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File No. 16.0062335.00

Ms. Abigail Hendershott
Acting District Supervisor – Remediation and Redevelopment Division
Michigan Department of Environmental Quality
350 Ottawa Avenue NW #10
Grand Rapids, MI 49503

Re: Work Plan - Site Investigation - PFAS Response
Former Wolverine Tannery, 123 Main Street, Rockford, Michigan

Dear Ms. Hendershott:

On behalf of Wolverine World Wide, Inc. (Wolverine), Rose & Westra, a Division of GZA GeoEnvironmental, Inc. (R&W/GZA), prepared this letter to provide the Michigan Department of Environment Quality (MDEQ) a proposed Site Investigation (SI) Work Plan related to the presence of per– and poly-fluoroalkyl substances (PFAS) at the Former Wolverine Tannery (Site). The Work Plan and attached documents were prepared in response to certain requests included in MDEQ's November 2, 2017 letter[1] to Wolverine and Wolverine's ongoing investigation. Specifically, this letter addresses Requests A and C related to the Wolverine Former Tannery described in MDEQ's November 2, 2017 letter, and provides a proposed Work Plan and a conceptual site model (CSM), respectively. Request B, "Provide all existing data from the Tannery …" including PFAS data are summarized in R&W/GZA's November 8, 2017 letter[2] to MDEQ.

As requested, the proposed Work Plan is focused on evaluating the vertical and lateral extent of PFAS, in particular, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). The proposed investigation is based on the CSM, our experience at the Site, and experience at other PFAS-related sites. Refer to the November 27, 2017 House Street Work Plan for a summary of physical properties and likely fate/transport of PFOA and PFOS.

BACKGROUND AND INVESTIGATION APPROACH

Site hydrogeology is described in the attached CSM, and generally includes fill and sand dominated alluvial deposits overlying a relatively thick sequence of alternating sand and silt/clay deposits. The interface between the alluvial and silt/clay deposits has been encountered in subsurface explorations at varying depths beneath the Site. Shallow overburden groundwater flow (i.e., within the alluvial deposits) is generally toward the west with discharge to the Rogue River. Rum Creek traverses the Site from east to west. Locally, shallow overburden flow is influenced by, and discharges to Rum Creek. Site features are

[1] Letter by MDEQ titled "*Wolverine World Wide, Inc. (Wolverine) PFAS Response, House Street, Plainfield Township, and Wolverine Tannery, 123 Main Street, Rockford, Kent County, Michigan*."

[2] Letter by R&W/GZA titled "*Wolverine World Wide, Inc. – Former Tannery, 123 North Main Street, Rockford, Michigan*."

illustrated on **Figure 1**. Based on ground surface topography and the location of surface water bodies within the vicinity of the Site, the vertical groundwater flow within deeper overburden is anticipated to be upward. While work has been performed at the Site to evaluate hydrogeology and sources of compounds other than PFAS within the shallow overburden, hydraulic head data from within or beneath the upper silt/clay deposits and an understanding of the lateral continuity of the silt/clay deposits are needed to further evaluate vertical groundwater flow and related PFAS transport and develop potential remedial alternatives.

PFAS detected in the groundwater are anticipated to be related to the former leather finishing processes used at the Site. We believe the PFAS would have been applied to leather in the finishing steps by either aerosol application or in the finishing mills themselves (i.e., waterborne). The finishing department was in the central portion of the Site. A specific Site-related source of the PFAS has not been identified. The preliminary PFAS data indicate a potential source area up gradient of well TMW-101 in the southwestern portion of the Site; however, PFAS were detected along the entire western border of the Site. The absence of a specific source area is consistent with ammonia distribution in groundwater except for the hide/leather area TMW-110 (refer to the CSM). Representative local background conditions for potentially impacted media (e.g., groundwater, surface water, soil) have not been fully evaluated. PFAS were measured in surface water samples collected up and down gradient from the Site in Rum Creek and the Rogue River.

Based on the Site's complex hydrogeology, limited information regarding potential PFAS use, and the distribution of PFAS indicated by the data included in R&W/GZA's November 8, 2017 letter, the proposed Work Plan assumes a phased investigation approach. The proposed Work Plan included herein describes the first phase (Phase I) of investigation, and assumes that one or more additional phases of investigation will be performed, with subsequent investigations based on the results of the work proposed herein. Phase I tasks have been selected to further evaluate the hydrogeology of the Site, including groundwater flow and groundwater surface water interactions relative to PFAS transport from the Site, and identification of potential PFAS sources. Tasks/explorations are included in Phase I to collect data that will also be used to evaluate potential remedial alternatives, if needed, as PFAS fate and transport are refined.

The proposed Work Plan, including the rationale for the selected investigation methods, are summarized in the following sections. The CSM is attached along with available requested summary documents.

WORK PLAN

Objectives of the Phase I SI Work Plan include:

- Further evaluation of upper alluvial (sand) deposit thickness and the interface with the top of low permeability silt/clay deposits underlying the upper alluvial deposits;
- Evaluation of the thickness and probable lateral continuity of the low permeability silt/clay deposits directly underlying the upper alluvial deposits;
- Evaluation of horizontal and vertical components of the hydraulic gradient within the upper sand deposits and hydraulic gradients within the low permeability silt/clay deposits;
- Measure PFAS concentrations in groundwater with specific evaluation of concentrations within the hydrogeologic units beneath the Site such as the upper alluvial sand deposit, and within and/or beneath the low permeability silt/clay deposits;

- Refinement of the lateral direction of groundwater flow within the alluvial deposit;
- Evaluation groundwater surface water interactions (potential mass flux/transport velocity) relative to PFAS transport;
- Identification and preliminarily evaluation of potential source areas (shallow PFOA-/PFOS-containing soil) via shallow soil sampling in areas targeted based on groundwater flow and physical possible given the presence of underground structures, potential historical PFAS Site use, and site wide shallow groundwater PFAS concentrations; and
- Preliminary identification of potential remedial alternatives. This will assist with identification and data needs in subsequent phases of the investigation.

Anticipated Phase II objectives (i.e., not included in this Work Plan) include:

- Evaluation of data gaps identified following Phase I;
- Collection of additional data needed to evaluate potential remedial alternatives identified during Phase I;
- Collection of data needed to develop a conceptual Remedial Design/Remedial Action Plan; and
- Collection and testing of sediment samples.

This proposed Work Plan is organized into the following tasks. Tasks are presented in the general order that they would be performed; however, certain tasks may be performed concurrently.

To maintain the integrity of sampling and analytical methodologies to be employed, the work proposed in the following tasks will be completed, as applicable, in accordance with the following guidance documents:

- DEQ Published List of Target Detection Limits and Designated Analytical Methods, Michigan Department of Environmental Quality, Remediation and Redevelopment Division, March 10, 2016.
- "Master Quality Assurance Project Plan, of the Hazardous Water Remediation Bureau, Waste Management Division, New Hampshire Department of Environment Services EQA RFA# 13027," Approved December 2012, Revision 4, March 2017;
- Commonwealth of Massachusetts, Department of Environmental Protection document, "DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites, Regulated under the Massachusetts Contingency Plan," dated January 2017; and
- Department of Defense (DOD) guidance document, "Bottle Selection and other Sample Considerations When Sampling for Per- and Poly-Fluoroalkyl Substances (PFAS)."

TASK 1 – ADDITIONAL HISTORICAL RESEARCH

Site documents will be evaluated for potential PFAS use and storage, including process information, to understand probable locations of PFAS use/release, and findings will be summarized in the SI Report described in **Task 9**. This task will include evaluating available tannery design/layout documents, spill control plans, stormwater plans, etc. provided by Wolverine. R&W/GZA will also evaluate publicly available historical maps and aerial photographs and, as available,

published sources. The information collected will be used along with shallow groundwater flow and PFAS concentration data collected during completion of **Task 4** and **Task 6** to select shallow soil sampling locations described in **Task 8**.

TASK 2 – SURFICIAL GEOPHYSICAL SURVEY

The former tannery slab/foundation and associated infrastructure remains at the Site. Therefore, areas without anthropogenic interferences for geophysical investigations are significantly limited. R&W/GZA will, however, select transect locations to attempt a seismic refraction survey to identify top of the low permeability silt/clay deposits, and to the extent possible layering and discontinuities within the upper portion of the low permeability silt/clay deposits.

