TRANSMITTAL LETTER

ARCADIS Design & Consultancy for natural and built assets

To:
Brandon Alger
Michigan Department of Environmental Quality
Remediation and Redevelopment Division

From:
Kris Hinskey

Arcadis U.S., Inc.
28550 Cabot Drive
Suite 500
Novi
Michigan 48377
Tel 248 994 2240
Fax 248 994 2241

Copies:

Date:
April 13, 2018

Subject:
Livonia Transmission Plant
Response Activity Plans

Arcadis Project No.:
MI001322.0001

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Ford Motor Company

RESPONSE ACTIVITY PLAN – REMEDIAL INVESTIGATION

Livonia Transmission Plant

This document is a DRAFT document that has not received approval from the Michigan Department of Environmental Quality (MDEQ). This document was prepared pursuant to a court Consent Decree. The opinions, findings, and conclusions expressed are those of the authors and not those of the MDEQ.

April 13, 2018

RESPONSE ACTIVITY PLAN – REMEDIAL INVESTIGATION

Livonia Transmission Plant Area of Concern
Court Case: No. 2:1712372-GAD-RSW

Patrick Curry, PG, CPG
Principal Geologist

Mitch Wacksman
Principal Toxicologist

Kristoffer Hinskey
Certified Project Manager

Joseph A. Quinnan, PG, PE
Senior Vice President

Prepared for:

Ford Motor Company

Environmental Quality office

Fairlane Plaza North
290 Town Center Drive, Suite 800
Dearborn, MI 48126

Prepared by:

Arcadis of Michigan, LLC

28550 Cabot Drive

Suite 500

Novi

Michigan 48377

Tel 248 994 2240

Fax 248 994 2241

Our Ref.:

MI001322.0001

Date:

April 13, 2018

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ACRONYMS AND ABBREVIATIONS

CSM	conceptual site model
CCTV	closed-circuit television
cDCE	cis-1,2-dichloroethene
COC	constituent of concern
cSt	centistoke
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ELAP	Environmental Laboratory Accreditation Program
°F	degrees Fahrenheit
ft amsl	feet above mean sea level
ft bgs	feet below ground surface
GWIC	groundwater in contact
HCS	hydraulic control system
HPT	hydraulic profiling tool
LIF-HP	laser-induced fluorescence-hydraulic profile
LNAPL	light non-aqueous phase liquid
LTP	Livonia Transmission Plant
µg/L	microgram per liter
MDEQ	Michigan Department of Environmental Quality
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
PS	potential source
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RespAP	Response Activity Plan
RI	Remedial Investigation
RIASL	residential interim action screening level
RRD	Remediation and Redevelopment Division
TCA	trichloroethane

TCE	trichloroethene
tDCE	trans-1,2-dichloroethene
TDL	target detection limit
USEPA	United States Environmental Protection Agency
VAP	vertical aquifer profiling
VC	vinyl chloride
VI	vapor intrusion
VIAC	Volatilization to Indoor Air Criteria
VOC	volatile organic compound
WCSS	whole core soil sampling
WWTP	waste water treatment plant

1 INTRODUCTION

Arcadis of Michigan LLC (Arcadis) has prepared the following Remedial Investigation (RI) Response Activity Plan (RespAP) on behalf of Ford Motor Company (Ford) for the Livonia Transmission Plant (LTP) site (the site). The site investigation area is included as **Figure 1**. This document describes the RI activities that will be used to comprehensively assess the nature and extent of environmental releases and impacts and further evaluate potential exposure pathways at the LTP in accordance with the Consent Decree effective July 27, 2017 (No: 2:1712372-GAD-RSW), and satisfies section 6.7 of the response activity plan for conducting an RI and section 6.6 (a)(ii)(A). All related activities associated with 6.6 (b)(i) will be submitted in a separate RespAP.

The proposed response activities will address the data gaps identified in the conceptual site model (CSM; Arcadis 2017a), address the Michigan Department of Environmental Quality's (MDEQ's) comments provided in the approval letter for the CSM received on November 13, 2017, address MDEQ comments provided in the disapproval letter for the RespAP dated on March 9, 2018 and received on March 16, 2018, present items discussed with MDEQ staff during the April 5, 2018 meeting, continue to satisfy section 6.7 of the CD, and complete other activities required for a comprehensive RI report. The proposed response activities will be completed systematically in phases to provide the appropriate data for decision making. Additional phases might be required to address data gaps that evolve with the changes in the CSM, or to collect additional information deemed vital to the RI and site remedy evaluation.

This RespAP is organized to describe on-site and off-site RI activities. On-site activities will include:

- Source area characterization
- Site use history desktop review
- Delineation of light non-aqueous phase liquid (LNAPL)
- Evaluation of potential pathways created by utility corridors.

Additional off-site RI activities include:

- Delineation of groundwater impacts to the north and northeast of the site.

In addition, groundwater will be monitored routinely to establish and evaluate spatial and temporal trends on and off site.

The constituents of concern (COCs) for the site, as defined by the Consent Decree, include:

- Trichloroethene (TCE)
- Tetrachloroethene (PCE)
- 1,1-dichloroethene (DCE)
- Cis-1,2-dichloroethene (cDCE)
- Trans-1,2-dichoroethene (tDCE)
- Vinyl chloride (VC)
- 1,4-Dioxane.

The target detection limits (TDLs) for COCs in soil and groundwater are also defined in the Consent Decree. Due to analytical limitations, a separate RespAP requesting a TDL change for TCE and VC in residential groundwater was submitted to the MDEQ on November 21, 2017 and approved on December 20, 2017. Therefore, the goal of off-site groundwater delineation is to define TCE and VC to a TDL of 1.0 microgram per liter (µg/L).

This document provides a framework for the proposed RI activities. Investigation sampling, routine monitoring, and laboratory analyses methodology to be employed during the RI are presented in two Quality Assurance Project Plans (QAPPs; Arcadis 2017b, Arcadis 2017c), prepared and submitted to the MDEQ in August 2017. QAPP addenda may be prepared and submitted to MDEQ for review and approval should an investigation method require additional methods.

Schedule

The activities proposed herein will begin upon approval from the MDEQ and pending access to applicable off-site properties. The activities proposed below will be discussed with the MDEQ in a meeting before the approval of the RespAP. A schedule is provided below to show the approximate duration of the proposed response activities and is in compliance with Section 6.7(a)(iii). The schedule is not linear, and various tasks may be completed in parallel. Upon approval of the RespAP, a more detailed schedule will be provided to the MDEQ for review.

Scope Define Below	Approximate Duration
RI Activities (Off Site)	
Routine Groundwater Monitoring	Quarterly
Routine Soil Gas Sampling	Quarterly
Routine Progress Reporting	Quarterly
Send Access Agreements to Property Owners	1 week after MDEQ notifies Ford that the revised RI RespAP is approved.
Signed Access Agreements Received From Property Owners	TBD
Groundwater and Soil Investigation and Characterization Field Activities (North and Northeast of LTP)	Mobilize and Complete Work once Access Agreements are in Place.
Receive Analytical Results from Laboratory	10-Business Day Turn-Around-Time.
Review Groundwater and Soil Sample Data	Within 5-Business Days of Receiving Lab Analytical Reports.
Update and Submit Next Steps RI RespAP based on Data (Additional Investigation and delineation).	Within 30-Business Days of Receiving Lab Analytical Reports.

Scope Define Below	Approximate Duration
RI Activities (On Site)	
Routine Groundwater Monitoring	Quarterly
Routine Progress Reporting	Quarterly
LTP Source Area Investigation	Estimated 6 Months to Complete SOW pending MDEQ Approval of the RI RespAP.
LTP/ATNPC Vapor Intrusion Evaluation and Delineation	Estimated 3 Months to Complete SOW pending MDEQ Approval of the RI RespAP.
LTP Northwest Soil and Groundwater Investigation	SOW will be Completed In-Line with the Source Area Investigation
Utility Corridor Evaluation and Investigation	Estimated 6 Months to Complete SOW pending MDEQ Approval of the RI RespAP.
Remedial Investigation Report	Upon Completion and Review of the RI Activities Discussed Above.

2 ON-SITE REMEDIAL INVESTIGATIONS

The on-site RI activities completed to date have been focused on characterizing the nature and extent of groundwater impacts on site and evaluating mass flux of COCs emanating from previously identified potential source areas. Because of the early findings, and before issuance of the Consent Decree, Ford installed and began operating a hydraulic control system (HCS) in spring 2017 as an interim measure to capture the majority of the mass flux from the potential source areas and prevent further off-site migration of groundwater impacts to the east. The installation and general design of the HCS is documented in the CSM (Arcadis 2017a).

In addition, preliminary soil vapor analytical results indicated the potential for vapor intrusion (VI) below the footprint of the LTP. Therefore, Ford has designed and is constructing a focused sub-slab depressurization system that will become operational during the second quarter 2018.

Going forward, the focus of the on-site RI activities will be to address on-site data gaps described in the CSM. The on-site response activities include:

- **Potential Source Area Characterization** - As an initial step, the six potential source (PS) areas (PS-1 through PS-6) identified in the CSM (Arcadis 2017a) will be further evaluated beneath or adjacent to the LTP building. The results of the sampling data, summarized as part of the CSM, suggest that these six areas may have historically contributed to soil, groundwater, and/or vapor impacts at the site.
- **Site Use History Desktop Review -** Ford will complete a desktop review of documents describing historical site use (e.g., equipment, processes), tank closure records, construction records, and other documentation, and will interview site personnel to help locate other potential sources of COCs at the site. If additional potential sources are identified, they will be characterized as part of the RI activities.
- **LNAPL Delineation -** Delineation of LNAPL beneath the northwest portion of the building will continue.

- **Northwest Corner -** Impacts to groundwater identified in the northwestern portion of the site, potentially associated with the storm sewer system, will be evaluated.
- **Utility Corridors –** Utility corridors will be further evaluated to determine which corridors are at greatest risk of intercepting impacted groundwater. As necessary, the data will be used to develop a focused approach to evaluate impacts to utilities as part of a future RespAP.

Potential Source Area Characterization

The identification of potential source areas and the response activities described below are based on the available soil, groundwater, LNAPL, and soil vapor data, as well as the known historical operations documented to date as part of the site review and initial CSM development. To date, six PS areas have been identified based on impacts observed in soil, groundwater, LNAPL, and/or soil vapor. The approximate locations of the PS areas are shown on **Figure 2**. For reference, the source investigation figures include the TCE sub-slab soil vapor impacts and the approximate extents of the LNAPL plume. Details regarding sub-slab soil vapor impacts, as well as soil and groundwater data, are provided in the CSM. PS areas include:

- PS-1 - Located in the southeastern portion of the LTP near several PS areas including the former broach machine pit. Downgradient impacts are well characterized; however, the lateral extents of source impacts have not been delineated.
- PS-2 - Soil vapor results identified concentrations of COCs beneath the northwestern portion of the LTP building near the former rail lines. The lack of high concentrations of COCs in downgradient groundwater samples suggests that impacts in the area of PS-2 are not contributing significant mass to groundwater; however, additional sampling is required to verify that impacts are confined to the vadose zone or entrained within the LNAPL.
- PS-3 - Soil vapor results suggest a source of volatile organic compounds (VOCs) in this area. Soil samples collected from below the water table at one location (LMW-15-02) indicate concentrations of DCE and VC in groundwater at depths between 13 and 20 feet below ground surface (ft bgs). However, the LNAPL samples from this area indicate only nominal concentrations of VOCs. These results suggest that a potential upgradient source of dissolved-phase VOCs may be present.
- PS-4 - Sampling at one location (LMW-15-05) has indicated concentrations of VOCs (1,1,1-trichloroethane [1,1,1-TCA], TCA, 1,1-dichloroethane [1,1-DCA], and DCE) in soil vapor and in LNAPL. Saturated soil sampling indicates high concentrations of DCE at 9 to 10 ft bgs, representing LNAPL-impacted soils. Additional sampling is required to verify that impacts are limited to the LNAPL smear zone and are not contributing to groundwater impacts at the site.
- PS-5 - Soil vapor 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. Additional sampling is required to determine if the source of VOCs is the LNAPL or is potentially associated with shallow soil impacts within the vadose zone
- PS-6 – This area is located north and west of the wastewater treatment plant (WWTP). To date, characterization has suggested low levels of VOCs in groundwater east to the property boundary and at the northern site boundary, but no hotspot or specific source of the VOC impacts has been identified.

Proposed Source Characterization Response Activity Plan

As identified above, the source characterization is centered around PS-1 through PS-6. Source characterization has been and will continue to be hindered by the presence of subsurface utilities, large equipment, and ongoing manufacturing operations within the LTP facility. Access to the subsurface will be limited to existing walkways within and around each PS area. Therefore, the source area RI will rely on transects of borings and sample collection where access is available. The locations of walkways within the LTP facility are included on **Figure 2**, as well as on the other source area figures.

PS area characterization will be completed as one continuous mobilization with samples evaluated on site for COCs (including 1,4-dioxane) with an Environmental Laboratory Accreditation Program (ELAP) certified mobile laboratory using gas chromatography/mass spectrometry and United States Environmental Protection Agency (USEPA) Method 8260 for VOC analysis. The mobile lab will be calibrated to meet the TDLs specified by the Consent Decree, as modified and agreed upon with the MDEQ. The near real-time results will be used to adapt the source investigation to focus on areas most likely to contribute to VI or groundwater impacts at the site. If concentrations observed with the mobile laboratory are above applicable Part 201 criteria (i.e., soil or groundwater) or the non-residential Volatilization to Indoor Air Criteria (VIAC) provided by the MDEQ, additional borings will be completed to refine the delineation. The PS primary borings will be completed at nominal 50- to100-foot spacing, with adaptive borings used to reduce the spacing and complete step-outs as necessary to refine the delineation. Five percent of the samples collected during the source characterization will be split to TestAmerica located in North Canton, OH for comparison and validation of the mobile laboratory results. All soil, vapor, and groundwater samples will be collected and analyzed in accordance with the methodology specified in the QAPPs (Arcadis 2017b). If delineation to criteria is not achieved within the number of borings proposed as part of the RespAP, the results will be discussed with the MDEQ, to include a discussion of the benefit (or lack thereof) of completing additional source characterization in a given PS area.

