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# PERIMETER MONITORING RESPONSE ACTIVITY PLAN

## North Kent Study Area

***DRAFT***

*Disclaimer: This document is a DRAFT document that has not received approval from the Michigan Department of Environment, Great Lakes, and Energy (EGLE). 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 EGLE.*

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AMSL | Above Mean Sea Level |
| CD | Consent Decree |
| cfs | Cubic feet per second |
| COVID-19 | Coronavirus Disease 2019 |
| CSM | Conceptual Site Model |
| DoD | United States Department of Defense |
| DWC | Part 201 Generic Groundwater Cleanup Criteria Protective of Drinking Water for Residential Land Uses |
| EGLE | Michigan Department of Environmental, Great Lakes and Energy |
| EPA | United States Environmental Protection Agency |
| GIS | Geographic Information Systems |
| GSI | Groundwater-Surface Water Interface |
| HSDS | House Street Disposal Site |
| HUC | Hydrologic Unit Code |
| ID | Identification |
| MCL | Maximum Contaminant Level |
| MDEQ | Michigan Department of Environmental Quality |
| MDOT | Michigan Department of Transportation |
| MGDL | Michigan GIS Data Library |
| MS/MSD | Matrix Spike/Matrix Spike Duplicate |
| NE | Northeast |
| ng/L | Nanogram per Liter |
| NKLF | North Kent Landfill |
| NKSA | North Kent Study Area |
| PDF | Portable Document Format |
| PFAS | Per- and Polyfluoroalkyl Substances |
| PFBS | Perfluorobutane Sulfonic Acid |
| PFHxA | Perfluorohexanoic Acid |
| PFHxS | Perfluorohexane Sulfonic Acid |
| PFNA | Perfluorononanoic Acid |
| PFOA | Perfluorooctanoic Acid |
| PFOS | Perfluorooctane Sulfonate |
| ppt | Parts per Trillion |
| QAPP | Quality Assurance Project Plan [*Former Wolverine Tannery, House Street Disposal Area, and Wolven/Jewell Area, Per- and Polyfluoroalkyl Substances Investigation Program]* |
| QA/QC | Quality Assurance/Quality Control |
| QSM | Quality Systems Manual |
| R&W/GZA | Rose & Westra, a Division of GZA GeoEnvironmental, Inc. |
| RAP | Response Activity Plan |
| SAP | Sampling and Analysis Plan |
| SOP | Standard Operating Procedures |
| TCRA | Time Critical Removal Action |
| µg/L | Micrograms per Liter |
| USGS | United States Geological Survey |
| VAP | Vertical Aquifer Profiling |
| WJSA | Wolven Jewell Study Area |
| Wolverine | Wolverine World Wide, Inc. |

## 1.0 INTRODUCTION

On behalf of Wolverine, R&W/GZA prepared this RAP for the Perimeter Monitoring investigation in the NKSA. The objective of this RAP is monitor for potential migration outside of the municipal water areas by further evaluating the vertical and horizontal extent of PFAS at the perimeter of the municipal water areas.

The municipal water areas are shown on **Figure 1**. In areas of the NKSA where municipal water is not being installed, most residential well PFOA+PFOS concentrations are below the new Michigan Part 201 drinking water criteria.

This RAP is prepared pursuant to CD No. 1:18-cv-00039-JTN-SJB, effective February 19, 2020. Specifically, this scope of work is established in Sections 7.4, 7.9(a), and Appendix N of the CD. This RAP is organized into the following sections:

- Introduction
- CSM
- Proposed Statement of Work
- Investigation Methodologies
- Sampling and Analysis Methods and Procedures
- Data Quality Objectives
- Data Quality Control and Assurance
- Project Schedule for Field Sampling and Analysis
- Project Schedule for Data Evaluation and Report Submittals

## 2.0 CONCEPTUAL SITE MODEL

The CSM (as defined in Section 4.4 of the CD) was based on interpretation of the HSDS Study Area and WJSA investigation data, regional geology and hydrogeology, residential water well sampling data in the NKSA, and groundwater investigations performed associated with the former HSDS and WJSA.

The CSM is focused on the groundwater flow from the EGLE-presumed source areas in both the HSDS Study Area and WJSA to outside the municipal water areas, PFAS distribution in groundwater, and the fate and transport of PFAS in groundwater. See **Figure 1** for a layout of the NKSA, WJSA, and HSDS Study Area.

For the purpose of this RAP, the CSM is focused on PFAS distribution in groundwater, and the fate and transport of PFAS in groundwater likely to migrate outside the municipal water areas within the NKSA. The following sections provide discussions of source areas, hydrology, geology and hydrogeology, PFAS distribution in groundwater, groundwater flow, and PFAS transport.

### 2.01 SOURCE AREAS

The HSDS, located at 1855 House Street NE, Plainfield Township, Kent County, Michigan comprises approximately 76 acres (included on **Figure 1**). The HSDS is currently undeveloped and according to available information, no

buildings were previously present. An electric utility right-of-way and associated high-voltage transmission lines cross the northern portion of the HSDS, and an access road from House Street runs south to north across the HSDS.

The properties surrounding the HSDS are primarily undeveloped or residential. Properties to the northwest are undeveloped, extending to Clear Bottom Lake and Freska Lake. Properties to the west, southwest, and northeast are primarily residential. House Street NE abuts the HSDS to the south and southeast. Portions of the eastern HSDS boundary are formed by Herrington Avenue NE. Land owned by MDOT is present south and southeast of the HSDS (US 131 right-of-way), and additional residential properties are located westward along House Street.

PFAS were in Scotchgard™, a waterproofing material manufactured by 3M Company, that was applied to some leather goods manufactured at the former Wolverine Tannery site in Rockford, Michigan, over a period of time. Some tanning byproducts contained PFOS, PFOA, and their precursors which are part of a larger group of PFAS.

The HSDS was a State of Michigan licensed and regulated disposal facility from the mid-1960s through 1978. EGLE Remediation and Redevelopment Division files indicated that HSDS's waste disposal license expired in 1978, but it appears no waste was disposed by Wolverine at HSDS after 1970. Based on past investigation data at Wolverine's tannery site (R&W/GZA, 2019), the byproducts also contained other substances which were addressed in the USEPA TCRA removal action. However, the data indicates that only PFAS appear to be materially migrating off-Site from the HSDS.

EGLE has alleged that there is a potential source area in the Wellington Ridge neighborhood where historic disposal of PFAS took place, but investigations have not revealed any physical evidence of a source. Historical aerial photographs suggest a portion of a former gravel pit was previously located in the area of the Lady Lauren cul-de-sac of the Wellington Ridge Development. The Wellington Ridge neighborhood is a high point within the WJSA (approximately 860 feet AMSL) resulting in groundwater flow in multiple directions.

In addition to the HSDS Study Area and WJSA, analytical data and groundwater flow information indicates the North Kent Landfill, which is owned and operated by Kent County, is likely also a source area of PFAS in some parts of both HSDS Study Area and WJSA. Lastly, while not specifically investigated, there are other possible sources of PFAS at residential properties, including septic systems, rain deposition, and the use of domestic products that contain PFAS (Schaider et al, 2016; EGLE, 2019a; ITRC, 2020).

**Figure 1** includes an outlined boundary showing the HSDS Study Area and WJSA.

## 2.02 TOPOGRAPHY

As shown in **Figure 1**, the terrain is generally hilly in the region. The ground surface elevation at HSDS ranges from 740 feet to 800 feet. The HSDS is flanked by higher ground to the northeast and southwest, but ground surface generally dips to the northwest toward Clear Bottom Lake and Freska Lake, and to the southeast toward the Rogue River. Ground surface elevations for the area east of the HSDS range from 800 to more than 900 feet AMSL; ground surface elevations for the west to southwest of the HSDS range from 800 to 820 feet AMSL, with lower terrains to the northwest and southeast.

The ground surface elevations in the central portion of WJSA (where the Wellington Ridge neighborhood development is located) range from approximately 780 feet AMSL to greater than 930 feet AMSL. Most of the neighborhoods in the eastern portion of the WJSA are situated on topographically elevated areas sloping along surface water drainageways toward lowland areas. The terrain is sloped in various directions, to the west and northwest toward the Rogue River, and northeast toward the Rogue River. The portion of the WJSA located west of US 131 has ground surface elevations ranging from approximately 724 to 850 feet AMSL. The lowest elevations

occur along the Rogue River ranging from approximately 723 feet AMSL on the western boundary to 700 feet AMSL on the eastern boundary.

Ground surface elevations in the NKSA range from approximately 650 feet AMSL at the Rogue River to more than 900 feet AMSL near the North Kent Landfill. Ground surface generally dips southeast toward the Rogue River.

## 2.03 HYDROLOGY

The NKSA is situated within the Rogue River Basin (Basin No. 14F), which is part of the Lower Grand River watershed (HUC 04050006). Based on *Michigan's Major Watersheds – Sub-basins GIS data (*EGLE, 2019b*)* downloaded from MGDL, the HSDS is situated within the Rogue River Basin (Basin No. 14F), which is part of the Lower Grand River watershed (HUC 04050006). The Rogue River Basin consists of 12 sub-basins. The HSDS is situated on the water divide of two sub-basins: HUC 04050006040080 and HUC 04050006040120. The WJSA is also situated on a water divide of two sub-basins: HUC 04050006040110 and HUC 0405006040080. These sub-basins drain to the Rogue River, which discharges to the Grand River.

The 2016 National Oceanic and Atmospheric Administration climate data report[1] for Grand Rapids, Michigan, indicates that the mean annual precipitation for the 80-year record period is approximately 36 inches. Based on the state-wide GIS data, the estimated annual groundwater recharge from precipitation (Michigan State University, 2005) at the NKSA ranged from 9 to 15 inches.

From 1989 to 2016, the average annual streamflow rate at USGS Gaging Station No. 04118500 in Rockford, Michigan, is approximately 260 cfs, and the average baseflow rate approximately 210 cfs. The gaging station measures the flow for the sub-basin, HUC 04050006040110, and all the upstream sub-basins, representing a drainage area of approximately 234 square miles, according to the USGS record.

## 2.04 GEOLOGY

Overburden in Kent County is a thick sequence of Pleistocene glacial deposits. The thickness of glacial deposits ranges from 11 to 800 feet in Kent County; however, the majority of glacial deposits range from 200 to 400 feet in thickness (Western Michigan University, 1981; Farrand, 1982). The glacial deposits in the County include till, outwash and lacustrine deposits. Till occurs in end moraines and ground moraines (till plains), interspersed on the surface throughout the County (Stramel, Wisler, & Laird, 1954). For the area near the City of Rockford and Plainfield Township, the Michigan Glacial Land systems (Michigan State University, 2015) indicates that proglacial outwash plain is present along the Rogue River, and end moraines are present either side of the Rogue River extending to the "wide" near the Grand River. End moraines of medium-textured till are present at the NKSA and its vicinity. The ground moraine (till plain) and end moraine belong to the unstratified group of deposits, composed of fine- to coarse-grained material, including silt, sand, gravel, and boulders.

Based upon bedrock maps for the area (MDEQ, 1987), the bedrock beneath the NKSA includes the Michigan basin series. Based on GIS data from EGLE (MDEQ, 1987), Jurassic "red beds" are present in most of the site area and its vicinity, with small areas of Saginaw formation outcrops. The Jurassic "red beds" are often poorly consolidated or unconsolidated and consist primarily of clay, mudstone, siltstone, sandstone, shale, and gypsum. The "red beds" are of low permeability and are considered a confining unit. However, locally in the county, the "red beds" have been documented to supply small quantities of water (Apple & Reeves, 2007). Beneath the "red beds," bedrock in the region consists of the Mississippian-aged sandstone (Marshall formation), shale (Michigan formation), and the Bayport limestone as well as the Pennsylvanian-aged Saginaw formation. The regional dip is northeasterly toward the center of the Michigan basin.

[1] https://www.ncdc.noaa.gov/cdo-web/search

Based on the *Hydrogeologic Atlas of Michigan* (Western Michigan University, 1981), the top of bedrock elevation ranges from 500 to 550 feet near the City of Rockford and within the WJSA. The top of bedrock elevations at the HSDS Study Area were estimated to range from 540 to 580 feet (R&W/GZA, 2018).

***NKSA Geology***

This summary of the geology in the NKSA is based on borehole data collected during the subsurface exploration, groundwater monitoring well installation described in the previously submitted GSI RAP**,** and the residential water well construction information and lithology data downloaded from the online Wellogic System[2]. The Wellogic System made available individual well logs in PDF, GIS shapefiles of county-wide well locations and construction information, and database files of lithology data for some of the wells. R&W/GZA has attempted to verify the well locations by comparing the well addresses to the Kent County Parcel GIS shapefiles and found that some of the well locations in the Wellogic GIS shapefiles are incorrect. To rectify, the Kent County parcel center coordinates are used for the residential well locations if the well addresses are verified with the Kent County Parcel GIS shapefiles. The majority of the well addresses in the Wellogic System GIS shapefiles were verified, and the parcel center locations were used as their coordinates. For some well locations, the addresses of which were not verifiable, the locations in the Wellogic System GIS files were kept and qualified with a note. In addition, lithology data for some of the wells in the Wellogic System GIS shapefiles were not available; therefore, R&W/GZA downloaded the PDF well logs and compiled the available lithology data into the well lithology database.