TASK 3 – GEOLOGIC DATA SUMMARY

Existing Site geologic data will be summarized in a 3-dimensional model of the primary hydrogeologic units encountered during past subsurface explorations and the subsurface explorations described herein using Environment Visualization Software (EVS) software. The model will be prepared at the beginning of the SI and updated as data are collected. The 3--dimensional model will be used to evaluate and summarize the data collected, and will be used to selected sampling locations.

TASK 4 – MULTI-LEVEL MONITORING WELL NETWORK INSTALLATION

Install additional monitoring wells at current locations and install new multi-level monitoring nests at the Site to further evaluate site hydrogeology. The additional monitoring wells will be focused on evaluation of lateral and potential vertical groundwater hydraulic gradients and transport of PFAS. The number of additional wells at current nests and new locations will be based in part on findings from the preceding tasks and the initial round of groundwater sampling described in **Task 6**.

Multi-level wells will include well couplets or triplets, with individual wells within a nest installed in separate boreholes located within 5 feet to 10 feet of each other. Locations of individual multi-level monitoring well nests will be selected based on the results of the preceding tasks, and will include wells located throughout the Site (i.e., assumed, down gradient, central locations, and potentially up gradient [background]). Six preliminarily proposed locations for additional monitoring wells are illustrated on **Figure 1**. The number of screens and construction details will be preliminarily based on the CSM and geophysical survey but ultimately designed based on conditions observed while drilling. The deepest boring will be the first boring drilled at each location and will be used to select screen locations for the shallower well(s). Target well screen locations include:

- Upper saturated zone within the alluvial deposits;
- Lower portion of alluvial deposits above silt/clay deposits (installation contingent on sufficient thickness of saturated alluvial deposits); and
- Beneath or within the silt/clay deposits (location dependent thickness and homogeneity of the silt/clay deposits).

Existing shallow overburden monitoring wells may be utilized if applicable.

Borings will be drilled using standard hollow stem auger (HAS) or drive and wash drilling methods. Borings extending into the lower silt and clay deposit will be advanced using HAS or telescoping drilling techniques and drive and wash techniques where a larger steel casing is installed throughout the upper alluvium and grouted into the clay/silt unit. If necessary,

drilling into the lower silt/clay unit will then be accomplished with a smaller casing telescoped through the upper alluvium to limit cross contamination. Soil samples will be collected at 5-foot intervals using Standard Penetration Test methods. Continuous sampling may be used based on the anticipated subsurface conditions at the final target drilling locations. Soil boring and monitoring well construction will be observed and documented by R&W/GZA field personnel. R&W/GZA field personnel will also field screen soil samples in the field for general indicators of target analytes including visual, olfactory, and photoionization detector (PID) methods. Soil sampling for PFAS analysis is not anticipated during this task.

Soil and groundwater from the drilling of the boring and monitoring well construction activities will be containerized within 55-gallon open top steel drums and temporarily stored on Site. Containerized soil will be disposed of at an appropriate off-site disposal facility. Samples may be collected from excess soil and groundwater to meet waste disposal facility permit requirements.

Groundwater monitoring wells will be constructed using 2-inch ID SCH 40 PVC solid riser and slotted screen sections. The annulus of each borehole, above the screen section, will be filled using minimum 3-foot-thick bentonite seal above the screen section of the well, and bentonite, and/or a bentonite and Portland cement grout to within 5 feet of the ground surface. Monitoring wells will be completed using a locking protective standpipe or roadway box.

Monitoring wells will be developed following installation using inertia pump and surge block methods. Excess groundwater from the well development activities will be containerized within 55-gallon open top steel drums, or other secure containers temporarily stored on site, characterized and disposed off-site.

Monitoring well locations and reference point elevations will be established by a Licensed surveyor.

TASK 5 – SURFACE WATER/PORE WATER SAMPLING

This task includes collection of two rounds of samples of surface water/pore water for PFAS analysis from the Rogue River and Rum Creek, and assumes collection of samples at up to four existing and up to eight supplemental locations. Collection of the second round of surface water samples will be performed a minimum of 1 month after the first round. Existing and six of the proposed sampling locations are illustrated on **Figure 1**. Proposed sampling will include locations selected to further evaluate the spatial distribution of PFAS in surface water, collect data for future evaluation of temporal changes in PFAS concentration, evaluate groundwater surface water interactions and evaluate background surface water PFAS concentrations.

To the extent allowed by water level conditions, surface water/pore water will be collected at one or more multi-level groundwater monitoring well locations adjacent to the Rogue River. The surface water/pore water sampling locations will be co-located, and surface water elevation data collected at these locations to evaluate PFAS transport from groundwater to surface water. The investigation approach includes the installation of one nested well near the discharge zone of each of the surface water feature and will be directly up gradient of the concentration of pore water samples to evaluate the PFAS migration from groundwater to surface water.

This task includes installation and monitoring of two staff gauges in the Rogue River and Rum Creek. Short-term continuous water levels may be collected if deemed appropriate.

Surface Water Sample Collection, Preservation, and Transport

Surface water samples will be collected, as described in the referenced guidance documents (also see the November 27, 2017 House Street Work Plan for additional information including Standard Operating Procedures to be used until the unified [multi-party, multisite] Quality Assurance Project Plan [QAPP] is completed). Samples will be collected using laboratory-provided, PFAS-free, polyethylene plastic bottles. All sample containers will be cooled to 6˚ centigrade with no additional applied preservative per laboratory instructions. Shipping will consist of overnight delivery to the laboratory via a commercial courier in accordance with Chain of Custody (COC) procedures.

Laboratory Analyses and Quality Assurance and Quality Control (QA/QC) Measures

Samples will be submitted to a laboratory accredited by the Department of Defense and/or the National Environmental Laboratory Accreditation Program for most PFAS analytes by Environmental Protection Agency (EPA) Method 537 Rev. 1.1, modified. We anticipate using either Eurofins Lancaster Laboratories Environmental, LLC (ELLE) of Lancaster, Pennsylvania or ALS Environmental of Kelso, Washington. The minimum list of the PFAS compounds analyzed and their associated maximum Method Reporting Limits (MRLs) pertaining to water analysis follows:

Compound	CAS Number	MRL (ng/l)
Perfluoro-octanesulfonate	1763-23-1	5
Perfluorobutanesulfonate	375-73-5	10
Perfluorobutanoic Acid	375-22-4	5
Perfluoroheptanoic Acid	375-85-9	5
Perfluorohexanesulfonate	355-46-4	5
Perfluorohexanoic Acid	307-24-4	5
Perfluorooctanoic Acid	335-67-1	2
Perfluoroheptanesulfonate	375-92-8	5
Perfluoropentanoic Acid	2706-90-3	5
Perfluorodecanoic Acid	335-76-2	5
Perfluorododecanoic Acid	307-55-1	5
Perfluorononanoic Acid	375-95-1	5
Perfluorotridecanoic Acid	72629-94-8	5
Perfluoroundecanoic Acid	2058-94-8	5
Perfluorotetradecanoic Acid	376-06-7	5

The laboratories will report additional PFAS compounds if their Standard Operating Procedures have been validated for the additional analytes.

Laboratory QA/QC measures will include the following at a frequency of 1 set of QA/QC samples per 20 field samples or sampling round if less than 20 samples are collected during a sampling round:

- (1) Matrix spike
- (1) Matrix spike duplicate
- (1) Trip (field) blank
- (1) Equipment blank (if appropriate based on the sampling technique)

In addition to the laboratory QA/QC measures, one blind duplicate sample will be collected per sampling round, or per 20 field samples if more than 20 samples are collected during one sampling round. Laboratory-provided PFAS-free deionized water will be used for trip blanks.

Data evaluation will be performed by GZA and summarized in the report described in **Task 9**.

TASK 6 – GROUNDWATER SAMPLING

Two well nests (MW-309 and MW-310, see **Figure 1**) were recently installed along the southern property line. One round of groundwater samples from all existing monitoring wells will be collected prior to initiating **Task 4**. Groundwater samples will be collected using low-flow sampling methods, as described in the referenced guidance documents. Excess groundwater purged from monitoring wells will be containerized and temporarily stored at the Site. The containerized purged groundwater will be characterized and disposed off-site.