Potential Source Area 1

In addition to elevated soil vapor results in the area, high concentrations of COCs (primarily TCE, cDCE, and VC) were identified in groundwater underneath the LNAPL. A downgradient transect consisting of Dakota Technologies® laser-induced fluorescence - hydraulic profile (LIF-HP) borings coupled with high-resolution whole-core soil sampling (WCSS) has indicated that this PS area contributes 95% or more of the COC mass flux observed in groundwater at the site. The source area is thought to be associated with the former broach machine pit or other former degreasers in the area. During recent renovations, all sub-slab pits were backfilled, and the floor was brought to grade. The former broach machine pit is currently located below the clean room use for valve body assembly. Access to the clean room is limited.

The response activities proposed for the initial PS-1 source characterization are shown on **Figure 3** along with the LNAPL footprint, TCE sub-slab vapor results, and TCE results for groundwater. The goal of the PS-1 characterization is to identify and delineate the source(s) of the TCE contributing the majority of COC mass flux observed at the site. The scope of work will be completed around three former structures (broach machine pit, former degreaser pit, and a backfilled pit) that may contain residual impacts, as well as two other areas with elevated soil gas detections.

The scope of work will be completed adaptively, with up to 19 primary borings complete around the PS areas as access allows. At each primary boring, the Geoprobe® Hydraulic Profiling Tool (HPT) or Dakota Technologies® LIF-HP will be advanced to a depth of 30 feet to provide a continuous hydraulic conductivity profile of the soil. Following completion of the initial boring, the hole will be grouted to grade. In an adjacent borehole, up to five soil samples will be collected through the vadose zone and LNAPL impacts. Once below the LNAPL impacts, up to three vertical aquifer profile (VAP) groundwater samples will be collected at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. Additional soil samples may be collected from low-permeability zones and the lower confining unit to evaluate stored COC mass. The continuous soil core will be screened with a photoionization detector (PID), and intervals suspected to be impacted by potential dense non-aqueous phase liquids (DNAPLs) will be tested with an Oil-In-Soil shake test kit, the results of which will be recorded on the soil boring log. Additional saturated soil samples may be collected from less permeable saturated zones, or intervals identified as potentially impacted with DNAPL, and submitted to the mobile lab for analysis.

Based on the mobile laboratory results, up to 18 adaptive soil borings will be completed as necessary to fill in data gaps and delineate the source (**Figure 3**). Adaptive borings will not include hydraulic profiling, but rather will focus on the collection of additional soil and VAP groundwater samples based on the geology from primary borings.

Potential Source Area 2 through 5

As indicated above, PS-2 through PS-5 have been primarily identified via sub-slab soil gas sampling or through limited saturated soil samples collected during LNAPL monitoring well installation. Although groundwater data collection in the central and northern portion of the LTP has been limited to date, downgradient groundwater samples suggest that dissolved-phase impacts associated with these source areas are relatively limited compared to those in PS-1. Nonetheless, the goal of the PS-2 through PS-5 characterization will be to evaluate the vadose and LNAPL-impacted zones and identify potential sources of the elevated COCs observed in sub-slab vapor samples to fill the identified data gaps.

Similar to the approach for investigating PS-1, the RI work will be completed within walkways in areas of elevated VOC soil gas impacts. The proposed borings for PS-2 through PS-5 are shown on **Figure 4**. The RI work will be completed adaptively with five to seven primary borings in each area that include hydraulic profiling with the HPT, vadose and LNAPL soil sampling, and then VAP groundwater sampling beneath the LNAPL impacts. Based on the results of the primary boring locations, adaptive step-outs will be added, as appropriate, to expand the characterization or isolate the VOC-impacted area. Adaptive borings will not include HPT soundings but will focus on the soil and groundwater sample collection. At each boring location, up to five soil samples will be collected through the vadose zone and LNAPL impacts. Once below the LNAPL impacts, up to three VAP groundwater samples will be collected at nominal 5-foot intervals up to a maximum depth of approximately 30 feet below grade.

Potential Source Area 6

A preliminary investigation completed around the WWTP in 2016 suggests a potential source of TCE associated with groundwater impacts present along the northern property boundary at boring HPT-1, as well as the northern impacted area that extends off site to the east. HPT and VAP borings were completed both east and west of the WWTP, as well as between the WWTP and northern property boundary (borings HPT-120 to HPT-130). Previous soil boring locations, along with the maximum TCE and VC results, are summarized on **Figure 5**. Between the WWTP and the LTP building (HPT-128 to HPT-130), only low concentrations of VC were observed at the southernmost location (HPT-130), suggesting limited contribution from impacts beneath the LTP building. Before construction of the WWTP, the area was used for waste storage (1960s and 70s). The area of waste storage included the current WWTP footprint and the areas to the north and south of the WWTP. An outline of the waste storage area based on the 1967 aerial photo is included on **Figure 5**. The goal of the PS-6 RI activities is to evaluate if a source of COCs (potentially TCE) exists in the area that may continue to contribute to low-level dissolved-phase TCE and VC groundwater impacts in the area.

The investigation at PS-6 will focus on the shallow soils and groundwater with maximum boring depths of 15 feet below grade and will include a grid of soil borings around the WWTP in areas potentially impacted by waste storage. The scope of work will be completed adaptively with up to 32 primary borings followed by up to 19 adaptive borings based on the sampling results. The locations of the proposed borings are included on **Figure 5**. At each boring location, up to five soil samples will be collected through the vadose zone, and one groundwater sample will be collected at the water table and evaluated for COCs using the mobile laboratory.

Northwest Corner Evaluation

In July 2017, Arcadis collected water samples from 34 storm sewer manholes to determine if COCs were still present in the eastern storm sewer system after storm sewer cleaning and rehabilitation, as described in the CSM (Arcadis 2017a). The evaluation showed TCE impacts within the northwestern portion of the storm system potentially related to infiltration of groundwater in this area of the site. The locations of the TCE detections, as well as the storm sewer layout, are included on **Figure 6**. The goal of the RI activities is to determine if there is a potential source of TCE contributing dissolved-phase impacts to the storm sewer, either on site or from an upgradient, off-site source.

An investigation will be completed in the northwestern portion of the site to evaluate potential sources of the TCE impacts. Transects of soil borings will be completed both east and west of the storm sewer lines located upgradient of the TCE detections, as well as along the western and northern property boundaries. The interior RI work will be focussed within the accessible walkways inside the LTP. The proposed borings for the northwest corner evaluation are shown on **Figure 6**. The RI work will be completed adaptively with up to 12 primary borings completed using HPT. Following completion of the initial boring, the hole will be grouted to grade. In an adjacent borehole, up to five soil samples will be collected through the vadose zone, followed by up to three VAP groundwater samples collected at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. Based on the results at the primary boring locations, up to 11 adaptive borings will be added, as appropriate, to focus on areas of interest. Adaptive borings will not include HPT soundings, but rather will focus on the soil and groundwater sample collection based on the geology from primary borings.

Source Area Desktop Review

In parallel with the potential source investigations described above, Ford will continue to review available documents and files regarding former site operations, locations of pits, tanks, waste handling areas, and other activities to gather more information regarding known PS areas and identify other PS areas. Response activities will include seeking and reviewing available documents at the LTP, as well as interviewing knowledgeable site personnel. The review will primarily focus on equipment and structures that historically used, stored, and/or transported chlorinated solvents and oils used in the manufacturing process. Based on the results of the desktop review, additional PS areas may be identified that require evaluation. Potential sources identified by the review, as well as data gaps identified as part of the initial source investigation activities, will be addressed as part of a future phase of RI work. Additional RI activities may include establishing a series of data collection transects to identify which former equipment and structures have contributed to LNAPL and COC impacts observed in soil and groundwater.

LNAPL Characterization

The LNAPL beneath the LTP was delineated previously using 68 LIF borings, and subsequently confirmed by soil sampling, sub-slab soil vapor sampling, and the installation of 10 LNAPL monitoring wells. As outlined in the CSM (Arcadis 2017a), the exception was within the northwest portion of the LTP.

As noted above, to date, the lines of evidence for LNAPL presence/absence include a comprehensive LIF survey across the building footprint, LNAPL saturated soil sampling with shake tests, installation of 10 LNAPL monitoring wells to verify LNAPL thickness and provide locations to conduct initial LNAPL mobility and recoverability testing, and laboratory analysis of eight LNAPL samples to evaluate LNAPL composition. In addition, a comprehensive evaluation of sub-slab soil gas, including methane, was completed across the footprint of the delineated LNAPL. The LNAPL wells, soil sampling, and sub-slab samples have verified the findings of the LIF survey. A brief summary of the LNAPL evaluation completed to date is provided below.

- LNAPL samples were collected and analyzed for density, viscosity, and interfacial tension from the eight monitoring wells (LMW-15-01, LMW-15-02, LMW-15-03, LMW-15-04, LMW-15-05, LMW-15-06, LMW-15-09, and LMW-15-10) containing LNAPL. LNAPL fluid properties often support LNAPL mobility evaluations and can support inferences regarding LNAPL type and origin. Results are detailed below:
    - Density ranged from 0.86 to 0.91 grams per cubic centimetre.
    - Kinematic viscosity values measured at 55 degrees Fahrenheit (°F; an approximate representative groundwater temperature) ranged from 16.2 to 333 centistokes (cSt).
    - Interfacial tension values for the LNAPL ranged from 4.4 to 12.4 dynes/centimeter.
- Whole oil analysis (C3-C36) was performed on the eight monitoring wells. The analysis provides a high-resolution chromatogram that can be used to identify phase-separated hydrocarbon type and extent of weathering. Results are detailed in the CSM, but in general:
    - The eastern portion of the LNAPL plume consists mainly of lighter oils that are more like mineral oil or light cutting oil.
    - LNAPL in the central and western portions of the LNAPL plume consists of heavier oil like cutting oils, quench/heat transfer oils, or lubricating oils.
- Transmissivity testing was completed at the site. The testing and evaluation were conducted in general accordance with the ASTM E-2856 Standard Guide for Estimation of LNAPL Transmissivity. The MDEQ has established an LNAPL transmissivity threshold recover of 0.5 ft^2/day to define recovery to the maximum extent practical. Transmissivity testing at several areas

within the LNAPL body are above the 0.5 ft^2/day, which indicates that the LNAPL recovery is possible. Details on the test results are detailed within the CSM.

LNAPL Response Activity Plan

The LNAPL impacts in that area will be delineated as part of the northwest corner investigation and will consist of three to seven LIF borings as illustrated on **Figure 6**. The QAPP (Arcadis 2017b) will be updated to include details on LIF methods.

3 UTILITY CORRIDORS

From October 2016 to July 2017, Arcadis oversaw the rehabilitation of more than 95% of the eastern storm sewer system on site, as documented in the CSM (Arcadis 2017a). Water and sediment samples were collected during and after the rehabilitation to evaluate the presence or absence of chlorinated VOCs and polychlorinated biphenyls (PCBs) within the storm system. In addition, water and sediment samples were collected within the sanitary sewers and process waste lines for the same purpose.

In August and September 2017, a portion of the sanitary sewer system and the western diversion chamber were jetted and cleaned as described in the Third Quarter 2017 Progress Report. Locations of the cleaned sanitary lines and the western diversion chamber are provided on **Figure 7**.

Preferential pathways around utility corridors are more common in low-permeability settings (i.e., clay-dominant), where the contrast in permeability between the fill material and native formation is very high. For example, a storm sewer with sandy bedding excavated into a lacustrine clay would provide a potential conduit for preferred migration along the utility corridor pathway. Based on the site CSM (moderately high permeability sand to 15 to 20 feet below grade), it is unlikely that the contrast in permeability would be sufficient at LTP for utilities to act as a conduit for preferred migration of groundwater.

Proposed Utility Corridor Response Activities Plan

Utility assessment has and will focus on evaluating potential impacts to utilities in areas where impacts have been identified. The focused approach will determine what corridors might be in contact with impacted water and potentially impacted with COCs. The focus approach will include the following, and is compliant with Section 6.7(v) of the Consent Decree:

- Additional closed-circuit television (CCTV) survey work and a survey of manhole structures will be completed for the remainder of the on-site eastern storm sewer system where COC impacts have been identified. The CCTV will be used to determine if additional pipe rehabilitation is warranted, and the manhole survey will determine which structures (manhole and inverts) are below the water table.
- Sediment samples will be collected from the eastern and western diversion chambers to determine if COCs are present.
- Storm and sanitary sewer systems (both on site and off site) will be systematically evaluated in relation to potential contact with groundwater, refer to **Figures 8** through **11**. The evaluation will include a field survey to confirm locations; survey of inverts and sumps; and if necessary, third-party locates of storm sewer, sanitary sewer, potential water lines, and gas lines. The evaluation will aid in determining additional field activities, if necessary, to understand potential utility corridor

pathways. In addition, existing monitoring well locations and screened intervals will be compared to the elevations of adjacent sanitary and storm sewer system pipes and manholes. This review will help determine if the well screens are constructed at similar elevations to allow use of the existing well network in evaluate potential pathways for migration of COCs along the utility corridors.

- Once all data stated above have been evaluated, a sampling program will be implemented to determine if impacts are entering and or migrating through the utility corridor. Additional investigation will include storm and sanitary sampling and potential VAP borings if necessary. Before implementing this phase of the utility corridor investigation, a meeting with the MDEQ will be requested.

4 OFF-SITE REMEDIAL INVESTIGATIONS

High-resolution site characterization was completed to characterize the nature and extents of impacts in both on-site and off-site groundwater. Most of the VC impacts that migrated to the east have been well characterized and delineated. The exceptions are areas to the northeast of the WWTP (PS-6), where TCE has not been delineated to the north of the site boundary; off site at the northeast corner of the property boundary, where low levels of VC have not been delineated; and in two additional areas of VC impacts east of the site and north of Rosati Drive (one area near the cul-de-sac and one near the north-south bend in the road).

