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From:
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Date:
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Arcadis Project No.:
30075936.00005

Subject:
RACER Pontiac North Campus - 2020 Additional LNAPL Transmissivity
Testing

INTRODUCTION

Arcadis of Michigan, LLC (Arcadis) prepared this memorandum to summarize the results of additional light non-aqueous phase liquid (LNAPL) transmissivity testing activities on behalf of Revitalizing Auto Communities Environmental Response (RACER) Trust for the Pontiac North Campus Site (Site) located in Pontiac, Michigan (**Figure 1**). LNAPL gauging and testing activities were conducted in November 2020 to evaluate the feasibility of continued LNAPL recovery at recovery well RW-08-14, verify previous transmissivity testing results at monitoring wells SB-25-14 and TW-11-01, and determine the feasibility for LNAPL removal at one additional location (TW-11-02) which had not been previously tested. The scope of November 2020 LNAPL gauging and testing activities was developed based on the following:

- The results of LNAPL transmissivity and cumulative recovery at the RW-08-14 LNAPL Recovery System which was summarized and reported in the *RACER Pontiac North Campus –LNAPL Recovery Well RW/SB-08-14 Interim Measures Implementation, System Installation and Operation Update* (Arcadis 2020), subsequent USEPA correspondence, and more recent LNAPL gauging activities.
- Previous investigation activities, internal LNAPL Conceptual Site Model and Decision Tree analyses and previous reports and references including the *Draft RACER Pontiac North Campus – Corrective Measures Proposal* (Arcadis 2013), the *Michigan Department of Environmental*

Quality (MDEQ) Non-Aqueous Phase Liquid (NAPL) Characterization, Remediation, and Management for Petroleum Releases (MDEQ 2014), the RACER Pontiac North Campus – 2013/2014 LNAPL Investigation Technical Memorandum (Arcadis 2015), the 2018 LNAPL IM Feasibility Confirmation and Pre-Design Specification Testing Memorandum (Arcadis 2018a), and the RACER Pontiac North Campus Additional LNAPL Pre-Design / Transmissivity Testing and Interim Measure Removal Work Plan (2018b).

- Recent LNAPL gauging measurements confirming significant LNAPL accumulation.

Following up on the results of July 2018 investigation activities and the LNAPL Recovery System operation, the scope of November 2020 activities included evaluating the feasibility of continued LNAPL system operation at RW-08-14 and re-evaluating the feasibility of removing LNAPL at monitoring well locations SB-25-14 (LNAPL Area No. 2B within area of interest (AOI) W-10) and TW-11-01 (LNAPL Area No. 11 within AOI W-8). In addition, based on results of recent gauging activities, evaluating the transmissivity at well TW-11-02 (LNAPL Area No. 11 within AOI W-8), which had never been tested due to lack of adequate LNAPL accumulation, was included in the November 2020 scope. Although previous assessments of recoverability at wells MWW8-65 and TWW8-01 (LNAPL Area No. 11 within AOI W-5) showed LNAPL recovery was not feasible, LNAPL that had accumulated in those wells was removed during November 2020 activities as well. Refer to **Figure 2** for the location of these wells.

LNAPL transmissivity testing and analysis was completed following ASTM International (ATSM), Interstate Technology and Regulatory Council (ITRC) and American Petroleum Institute (API) methods.

PRE-MOBILIZATION GAUGING AND TEST PLANNING ACTIVITIES

Prior to mobilizing to the Site to conduct LNAPL transmissivity testing activities, Arcadis gauged the recovery well and monitoring wells to confirm that the locations would be conducive to LNAPL transmissivity testing, based on LNAPL thickness.

Monitoring Well SB-25-14

Transmissivity testing was first completed at SB-25-14 in September 2014 with a mean result of 0.68 ft²/day; however, this was likely representative of filter pack drainage and not the actual formation. This conclusion was based on LNAPL volume removed versus estimated volume in the well casing and filter pack, and the minor LNAPL recharge observed after test initiation. Follow-up testing could not be completed during the 2018 LNAPL activities due to inadequate LNAPL accumulation for testing. Monitoring well SB-25-14 was gauged again on October 12, 2020 to determine if LNAPL might be present in the well at a thickness which would warrant transmissivity testing and further consideration for the feasibility of removal. The thickness of LNAPL measured in the well during the October annual sampling event was 0.29-foot, which was sufficient to support transmissivity testing in November. A summary of historical gauging data at SB-25-14 is included as **Table 1**. The well construction/soil boring log for SB-25-14 is included in **Attachment 1**.

Monitoring Well TW-11-01

Two transmissivity tests were conducted at TW-11-01 in 2014. The tests were not valid as the LNAPL-water interface was located above the well screen during test initiation which resulted in the LNAPL column being essentially hydraulically isolated from the formation for the duration of the tests. The results of gauging in October 2020 revealed that 2.64 feet of LNAPL was present in monitoring well TW-11-01 which was adequate for further testing. As the LNAPL-water interface was above the well screen in

October 2020, an alternate method of testing transmissivity was employed instead of the baildown test used in 2014 as discussed below.

The well screen interval at TW-11-01 was installed in September 2012 based on historic laser-induced fluorescence (LIF) screening responses and LNAPL saturation data from laboratory-analyzed soil cores completed by ENCORE in 2007. The screen targeted the coarse-grained interval (11 to 14 feet below ground surface (bgs)) as well as several feet of underlying clay. The overlying lithology above the coarse-grained material consists of silt (6 to 11 ft bgs) and silty sand (fill material) (1 to 6 ft bgs). The well construction/soil boring log for TW-11-01 is included in **Attachment 1**. A summary of historical gauging data at TW-11-01 is included as **Table 2**.

While LNAPL thickness varied in 2012 through early 2014 along with groundwater level/potentiometric surface fluctuations, LNAPL thicknesses have increased from 2014 through 2020 to over 6 feet in a few instances. During times of lower groundwater elevation, the water table exists within the more permeable layer characterized as silty-sand and an increase in measured LNAPL thickness in wells generally coincided with the lower groundwater elevations, consistent with behavior in an unconfined groundwater condition. However, as the water table rose above the well screen and above the silty sand/silt interface, a confined groundwater condition arose in which an increase in measured LNAPL thickness in wells coincided with the increase in groundwater elevations. Subsequently, this has resulted in exaggerated in-well LNAPL thicknesses as the LNAPL, which is under pressure against the underside of the confining unit, accumulates and equalizes with atmospheric pressure (ITRC 2018).

Monitoring Well TW-11-02

TW-11-02 could not be tested for recoverability during the 2014 testing events due to a lack of LNAPL accumulation. Monitoring well TW-11-02 was gauged again on October 12, 2020 to determine if LNAPL might be present in the well at a thickness which would warrant transmissivity testing. The thickness of LNAPL measured in the well during the October annual sampling event was 3.71 feet which was sufficient to support transmissivity testing in November.

Monitoring well TW-11-02 was also installed in September 2012 at the same time as monitoring well TW-11-01. The well was screened predominately across silty sand based on historic LIF screening responses and LNAPL saturation data from laboratory-analyzed soil cores. The silty sand interval (12 to 18 ft bgs) is overlain by silt and clay (7 to 12 ft bgs) and fill material (0.4 to 7 ft bgs) consisting of sand, silt, and clay. The well construction/soil boring log for TW-11-02 is included in **Attachment 1**. A summary of historical gauging data at TW-11-02 is included as **Table 3**.

Less than 0.1-foot of LNAPL was observed in TW-11-02 during its first two years following installation. As in TW-11-01, several feet of LNAPL have accumulated in TW-11-02 since 2014. LNAPL behavior observed in the well initially appeared to be consistent with an unconfined groundwater condition, but as the groundwater/potentiometric elevation rose above the well screen and above the silty sand/silt and clay interface, a direct relationship between increased potentiometric elevation and LNAPL thickness has been observed that is consistent with a confined groundwater condition. Similar to TW-11-01, this resulted in accumulation of an exaggerated in-well LNAPL thickness as the LNAPL came into equilibrium with atmospheric pressure.

Recovery Well RW-08-14

As outlined in the *LNAPL Recovery Well RW/SB-08-14 Interim Measures Implementation, System Installation and Operation Update* (Arcadis 2020), RW-08-14 was installed in 2018 (over-drilled and

replaced SB-08-14) as part of the USEPA-approved LNAPL Interim Measures completed at the Site. The LNAPL Recovery System includes an automated skimmer which operated from May 2019 through August 2020. The recovery system fluid measurements and LNAPL volumes recovered were used to calculate monthly transmissivity estimates which fell below the EGLE lower limit LNAPL transmissivity value of 0.5 ft²/day. As this threshold was identified as a milestone for system shut down, the recovery system was shut down on August 3, 2020 to allow LNAPL to accumulate for a short-term transmissivity test. After shutdown, LNAPL thickness was regularly measured in the well simultaneous with Operations & Maintenance (O&M) activities being conducted at the Site. LNAPL thickness increased from approximately 0.08 ft at the time of shutdown to a maximum of approximately 6.98 ft in late October, which was adequate to support the November transmissivity testing event. A summary of gauging data at SB-08-14 (2014 through 2018) and at RW-08-14 beginning at system start-up is included as **Table 4**. The well construction log for RW-08-14 is included in **Attachment 1**.