Groundwater samples will be collected, transported, and analyzed using the same techniques as surface water described previously.

Aliquots for alkalinity (Standard Methods SM 2320 or EPA Method 310.1), ammonia-nitrogen (EPA Method 350.1), iron (EPA 6000 or 7000 Series), hardness (Standard Methods SM 2340B [calculation]), manganese (EPA 6000 or 7000 Series), total dissolved solids (TDS, Standard Methods SM 2540C or EPA Method 160.1), and total organic carbon (TOC, EPA Method 9060A or Standard Methods SM 5310) will be collected from selected monitoring wells.

Two rounds of groundwater samples will be collected from each of the wells installed as described in **Task 4**, and up to 10 existing wells. R&W/GZA will perform two rounds of water level gauging (i.e., staff gages and monitoring wells), each following collection of groundwater samples. Gauging will take place within approximately 1 week after the collection of groundwater samples to avoid potential PFAS cross contamination. Depth-to-groundwater within each monitoring well will be gauged using an electronic water level indicator, with results being reported as a precision level of 0.01 feet.

TASK 7 – HYDRAULIC CONDUCTIVITY TESTING

Selected proposed and existing monitoring wells will be tested to provide data needed to calculate estimates of hydraulic conductivity for the primary hydrogeologic units identified in the subsurface explorations. Water level response data will be collected using standard slug and pneumatic slug methods.

In addition, borehole permeability testing may be performed during the advancement of the borings within the lower silt/clay unit to evaluate permeability in specific soil layers.

TASK 8 – SOIL SAMPLING

As physically practicable, given the presence of extensive remnants of former Site structures, soil samples will be collected within the upper 5 feet of the pre-demolition ground surface using GeoProbe® (direct push) drilling methods. Soil sample locations will be selected based the results of the proceeding tasks, with the objective of evaluating PFAS concentrations within soil within potential source areas. Soil samples may also be collected from potential background locations within the Site. R&W/GZA anticipates collection of soil samples from up to 25 borings, with two soil samples submitted for laboratory PFAS analysis from each boring.

Soil samples may also be collected manually using hand auger methods. As borings are advanced either by direct-push or manual methods, soil samples will be continuously screened by GZA using a PID. Borings will be backfilled with auger spoils, drill cuttings and/or filter sand, as necessary.

The investigation approach includes collection of the proposed soil samples in two phases, with the first phase performed based on existing data and historical information prior to the installation of monitoring wells described in **Task 4**. Data from the initial phase of soil sampling would then be used to select drilling locations for the proposed monitoring wells.

Soil samples will be collected by R&W/GZA's field geologist and submitted to a task-specific project laboratory for PFAS analysis. Samples subject to analysis for PFAS compounds will be collected using laboratory-provided, PFAS-free, polyethylene plastic bottles (i.e., 250-milliliter volume).

Shipping will consist of overnight delivery to the applicable project laboratory via a commercial courier in accordance with COC procedures.

Laboratory Analyses and QA/QC Measures

The following analytical method applies to soil samples:

- PFAS compounds via EPA Method 537 Rev. 1.1, modified.

A minimum list of the PFAS compounds analyzed via the above-referenced method and the associated MRL pertaining to soil analysis is provided as follows:

Compound	CAS Number	MRL (ng/g)
Perfluoro-octanesulfonate	1763-23-1	1.0
Perfluorobutanesulfonate	375-73-5	1.0
Perfluorobutanoic Acid	375-22-4	1.0
Perfluoroheptanoic Acid	375-85-9	1.0
Perfluorohexanesulfonate	355-46-4	1.0
Perfluorohexanoic Acid	307-24-4	1.0
Perfluorooctanoic Acid	335-67-1	1.0
Perfluoroheptanesulfonate	375-92-8	1.0
Perfluoropentanoic Acid	2706-90-3	1.0
Perfluorodecanoic Acid	335-76-2	1.0
Perfluorododecanoic Acid	307-55-1	1.0
Perfluorononanoic Acid	375-95-1	1.0
Perfluorotridecanoic Acid	72629-94-8	1.0
Perfluoroundecanoic Acid	2058-94-8	1.0
Perfluorotetradecanoic Acid	376-06-7	1.0

The laboratories may report additional PFAS compounds if their Standard Operating Procedures have been validated for the additional analytes.

QA/QC measures for PFAS-specific analyses will include the following:

- (1) Trip (field) blank
- (1) Field sample duplicate
- (1) Equipment rinsate blank

Laboratory-provided PFAS-free deionized water will be used for the equipment rinsate and trip blanks.

As stated previously, the former tannery floor and associated infrastructure remains at the Site; therefore, soil sampling areas without anthropogenic interferences for geophysical investigations are significantly limited.

TASK 9 – PHASE I DATA EVALUATION AND REPORT

The information and data collected during **Task 1** through **Task 8** will be evaluated by W&R/GZA relative to the previously-presented SI objectives. The data will be compiled and conclusions and recommendations presented in a report including figures and tables summarizing the information collected and results of soil, groundwater, and surface water sampling and analyses. The report will also include illustrations of the three-dimensional site model prepared as described in **Task 3**.

The report will also include a Phase II SI work plan for proposing activities associated with additional activities meant to address data gaps necessary to meet the project objectives. Sediment sampling will be proposed once the extent of groundwater discharge to the surface waters is better defined.

ANTICIPATED SCHEDULE

Per our November 8, 2017 letter, R&W/GZA installed two well nests along the southern property line last week. R&W/GZA will collect samples from all existing monitoring wells described in **Task 6** in December 2017. Following MDEQ's acceptance of this Work Plan, R&W/GZA estimates approximately 6 months will be required to complete the remainder of proposed Work Plan and submit the report described in **Task 9** to MDEQ.

R&W/GZA trust that this letter and attachments are responsive to MDEQ requests referenced herein, and look forward to receiving your comments on the proposed Work Plan. Should you have any questions, please do not hesitate to contact the undersigned.

Very truly yours,

Rose & Westra, a Division of GZA GeoEnvironmental, Inc.

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Consultant/Reviewer

Attachments: Conceptual Site Model
Figure 1

Conceptual Site Model

Preliminary Conceptual Site Model for the Former Wolverine Tannery, 123 North Main Street, Rockford, Michigan

Site name, address, location, alias identification numbers, etc.	Wolverine World Wide (Wolverine) Tannery (former) 123 North Main Street, Rockford, Michigan 49341 Latitude: 43.123056°; Longitude: -085.560278° (former main tannery building) U.S. EPA ID No. MIN000510613
Overview of site history	The Site was first developed in the 1800s, with an ice house, lumber yard and associated coal storage being located north of Courtland Street and west of Main Street in the late 1800s. A shoe factory was constructed north of Rum Creek circa 1903, and the tannery was constructed south of Rum Creek circa 1908. Both buildings were expanded throughout the years, with the tannery expanding to the south and west onto formerly-residential land and a lumber/coal yard, respectively. The tannery operated until 2009 and was demolished during 2010 and 2011. Prior to tanning, salted hides were fleshed, trimmed, washed, and the hair removed (using lime and sodium hydrosulfide). The tanning process itself included removing lime used for hair removal (i.e., bating); pickling; trivalent chromium tanning; and splitting the hides. The hides were then shaved and skived to remove the grain and create a plush texture. Following tanning, the hides were dyed, "fat-liquored" (i.e., adding oil back to the leather), and dried. The hides were finished using solvent-borne finishes initially; later processes involved use of water-borne finishes. Prior to the late 1940s, Wolverine screened tannery-related wastewater prior to discharging to a separate sewer line. In the late 1940s early 1950s, Wolverine constructed a wastewater treatment plant on the peninsula south of Rum Creek and west of the tannery building. The wastewater treatment plant was expanded and reconstructed over the years and was decommissioned and demolished during 2011 and 2012 (i.e., following demolition of tannery-related structures). A separate sewer was constructed when the tannery began operating to ensure that wastewater would not be discharged to the Rogue River or otherwise impact the City's water supply. The sanitary sewer conveyed wastewater to the south, parallel to a City of Rockford sanitary sewer, to the former Rockford wastewater treatment plant