The goal of the off-site delineation is to define COC impacts to the site-specific Residential Groundwater in Contact Vapor Intrusion Screening Levels. A Response Action Plan requesting a TDL change for TCE and VC in residential groundwater was submitted to the MDEQ on November 21, 2017. Therefore, pending approval, the goal is to delineate the extent of TCE and VC off site to a TDL of 1.0 µg/L.

The proposed activities will be completed in a manner similar to that of the previous off-site work activities and include phases of HPT/VAP borings to define the extents of off-site impacts followed by a focused monitoring well installation based on the VAP results. The HPT/VAP borings will be completed at a nominal 100- to 200-foot spacing, consistent with work previously completed at the site. The proposed locations of the borings are shown on **Figures 12** and **13**.

Proposed Groundwater Sampling Response Activity Plan

Access Agreements

Access agreements will be delivered to each property via certified mail. When signed access agreements are returned, additional work on these private properties will be scheduled. At properties where an access agreement is not returned within 2 weeks, Arcadis staff will hand-deliver another copy. MDEQ will be notified of properties that have not returned a signed access agreement, and Ford will take judicial action to gain access within 60 days of MDEQ approval of the RespAP in accordance with Section 7.2 of the Consent Decree. Ford proposes to initiate sampling and installation of new monitoring wells as soon as possible following receipt of a signed access agreement at each property and coordinate with each property owner. Ford will notify the MDEQ at least 10 days before any sampling activities conducted in the area of concern as described within Section 8.2 of the Consent Decree.

North of LTP Property

The response activities to address impacts identified along the northern LTP property boundary will be completed in phases. The locations of the proposed northern property borings are included on **Figure 12.** The first phase of activities will include the installation of six additional HPT/VAP borings along the northern property boundary, north of the LTP building and in the vicinity of the TCE impacts observed at HPT-01. Based on the analytical results along the northern boundary, the second step will initially include up to five HPT/VAP borings north of the LTP property to define the extents of the COCs in groundwater. Completion of the off-site borings is access-dependent, with the final locations of borings determined by feedback from commercial property owners. At each VAP boring location, up to three groundwater samples will be collected from the saturated zone at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. If the first line of borings is unsuccessful, a contingency line of up to five HPT/VAP borings will be completed further to the north. The final locations of the contingency borings will be determined based on the results of the initial round of HPT/VAP sampling. Once the extent of impacts is defined, the third step will include the installation of up to six additional monitoring wells at key locations within the impacted zones along the northern property boundary (if identified), and off site to serve as part of the sentinel monitoring network. Monitoring well screens will be installed at a depth consistent with the upgradient groundwater impacts and will consist of a 5-foot-long, 2-inch, 0.010-slot stainless steel wire-wrapped screen with an appropriate sand pack followed by a 2-inch polyvinyl chloride (PVC) riser. The annulus above the screen will be backfilled with bentonite grout to grade.

Northeast of LTP Property

Similar to those at the northern property boundary, response activities to the east of the site will be completed in phases and will consist of HPT/VAP borings to delineate VC to the TDL. The locations of the proposed borings are shown on **Figure 13.** The first phase of the activities will include up to 13 additional HPT/VAP borings north of Rosati Drive to define the extents of the COCs in groundwater. Completion of the off-site borings is access-dependent, with the final locations of borings determined by feedback from the various commercial property owners. At each VAP boring location, up to three groundwater samples will be collected from the saturated zone at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. If the first phase of borings is unsuccessful, up to 14 contingency HPT/VAP borings will be completed further to the north. Once the extent of impacts is defined, the third step will include the installation of up to ten additional monitoring at key locations off site to serve as part of the sentinel monitoring network. Monitoring well screens will be installed at a depth consistent with the upgradient groundwater impacts and will consist of a 5-foot-long, 2-inch, 0.010-slot stainless steel wire-wrapped screen with an appropriate sand pack followed by a 2-inch PVC riser. The annulus above the screen will be backfilled with bentonite grout to grade.

5 ROUTINE MONITORING

The following sections describe routine groundwater monitoring that will be completed in 2018. The monitoring program (i.e., appropriate wells and analytes) will be evaluated annually as new information becomes available and data trends become established.

Groundwater Sampling Response Activity Plan

Groundwater sampling activities were and will continue to be completed quarterly throughout 2018 as outlined in Arcadis' Technical Guidance (December 2016), included as **Attachment 1**. Additional wells installed as part of the RI will be included in future monitoring events. A list of the current monitoring wells, including associated construction details, is included as **Table 1**. All groundwater samples from on-site and off-site monitoring wells will be collected in pre-cleaned, laboratory-supplied sample containers preserved with hydrochloric acid. Each sample will be submitted to TestAmerica Laboratories, Inc. in Canton, Ohio on a standard 10-business day turnaround time. Detailed groundwater sampling methods are presented in the QAPPs (Arcadis 2017b, 2017c).

On-Site Sampling

Groundwater sampling will continue as follows:

- Depth-to-groundwater measurements will be collected from all 69 on-site monitoring wells using an electronic water level meter to within 0.01 foot and measured from the top of casing. Groundwater elevations will be calculated using the monitoring well survey data collected for each respective monitoring well in units of feet above mean sea level (ft amsl). The locations of on-site monitoring wells are shown on **Figure 14**.
- Depth-to-groundwater and LNAPL thickness measurements will be collected from all ten on-site LNAPL monitoring wells using an interface probe to within 0.01 foot and measured from the top of casing. Groundwater elevations will be calculated using an LNAPL correction factor and the monitoring well survey data collected for each respective monitoring well in units of ft amsl.
- Sixty-nine on-site monitoring wells will be sampled for analysis of COCs via USEPA Method 8260B and via USEPA 8260B-SIM (1,4-dioxane).

On-site groundwater analytical results will be compared to MDEQ Non-Residential Drinking Water Criteria (December 2013).

Off-Site Sampling

Groundwater sampling will continue off-site as follows:

- Depth-to-groundwater measurements will be collected at the 20 off-site monitoring wells using an electronic water level meter to within 0.01 foot and measured from the top of casing. Groundwater elevations will be calculated using the monitoring well survey data collected for each respective monitoring well in units of ft amsl. The locations of off-site monitoring wells are included as **Figure 14**.
- The 20 off-site monitoring wells will be sampled for analysis of site COCs via USEPA Method 8260B and 1,4-dioxane via USEPA 8260B-SIM.

Off-site sample results will be compared to MDEQ Remediation and Redevelopment Division (RRD) TDLs for TCE and VC (March 2016) as applicable screening levels for potential VI evaluation. All other constituents will be compared to MDEQ site-specific residential interim action screening levels (RIASLs) for groundwater in contact (GWIC) with a basement, which were provided within the Consent Decree.

6 WASTE MANAGEMENT

All investigation-derived soil waste was and will be containerized in 55-gallon drums and labelled non-hazardous waste pending disposal off site by Ford's approved waste vendor. It is estimated that approximately 100 to 115 drums of waste will be produced as part of the RespAP, compliant with Section 6.7(vi).

7 REPORTING

Proposed Reporting Response Activity Plan

Arcadis will communicate progress on activities detailed within the RespRAP within the quarterly progress reports. The information provided in those reports will summarize activities and will not provide detailed data and lab reports. Detailed information will be provided in subsequent RI reports as required in the Consent Decree.

8 OFF-SITE RESIDENTIAL AND IRRIGATION WELLS

As detailed in the CSM, Ford has identified one drinking water well located east of Stark Road. Ford also sent out surveys requesting information about any potential water wells on private residential properties on December 7, 2016. On March 1, 2017, Arcadis went door-to-door to deliver construction surveys at 24 properties east of the LTP where the initial construction survey was not returned. Thirty-six residential construction surveys were sent out to private property owners east of the LTP. To date, 23 surveys were received and evaluated. Twenty-eight surveys were sent out to commercial property owners; ten were received back to date.

Proposed Response Activity Plan

When each property is assessed and visited as part of response activities detailed in the VI RespAP, when an access agreement has been received, Ford representatives will ask property owners about the presence of wells and visually inspect for the potential well from inside and outside of the resident's home and or structures as identified in Section 6.7 (viii) of the Consent Decree. If irrigation or drinking wells are identified, Ford will notify the MDEQ and City of Livonia.

9 CLOSING

The goal of the RespAP outlined above is to document how Ford Motor Company will address the data gaps identified in the CSM (Arcadis 2017a), address the MDEQ comments to the CSM, incorporate comments received from the MDEQ during the April 5, 2018 meeting, and complete other activities that will be required for a comprehensive RI report in accordance with the Consent Decree. The work will be completed in phases to provide the appropriate data for decision making in accordance with the RI schedule contained herein. Quarterly progress and RI report(s) will be submitted to MDEQ throughout the RI process.

10 REFERENCES

Arcadis of Michigan LLC (Arcadis). 2017a. Conceptual Site Model. Livonia Transmission Plant. August.

Arcadis. 2017b. Quality Assurance Project Plan – On-Site. Livonia Transmission Plant, Livonia, Michigan. August.

Arcadis. 2017c. Quality Assurance Project Plan – Off-Site. Livonia Transmission Plant, Livonia, Michigan. August.

Michigan Department of Environmental Quality (MDEQ). 2013. Guidance Document for the Vapor Intrusion Pathway. Remediation and Redevelopment Division. May.

Arcadis of Michigan, LLC

28550 Cabot Drive

Suite 500

Novi, Michigan 48377

Tel 248 994 2240

Fax 248 994 2241

www.arcadis.com

FIGURES

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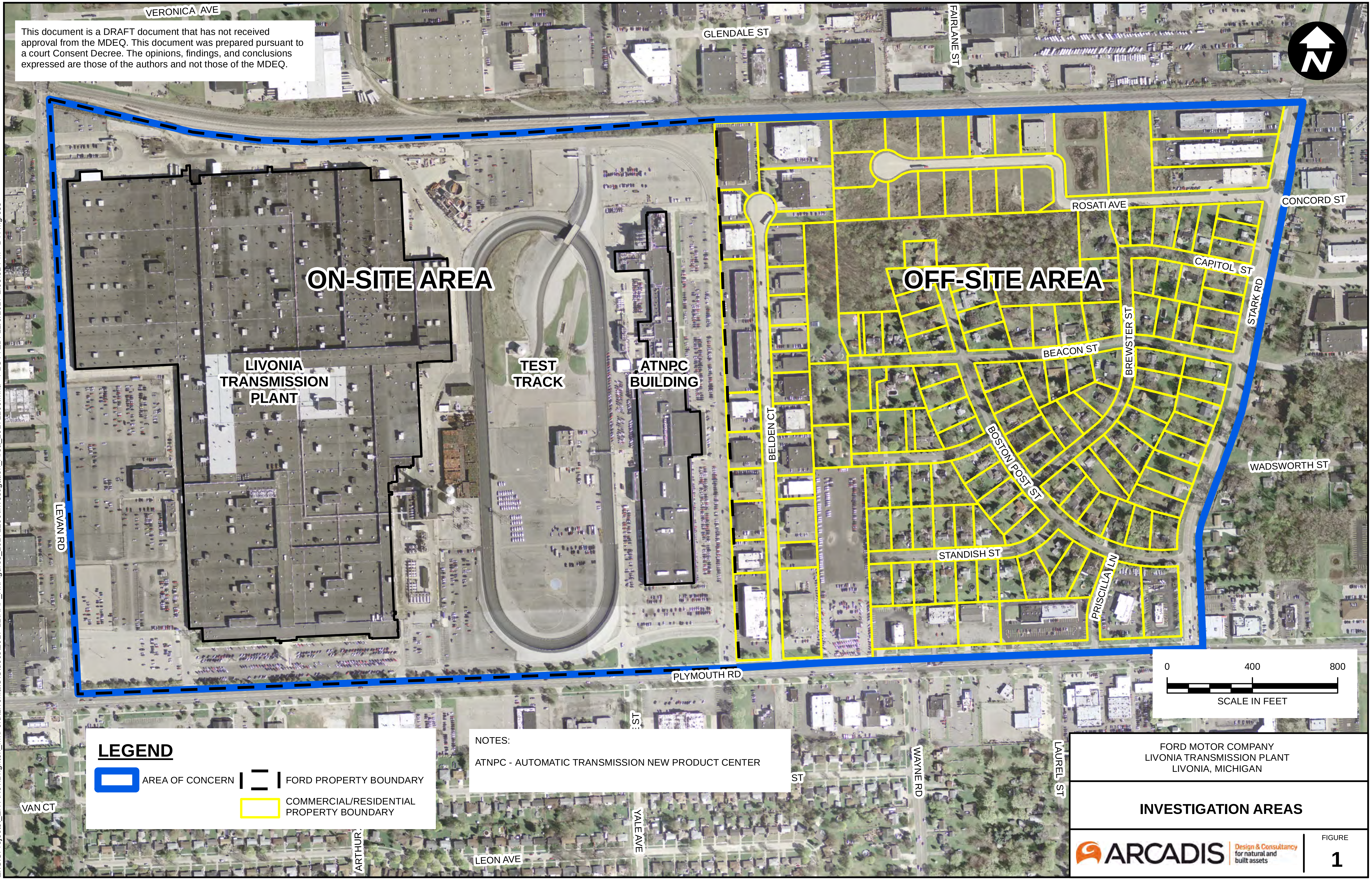

LEGEND

- AREA OF CONCERN
- FORD PROPERTY BOUNDARY
- COMMERCIAL/RESIDENTIAL PROPERTY BOUNDARY

NOTES:

