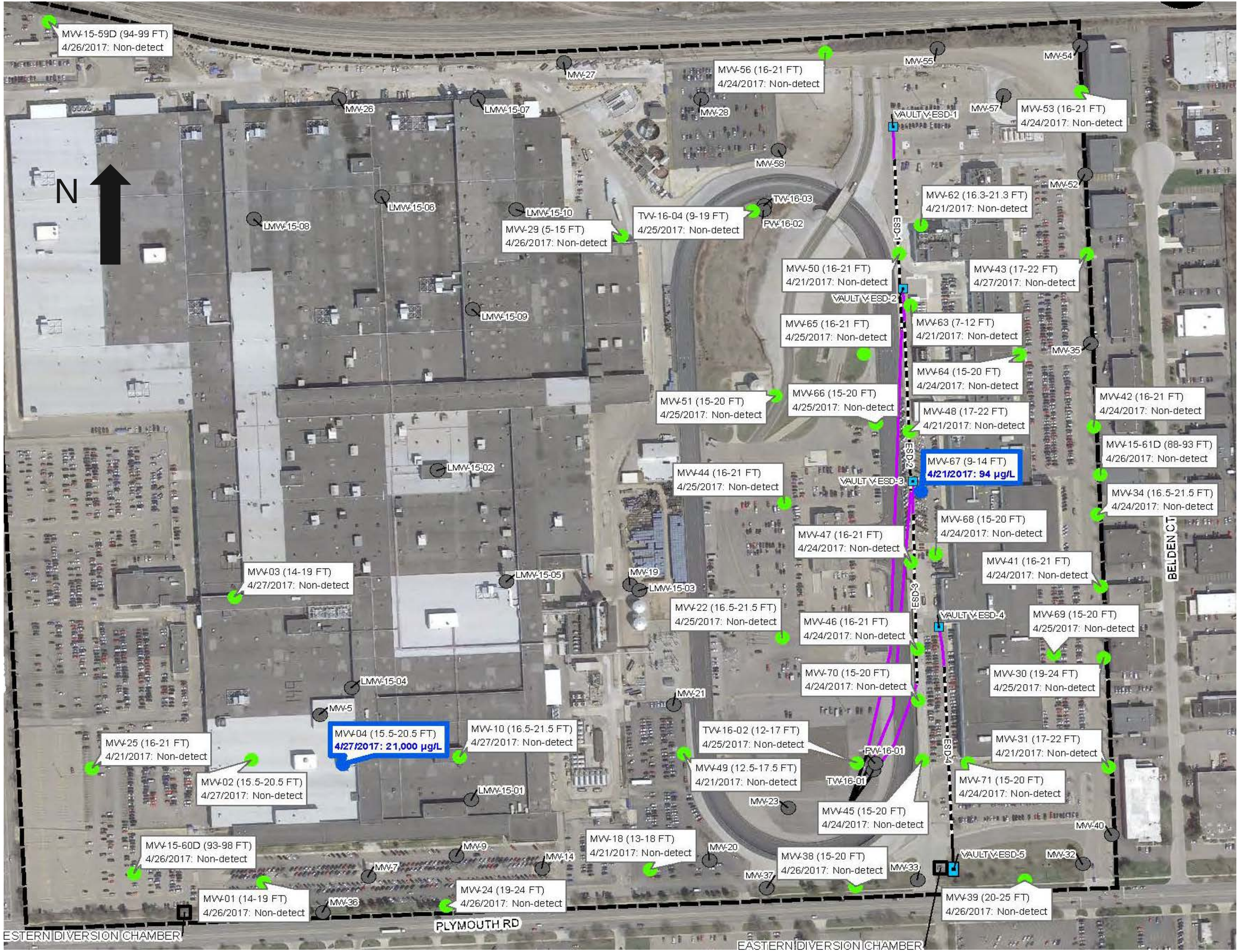
"NON-DETECT" INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT OF 1.0 µg/L FOR TRICHLOROETHENE

MW = MONITORING WELL

LMW = LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

RESULTS COLLECTED DURING THE APRIL 2017 SAMPLING EVENT.

BLUE BOX INDICATES EXCEEDANCE OF NONRESIDENTIAL DRINKING WATER CRITERIA



Total DCE

RI Data – August 2016

LEGEND

DCE - GROUNDWATER

- 🔵 ND - 70 µg/L
- 🟢 70 - 100 µg/L
- 🟡 100 - 1000 µg/L
- 🔴 >1000 µg/L

DCE - EQUIVALENT GROUNDWATER

- 🟦 ND - 70 µg/L
- 🟩 70 - 100 µg/L
- 🟨 100 - 1000 µg/L
- 🟥 >1000 µg/L
- ▭ PROPERTY BOUNDARIES
- ▭ FORD PROPERTY BOUNDARY

NOTE:

VALUES PROVIDED IN MICROGRAMS PER LITER (µg/L)

MUCH OF THE 2015-2016 RI INVESTIGATION WAS COMPLETING WITH A MOBILE LAB USING DSITMS (METHOD 8265). THIS METHOD PRODUCES A COMBINED DCE VALUE INCLUDING TRANS-1,2-DCE, 1,1-DCE AND CIS-1,2-DCE. HOWEVER, SUBSEQUENT SAMPLING INDICATES THE MAJORITY OF DCE CONSISTS OF CIS-1,2-DCE

EQUIVALENT GROUNDWATER CONCENTRATIONS ARE DETERMINED FOR SATURATED SOIL SAMPLES BY CALCULATIING THE SOIL TO GROUNDWATER PARTITIONING VALUE FOR THE SPECIFIC COMPOUND.

HPT BORINGS INCLUDE UP TO 5 VERTICAL AQUIFER PROFILE GROUNDWATER SAMPLES. ONLY THE MAXIMUM DETECTED VALUE IS PRESENTED ON THE FIGURE. LIKEWISE ONLY THE MAXIMMUM VALUE FOR SATURATED SOIL/EQUIVALENT GROUNDWATER ARE PRESENTED FOR EACH SOIL BORING COMPLETED BENEATH THE LTP BUILDING.

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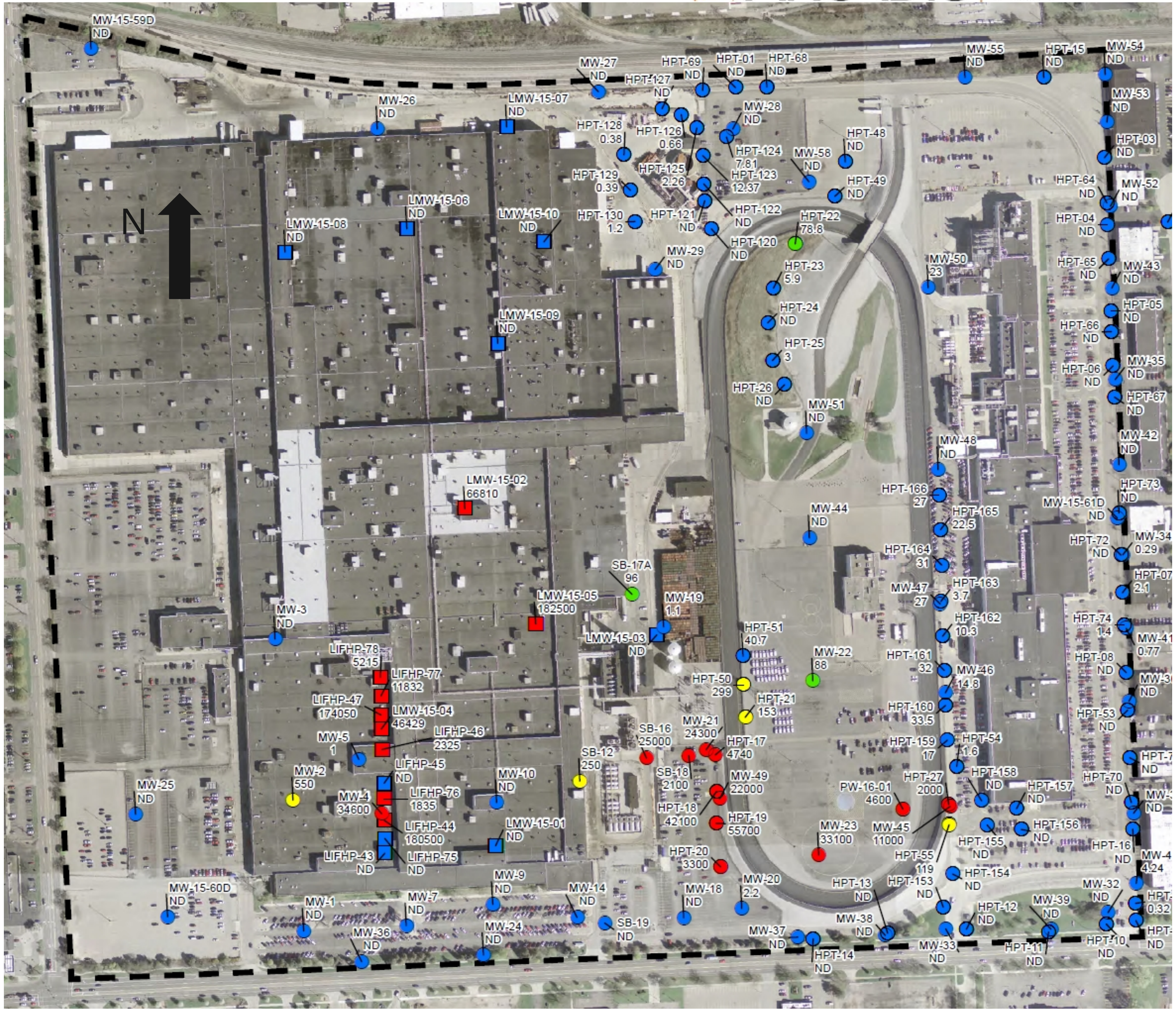


Groundwater Monitoring Event
cis-1,2-DCE – April 2017

ARCADIS Design & Consultancy for natural and built assets

LEGEND

- 🟢 ON-SITE MONITORING WELL CIS-1,2-DICHLOROETHENE ≤ 70 µg/L
- 🔵 ON-SITE MONITORING WELL CIS-1,2-DICHLOROETHENE > 70 µg/L
- ● WELL NOT SAMPLED
- ▣ VAULT (2 FT x 2 FT)
- ▣ VAULT (4 FT x 6 FT)
- - - - WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)
- — WELL BLANK CASING (4-INCH SDR-11 HDPE)
- — WELL BLANK CASING (6-INCH SDR-11 HDPE)
- ▭ FORD PROPERTY BOUNDARY

NOTES:

µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

THE NONRESIDENTIAL DRINKING WATER CRITERIA FOI CIS-1,2-DICHLOROETHENE IS 70 µg/L.

THE GROUNDWATER-SURFACE WATER INTERFACE CRITERIA FOR CIS-1,2-DICHLOROETHENE IS 620 µg/L.

FT = FEET BELOW GROUND SURFACE

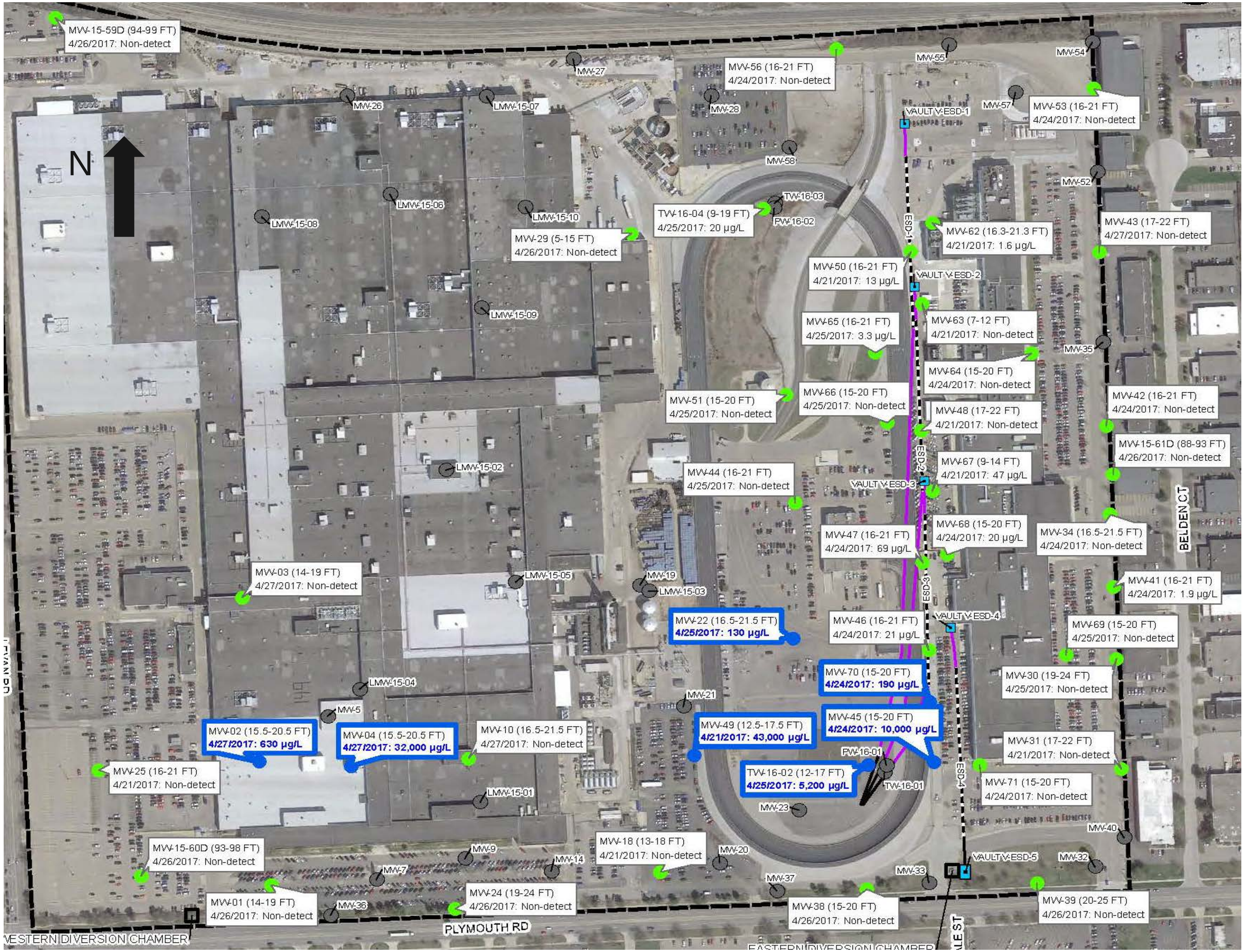
"NON-DETECT" INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT OF 1.0 µg/L FOR CIS-1,2-DICHLOROETHENE

MW = MONITORING WELL

LMW = LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

RESULTS COLLECTED DURING THE APRIL 2017 SAMPLING EVENT.

BLUE BOX INDICATES EXCEEDANCE OF NONRESIDENTIAL DRINKING WATER CRITERIA



Vinyl Chloride

RI Data – August 2016

LEGEND

VINYL CHLORIDE - GROUNDWATER

- 🔵 ND - 2 µg/L
- 🟢 2 - 100 µg/L
- 🟡 100 - 1000 µg/L
- 🔴 >1000 µg/L

VINYL CHLORIDE - EQUIVALENT GROUNDWATER

- 🟦 ND - 2 µg/L
- 🟩 2 - 100 µg/L
- 🟨 100 - 1000 µg/L
- 🟥 >1000 µg/L

NOTE:

VALUES PROVIDED IN MICROGRAMS PER LITER (µg/L)

EQUIVALENT GROUNDWATER CONCENTRATIONS ARE DETERMINED FOR SATURATED SOIL SAMPLES BY CALCULATIING THE SOIL TO GROUNDWATER PARTITIONING VALUE FOR THE SPECIFIC COMPOUND.

HPT BORINGS INCLUDE UP TO 5 VERTICAL AQUIFER PROFILE GROUNDWATER SAMPLES. ONLY THE MAXIMUM DETECTED VALUE IS PRESENTED ON THE FIGURE. LIKEWISE ONLY THE MAXIMMUM VALUE FOR SATURATED SOIL/EQUIVALENT GROUNDWATER ARE PRESENTED FOR EACH SOIL BORING COMPLETED BENEATH THE LTP BUILDING.

Groundwater Monitoring Event
Vinyl Chloride – April 2017

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LEGEND

🟢	ON-SITE MONITORING WELL VINYL CHLORIDE ≤ 2.0 µg/L
🔵	ON-SITE MONITORING WELL VINYL CHLORIDE > 2.0 µg/L
⚫	WELL NOT SAMPLED
▣	VAULT (2 FT x 2 FT)
▣	VAULT (4 FT x 6 FT)
- - - -	WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)
──	WELL BLANK CASING (4-INCH SDR-11 HDPE)
──	WELL BLANK CASING (6-INCH SDR-11 HDPE)
⬚	FORD PROPERTY BOUNDARY

NOTES:

µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

THE NONRESIDENTIAL DRINKING WATER CRITERIA FOR VINYL CHLORIDE IS 2.0 µg/L.

THE GROUNDWATER-SURFACE WATER INTERFACE CRITERIA FOR VINYL CHLORIDE IS 13 µg/L.

FT = FEET BELOW GROUND SURFACE

"NON-DETECT" INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT OF 1.0 µg/L FOR VINYL CHLORIDE

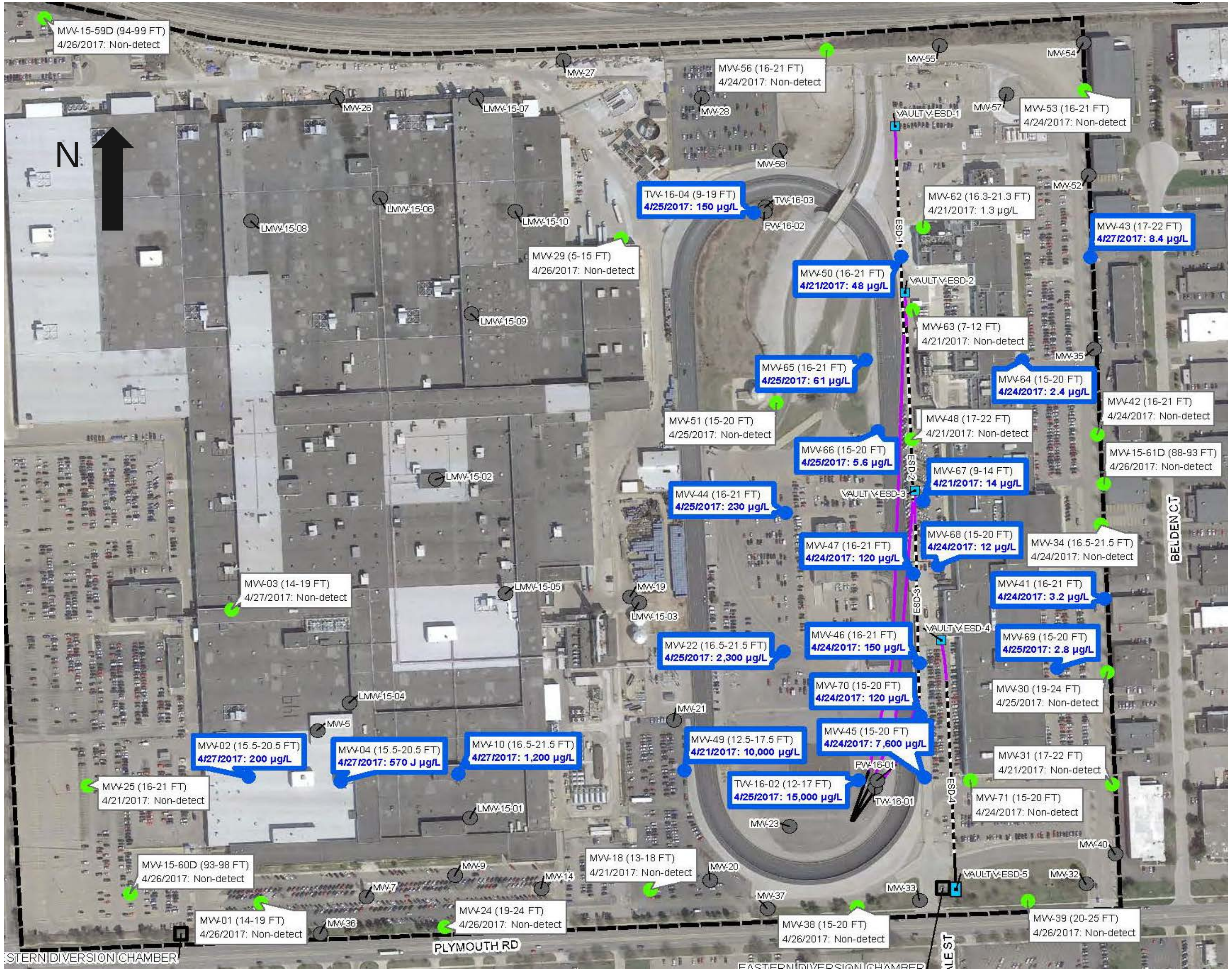
J = ESTIMATED RESULT

MW = MONITORING WELL

LMW = LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

RESULTS COLLECTED DURING THE APRIL 2017 SAMPLING EVENT.

BLUE BOX INDICATES EXCEEDANCE OF NONRESIDENTIAL DRINKING WATER CRITERIA



Groundwater Monitoring Event

1,4-Dioxane – April 2017

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LEGEND

🟢	ON-SITE MONITORING WELL 1,4-DIOXANE ≤ 350 µg/L
⚫	WELL NOT SAMPLED
🟦	VAULT (2 FT x 2 FT)
🟦	VAULT (4 FT x 6 FT)
- - - -	WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)
━	WELL BLANK CASING (4-INCH SDR-11 HDPE)
—	WELL BLANK CASING (6-INCH SDR-11 HDPE)
⬚	FORD PROPERTY BOUNDARY

NOTES:

µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

THE NONRESIDENTIAL DRINKING WATER CRITERIA FOR 1,4-DIOXANE IS 350 µg/L.

THE GROUNDWATER-SURFACE WATER INTERFACE CRITERIA FOR 1,4-DIOXANE IS 2,800 µg/L.

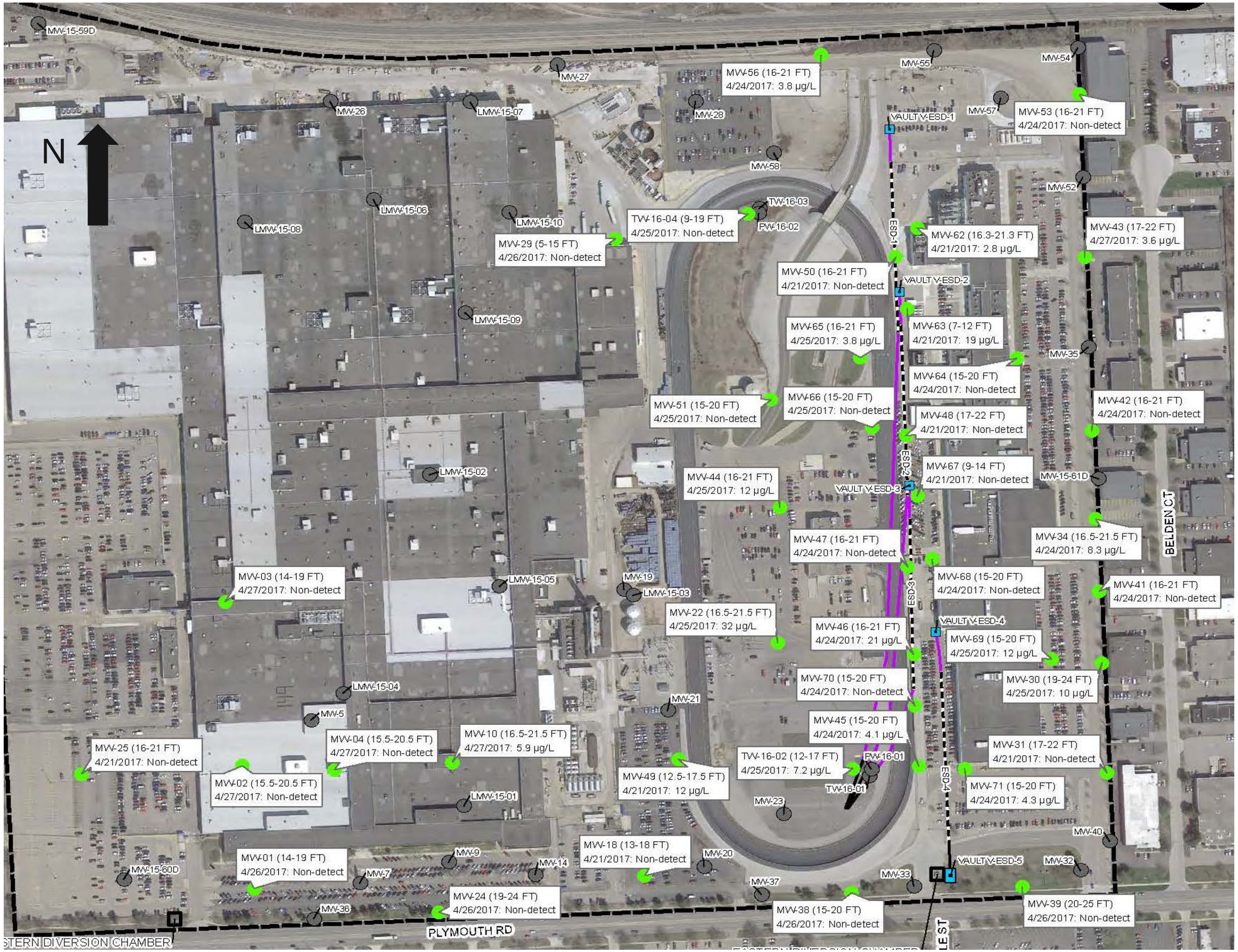
FT = FEET BELOW GROUND SURFACE

"NON-DETECT" INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT OF 2.0 µg/L FOR 1,4-DIOXANE

MW = MONITORING WELL

LMW = LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

RESULTS COLLECTED DURING THE APRIL 2017 SAMPLING EVENT.