The monitoring well locations and the residential water wells are shown in **Figures 2** and **3.** Geologic cross-sections A-A' through G-G' (see **Figure 4** for transect locations) were created to show the general spatial variability of the depositional environment beneath the NKSA. See **Figures 5** through **11** for geological cross-sections A-A' through G-G', respectively.

HSDS Study Area

In the HSDS study area, cross-section A-A' is constructed along the primary plume center line, extending northwest to the Freska Lake area and southeast to the Rogue River. Cross-section F-F' runs perpendicular to the primary plume, upgradient of the Rogue River and extends from the south side of the HSDS municipal water area northeast to 10 Mile Road and the North Childsdale municipal water area (see **Figure 1**). Cross-section G-G' is located southeast of cross-section A-A' and extends from U.S. Route 131 southeast to the Grand River, parallel to the primary HSDS plume.

The area depicted in cross-section A-A' is predominantly coarse-grained soils. Fine-grained soils are present in some boreholes in thickness ranging from less than 10 feet to approximately 140 feet. However, water-bearing units were encountered in all of these wells.

Cross-section F-F' depicts an area that is predominantly coarse-grained material to the southwest with increasingly thick fine-grained layers moving to the northeast. Fine-grained soils are present in some boreholes in thickness ranging from less than 10 feet to approximately 70 feet. Water-bearing units are either between clay strata or below the deepest clay strata encountered.

Cross-section G-G' is predominantly coarse-grained material, with a few exceptions where there are clay layers up to 100 feet thick. Toward the southeast end of the cross-section there are more interbedded layers of fine-

[2] https://secure1.state.mi.us/wellogic/Login.aspx?ReturnUrl=%2fwellogic%2fdefault.aspx

and coarse-grained material. Water-bearing units are beneath the clay or between clay layers in most boreholes, though water is encountered above the shallowest clay layer in several boreholes approaching the Rogue River.

In general, coarse-grained soil is dominant in most of the soil borings and water well logs in the HSDS Study Area. The presence and thickness of clay and silt deposits varies horizontally and vertically without stratified correlation between borings. The lithologies shown on the cross-sections in the HSDS Study Area are characteristic of glacial outwash, and end moraines, to a lesser extent, as documented in regional geology.

Wolven/Jewell Study Areas

Cross-section B-B' is constructed from the Freska Lake area northeast to Algoma Avenue. The southwest portion is primarily sand and gravel until approximately Jewell Road and 11 Mile Road, where thicker clay layers are present.

Cross-section C-C' extends from the Rogue River northwest of the intersection of 11 Mile Road and Jewell Road southeast to the Rogue River south of 10 Mile Road. Fine-grained soils are predominant across this area with the exception of the homes nearest the Rogue River, that were predominantly sand. The thickness of fine-grained soil varies from approximately 20 feet to more than 100 feet across the area. Water-bearing units were encountered below the clay stratum or between clay strata.

Cross-section D-D' extends from U.S. Route 131 north of 11 Mile Road to the southeast, ending southeast of the intersection of 11 Mile Road and Wolven. This cross-section is northeast of the Wellington Ridge municipal water area. Soils are predominantly fine-grained through this area. In most of the boreholes on cross-section D-D', the top of the clay stratum was shallow, except the well at 3616 11 Mile Road, where more than 100 feet of sand were present above the top of the clay stratum, presenting a potential pathway for surface/shallow contamination to migrate to deeper zones.

Cross-section E-E' extends from the Wellington Ridge neighborhood to the northeast, along one of the WJSA plumes. This area is also dominated by fine-grained soil. Water bearing units were encountered below the clay stratum or between clay strata.

In general, fine-grained soil predominates in most of the soil borings and water well logs in the WJSA. In the soil borings located west of US 131 or closer to the Rogue River, coarse-grained soils are present in greater thickness and are even dominant in some locations. In addition, individual borings containing only coarse-grained soil exist even in the areas where fine-grained soils are predominant. These locations provide potential migration pathways from the surface/shallow to the deeper zone. The presence and thickness of clay and slit deposits varies horizontally and vertically. They appear to be unstratified and discontinuous in the area. In the soil borings where fine-grained soils are predominant, water-bearing units were encountered below the clay stratum or between clay strata. In rare cases, water wells were screened in the bedrock. The lithologies shown on the cross-sections in the WJSA are characteristic of end moraines as documented in regional geology. The presence of a relatively large volume of fine-grained soil limits the hydraulically conductive saturated zone, and therefore affects groundwater flow and contaminant transport pathway.

The moraine and ablation till deposits are characterized by sandy till that includes varying amounts of silt and clay and can vary from loose to medium density. West of US 131 closer to the Rogue River, coarse-grained sand and sand with some gravel are present in stratigraphically greater thickness and are dominant in some locations. Individual borings containing only coarse-grained sand exist even in the areas where fine-grained soils are predominant. Where continuous, these more permeable strata may provide preferential migration pathways to the deeper water-bearing zone. The presence and thickness of clay and silt till deposits varies horizontally and

vertically, are unstratified and appear discontinuous in the WJSA. The lithologies shown on the cross-sections are characteristic of end moraines and complex depositional mechanisms vertically and horizontally in the hillier portions of the WJSA, and are characteristic of glacial outwash sand and gravel and post-glacial alluvium deposition in low-lying areas approaching the Rogue River. The complex depositional environment and variability horizontally and vertically affects the transmissivity of the water-bearing deposits, and therefore influences groundwater flow and contaminant transport.

## 2.05 HYDROGEOLOGY

The direction of regional groundwater flow is influenced by the primary surface water features of the Rogue River and the Grand River. Streamflow data from the USGS Gaging Station indicates that the Rogue River is a gaining stream, acting as a groundwater discharge zone. R&W/GZA interpolated regional groundwater flows based on the static groundwater level in *Wellogic - Statewide Wells GIS Data for Kent County* (Michigan State University, 2005a through 2005d). The regional groundwater contours also indicate regional groundwater flow pattern generally follows the topography, discharging to the Rogue River and the Grand River.

Static water levels were collected from the monitoring wells and the staff gages. Groundwater and surface water elevations were calculated from the surveyed elevations of the top of casing for the monitoring wells or reference points for the staff gages. In addition, surface water elevations recorded at USGS Gaging Station No. 04118500 were also downloaded and converted to the same datum as the monitoring well survey. See **Table 3** of the GSI RAP for the well installation information in the NKSA and **Table 4** of the GSI RAP for a summary of the static groundwater level measurements.

In addition to the R&W/GZA-installed groundwater monitoring wells, EGLE also collected static water level data from the monitoring wells installed by EGLE during the November 2019 monitoring event and requested that NKLF collect and provide static water level data in November 2019. In combination, the November 2019 static water level data provided the most complete set of static water levels and elevations for the NKSA.

For the locations where multiple wells were installed at different intervals, R&W/GZA grouped the wells into the shallow zone and deep zone by borehole lithologies, screen intervals, and static water elevations. See **Table 3** of the GSI RAP for the well grouping designations.

Based on the November 2019 data set, groundwater elevation contours were interpolated from the static water level data. See **Figure 12** for the groundwater elevation contours in the shallow zone and **Figure 13** for the deep zone. As shown on **Figures 12** and **13**, groundwater in both the deep and shallow zones of the NKSA flows to the Rogue River.

### ***HSDS Groundwater Flow***

The HSDS is situated at or near a groundwater divide. Groundwater predominantly flows from the HSDS to the southeast to the Rogue River, but a portion of the flow appears to be to the northwest. Because of groundwater discharge to Freska Lake and Clear Bottom Lake, the hydraulic gradient to the northwest appears to be flat as compared to the southeast.

### ***Wolven/Jewell Study Area Groundwater Flow***

The shallow groundwater flow regime in the WJSA is characterized by a radial pattern from topographic highs toward the Rogue River. There appears to be a groundwater divide that corresponds to a topographically elevated moraine in the Wellington Ridge neighborhood. The divide is likely a primary recharge zone and appears oriented

northeast to southwest. Groundwater flow is predominantly to the northwest from the Wellington Ridge area across the WJSA. However, components of flow toward the northeast and east are evident in the Wolven Northeast area. Deep zone groundwater contours are similar to the shallow zone although the groundwater divide appears within the approximate north-central portion of the WJSA.

## 2.06 PFAS DISTRIBUTION IN GROUNDWATER

***Distribution of PFAS in the House Street Study Area***

Groundwater and residential well sampling completed since 2017 has identified one primary PFAS plume within the HSDS Study Area ("House Street Primary Plume"). Groundwater samples collected from the monitoring wells across the HSDS Study Area in 2019 identified PFOA and PFOS as the primary PFAS compounds (approximately 11 percent and 60 percent of the total PFAS in monitoring well samples respectively). Note total PFAS analyte lists have varied between 14 and 23 (i.e., the EPA Method 537.1 14-analyte list and the 23 analytes included in the isotope dilution methodology under the most recent DoD QSM revision in effect at the time of sampling). However, given that the percent of the total PFAS mass that is comprised of PFOA+PFOS is relatively high, the slight variations in the total PFAS due to the varied number of analytes is negligible. Specifically, the analytes included on the 23 list that are not on the 14 list (i.e., nine different compounds) comprise approximately 8 percent of the total PFAS in the monitoring well samples. For consistency in the mapping, the total PFAS presented on **Figure 14** are calculated from the sum of the 12 PFAS compounds that are common between EPA Method 537.1 and the isotope dilution, DoD QSM methodology. However, the total PFAS values used throughout the remainder of this RAP and associated documents are reported as full totals of either the 14 or 23 analytes.

PFAS analytical data from the groundwater monitoring wells, and residential water well samples collected until December 2019 were combined and used for the interpolation of isoconcentration maps for total PFAS (**Figure 14**), and PFOA+PFOS **(Figure 15**). Where data from multiple sampling depths or sampling events are available at one location, the maximum concentrations were used during interpolation. It is important to note that the isoconcentration maps were geostatistically interpolated from spatially distributed point data, therefore they may overestimate the concentrations or extents in areas where data points were relatively sparse. As implied by the method, the isoconcentration maps are estimations only and are not intended to represent measured or true conditions.

Given the mobility of PFAS in groundwater, the migration and distribution in the HSDS Study Area is expected to correlate strongly to the groundwater flow pattern. Based on available data, it appears that there are two potential PFAS source areas in the primary HSDS plume:

1. The HSDS where PFAS contamination was identified.
2. The NKLF, where PFAS contamination was identified. Groundwater underlying the NKLF could migrate southwest into the HSDS Study Area and contribute to PFAS in residential wells.

The total PFAS isoconcentration map (**Figure 14**) suggests the primary PFAS plume migrated from the HSDS toward the Rogue River, primarily in the southeast direction, along the plume centerline. The PFOA+PFOS isoconcentration map (**Figure 15**) indicates a similar distribution to the total PFAS isoconcentration map, but their extents and the concentration ranges are less than that of total PFAS because the total PFAS isoconcentration map included other compounds, such as PFBS, PFHxA, PFHxS, and PFNA.

***Distribution of PFAS in the Wolven/Jewell Study Area***

Groundwater and residential well sampling completed since 2017 has identified two primary PFAS plumes within the WJSA. Groundwater samples collected from the monitoring wells across the WJSA in 2019 identified PFOA and PFOS as the primary PFAS compounds (approximately 26 percent and 57 percent of the total PFAS in monitoring well samples, respectively). Note total PFAS analyte lists have varied between 14 and 23 (i.e., the EPA Method 537.1 14-analyte list and the 23 analytes included in the isotope dilution methodology under the most recent DoD QSM revision in effect at the time of sampling). However, given that the percent of the total PFAS mass that is comprised of PFOA+PFOS is relatively high, the slight variations in the total PFAS due to the varied number of analytes is negligible. Specifically, the analytes included on the 23 list that are not on the 14 list (i.e., nine different compounds) comprise approximately 8 percent of the total PFAS in the monitoring well samples. For consistency in the mapping, the total PFAS presented on **Figure 14** are calculated from the sum of the 12 PFAS compounds that are common between EPA Method 537.1 and the isotope dilution, DoD QSM methodology. However, the total PFAS values used throughout the remainder of this RAP and associated documents are reported as full totals of either the 14 or 23 analytes.

PFAS analytical data from the groundwater monitoring wells and residential water well samples collected until December 2019 were combined and used for the interpolation of isoconcentration maps for total PFAS (**Figure 14**), and PFOA+PFOS **(Figure 15**). Where data from multiple sampling depths or sampling events are available at one location, the maximum concentrations were used during interpolation. It is important to note that the isoconcentration maps were geostatistically interpolated from spatially distributed point data, therefore they may overestimate the concentrations or extents in areas where data points were relatively sparse. As implied by the method, the isoconcentration maps are estimations only and are not intended to represent measured or true conditions.

Given the mobility of PFAS in groundwater, the migration and distribution in the WJSA is expected to correlate strongly to the groundwater flow pattern. Based on available data, it appears that there are two potential PFAS source areas in the primary WJSA:

1. The Wellington Ridge neighborhood. Note that investigation of this area did not yield physical or chemical evidence of a PFAS source in soil.
2. The NKLF, where PFAS contamination was previously identified. A reported landfill underdrain system previously discharged to the northwest trending drainage feature that discharges under 10 Mile Road then northwest toward US 131. Both the underdrain discharge and groundwater impacted by a reported liner leak underlying the NKLF could migrate into the WJSA and contribute to PFAS in residential wells.