ATNPC - AUTOMATIC TRANSMISSION NEW PRODUCT CENTER

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

INVESTIGATION AREAS

ARCADIS Design & Consultancy for natural and built assets

FIGURE 1

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
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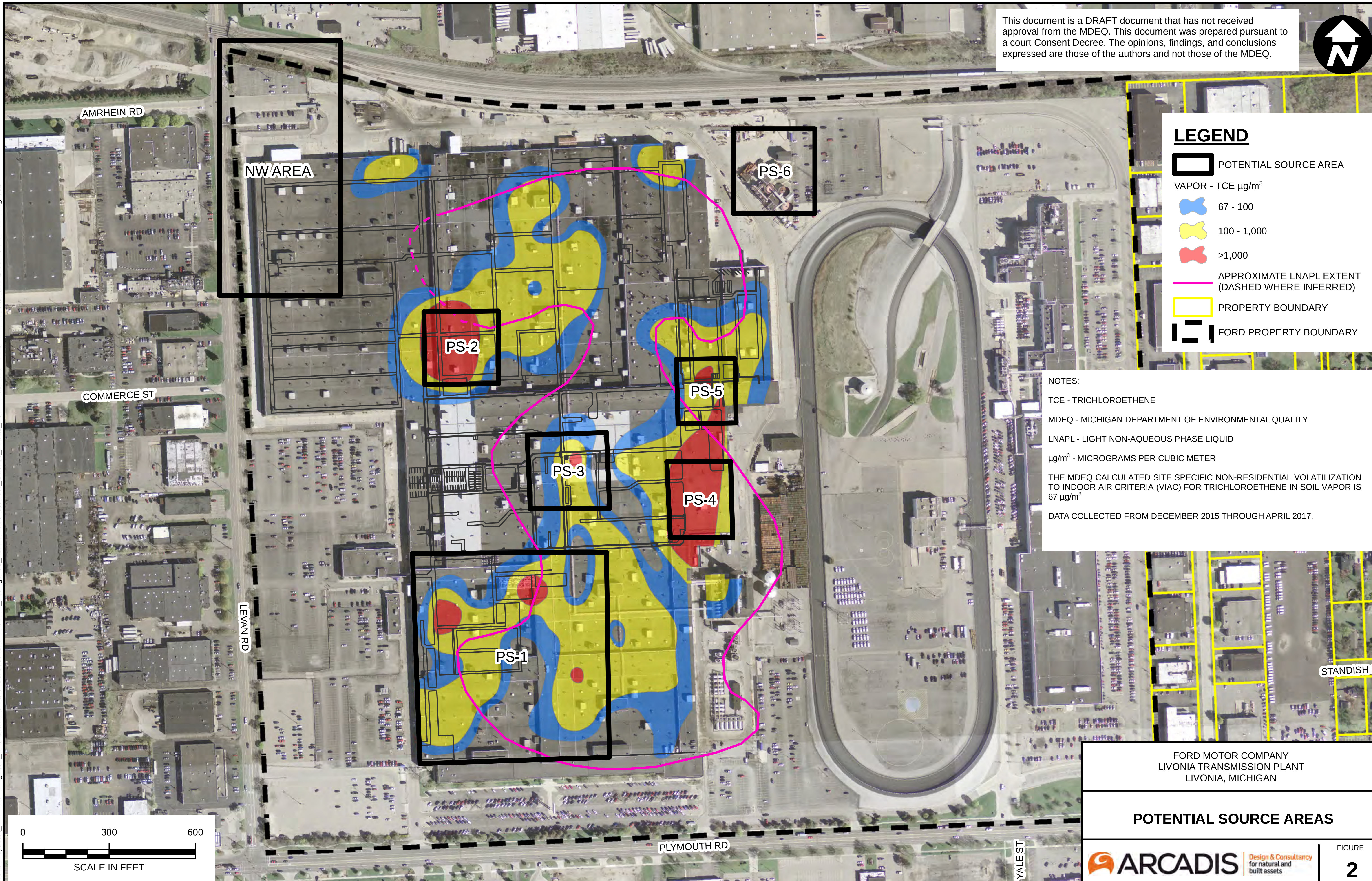

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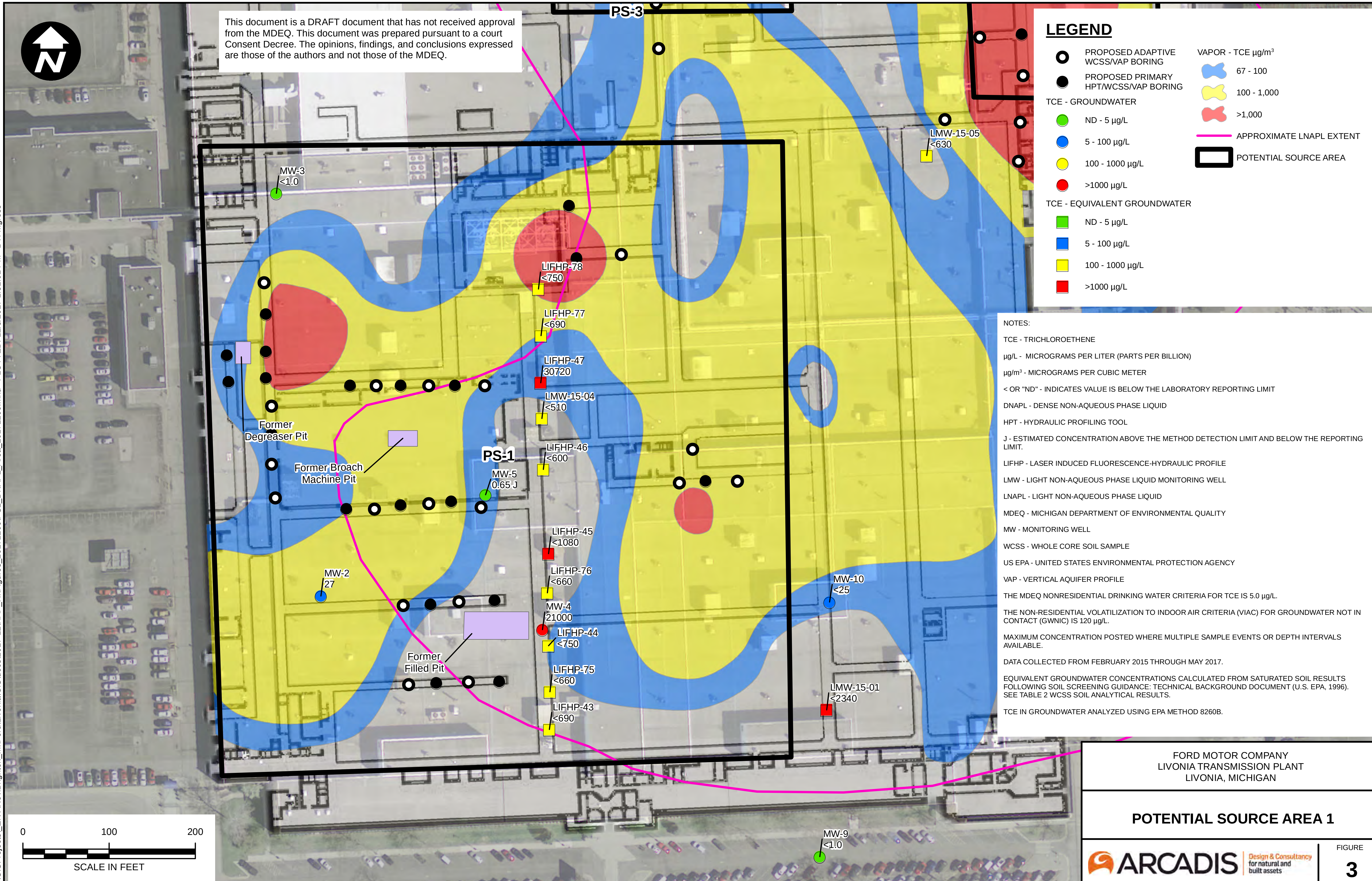

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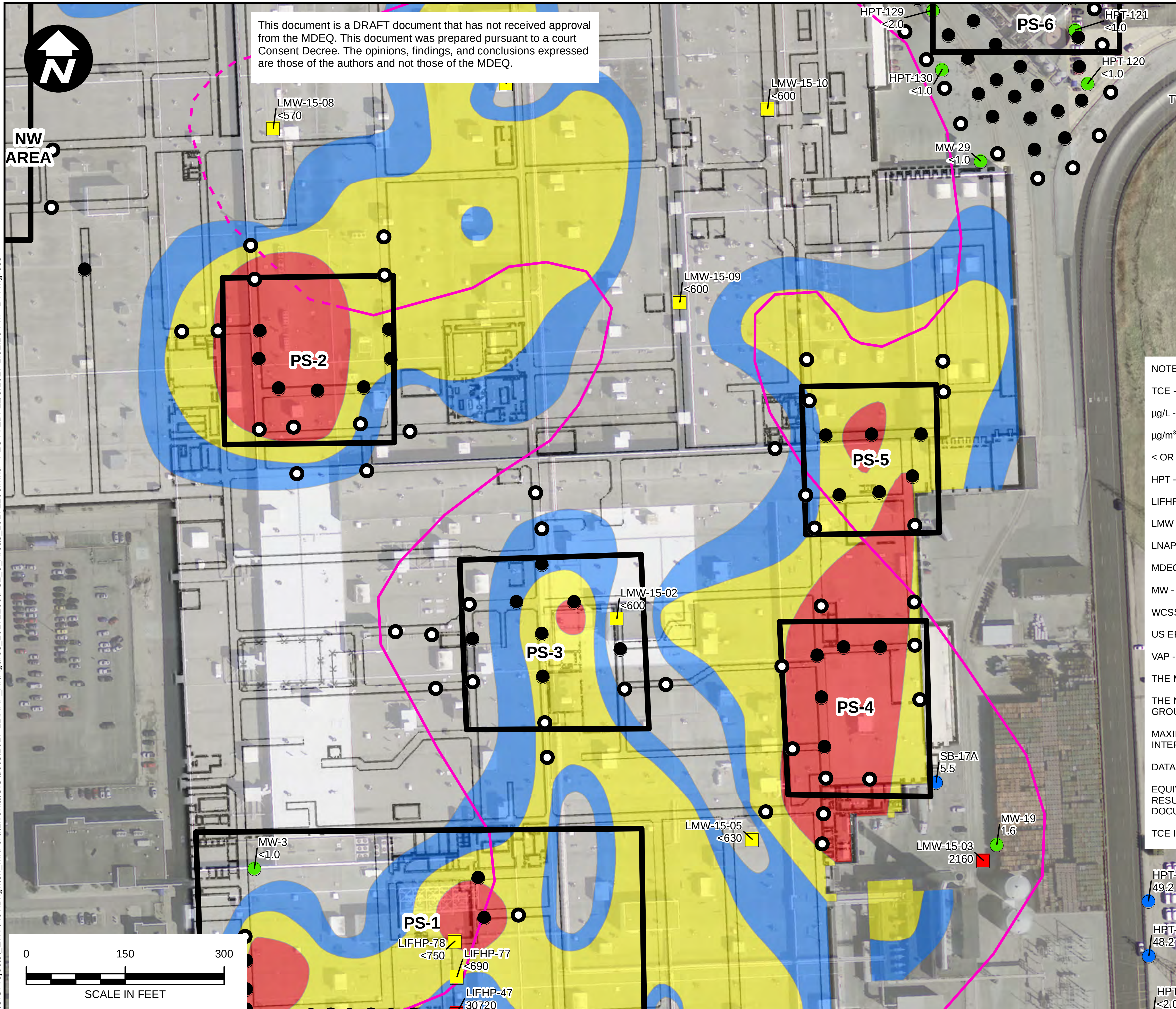

LEGEND

- PROPOSED ADAPTIVE WCSS/VAP BORING
- PROPOSED PRIMARY HPT/WCSS/VAP BORING

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

VAPOR - TCE µg/m³
- 67 - 100
- 100 - 1,000
- >1,000

- APPROXIMATE LNAPL EXTENT (DASHED WHERE INFERRED)
- POTENTIAL SOURCE AREA

NOTES:

TCE - TRICHLOROETHENE

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

µg/m³ - MICROGRAMS PER CUBIC METER

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

HPT - HYDRAULIC PROFILING TOOL

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

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

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

TCE IN GROUNDWATER ANALYZED USING EPA METHOD 8260B.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

POTENTIAL SOURCE AREAS 2, 3, 4 AND 5

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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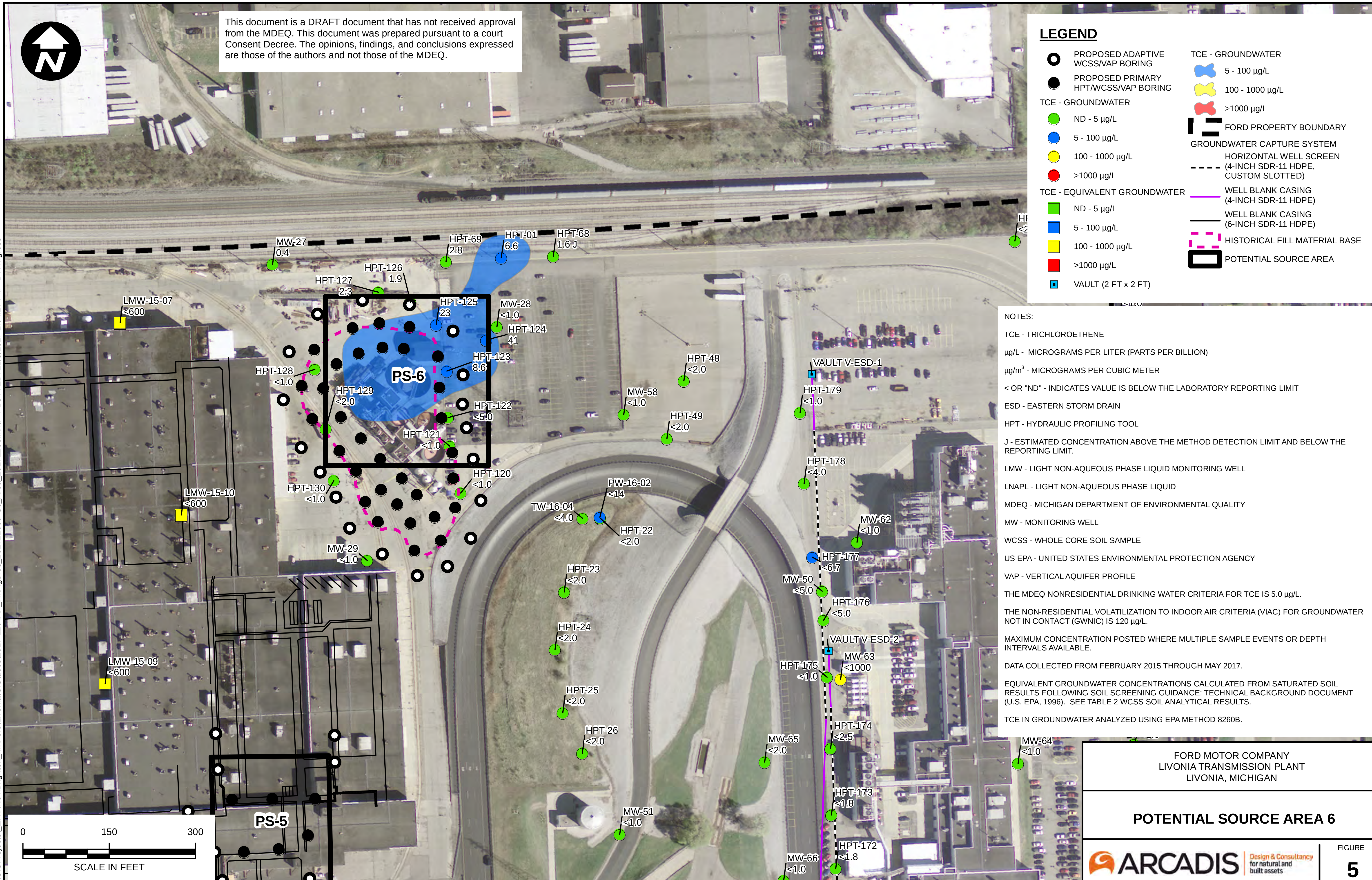