Stratigraphic Flux Model

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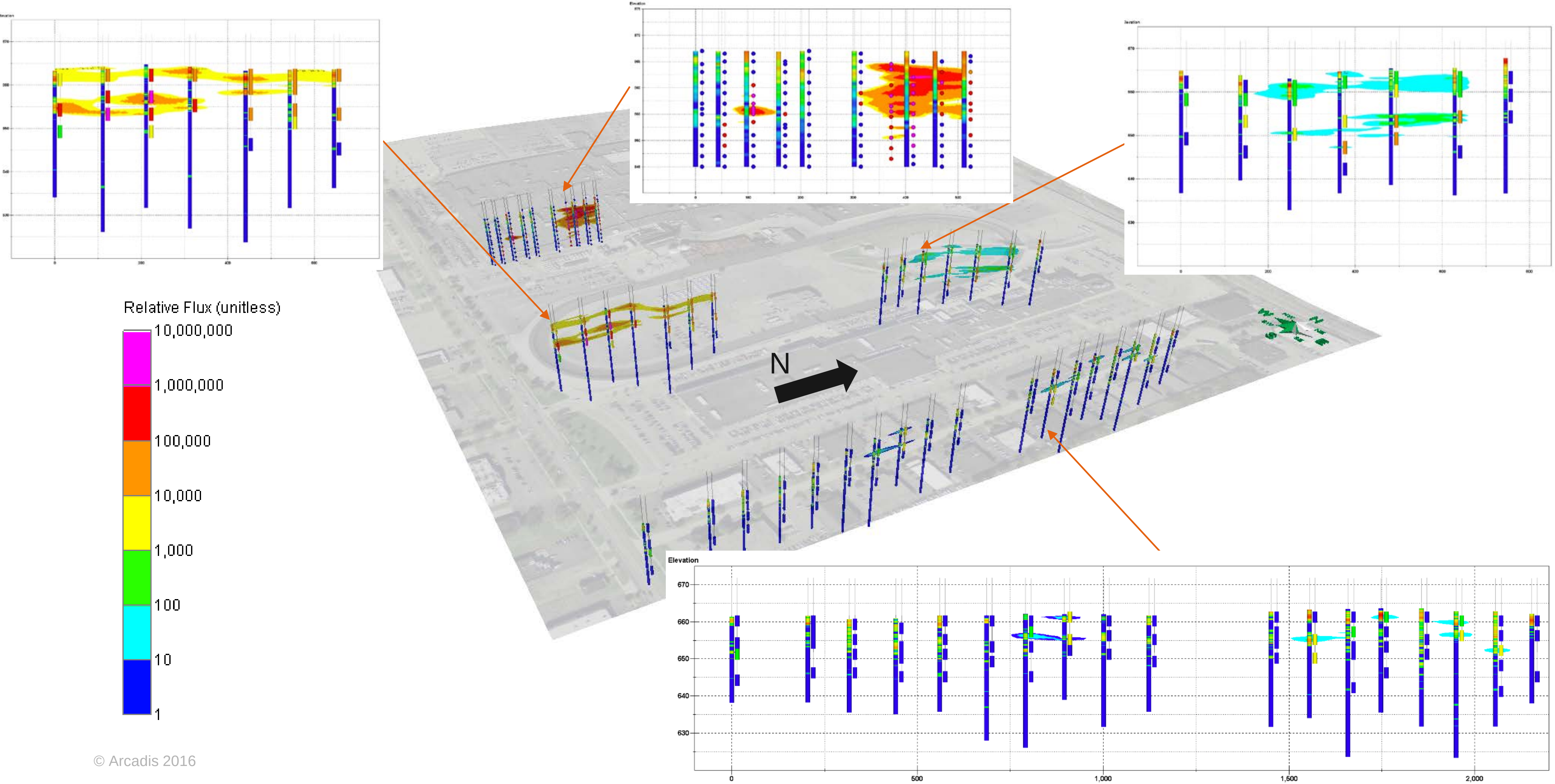
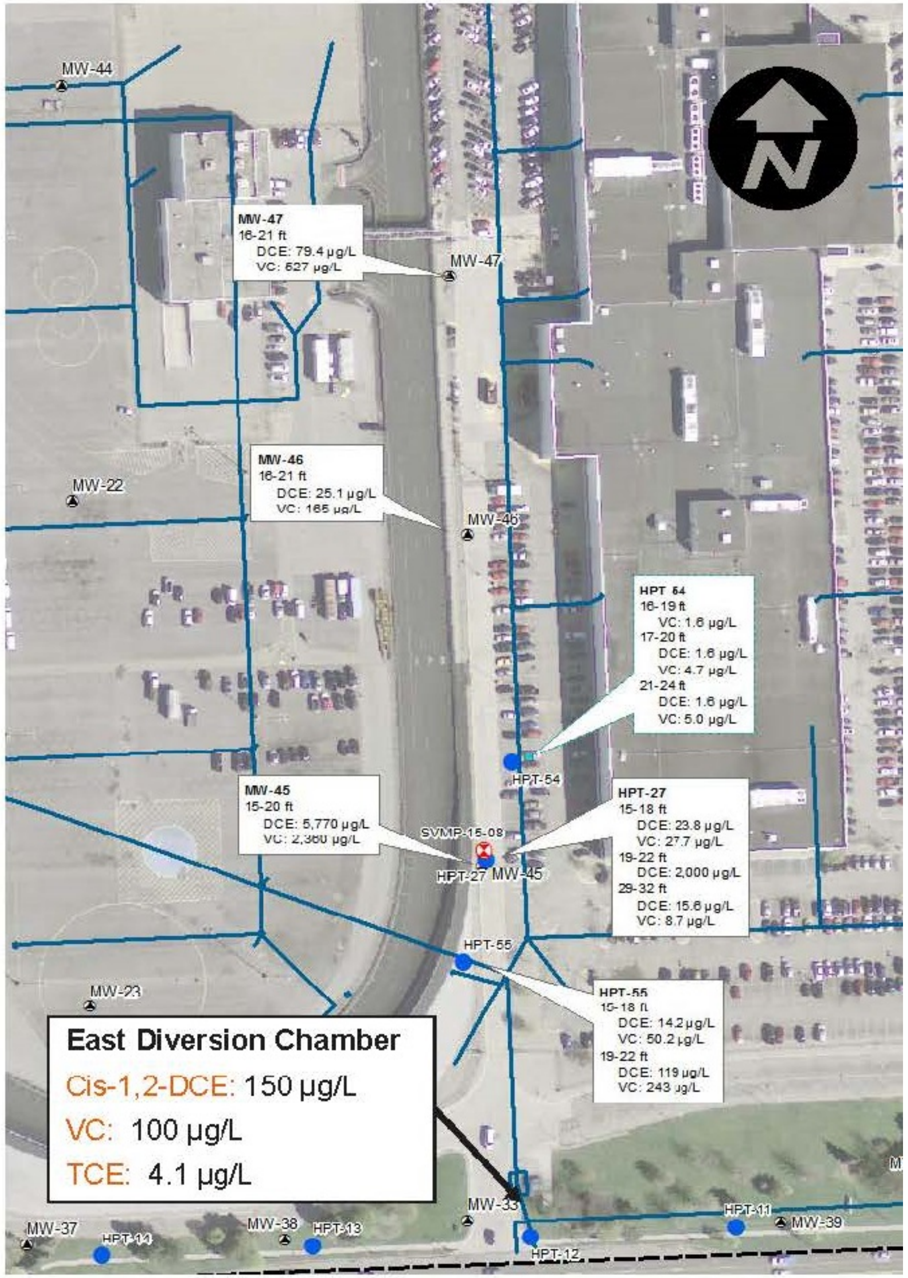


Discharge to Eastern Storm Main

Based on the distribution of VOCs and groundwater low identified near MW-45 on the southern portion of the Site, the eastern storm main was identified as receiving the bulk of VOCs migrating east of the LTP building

- Groundwater plume at 8 ppm total VOCs west of storm main, diminishes to the east
- Storm water discharges to sanitary sewer, under base flow conditions
- Permit 006-27510-IU issued by Great Lakes Water Authority on March 23, 2017
- Groundwater low around MW-45 area



LEGEND

● HPT-VAP BORING
⊗ SOIL VAPOR SAMPLING LOCATION
▲ EXISTING MONITORING WELLS
— STORM SEWER
⬚ APPROXIMATE PROPERTY BOUNDARY

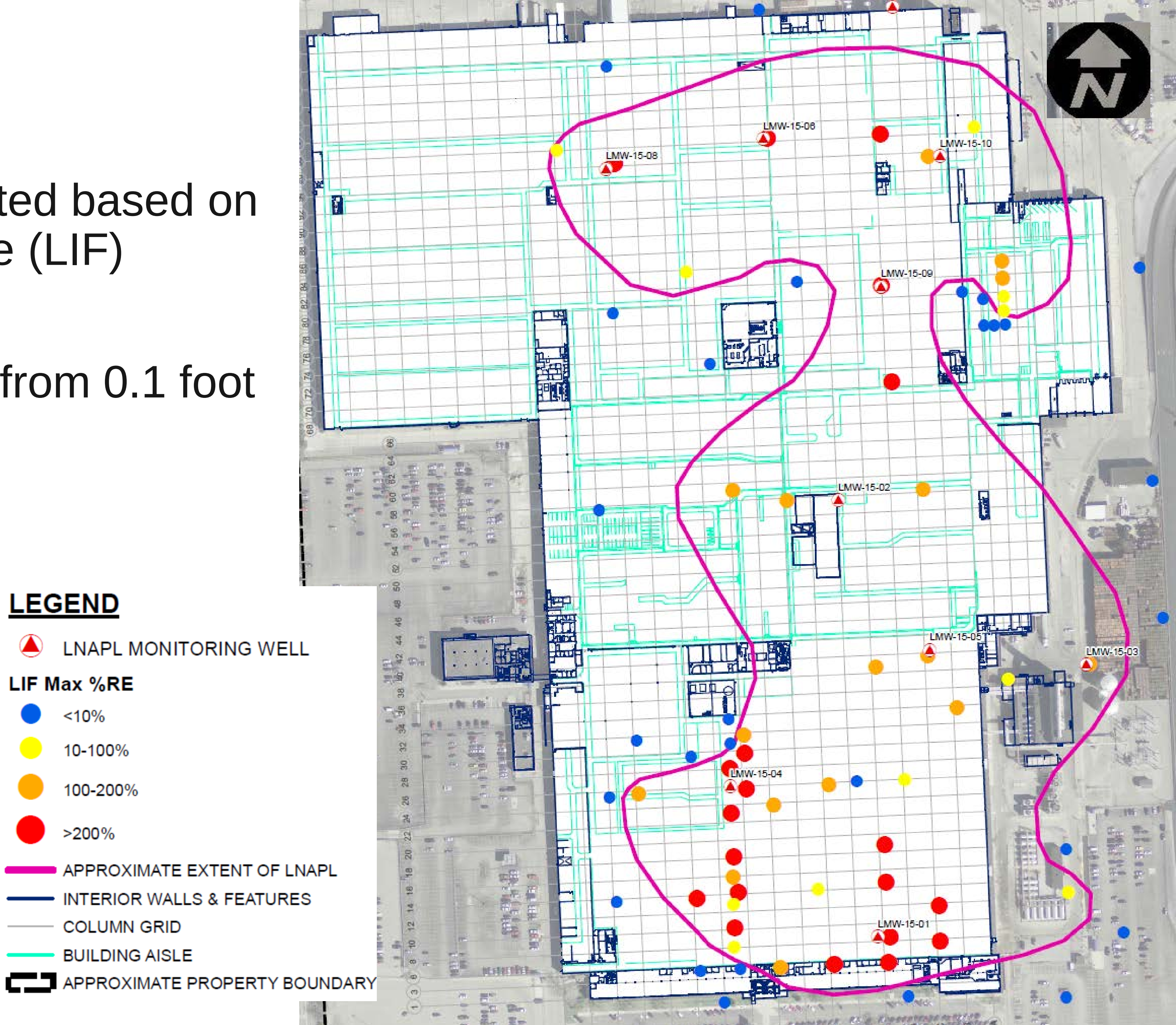
LNAPL Characterization

LNAPL Delination

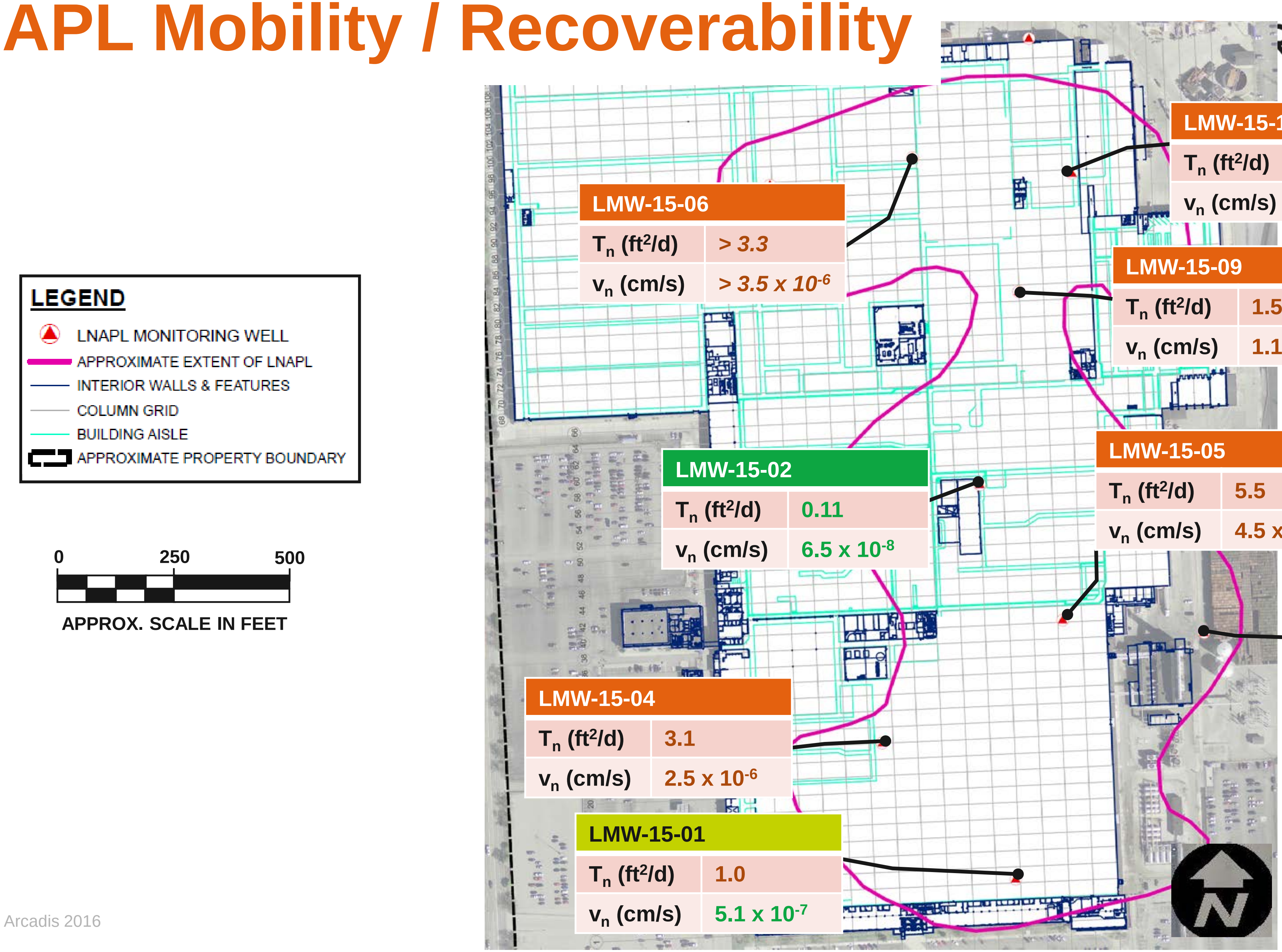
Extents of LNAPL interpreted based on laser-induced fluorescence (LIF) investigations

Gauged thickness ranges from 0.1 foot to 3.0 feet

- 0.1 feet at LMW-15-07 & 08
- 3.0 feet at LMW-15-01



LNAPL Mobility / Recoverability



LMW-15-10	
T_n (ft^2/d)	2.1
v_n (cm/s)	6.5 x 10^{-6}

LMW-15-06	
T_n (ft^2/d)	*> 3.3*
v_n (cm/s)	*> 3.5 x 10^{-6}*

LMW-15-09	
T_n (ft^2/d)	1.5
v_n (cm/s)	1.1 x 10^{-6}

LMW-15-05	
T_n (ft^2/d)	5.5
v_n (cm/s)	4.5 x 10^{-6}

LMW-15-02	
T_n (ft^2/d)	0.11
v_n (cm/s)	6.5 x 10^{-8}

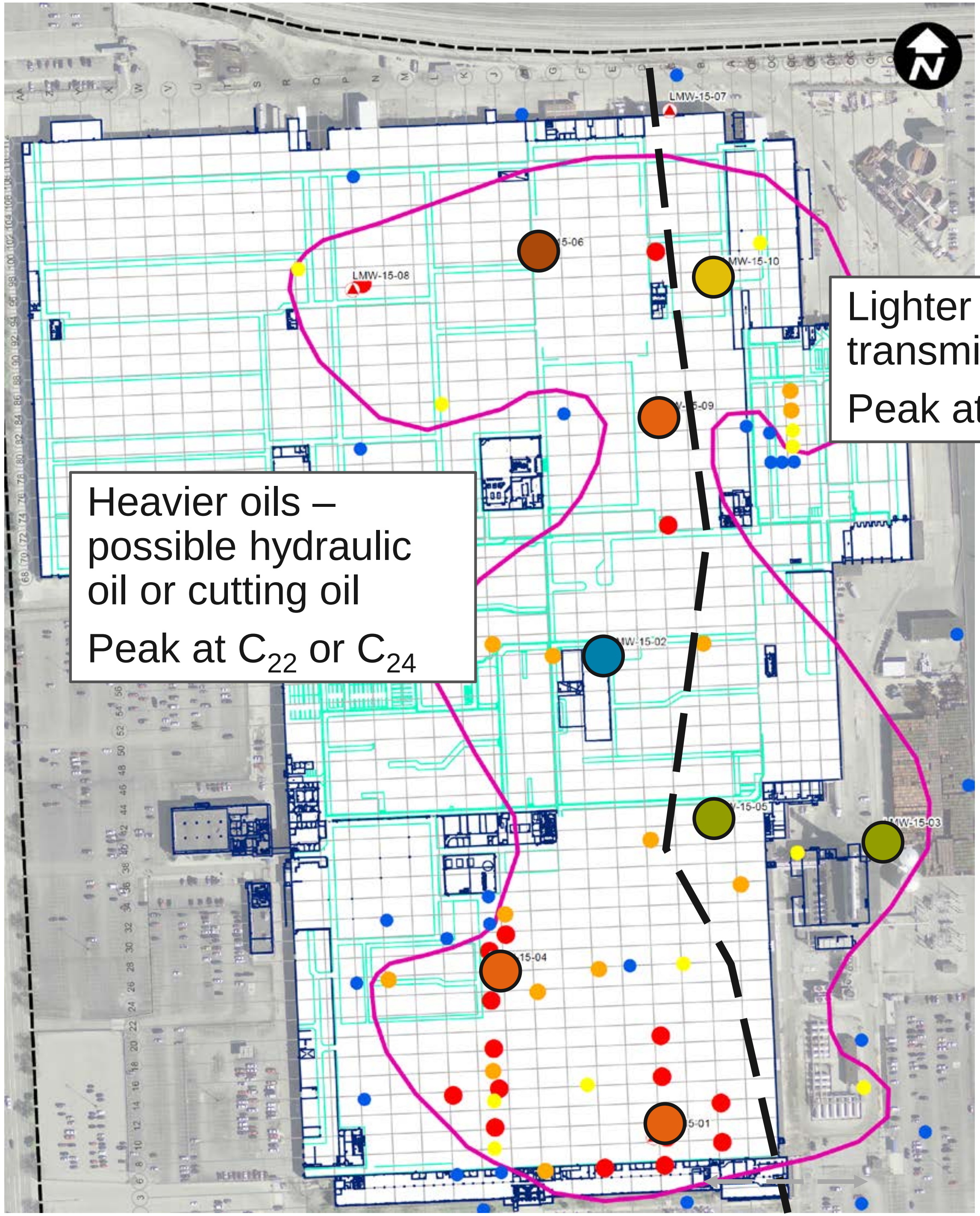
LMW-15-03	
T_n (ft^2/d)	*> 0.64*
v_n (cm/s)	*> 5.5 x 10^{-7}*

LMW-15-04	
T_n (ft^2/d)	3.1
v_n (cm/s)	2.5 x 10^{-6}

LMW-15-01	
T_n (ft^2/d)	1.0
v_n (cm/s)	5.1 x 10^{-7}

LNAPL Forensics

LNAPL composition was evaluated using PIANO forensic analysis of oil samples



Heavier oils – possible hydraulic oil or cutting oil

Peak at C_{22} or C_{24}

Lighter oils – possible transmission oil

Peak at C_{18} or C_{19}

LEGEND

▲ LNAPL MONITORING WELL

LIF Max %RE

- ● <10%
- ● 10-100%
- ● 100-200%
- ● >200%

— APPROXIMATE EXTENT OF LNAPL

— INTERIOR WALLS & FEATURES

— COLUMN GRID

— BUILDING AISLE

- ● Possible transmission oil, weathered. Peak at C_{18}
- ● Possible transmission oil, partially weathered. Peak at C_{19}
- ● Possible hydraulic oil or cutting oil, partially weathered. Peak at C_{22}
- ● Possible hydraulic oil or cutting oil, unweathered. Peak at C_{22}
- ● Possible hydraulic oil or cutting oil, partially weathered. Peak at C_{24}
- \ Theoretical divide between lighter and heavier oils