The PFOA+PFOS isoconcentration map (**Figure 15**) suggests radial migration from the groundwater divide, east-northeast toward Wolven Northeast, 12 Mile Road and Summit Avenue areas, northwest across US 131 toward the Rogue River, and to the south-southeast into the North Childsdale area. Based on the groundwater flow evaluation; the PFOA+PFOS-impacted groundwater is expected to continue migrating along preferential flow paths primarily controlled by a complex depositional environment, established surface drainage and surface water features as well as topography toward the Rogue River.

## 2.07 EXPOSURE PATHWAYS – APPLICABLE PART 201 CLEANUP CRITERIA, MI MCLS, AND CD ACTION LEVELS

Based on EGLE's Part 201 administrative rules, the applicable Part 201 groundwater cleanup criterion for the perimeter monitoring is the DWC, which is protective of human health from being exposed to groundwater via ingestion.

For PFAS compounds, Michigan has Part 201 cleanup criteria for PFOS and PFOA of 16 ng/L and 8ng/L, respectively[3]. Section 7.1 of the CD requires preventing exposure to PFOA+PFOS concentration in excess of 10 ng/L as one of the performance objectives.

| Compound | Threshold Value (µg/L) | Basis for Value |
|---|---|---|
| PFOA | 12 | GSI |
| PFOS | 0.012 | GSI |
| PFOA | 0.008 | DWC |
| PFOS | 0.016 | DWC |

The GSI pathway for PFAS and PFOA+PFOS is addressed in a separate Draft RAP submitted to EGLE in April 2020 (R&W/GZA, 2020).

Based on the Part 201 cleanup criteria, the project action levels are set to be 8 ng/L for PFOA and 16 ng/L for PFOS. The project objectives are to monitor possible migration of PFAS/PFOA+PFOS from the municipal areas and evaluate if downgradient receptors are potentially exposed to PFOA above 8 ng/L or PFOS above 16 ng/L via groundwater ingestion.

## 2.08 DATA GAPS

Based on the current understanding of the CSM and the above discussions, the following data gaps are identified and intended to be addressed with this RAP:

- Potential for PFAS/PFOA+PFOS-impacted groundwater in the shallow and deep zones migrating from the municipal water areas.

R&W/GZA has identified the following areas where additional data is needed to further characterize the plume and meet the project objectives and address the data gaps:

- West, northwest and south of the HSDS primary plume (west of US 131);
- North and south of the northwest portion of the WJSA plume, near the Rogue River;
- North of the WJSA plume north of Wellington Ridge, along US 131);
- Southeast of the WJSA plume, north of 10 Mile Road; and
- West of the North Childsdale municipal water area.

[3] EGLE promulgated state drinking water standards for seven per- and polyfluoroalkyl substances (PFAS) that are effective August 3, 2020. State drinking water standards are also commonly referenced as maximum contaminant levels and developed under section 5 of the State Drinking Water Act, 1976 PA 299 [MCL 325.1005]. EGLE previously developed generic cleanup criteria for groundwater used as drinking water for PFOA and PFOS that were effective January 10, 2018. As established under Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended [MCL 324.20120a(5)], the state drinking water standards become the PFOA and PFOS generic cleanup criteria for groundwater used as drinking water. The state drinking water standards 0.008 µg/L (parts per billion) and 0.016 µg/L, respectively for PFOA and PFOS, are effective August 3, 2020 and replace the previously established residential and nonresidential drinking water criteria of 0.07 µg/L for the combined concentrations of PFOA and PFOS.

## 3.0 PROPOSED STATEMENT OF WORK

The following provides a summary of the proposed investigation, based on the identified data gaps. The proposed sampling locations are shown on **Figure 16**. Actual monitoring well locations may vary slightly from the proposed locations of **Figure 16** during installation. While the target locations are shown, limitations for access on private properties, site conditions, and utilities may require moving monitoring well locations.

- Two monitoring well locations, HS-PMW-16 and HS-PMW-22, were previously proposed. These well locations were proposed to assist with delineating the east-northeast boundary of the House Street plume[4]. Well location HS-PMW-16 will be utilized as a perimeter monitoring well cluster to evaluate potential PFAS migration to the east.
- Three perimeter well locations, HS-PMW-RI-105, HS-PMW-RI-106, and HS-PMW-RI-101, located northwest, and hydraulically downgradient of the House Street site, are proposed to evaluate potential PFAS migration at the edge of the Freska Lake area toward the edge of the NKSA. In addition, the existing well cluster, HS-MW-32A/B/C/D, will be included as perimeter monitoring wells to evaluate potential PFAS migration to this area.
- Well location HS-PMW-RI-102, located hydraulically downgradient of the House Street Site to the southwest, is proposed to monitor for PFAS migration from the municipal water areas to the southeast.
- For the Wolven West and Wolven Northwest Study Areas, perimeter well locations WV-PMW-RI-101 and WV-PMW-RI-102 are proposed immediately west of the US 131 right-of-way, hydraulically downgradient of the PFAS plume in Wellington Ridge. These wells are proposed to evaluate potential migration of PFAS from Wellington Ridge municipal water area to the west. Well locations WV-PMW-RI-104 and WV-PMW-RI-105 are proposed to delineate the southwest and northeast boundary of the PFAS plume within the Wolven Northwest municipal water area. In addition, existing monitoring well clusters, WV-MW-5, WV-MW-4, WV-MW-11, and WV-MW-15 will be included as part of the perimeter monitoring for the Wolven West and Wolven Northwest areas.
- Well locations WV-PMW-RI-106 and WV-PMW-RI-107 are located in the southeastern portion of the Wolven/Jewell area municipal water area. These wells are proposed to evaluate the potential migration of PFAS plume from Wolven Southeast municipal water area to the southeast.
- Well location WV-PMW-RI-108 is located southwest of the North Childsdale municipal water area and is proposed to evaluate flow from that area to the west and south.

The combination of groundwater monitoring, institutional controls (groundwater use ordinance), and filters (as required) are designed to protect downgradient receptors from unacceptable exposure to PFAS in drinking water. In addition to groundwater monitoring proposed in this RAP, additional residential well resampling is proposed (see separate Residential Well Resampling RAP submitted May 2020).

## 4.0 INVESTIGATION METHODOLOGY

Relevant tasks included in this RAP will be completed in accordance with the most recent revision of the EGLE-approved QAPP prepared for Wolverine by R&W/GZA.

[4] For the sake of this Work Plan, the edge of the PFAS plume is defined as PFOA+PFOS = 10 ppt or PFOA = 8 ppt. If the applicable PFAS criteria change during the life of this Work Plan and subsequent monitoring, the Work Plan will be reassessed for its adequacy and modified as needed.

The proposed well cluster locations will be drilled using either hollow-stem auger or rotosonic methods in accordance with SOPs A03 through A06 of the QAPP. When possible, the initial boring at each location will be drilled to the top of bedrock or upon refusal. The borehole terminal depth will also be evaluated based on the depths of adjacent water wells and the presence of confining strata.

As the original borings are drilled at each location, vertical aquifer profiling samples will be collected for PFAS analysis from water-bearing and permeable formation(s) at intervals of 10 feet. Vertical Aquifer Profiling will be completed in accordance with *SOP A25, Vertical Aquifer Profiling* included in the QAPP. The turn-around time for laboratory samples will be approximately three weeks.

Based on the profiling data, encountered geology, and nearby drinking water well elevations, R&W/GZA will determine the depth(s) of wells installed at each location. The monitoring wells will be developed in accordance with *SOP A13, Well Development* in the QAPP. Upon completion, the wells will also be surveyed by a licensed surveyor.

## 5.0 SAMPLING AND ANALYTICAL PROCEDURES

This section provides a generalized SAP for the perimeter monitoring well sampling. Specific information regarding sampling procedures and analytical methods is provided in the site-specific QAPP.

Wells will be sampled as follows:

- Initial sampling post installation/development;
- Annual sampling until substantial completion of the perimeter well network; and
- Once the perimeter well network is substantially complete, all newly installed wells will be sampled quarterly for one year. (Substantial Completion will be agreed upon by R&W/GZA and EGLE.)

### 5.01 SAMPLING LOCATIONS

As discussed in **Section 3.0**, the following monitoring wells will be sampled:

| Grouping/Area | Well Nomenclature |
|---|---|
| Existing | HS-MW-32A/B/C/D, WV-MW-5S/D, WV-MW-4S/D, WV-MW-11S/D, and WV-MW-15A/B/C/D |
| Delineation of the northeastern boundary of the House Street plume | HS-MW-13, HS-PMW-16 and HS-PMW-22 |
| Evaluate potential migration at the edge of Freska Lake toward the eastern edge of NKSA | HS-PMW-RI-105, HS-PMW-RI-106, HS, and PMW-RI-101 |
| Evaluate potential migration from municipal areas within HSDS to the southeast | HS-PMW-RI-102 |
| Evaluate potential migration to the northwest in WJSA | WV-PMW-RI-101 and WV-PMW-RI-102 |
| Delineate the southwest and northeast boundary of the PFAS plume with in the Wolven Northwest municipal area | WV-PMW-RI-104 and WV-PMW-RI-105 |
| Evaluate potential migration from the Wolven Southeast municipal water area to the southeast | WV-PMW-RI-106 and WV-PMW-RI-107 |
| Evaluate potential migration southwest of North Childsdale municipal water area | WV-PMW-RI-108 |

5.02 SAMPLE COLLECTION AND LABELING

Samples will be collected for PFAS analysis following the methods summarized in **Section 4.0** and detailed in the sampling SOPs for Groundwater Monitoring Wells (SOP A16; Low Flow Sampling). Detailed field and laboratory requirements are provided in the project-specific QAPP.

Sample identification will consist of nomenclature that includes the sample's unique location identification (see reference table above). If applicable, sample identification for each sample will be repeated for each sampling event with consistent spelling.

To prevent misidentification of samples, legible labels will be affixed to each sample container. The labels will be sufficiently durable to remain legible even when wet. At a minimum, the labels will contain the following information:

- Location ID;
- Name or initials of collector; and
- Date and time of collection.

5.03 SAMPLE SHIPPING

Sample bottles will be placed into the cooler and packed with double-bagged wet ice immediately following collection. Packing material will be used as necessary. A temperature blank will be placed in the cooler prior to shipment. The cooler shall be addressed to the appropriate laboratory and dispatched as soon as practical to ensure timely arrival.

5.04 ANALYTICAL METHOD AND PARAMETERS

PFAS will be analyzed using DoD QSM 5.3 guidelines for PFAS by isotope dilution methodology. The analyte list will include the 28 PFAS compounds specified by EGLE, and reporting limits are provided in Table A.7.7 of the project-specific QAPP.

## 6.0 DATA QUALITY ASSURANCE AND CONTROL

The following field quality control samples will be collected at a rate of one per 20 samples in accordance with the project-specific QAPP: *Field blanks, field duplicates, and MS/MSDs*.

- Field blanks will be collected by pouring laboratory-supplied, certified PFAS-free water into a sample container at the point of sample collection. The purpose of field blanks is to assess potential contamination at the sample point.
- Field duplicates will be collected by filling one additional sample container with water from the sample point. The purpose of field duplicates is to assess variability in sample composition. Field duplicates are not intended to be blind duplicates.
- MS/MSD will be collected by filling two additional sets of sample bottles with water from the sample point. MS/MSD analyses are conducted by the analytical laboratory after samples have been collected and submitted. Analysis of known concentrations of analytes spiked in the MS/MSD samples indicate if matrix interference effects are occurring.

- QA/QC samples will be collected using the methods described in **Section 5.0** and the SOPs in the site-specific QAPP. Samples will be labeled as described in **Section 5.0.** The location of QA/QC samples will be entered into the Monitoring Checklist. QA/QC samples will be analyzed using the same analytical methods used for the primary sample.

## 7.0 INVESTIGATION-DERIVED WASTE

Soil cuttings from beneath the water table and development/purge water from the well installations and sampling will be containerized and transported to the HSDS property for staging/storage until off-site treatment/disposal or other approved handling can be arranged. Soil cuttings from above the water table will be spread near the wellhead and/or transported to another location to be used as clean fill.

## 8.0 ANTICIPATED SCHEDULE

The schedule for monitoring well installation will depend greatly on R&W/GZA's ability to procure access to the desired or proximate alternate locations and the potential impact of coronavirus disease 2019 (COVID-19). The following table outlines R&W/GZA's current estimates of the steps and approximate timeframes for the tasks in this RAP (upon EGLE approval).

| Task | Estimated Timeframe per Location |
|---|---|
| Access | 1 to 3 months |
| Initial Drilling | 2 to 3 weeks |
| VAP analysis | 3 weeks |
| Monitoring Wells Installation | 1 to 2 weeks |
| Development Wait Time | 2 weeks |
| First Groundwater Sampling | 1 week |
| First Laboratory Analysis | 3 weeks |

Assuming one month per location, R&W/GZA estimates this SOW will require eleven months to complete drilling, vertical aquifer profiling, and monitoring well installation. This will be completed in conjunction with the other RAPs submitted under the CD. R&W/GZA will coordinate with EGLE to prioritize drilling locations if access is obtained for multiple locations throughout the RAPs simultaneously. Because access will likely be obtained piecemeal, the actual well installation schedule may exceed eleven months.

Following the full year of quarterly sampling of the well network, R&W/GZA will evaluate the data in consultation with EGLE and determine appropriate next steps.