LNAPL TRANSMISSIVITY TESTING

LNAPL transmissivity represents the volumetric rate of LNAPL flow through a unit width of porous media per unit time under a unit hydraulic gradient. LNAPL transmissivity is an ideal parameter for assessing LNAPL recoverability, inherently accounting for the combined effects of aquifer matrix permeability, LNAPL physical properties, and the relative proportion of pore space occupied by LNAPL within a specified vertical interval of aquifer material.

Based on the previous information discussed in this memo, transmissivity testing was conducted at RW-08-14, TW-11-01, TW-11-02, and SB-25-14.

Monitoring Well SB-25-14

A baildown transmissivity test was performed at monitoring well SB-25-14 on November 4, 2020 per ASTM guidance (ASTM 2013) based on LNAPL thickness and fluid levels. The well had an initial depth to LNAPL of 16.72 feet and a depth to water of 17.03 feet, for a total LNAPL thickness of 0.31 feet. Field staff removed the LNAPL with a peristaltic pump. Recovery was noted as being limited, as the LNAPL thickness had recovered to only 0.07 feet after one hour.

Transmissivity was estimated in the range of 0.05-0.23 ft²/day depending on the analytical drawdown solution with an average of 0.13 ft²/day (see **Attachment 2**). This transmissivity value falls below the EGLE lower limit LNAPL transmissivity value of 0.5 ft²/day and indicates that removal activities are not feasible at this location. A summary of the November 2020 data as well as the historic 2014 transmissivity results are presented in **Table 5**.

Recovery Well RW-08-14

Transmissivity testing was performed at recovery well RW-08-14 on November 2-4, 2020 per ASTM guidance (ASTM 2013) based on LNAPL thickness and fluid levels. RW-08-14 is a six-inch diameter PVC well screened from 5 to 25 feet below ground surface (bgs), with a saturated zone under confined conditions. The well had an initial depth to LNAPL of 10.93 feet and a depth to water of 17.61 feet, for a total LNAPL thickness of 6.68 feet. Using a peristaltic pump, field staff evacuated LNAPL from the well, a total of approximately 10 gallons, and monitored LNAPL and water depths periodically over the next three days. LNAPL thickness recovered to 2.80 feet by the end of the monitoring period. The LNAPL recharge rate was calculated based on test data which showed approximately 1.08 gallons of LNAPL recharge over the 3,130 minutes of the testing. Using the Theim Equation solution for confined conditions (ASTM International 2013; Equation 16), transmissivity was estimated at 0.11 ft²/day. This transmissivity falls

below the EGLE lower limit LNAPL transmissivity value of 0.5 ft²/day and indicates that removal activities are no longer feasible at this location. A summary of the November 2020 data is presented in **Table 5**.

Monitoring Wells TW-11-01 and TW-11-02

Fluid levels at both TW-11-01 and TW-11-02 were located above the well screens during October 2020 gauging activities. To ensure that the LNAPL column was not hydraulically isolated from the formation during transmissivity testing, water-enhanced LNAPL recovery (LNAPL/water ratio testing) was utilized as the testing method per ASTM guidance (ASTM 2013). For this type of testing, a peristaltic pump was used to drawdown fluid levels in each well within the well screen until a sustained flow rate was maintained. Total water and LNAPL volumes were measured following pumping.

Transmissivity at wells TW-11-01 and TW-11-02 was estimated as 2.1E-04 and 5.7E-04 ft²/day, respectively, utilizing ASTM E-2856 equation 21 (ASTM 2013). These results are well under the EGLE lower limit of LNAPL transmissivity value of 0.5 ft²/day and indicates that removal activities are not feasible at these locations. A summary of the November 2020 data and results are presented in **Table 6**.

LNAPL REMOVAL ACTIVITIES

Monitoring Wells TWW8-01 and MWW8-65

Previous transmissivity testing results from TWW8-01 and MWW8-65 from 2014 and 2018 showed LNAPL recovery was not feasible as a remedy at both these locations. However, because of the significant thickness of LNAPL accumulation in these wells, LNAPL was proactively removed from these two wells during transmissivity testing at other locations as the equipment was on-site and waste handling procedures were in place for testing waste. LNAPL was removed from wells TWW8-01 and MWW8-65 on November 2-3, 2020. No depth to water was noted in either well indicating that LNAPL had likely displaced the water in both wells. TWW8-01 contained approximately 9.15 feet of LNAPL while MWW8-65 contained approximately 8.60 feet of LNAPL. A total of approximately 5.6 gallons of LNAPL were removed from these two monitoring wells. Note that both wells are screened across predominantly clay and the confined groundwater conditions in this area lead to the exaggerated LNAPL thicknesses in both wells. Fluid levels in both wells have varied since installation in 2008 (MWW8-65) and 2013 (TWW8-01) and instances of no measurable water/LNAPL fluid interface as well as dry conditions have been observed. As described above, significant thicknesses of LNAPL accumulation in the wells does not equate to feasible recoverability. Well construction/soil boring logs for MWW8-65 and TWW8-01 are included in **Attachment 1** for reference.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the results of gauging and testing:

- Based on the transmissivity results at monitoring well location SB-25-14, no future transmissivity testing or consideration of removal is recommended for this location.
- Based on both the calculated monthly transmissivity estimates made from RW-08-14 LNAPL recovery data (Arcadis 2020) and the results of November 2020 transmissivity testing, it is recommended that the LNAPL recovery system at RW-08-14 remain shut down. In the USEPA-approved *Additional LNAPL Pre-Design / Transmissivity Testing and Interim Measure Removal Work Plan* (Arcadis 2018b), it was proposed that following the initial shut down and transmissivity test verification, if after a year transmissivity values remain below the EGLE threshold in the

recovery well, the system would be dismantled and removed from the Site. An additional transmissivity testing event is recommended in November 2021 to verify that the transmissivity values remain below the EGLE threshold.

- Based on the results of transmissivity testing at TW-11-01 and TW-11-02, no future transmissivity testing or consideration of removal is recommended for these two locations.

Please contact us if you have any questions regarding this memo or its attachments.

Sincerely,

Arcadis of Michigan, LLC



Brad Saunders, P.E.
Principal Engineer/ Certified Project Manager

Figures

- Figure 1 Site Layout Map
Figure 2 Transmissivity Testing and LNAPL Removal Activities Locations

Tables

- Table 1 SB-25-14 Gauging Data
Table 2 TW-11-01 Gauging Data
Table 3 TW-11-02 Gauging Data
Table 4 SB-08-14/RW-08-14 Gauging Data
Table 5 LNAPL Baildown Testing and Analysis Results
Table 6 LNAPL/Water Ratio Testing and Analysis Results

Attachments

- Attachment 1 Well Construction/Boring Logs
Attachment 2 Transmissivity Test Output Graph – SB-25-14

References

American Petroleum Institute (API). 2016. API LNAPL Transmissivity Workbook: A Tool for Baildown Test Analysis User Guide. API PUBLICATION 4762. April 2016.

