Location Restrictions Demonstrations

DTE Electric Company
Belle River Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4505 King Road
China Township, Michigan

October 2018

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Prepared For
DTE Electric Company

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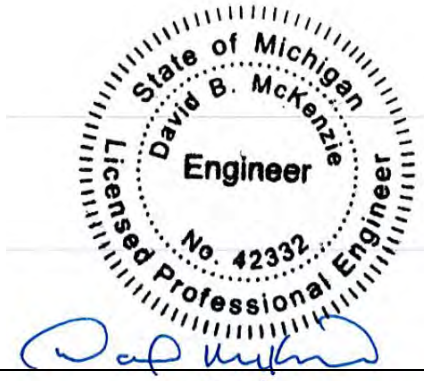
Table of Contents

List of Appendices

Certification

I, the undersigned Michigan Professional Engineer, hereby certify that I am familiar with the technical requirements of Title 40 Code of Federal Regulations Part 257 Subpart D (§257). I also certify that it is my professional opinion that, to the best of my knowledge, information, and belief, that the information in this demonstration is in accordance with current good and accepted engineering practice(s) and standard(s) and meets the requirements of §257.60 through §257.64.

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Michigan Licensed Professional Engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.



Seal/Date 10/15/18

David B McKenzie, P.E.

License No: 6201042332

Section 1
Background

The purpose of this document is to determine whether the Coal Combustion Residual (CCR) Bottom Ash Basins (BABs) at the Belle River Power Plant (BRPP) are in compliance with the location restrictions outlined in the Environmental Protection Agency's (EPA) final CCR rule [Title 40 Code of Federal Regulations Parts 257 and 261] Subpart D - "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" (§257.60 through §257.64, federal rule). The BABs are considered CCR surface impoundments according to the federal rule (§257.53).

This document includes information from a desktop study and well installation activities as well as engineering calculations to demonstrate that the BABs comply with placement above the uppermost aquifer criteria (§257.60), and location criteria with respect to wetlands (§257.61), fault areas (§257.62), seismic impact zones (§257.63), and unstable areas (§257.64).

Supporting documents are provided in appendices to this demonstration.

1.1 Facility and CCR Unit Information

The BRPP was constructed in the early 1980s, and is located in Section 13, Township 4 North, Range 16 East, at 4505 King Road, China Township in St. Clair County, Michigan. Prior to construction, the BRPP property was generally wooded and farmland. The property has been used continuously as a coal-fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984. The facility is generally constructed over a natural clay-rich soil base. The BABs have been in use with the BRPP since it began operation and have collected CCR bottom ash that is periodically cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The BRPP BABs are two adjacent physical sedimentation basins that are slightly raised CCR surface impoundments referred to as the North and South BABs, located north of the BRPP. These are considered one CCR unit. The BABs receive sluiced bottom ash and other process flow water from the power plant. Discharge water from each BAB flows over an outlet weir that gravity flows to a site storm water conveyance network of ditches and pipes, then flows into the diversion basin (DB) CCR unit, which is monitored as a separate CCR unit in accordance with the CCR Rule. The North and South BABs run roughly east to west and are both approximately 420 feet long by 120 feet wide with bottom elevations of approximately 580 feet relative to the North American Vertical Datum (NAVD) 1988, with outflow weir elevations of approximately 590.25 feet relative to the NAVD 1988.

1.2 Site Setting

A groundwater monitoring system has been established for the BRPP BABs CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of five monitoring wells that are screened in the uppermost aquifer. Well boring logs are included in Appendix A.

The BRPP BABs CCR unit is located approximately one-mile west of the St. Clair River. The BRPP BABs CCR unit is underlain by more than 130 feet of unconsolidated sediments, with the lower confining Bedford Shale generally encountered from 135 to 145 feet below ground surface (bgs). The BABs are incised into the clay to an elevation 580 ft MSL. In general, the BRPP BABs CCR unit is initially underlain by at least 90 feet to as much as 136 feet of laterally extensive low hydraulic conductivity silty clay-rich deposits. The depth to the top of the confined sand-rich uppermost aquifer encountered immediately beneath the silty clay-rich deposits varies up to 46 feet within the monitoring well network and rapidly thins to the south and east of the BABs and pinches out (e.g., no longer present) to the southeast in the vicinity of SB-16-01. Consequently, the uppermost aquifer is not laterally contiguous across the entire BRPP BABs CCR unit and is not present in the southeastern corner of the BABs.