## 9.0 REFERENCES

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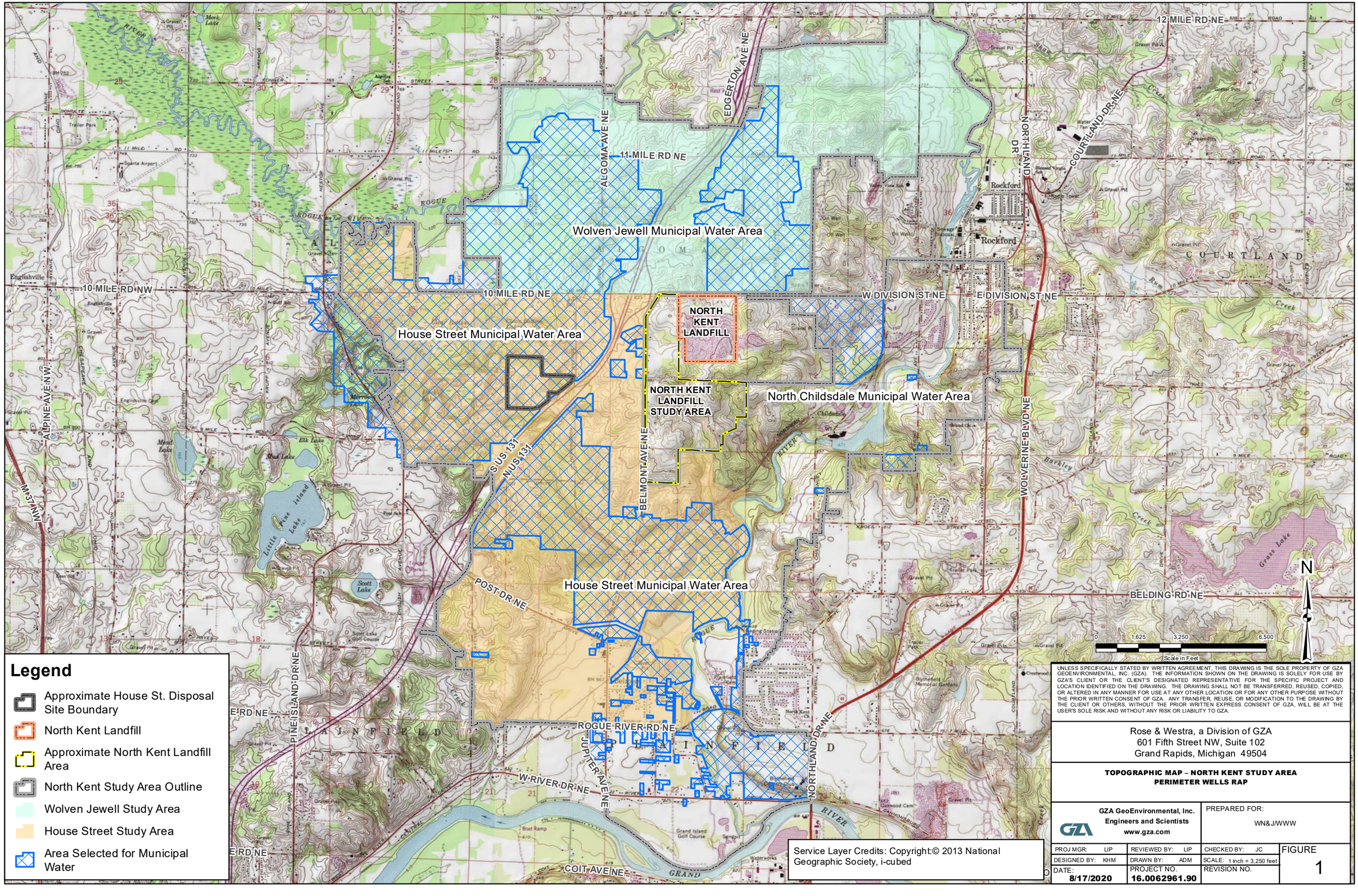
**FIGURES**




## Legend

- Approximate House St. Disposal Site Boundary
- North Kent Landfill
- Approximate North Kent Landfill Area
- North Kent Study Area Outline
- Wolven Jewell Study Area
- House Street Study Area
- Area Selected for Municipal Water

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**TOPOGRAPHIC MAP – NORTH KENT STUDY AREA**
**PERIMETER WELLS RAP**

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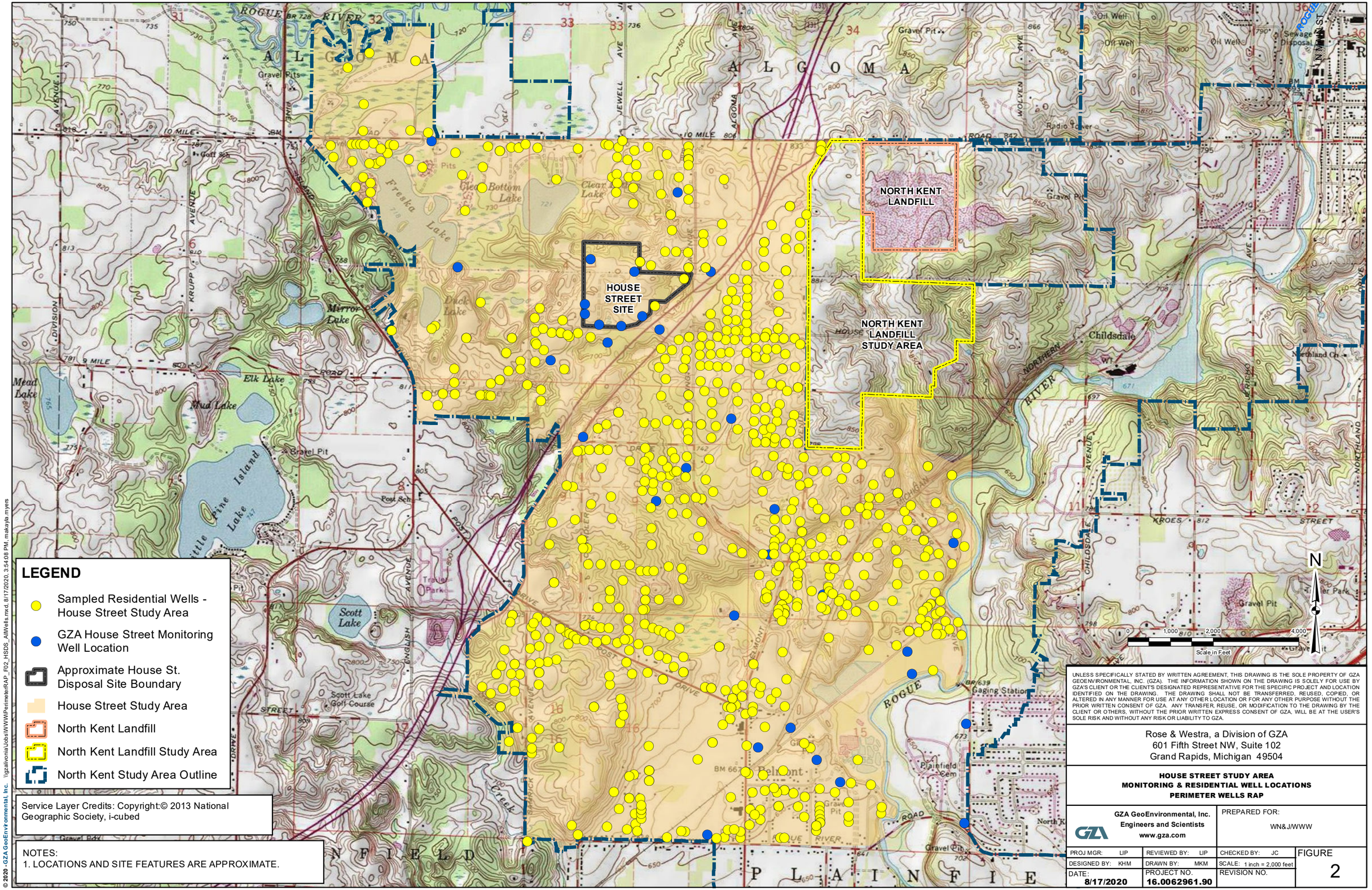
PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 1 |
| DESIGNED BY: KHM | DRAWN BY: ADM | SCALE: 1 inch = 3,250 feet | |
| DATE: 8/17/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |




## LEGEND

- Sampled Residential Wells - House Street Study Area
- GZA House Street Monitoring Well Location
- Approximate House St. Disposal Site Boundary
- House Street Study Area
- North Kent Landfill
- North Kent Landfill Study Area
- North Kent Study Area Outline

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NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.





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**HOUSE STREET STUDY AREA**
**MONITORING & RESIDENTIAL WELL LOCATIONS**
**PERIMETER WELLS RAP**

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| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 2 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 2,000 feet | |
| DATE: 8/17/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |

## Legend

- EGLE Monitoring Well
- GZA Monitoring Well - Wolven Jewell Study Area
- Sampled Residential Well
- North Kent Landfill
- North Kent Landfill Study Area
- North Kent Study Area Outline
- Wolven Jewell Study Area
- Approximate House St. Disposal Site Boundary

NORTH KENT LANDFILL

NORTH KENT LANDFILL STUDY AREA

HOUSE STREET SITE

N

0 1,000 2,000 4,000

Scale in Feet

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.



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**WOLVEN JEWELL STUDY AREA**
**MONITORING & RESIDENTIAL WELL LOCATIONS**
**PERIMETER WELLS RAP**

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| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: LJP | CHECKED BY: JC | FIGURE 3 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 2,000 feet | |
| DATE: 8/17/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |

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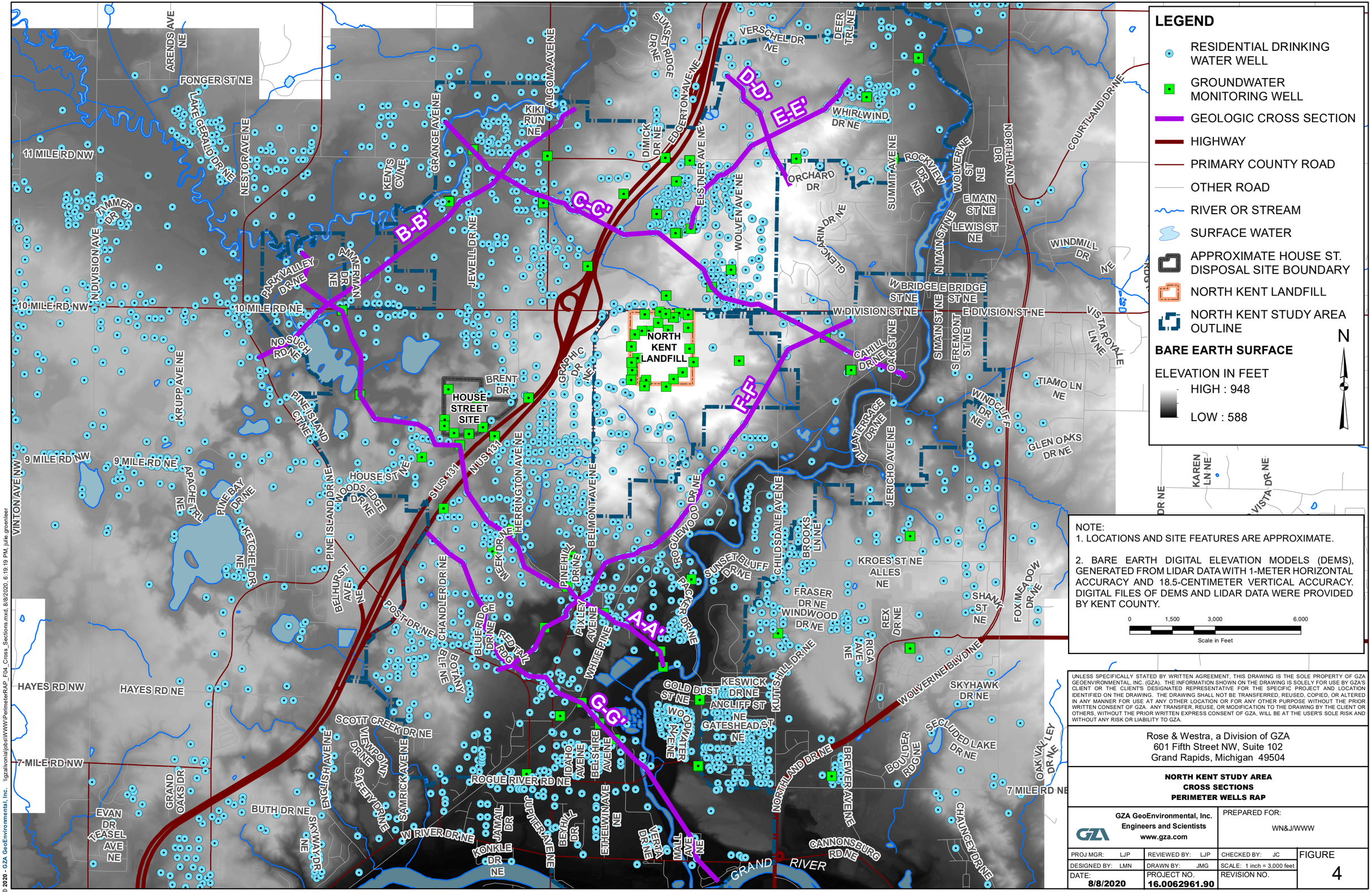


NOTE:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

0 1,500 3,000 6,000
Scale in Feet



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**NORTH KENT STUDY AREA**
**CROSS SECTIONS**
**PERIMETER WELLS RAP**