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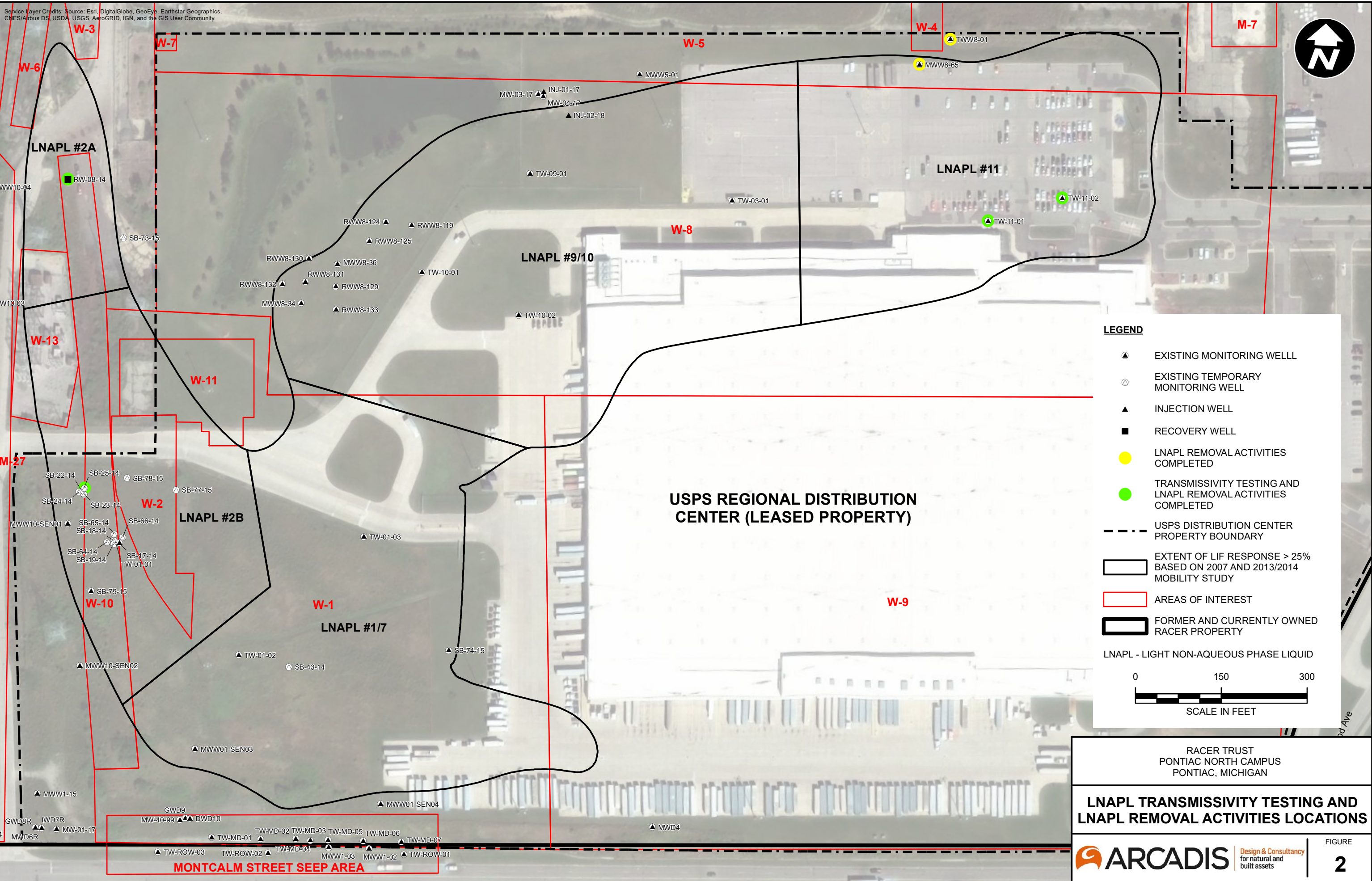
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ITRC. 2018. LNAPL-3: LNAPL Site Management: LNAPL Conceptual Site Mode (LCSM) Evolution, Decision Process, and Remedial Technologies. March. <https://lnapl-3.itrcweb.org/>

Michigan Department of Environmental Quality (MDEQ). 2014. Non-Aqueous Phase Liquid (NAPL) Characterization, Remediation, and Management for Petroleum Releases. RRD Resource Materials-25-2014-01. June 2014.

FIGURES



LEGEND

- ▲ EXISTING MONITORING WELL
- ⊙ EXISTING TEMPORARY MONITORING WELL
- ▲ INJECTION WELL
- RECOVERY WELL
- LNAPL REMOVAL ACTIVITIES COMPLETED
- TRANSMISSIVITY TESTING AND LNAPL REMOVAL ACTIVITIES COMPLETED
- - - USPS DISTRIBUTION CENTER PROPERTY BOUNDARY
- ▭ EXTENT OF LIF RESPONSE > 25% BASED ON 2007 AND 2013/2014 MOBILITY STUDY
- ▭ AREAS OF INTEREST
- ▭ FORMER AND CURRENTLY OWNED RACER PROPERTY

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

0 150 300
SCALE IN FEET

RACER TRUST
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN

LNAPL TRANSMISSIVITY TESTING AND LNAPL REMOVAL ACTIVITIES LOCATIONS

TABLES

**Table 1
SB-25-14 Gauging Data
RACER - Pontiac North Campus
Pontiac, MI**

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
6/17/2014	9-19	10.62-20.62	966.21	NA	15.21	NA	NA	951.00	0	
6/30/2014			966.21	NA	15.64	NA	NA	950.57	0	
7/28/2014			966.21	NA	16.13	NA	NA	950.08	0	
9/10/2014			966.21	16.62	17.95	949.59	948.26	949.39	1.33	Transmissivity testing 9/18/14
10/24/2014			966.21	16.08	16.73	950.13	949.48	950.03	0.65	
10/30/2014			966.21	16.05	16.36	950.16	949.85	950.11	0.31	LNAPL sampled
6/24/2015			966.21	16.27	17.14	949.94	949.07	949.80	0.87	
9/21/2015			966.21	17.41	18.72	948.80	947.49	948.60	1.31	
10/23/2015			966.21	16.08	16.73	950.13	949.48	950.03	0.65	
1/18/2016			966.21	16.12	18.61	950.09	947.60	949.71	2.49	
8/15/2016			966.21	16.53	16.76	949.68	949.45	949.64	0.23	
1/17/2018			966.21	16.15	16.16	950.06	950.05	950.05	0.01	
1/29/2018			966.21	15.81	15.82	950.40	950.39	950.39	0.01	
2/19/2018			966.21	15.88	15.89	950.33	950.32	950.32	0.01	
6/22/2018			966.21	15.22	15.30	950.99	950.91	950.97	0.08	
10/1/2018			966.21	16.73	16.85	949.48	949.36	949.457	0.12	
10/1/2019			966.21	15.89	15.96	950.32	950.25	950.3045	0.07	
10/12/2020			966.21	16.46	16.75	949.75	949.46	949.7015	0.29	
11/4/2020	966.21	16.72	17.03	949.49	949.18	949.4385	0.31	Transmissivity testing 11/4/20		

ft = feet

AMSL = above mean sea level

TOC = top of casing

bTOC = below top of casing

bgs = below ground surface

NA = not applicable due to lack of LNAPL

LNAPL = light non-aqueous phase liquid

**Table 2
TW-11-01 Gauging Data
RACER - Pontiac North Campus
Pontiac, MI**

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
10/4/2012	9.4-19.4	9.15-19.15	969.28	NA	7.41	NA	961.87	961.87	0.00	
11/20/2012			969.28	8.11	8.32	961.17	960.96	961.14	0.21	
1/7/2013			969.28	NA	9.68	NA	959.60	959.60	0.00	
2/18/2013			969.28	10.41	10.62	958.87	958.66	958.84	0.21	
2/22/2013			969.28	9.11	9.15	960.17	960.13	960.16	0.04	
4/22/2013			969.28	6.68	8.60	962.60	960.68	962.33	1.92	
4/23/2013			969.28	6.33	8.38	962.95	960.90	962.67	2.05	
5/3/2013			969.28	9.60	9.72	959.68	959.56	959.66	0.12	
6/24/2013			969.28	9.61	9.80	959.67	959.48	959.64	0.19	
8/2/2013			969.28	9.91	10.07	959.37	959.21	959.35	0.16	
10/17/2013			969.28	10.40	10.49	958.88	958.79	958.87	0.09	
11/22/2013			969.28	10.46	10.60	958.82	958.68	958.80	0.14	
12/2/2013			969.28	9.87	11.11	959.41	958.17	959.24	1.24	
2/17/2014			969.28	10.41	10.44	958.87	958.84	958.87	0.03	
4/7/2014			969.28	6.01	8.52	963.27	960.76	962.92	2.51	Transmissivity testing completed on 4/7 and 4/17
9/15/2016			969.28	5.44	9.40	963.84	959.88	963.29	3.96	
10/15/2017			969.28	4.98	10.18	964.30	959.10	963.58	5.20	
6/22/2018			969.28	4.39	10.49	964.89	958.79	964.05	6.10	
10/1/2018			969.28	5.09	10.95	964.19	958.33	963.38	5.86	
10/1/2019			969.28	5.14	10.01	964.14	959.27	963.47	4.87	
10/12/2020	969.28	5.85	8.49	963.43	960.79	963.07	2.64			
11/3/2020	969.28	5.49	11.87	963.79	957.41	962.91	6.38	Transmissivity testing 11/3/20		

ft = feet

AMSL = above mean sea level

TOC = top of casing

bTOC = below top of casing

bgs = below ground surface

NA = not applicable due to lack of LNAPL

LNAPL = light non-aqueous phase liquid

Table 3
TW-11-02 Gauging Data
RACER - Pontiac North Campus
Pontiac, MI

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
10/4/2012	9.5-19.5	9.25-19.25	970.38	NA	6.33	NA	NA	964.05	0.00	
11/20/2012			970.38	NA	8.95	NA	NA	961.43	0.00	
1/7/2013			970.38	NA	7.67	NA	NA	962.71	0.00	
4/22/2013			970.38	NA	6.34	NA	NA	964.04	0.00	
5/3/2013			970.38	6.31	6.41	964.07	963.97	964.06	0.10	
6/24/2013			970.38	9.81	9.90	960.57	960.48	960.56	0.09	
8/2/2013			970.38	NA	8.91	NA	NA	961.47	0.00	
10/17/2013			970.38	NA	9.42	NA	NA	960.96	0.00	
11/22/2013			970.38	6.45	6.50	963.93	963.88	963.92	0.05	
12/2/2013			970.38	6.65	6.75	963.73	963.63	963.72	0.10	
2/17/2014			970.38	8.57	8.59	961.81	961.79	961.81	0.02	
4/7/2014			970.38	6.05	6.13	964.33	964.25	964.32	0.08	
9/15/2016			970.38	6.69	8.21	963.69	962.17	963.48	1.52	
10/15/2017			970.38	6.05	8.55	964.33	961.83	963.98	2.50	
6/22/2018			970.38	6.00	9.15	964.38	961.23	963.94	3.15	
10/1/2018			970.38	5.30	8.61	965.08	961.77	964.62	3.31	
10/1/2019			970.38	4.84	9.07	965.54	961.31	964.96	4.23	
10/12/2020			970.38	6.64	10.35	963.74	960.03	963.23	3.71	
11/3/2020	970.38	5.88	11.48	964.50	958.90	963.73	5.60	Transmissivity test 11/3/20		