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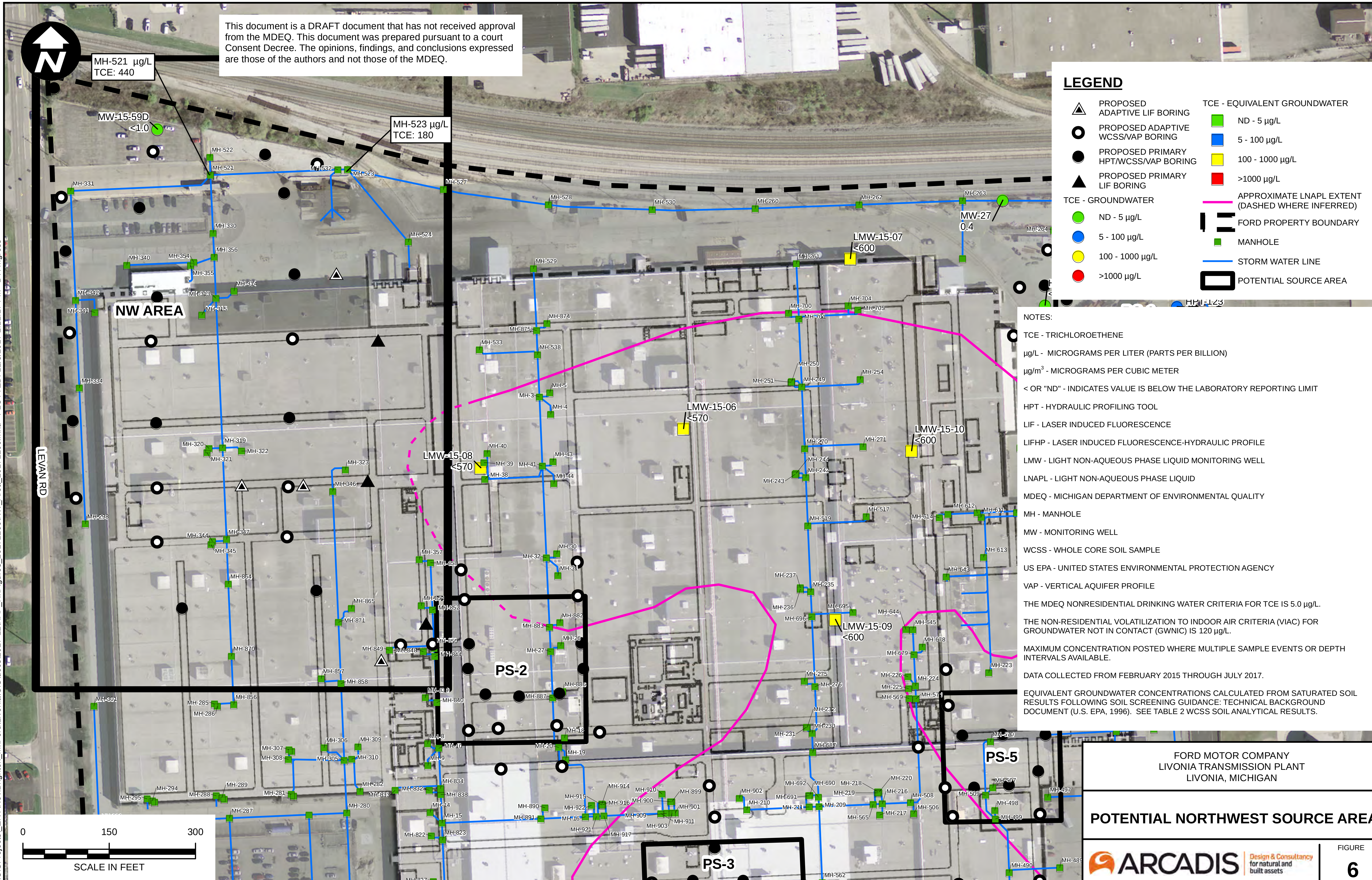

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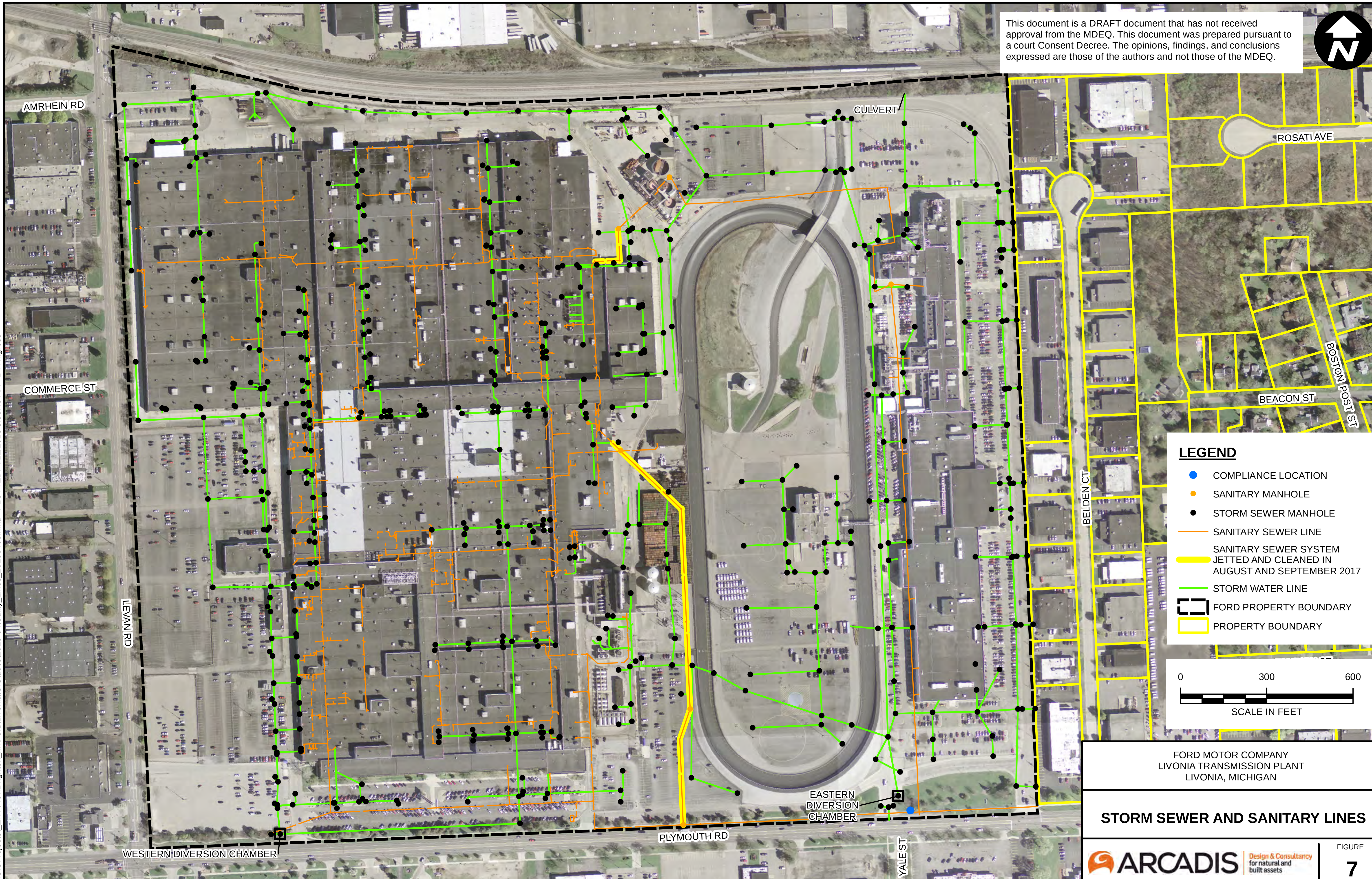

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

STORM SEWER AND SANITARY LINES

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FIGURE 7

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
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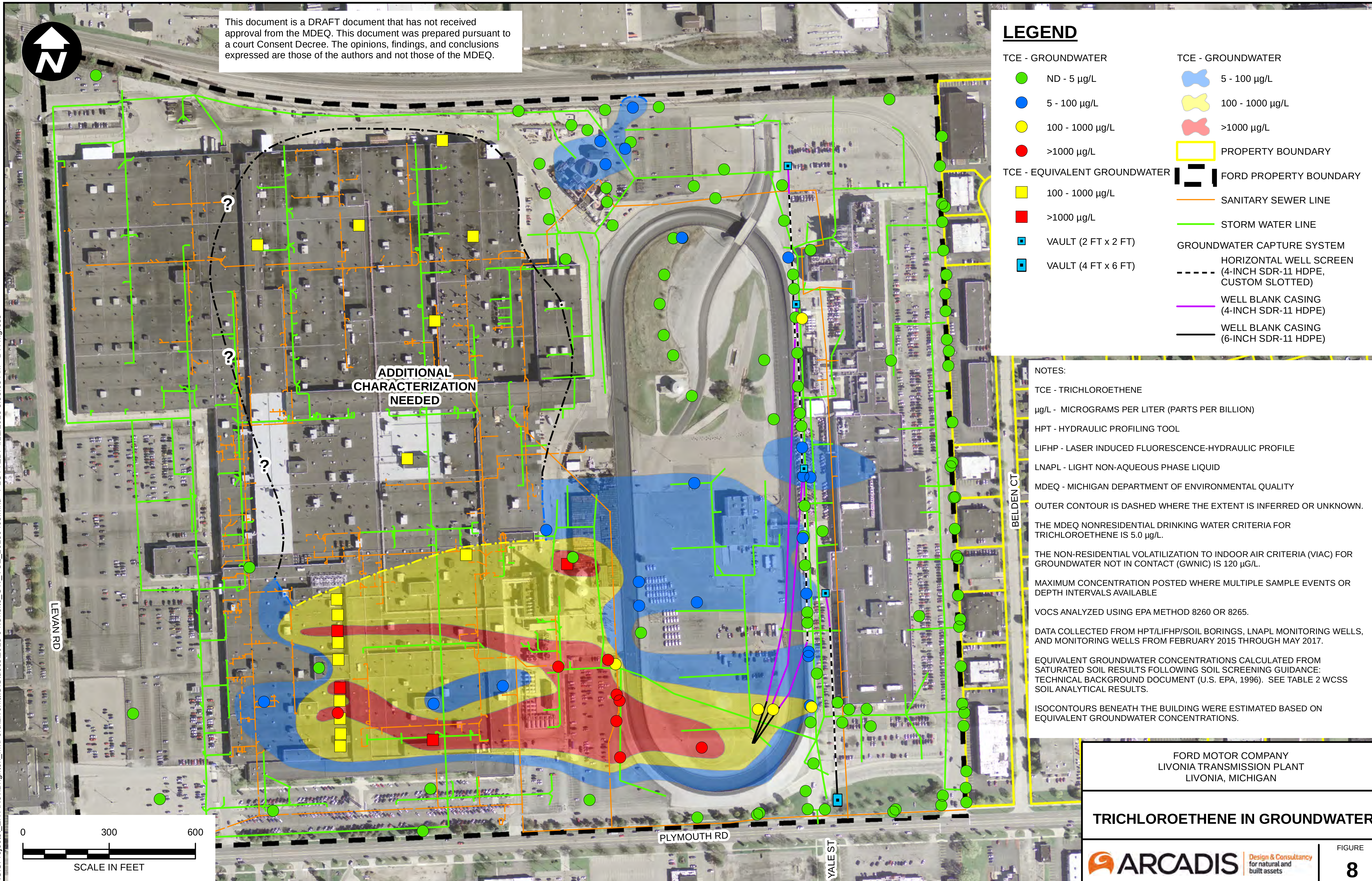

NOTES:

TCE - TRICHLOROETHENE

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

HPT - HYDRAULIC PROFILING TOOL

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

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

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µG/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE

VOCS ANALYZED USING EPA METHOD 8260 OR 8265.