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| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: LJP | CHECKED BY: JC | FIGURE 4 |
| DESIGNED BY: LMN | DRAWN BY: JMG | SCALE: 1 inch = 3,000 feet | |
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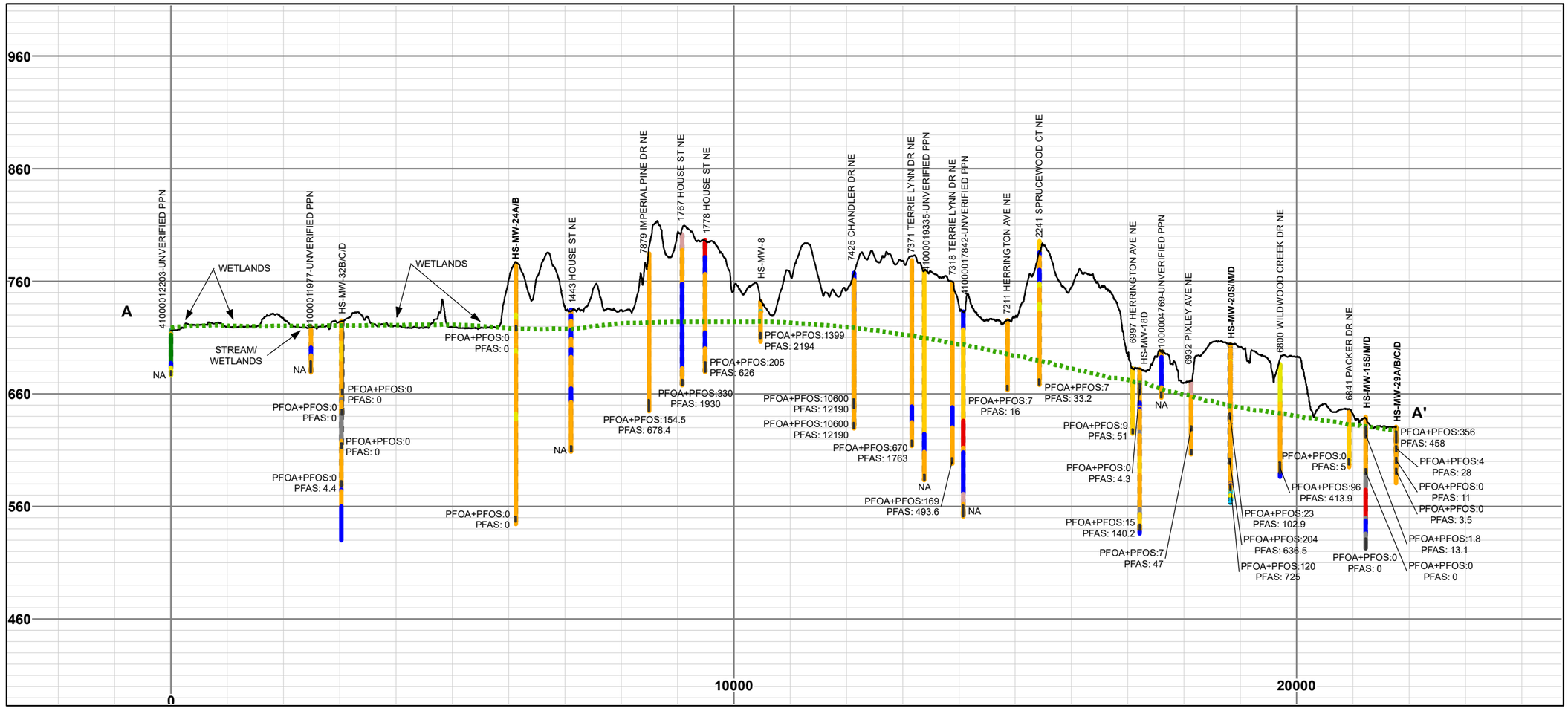



NORTHWEST

SOUTHEAST

## CROSS SECTION LEGEND

**WELL SCREEN**

PFOA+PFOS (ng/L)
PFAS (ng/L)
0 = NOT DETECTED
NA = NOT AVAILABLE

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- SILT
- CLAY AND SILT
- CLAY
- TOP SOIL
- ORGANIC SOIL
- NOT

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
- NORTH KENT LANDFILL

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

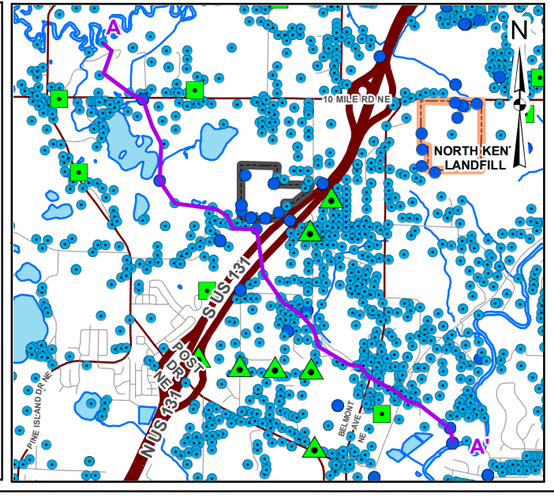
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 2,750 5,500 11,000
SCALE IN FEET



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**NORTH KENT STUDY AREA**
**CROSS SECTION A-A'**
**PERIMETER WELLS RAP**

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| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE 5 |
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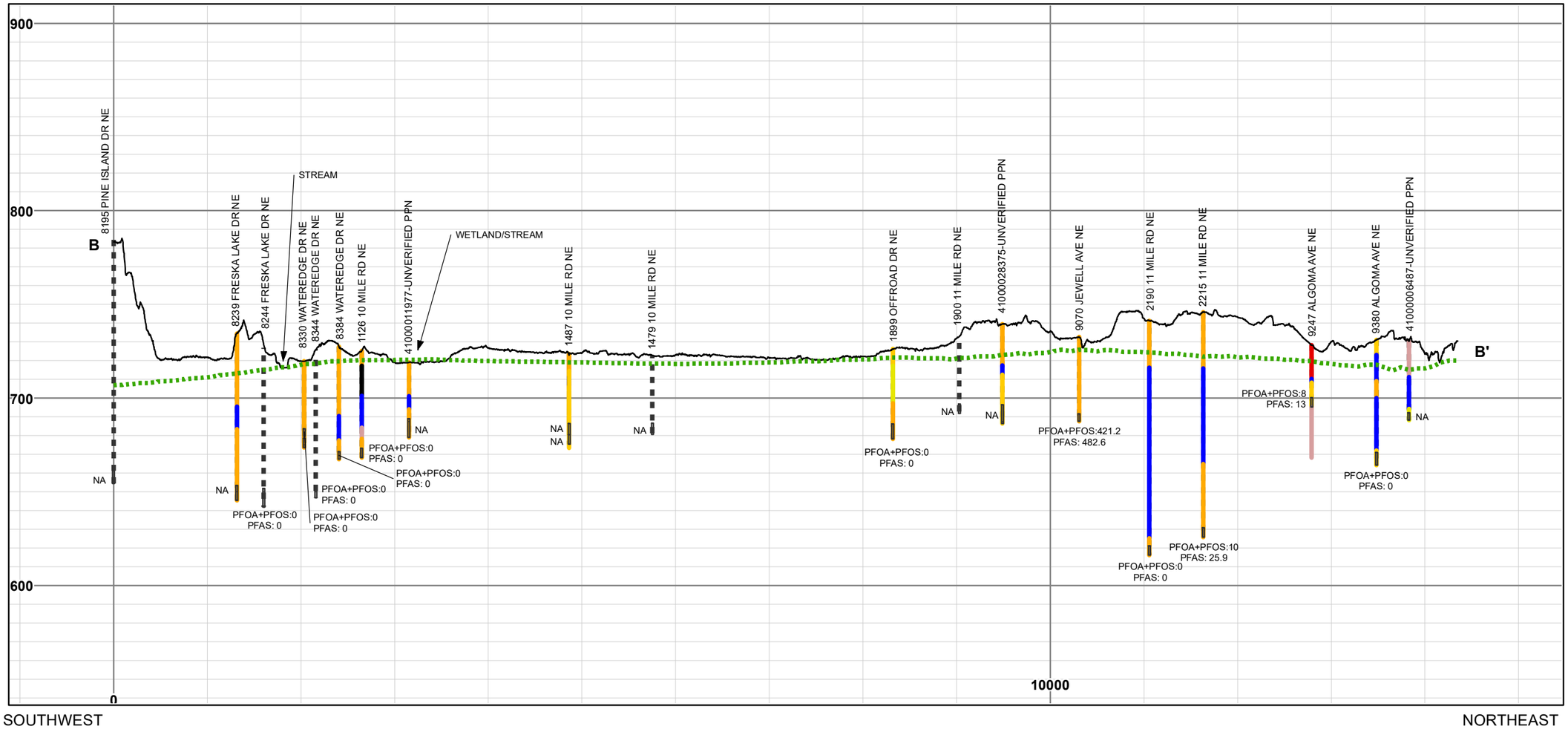
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




## CROSS SECTION LEGEND

**WELL SCREEN**

PFOA+PFOS (ng/L)
PFAS (ng/L)
0 = NOT DETECTED
NA = NOT AVAILABLE

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- CLAY
- MARL
- NOT

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
- NORTH KENT LANDFILL

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

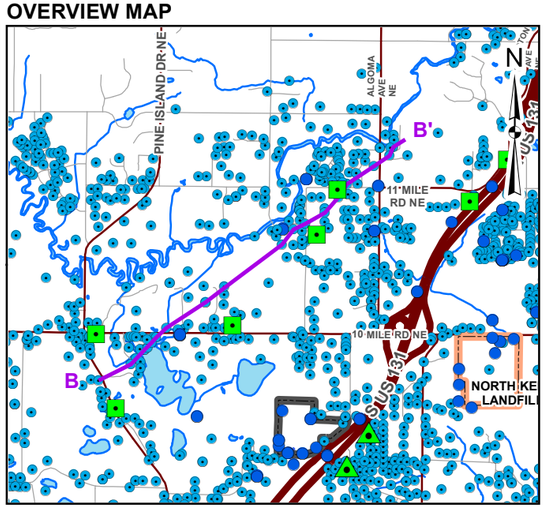
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 2,750 5,500 11,000
SCALE IN FEET



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**NORTH KENT STUDY AREA**
**CROSS SECTION B-B'**
**PERIMETER WELLS RAP**

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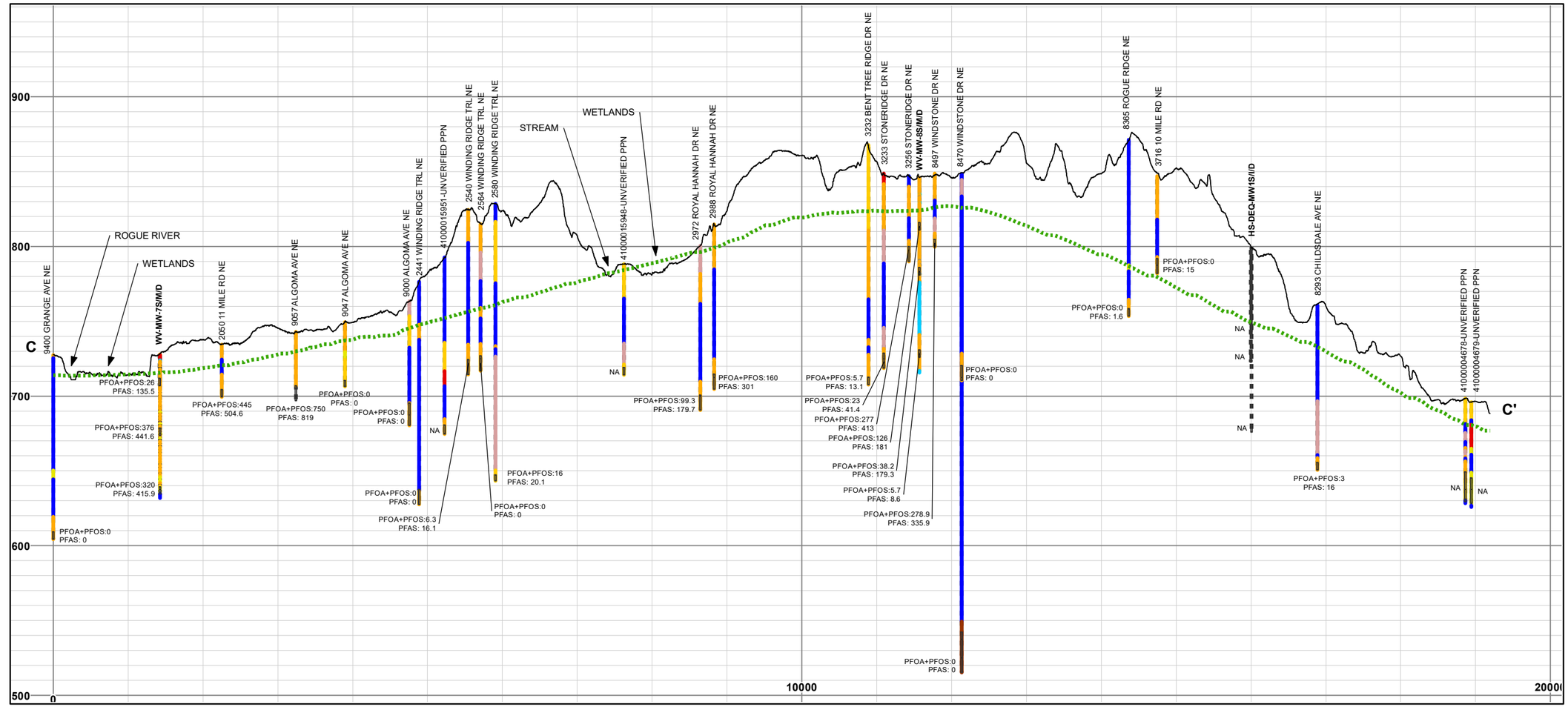
|---|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 5,500 ft | 6 |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