ft = feet

AMSL = above mean sea level

TOC = top of casing

bTOC = below top of casing

bgs = below ground surface

NA = not applicable due to lack of LNAPL

LNAPL = light non-aqueous phase liquid

Table 4
SB-08-14/RW-08-14 Gauging Data
RACER - Pontiac North Campus
Pontiac, MI

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
SB-08-14										
6/17/2014	10-20'	12.23-22.23'	965.97	11.06	22.30	954.91	943.67	953.22	11.24	LNAPL sample collected
6/30/2014			965.97	13.41	24.02	952.56	941.95	950.96	10.61	
7/28/2014			965.97	12.30	21.51	953.67	944.46	952.28	9.21	
9/11/2014			965.97	11.75	20.82	954.22	945.15	952.85	9.07	
9/17/2014			965.97	11.45	21.41	954.52	944.56	953.02	9.96	Transmissivity testing completed on 9/17 through 9/19
10/24/2014			965.97	11.94	21.50	954.03	944.47	952.59	9.56	
3/31/2015			965.97	12.55	21.30	953.42	944.67	952.10	8.75	
6/24/2015			965.97	11.42	21.37	954.55	944.60	953.05	9.95	
9/21/2015			965.97	13.30	21.10	952.67	944.87	951.50	7.80	
10/23/2015			965.97	11.94	21.50	954.03	944.47	952.59	9.56	
1/18/2016		965.97	13.09	21.43	952.88	944.54	951.62	8.34		
8/15/2016		965.97	13.66	21.77	952.31	944.20	951.09	8.11	Stick-up protective casing installed 7/20/2017. Top of casing not resurveyed	
1/17/2018		NA	NS	13.95	22.97	NA	NA	NA	9.02	LNAPL sample collected
1/29/2018			NS	13.51	23.25	NA	NA	NA	9.74	
2/19/2018			NS	13.91	23.32	NA	NA	NA	9.41	LNAPL sample collected; Transmissivity test completed
7/16/2018	NS		13.15	23.47	NA	NA	NA	10.32	LNAPL sample collected; LNAPL Removal pre-design recovery testing completed on 7/16 through 7/19	
10/1/2018	NS		13.76	21.87	NA	NA	NA	8.11		

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
RW-08-14										
4/26/2019	5-25'	NA	NS	9.38	11.10	NA	NA	NA	1.72	Fluent LNAPL Recovery System operation start
5/2/2019			NS	8.88	10.15	NA	NA	NA	1.27	
5/6/2019			NS	8.74	9.01	NA	NA	NA	0.27	
5/9/2019			NS	8.10	8.70	NA	NA	NA	0.60	
5/13/2019			NS	8.61	8.65	NA	NA	NA	0.04	
5/21/2019			NS	8.81	8.88	NA	NA	NA	0.07	
5/23/2019			NS	8.66	8.71	NA	NA	NA	0.05	
5/28/2019			NS	8.45	9.10	NA	NA	NA	0.65	
5/30/2019			NS	8.53	9.58	NA	NA	NA	1.05	
6/4/2019			NS	8.56	8.65	NA	NA	NA	0.09	
6/7/2019			NS	8.57	8.60	NA	NA	NA	0.03	
6/10/2019			NS	8.55	8.64	NA	NA	NA	0.09	
6/14/2019			NS	8.14	8.21	NA	NA	NA	0.07	
6/18/2019			NS	7.79	7.81	NA	NA	NA	0.02	
6/21/2019			NS	8.00	8.10	NA	NA	NA	0.10	
6/24/2019			NS	8.00	8.09	NA	NA	NA	0.09	
6/28/2019			NS	8.45	8.50	NA	NA	NA	0.05	
7/1/2019			NS	8.64	8.70	NA	NA	NA	0.06	
7/2/2019			NS	8.71	8.79	NA	NA	NA	0.08	
7/5/2019			NS	8.95	9.05	NA	NA	NA	0.10	
7/8/2019			NS	9.14	9.28	NA	NA	NA	0.14	
7/11/2019			NS	9.28	9.39	NA	NA	NA	0.11	
7/15/2019			NS	9.64	9.73	NA	NA	NA	0.09	
7/17/2019			NS	9.43	9.50	NA	NA	NA	0.07	
7/19/2019			NS	9.45	9.53	NA	NA	NA	0.08	
7/22/2019			NS	9.52	9.76	NA	NA	NA	0.24	
7/25/2019			NS	9.73	9.83	NA	NA	NA	0.10	
7/29/2019			NS	9.81	9.95	NA	NA	NA	0.14	
7/31/2019			NS	9.92	10.03	NA	NA	NA	0.11	
8/5/2019			NS	10.30	10.41	NA	NA	NA	0.11	
8/6/2019			NS	10.03	10.15	NA	NA	NA	0.12	
8/9/2019			NS	10.29	10.44	NA	NA	NA	0.15	
8/14/2019	NS	10.38	10.64	NA	NA	NA	0.26			
8/16/2019	NS	10.40	11.00	NA	NA	NA	0.60			
8/20/2019	NS	10.01	10.15	NA	NA	NA	0.14			
8/23/2019	NS	9.99	10.02	NA	NA	NA	0.03			
8/26/2019	NS	9.90	10.02	NA	NA	NA	0.12			
8/30/2019	NS	10.18	10.32	NA	NA	NA	0.14			

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
RW-08-14										
9/3/2019	5-25'	NA	NS	10.22	10.36	NA	NA	NA	0.14	
9/6/2019			NS	10.32	10.60	NA	NA	NA	0.28	
9/10/2019			NS	10.45	11.12	NA	NA	NA	0.67	
9/13/2019			NS	10.10	10.22	NA	NA	NA	0.12	
9/17/2019			NS	9.53	9.65	NA	NA	NA	0.12	
9/20/2019			NS	9.52	9.64	NA	NA	NA	0.12	
9/24/2019			NS	9.73	9.85	NA	NA	NA	0.12	
9/27/2019			NS	9.94	10.02	NA	NA	NA	0.08	
9/30/2019			NS	9.83	9.98	NA	NA	NA	0.15	
10/4/2019			NS	9.58	9.70	NA	NA	NA	0.12	
10/8/2019			NS	9.40	9.53	NA	NA	NA	0.13	
10/10/2019			NS	9.42	9.55	NA	NA	NA	0.13	
10/14/2019			NS	9.64	9.78	NA	NA	NA	0.14	
10/21/2019			NS	9.97	10.14	NA	NA	NA	0.17	
10/24/2019			NS	10.30	10.48	NA	NA	NA	0.18	
10/28/2019			NS	10.10	10.25	NA	NA	NA	0.15	
11/4/2019			NS	9.18	9.27	NA	NA	NA	0.09	
11/11/2019			NS	9.37	9.50	NA	NA	NA	0.13	
11/14/2019			NS	9.57	9.62	NA	NA	NA	0.05	
11/18/2019			NS	9.62	9.78	NA	NA	NA	0.16	
11/25/2019			NS	9.82	9.97	NA	NA	NA	0.15	
12/4/2019			NS	9.30	9.40	NA	NA	NA	0.10	
12/9/2019			NS	9.29	9.38	NA	NA	NA	0.09	
12/16/2019			NS	9.75	9.83	NA	NA	NA	0.08	
12/24/2019			NS	10.13	10.30	NA	NA	NA	0.17	
12/30/2019			NS	10.28	10.42	NA	NA	NA	0.14	
1/6/2020			NS	9.95	10.08	NA	NA	NA	0.13	
1/16/2020			NS	8.01	8.10	NA	NA	NA	0.09	
1/20/2020			NS	8.75	8.83	NA	NA	NA	0.08	
1/30/2020			NS	7.22	7.32	NA	NA	NA	0.10	
2/6/2020			NS	7.55	7.70	NA	NA	NA	0.15	
2/13/2020			NS	8.11	8.26	NA	NA	NA	0.15	
2/25/2020			NS	8.55	8.65	NA	NA	NA	0.10	
3/4/2020			NS	8.40	8.52	NA	NA	NA	0.12	
3/9/2020	NS	8.61	8.72	NA	NA	NA	0.11			
3/17/2020	NS	8.96	9.07	NA	NA	NA	0.11			
3/26/2020	NS	9.19	9.32	NA	NA	NA	0.13			
3/30/2020	NS	8.61	8.69	NA	NA	NA	0.08			
4/8/2020	NS	8.50	8.52	NA	NA	NA	0.02			
4/13/2020	NS	8.59	8.71	NA	NA	NA	0.12			
4/20/2020	NS	9.10	9.19	NA	NA	NA	0.09			
4/27/2020	NS	9.49	9.59	NA	NA	NA	0.10			
5/4/2020	NS	9.60	9.77	NA	NA	NA	0.17			
5/11/2020	NS	9.74	9.98	NA	NA	NA	0.24			
5/18/2020	NS	9.05	9.18	NA	NA	NA	0.13			
5/27/2020	NS	8.05	8.13	NA	NA	NA	0.08			