Preliminary Conceptual Site Model for the Former Wolverine Tannery, 123 North Main Street, Rockford, Michigan

		which was located several blocks to the south. The Rockford sewer system, including the pre-treated tannery wastewater, was treated at the City of Grand Rapids Wastewater Treatment Plant for several decades, and more recently, at the North Kent Sewer Authority Wastewater Treatment Plant.
Site Conditions	**Physical Characteristics**	The Site resides along the eastern bank of the Rogue River, just north of Rockford Dam in Rockford, Michigan. North Main Street borders the Site to the east, and the Rogue River borders the Site to the west. Rum Creek, which flows from east-to-west, divides the Site into northern and southern parcels. Topography is gently sloping from east-to-west and north-to-south in the vicinity of the Site.
	Regional hydrogeology	The Michigan Department of Environmental Quality (MDEQ) described the regional geologic/hydrogeologicsetting as follows: *"the near surface geology in the area of the Site consists of glacial outwash sand and gravel deposits and end moraine complexes. These deposits occur as fluvial terraces along the Rogue River with the end moraine complexes flanking the river and underlying the terrace deposits. The terrace deposits range in thickness from approximately 10 to 60 feet while the morainal deposits can exceed 300 feet in thickness. The bedrock geology of the area consists of the Red Beds and Grand River Formation. The depth to bedrock in the Site area ranges from approximately 215 to over 320 feet."* (MDEQ, 2012). Sheets 1 and 2 present a plan and regional cross sections.
	Local Hydrogeology	Local geologic and hydrogeologic conditions are generally consistent with the MDEQ's description, as quoted above. Logs associated with borings advanced in the Site vicinity commonly report shallow geology consisting of outwash deposits dominated by fine-to-coarse sands overlying a clay-dominated, low-permeability unit of low-energy depositional origin. Alluvial deposits associated the Rogue River including sand and silt over peat are also at the Site. Anthropogenic fill consisting of dust, brick, cinder, and other debris commonly overly the native deposits (i.e., outwash and alluvial deposits). Geologic deposits encountered in soil borings drilled beneath the site and within the site vicinity are illustrated on the attached cross sections

		previously prepared by R&W. Sheets 3 and 4 show a plan and on-Site cross sections including the approximate former building locations and known process piping. (R&W/GZA does not have sufficient information to show process drains and piping on the sections themselves.) Based on interpretation of water levels collected from Site monitoring wells, groundwater appears to generally flow from east-to-west, with the Rogue River and Rum Creek representing the primary local groundwater discharge zones. Vertical hydraulic gradients above the local low-permeability unit are generally neutral, with limited evidence of local zones of upward flow existing in the vicinity of the aforementioned groundwater discharge zones. Hydraulic conductivities measured via slug testing within Site monitoring wells screened above the low-permeability unit range from less than 0.1 feet per day to greater than 10 feet per day.
Historical Process and Fill-Related Chemicals		The tanning processes used a variety of chemicals, including: salt to preserve and pickle hides; surfactants (i.e., detergents/soap) for fatliquoring/oil introduction; lime and sodium sulfide to remove hair from the hides; ammonium salts to remove lime from the hides and to aid the coloring process; enzymes; sulfuric acid and chromium sulfate to tan the hides; and various dyes, colorants, oils, and protectants/additives to finish the hides. As previously indicated, Wolverine used solvent-borne and water-borne finishes over the history of tannery operations at the Site. Substantial investigations have been performed since 2011. Given the operational history of the Site and the results of those past investigations, a variety of compounds could potentially have been released to the subsurface at the Site. The prior investigations identified ammonia, trivalent chromium and a few other compounds, as well as certain per- and polyfluorinated alkyl substances (PFAS). Refer to the R&W/GZA November 2017 Interim Report for tables summarizing all prior soil and groundwater test results.
Potential source area(s)		In prior descriptions of the Site, the MDEQ (MDEQ, 2012) identified four (4) potential release (source) areas all four of which have been investigated previously:

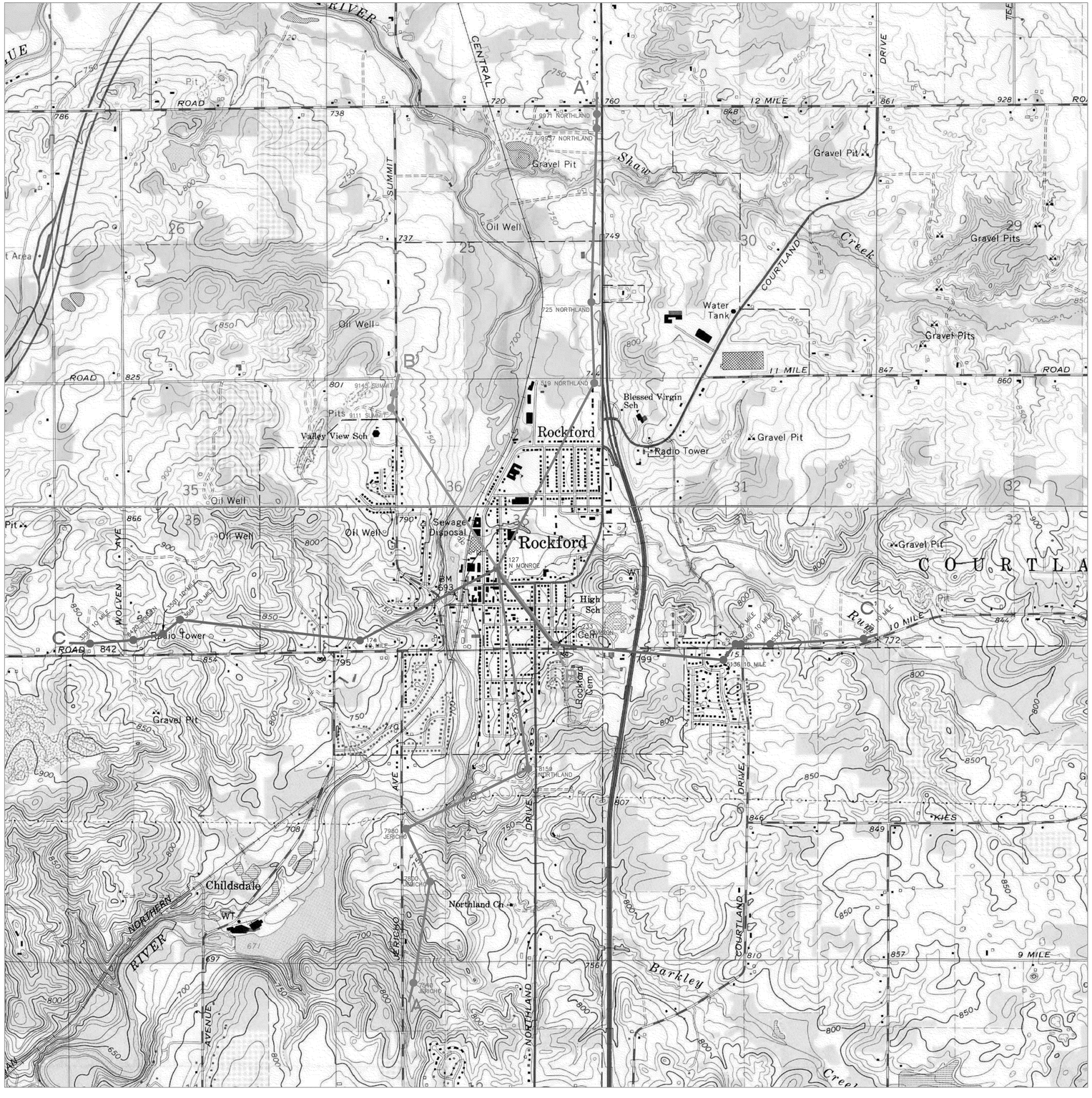
Preliminary Conceptual Site Model for the Former Wolverine Tannery, 123 North Main Street, Rockford, Michigan