## CROSS SECTION LEGEND

**WELL SCREEN**

PFOA+PFOS (ng/L)
PFAS (ng/L)
0 = NOT DETECTED
NA = NOT AVAILABLE

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- SILT
- CLAY AND SILT
- CLAY
- BEDROCK
- NOT

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
- NORTH KENT LANDFILL

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

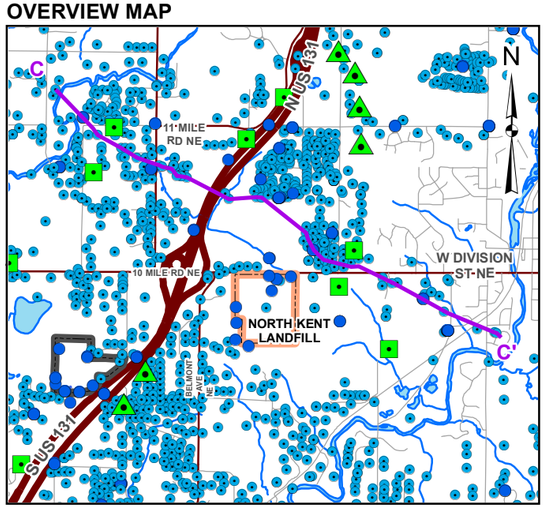
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 2,750 5,500 11,000
SCALE IN FEET



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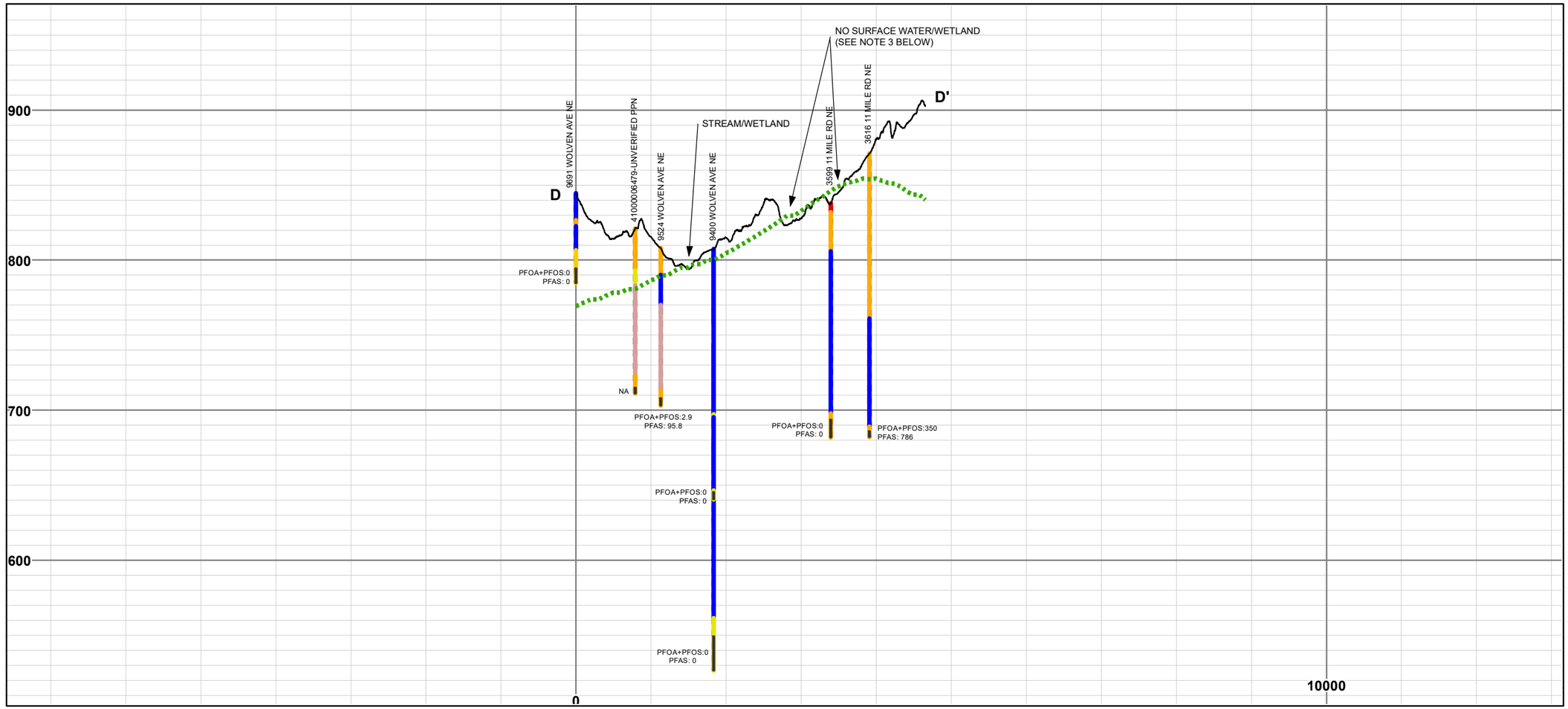
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**CROSS SECTION C-C'**
**PERIMETER WELLS RAP**

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE 7 |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 5,500 ft | |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




## CROSS SECTION LEGEND

**WELL SCREEN**

PFOA+PFOS (ng/L)
PFAS (ng/L)
0 = NOT DETECTED
NA = NOT AVAILABLE

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND GRAVEL
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- CLAY

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

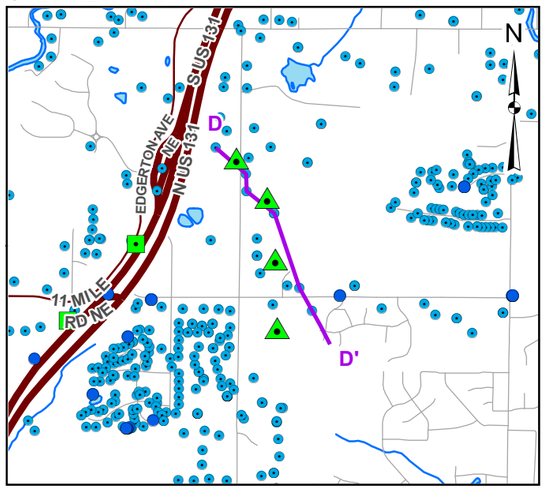
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 1,500 3,000 6,000
SCALE IN FEET



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Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**CROSS SECTION D-D'**
**PERIMETER WELLS RAP**

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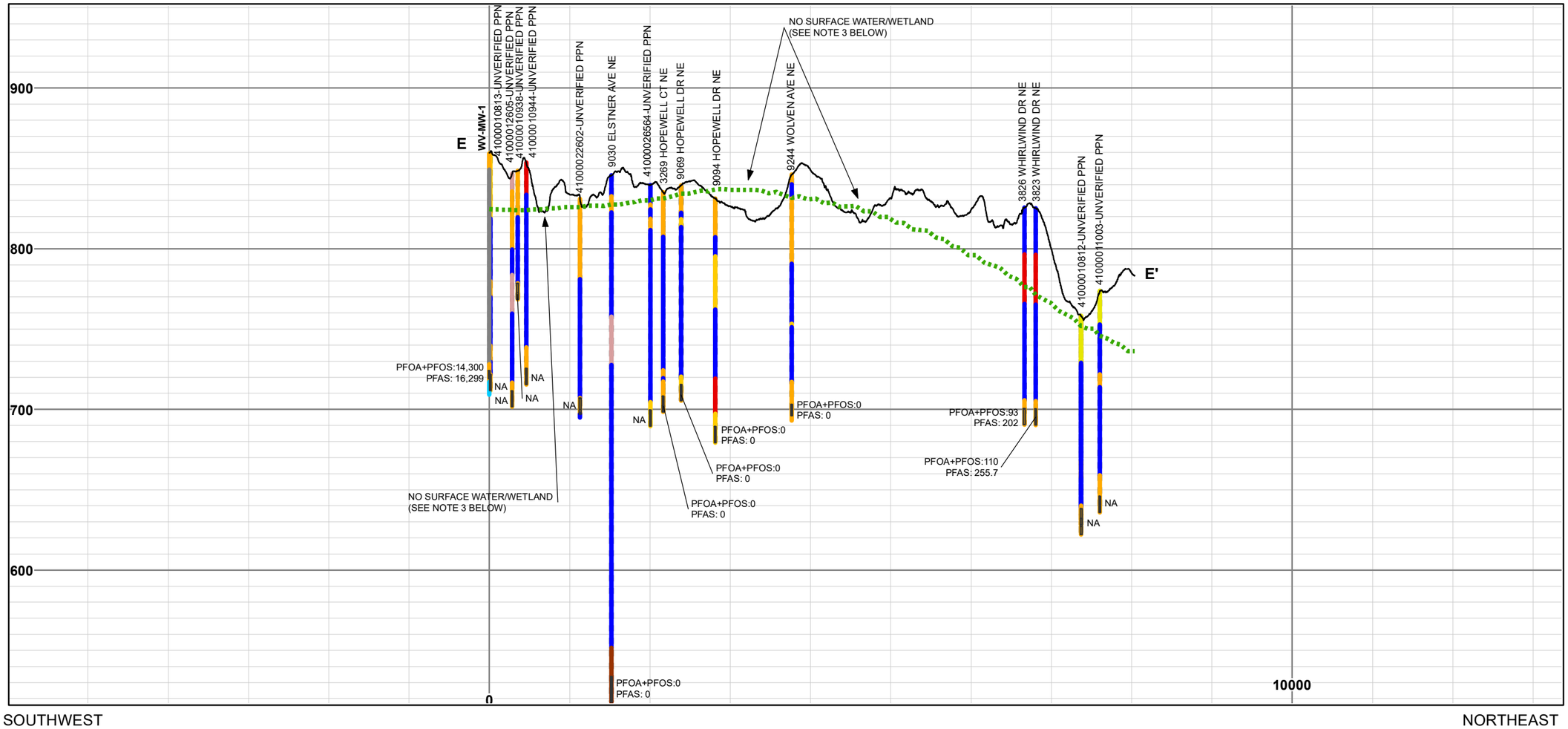
PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 3,000 ft | 8 |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




## CROSS SECTION LEGEND

**WELL SCREEN**

- PFOA+PFOS (ng/L)
  PFAS (ng/L)
  0 = NOT DETECTED
  NA = NOT AVAILABLE
- ESTIMATED GROUNDWATER TABLE (11/2019)
- GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND GRAVEL
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- SILT
- CLAY AND SILT
- CLAY
- BEDROCK

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

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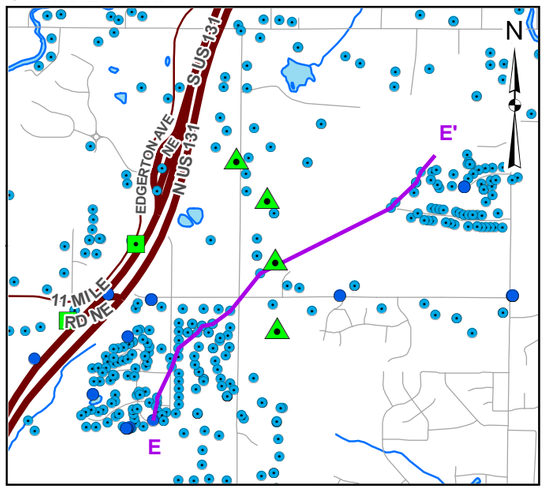
4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 1,500 3,000 6,000
SCALE IN FEET



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Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**CROSS SECTION E-E'**
**PERIMETER WELLS RAP**