Date	Well Screen (ft bgs)	Well Screen (ft bTOC)	TOC (ft AMSL)	Depth to LNAPL (ft bTOC)	Depth to Water (ft bTOC)	Air/LNAPL Interface (ft AMSL)	LNAPL/Water Interface (ft AMSL)	Potentiometric Surface (ft AMSL)	LNAPL thickness (ft)	Notes
RW-08-14										
6/4/2020	5-25'	NA	NS	8.52	8.59	NA	NA	NA	0.07	
6/11/2020			NS	8.82	8.91	NA	NA	NA	0.09	
6/17/2020			NS	8.77	8.90	NA	NA	NA	0.13	
6/23/2020			NS	9.07	9.18	NA	NA	NA	0.11	
6/29/2020			NS	9.41	9.52	NA	NA	NA	0.11	
7/6/2020			NS	9.80	10.41	NA	NA	NA	0.61	
7/14/2020			NS	9.96	11.58	NA	NA	NA	1.62	
7/20/2020			NS	10.20	10.30	NA	NA	NA	0.10	
7/27/2020			NS	10.40	10.53	NA	NA	NA	0.13	
8/3/2020			NS	10.52	10.60	NA	NA	NA	0.08	LNAPL Recovery System shut down
8/13/2020			NS	10.40	11.58	NA	NA	NA	1.18	
8/20/2020			NS	10.52	12.58	NA	NA	NA	2.06	
8/24/2020			NS	10.62	13.00	NA	NA	NA	2.38	
8/31/2020			NS	9.82	12.72	NA	NA	NA	2.90	
9/8/2020			NS	9.89	13.68	NA	NA	NA	3.79	
9/14/2020			NS	9.81	14.20	NA	NA	NA	4.39	
9/22/2020			NS	10.00	15.40	NA	NA	NA	5.40	
10/5/2020			NS	10.52	16.50	NA	NA	NA	5.98	
10/14/2020			NS	10.72	17.20	NA	NA	NA	6.48	
10/21/2020			NS	10.82	17.80	NA	NA	NA	6.98	
10/27/2020			NS	10.78	17.50	NA	NA	NA	6.72	
11/12/2020			NS	11.40	14.40	NA	NA	NA	3.00	Transmissivity testing completed on 11/2 through 11/4
11/19/2020			NS	11.26	15.35	NA	NA	NA	4.09	
11/23/2020			NS	11.38	15.78	NA	NA	NA	4.40	
11/30/2020			NS	11.13	16.02	NA	NA	NA	4.89	
12/9/2020			NS	11.20	16.23	NA	NA	NA	5.03	
12/14/2020			NS	11.10	16.70	NA	NA	NA	5.60	
12/21/2020			NS	10.90	17.00	NA	NA	NA	6.10	
12/30/2020	NS	10.98	17.33	NA	NA	NA	6.35			
1/20/2021	NS	11.19	17.80	NA	NA	NA	6.61			

Notes:

SB-08-14 was overdrilled and replaced with RW-08-14 on October 22, 2018.

ft = feet

AMSL = above mean sea level

TOC = top of casing

bTOC = below top of casing

bgs = below ground surface

NA = not available

LNAPL = light non-aqueous phase liquid

NS = not surveyed

Table 5
LNAPL Baildown Testing and Analysis Results
RACER - Pontiac North Campus
Pontiac, MI

Well ID	Date	Test	Initial LNAPL Thickness (ft)	Test Duration (min)	Final LNAPL Thickness (ft)	LNAPL Recovery (%)	LNAPL Transmissivity, T_0 (ft ² /day)					Notes/Comments
							Thiem	B&R	C&J	CB&P	Mean	
AOI W-10												
RW-08-14	11/2/2020	Test 1	6.68	3,130 ¹	2.8	42%	0.11	NA	NA	NA	NA	Tn estimate based on attaining stable conditions, i.e., drawdown and discharge were relatively constant. Used Thiem equation ² to estimate with field data.
AOI W-1												
SB-25-14	9/18/2014	Test 1	0.36	1,216	0.28	78%	NA	0.28	0.96	0.80	0.68	Very little LNAPL recharge observed following test initiation. Results are likely representative of filter pack drainage; and the reported value should thus be regarded as an upper limit estimate of LNAPL transmissivity.
	11/4/2020	Test 1	0.31	55	0.07	23%	NA	0.05	0.12	0.23	0.13	

General Notes:

All analyses completed using American Petroleum Institute (API) LNAPL Transmissivity Workbook (API 2016).

Bold Exceeds 0.1 to 0.8 ft²/day lower criterion range to produce sufficient LNAPL recoverability (ITRC 2009).

Shaded Exceeds 0.5 ft²/day lower limit LNAPL transmissivity value defining recovery to the maximum extent practicable (MDEQ 2014).

Acronyms and Abbreviations:

AOI = Area of interest

ft = feet

LNAPL = light non-aqueous phase liquid

min = minute

NA = not analyzed

B&R = Method based on Bouwer & Rice (1976) method for analysis of groundwater slug tests in unconfined aquifers.

C&J = Method based on Cooper & Jacob (1946)/Jacob & Lohman (1952) methods for groundwater flow to a well under constant drawdown or constant discharge conditions

CB&P = Method based on Cooper, Bredehoeft and Papadopoulos (1967) method for analysis of groundwater slug tests in confined aquifers.

Footnotes:

¹ Note that test was completed once a stable condition was achieved and pumping had stopped. Total LNAPL recovery includes recharge time following LNAPL pumping.

² LNAPL transmissivity estimated based on Thiem solution for confined conditions (ASTM International 2013; Equation 16).

References:

American Petroleum Institute (API). 2016. API LNAPL Transmissivity Workbook: A Tool for Baildown Test Analysis User Guide. API PUBLICATION 4762. April 2016.

Interstate Technology & Regulatory Council (ITRC). 2009. Evaluating LNAPL Remedial Technologies for Achieving Project Goals. LNAPL-2. Washington, D.C.: Interstate Technology & Regulatory Council, LNAPLs Team. www.itrcweb.org

Michigan Department of Environmental Quality (MDEQ). 2014. Non-Aqueous Phase Liquid (NAPL) Characterization, Remediation, and Management for Petroleum Releases. RRD Resource Materials-25-2014-01. June 2014.

Table 6
LNAPL/Water Ratio Testing and Analysis Results
RACER - Pontiac North Campus
Pontiac, MI

		Stabilized Oil to Water Ratio (Q_o/Q_w)	Water Transmissivity (T_w) (ft ² /d)	LNAPL/Water Density Ratio (ρ_r)	LNAPL Transmissivity (T_n) (ft ² /d)
TW-11-01	11/3/2020	2.7E-04	0.9	0.86	2.1E-04
TW-11-02	3/19/2020	6.0E-04	1.1	0.86	5.7E-04

$$T_n = \frac{Q_o T_w \rho_r}{Q_w}$$

Notes:

LNAPL Transmissivity calculation uses ASTM E-2856 Eq. 21:

Water transmissivity approximated from water drawdown and specific capacity following Driscoll (1986).

Bold Exceeds 0.1 to 0.8 ft²/day lower criterion range to produce sufficient LNAPL recoverability (ITRC 2009).

Shaded Exceeds 0.5 ft²/day lower limit LNAPL transmissivity value defining recovery to the maximum extent practicable (MDEQ 2014).

No transmissivity result exceeded applicable criteria for recoverability.

Acronyms and Abbreviations:

gpm: gallons per minute

ft²/d: square feet per day

LNAPL: light nonaqueous phase liquid

References:

ASTM E2856-13, Standard Guide for Estimation of LNAPL Transmissivity, ASTM International, West Conshohocken, PA, 2013, www.astm.org

Driscoll, F.G., 1986, Groundwater and wells (Second edition): Johnson Division, St. Paul, Minnesota, p.1089

Interstate Technology & Regulatory Council (ITRC). 2009. Evaluating LNAPL Remedial Technologies for Achieving Project Goals. LNAPL-2. Washington, D.C.: Interstate Technology & Regulatory Council, LNAPLs Team. www.itrcweb.org

Michigan Department of Environmental Quality (MDEQ). 2014. Non-Aqueous Phase Liquid (NAPL) Characterization, Remediation, and Management for Petroleum Releases. RRD Resource Materials-25-2014-01. June 2014.