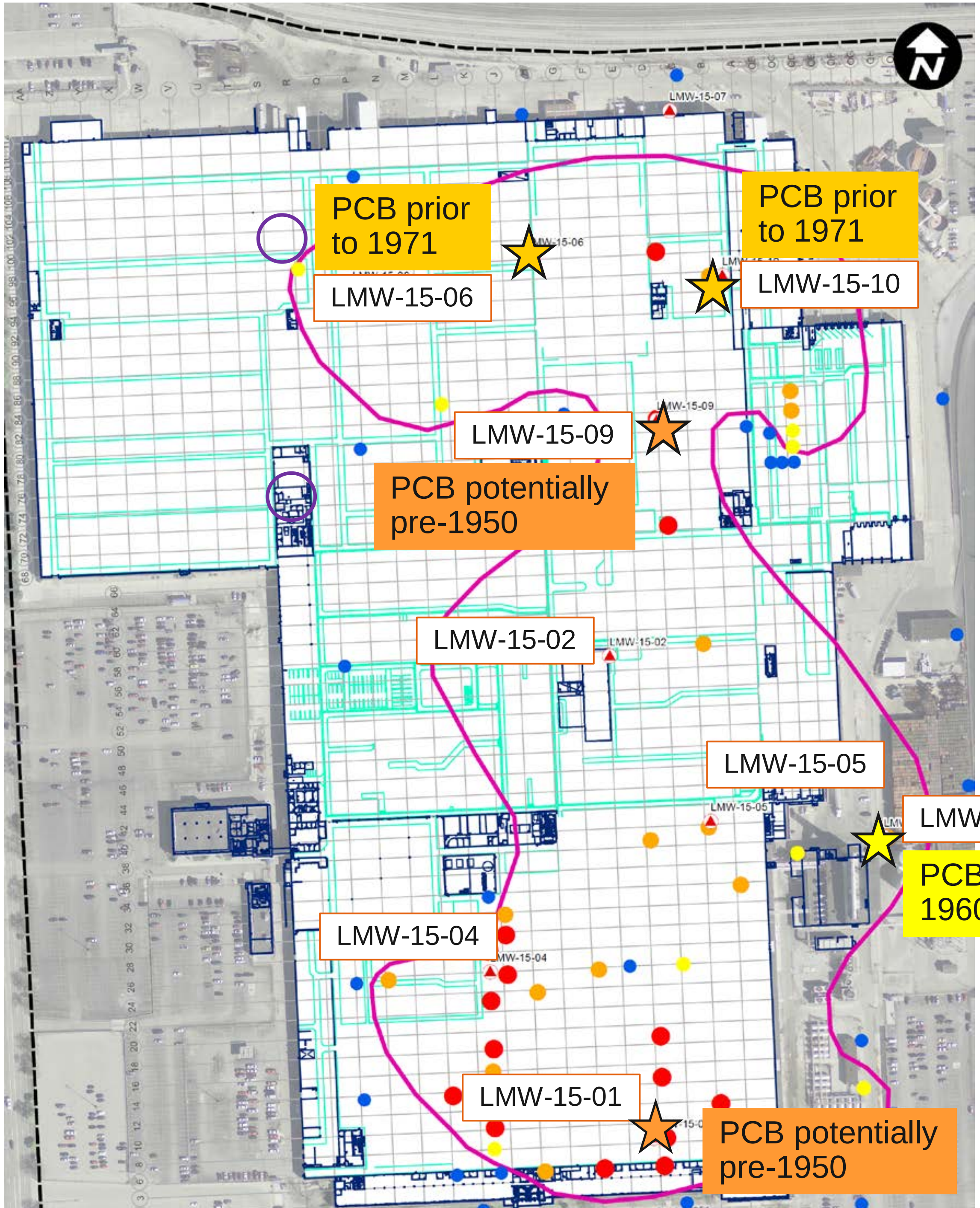
LNAPL PCBs

LEGEND

- ▲ LNAPL MONITORING WELL

LIF Max %RE

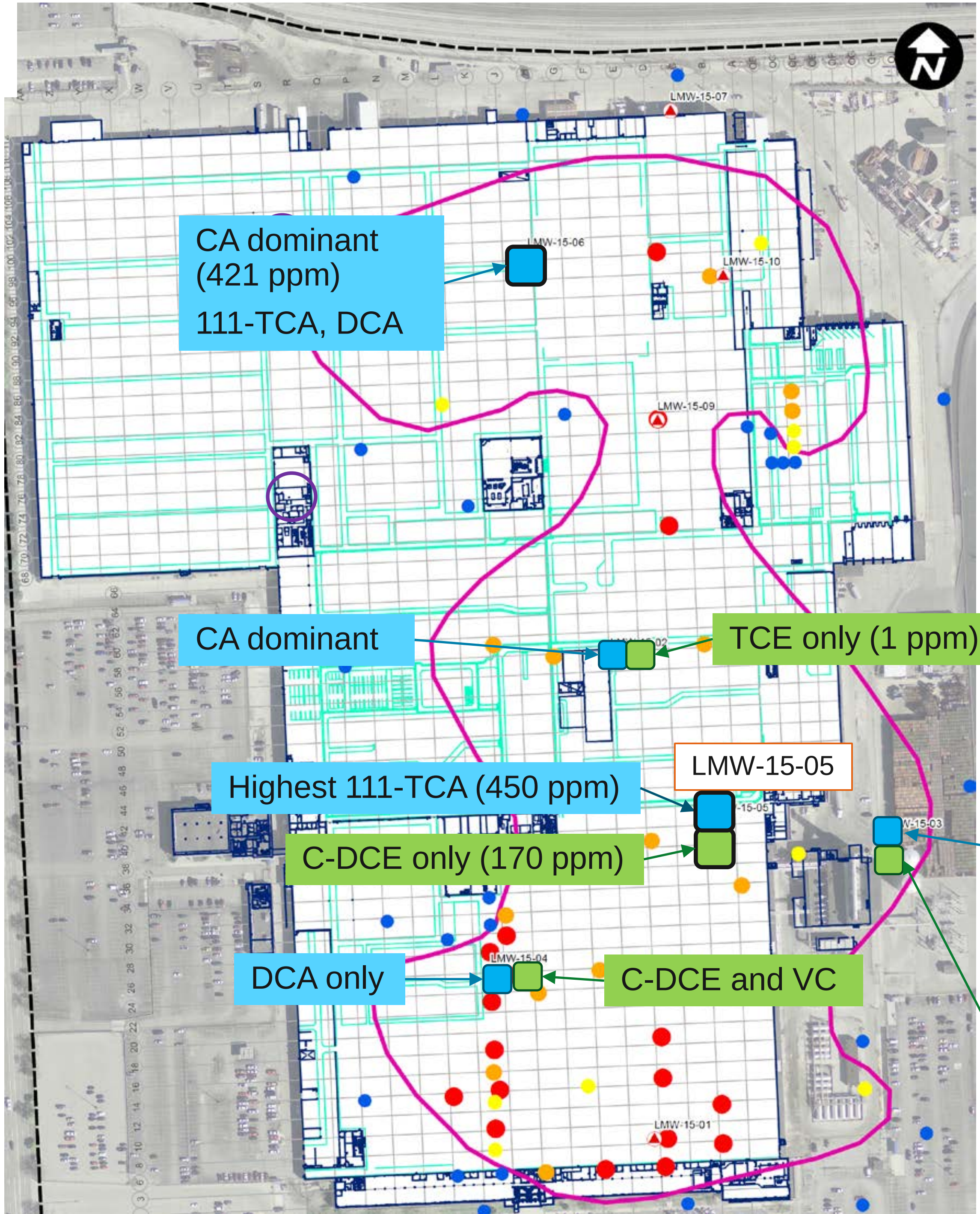
- ● <10%
- ● 10-100%
- ● 100-200%
- ● >200%
- ━ APPROXIMATE EXTENT OF LNAPL
- ━ INTERIOR WALLS & FEATURES
- ━ COLUMN GRID
- ━ BUILDING AISLE



- PCB concentrations in oil ≤ 5 ppm
- PCBs in oil have congeners that can be used to correlate era of oil manufacture
- PCBs may be inherent in oil, but no clear relation between PCB type and oil type

★ PCB-1242
★ PCB-1248
★ PCB-1260

VOCs in LNAPL



CA dominant (421 ppm)

111-TCA, DCA

CA dominant

TCE only (1 ppm)

LMW-15-05

Highest 111-TCA (450 ppm)

C-DCE only (170 ppm)

CA dominant

DCA only

C-DCE and VC

TCE (1 ppm) and degradation products

LEGEND

▲ LNAPL MONITORING WELL

LIF Max %RE

● <10%

● 10-100%

● 100-200%

● >200%

— APPROXIMATE EXTENT OF LNAPL

— INTERIOR WALLS & FEATURES

— COLUMN GRID

— BUILDING AISLE

- VOC concentrations in oil <0.1%
- Highest concentrations, at LMW-15-05
- Distribution of VOCs consistent with presence of southern plume
- Limited VOCs to the north

🟦 Chlorinated Ethanes

🟩 Chlorinated Ethenes

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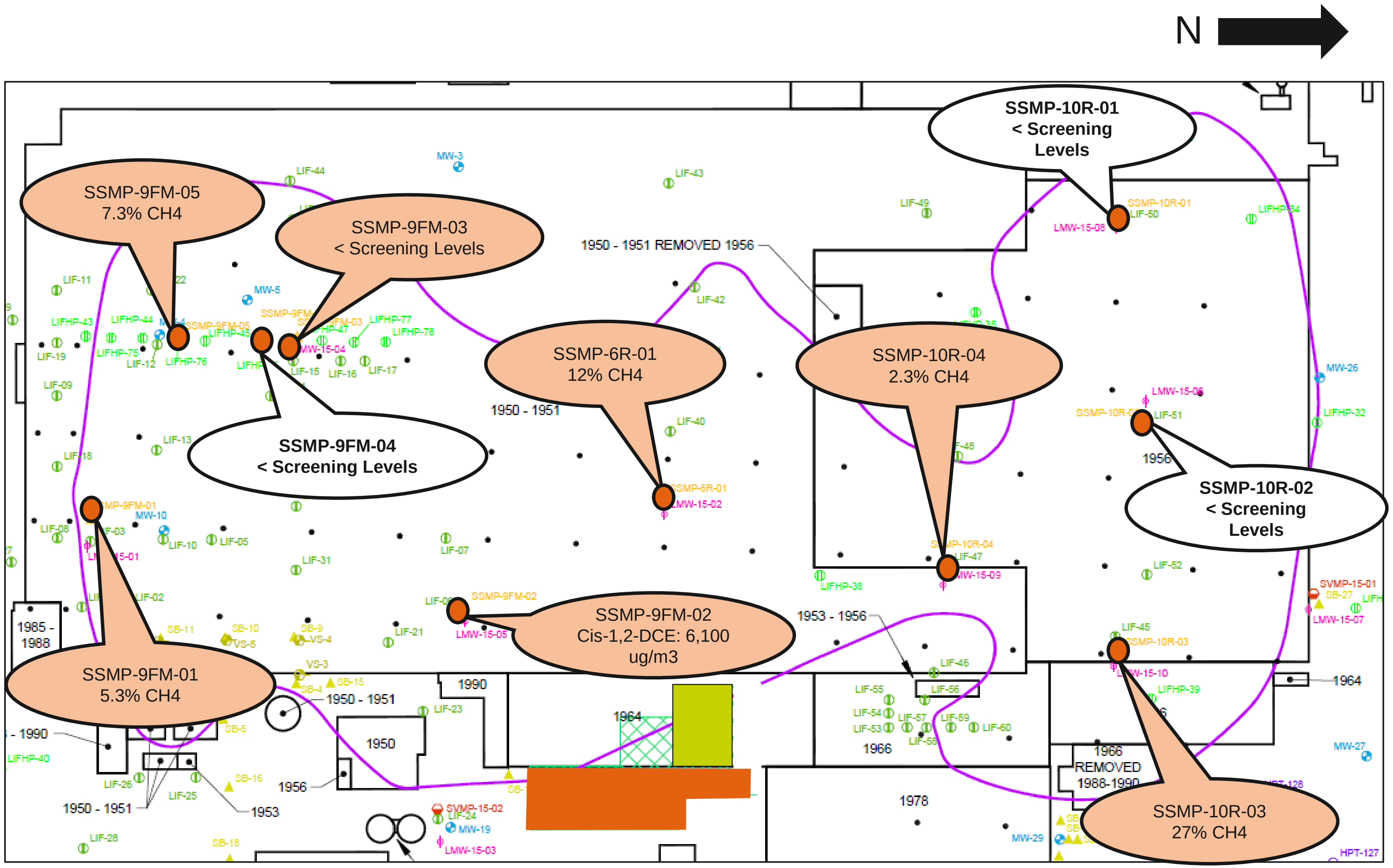
Sub-Slab Vapor and Methane Evaluation

Initial Sub-Slab Soil Vapor: 12/2015

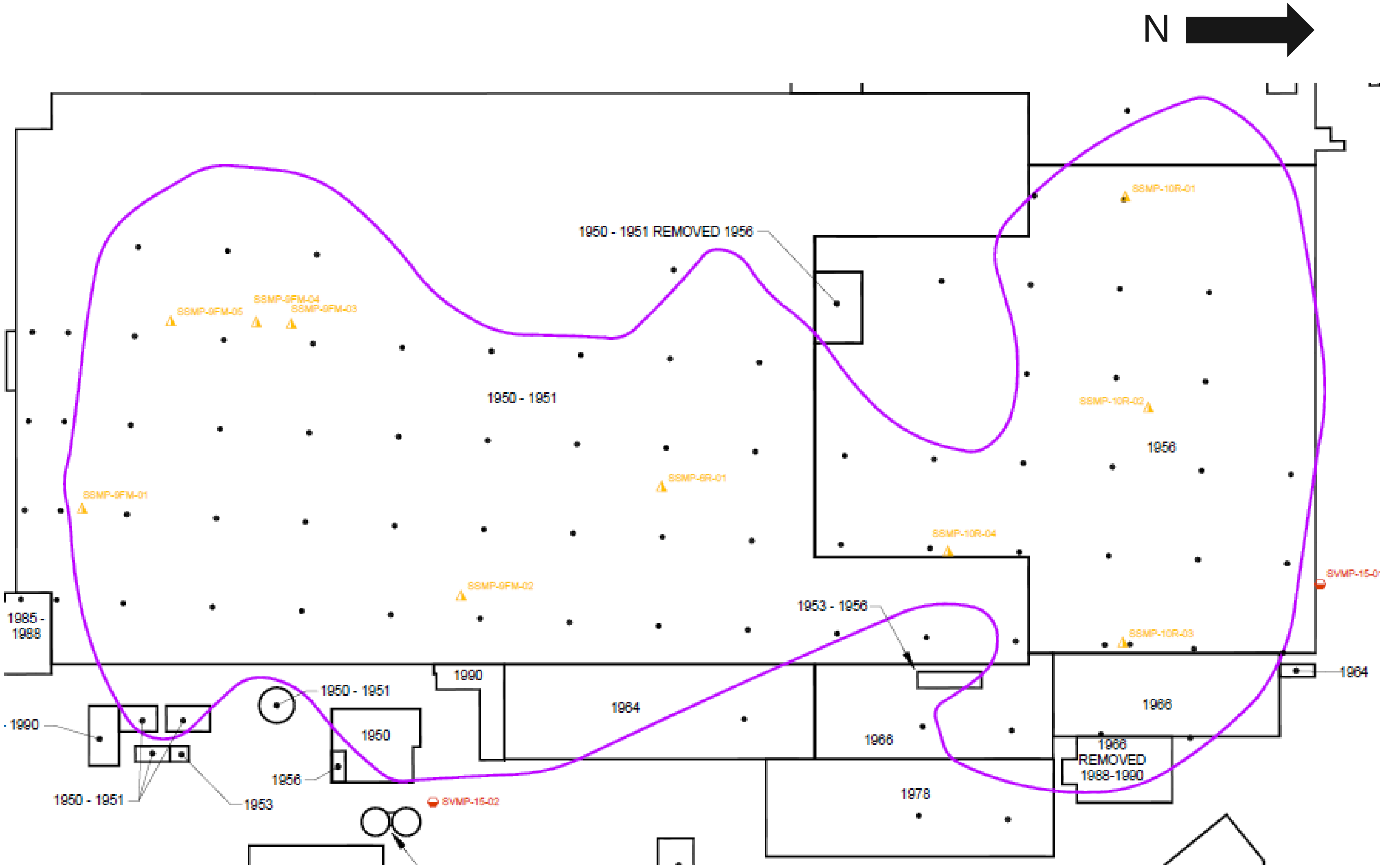
- 10 Sub-Slab soil vapor samples collected over LNAPL
  - Six results > methane criteria
  - One result > non-residential VI criteria for cis-1,2-DCE

Further investigation warranted



Comprehensive Soil Vapor Evaluation: June 7 – August 31, 2016

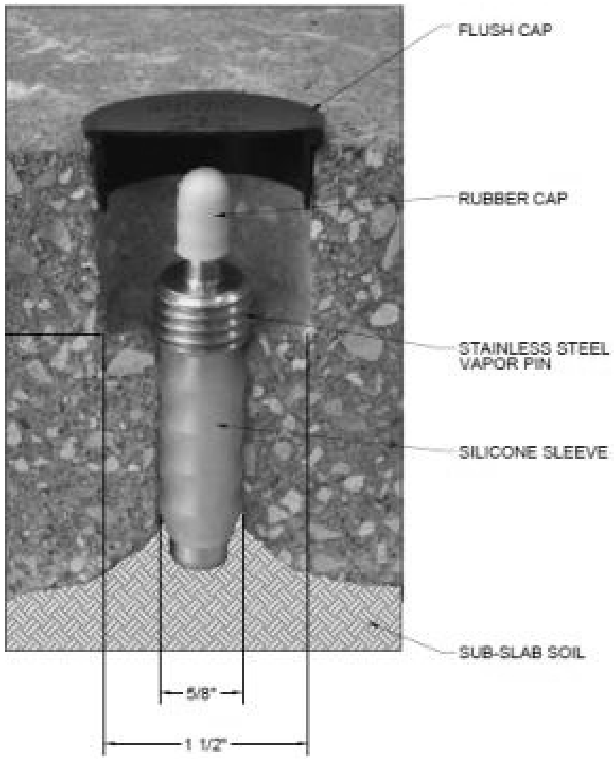
- 81 Samples collected based on LNAPL
- Field screened for CH_4 in real time
- Sampled for VOCs via sorbent tubes: USEPA Method TO-17



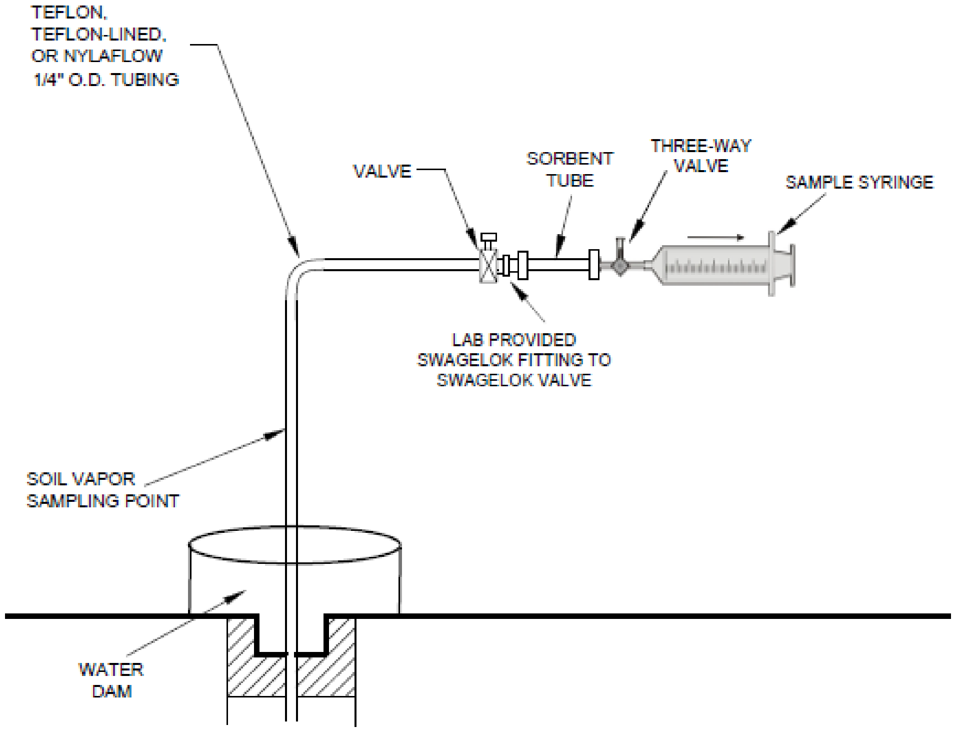
LEGEND:

- VAPOR POINTS

Sampling Methods - VOCs



Permanent, flush-mounted sample points installed through slab

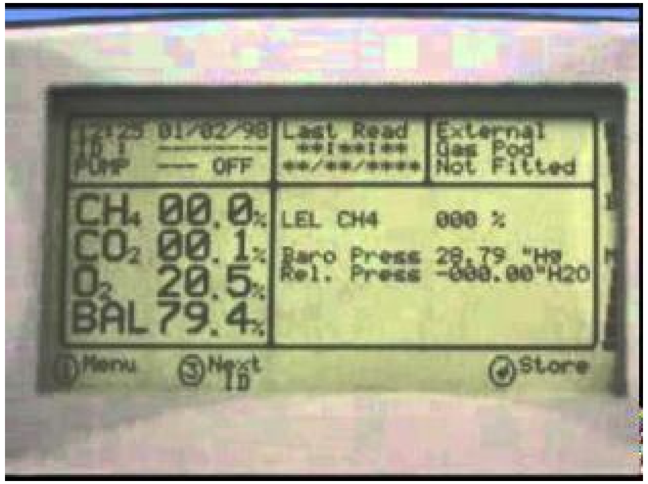


Each installation leak tested prior to use

VOC samples collected using sorbent tubes

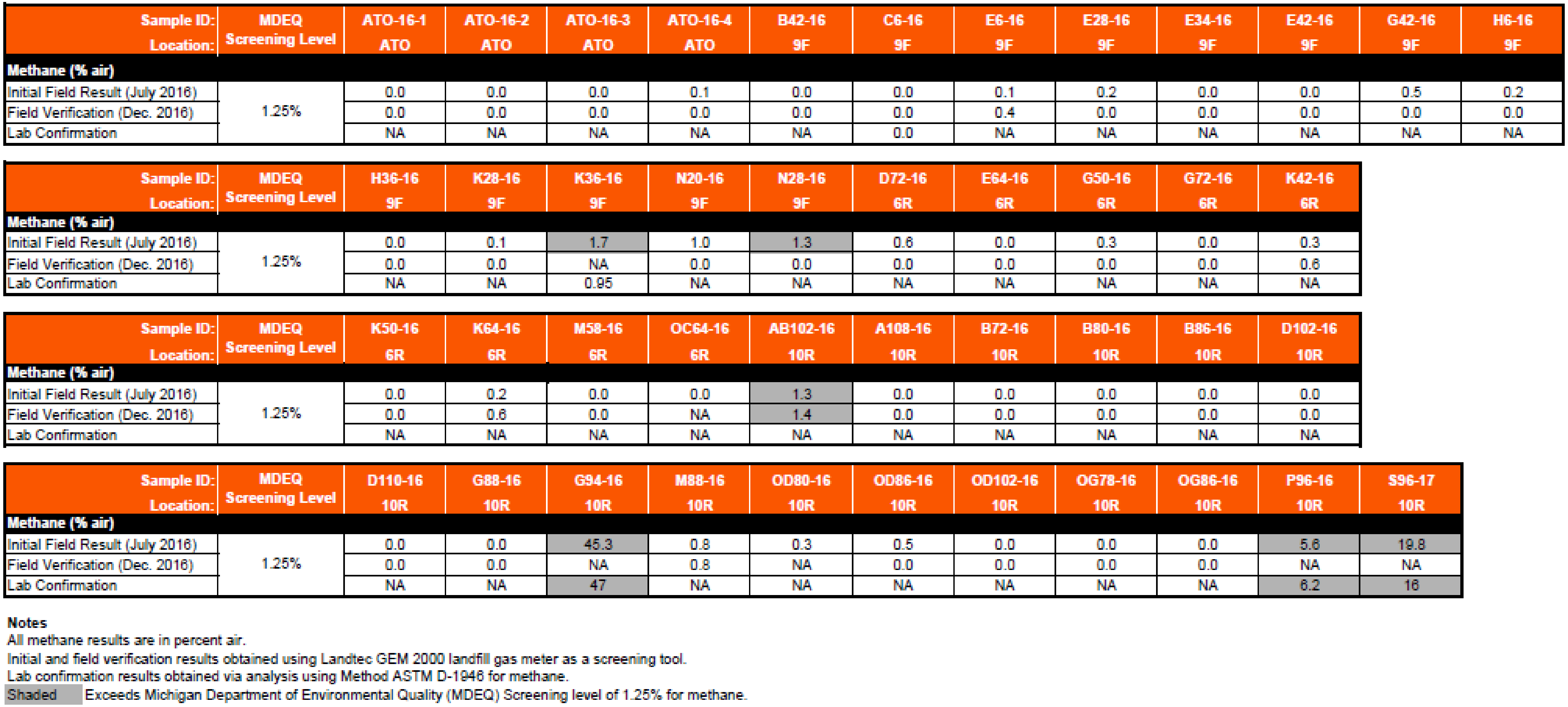
Real-Time Monitoring

- Differential Pressure
  - < 0.1 in water column pressure noted
  - Sub-grade pressure not sufficient to generate mass flow into building
- Methane
  - 0 – 46 % by volume
- CO_2
  - Indicator of biogenic methane production
- O_2
  - Indicator of attenuation
- No pathways to indoor air noted during monitoring
- Plant H&S staff conducted additional methane monitoring



```
[illegible] 01/02/98   Last Read      External
[illegible]            **:**:**       Gas Pod
PUMP    ---- OFF       **/**/****     Not Fitted
CH4 00.0%   LEL CH4       000 %
CO2 00.1%
O2  20.5%   Baro Press  28.79 "Hg
BAL 79.4%   Rel. Press -000.00"H20
Menu    Next ID                 Store
```

Methane Screening Verification Data



Sample ID:	MDEQ Screening Level	ATO-16-1	ATO-16-2	ATO-16-3	ATO-16-4	B42-16	C6-16	E6-16	E28-16	E34-16	E42-16	G42-16	H6-16
Location:		ATO	ATO	ATO	ATO	9F	9F	9F	9F	9F	9F	9F	9F
Methane (% air)													
Initial Field Result (July 2016)	1.25%	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.0	0.5	0.2
Field Verification (Dec. 2016)		0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Lab Confirmation		NA	NA	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA

Sample ID:	MDEQ Screening Level	H36-16	K28-16	K36-16	N20-16	N28-16	D72-16	E64-16	G50-16	G72-16	K42-16
Location:		9F	9F	9F	9F	9F	6R	6R	6R	6R	6R
Methane (% air)											
Initial Field Result (July 2016)	1.25%	0.0	0.1	1.7	1.0	1.3	0.6	0.0	0.3	0.0	0.3
Field Verification (Dec. 2016)		0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Lab Confirmation		NA	NA	0.95	NA	NA	NA	NA	NA	NA	NA

Sample ID:	MDEQ Screening Level	K50-16	K64-16	M58-16	OC64-16	AB102-16	A108-16	B72-16	B80-16	B86-16	D102-16
Location:		6R	6R	6R	6R	10R	10R	10R	10R	10R	10R
Methane (% air)											
Initial Field Result (July 2016)	1.25%	0.0	0.2	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
Field Verification (Dec. 2016)		0.0	0.6	0.0	NA	1.4	0.0	0.0	0.0	0.0	0.0
Lab Confirmation		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample ID:	MDEQ Screening Level	D110-16	G88-16	G94-16	M88-16	OD80-16	OD86-16	OD102-16	OG78-16	OG86-16	P96-16	S96-17
Location:		10R	10R	10R	10R	10R	10R	10R	10R	10R	10R	10R
Methane (% air)												
Initial Field Result (July 2016)	1.25%	0.0	0.0	45.3	0.8	0.3	0.5	0.0	0.0	0.0	5.6	19.8
Field Verification (Dec. 2016)		0.0	0.0	NA	0.8	NA	0.0	0.0	0.0	0.0	NA	NA
Lab Confirmation		NA	NA	47	NA	NA	NA	NA	NA	NA	6.2	16

Notes

All methane results are in percent air.