PREPARED BY:
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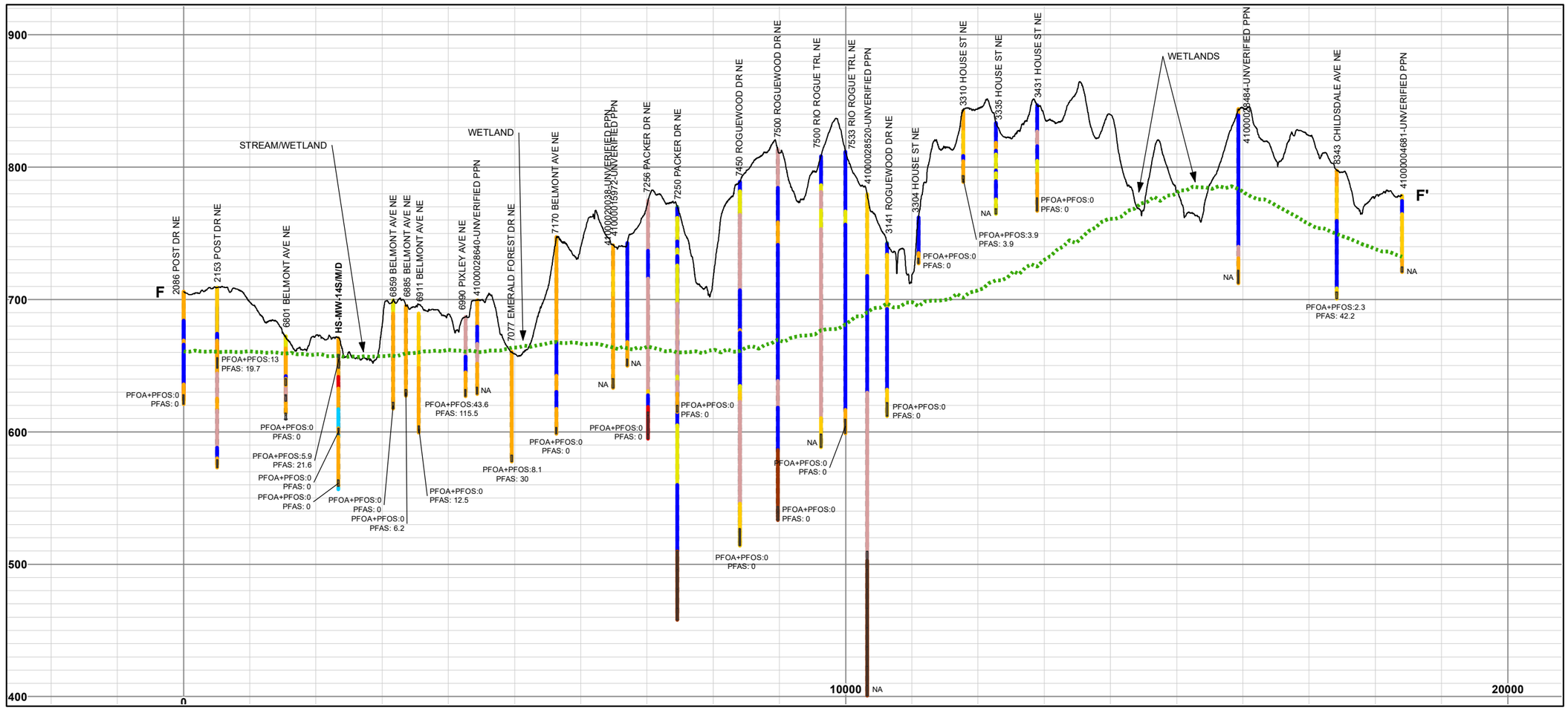
WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 3,000 ft | 9 |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




SOUTHWEST NORTHEAST

## CROSS SECTION LEGEND

**WELL SCREEN**

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

GRAVEL
SAND AND
SAND
SAND/GRAVEL WITH CLAY/SILT
CLAY/SILT WITH SAND/GRAVEL
CLAY AND SILT
CLAY
TOP SOIL
BEDROCK

## OVERVIEW MAP LEGEND

PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
PROPOSED PERIMETER MONITORING WELL
RESIDENTIAL WATER WELL
MONITORING WELL
CROSS SECTION LINE
HIGHWAY
PRIMARY COUNTY ROAD
OTHER ROAD
RIVER OR STREAM
SURFACE WATER
APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
NORTH KENT LANDFILL

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

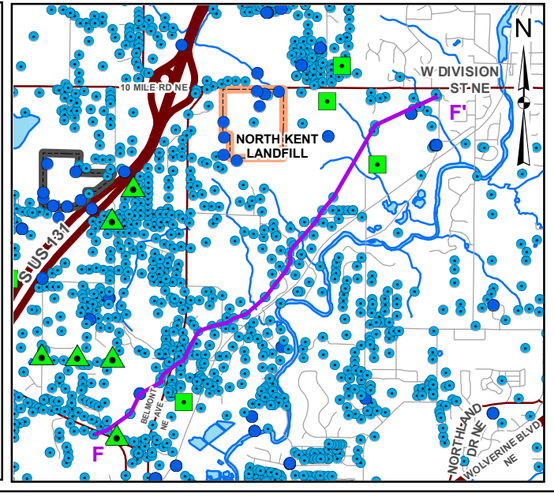
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 2,750 5,500 11,000
SCALE IN FEET



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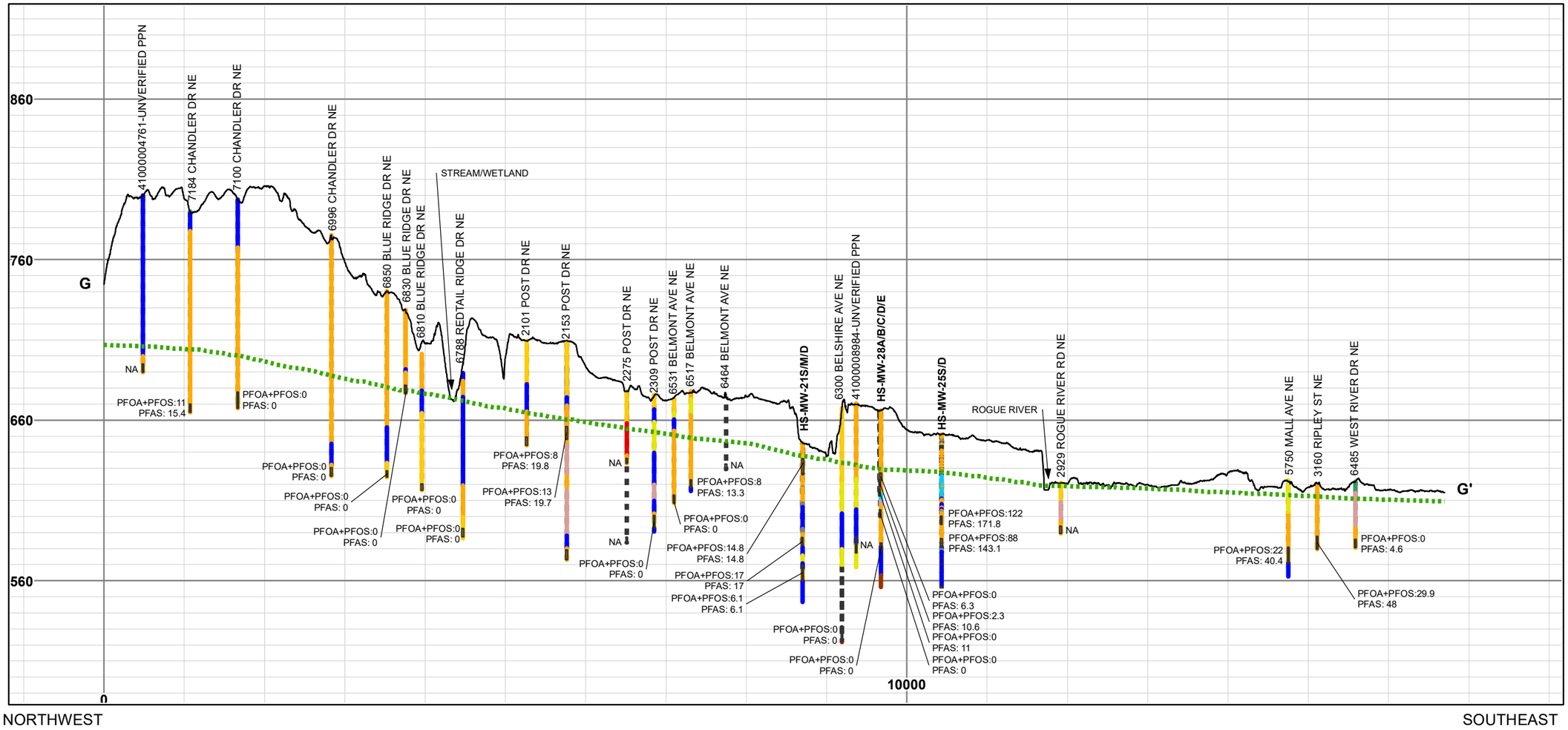
Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**CROSS SECTION F-F'**
**PERIMETER WELLS RAP**

| PREPARED BY: | | PREPARED FOR: | |
|---|---|---|---|
| GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com | | WN&J/WWW | |
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | FIGURE |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 5,500 ft | 10 |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | |




## CROSS SECTION LEGEND

**WELL SCREEN**

ESTIMATED GROUNDWATER TABLE (11/2019)

GROUND SURFACE

**BOREHOLE LITHOLOGY**

- GRAVEL
- SAND AND
- SAND
- SAND/GRAVEL WITH CLAY/SILT
- CLAY/SILT WITH SAND/GRAVEL
- SILT
- CLAY AND
- CLAY
- TOP SOIL
- BEDROCK
- NOT

## OVERVIEW MAP LEGEND

- PROPOSED INVESTIGATION/ PERIMETER MONITORING WELL
- PROPOSED PERIMETER MONITORING WELL
- RESIDENTIAL WATER WELL
- MONITORING WELL
- CROSS SECTION LINE
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

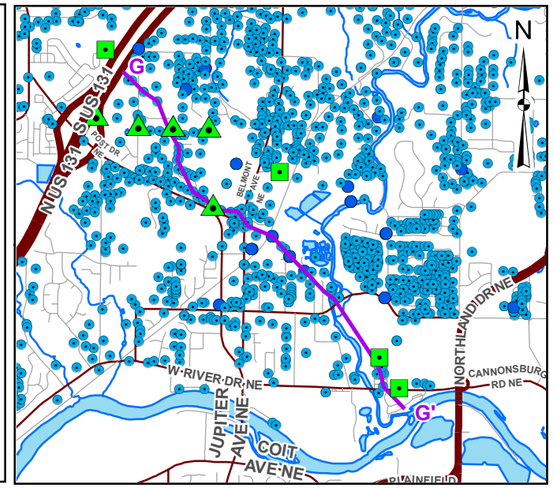
2. GROUND SURFACE ELEVATIONS ARE BASED ON DIGITAL RASTER FILES OF BARE EARTH DIGITAL ELEVATION MODELS (DEMS), GENERATED FROM LIDAR DATA WITH 1-METER HORIZONTAL ACCURACY AND 18.5-CENTIMETER VERTICAL ACCURACY. DIGITAL FILES OF DEMS AND LIDAR DATA WERE PROVIDED BY KENT COUNTY.

3. ESTIMATED GROUNDWATER TABLE WAS DEVELOPED BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATIONS WERE NOT MEASURED FROM RESIDENTIAL WATER SUPPLY WELLS.

4. WELL SCREEN ELEVATIONS PROVIDED IN FEET ABOVE MEAN SEA LEVEL, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RESIDENTIAL WELL SCREEN ELEVATIONS AND BOREHOLE LITHOLOGY ELEVATIONS WERE CALCULATED USING WELL INFORMATION PROVIDED BY THE STATE OF MICHIGAN'S WELLOGIC DATABASE AND GROUND SURFACE ELEVATIONS OF THE CENTER OF THE PPN GENERATED FROM LIDAR DATA PROVIDED BY KENT COUNTY. ELEVATIONS ARE ROUNDED TO THE NEAREST FOOT.

5. CONCENTRATIONS OF TOTAL PFAS AND PFOA+PFOS DEPICTED ARE MAXIMUM CONCENTRATIONS DETECTED AT THE SPECIFIED LOCATION.

## OVERVIEW MAP




0 2,750 5,500 11,000
SCALE IN FEET



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Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**CROSS SECTION G-G'**
**PERIMETER WELLS RAP**

| PREPARED BY: | | | PREPARED FOR: | |
|---|---|---|---|---|
| GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com | | | WN&J/WWW | |
| PROJ MGR: LJP | REVIEWED BY: MW | CHECKED BY: LMN | | FIGURE |
| DESIGNED BY: JC | DRAWN BY: JMG | SCALE: 1 in = 5,500 ft | | 11 |
| DATE: 08/08/2020 | PROJECT NO: 16.0062961.90 | REVISION NO: | | |

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. GROUNDWATER ELEVATION CONTOURS WERE DEVELOPED USING INTERPOLATION IN AQUAVEO GROUNDWATER MODELING SYSTEM (GMS) VERSION 10.4 BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATION CONTOURS ARE BASED ON LIMITED WELL INSTALLATIONS, AND DATA GAPS MAY ALTER THE GROUNDWATER CONTOURS. GROUNDWATER CONTOURS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREAS OF MEASURED ELEVATIONS.

## LEGEND

- GZA Wolven Jewell Monitoring Well Location
- Michigan Department of Environment, Great Lakes, and Energy (EGLE) Wolven Jewell Monitoring Well Location
- North Kent Landfill (NKLF) Monitoring Well Location
- GZA House Street Monitoring Well Location
- Shallow Groundwater Contour (ft) - November 2019
- Highway
- Primary County Road
- Other Road
- River or Stream
- Surface Water
- Approximate House St. Disposal Site Boundary
- North Kent Landfill
- North Kent Landfill Study Area
- North Kent Study Area Outline

PINE ISLAND DR NE
ALGOMA AVE NE
EDGERTON AVE NE
NORTHLAND DR
COURTLAND DR NE
11 MILE RD NE
10 MILE RD NW
10 MILE RD NE
W DIVISION ST NE
E DIVISION ST NE
HOUSE STREET SITE
NORTH KENT LANDFILL
NORTH KENT LANDFILL STUDY AREA
M-37 NW
US 131
POST DR NE
BELDING RD NE
WOLVERINE BLVD NE
7 MILE RD NW
7 MILE RD NE
ROGUE RIVER RD NE
BELMONT AVE NE
ALPINE AVE NW
N DIVISION AVE
6 MILE RD NW
6 MILE RD NE
W RIVER DR NE
JUPITER AVE NE
COIT AVE NE
CANNONSBURG

N

0 1,625 3,250 6,500
Scale in Feet



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**NORTH KENT STUDY AREA**
**SHALLOW GROUNDWATER ELEVATION CONTOURS - NOVEMBER 2019**
**PERIMETER WELLS RAP**

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 12 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 3,250 feet | |
| DATE: 8/10/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |

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NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. GROUNDWATER ELEVATION CONTOURS WERE DEVELOPED USING INTERPOLATION IN AQUAVEO GROUNDWATER MODELING SYSTEM (GMS) VERSION 10.4 BASED ON MEASUREMENTS MADE IN GROUNDWATER MONITORING WELLS IN NOVEMBER 2019. GROUNDWATER ELEVATION CONTOURS ARE BASED ON LIMITED WELL INSTALLATIONS, AND DATA GAPS MAY ALTER THE GROUNDWATER CONTOURS. GROUNDWATER CONTOURS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREAS OF MEASURED ELEVATIONS.