	1. An abandoned fuel oil underground storage tank (UST), which Wolverine records indicate was emptied, cleaned and abandoned in place; 2. Wastewater piping under the former tannery maintenance room (Wolverine previously removed stained soil from this area); 3. Soil near the former wastewater treatment plant; and 4. Soil on the western portion of the Site along the Rogue River (this may include the fill discussed below). The two soil areas described above (i.e., items 3 and 4) are believed to represent secondary, as opposed to primary, source areas. From 2012 through 2015, additional site investigation and historical Site information have resulted in independent identification of the additional potential source areas listed below, all of which have been previously investigated: 1. The former lumber yard and tannery fuel storage area, including coal piles and fuel oil USTs; 2. Fill associated with railroad bed construction, railroad operations, and loading/off-loading areas along the railroad spur (i.e., including soil identified by MDEQ as a potential source area); 3. A former salt storage area located along the railroad right-of-way; 4. The former wastewater treatment plant; and 5. An area north of Rum Creek and west of the retail building where hides were buried (note: Wolverine previously committed to and is working toward removal of the hide/leather/fill mixture from this area in 2017). Relative to non-PFAS Site constituents, soil and/or groundwater samples have been collected from the potential source areas described above. With the exception of Source 5, above, data obtained to-date have not provided evidence of historical on-site waste disposal, including wastewater treatment sludges. Additionally, with the exception of the fill and hides, prior reports document these sources have been removed. Potential secondary sources remain in some areas.

	Certain PFAS-related compounds were used in the tannery finishing area in the south-central portion of the Site. The groundwater data is more limited than other analytes, but, groundwater contains ammonia and certain PFAS (e.g., PFOS) north and south of Rum Creek (R&W/GZA, 2017). Current and sufficient information is not available to create iso-concentration maps because only monitoring wells along the surface water bodies were sampled in 2017.
Potential migration and exposure pathways	**Groundwater** Groundwater is a potential migration pathway pertaining to Site-related compounds, as reflected in previous analytical results of groundwater samples collected from Site monitoring wells. However, as noted by Rose and Westra (R&W): *"the City of Rockford municipal well field is located over two miles east of the Site and the Site is not located within the established area designed to protect the wells from potential sources of contamination (i.e., the "well-head protection zone)."* (R&W, 2012). Furthermore, there are no known on-Site drinking water supply wells, and Wolverine has already committed to recording enforceable restrictions to prevent future groundwater use for human consumption. **Surface Water** Migration of PFAS-containing surface water is a potential migration pathway, because the primary local groundwater discharge areas are flowing to surface water bodies (i.e., Rum Creek and the Rogue River). Sampling and analysis of pore water occurring within Rum Creek and the Rogue River identified ammonia and PFOS (R&W/GZA, 2017). Surface water is a potential migration pathway associated with the Site given discharge of Site groundwater to Rum Creek and the Rogue River; therefore, direct contact with surface water is a potential exposure pathway. For PFAS, ATSDR (2017) states, "Dermal exposure is a minor pathway. Dermal absorption is slow and does not result in significant absorption." Therefore, dermal contact with surface water is not

	anticipated to pose a concern. Downstream areas have been associated with habitats of threatened and endangered species at the State and Federal levels (MDEQ, 2012). Direct consumption of surface water (i.e., surface water serving as a source of drinking water) is not a potential exposure pathway, as there are no public surface water intakes along the Rogue River or Grand River downstream from the Site. **Soil** Direct contact with contaminated soil is a potential exposure pathway associated with the Site (primarily related to metals), as *"soil samples collected from the Site in three known source areas have been shown to be contaminated with elevated levels of several organic and inorganic contaminants."* (MDEQ, 2012). However, *"Soil samples contain various substances above their generic criteria for drinking water protection, but there are no drinking water wells on-site (i.e., the protection of drinking water exposure pathway is not complete at the Site)."* (R&W, 2012). All soil known to contain metals at concentrations greater than direct contact criteria were addressed with clean fill. **Air** Air exposure is unlikely to be a pathway of concern associated with the Site, as *"The majority of the known contamination is either in areas that are well vegetated or are subsurface."* (MDEQ, 2012).
References	**ATSDR 2017.** An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns. Interim Guidance Revised on June 7, 2017. **MDEQ, 2012**. CERCLA Preliminary Assessment Report for Wolverine World Wide Former Tannery, 123 North Main Street, Rockford, Michigan, 49341, U.S. EPA ID NO.: MIN000510613, dated June 14, 2012.

	R&W, 2011. Wolverine World Wide (WWW) – Former Rockford, Michigan Tannery – Post Demolition Environmental Investigation. Addressed to Mr. David Latchana of Wolverine World Wide, Inc., dated September 19, 2011. **R&W, 2012**. Wolverine World Wide (WWW) – Former Rockford, Michigan Tannery – Round 2 Environmental Investigation. Addressed to Mr. David Latchana of Wolverine World Wide, Inc., dated February 6, 2012. **R&W/GZA, 2017**. Wolverine World Wide (WWW) – Former Rockford, Michigan Tannery – 123 North Main Street, Rockford, Michigan. Addressed to Ms. Abigail Hendershott of the Michigan Department of Environmental Quality, dated November 8, 2011.



NORTH

SCALE: 1" = 1,000'

SECTION CUT LEGEND

= SECTION A–A'
= SECTION B–B'
= SECTION C–C'

ROCKFORD AREA PLAN
W/ GEOLOGICAL SECTION CUTS

DRAWN BY	DESIGN BY	DATE
KJB	JMW	11/27/17

FILE NO.: 62335_C9M

NO.	REVISIONS	BY	DATE

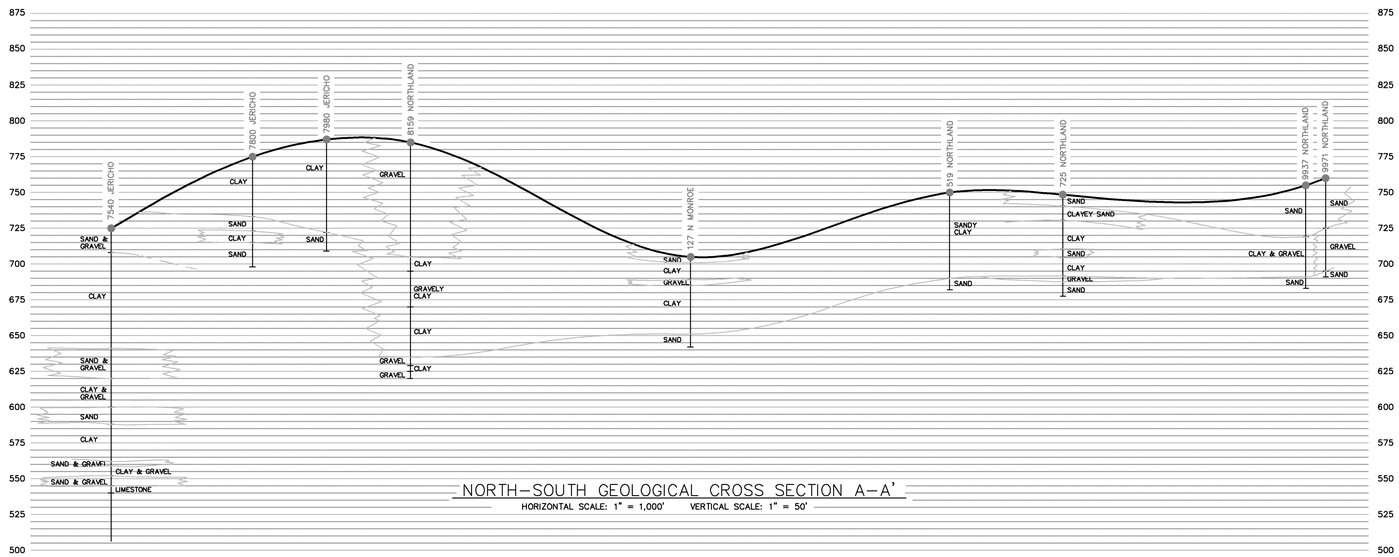
REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

WOLVERINE WORLD WIDE
FORMER TANNERY - ROCKFORD, MICHIGAN
TANNERY CONCEPTUAL SITE MODEL

ROSE & WESTRA
A DIVISION OF GZA
Grand Rapids, Michigan
GEOTECHNICAL- ENVIRONMENTAL- ECOLOGICAL- WATER- CONSTRUCTION MANAGEMENT