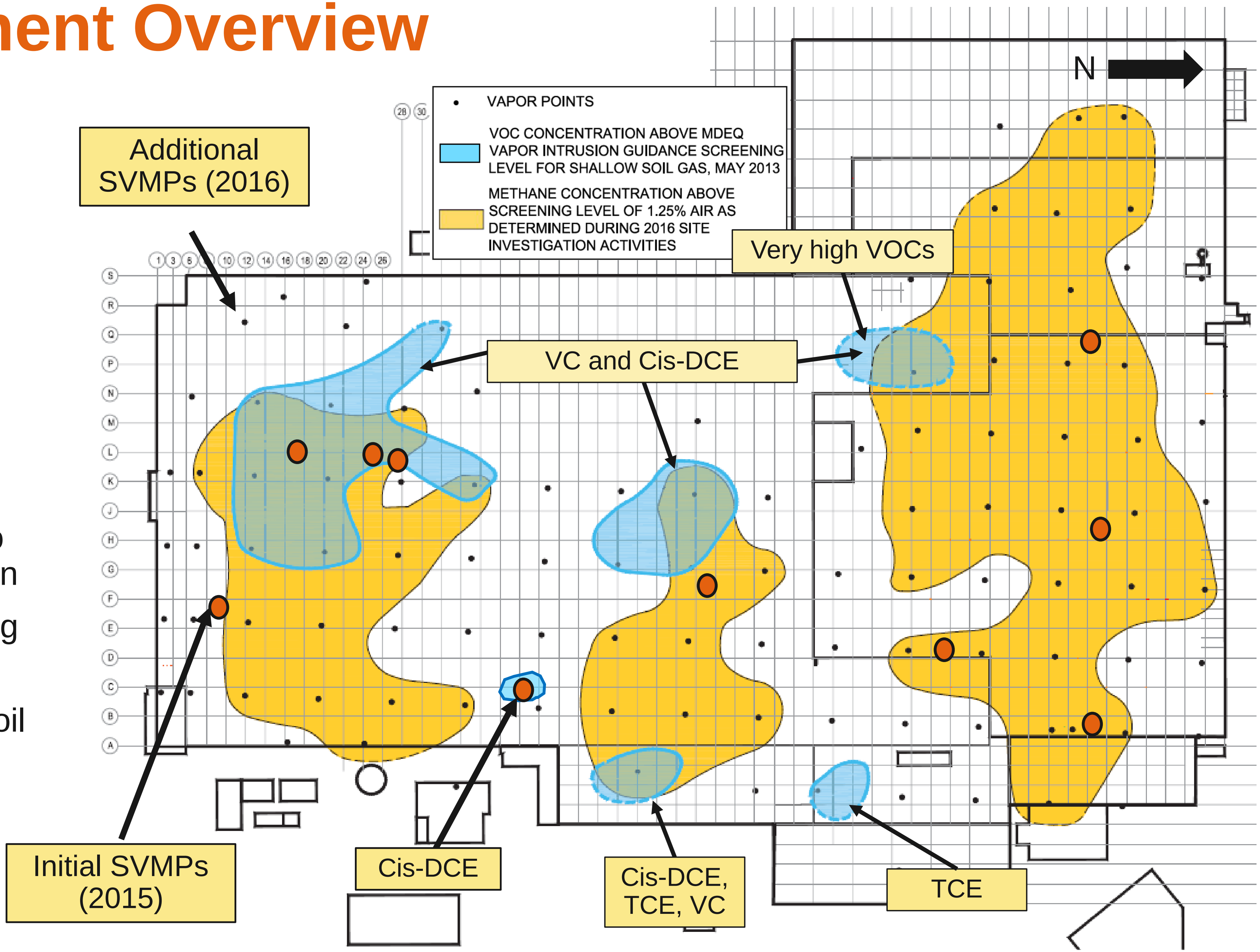
Initial and field verification results obtained using Landtec GEM 2000 landfill gas meter as a screening tool.

Lab confirmation results obtained via analysis using Method ASTM D-1946 for methane.

Shaded Exceeds Michigan Department of Environmental Quality (MDEQ) Screening level of 1.25% for methane.

Vapor Assessment Overview

- Approx. 40-ac. LNAPL body identified
- VOCs present in soil, groundwater and LNAPL
- Biodegradation of LNAPL produces methane
  - Vertical methane flux
  - Limited oxygen ingress to support methane oxidation
  - MDEQ methane screening level of 1.25% by vol.
- VOCs present in sub-slab soil vapor > MDEQ criteria



Additional SVMPs (2016)

Very high VOCs

VC and Cis-DCE

Initial SVMPs (2015)

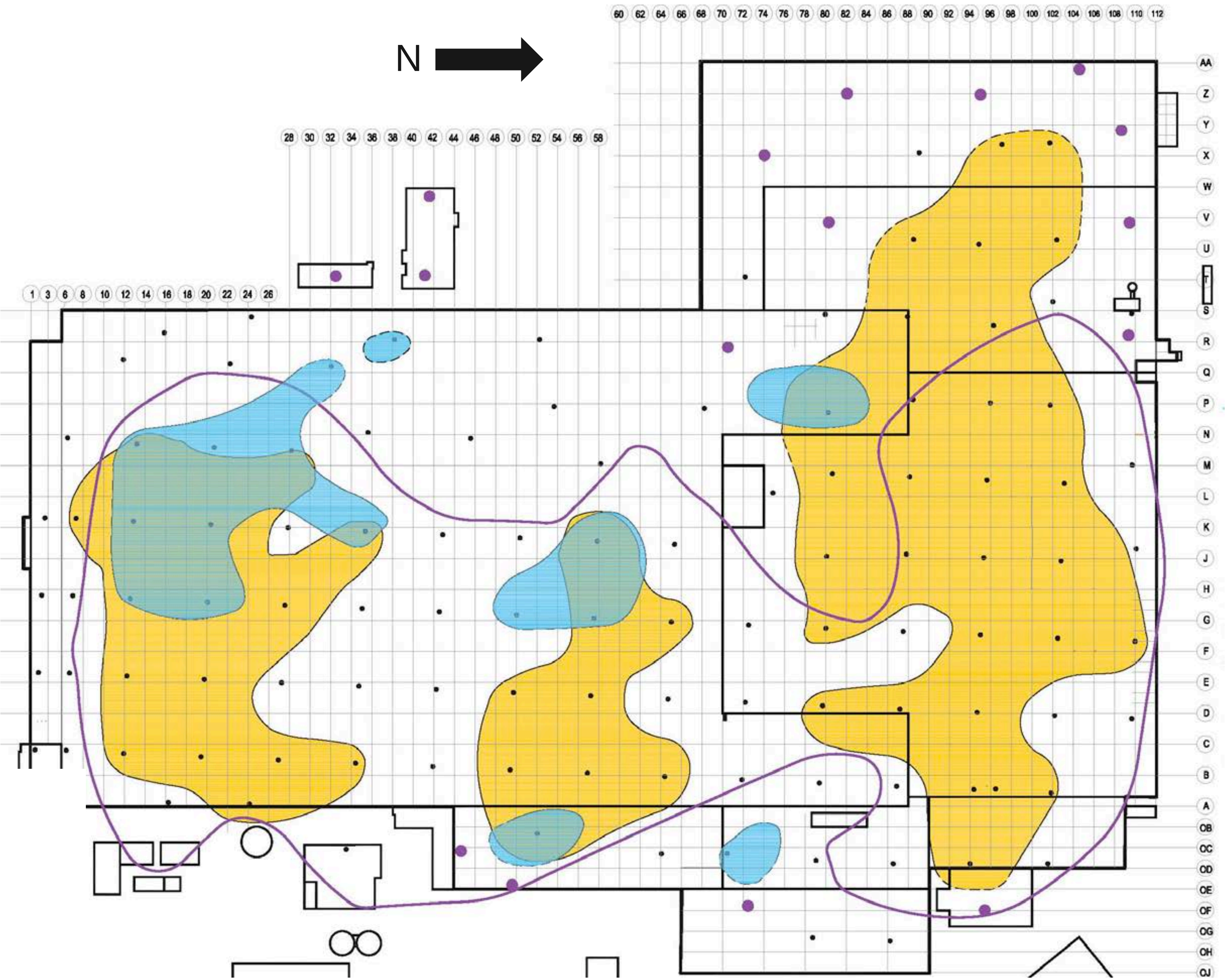
Cis-DCE

Cis-DCE, TCE, VC

TCE

Proposed Delineation Locations

- Up to 16 additional delineation locations to further delineate and define the extent of VOCs and methane



LEGEND:

● EXISTING SUB-SLAB VAPOR MONITORING POINTS

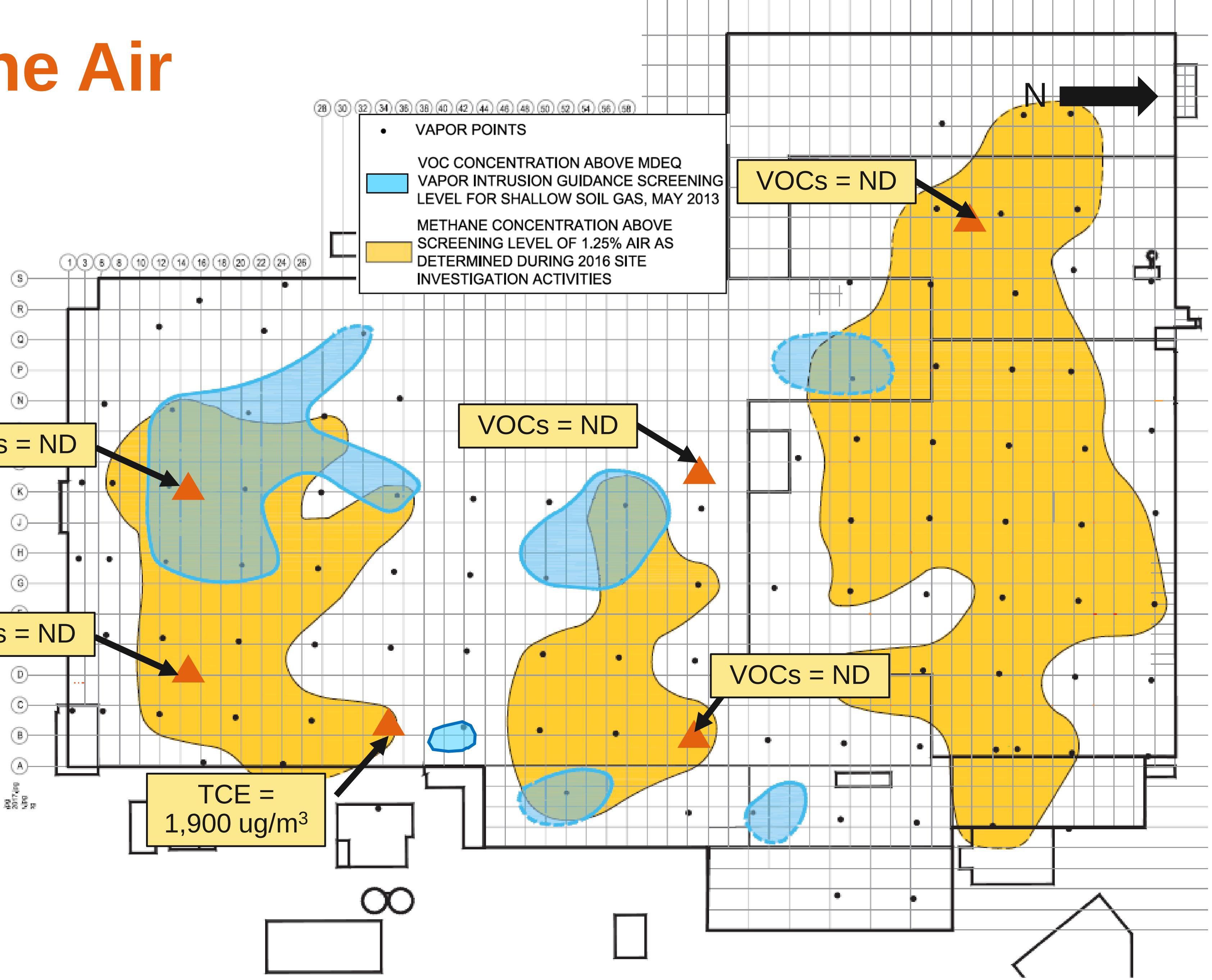
🟨 **METHANE CONCENTRATION ABOVE SCREENING LEVEL OF 1.25%**

– – **VOC CONCENTRATION ABOVE MDEQ VAPOR INTRUSION GUIDANCE SCREENING LEVEL FOR SHALLOW SOIL GAS, MAY 2013 (RESCINDED JUNE 2017)**

● **PROPOSED SUB-SLAB DELINEATION POINT**

Industrial Hygiene Air Sample Data

- Six samples collected 7/30/2015 using industrial hygiene methods
- Elevated detection limits limit data utility
- VOCs not-detected at 5 locations (DLs = 0.1 ppmv)
- TCE detected at 360 ppbv (1,900 ug/m$^{3)}$ at final location
    - Sample collected near an open trench during construction
    - Not considered a representative indoor air sample



VOCs = ND

VOCs = ND

VOCs = ND

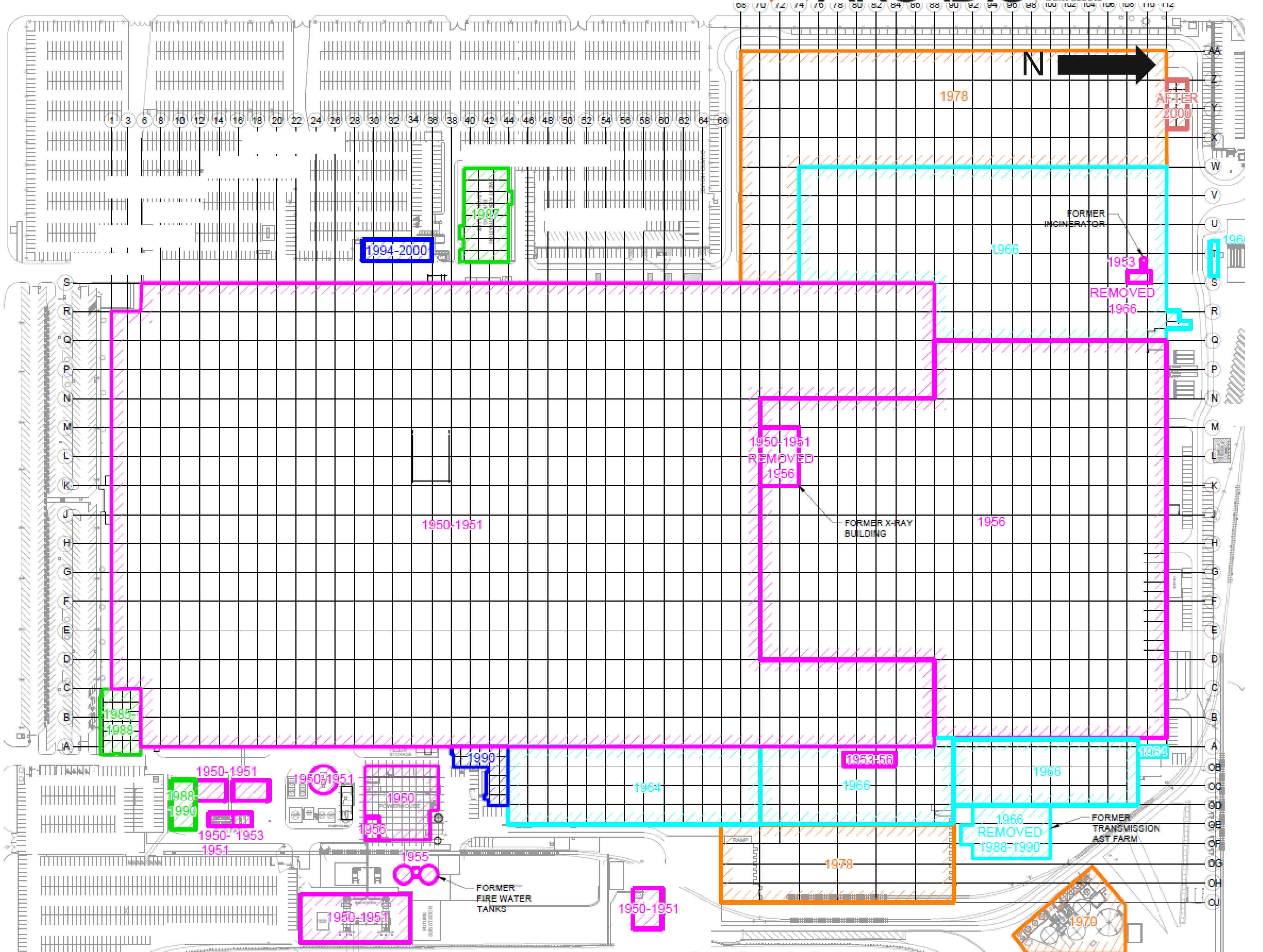
VOCs = ND

VOCs = ND

TCE = 1,900 ug/m^3

Building Construction Details

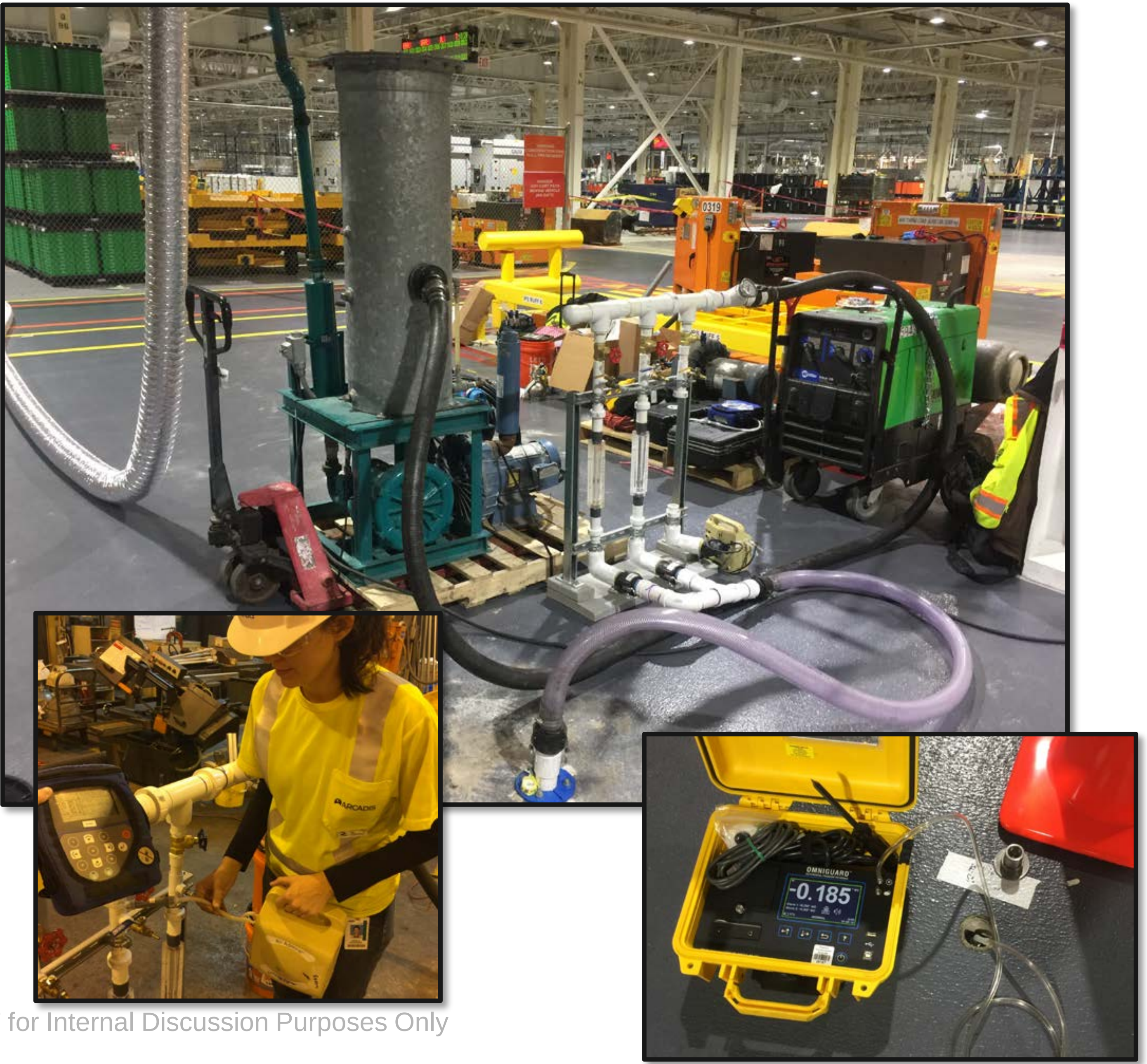
- 🟪 1950s CONSTRUCTION
- 🟦 1960s CONSTRUCTION
- 🟧 1970s CONSTRUCTION
- 🟩 1980s CONSTRUCTION
- 🟦 1990s CONSTRUCTION
- 🟥 2000s CONSTRUCTION



Sub-Slab Depressurization (SSD) Pilot Test

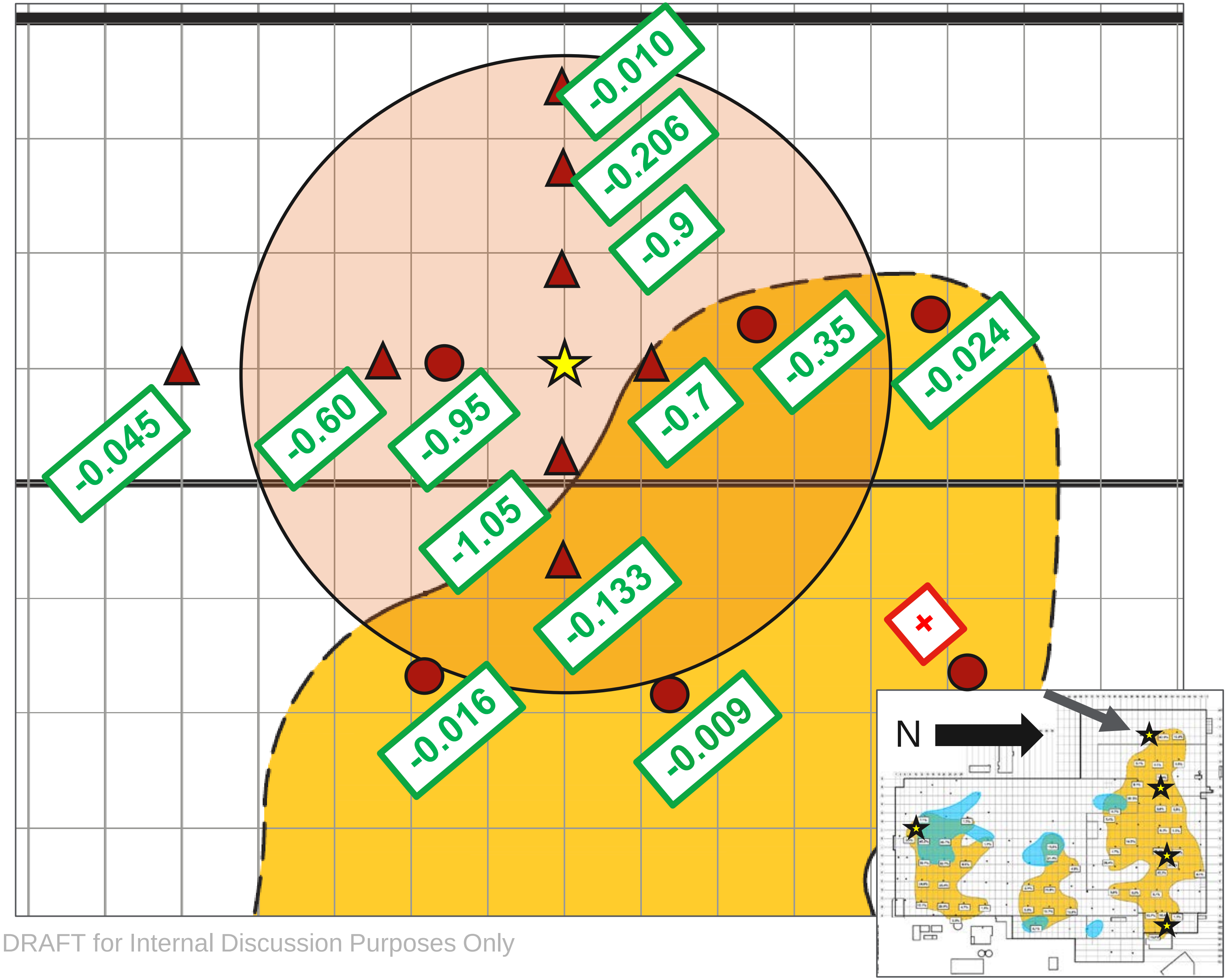
- Completed Dec. 28-30, 2016
- Five test areas across the plant

Testing was not completed in production area due to limited access and consistent results at other test locations



SP-X92 SSD Pilot Test Results

- Test ran for ~2.7hrs. at 20 cfm and 61 in H2O
- Target vacuum of 0.004 in H2O achieved at greater than 170 ft.
- Emission rates (at 20 cfm)
  - TVOCs: 0.57 lbs./mo.
  - Carcinogens: 0.0005 lbs./mo.