Attachment 1

Well Construction/Boring Logs

Date Start/Finish: 4/4/08 Drilling Company: Boart Longyear Driller's Name: Joe Tidwell Drilling Method: Rotosonic Sampler Size: 4" Rig Type: Track Mounted Spyder Sonic	Northing: 424620.6032 Easting: 13413255.93 Casing Elevation: 969.624 Borehole Depth: 40' bgs Surface Elevation: 970.194 Descriptions By: Beth Lindblade	Well ID: MWW8-65 Client: General Motors Corporation Location: Pontiac North Campus Pontiac, Michigan
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DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	USCS Code	Geologic Column	Stratigraphic Description	Well Construction
20-20		3	14.9'-25'	10				CLAY (CL) - (10YR 4/1 - 4/2) dark gray to dark grayish brown Clay, stiff, few medium to coarse subangular gravel, few little subangular to subrounded cobbles, dry to moist, no odor, low plasticity.	
					4.2				
					1.3				
					0.0				
25-25								CLAY (CL) - (10YR 4/1 - 4/2) dark gray to dark grayish brown Clay, stiff, few medium to coarse subangular gravel, few little subangular to subrounded cobbles, dry to moist, slight odor, no visible sheen, low plasticity.	
					1.3				
					4.2	CL	Moist to wet (28-30' bgs)		
30-30									
		4	25'-40'	15					
					10				
35-35								Hydrated Bentonite Chip (35'-40' bgs)	
					3.1				
					6.3				
40-40								End of boring - 40' bgs.	

	Remarks: bgs = below ground surface ppm = parts per million BG = Background NA = Not applicable/Not available
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Soil Boring Log

Project Name: RACER PNC Date Started: 10/22/2018 Logger: K. Briggs
 Project Number: 30042811 Date Completed: 10/22/2018 Editor: C. Barton
 Project Location: Pontiac, MI Weather Conditions: Sunny, 60F

Depth (feet)	Sample Interval	Blow Counts	Recovery (in.)	Sample ID	PID (ppm)	USCS Class	Description	Construction Details	Well
1							***Lithology taken from SB-08-14. Location was overdrilled for RW-08-14 installation (0.0-2.0') PEBBLES, medium to large, subangular to angular; and SAND, fine to medium; poorly sorted; dry; dark brown (10YR 4/3). NOTE: Slag at 1.0' bgs.	(0.0-0.5') Cement (0.5-1.0') Fill Sand	
2							(2.0-9.0') CLAY, low plasticity; some very fine to fine sand; trace small to medium pebbles, subrounded to subangular; moist; soft; dark olive gray (5Y 3/2). NOTE: Moderate odor from 2.0'-4.0' bgs.	(1.0-3.5') Bentonite Pellets	
3								(0.5-5.0' bgs) 2" Sch 40 PVC Well Casing	
4									
5									
6									
7									
8									
9							NOTE: Moist at 8.5' bgs.		
10							(9.0-11.0') SAND, very fine; some silt; well sorted; wet; gray (5Y 5/1). NOTE: Moderate odor.		
11									
12							(11.0-15.0') SAND, very fine to fine; little silt; poorly sorted; wet; olive gray (5Y 4/2). NOTE: Moderate odor.	(3.5-25.5') Filter Pack Sand	
13		306			NA				
14									
15									
16							(15.0-25.0') SAND, fine to medium; trace silt; poorly sorted; wet; olive (5YR 4/3). NOTE: Strong odor; oily residue.		
17									
18							NOTE: Little coarse to very coarse sand at 18.0' bgs. Some silt at 18.5'-19.0' bgs.		
19									
20									

Drilling Co.: Cascade Sampling Method: Core Barrel
 Driller: NA Sampling Interval: Continuous
 Drilling Method: Sonic Drilling Water Level Start (ft. bgs.): NA
 Drilling Fluid: Water Water Level Finish (ft. btoc.): NA
 Remarks: Lithology taken from SB-08-14. Location was overdrilled for RW-08-14 installation. Converted to Well: Yes No
 Surface Elev.: _____
 North Coor.: _____
 East Coor.: _____

SOIL BORING LOG - 2013 C:\USERS\AWEST\HUIS\DESKTOP\RACER PNC - RW-08-14_04162020.GPJ ARCADIS_2013.GDT 4/16/20

Soil Boring Log

Project Name: RACER PNC Date Started: 10/22/2018 Logger: K. Briggs
 Project Number: 30042811 Date Completed: 10/22/2018 Editor: C. Barton
 Project Location: Pontiac, MI Weather Conditions: Sunny, 60F

Depth (feet)	Sample Interval	Blow Counts	Recovery (in.)	Sample ID	PID (ppm)	USCS Class	Description	Construction Details	Well
21	[Diamond symbol]					[Dotted pattern]	(15.0-25.0') SAND, fine to medium; trace silt; poorly sorted; wet; olive (5YR 4/3). NOTE: Strong odor; oily residue.	(3.5-25.5') Filter Pack Sand	[Well diagram]
22									
23									
24									
25									
26						[Diagonal hatching]	(25.0-25.5') CLAY, high plasticity; little silt, moist; soft; gray (10YR 5/1).	6" PVC 10-Slot Well Screen	
27							End of boring at 25.5' bgs.	6" PVC 10-Slot Well Screen	
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									

Remarks:

Date Start: 6/12/14
Date Finish: 6/12/14
Drilling Company: Fibertec
Driller's Name: Nick
Drilling Method: AK to 5.0' bgs/Continuous
Sampling Method: Macrocore
Rig Type: Geoprobe
Water Level Start (ft. bgs.):
Water Level Finish (ft. btoc.):

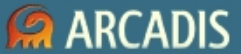
Northing: 423812.134
Easting: 13411860.8
Casing Elevation: 966.205
Borehole Depth (ft. bgs.): 30.0' bgs.
Surface Elevation: 964.584
Descriptions By: C. Snyder

Well/Boring ID: SB-25-14
Client: RACER
Location: RACER PNC
Weather Conditions: Light rain, 75 F

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
945		4	15.0-20.0	4.0		X		NOTE: Odor.		
20		5	20.0-25.0	3.5		X		(19.0 - 24.0') CLAY, medium plasticity; some silt, rapid dilatancy; wet; soft; grayish brown (10YR 5/2).		
25		6	25.0-30.0	2.3		X		(24.0 - 30.0') SAND, fine to medium; trace coarse to very coarse; poorly sorted; wet; grayish brown (10YR 5/2).		Backfill (19.0'-30.0' bgs)
30								End of boring at 30.0' bgs.		

Remarks: bgs = below ground surface
 Groundwater encountered at 10'-30' bgs.
 Odor at 10'-13' and 14'-19'. No staining observed.
 Negative Shake Tests at: 5'-7', 19'-20', 21'-22', 23'-24', 26'-27' and 29'-30'.
 Positive Shake Test at: 8'-10', 10'-12', 14'-15', and 16'-17' bgs.





Boring No.: TW-11-01

Soil Boring Log

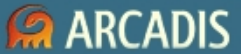
Sheet: 1 of 1

Project Name: MLC-PNC Date Started: 09/11/2012 Logger: T. Stevens
 Project Number: B0064607.2012.0005 Date Completed: 09/12/2012 Editor: I. Drost
 Project Location: 900 Baldwin Ave., Pontiac, MI Weather Conditions: 80, Sunny

Depth (feet)	Sample Interval	Blow Counts	Recovery (in.)	Sample ID	PID (ppm)	USCS Class	Description	Construction Details
0					0.0	(0.0-0.3') ASPHALT.		
1					0.0	(0.3-1.0') Sand medium to coarse, subangular to subrounded; and PEBBLES, little granules, subangular to subrounded; some silt; poorly sorted; dry; dark grayish brown (10YR 4/2). Note: Fill.		
2			60		5.0	(1.0-6.0') SILT, little clay, nonplastic, slow dilatancy; and SAND, fine to medium, subrounded; some granule to small pebble, subrounded to subangular; poorly sorted; dry; dark yellowish brown (10YR 4/4).		
3					11.9			
4					10.4			
5				Negative	17.1			
6			24		21.0	(6.0-11.0') SILT, little clay, medium plasticity, slow to no dilatancy; some very fine to fine sand, subrounded; trace granule, subrounded; poorly sorted; dry; dark grayish brown (10YR 4/2). Note: Slight odor at 7.0' bgs.		
7				Negative	12.2			
8					1.9			
9					6.2			
10					10.2			
11				Negative	31.4	(11.0-14.0') SAND, fine to medium, subrounded; and PEBBLES, some granules, subrounded to rounded; some silt, medium plasticity; poorly sorted; moist; dark grayish brown (10YR 4/2). Note: Strong odor from 11.0-14.0' bgs.		
12				Negative	23.4			
13				Negative	3.6			
14			156		2.2	(14.0-20.0') CLAY, little silt, high plasticity; rapid dilatancy; some fine to medium sand, subrounded; little granule, subrounded to subangular; poorly sorted; moist; dark grayish brown (10YR 4/2). Note: Till		
15					1.8			
16					2.1			
17					0.9			
18					0.7			
19					0.0			
20				Negative			End of boring at 20.0' bgs.	