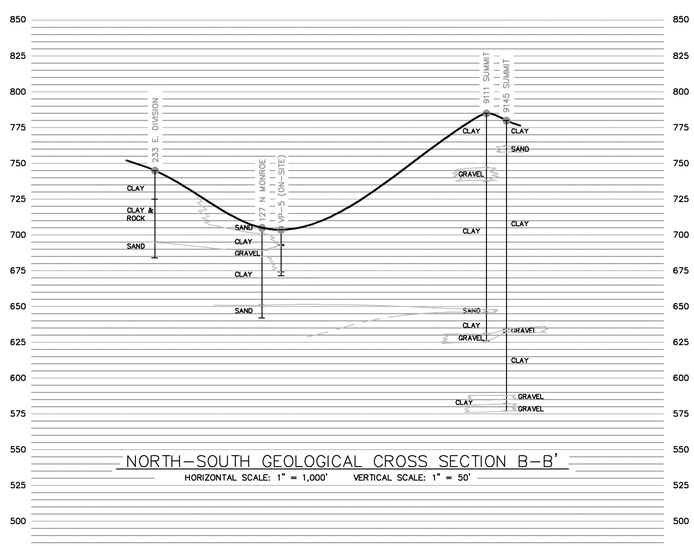
PROJECT NO.
16.0062335.00

SHEET NO.
1 OF 4



NORTH–SOUTH GEOLOGICAL CROSS SECTION A–A'

HORIZONTAL SCALE: 1" = 1,000' VERTICAL SCALE: 1" = 50'



NORTH–SOUTH GEOLOGICAL CROSS SECTION B–B'

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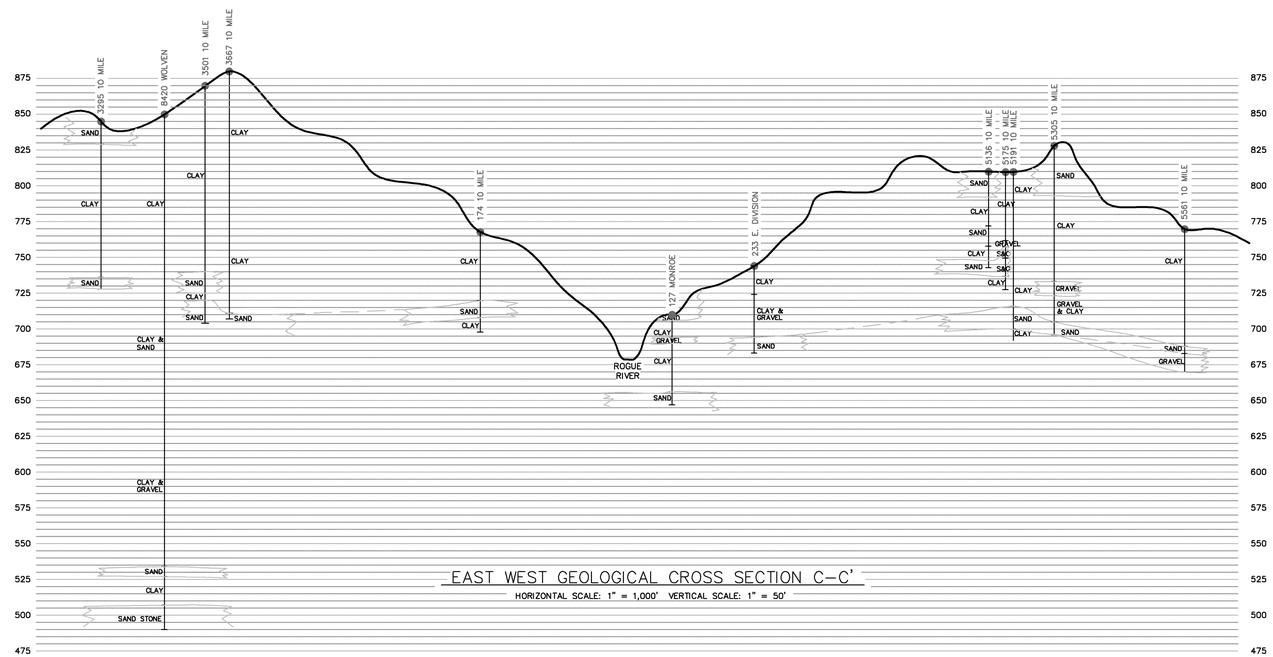

EAST WEST GEOLOGICAL CROSS SECTION C–C'

HORIZONTAL SCALE: 1" = 1,000' VERTICAL SCALE: 1" = 50'

ROCKFORD AREA GEOLOGICAL SECTION CUTS

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KJB	JMW	11/27/17

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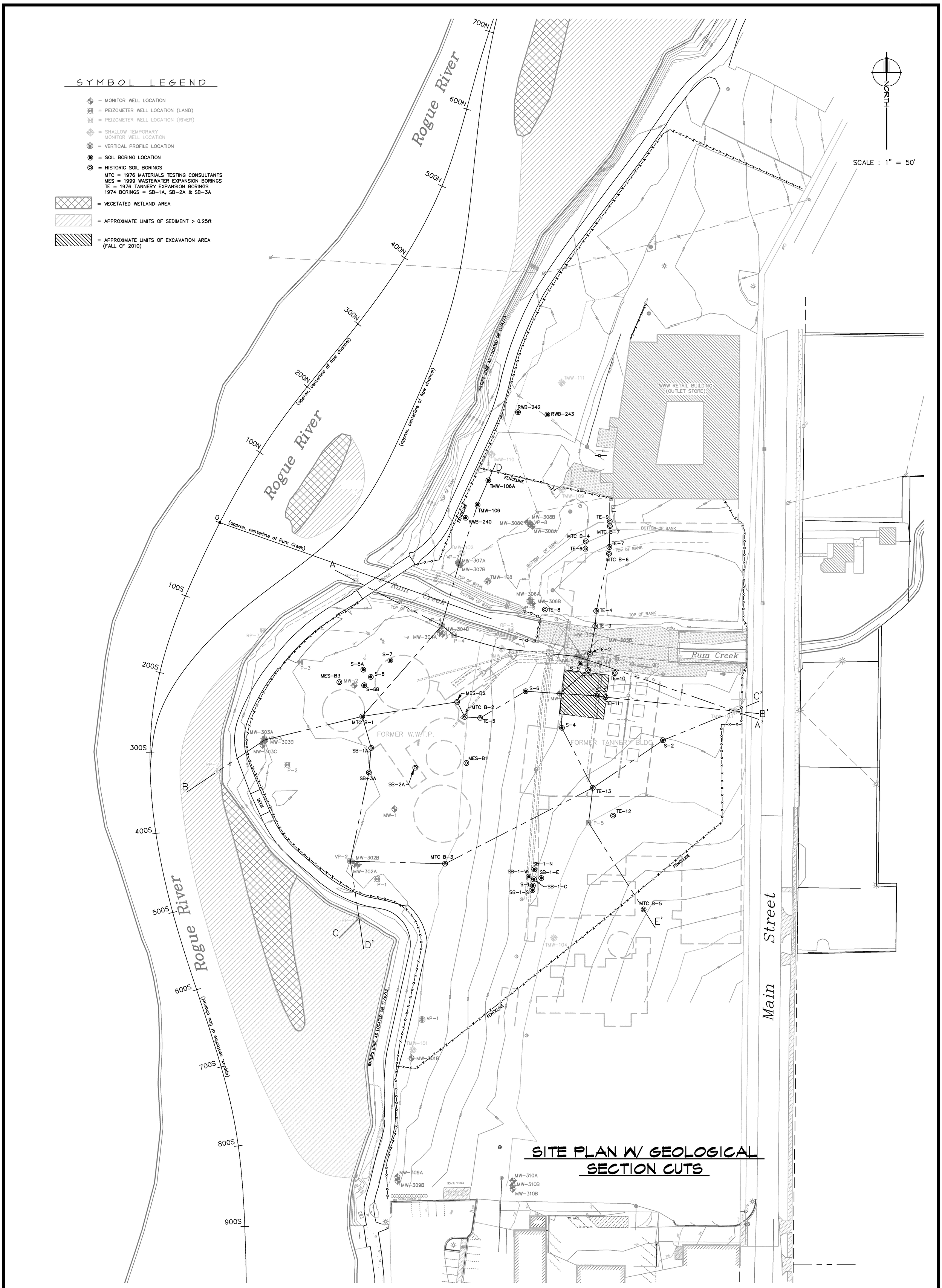
WOLVERINE WORLD WIDE
FORMER TANNERY - ROCKFORD, MICHIGAN
TANNERY CONCEPTUAL SITE MODEL