★ Suction Pit
▲ Temporary Monitoring Point
● Existing Vapor Pin
-1.0 Observed pressure (in H2O)

SP-R96 SSD Pilot Test Results

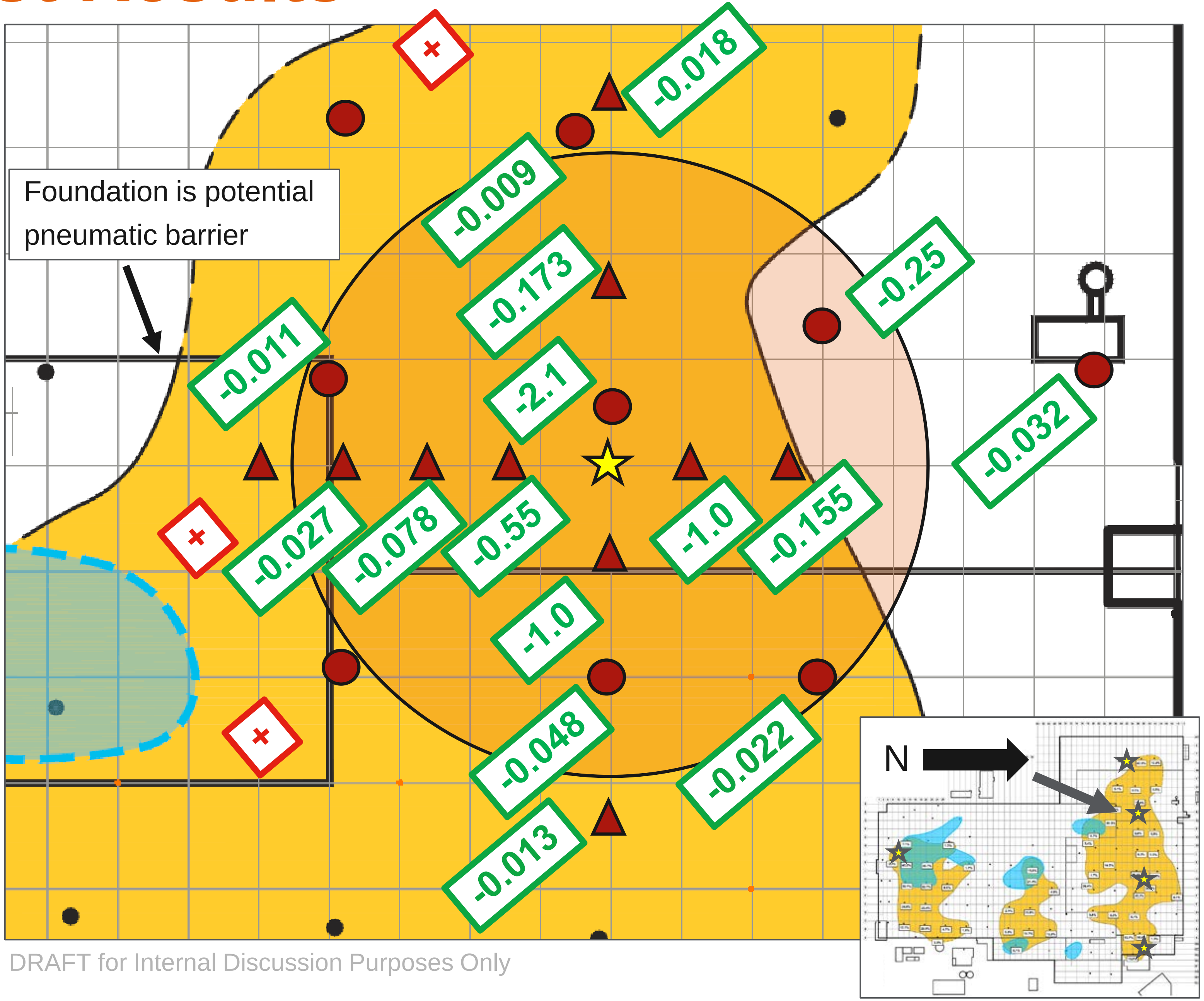
- Test ran for ~3.5 hrs. at 24 cfm and 58 in H2O
- Target vacuum of 0.004 in H2O achieved to 170 ft.
- Emission rates (at 24 cfm)
  - TVOCs: 1.36 lbs./mo.
  - Carcinogens: 0.0082 lbs./mo.

☆ Suction Pit

▲ Temporary Monitoring Point

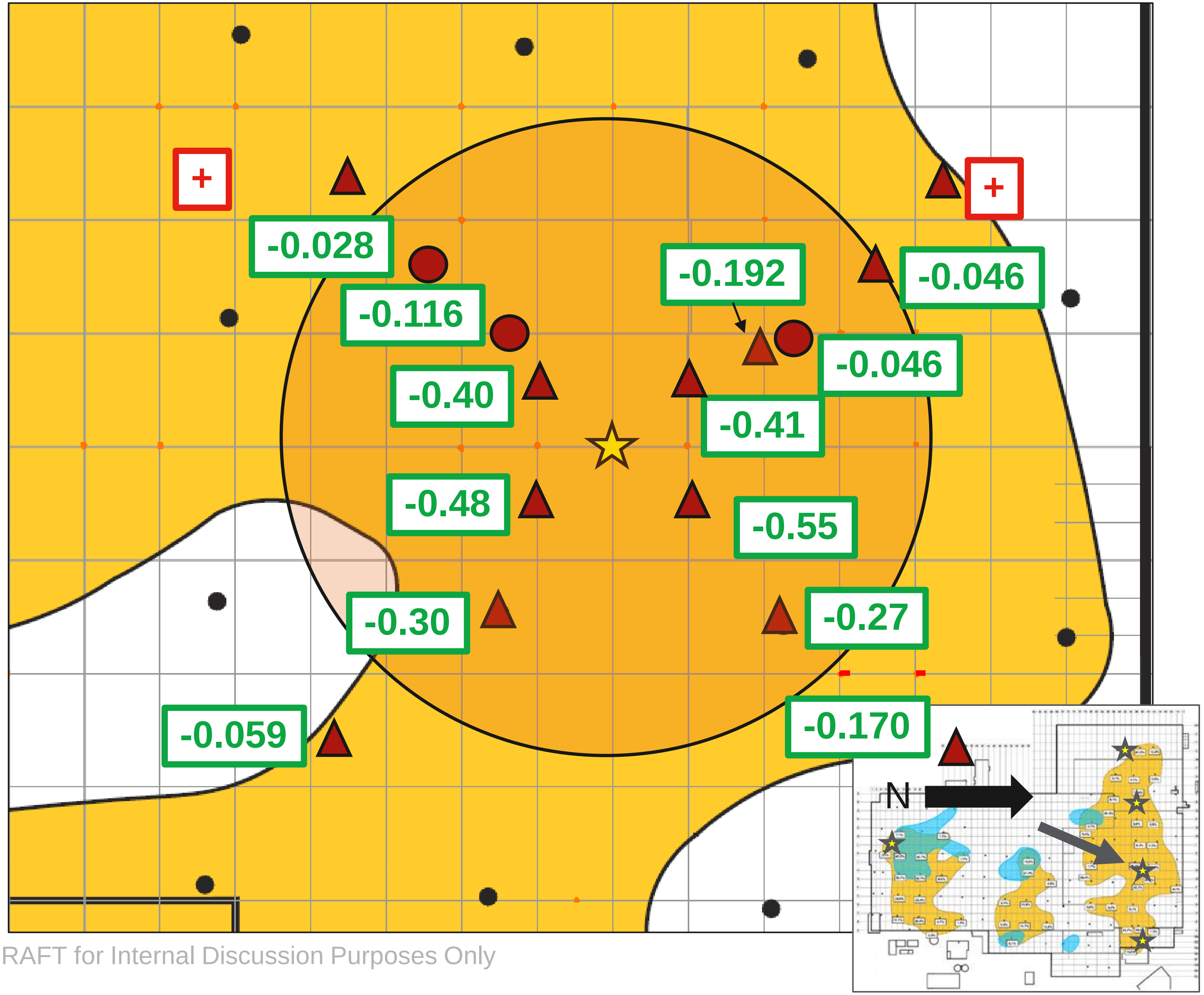
● Existing Vapor Pin

-1.0 Observed pressure (in H2O)



SP-H98 SSD Pilot Test Results

- Test ran for ~5.3hrs. at 34 cfm and 53 in H2O
- Target vacuum of 0.004 in H2O achieved at greater than 170 ft.
- Emission rates (at 34 cfm)
  - TVOCs: 22.8 lbs./mo.
  - Carcinogens: 0.114 lbs./mo.



☆ Suction Pit

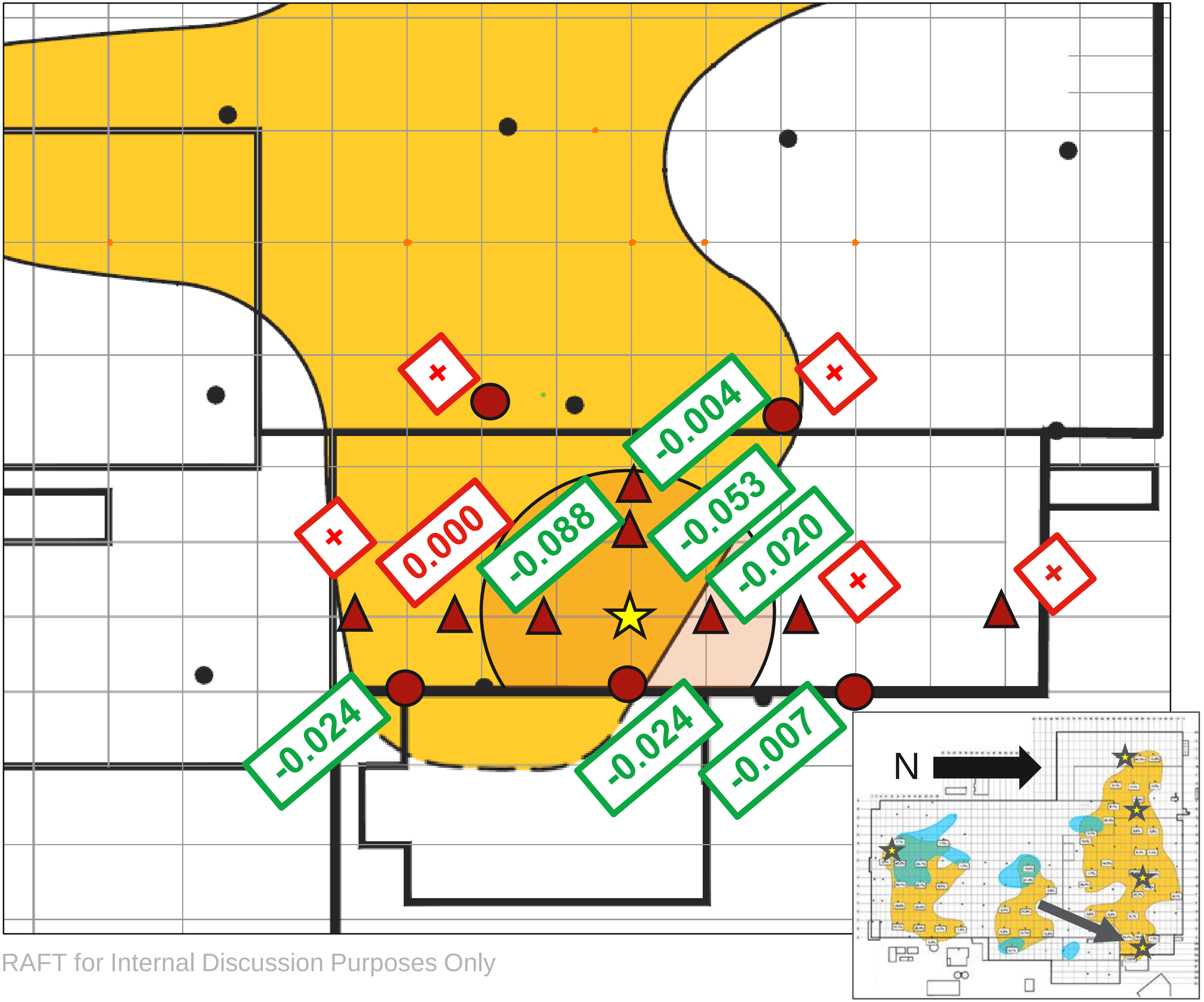
▲ Temporary Monitoring Point

● Existing Vapor Pin

-1.0 Observed pressure (in H2O)

SP-OC98 SSD Pilot Test Results

- Test ran for ~2 hrs. at 4 cfm and 63 in H2O
- Target vacuum of 0.004 in H2O achieved to 80 ft.
- Emission rates (at 4 cfm)
  - TVOCs: 0.15 lbs./mo.
  - Carcinogens: 0.0007 lbs./mo.



☆ Suction Pit

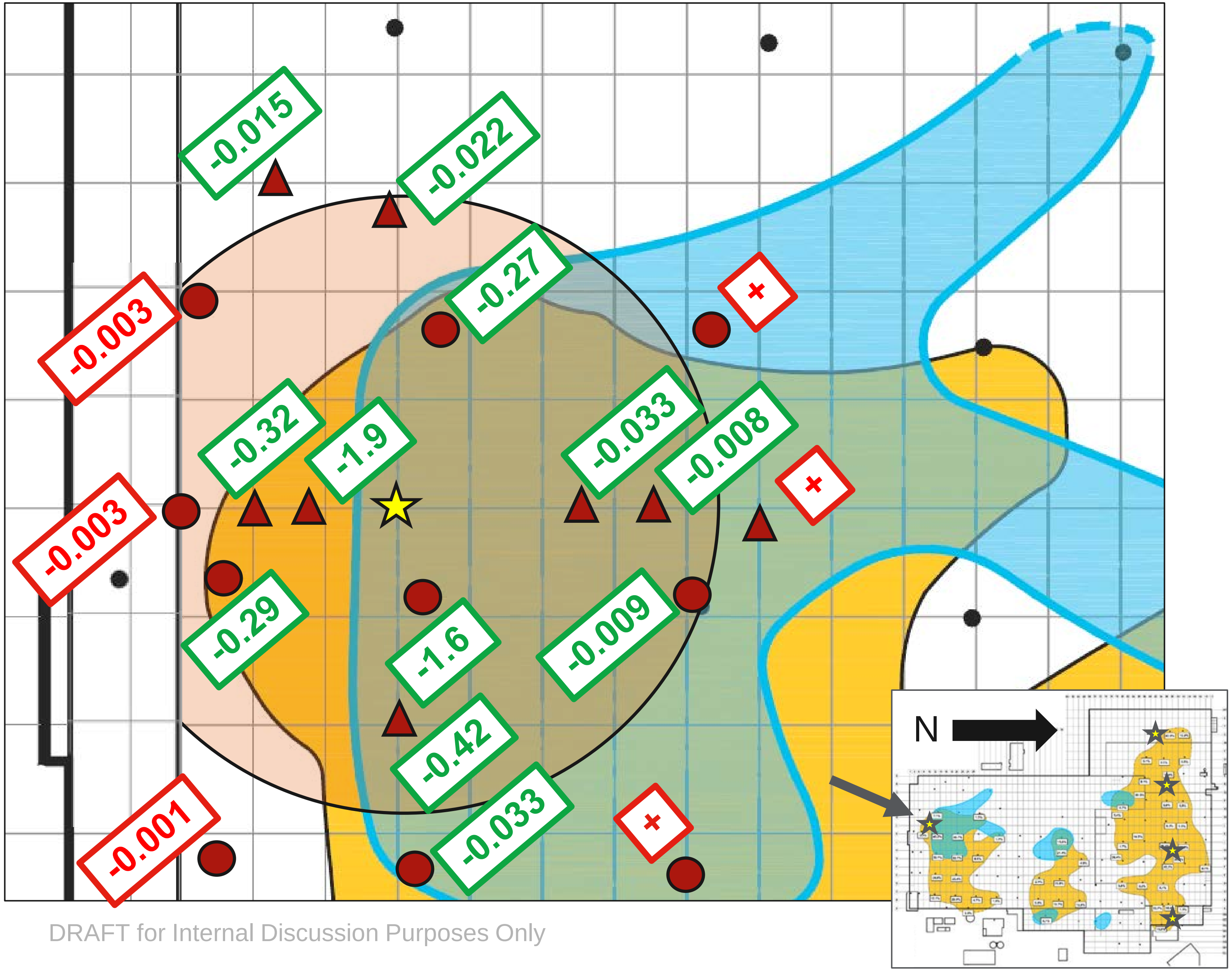
▲ Temporary Monitoring Point

● Existing Vapor Pin

-1.0 Observed pressure (in H2O)

SP-L12 SSD Pilot Test Results

- Test ran for ~4.5hrs. at 27 cfm and 57 in H2O
- Target vacuum of 0.004 in H2O achieved to 170 ft.
- Emission rates (at 27 cfm)
  - TVOCs: 0.23 lbs./mo.
  - Carcinogens: 0.0007 lbs./mo.



★ Suction Pit

▲ Temporary Monitoring Point

● Existing Vapor Pin

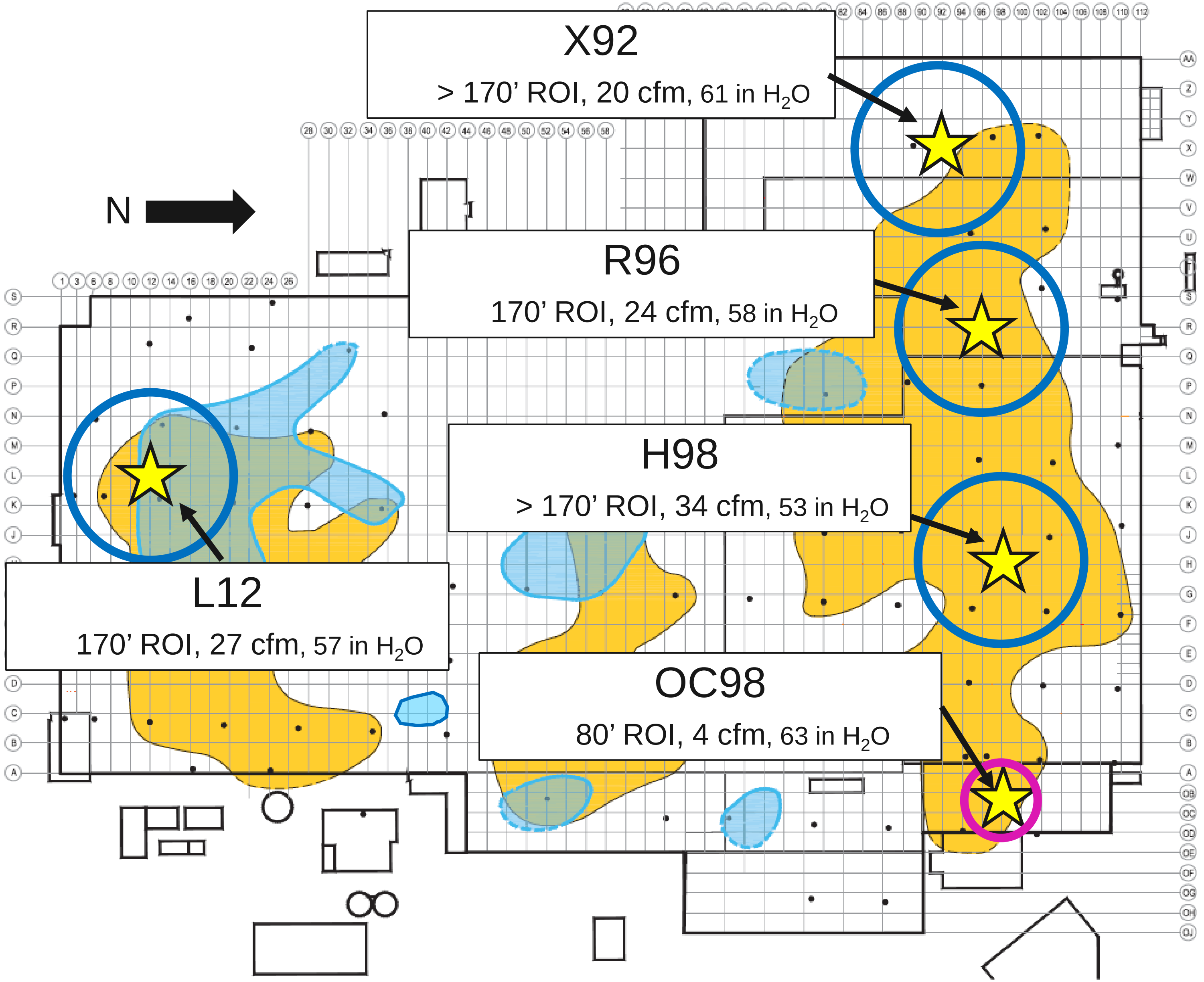
-1.0 Observed pressure (in H2O)

SSD Pilot Test Summary

- Consistent results at all test locations except OC98
- Target vacuum of 0.004 in H_2O achieved >170 ft. at 4 of 5 test locations
- Target vacuum achieved to 80 ft. at OC98