Drilling Co.: Stearns Drilling Company Sampling Method: Hand Auger/Sonic
 Driller: Brian Marshall Sampling Interval: Continuous
 Drilling Method: Sonic Drilling Water Level Start: NA
 Drilling Fluid: Water Water Level Finish: NA
 Remarks: Hand Auger to 5.0' bgs. (0.0-1.0' bgs) Cement; Converted to Well: Yes No
(1.0-8.0' bgs) Bentonite; (8.0-20.0' bgs) #1 K&E Surface Elev.: _____
sand; (9.4-19.4' bgs) 20-slot S.S. screen. North Coor: _____
 East Coor: _____

SOIL BORING LOG - \ARCADIS\US\COMMON\MONMLC\B0064607 - PONTIAC NORTH CAMPUS\B0064607.MLC\PC\NOTES & DATA\PCRA PA\SOIL BORING LOGS.GPJ - ARCADIS.GDT - 10/11/12



Boring No.: TW-11-02

Soil Boring Log

Sheet: 1 of 2

Project Name: MLC-PNC
 Project Number: B0064607.2012.0005
 Project Location: 900 Baldwin Ave., Pontiac, MI

Date Started: 09/10/2012 Date Completed: 09/11/2012
 Logger: T. Stevens Editor: I. Drost
 Weather Conditions: 75, Sunny

Depth (feet)	Sample Interval	Blow Counts	Recovery (in.)	Sample ID	PID (ppm)	USCS Class	Description	Construction Details
0.0							(0.0-0.4') ASPHALT.	
1					0.0		(0.4-1.0') SAND, medium to coarse, subangular to subrounded; and PEBBLES, subangular to subrounded; little granules; some silt; poorly sorted; dry; dark grayish brown (10YR 4/2). Note: Fill	
2			60		0.0		(1.0-2.0') CLAY, some silt, medium plasticity; slow dilatancy; and SAND, fine to medium, subrounded; poorly sorted; dry; dark grayish brown (10YR 4/2). Note: Fill.	
3					0.0		(2.0-7.0') SAND, medium to coarse, subrounded; some granules, subrounded; trace small pebbles; and SILT, low plasticity, slow to no dilatancy; poorly sorted; moist; dark grayish brown (10YR 4/2). Note: Fill.	
4					0.0			
5					0.0			
6			24		5.4			
7				Negative	7.3			
8			18	SD	15.5		(7.0-12.0') SILT, some clay, high plasticity; slow dilatancy; some fine to medium sand, subrounded; little granules, subangular; poorly sorted; dry; stiff; brown (10YR 4/3). Note: Large cobble at 8.0' bgs.	
9					0.0			
10					0.0			
11				Negative	2.3		Note: Wet at 10.0' bgs.	
12				Positive	7.7			
13			40		9.2		(12.0-18.0') SILT, little clay, low plasticity, no dilatancy; and SAND, fine to medium, subrounded; little granules, subrounded; poorly sorted; wet; very dark grayish brown (10YR 3/2). Note: Slight odor from 12.0-16.0' bgs.	
14				Positive	18.8			
15					17.7			
16				Positive	19.3			
17				Negative	23.3			
18					0.0			
19					0.0			
20					0.0			

Drilling Co.: Stearns Drilling Company Sampling Method: Hand Auger/Sonic
 Driller: Brian Marshall Sampling Interval: Continuous
 Drilling Method: Sonic Drilling Water Level Start: NA
 Drilling Fluid: Water Water Level Finish: NA
 Remarks: Hand Auger to 5.0' bgs. (0.0-1.0' bgs) Cement; Converted to Well: Yes No
(1.0-8.1' bgs) Bentonite; (8.1-22.0' bgs) #1 K&E Surface Elev.: _____
sand; (9.5-19.5' bgs) 20-slot S.S. screen; North Coor: _____
(22.0-40.0' bgs) bentonite seal East Coor: _____

SOIL BORING LOG - ARCADIS US.COM\OFFICE\DATA\NOV-MICOMMON\MLC\B0064607 - PONTIAC NORTH CAMPUS\US64607-MLC\PNC005 NOTES & DATA\PCRA PAID\SOIL BORING LOGS.GPJ - ARCADIS.GDT - 10/11/12



Boring No.: TW-11-02

Soil Boring Log

Sheet: 2 of 2

Project Name: MLC-PNC

Date Started: 09/10/2012

Logger: T. Stevens

Project Number: B0064607.2012.0005

Date Completed: 09/11/2012

Editor: I. Drost

Project Location: 900 Baldwin Ave., Pontiac, MI

Weather Conditions: 75, Sunny

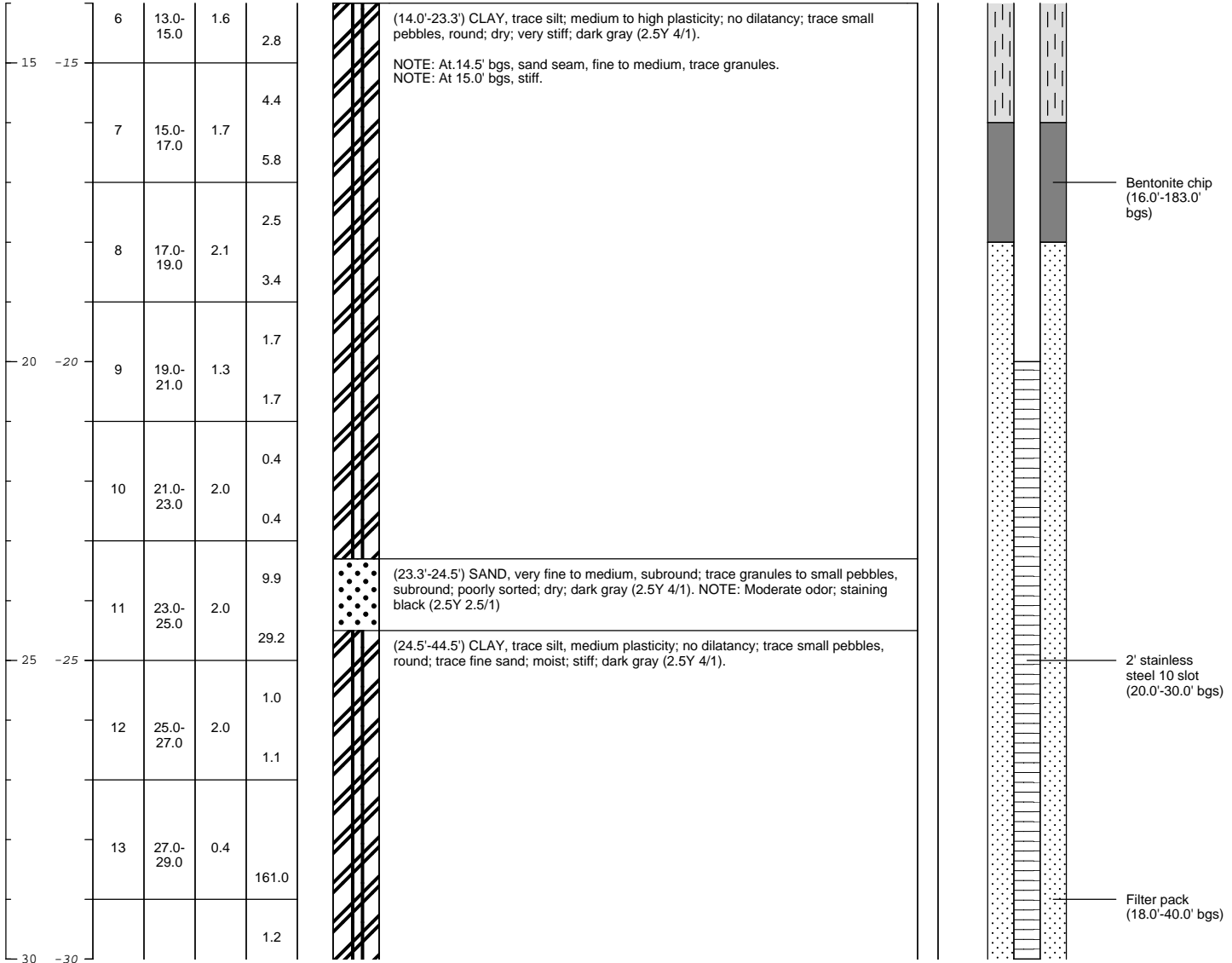
Depth (feet)	Sample Interval	Blow Counts	Recovery (in.)	Sample ID	PID (ppm)	USCS Class	Description	Construction Details
21					0.0		(18.0-40.0') SILT, some clay, high plasticity, slow dilatancy; some fine to medium sand, subrounded; little small pebbles, subangular; little granules, subrounded; poorly sorted; moist; soft; dark grayish brown (10YR 4/2). Note: Till.	
22		108	Negative	0.0				
23			Negative	0.0				
24			Negative	0.1				
25			Negative	0.1				
26					0.2			
27					0.5			
28					0.0			
29					0.0			
30					0.4			
31					0.0			
32					0.0			
33					0.0			
34		72			0.0			
35					0.0			
36					0.0			
37					0.0			
38					0.0			
39					0.0			
40					0.0			
41								