ROSE & WESTRA
A DIVISION OF GZA
Grand Rapids, Michigan
GEOTECHNICAL–ENVIRONMENTAL–ECOLOGICAL–WATER–CONSTRUCTION MANAGEMENT

PROJECT NO.
16.0062335.00

SHEET NO.
2 OF 4



PROJECT NO. 16.0062335.00

SHEET NO. 3 OF 4

ROSE & WESTRA
A DIVISION OF GZA
Grand Rapids, Michigan
GEOTECHNICAL-ENVIRONMENTAL-ECOLOGICAL-WATER-CONSTRUCTION MANAGEMENT

WOLVERINE WORLD WIDE
FORMER TANNERY - ROCKFORD, MICHIGAN
TANNERY CONCEPTUAL SITE MODEL

NO.	REVISIONS	BY	DATE

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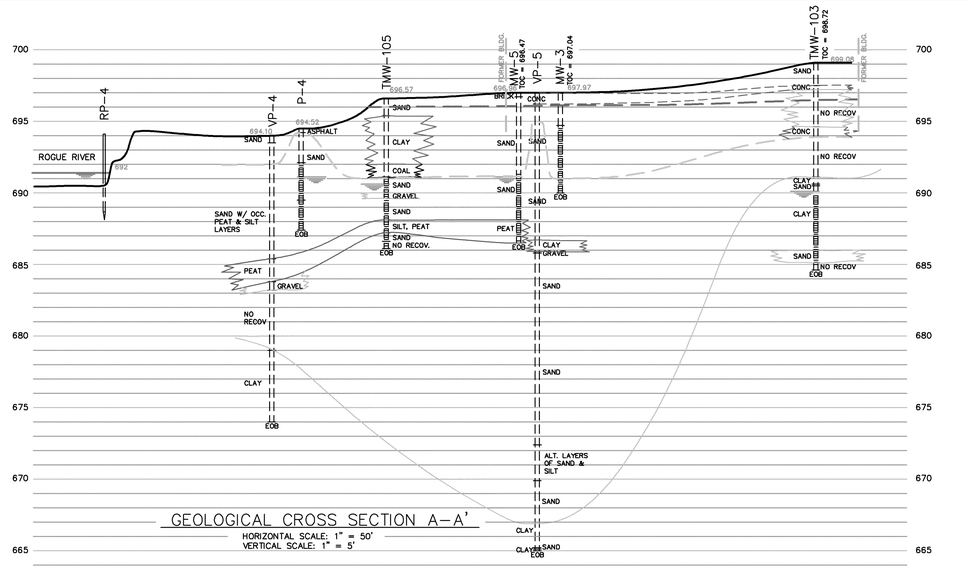
FILE NO.: 62335_CSM

DRAWN BY KJB

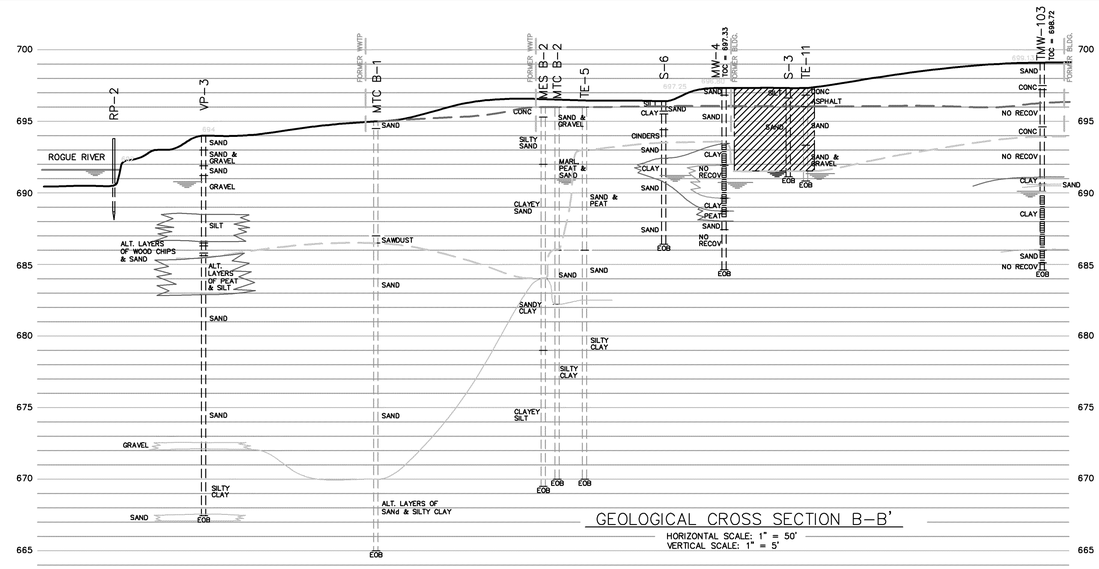
DESIGN BY JMW

DATE 11/27/17



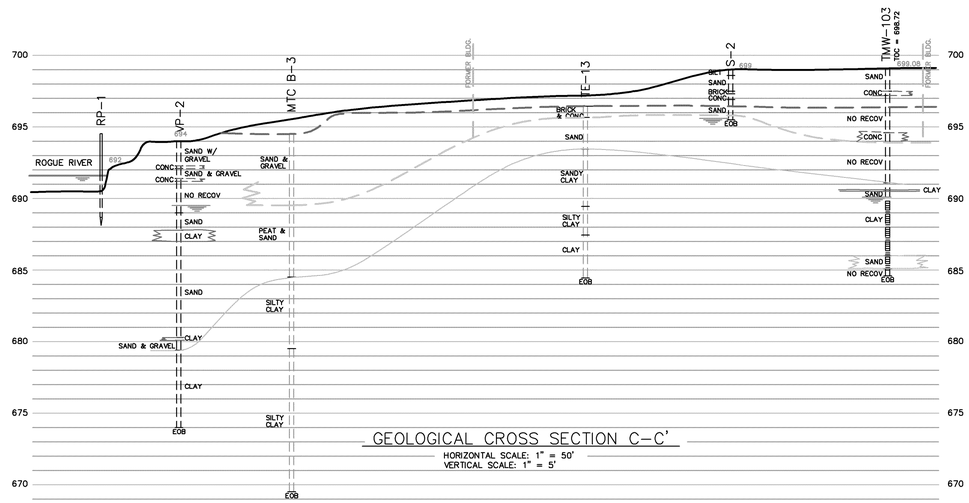
GEOLOGICAL CROSS SECTION A–A'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'



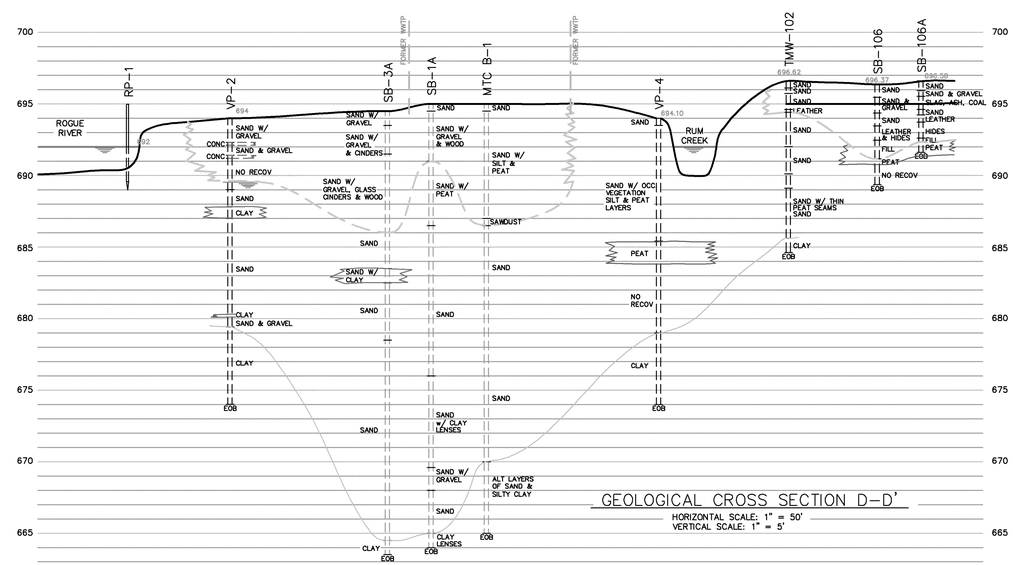
GEOLOGICAL CROSS SECTION B–B'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'