○ 170 ft. ROI

○ 80 ft. ROI



X92
> 170’ ROI, 20 cfm, 61 in H_2O

R96
170’ ROI, 24 cfm, 58 in H_2O

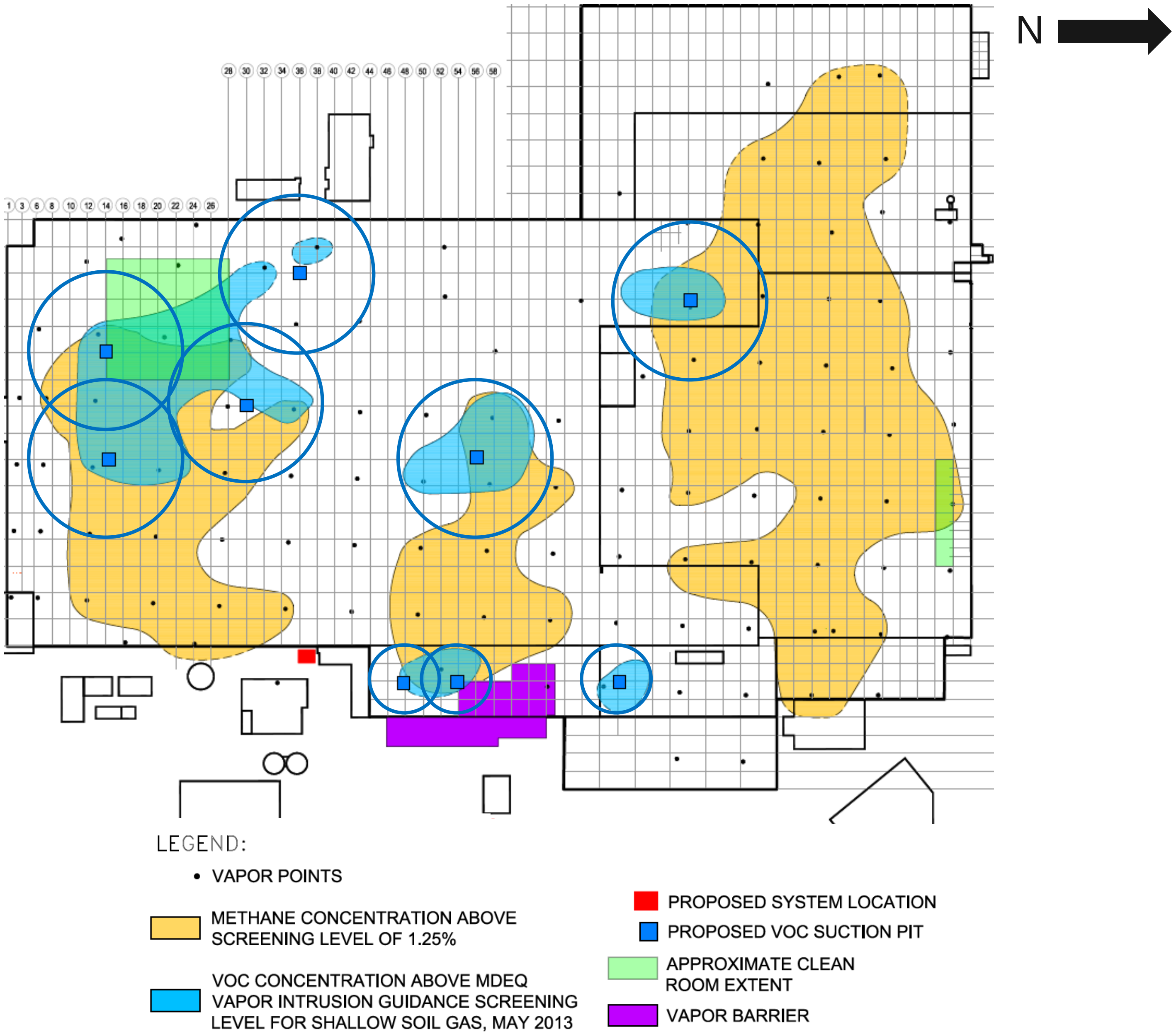
H98
> 170’ ROI, 34 cfm, 53 in H_2O

L12
170’ ROI, 27 cfm, 57 in H_2O

OC98
80’ ROI, 4 cfm, 63 in H_2O

VOC SSD System

- Active VI mitigation
- Nine SP extraction system
- Mitigates VOC areas exceeding 2013 VI shallow soil-gas screening levels
- Currently being designed
- Clean room(s) are under positive pressure

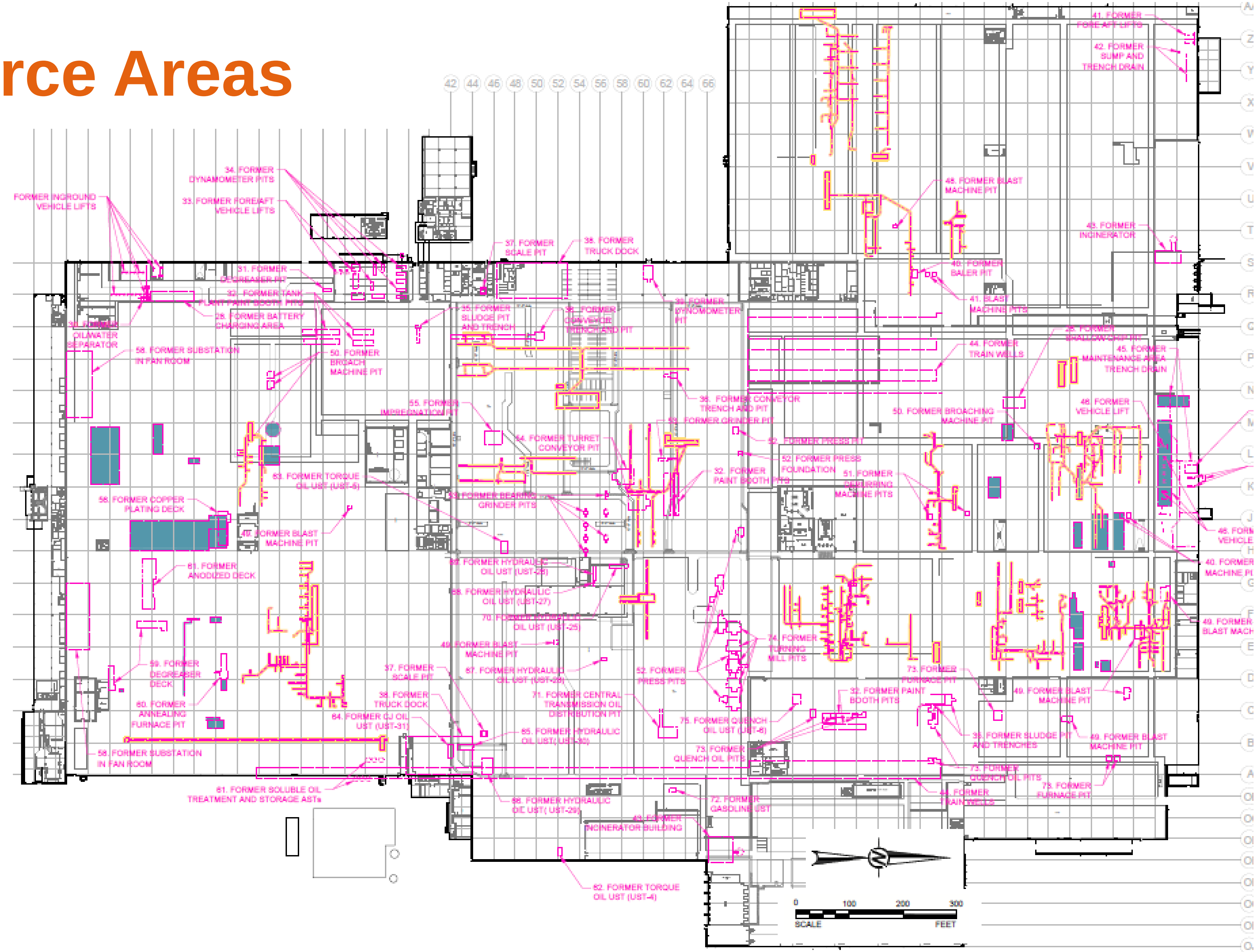


Potential Historical Sources

Potential Source Areas

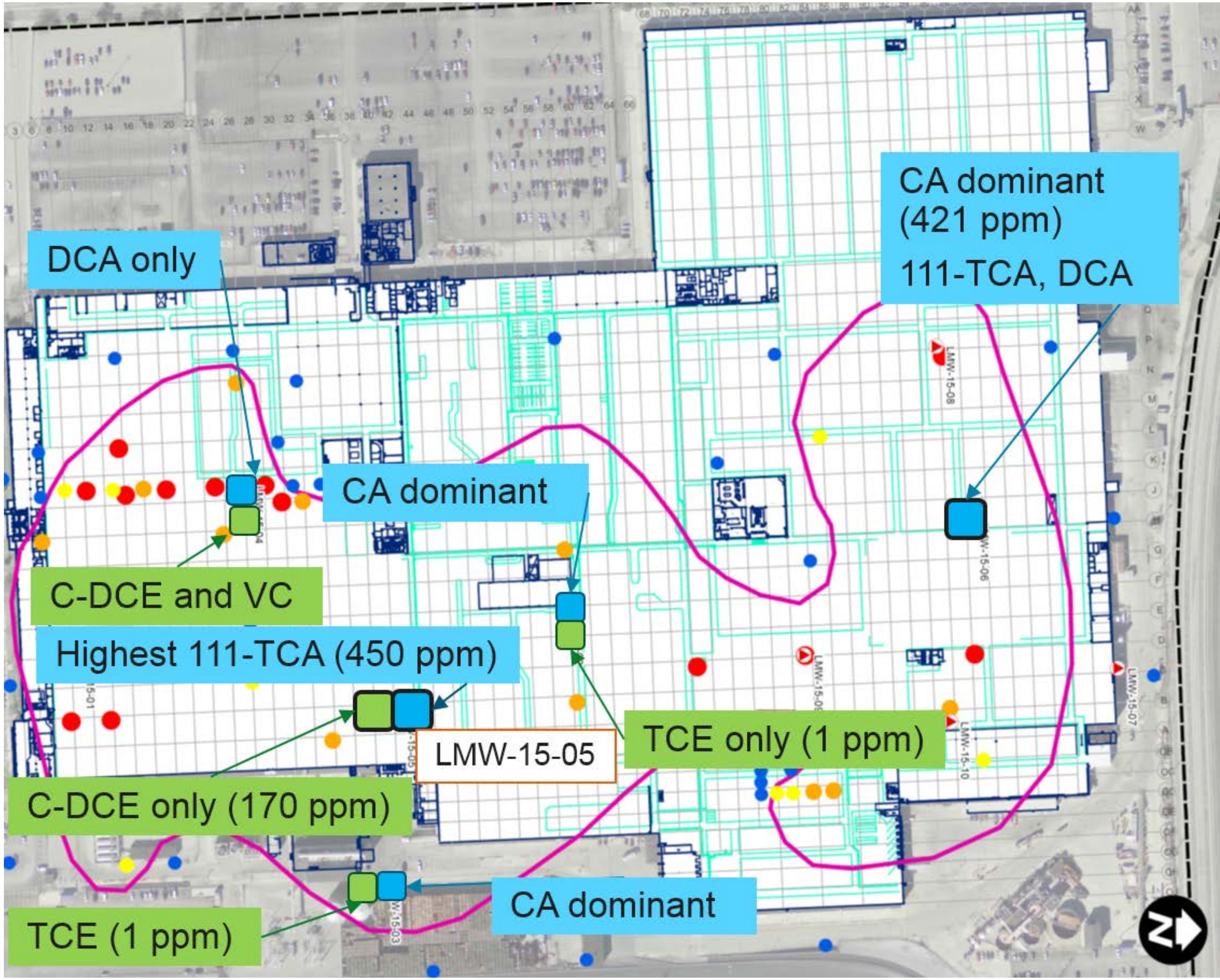
2014 Evaluation of Potential Source Areas:

- Historical operations include many pits, tanks, and process lines, making specific source identification difficult
- Recent re-configuration of the plant includes bringing the floor to grade level across the plant and placing many of the utilities overhead
- There are currently no ongoing sources suspected beneath the building



LNAPL Composition

- LNAPL consists of transmission fluids, diesel-range organics
    - Biodegradation leads to methane
    - Degradability of transmission fluids is not well understood
    - PCB impacts have cost implications for waste management
- VOC impacts in southern area consistent with groundwater and soil vapor, but less consistent in northern area



DCA only

CA dominant (421 ppm)

111-TCA, DCA

CA dominant

C-DCE and VC

Highest 111-TCA (450 ppm)

LMW-15-05

TCE only (1 ppm)

C-DCE only (170 ppm)

CA dominant

TCE (1 ppm)

LEGEND

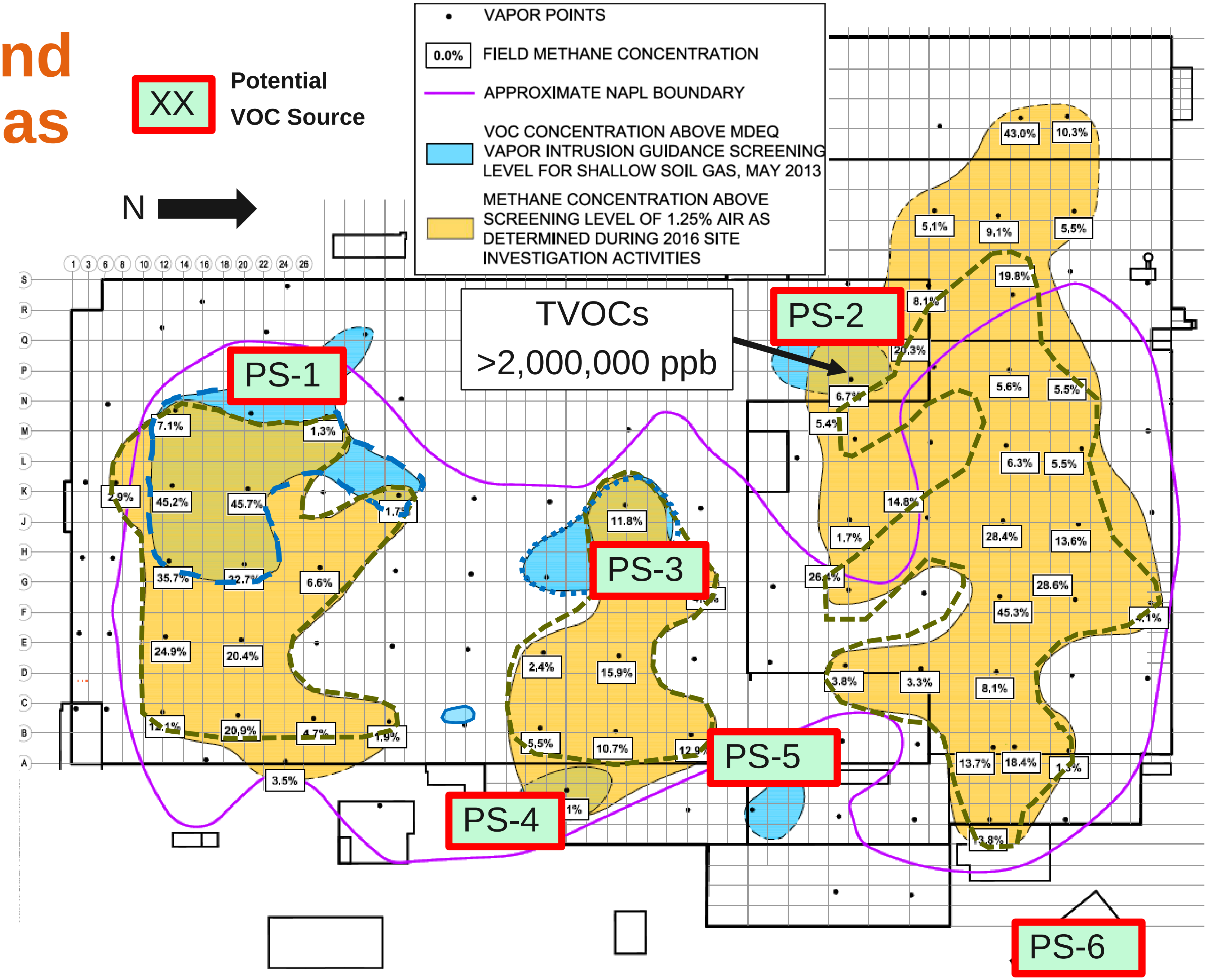
- ▲ LNAPL MONITORING WELL
- LIF Max %RE
    - ● <10%
    - ● 10-100%
    - ● 100-200%
    - ● >200%
- — APPROXIMATE EXTENT OF LNAPL
- — INTERIOR WALLS & FEATURES
- — COLUMN GRID
- — BUILDING AISLE

🟦 Chlorinated Ethanes

🟩 Chlorinated Ethenes

Vapor Assessment and Potential Source Areas

- Initial evaluation: June – Aug. 2016
- Recent delineation: Dec. 2016 – Jan. 2017
- Lab sampled 108 locations for VOCs
- Field screened all locations for methane
- Recent Work:
    - Completed additional ~40 (of the 108) locations – expanded area of exceedances (VOCs and methane)
    - Confirmation field screening verified results
    - Five locations lab verified, samples correlated well with field measurements



Source Areas and VOCs in Groundwater

VOCs in Soil Gas

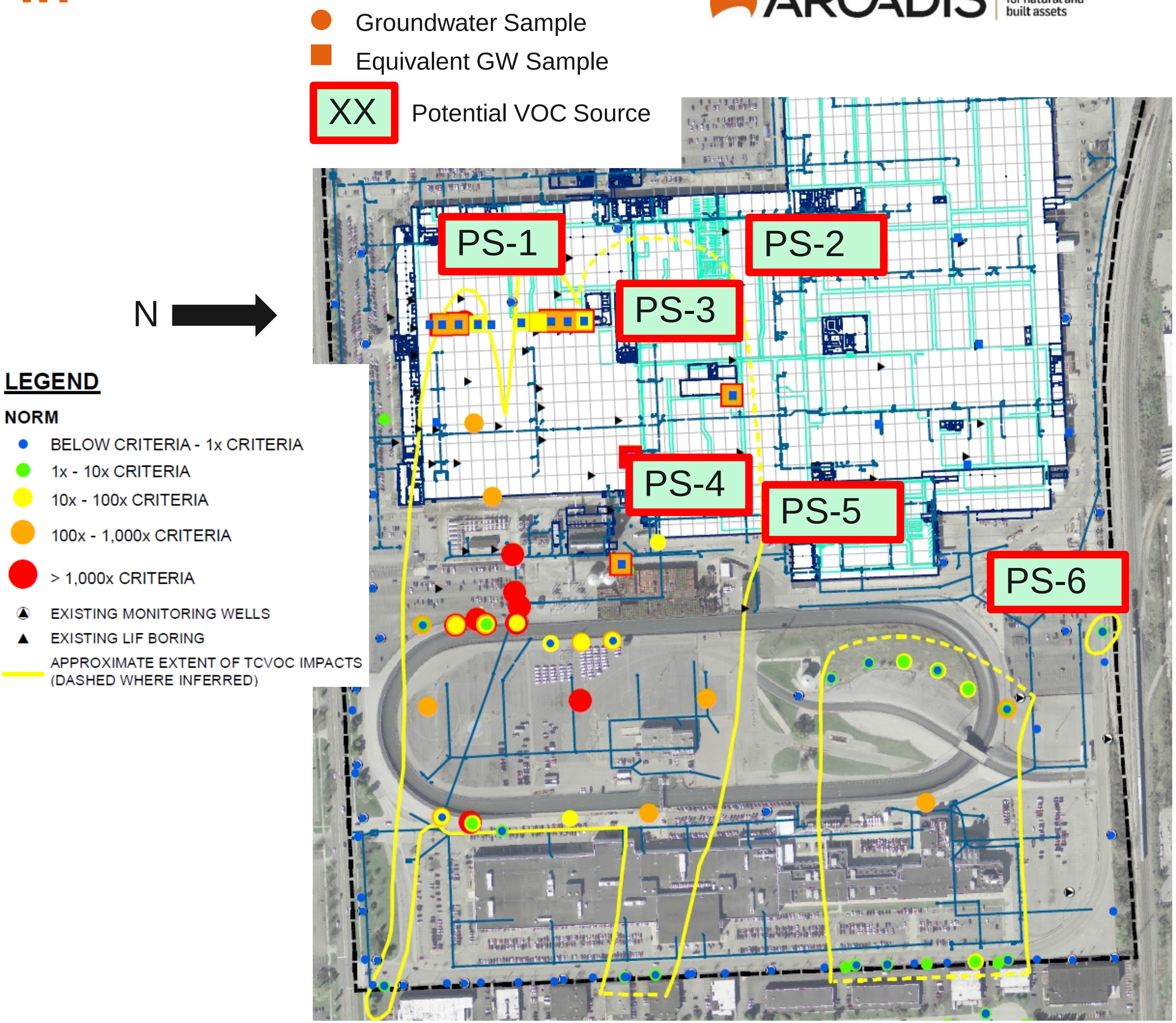
- Five potential sources to soil gas identified
- PS-2 had highest concentrations of VOCs in soil gas

VOCs in Groundwater

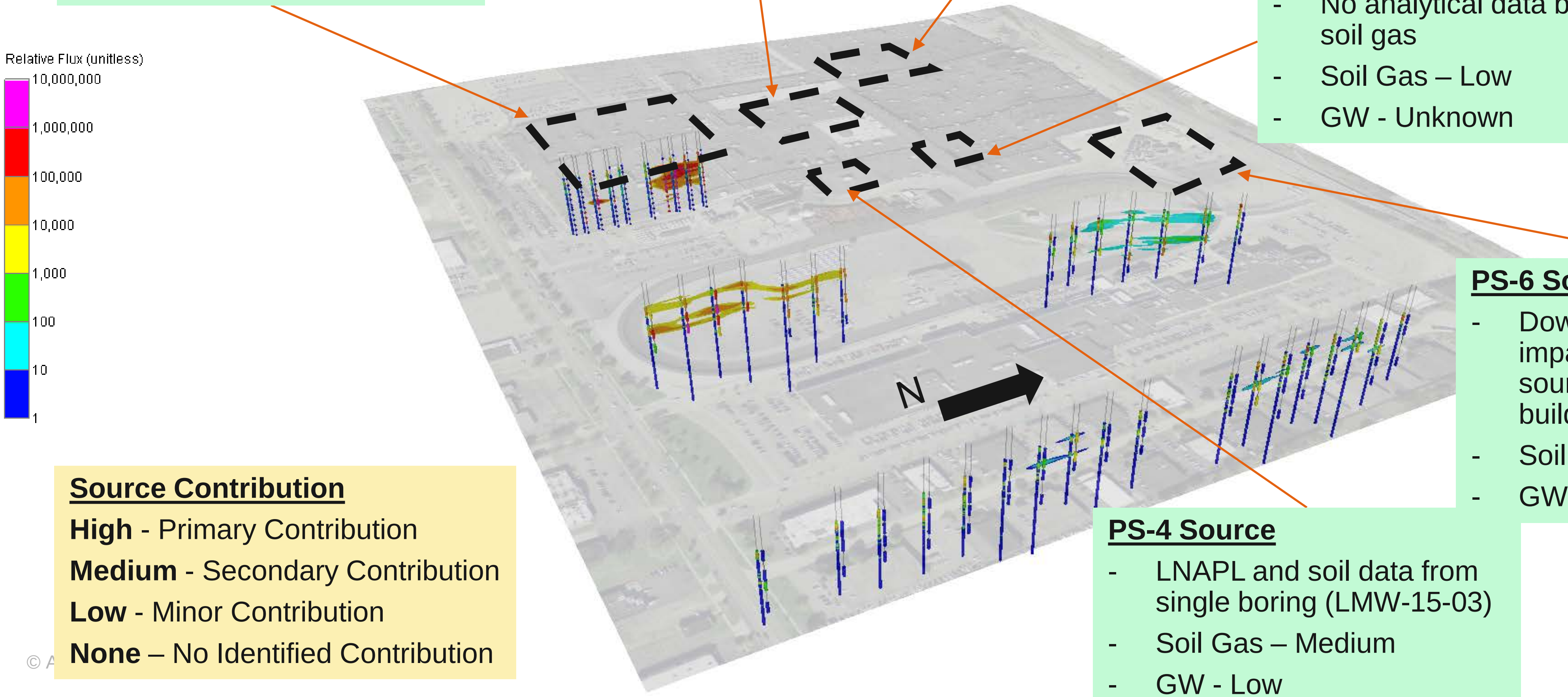
- PS-1 represents >95% of the VOC mass flux that is migrating in GW at the Site
  - characterized downgradient, but not defined
- Other potential sources need characterization and delineation.

VOCs in LNAPL

- Up to 450 ppm VOCs detected in LNAPL
- Highly variable concentrations/composition



Groundwater VOC Flux & Potential VOC Sources



PS-1 Source

- GW, LNAPL and Hyd. Cond. Data from transect investigation
- Soil Gas – High
- GW **-** High

PS-3 Source

- LNAPL and soil data from single boring (LMW-15-02)
- Soil Gas – Low
- GW - Low

PS-2 Source

- No analytical data beyond soil gas
- Soil Gas – High
- GW - None

PS-5 Source

- No analytical data beyond soil gas
- Soil Gas – Low
- GW - Unknown

PS-6 Source

- Downgradient VOC impacts with no apparent source beneath the LTP building
- Soil Gas – none
- GW - Low

PS-4 Source

- LNAPL and soil data from single boring (LMW-15-03)
- Soil Gas – Medium
- GW - Low

Source Contribution

High - Primary Contribution

Medium - Secondary Contribution

Low - Minor Contribution

None – No Identified Contribution

PS-6: Wastewater Pre-Treatment Facility Area Investigation

Completed additional HPT/VAP borings around pre-treatment facility to evaluate potential sources of the northern VOC impact area.