## LEGEND

- GZA Wolven Jewell Monitoring Well Location
- Michigan Department of Environment, Great Lakes, and Energy (EGLE) Wolven Jewell Monitoring Well Location
- North Kent Landfill (NKLF) Monitoring Well Location
- GZA House Street Monitoring Well Location
- Deep Groundwater Contour (ft) - November 2019
- Highway
- Primary County Road
- Other Road
- River or Stream
- Surface Water
- Approximate House St. Disposal Site Boundary
- North Kent Landfill
- North Kent Landfill Study Area
- North Kent Study Area Outline

HOUSE STREET SITE
NORTH KENT LANDFILL
NORTH KENT LANDFILL STUDY AREA
10 MILE RD NW
10 MILE RD NE
11 MILE RD NE
7 MILE RD NW
7 MILE RD NE
6 MILE RD NW
6 MILE RD NE
BELDING RD NE
W DIVISION ST NE
E DIVISION ST NE
ALGOMA AVE NE
EDGERTON AVE NE
BELMONT AVE NE
NORTHLAND DR
COURTLAND DR NE
PINE ISLAND DR NE
ALPINE AVE NW
N DIVISION AVE
POST DR NE
ROGUE RIVER RD NE
W RIVER DR NE
JUPITER AVE NE
WOLVERINE BLVD NE
COIT AVE NE
US 131
M-37 NW

N

0 1,625 3,250 6,500
Scale in Feet



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601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**DEEP GROUNDWATER ELEVATION CONTOURS - NOVEMBER 2019**
**PERIMETER WELL RAP**

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 13 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 3,250 feet | |
| DATE: 8/10/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |

## LEGEND

- GZA House Street Monitoring Well Location
- GZA Wolven Jewell Monitoring Well Location
- Michigan Department of Environment, Great Lakes, and Energy (EGLE) Wolven Jewell Monitoring Well Location
- Highway
- Primary County Road
- Other Road
- River or Stream
- Surface Water
- Approximate House St. Disposal Site Boundary
- North Kent Landfill
- North Kent Landfill Study Area
- North Kent Study Area Outline

**Approximate Total PFAS Extent (ppt)**

- < 4 ng/L
- 4 -10 ng/L
- 11 - 70 ng/L
- 70 - 1,000 ng/L
- 1,001 - 127,000

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. ACRONYMS
- (MAX) = MAXIMUM DETECTED CONCENTRATION IN THE SAMPLES.
- ng/L = NANOGRAM PER LITER
- PFAS = PER- AND POLY-FLUOROALKYL SUBSTANCES
- (PPT) = PARTS PER TRILLION

3. NO TOTAL PFAS CRITERIA / SCREENING LEVELS.

4. MAXIMUM CONCENTRATION FROM MONITORING AND RESIDENTIAL WELL SAMPLE RESULTS WERE USED TO DEVELOP CONCENTRATION ISOPLETHS.

5. CONCENTRATION ISOPLETHS WERE DEVELOPED USING NATURAL NEIGHBOR INTERPOLATION IN ARCGIS. CONCENTRATIONS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREA OF KNOWN CONCENTRATIONS.

6. RESIDENTIAL WELL SAMPLES WERE ANALYZED FOR PFAS USEING EPA METHOD 537.1 WHICH REPORTS THE RESULTS FOR 14 COMPOUNDS. SEE TABLE 2 OF THIS WORKPLAN FOR THE COMPOUND LIST.

7. MONITORING WELL SAMPLES WERE ANALYZED FOR PFAS USING DOD QSM BY ISOTOPE DILUTION, WHICH REPORTS THE RESULTS FOR 23 COMPOUNDS. SEE TABLE 6 OF THIS WORKPLAN FOR THE COMPOUND LIST.

8. THE TOTAL PFAS PRESENTED ON THIS FIGURE ARE CALCULATED FROM THE SUM OF THE 12 PFAS COMPOUNDS THAT ARE COMMON BETWEEN EPA METHOD 537.1 AND THE ISOTOPE DILUTION, DOD QSM METHODOLOGY.



12-MILE-RD-NE
ALGOMA-AVE-NE
EDGERTON-AVE-NE
11-MILE-RD-NE
NORTHLAND DR
COURTLAND-DR-NE
PINE-ISLAND-DR-NE
10-MILE-RD-NE
W-DIVISION-ST-NE
E-DIVISION-ST-NE
NORTH KENT LANDFILL
HOUSE STREET SITE
NORTH KENT LANDFILL STUDY AREA
SUS 131
NUS 131
BELMONT-AVE-NE
POST-DR-NE
ROGUE-RIVER-RD-NE
JUPITER-AVE-NE
NORTHLAND DR NE
W-RIVER-DR-NE
COIT-AVE-NE
BELDING-RD-NE
WOLVERINE-BLVD-NE

N

0 1,625 3,250 6,500
Scale in Feet



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Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**TOTAL PFAS ISOCONCENTRATION MAP**
**PERIMETER WELL RAP**

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www.gza.com

PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 14 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 3,250 feet | |
| DATE: 8/10/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |

## LEGEND

- GZA WOLVEN JEWELL MONITORING WELL LOCATION
- NORTH KENT LANDFILL (NKLF) MONITORING WELL LOCATION
- GZA HOUSE STREET MONITORING WELL LOCATION
- GZA HOUSE STREET PROPOSED MONITORING WELL LOCATION
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
- NORTH KENT LANDFILL
- NORTH KENT LANDFILL STUDY AREA
- NORTH KENT STUDY AREA OUTLINE

**PFOS + PFOA (ppt)**

- < 4 ng/L
- 4 - 10 ng/L (CD Value)
- 11 - 70 ng/L
- 71 - 1,000 ng/L
- 1,001 - 111,000 ng/L (MAX)

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. ACRONYMS
- (CD Value) = CONSENT DECREE VALUE
- (MAX) = MAXIMUM DETECTED CONCENTRATION IN THE SAMPLES.
- ng/L = NANOGRAM PER LITER
- PFOA = PERFLUORO-N-OCTANOIC ACID
- PFOS = PERFLUOROOCTANE SULFONATE
- (PPT) = PARTS PER TRILLION

3. MAXIMUM CONCENTRATION FROM MONITORING AND RESIDENTIAL WELL SAMPLE RESULTS WERE USED TO DEVELOP CONCENTRATION ISOPLETHS.

4. CONCENTRATION ISOPLETHS WERE DEVELOPED USING NATURAL NEIGHBOR INTERPOLATION IN ARCGIS. CONCENTRATIONS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREA OF KNOWN CONCENTRATIONS.

ALGOMA AVE NE
EDGERTON AVE NE
11 MILE RD NE
10 MILE RD NE
12 MILE RD NE
NORTHLAND DR
COURTLAND DR NE
W DIVISION ST NE
E DIVISION ST NE
HOUSE STREET SITE
NORTH KENT LANDFILL
NORTH KENT LANDFILL STUDY AREA
S US 131
N US 131
BELMONT AVE NE
POST DR NE
ROGUE RIVER RD NE
W RIVER DR NE
JUPITER AVE NE
NORTHLAND DR NE
WOLVERINE BLVD NE
BELDING RD NE
COIT AVE NE
GRAND

N

0 1,625 3,250 6,500
Scale in Feet



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Grand Rapids, Michigan 49504

**NORTH KENT STUDY AREA**
**PFOS + PFOA ISOCONCENTRATION MAP**
**PERIMETER WELLS RAP**

GZA GeoEnvironmental, Inc.
Engineers and Scientists
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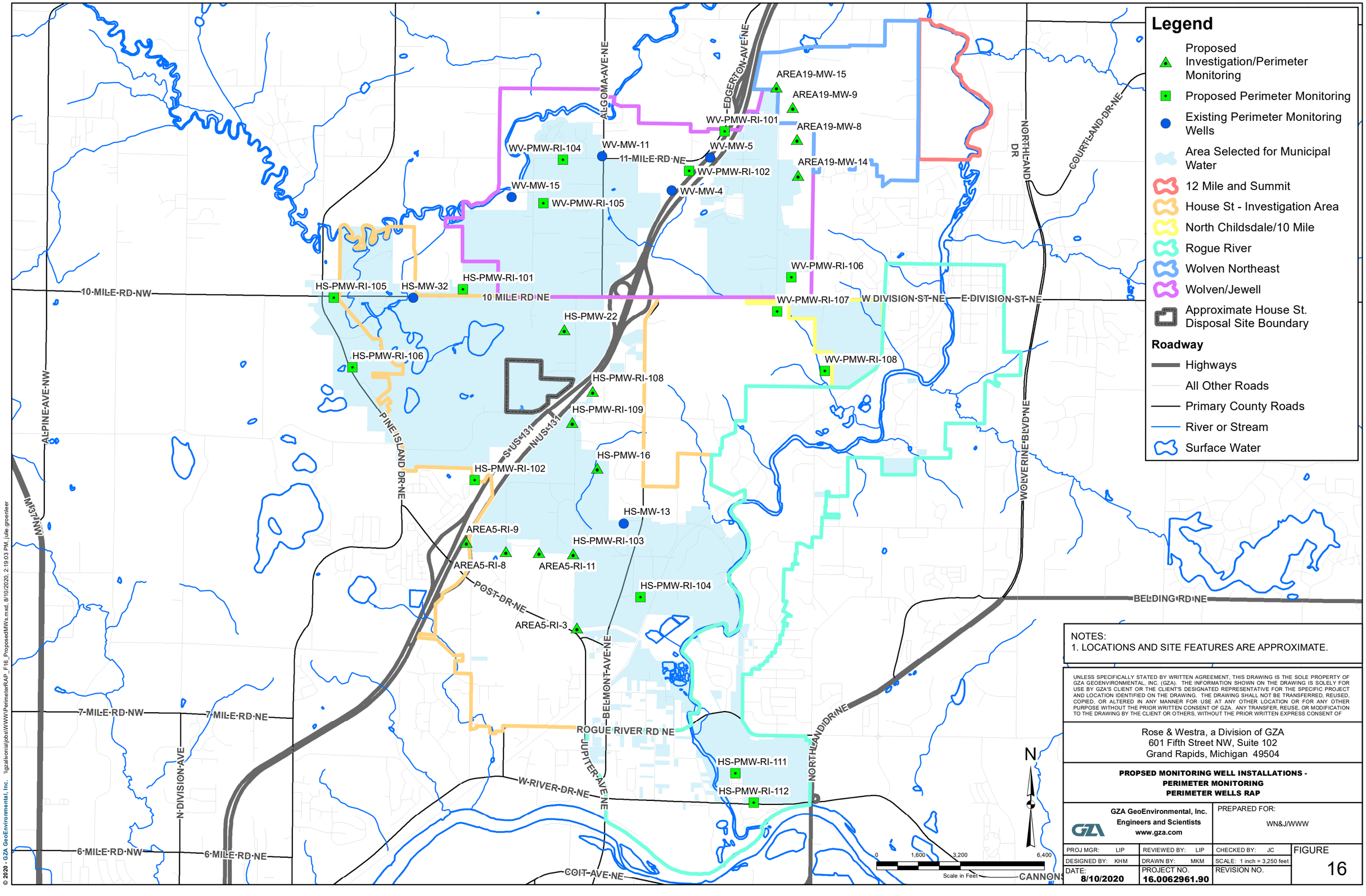
PREPARED FOR: WN&J/WWW

| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 15 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 3,250 feet | |
| DATE: 8/10/2020 | PROJECT NO. 16.0062961.90 | REVISION NO. | |




## Legend

- Proposed Investigation/Perimeter Monitoring
- Proposed Perimeter Monitoring
- Existing Perimeter Monitoring Wells
- Area Selected for Municipal Water
- 12 Mile and Summit
- House St - Investigation Area
- North Childsdale/10 Mile
- Rogue River
- Wolven Northeast
- Wolven/Jewell
- Approximate House St. Disposal Site Boundary

**Roadway**

- Highways
- All Other Roads
- Primary County Roads
- River or Stream
- Surface Water

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.



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**PROPSED MONITORING WELL INSTALLATIONS - PERIMETER MONITORING**
**PERIMETER WELLS RAP**

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| | | | |
|---|---|---|---|
| PROJ MGR: LIP | REVIEWED BY: LIP | CHECKED BY: JC | FIGURE 16 |
| DESIGNED BY: KHM | DRAWN BY: MKM | SCALE: 1 inch = 3,250 feet | |
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