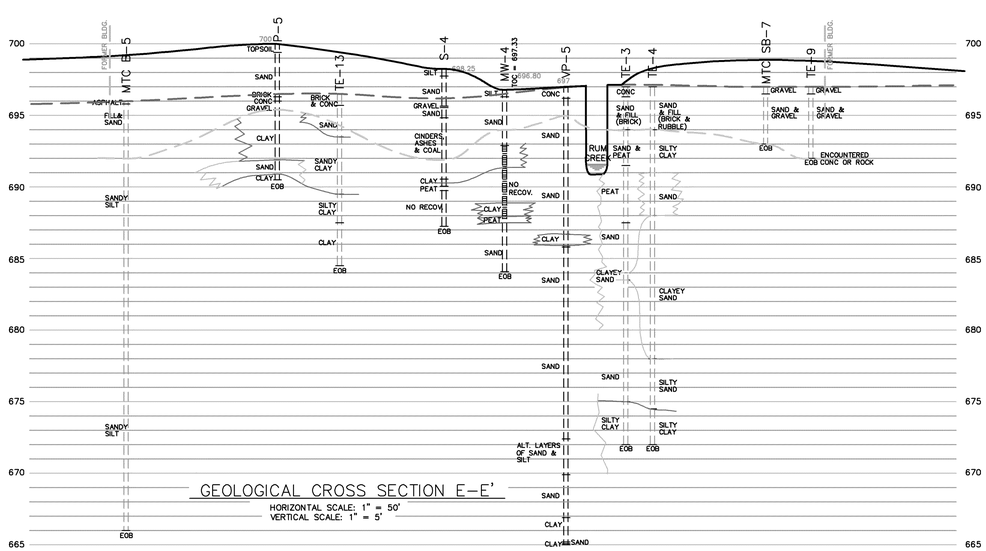
GEOLOGICAL CROSS SECTION C–C'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'



GEOLOGICAL CROSS SECTION D–D'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'



GEOLOGICAL CROSS SECTION E–E'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

LEGEND

= BOTTOM OF FILL (POST–TANNERY DEMOLITION)

= BOTTOM OF FILL (HISTORICAL)

DRAWN BY	DESIGN BY	DATE
KJB	JMW	11/27/17

FILE NO.: 62935_C9M

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WOLVERINE WORLD WIDE
FORMER TANNERY – ROCKFORD, MICHIGAN
TANNERY CONCEPTUAL SITE MODEL

ROSE & WESTRA
A DIVISION OF GZA
Grand Rapids, Michigan
GEOTECHNICAL–ENVIRONMENTAL–ECOLOGICAL–WATER–CONSTRUCTION MANAGEMENT

PROJECT NO.
16.0062335.00

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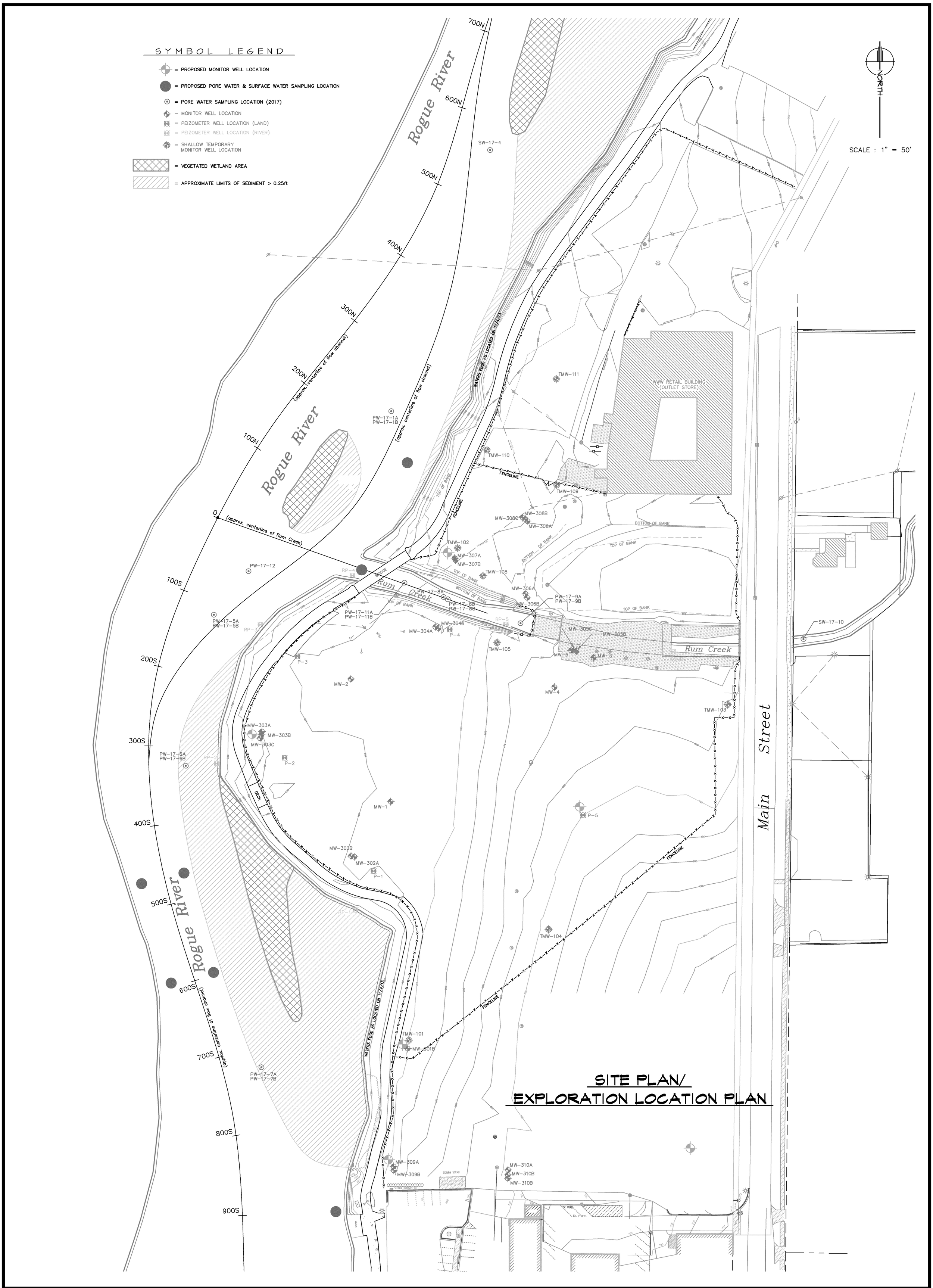
4 OF 4

Figure 1



1 OF 1
SHEET NO.

PROJECT NO. 16.0062335.00

ROSE & WESTRA
A DIVISION OF GZA
Grand Rapids, Michigan
GEOTECHNICAL-ENVIRONMENTAL-ECOLOGICAL-WATER-CONSTRUCTION MANAGEMENT

WOLVERINE WORLD WIDE
FORMER TANNERY - ROCKFORD, MICHIGAN
SITE INVESTIGATION - WORK PLAN

NO.	REVISIONS	BY	DATE

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

FILE NO.: 62335_SI_WP.dwg

DRAWN BY: KJB
DESIGN BY: JMW
DATE: 11/27/17