LEGEND

🟨 APPROXIMATE PROPERTY BOUNDARY

● WWTP HPT/VAP BORING

⊙ PEVIOUSLY COMPLETED HPT/VAP BORING

▲ LNAPL MONITORING WELL

▲ MONITORING WELL

UTILITIES

— STORM SEWER

— PROCESS WASTE

PS-6: Pre-Treatment Facility Area Results

Potential sources of low-level VOCs in WWTP area

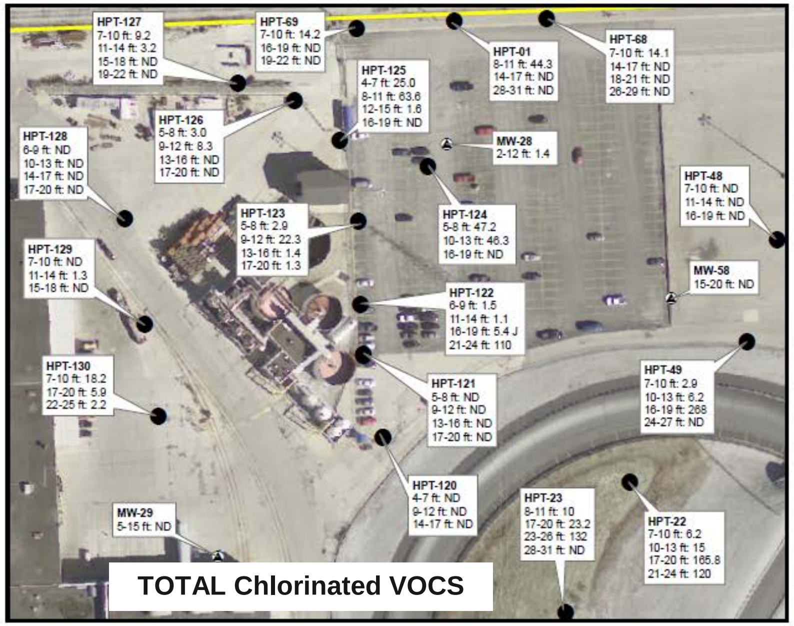
Area used for equipment staging and waste storage in the past and may have contributed to VOC groundwater impacts in the northern portion of the Site

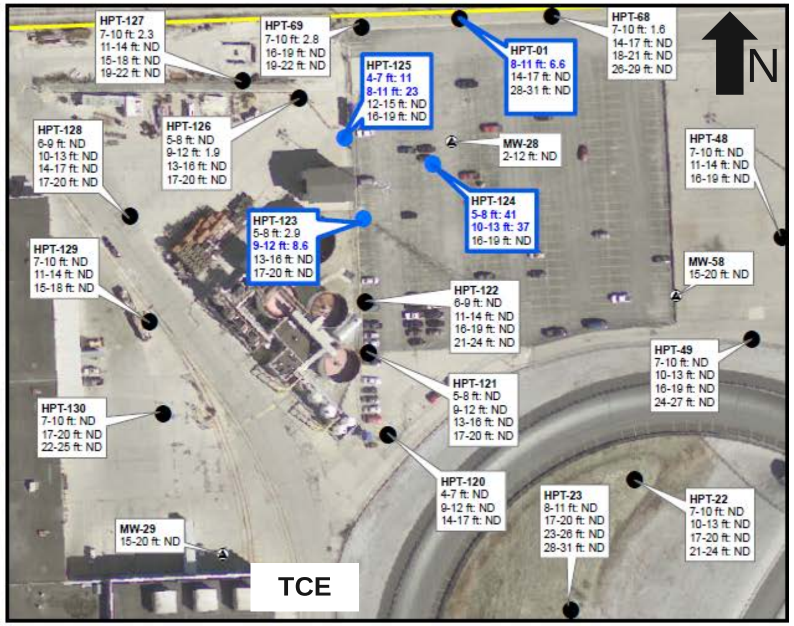
- north parking lot area shows low levels of TCE

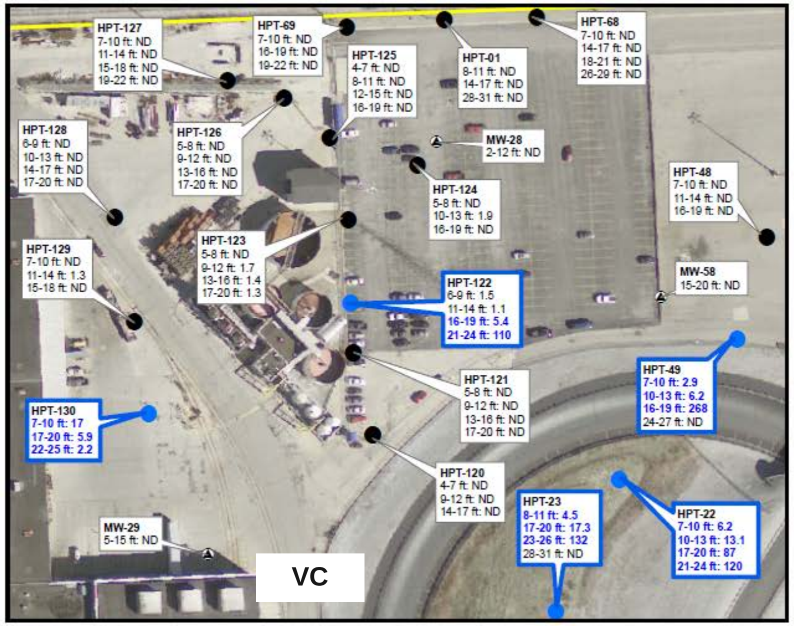
Groundwater analytical data suggest that some vinyl chloride and 1,4-dioxane migrates from beneath the LTP building and contributes to the northern groundwater impact area

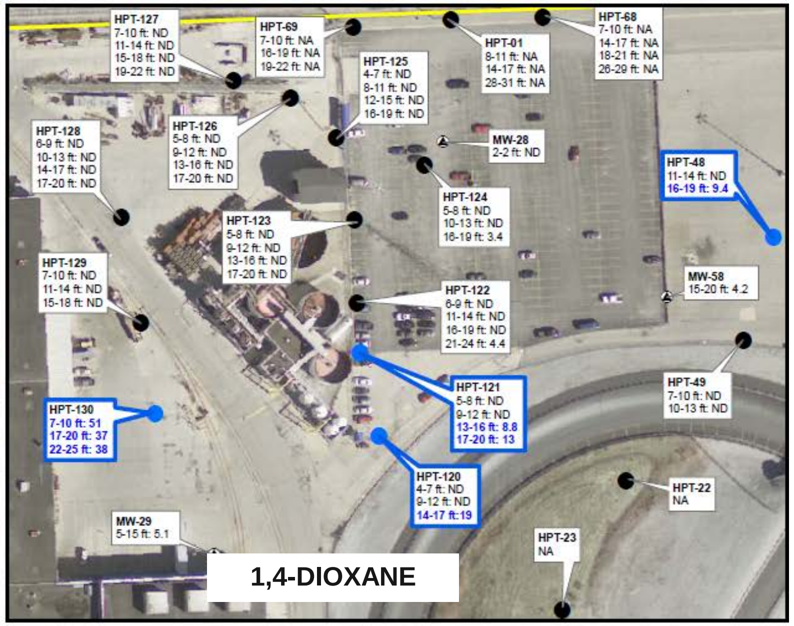
1,4-Dioxane possibly associated with TCA identified in LNAPL present beneath the north-central portion of the LTP building

Pre-treatment operations do not present ongoing source of VOCs

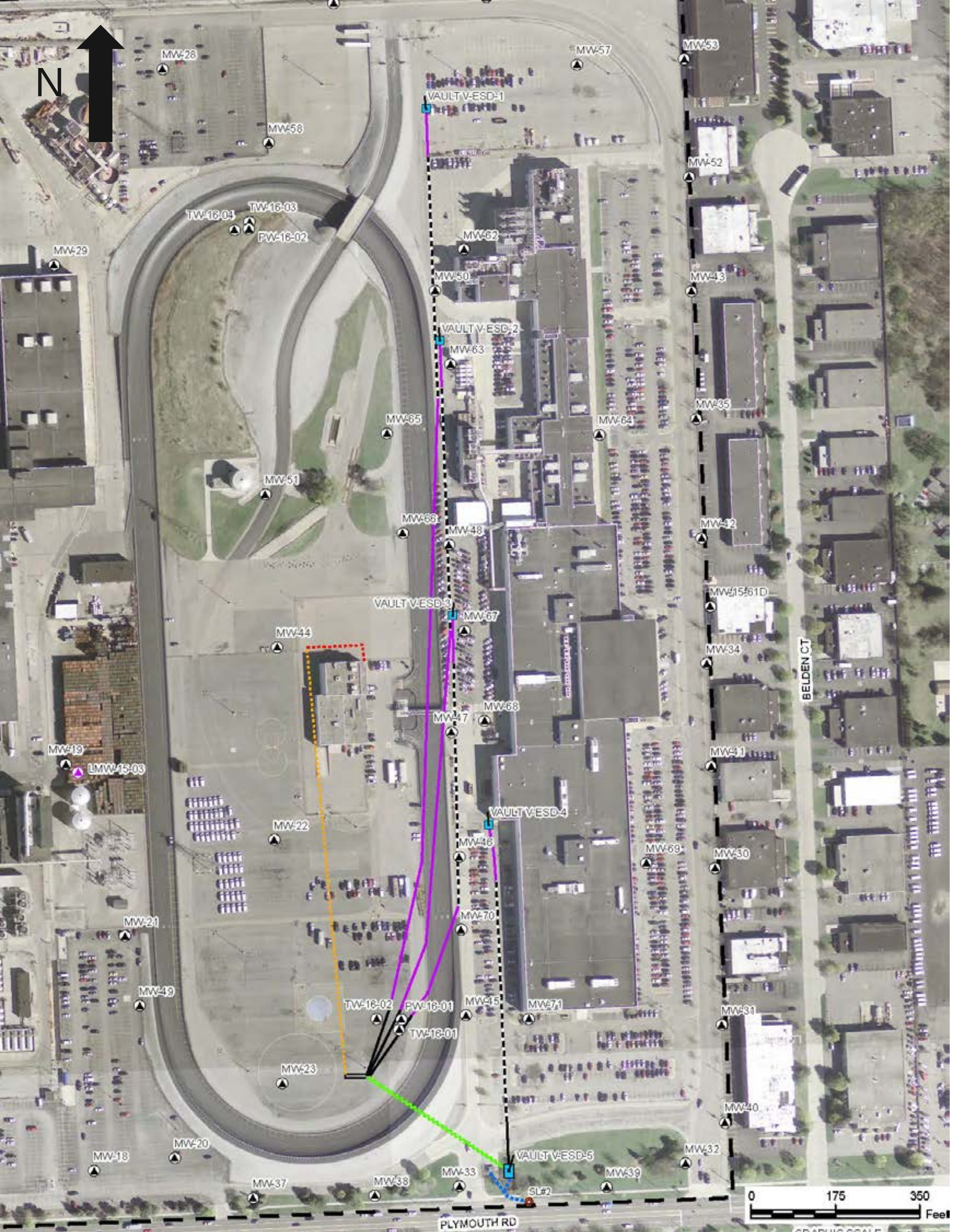

TOTAL Chlorinated VOCS


TCE


VC


1,4-DIOXANE

Comment #4
Hydraulic Control System



System Overview

ARCADIS Design & Consultancy for natural and built assets

- Four Horizontal Wells Installed November 2016 – February 2017
- Hydraulic Control System Operating Since March 2017
- System Installed February – March 2017
  - ~ 5.6M gallons treated as of July 28, 2017
  - ~30-40 gpm daily average flowrate
- Extraction wells configured to intercept contaminants migrating west to east via natural groundwater flow
- Extraction wells designed to provide a hydraulic barrier to migration of VOCs previously created by the compromised storm sewer.

LEGEND:

▲ MONITORING WELL

▲ LNAPL MONITORING WELL

⌐ ¬ FORD PROPERTY BOUNDARY

▣ VAULT (2 FT x 2 FT)

▣ VAULT (4 FT x 6 FT)

⊕ COMPLIANCE POINT (SL#2)

- - - WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)

— WELL BLANK CASING (4-INCH SDR-11 HDPE)

— WELL BLANK CASING (6-INCH SDR-11 HDPE)

······ CARRIER PIPES CP-ESD-1/2 (4-INCH SDR-11 HDPE)

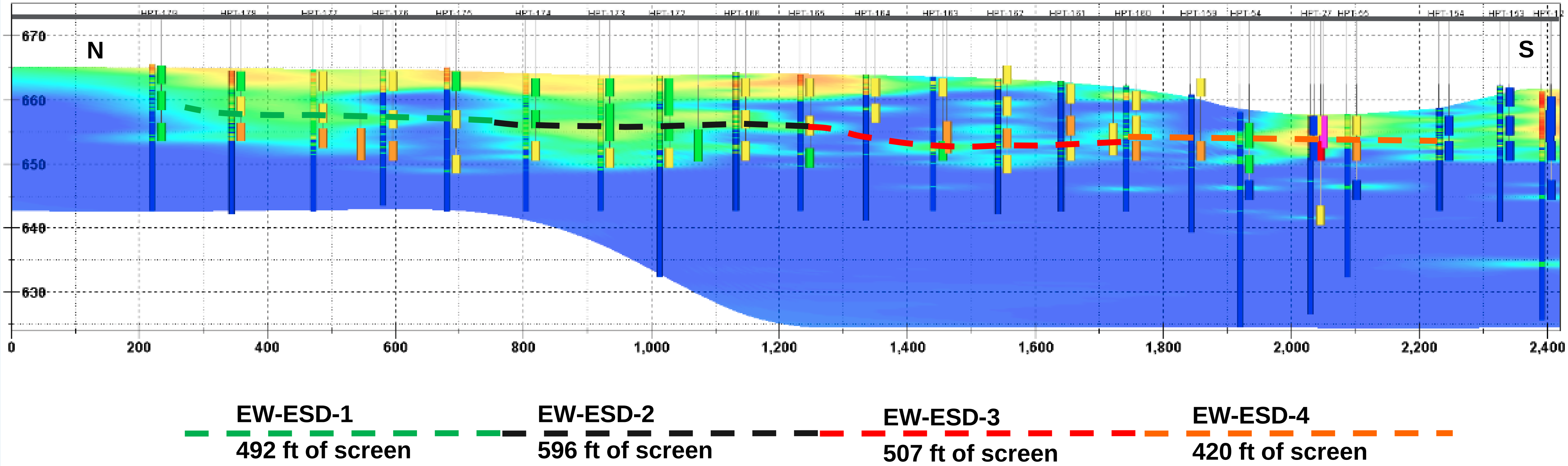
······ ELECTRICAL CARRIER PIPE CP-ESD-3 (3-INCH SDR-13.5 UL-LISTED HDPE)

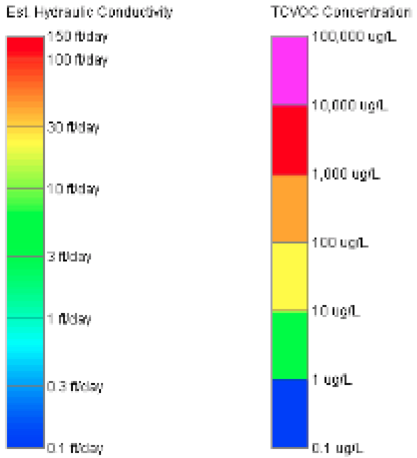
······ ELECTRICAL CARRIER PIPE (3-INCH CPVC)

······ GROUNDWATER DISCHARGE LINE

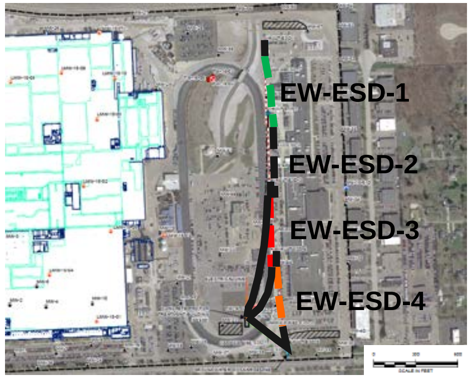
Hydraulic Barrier: Extraction Wells

Hydraulic Conductivity



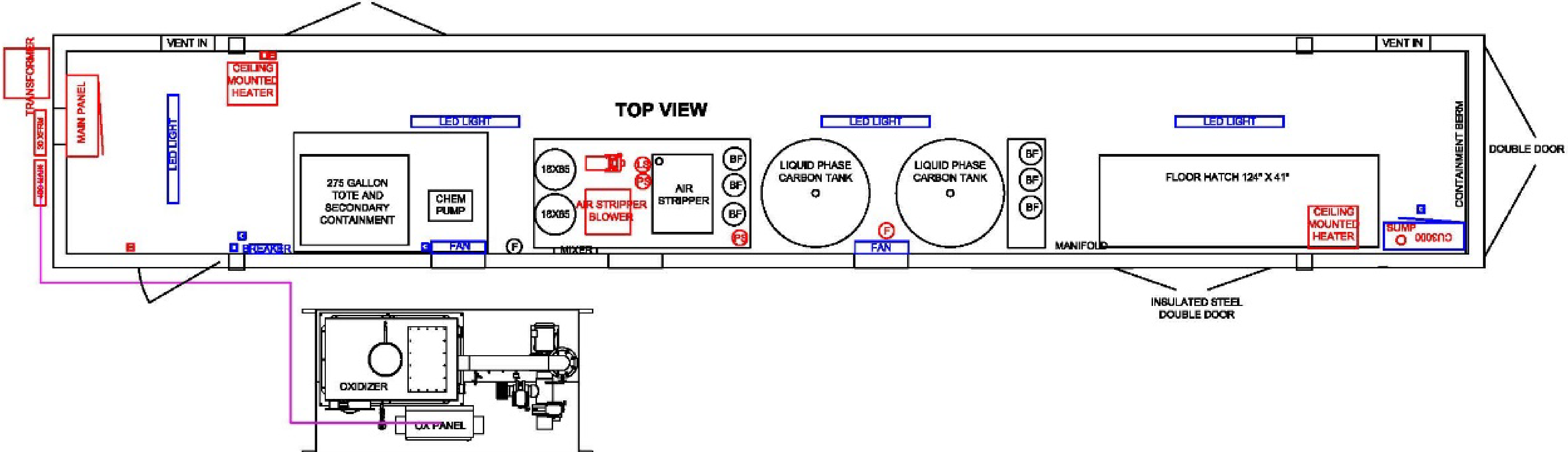


- 2,000 ft long Hydraulic barrier
- Four screens 16.5 – 22.5 feet below grade surface (bgs)
- Screens placed in high permeability (K) zones for optimal capture of VOCs
- 4-inch-diameter HDPE well materials with 6-inch risers at southern ends
- Solid riser sections not shown



Groundwater Treatment System: Overview

- Influent Groundwater flows through Bag Filters to remove solids
- Sequestrant added to prevent precipitation of naturally occurring metals (iron, manganese)
- Air Stripper removes VOCs from Groundwater
- Effluent Bag Filters remove remaining solids
- Carbon filter provides final polishing step prior to permitted discharge to sanitary sewer
- Catalytic Oxidizer polishes Air Stripper vapor, as needed prior to discharge to atmosphere



Groundwater Treatment System: OMM

- Visits Conducted Weekly
  - Data Collection
  - Bag Filter Replacement
  - Air Stripper Inspection/Cleaning
- OMM Data Collection:
  - Pressure
  - Flow
  - Power Usage
  - Maintenance Record and Observations
  - Samples Collected

OMM: Sample Collection

Sample Collected	Location(s)	Frequency	How data is used
Individual Extraction Wells (EWs)	EW Sample Ports on Influent GW Manifold	As needed	• Monitor Influent Concentrations
Combined Influent	Combined Sample Port on GW Manifold	As needed	• Monitor Combined Influent Concentrations
System Midfluent	Lead and Lag GAC Vessel Influent	As needed	• Monitor Air Stripper Performance and Carbon Usage Rates
System Effluent	After Lag GAC before Discharge to City of Livonia Sanitary Sewer	Monthly	• Compliance Requirement for GLWA Discharge Permit

Performance Metrics

- Primary Objective: Mitigate migration of impacted groundwater
  - Metric: Capture Zone Evaluation
  - Method: USEPA Guidance Evaluation of Capture Zone for Pump and Treat (EPA 600/08/003, 2008)
- Secondary Objective: Remove contaminant mass
  - Metric: Mass Removal Calculations
  - Method: System Sampling – USEPA Method 624
- Compliance Monitoring:
  - Discharge Permit Compliance: GLWA Total Toxic Organics (TTO) List

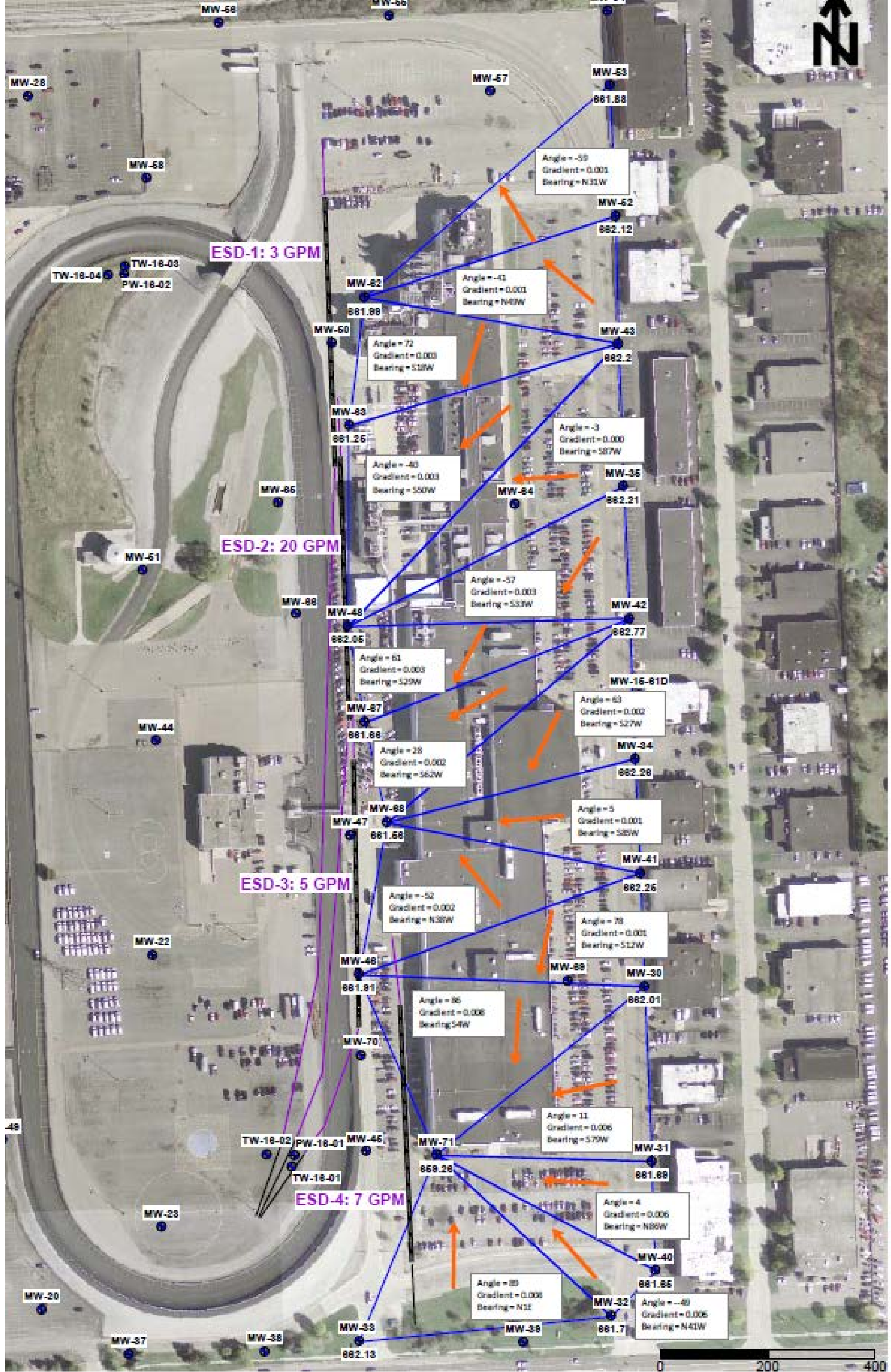
Table: Treatment System Influent Concentration Ranges

Extraction Well	Trichloroethene	1,2-Dichloroethene	Vinyl Chloride
ESD-1	ND	0-10 ppb	15 ppb
ESD-2	ND	0-10 ppb	0-10 ppb
ESD-3	ND	30 ppb	100 ppb
ESD-4	ND	30 ppb	80 ppb

- **Initial capture evaluation depicts inward gradient**
- **Effluent discharge in compliance with GLWA requirements**

System Performance: Hydraulic Capture
June 2017

- Gradient map developed consistent with USEPA Guidance Evaluation of Capture Zone for Pump and Treat (EPA 600/08/003, 2008)
- Consistent inward hydraulic gradient towards the groundwater treatment system extraction wells
- Demonstrated gradient provides evidence of capture zone, preventing off-site migration of impacted groundwater
- Gradient maps will be developed quarterly to document system capture



LEGEND:

MW-32 WELL ID

⊕ MONITORING WELL

661.63 GROUNDWATER ELEVATION (ft amsl)

△ WELL TRIPLET PLANE WITH HYDRAULIC GRADIENT DIRECTION

▥ WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)

— WELL BLANK CASING (4-INCH SDR-11 HDPE)

— WELL BLANK CASING (4-INCH SDR-11 HDPE)

Notes:

1. Only groundwater elevations used for hydraulic gradient calculations are posted.
2. June 2017 groundwater elevations represent pumping conditions after horizontal well installation Total system extraction rate in June 2017 was approximately 35 gallons per minute.
3. Wells were gauged on 6/28/17. An anomalous measurement at MW-43 prompted re-gauging of wells MW-35, MW-43, MW-48, MW-52, MW-53, MW-62, and MW-63 on 6/30/17.