The variability in the depth to the uppermost aquifer is a consequence of the heterogeneity of the glacial deposits and is driven by the lateral discontinuity of the sand outwash within the encapsulating fine-grained, silty-clay till that confines the uppermost aquifer. There is an apparent lack of interconnection and/or significant vertical variation between the uppermost aquifer sand unit(s) encountered across the BRPP BABs CCR unit as demonstrated by the extensive amount of time (months) it took for water levels in monitoring well MW-16-02 to reach equilibrium after well construction and development (TRC, 2017).

Given the horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the BRPP BABs CCR unit, the heterogeneity of the glacial deposits (with the top of the uppermost aquifer elevation across the BABs, where present varying up to 46 feet vertically), the no flow boundary where no sand or gravel is present in the southeastern portion of the BABs CCR unit area, and the apparent lack of hydraulic interconnectedness of the uppermost aquifer encountered at the BABs in some areas, it is not appropriate to infer horizontal flow direction or gradients across the BRPP BABs CCR unit.

Section 2
Location Restrictions

The location restrictions designated in the federal CCR rule are presented below with a corresponding demonstration to show compliance with each restriction. The location restrictions include placement above the uppermost aquifer, within wetlands, near fault areas, within seismic impact zones, and in unstable areas based on available geologic and geomorphologic information. Supporting information for the demonstrations is included in the appendices to this report.

2.1 §257.60 – Placement above the Uppermost Aquifer

The federal CCR rule requires that CCR units such as the BRPP BABs must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in the groundwater elevations (including the seasonal high water table). As stated in Section 1.2 (above), the BABs are incised into the clay to an approximate elevation of 580 ft MSL. The uppermost aquifer is the sand-rich unit found at an elevation of 453 to 498 ft MSL. The base of the BABs and the uppermost aquifer are separated by at least 82 ft of native, low permeability clay. Cross-sections showing the approximate pond bottom elevation for each BAB, and the depth to the uppermost aquifer are included in Appendix B.

Based on this demonstration, the base of each BAB is located greater than five feet above the upper limit of the uppermost aquifer, and there is not a hydraulic connection between the BABs and the underlying groundwater caused by normal fluctuation in groundwater level. Therefore, each BAB is in compliance with the requirements of §257.60.

2.2 §257.61 – Wetlands

The CCR location standards restrict existing and new CCR surface impoundments from being located in wetlands, as defined at 40 CFR 232.2 (40 CFR 257.61(a)). Wetlands are defined in 40 CFR 232.2 *Waters of the United States (3)(iv)* as, "…those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." TRC reviewed the National Wetland Inventory (NWI) Maps and Michigan Resource Information System (MIRIS) Land Cover Maps archived and available through Michigan Department of Natural Resources (MDNR) Michigan Resource Inventory Program (MRIP) to ascertain whether or not the BRPP BABs are located in wetlands.

As shown on the site map in Appendix C, soils at and in the vicinity of the site are designated primarily as wetland soils, most likely due to the proximity of the site to the St. Clair River. NWI (2005) recognizes one area located approximately 200 ft north of the BABs as a wetland. NWI also recognizes an area approximately 450 ft west of the BABs as a wetland. These areas are not immediately adjacent to the BABs, and therefore, there is no risk of impact to these areas from the BAB operations.

Based on TRC's review of wetland inventory resources and current site conditions, TRC is of the opinion that the BRPP BABs are not located in an area exhibiting wetland characteristics, and any continued operations at the BABs will have no potential to impact any wetlands near the CCR unit. TRC also concludes that, due to their use as NPDES treatment units, these basins are not wetlands, as defined in 40 CFR 232.2.

2.3 §257.62 – Fault Areas

The federal CCR rule requires that CCR units not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time (within the most recent 11,700 years) unless the owner or operator demonstrates that an alternative setback distance of less than 60 meters (200 feet) will not cause damage to the structural integrity of the CCR unit. As shown on the U.S. Quaternary Folds and Faults Database Map (USGS, Accessed 9/7/2018) in Appendix D, no faults have been mapped near the BRPP BABs.