DATA COLLECTED FROM HPT/LIFHP/SOIL BORINGS, LNAPL MONITORING WELLS, AND MONITORING WELLS FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

ISOCONTOURS BENEATH THE BUILDING WERE ESTIMATED BASED ON EQUIVALENT GROUNDWATER CONCENTRATIONS.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

TRICHLOROETHENE IN GROUNDWATER

ARCADIS Design & Consultancy for natural and built assets

FIGURE 8

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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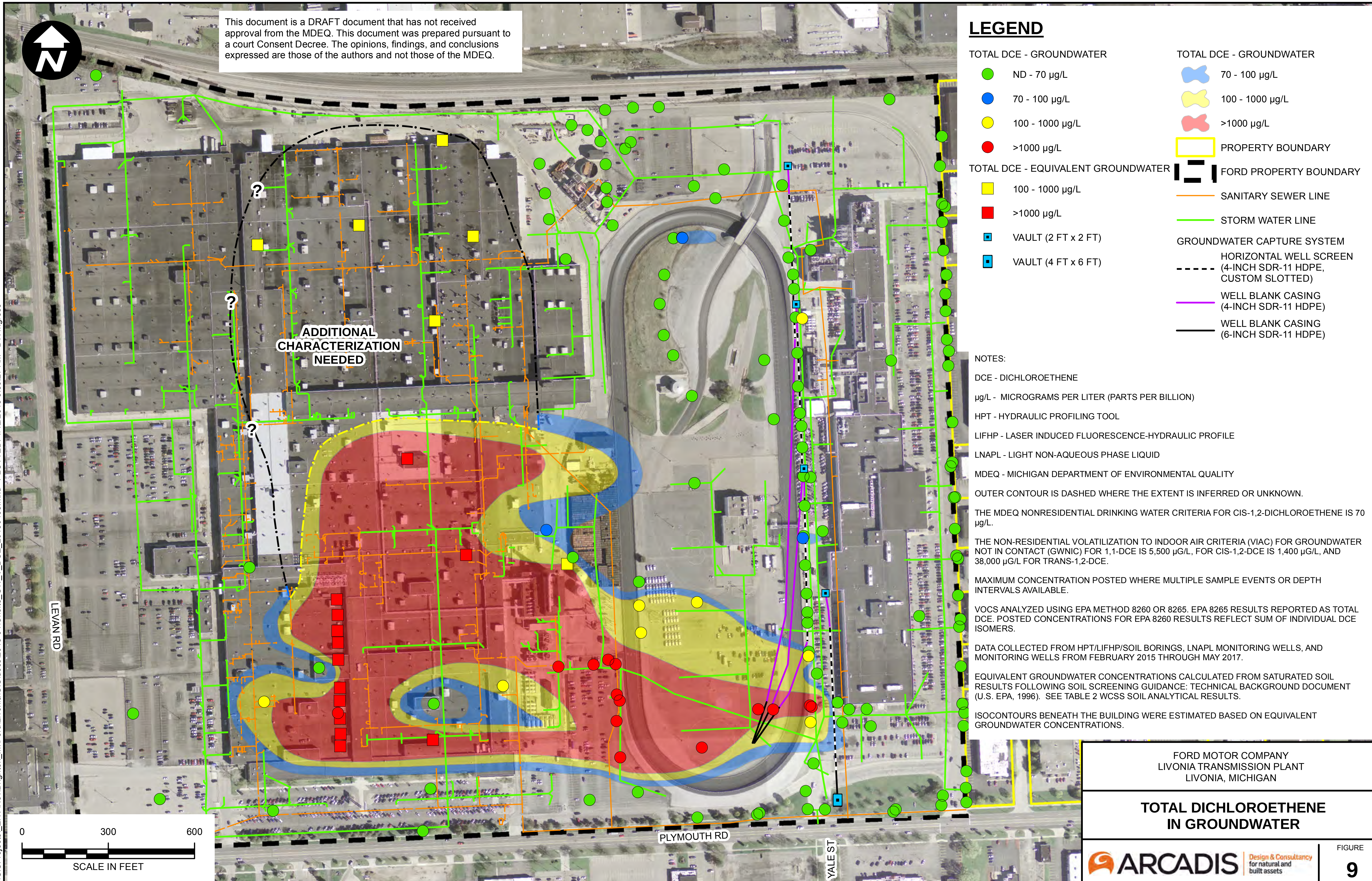

LEGEND

TOTAL DCE - GROUNDWATER
- ND - 70 µg/L
- 70 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

TOTAL DCE - EQUIVALENT GROUNDWATER
- 100 - 1000 µg/L
- >1000 µg/L
- VAULT (2 FT x 2 FT)
- VAULT (4 FT x 6 FT)

TOTAL DCE - GROUNDWATER
- 70 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY
- SANITARY SEWER LINE
- STORM WATER LINE

GROUNDWATER CAPTURE SYSTEM
- HORIZONTAL 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)

NOTES:

DCE - DICHLOROETHENE

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

HPT - HYDRAULIC PROFILING TOOL

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

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

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) FOR 1,1-DCE IS 5,500 µG/L, FOR CIS-1,2-DCE IS 1,400 µG/L, AND 38,000 µG/L FOR TRANS-1,2-DCE.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

VOCS ANALYZED USING EPA METHOD 8260 OR 8265. EPA 8265 RESULTS REPORTED AS TOTAL DCE. POSTED CONCENTRATIONS FOR EPA 8260 RESULTS REFLECT SUM OF INDIVIDUAL DCE ISOMERS.

DATA COLLECTED FROM HPT/LIFHP/SOIL BORINGS, LNAPL MONITORING WELLS, AND MONITORING WELLS FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

ISOCONTOURS BENEATH THE BUILDING WERE ESTIMATED BASED ON EQUIVALENT GROUNDWATER CONCENTRATIONS.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

TOTAL DICHLOROETHENE IN GROUNDWATER

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FIGURE 9

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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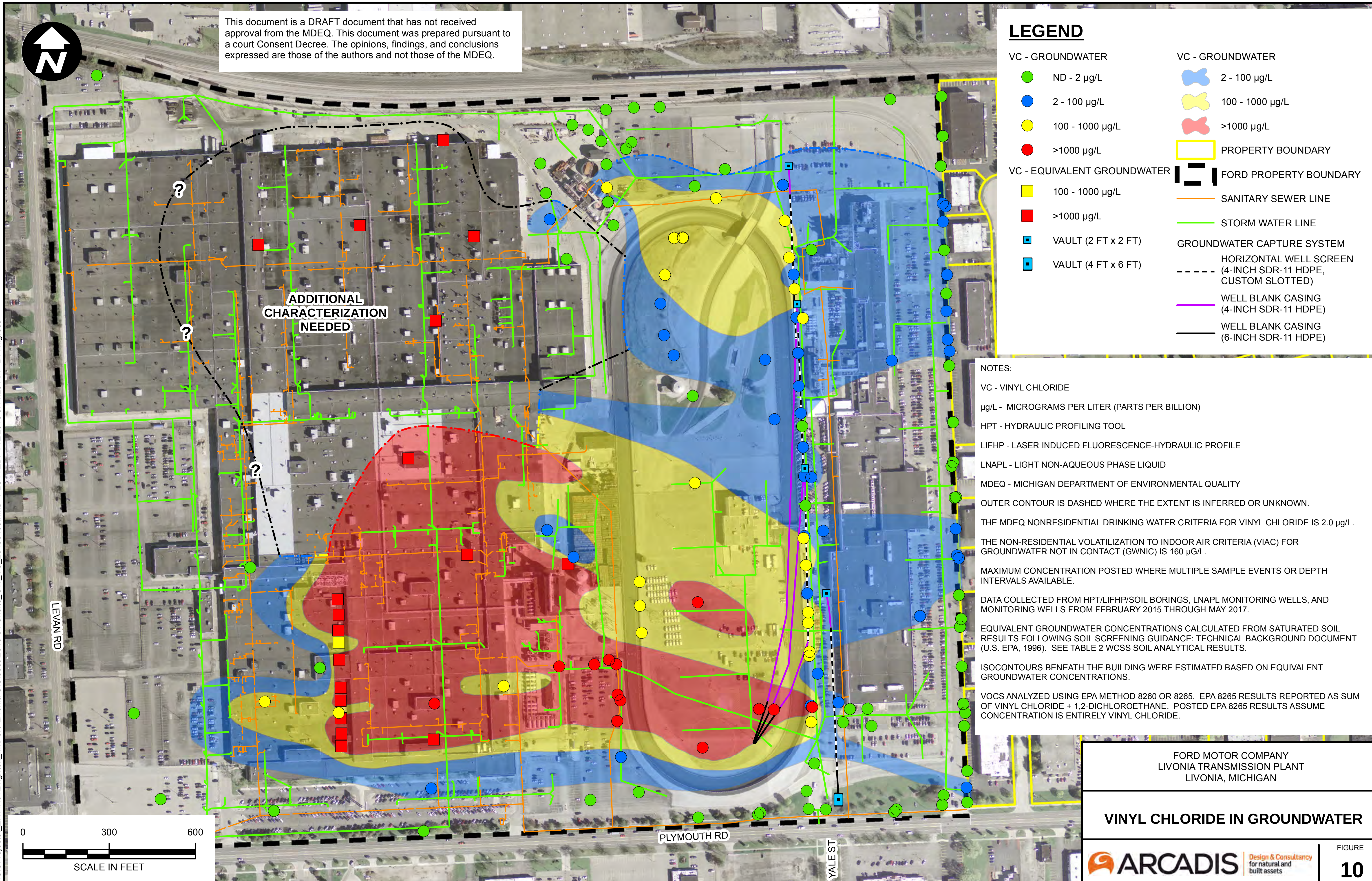

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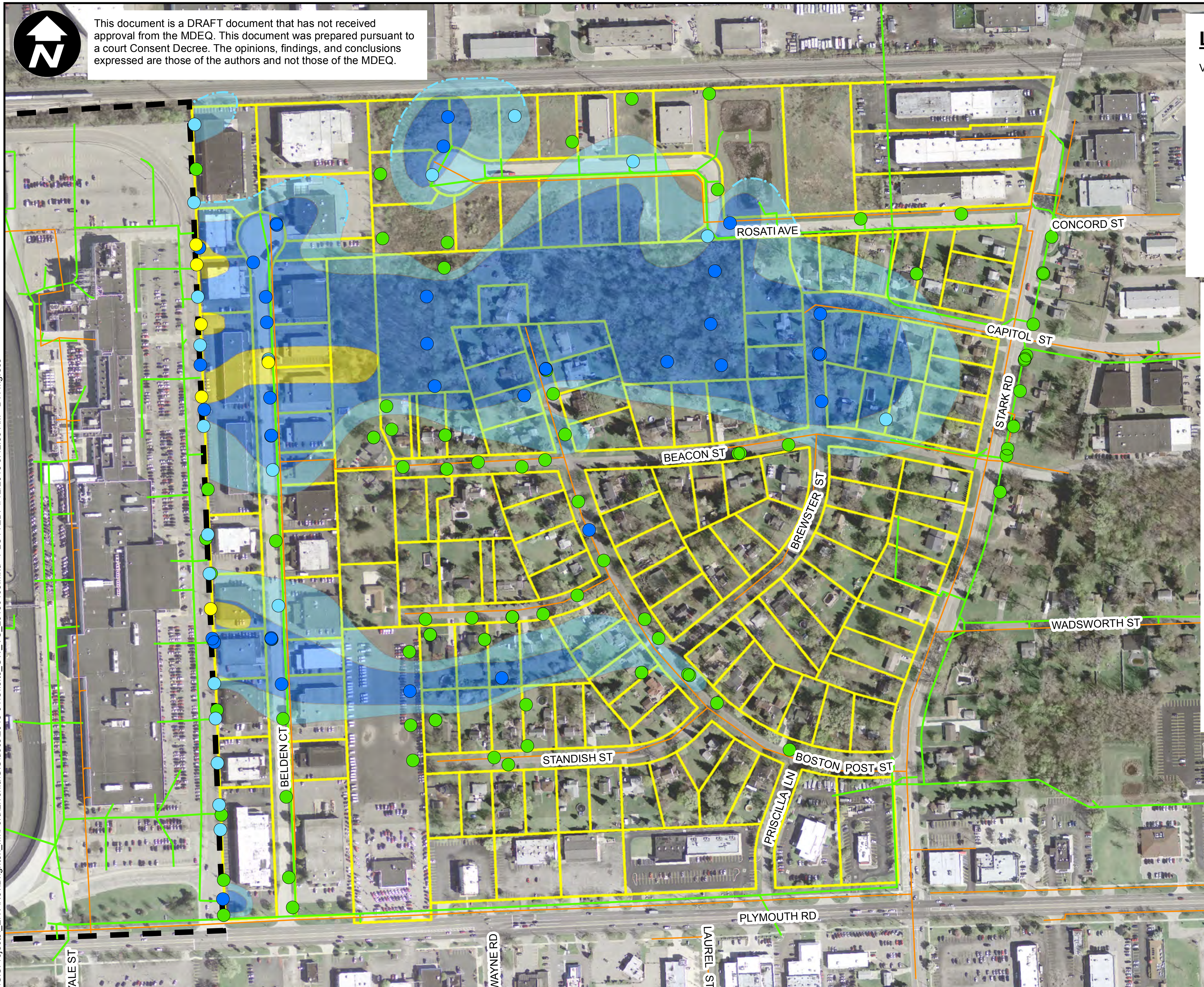

This document is a DRAFT document that has not received approval from the MDEQ. This document was prepared pursuant to a court Consent Decree. The opinions, findings, and conclusions expressed are those of the authors and not those of the MDEQ.

LEGEND

VC - GROUNDWATER (points):
- ND - 1 µg/L
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L

VC - GROUNDWATER (contours):
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L

- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY
- SANITARY SEWER LINE
- STORM WATER LINE

NOTES:

VC - VINYL CHLORIDE

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

HPT - HYDRAULIC PROFILING TOOL

VAP - VERTICAL AQUIFER PROFILE

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

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

THE SITE-SPECIFIC NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) FOR VINYL CHLORIDE IS 160 µg/L.