Operational Timeline

- System Startup: March 2017
- System Optimization: April - Present
    - Initial 6 months of operation
    - Adjust and optimize pumping rates
    - Develop and refine operation and maintenance procedures
- Evaluate Capture:
    - Capture zone evaluation
- Compliance Monitoring:
    - Discharge Permit Compliance: GLWA Total Toxic Organics (TTO) List

Comment #5
Storm Drain Rehabilitation

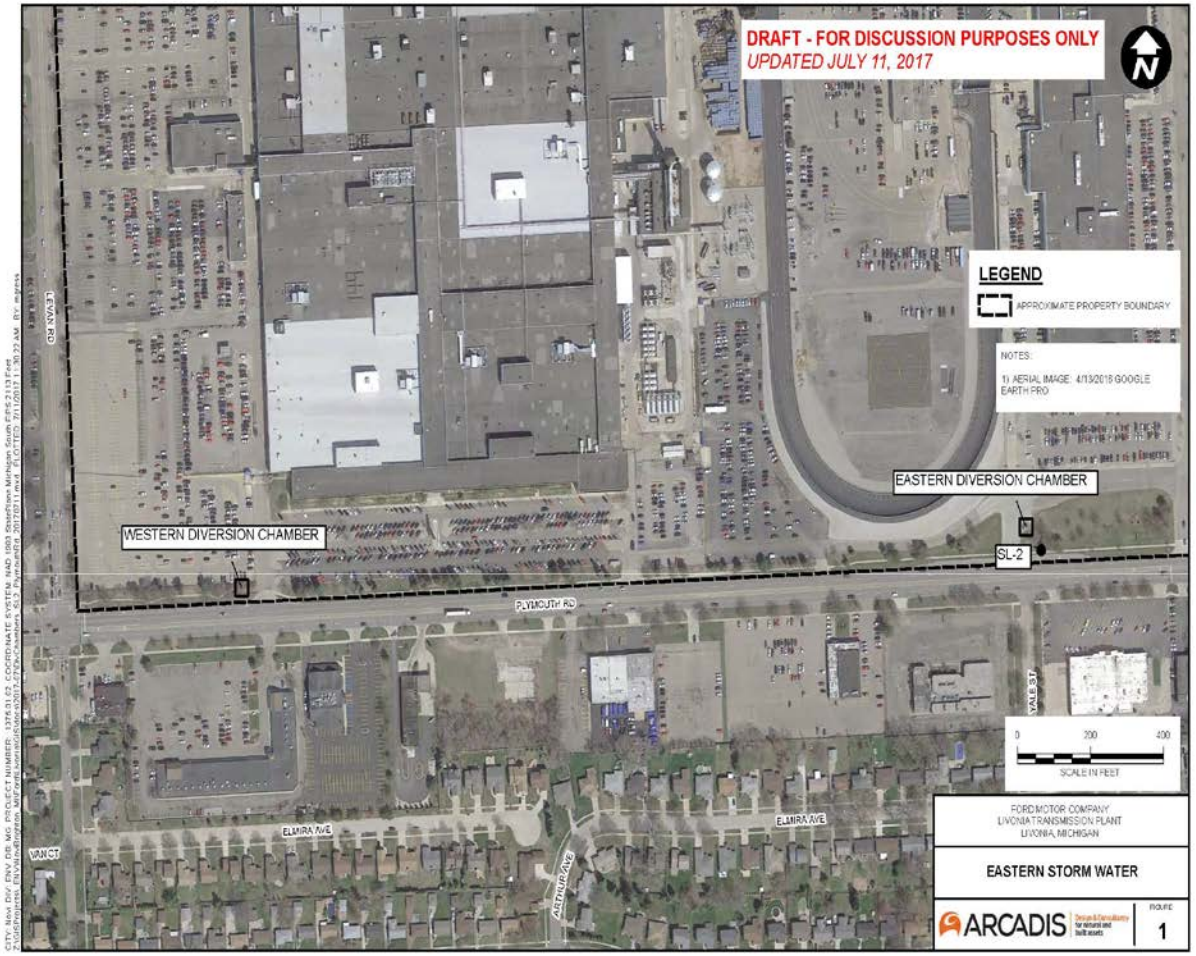
Compliance Sampling

Water samples collected on January 15, 2016 at the eastern diversion and western diversion chambers and compliance point SL-2. Samples were collected as routine per the GLWA permit requirements

- Results indicated that chlorinated solvents were present in the compliance water samples:

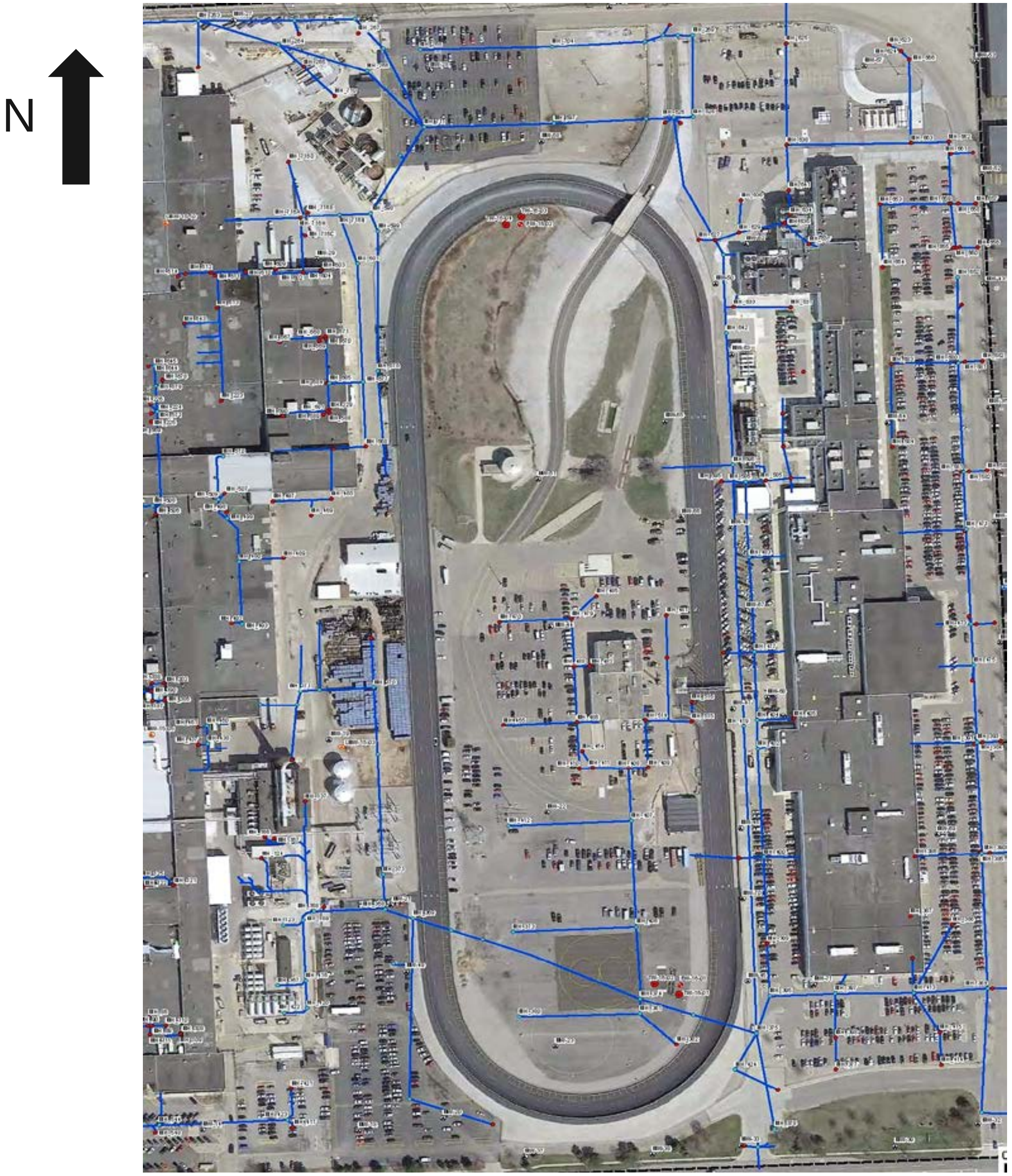
Sample Location: Sample Date	Eastern Diversion Chamber	Western Diversion Chamber	SL-2
VOC ug/L			
cis-1,2-dichloroethene	150	<1.0	220
Trichloroethylene	4.1	<1.0	56
Vinyl Chloride	100	<1.0	53

Notes:
All results are in units of micrograms per liter (ug/L).
< Result is less than laboratory reporting limit.



Scope of Work

- Review and assess ~17,000 linear feet of storm sewer pipe for structural deficiencies and potential rehabilitation.
- Review and assess 31 storm sewer manholes for structural deficiencies and rehabilitation.
- Rehabilitate compromised manholes and storm sewer pipes.

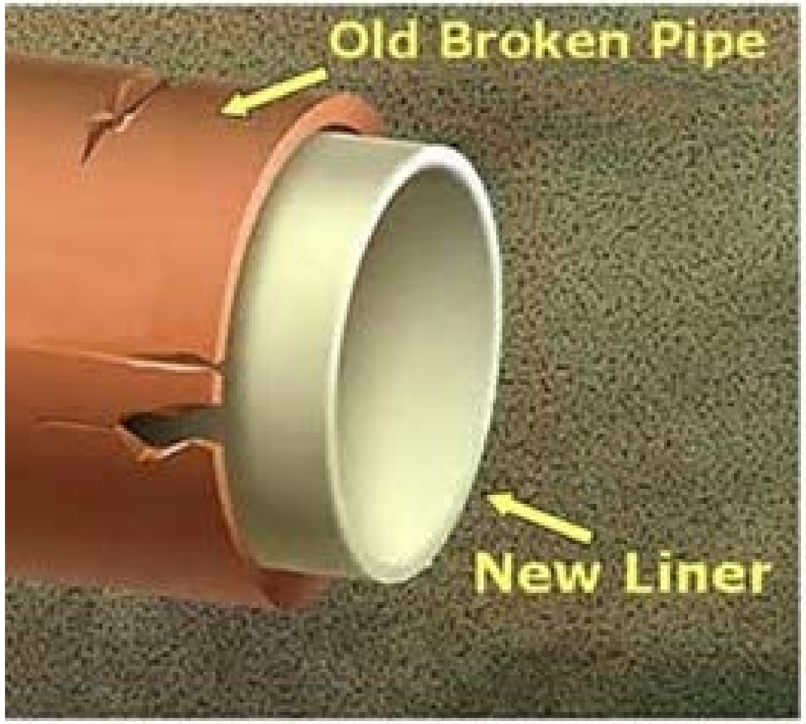


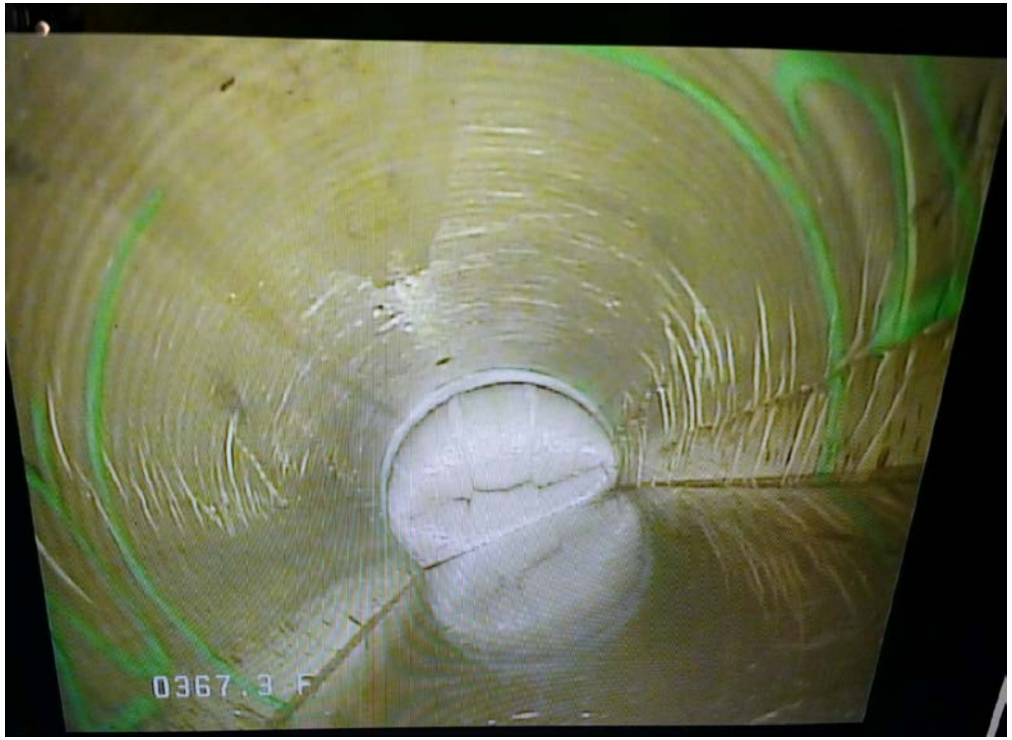
Technologies Implemented at the Livonia Transmission Plant

- **Closed-Circuit Television** - is a TV system in which signals are not publicly distributed but are monitored. The purpose of Closed Circuit Television Inspection (CCTV) is to determine:
  - Structural condition
  - Location of O&M and structural defects
  - Evidence of inflow and infiltration (I/I)
  - Size and material of construction
  - Locations of service laterals

Technologies Implemented at the Livonia Transmission Plant (cont.)

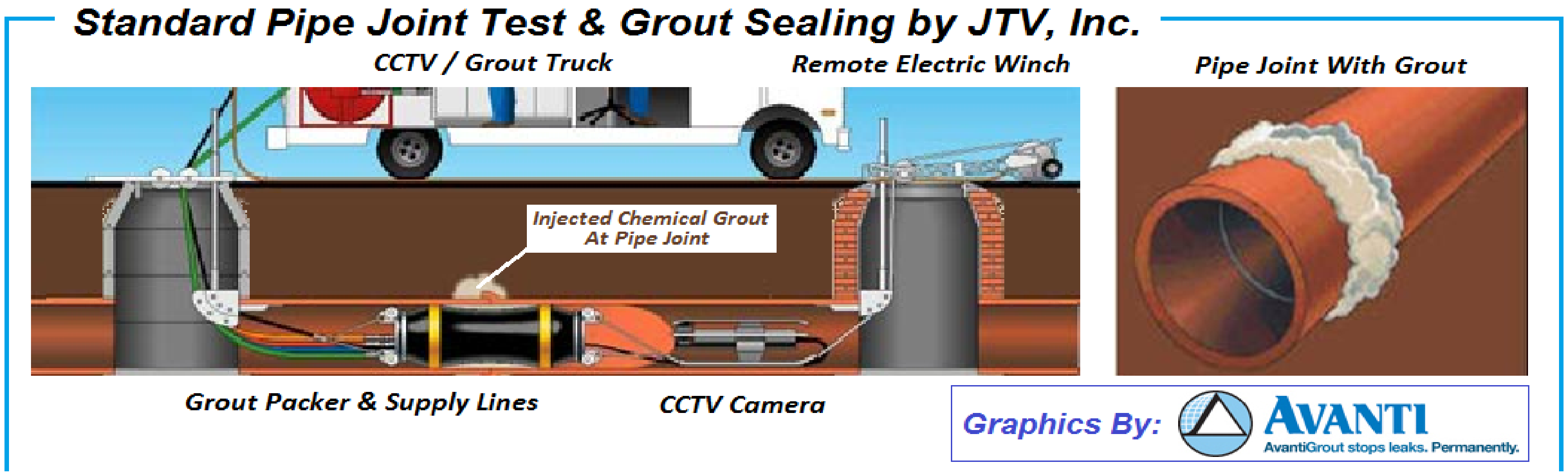
Cured-in-Place Pipe Lining – CIPP is a thermos-set resin system delivered via a felt, fiberglass, or carbon fiber tube of the designed thickness specified. The resin-saturated tube is installed either by directly inverting the tube into position using water or air or by pulling the resin-saturated tube into place and inflating the tube directly or with a calibration tube. Once in place and properly inflated, the raw material resin system is cured. After cleaning and inspection, the existing pipe is used as a mold. The resin-impregnated tube is inserted into the existing pipe and then is cured by hot water, steam, or UV light, resulting in a hard new pipe within a pipe.





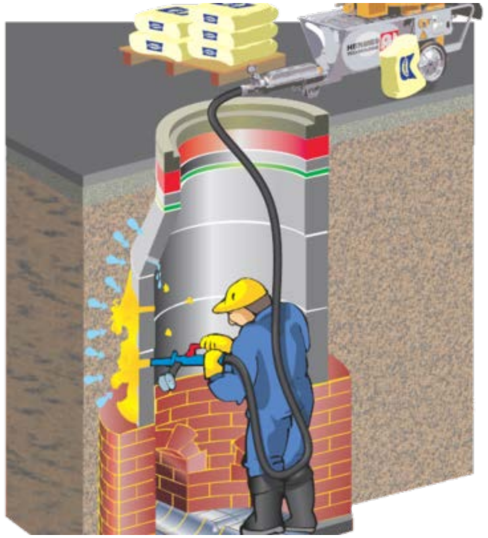
Technologies Implemented at the Livonia Transmission Plant (cont.)

Test and Seal – Packer injection grouting is a cost-effective technology used to stop infiltration and exfiltration from entering through defective pipe joints. Grout is pumped under pressure into the soil and bedding surrounding the pipe through each joint and defect using a packer sealed to the interior of the pipe. The grout reacts with the soil and bedding to form a solid seal on the exterior of the pipe, which prevents infiltration and entry of soil and bedding into the pipe. The grout process is typically preceded by a pressure test of the joint to determine if it is failing. If the joint does not hold, a specified pressure over a set period it is considered defective and then sealed with the grout.



Technologies Implemented at the Livonia Transmission Plant (cont.)

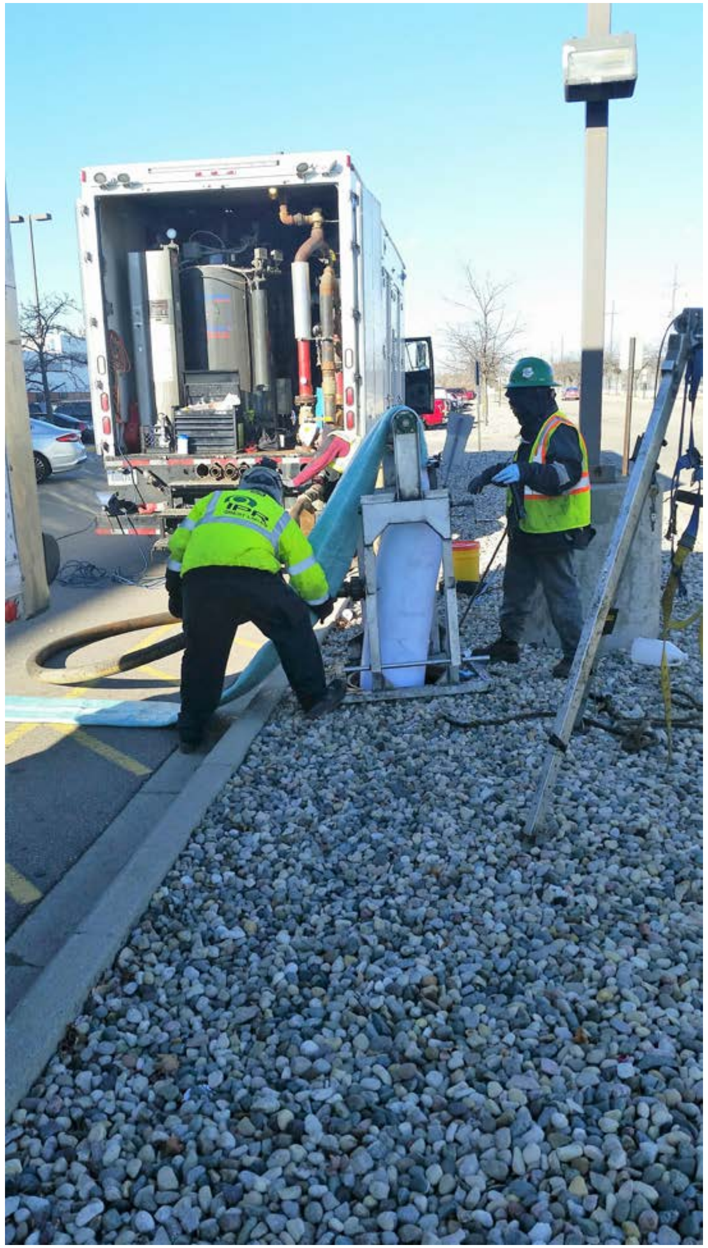
Manhole Rehabilitation – There are many methods available for the rehabilitation of manholes. Each method must be evaluated to determine the best solution. Different methods include grouting, lining (cementitious or polymer coating), and chimney seals.



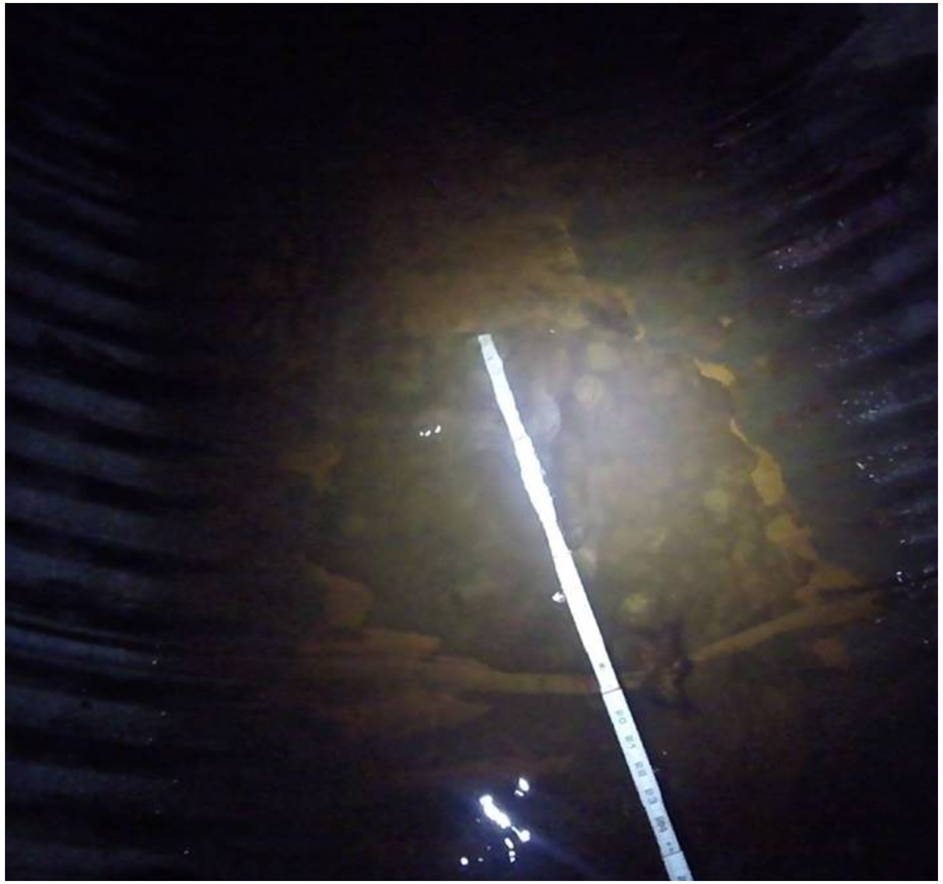
Man Entry Injection Grouting – Grout is injected through drilled holes into the pipe where leakage was found.

Project Scope Completed as of July 29, 2017

- **CCTV and Cleaned** – 15,852 linear feet
- **Cured-in-Place Pipe Liner** – 3,588 linear feet
- **Test and Seal** – 12,264 linear feet
- **Manholes** – 31 primary manholes rehabilitated
- **Man Entry Injection Grouting** – two locations rehabilitated
- **Installation of Storm Sewer Clean Outs** – seven Installed
- **Installation of Manholes/Implement CIPPL**– three installed



48-Inch Line before Rehabilitation



48-Inch Line Inspected after CIPPL Installed