Remarks:

SOIL BORING LOG - VARCADIS-US.COM\OFFICE\DATA\NOV-11\COMMON\MLC\B0064607 - PONTIAC NORTH CAMPUS\64607-MLC\PC\06\NOTES & DATA\PCRA PAD\SOIL BORING LOGS.GPJ - ARCADIS.GDT - 10/11/12

Date Start: 8/27/13 Date Finish: 8/27/13 Drilling Company: Stern's Drilling Driller's Name: B.Marshall Drilling Method: HA to 5.0' bgs/Continuous Sampling Method: 2" Split Spoon Rig Type: Geoprobe Water Level Start (ft. bgs.): Water Level Finish (ft. btoc.):	Northing: 424668.06 Easting: 13413334.70 Casing Elevation: 969.37 Borehole Depth (ft. bgs.): 45.0' bgs. Surface Elevation: 966.90 Descriptions By: D.Shaw	Well/Boring ID: TWW8-01 Client: RACER Location: RACER PNC Weather Conditions: Rain, 75 F
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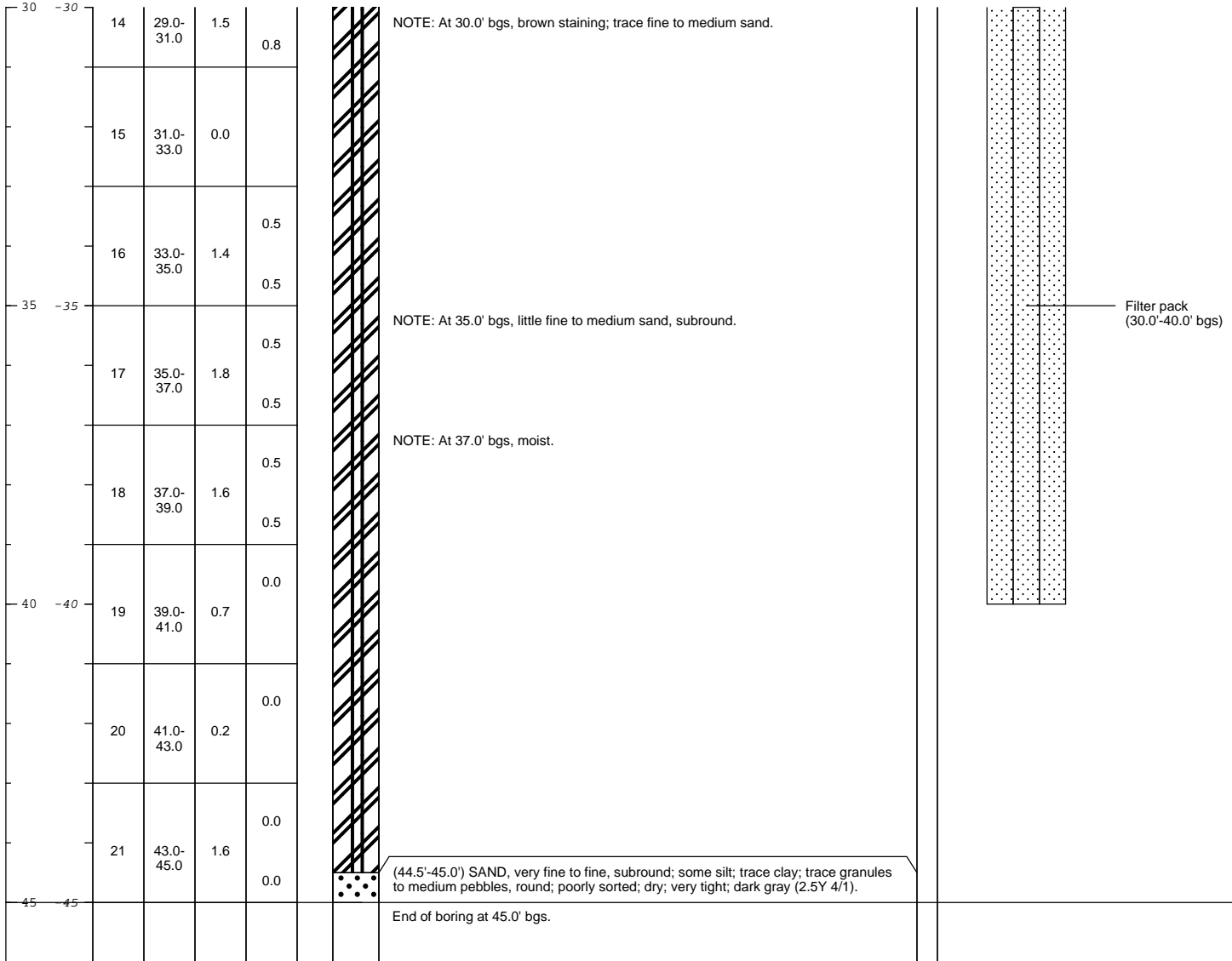
DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
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	Remarks: bgs = below ground surface No groundwater encountered. Odor detected from 23.3'-24.5' bgs. Staining observed from 23.3'-24.5' and at 30.0' bgs. Shake test at 14.5': slightly positive.
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Date Start: 8/27/13 Date Finish: 8/27/13 Drilling Company: Stern's Drilling Driller's Name: B.Marshall Drilling Method: HA to 5.0' bgs/Continuous Sampling Method: 2" Split Spoon Rig Type: Geoprobe Water Level Start (ft. bgs.): Water Level Finish (ft. btoc.):	Northing: 424668.06 Easting: 13413334.70 Casing Elevation: 969.37 Borehole Depth (ft. bgs.): 45.0' bgs. Surface Elevation: 966.90 Descriptions By: D.Shaw	Well/Boring ID: TWW8-01 Client: RACER Location: RACER PNC Weather Conditions: Rain, 75 F
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
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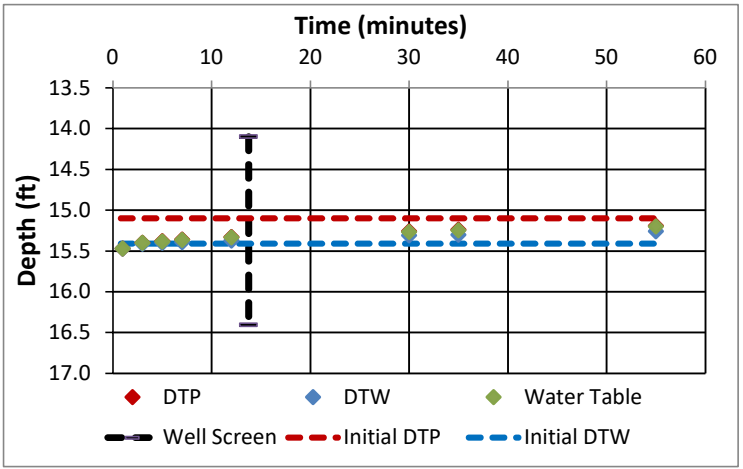
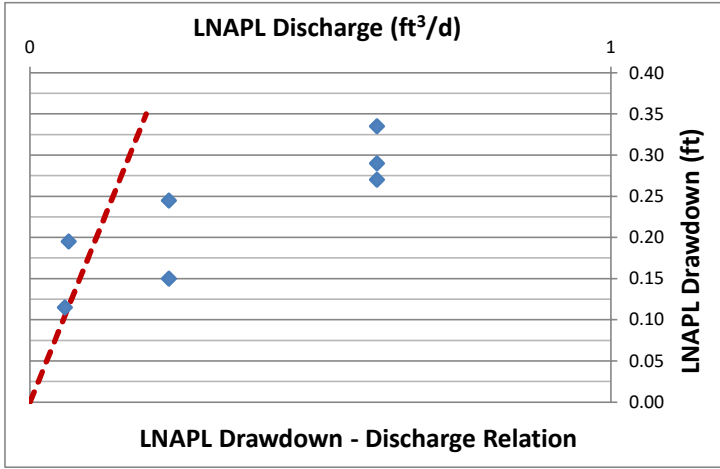


	Remarks: bgs = below ground surface No groundwater encountered. Odor detected from 23.3'-24.5' bgs. Staining observed from 23.3'-24.5' and at 30.0' bgs. Shake test at 14.5': slightly positive.
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Attachment 2

SB-25-14 Transmissivity Test Output Chart

SB-25-14 11/04/2020



Abbreviations:
 d = day
 DTP = depth to product
 DTW = depth to water
 ft = feet
 LNAPL = light non-aqueous phase liquid
 s = drawdown
 T = LNAPL transmissivity