THE SITE-SPECIFIC RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER IN CONTACT (GWIC) FOR VINYL CHLORIDE IS 0.12 UG/L. THIS SCREENING LEVEL IS BELOW THE TARGET DETECTION LIMIT FOR VINYL CHLORIDE OF 1 µg/L. A TARGET DETECTION LIMIT OF 1 µg/L HAS BEEN USED

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM HPT/VAP BORINGS, AND MONITORING WELLS FROM OCTOBER 2015 THROUGH MAY 2017.

ALL NON-DETECT GROUNDWATER VALUES WERE ASSUMED TO BE 1/2 THE DETECTION LIMIT FOR CONTOURING.

VOCS ANALYZED USING EPA METHOD 8260 OR 8265. EPA 8265 RESULTS REPORTED AS SUM OF VINYL CHLORIDE + 1,2-DICHLOROETHANE. POSTED EPA 8265 RESULTS ASSUME CONCENTRATION IS ENTIRELY VINYL CHLORIDE.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

VINYL CHLORIDE IN GROUNDWATER OFF-SITE

ARCADIS Design & Consultancy for natural and built assets

FIGURE 11

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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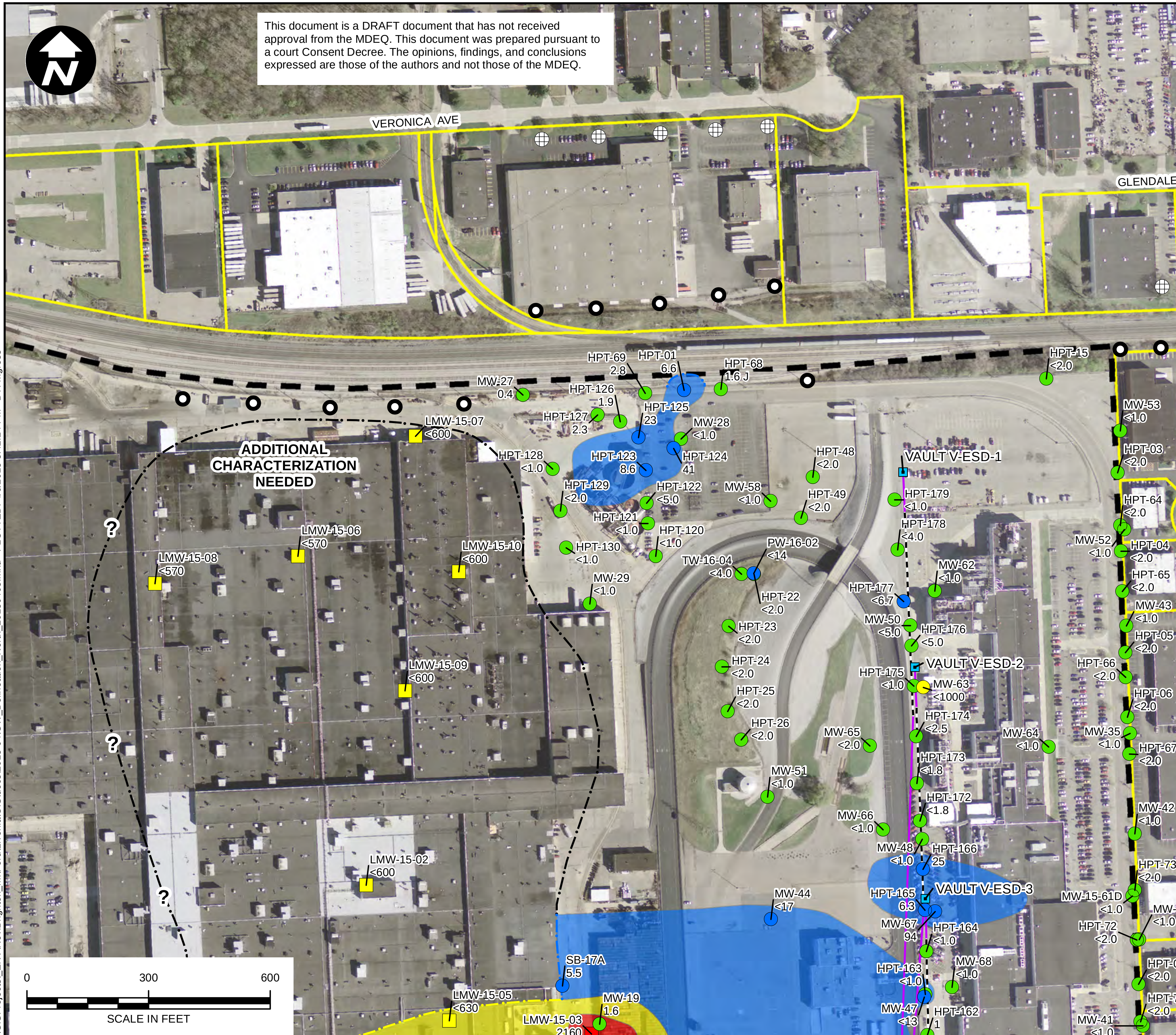

LEGEND

- PROPOSED HPT/VAP BORING
- CONTINGENCY HPT/VAP BORING

TCE - GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

TCE - EQUIVALENT GROUNDWATER
- 100 - 1000 µg/L
- >1000 µg/L
- VAULT (2 FT x 2 FT)

TCE - GROUNDWATER
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L
- INFERRED/UNKNOWN TCE CONTOUR
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY

GROUNDWATER CAPTURE SYSTEM
- HORIZONTAL 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)

NOTES:

TCE - TRICHLOROETHENE

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

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

ESD - EASTERN STORM DRAIN

HPT - HYDRAULIC PROFILING TOOL

J - ESTIMATED CONCENTRATION ABOVE THE METHOD DETECTION LIMIT AND BELOW THE REPORTING LIMIT.

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

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

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

* - EQUIVALENT GROUNDWATER CONCENTRATION BASED ON LNAPL IMPACTED SOIL SAMPLE FROM 18 FEET BELOW GRADE. THEREFORE TCE CONCENTRATION REPRESENTS LNAPL TCE CONCENTRATION, NOT DISSOLVED PHASE IMPACTS (SEE TABLE 3 [LNAPL ANALYTICAL])

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE

DATA COLLECTED FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

TCE IN GROUNDWATER ANALYZED USING EPA METHOD 8260B.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE GROUNDWATER DELINEATION - NORTH

ARCADIS Design & Consultancy for natural and built assets

FIGURE 12

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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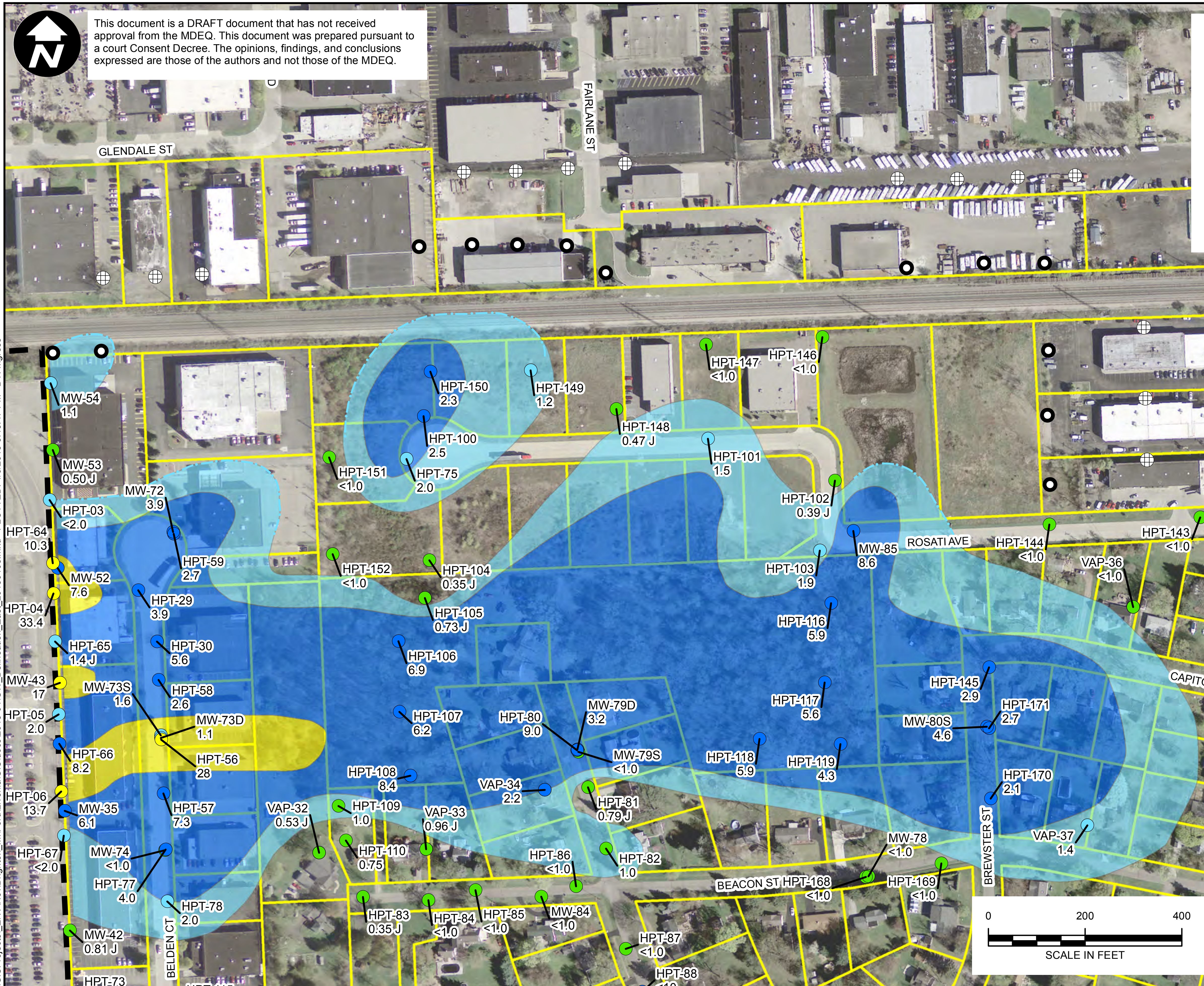

LEGEND

- PROPOSED HPT/VAP BORING
- CONTINGENCY HPT/VAP BORING

VC - GROUNDWATER (points)
- ND - 1 µg/L
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L

VC - GROUNDWATER (contours)
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY

NOTES:

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

VC - VINYL CHLORIDE

HPT - HYDRAULIC PROFILING TOOL

MW - MONITORING WELL

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

VOCS - VOLATILE ORGANIC COMPOUNDS

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

J - ESTIMATED CONCENTRATION ABOVE THE METHOD DETECTION LIMIT AND BELOW THE REPORTING LIMIT.

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

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

THE SITE-SPECIFIC NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) FOR VINYL CHLORIDE IS 160 µg/L.

THE SITE-SPECIFIC RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER IN CONTACT (GWIC) FOR VINYL CHLORIDE IS 0.12 UG/L. THIS SCREENING LEVEL IS BELOW THE TARGET DETECTION LIMIT FOR VINYL CHLORIDE OF 1 µg/L. A TARGET DETECTION LIMIT OF 1 µg/L HAS BEEN USED

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM OCTOBER 2015 THROUGH MAY 2017.

ALL NON-DETECT GROUNDWATER VALUES WERE ASSUMED TO BE 1/2 THE DETECTION LIMIT FOR CONTOURING.

VOCS ANALYZED USING EPA METHOD 8260 OR 8265. EPA 8265 RESULTS REPORTED AS SUM OF VINYL CHLORIDE + 1,2-DICHLOROETHANE. POSTED EPA 8265 RESULTS ASSUME CONCENTRATION IS ENTIRELY VINYL CHLORIDE.

0 200 400
SCALE IN FEET

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE GROUNDWATER DELINEATION - NORTHEAST

ARCADIS Design & Consultancy for natural and built assets

FIGURE
13

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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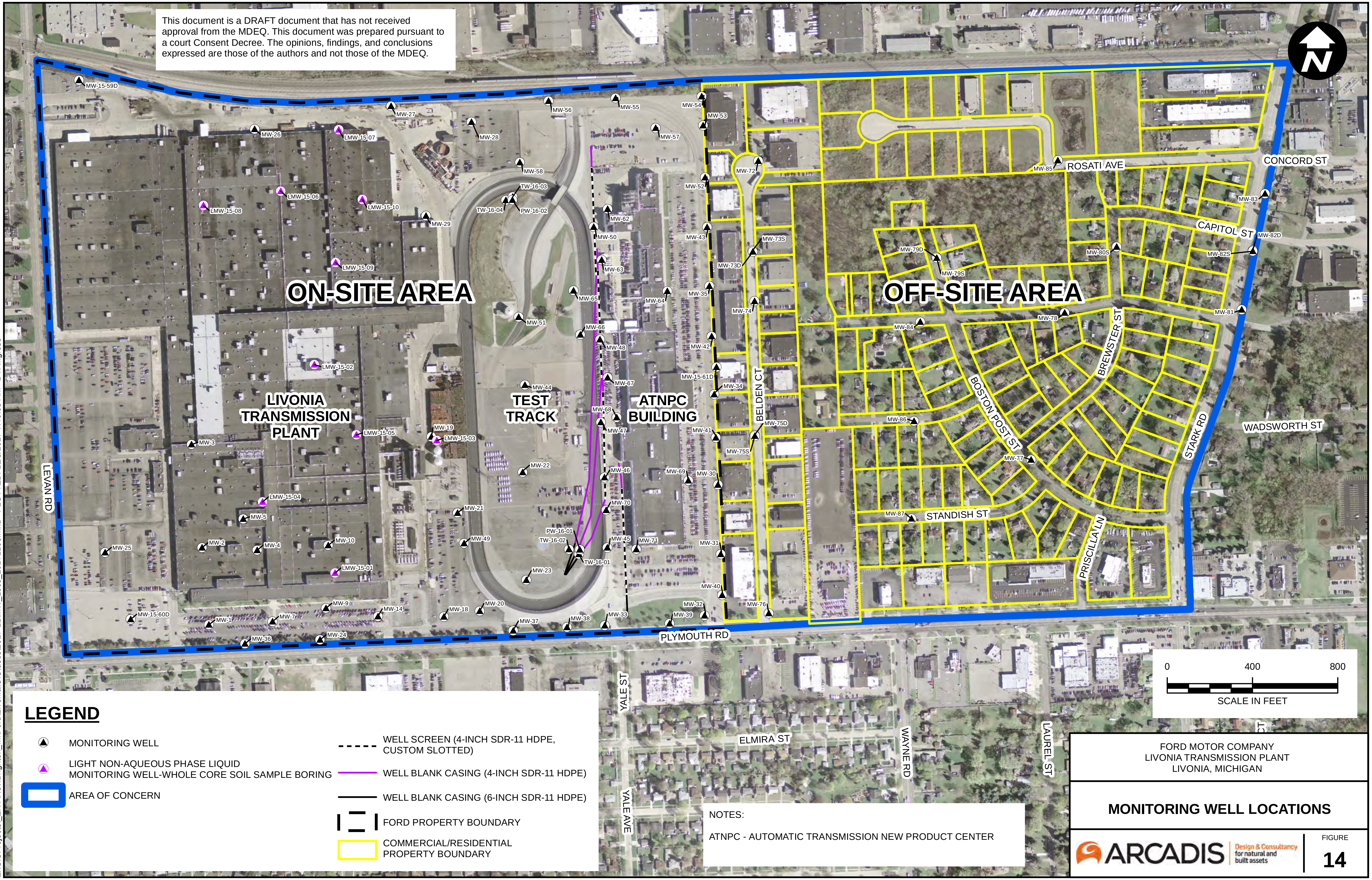

LEGEND

- MONITORING WELL
- LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL-WHOLE CORE SOIL SAMPLE BORING
- AREA OF CONCERN
- 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
- COMMERCIAL/RESIDENTIAL PROPERTY BOUNDARY

NOTES:

ATNPC - AUTOMATIC TRANSMISSION NEW PRODUCT CENTER

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

MONITORING WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
14

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
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TABLES

Table 1
Site-Wide Well Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

ARCADIS Design & Consultancy for natural and built assets

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
On-Site Wells			
LMW-15-01	2	7-12	12
LMW-15-02	2	7-12	12
LMW-15-03	2	7-12	12
LMW-15-04	2	6-11	11
LMW-15-05	2	7-12	12
LMW-15-06	2	7-12	12
LMW-15-07	2	7-12	12
LMW-15-08	2	7.5-12.5	12.5
LMW-15-09	2	7-12	12
LMW-15-10	2	7-12	12
MW-15-59D	2	94-99	99
MW-15-60D	2	93-98	98
MW-15-61D	2	88-93	93
MW-1	2	14-19	19
MW-2	2	15.5-20.5	20.5
MW-3	2	14-19	19
MW-4	2	15.5-20.5	20.5
MW-5	2	15.5-20.5	20.5
MW-7	2	18-23	23.0
MW-9	2	19.5-24.5	24.5
MW-10	2	16.5-21.5	21.5
MW-14	2	15-20	20
MW-18	2	13-18	18
MW-19	2	15-20	20
MW-20	2	13.5-18.5	18.5
MW-21	2	13.5-18.5	18.5
MW-22	2	16.5-21.5	21.5
MW-23	2	15-20	20
MW-24	2	19-24	24
MW-25	2	16-21	21
MW-26	2	4.5-14.5	14.5
MW-27	2	4-14	14
MW-28	2	2-12	12
MW-29	2	5-15	15
MW-30	2	19-24	24
MW-31	2	17-22	22
MW-32	2	18-23	23
MW-33	2	14-19	19
MW-34	2	16.5-21.5	21.5
MW-35	2	19.5-24.5	24.5
MW-36	2	20-25	25
MW-37	2	18-23	23
MW-38	2	15-20	20
MW-39	2	19.5-24.5	24.5

See Notes on Last Page.

Table 1
Site-Wide Well Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
MW-40	2	15-20	20
MW-41	2	16-21	21
MW-42	2	16-21	21
MW-43	2	17-22	22
MW-44	2	16-21	21
MW-45	2	15-20	20
MW-46	2	16-21	21
MW-47	2	16-21	21
MW-48	2	17-22	22
MW-49	2	12.5-17.5	17.5
MW-50	2	16-21	21
MW-51	2	15-20	20
MW-52	2	15-20	20
MW-53	2	16-21	21
MW-54	2	16-21	21
MW-55	2	15-20	20
MW-56	2	16-21	21
MW-57	2	17-22	22
MW-58	2	15-20	20
MW-62	2	16.3-21.3	21.3
MW-63	2	7-12	12
MW-64	2	15-20	20
MW-65	2	16-21	21
MW-66	2	15-20	20
MW-67	2	9-14	14
MW-68	2	15-20	20
MW-69	2	15-20	20
MW-70	2	15-20	20
MW-71	2	15-20	20
PW-16-01	6	9.7-19.7	21.7
PW-16-02	6	6-21	23
TW-16-01	2	12-17	17
TW-16-02	2	12-17	17
TW-16-03	2	9-19	19
TW-16-04	2	9-19	19
Off-Site Wells			
MW-72	2	15-20	20
MW-73S	2	7-12	12
MW-73D	2	13.5-18.5	18.5
MW-74	2	14-19	19
MW-75S	2	5-10	10
MW-75D	2	12-17	17
MW-76	2	15-20	20
MW-77	2	9-14	14
MW-78	2	7-12	12

See Notes on Last Page.

Table 1
Site-Wide Well Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
MW-79S	2	5-10	10
MW-79D	2	10-15	15
MW-80S	2	7-12	12
MW-81	2	8-13	13
MW-82S	2	9-14	14
MW-82D	2	18-23	23
MW-83	2	8-13	13
MW-84	2	8-13	13
MW-85	2	8-13	13
MW-86	2	12-17	17
MW-87	2	14-19	19

Notes:

D Deep well
ft. Feet
ft. bgs Feet below ground surface
LMW LNAPL Monitoring Well
LNAPL Light non-aqueous phase liquid
MW Monitoring Well
PW Pumping Well
S Shallow well
TW Test Well

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ATTACHMENT 1

Technical Guidance Documents

LOW-FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURES FOR MONITORING WELLS

Rev. #: 5

Rev Date: 12/30/2016

TGI VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by

APPROVAL SIGNATURES

Prepared by: Ryan McKinney Date: 12/30/2016

Reviewed by: Eric Killenbeck Date: ________________
(Technical Expert)

I. SCOPE AND APPLICATION

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures recommended to purge monitoring wells and collect groundwater samples. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I Low Stress (Low-Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (EQASOP-GW001; January 19, 2010). Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples should be obtained using a 0.45-micron disposable filter. Project teams should determine the last time the wells were developed and if additional development might be necessary. Groundwater samples should not be collected within 1 week following well development.

II. PERSONNEL QUALIFICATIONS

Arcadis personnel providing assistance to groundwater sample collection and associated activities should have a minimum of 6 months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology. The supervisor of the groundwater sampling team should have at least 1 year of previous supervised groundwater sampling experience. Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents including but not limited to the site work plan, field sampling plan, Quality Assurance Project Plan (QAPP), Health and Safety Plan (HASP), historical information, and site relevant documents.
Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization.

III. EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) should be available:

- Health and safety documents and equipment (as identified in the site HASP)
- Site Plan, well construction records, prior groundwater sampling records (if available)
- Sampling pump, which may consist of one or more of the following:

  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:

  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery.
  - Submersible pumps such as Grundfos require a pump controller to run the pump.

- Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N_2 or CO_2 gas cylinders).

- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used. For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) should also be used through the pump apparatus. When collecting samples for perflourinated compounds (PFCs), Teflon® components or tubing should not be used. Teflon® components or tubing may not be necessary when sampling for metals and/or inorganics.
- Water-level probe (e.g., Solinist Model 101)
- Water-quality (temperature/pH/specific conductivity/oxidation reduction potential [ORP]/turbidity/dissolved oxygen) meter and flow-through measurement cell. Several brands may be used, including:
  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument
  - Hydrolab Series 3 or Series 4a Multiprobe and Display
- Supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020). Turbidity measurements collected with multi-parameter meters have sometimes been shown to be unreliable due to fouling of the optic lens of the turbidity meter within the flow-through cell. A supplemental turbidity meter should be used to verify turbidity data during purging if such fouling is suspected. An in-line tee and valve should allow for collection of water for turbidity measurements before the pump discharge enters the flow-through cell. Note that industry improvements may eliminate the need for these supplemental measurements in the future.
- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- 0.45-micron disposable filters (if field filtering is required)
- Cleaning equipment
- Groundwater sampling log (attached) or bound field logbook.

Note that, in the future, the client may acquire different makes/models of some of this equipment if the listed makes/models are no longer available, or as a result of general upgrades or additional equipment acquisitions. Note the specific make/model of the equipment used during a sampling event on the groundwater sampling log. The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment should be serviced by a qualified technician.

IV. CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Manager or Technical manager to be fully aware of the requirements from the applicable regulatory framework.

If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples. Do not use permanent marker or felt-tipped pens for labels on sample container or sample coolers; use indelible ink. Permanent markers could introduce volatile constituents into the samples. It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives. Store and/or stage empty and full sample containers and coolers out of direct sunlight. To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of upgradient, then furthest downgradient to source area locations. Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Overtightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

V. HEALTH AND SAFETY CONSIDERATIONS

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work. Generators and cord and plug equipment should employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source should be equipped with other overcurrent protection means.

VI. PROCEDURE

Groundwater should be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet), submersible pumps or bladder pumps should be used provided that the well is constructed with a casing diameter greater than or equal to 2 inches (the minimum well diameter capable of accommodating such pumps). Bladder pumps are preferred over peristaltic and submersible pumps if sampling of volatile organic compounds (VOCs) is required to prevent volatilization. For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) should be used to purge and sample the groundwater. Purge water should be collected and containerized according to the direction of the project team.

1. Calibrate field instruments according to manufacturer procedures for calibration and document.

2. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. Insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA. Measure the initial depth to groundwater prior to placing the pumps.
3. Prepare and install the pump in the well: For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air line, sample discharge line, and safety cable prior to placement in the well. Attach the air line tubing to the air port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture.

   Attach and secure a safety cable to the eyebolt on the top of bladder pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to well contamination. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

   4. If using a bladder pump, connect the air line to the pump controller output port. The pump controller should then be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power if an on/off switch is present, and verify that all batteries are charged and fully operating before beginning to pump.

   5. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the water quality meter.

   6. Measure the water level again with the pump in the well before starting the pump to ensure that it has stabilized. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified). Adjust the pump rate to cause little or no water level drawdown in the well (less than 0.3 foot below the initial static depth to water measurement), and the water level should stabilize; however, this is not always possible. The water level should be monitored every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping if the well diameter is of sufficient size to

allow such monitoring. Do not break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters. Maintain a steady flow rate to the extent practicable. Review groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition. If the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position. For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 foot) is maintained, and monitoring for stabilization of field indicator parameters can commence. If a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen. Sampling may commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples. During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, and dissolved oxygen [DO]) every 3 to 5 minutes (or after each volume of the flow-through cell has been purged). Measure field indicator parameters using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 nephelometric turbidity unit [NTU] if the turbidity reading is less than 10 NTU), the specific conductance and temperature values remain within 3%, ORP readings remain within ± 10 mV, DO values remain within 10%, and pH remains within 0.1 unit for three consecutive readings collected at 3- to 5-minute intervals (or other appropriate interval, alternate stabilization goals may exist in different geographic regions, consult the site-specific Work Plan for stabilization criteria). If the field indicator parameters do not stabilize within 1 hour of the start of purging, but the groundwater turbidity is below the goal of 50 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized but the turbidity is not in the range of the 50 NTU goal, the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); care should be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater (Attachment 1), then again check for and remove air bubbles on the probe before re-measuring. If the DO value is 0.00 or less, then the meter should be serviced and re-calibrated. If the DO values are above possible results, then the meter should be serviced and re-calibrated.

During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) should be documented in the field notes. If other field conditions preclude stabilization of certain parameter, an explanation of why the parameters did not stabilize should also be documented in the field logbook.

7. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.

8. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell. When the container is full, tightly screw on the cap. Samples should be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific Work Plan).

9. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample should be collected. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected. Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL). Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container. When the container is full, tightly screw on the cap.

10. Secure with packing material and store at 4°C in an insulated transport container provided by the laboratory.

11. Record on the groundwater sampling log or bound field logbook the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (Attachment 2 – Example Sampling Log).

12. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup. Slowly remove the pump, tubing, lines, and safety cable from the well. Do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.

13. If tubing is to be dedicated to a well, it should be folded to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events. A length of rope or string should be used to tie the tubing to the well cap. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, they may be coiled neatly and placed in a clean plastic bag that is clearly labeled with the well ID. Make sure the bag is tightly sealed before placing it in storage.

14. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.

15. Complete the procedures for packaging, shipping, and handling with the associated chain of custody.

16. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate.
17. At the end of the day, perform calibration check of field instruments.

VII. WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment, should be placed in appropriate containers. Containerized waste should be disposed of by the client consistent with the procedures identified in the HASP.

VIII. DATA RECORDING AND MANAGEMENT

Initial field logs and chain-of-custody records should be transmitted to the Arcadis Project Manager at the end of each day unless otherwise directed. The groundwater team leader retains copies of the groundwater sampling logs.

IX. QUALITY ASSURANCE

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures should be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available.
- Equipment blanks should include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well).
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled.
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following procedures for equipment decontamination.

X. REFERENCES

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Arcadis of Michigan, LLC

28550 Cabot Drive

Suite 500

Novi, Michigan 48377

Tel 248 994 2240

Fax 248 994 2241

www.arcadis.com