Evidence of active faulting during the Holocene near the BRPP BABs is not supported by this determination; therefore, the existing BABs are in compliance with the requirements of §257.62.

2.4 §257.63 – Seismic Impact Zones

The federal CCR rule requires that CCR units not be located in seismic impact zones unless the owner or operator demonstrates that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The federal CCR rule defines a seismic impact zone as "an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitation pull (g), will exceed 0.10 g in 50 years."

To determine whether the BRPP BABs are located in a seismic impact zone, the USGS Earthquake Hazards Program was consulted to determine the earthquake hazard for the BRPP. The 2015 National Earthquake Hazards Reduction Program U.S. seismic design maps website (USGS 2015; Appendix E) indicates a mapped peak ground acceleration of 0.043 g for the BRPP BABs area. Using the default site adjustment factor results in a design peak ground acceleration of 0.068 g in 50 years. Since this calculation indicates that the design peak ground acceleration

value will not exceed 0.10 g in 50 years, the BRPP BABs are not located in a seismic impact zone, and therefore the BABs are in compliance with the requirements of §257.63.

2.5 §257.64 – Unstable Areas

The federal CCR rule requires that CCR units not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. Factors associated with soil conditions resulting in significant differential settlement, geologic or geomorphologic features, and human-made features or events must be evaluated to determine compliance. This demonstration was performed by reviewing geotechnical data, local geology and topography, and evaluating human-made features in the area of the BRPP BABs.

Geotechnical explorations performed at the BRPP BAB area identified clay with lenses of silt and sand. The soils occur above soft to very hard shale bedrock. These observations suggest that there are no unstable soil or unstable underlying bedrock proximal to the BABs.

Geological and geomorphological information was reviewed to determine potential unstable areas at the BRPP BABs. None of the geological or geomorphological information reviewed suggest the presence of unstable areas at or near the BABs.

Evidence of unstable areas due to soil conditions resulting in significant differential settling, geologic or geomorphologic features, or human-made features or events is not supported by this determination; therefore, the BRPP BABs are not located in an unstable area. The BABs are in compliance with the requirements of §257.64.

Section 3
Conclusions

Based on the evaluation provided in this demonstration, the BRPP BABs are in compliance with the location restrictions provided in §257.60 through §257.64 of the CCR rule. No additional action, justification, or demonstration is required to document compliance with the location restrictions provided in the CCR rule after this demonstration has been placed into the operating record, posted to the publicly-accessible website, and government notifications provided.

Section 4
References

United States Geological Survey (USGS). U.S. Quaternary Faults and Fold Database. USGS Geologic Hazards Science Center, Golden, CO Available online at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=db287853794f4555b8e93e42290e9716. Accessed [9/7/2018].

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TRC January 2018. Annual Groundwater Monitoring Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins Coal Combustion Residual Unit.

United States Fish and Wildlife Service. 2010. "Wetlands Mapper." National Wetlands Inventory. Available online at http://geohazards.usgs.gov/deaggint/2008/. Accessed [8/17/2018].

USGS. 2015. U.S. Seismic Design Maps: 2015 National Earthquake Hazards Reduction Program Provisions. Available Online at http://earthquake.usgs.gov/designmaps/beta/us/. Accessed [8/16/208].

Appendix A
Monitoring Well Boring Logs

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	2/29/16	2/29/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.17	591.30	120.0	6/4

Boring Location: Approximately 188 feet off road to the S, W of bottom ash basins.
N: 471155.70 E: 13625546.02

Personnel
Logged By - A. Knutson
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time
After Drilling: Date/Time 4/13/16 08:45 ▼ Depth (ft bgs) 14.52

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	60		0	**SILTY CLAY WITH GRAVEL** mostly clay, little to some silt, little fine to coarse gravel, few fine sand, low plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				CLAY mostly clay, trace fine to coarse gravel, high plasticity, brown (10YR 5/3), moist, stiff.				Original boring abandoned due to compromised screen. Redrilled and installed at survey location noted above within 10 feet of original location.
			5	Change to dark gray (10YR 4/1), very stiff at 5.0 feet.				
				Change to soft at 8.0 feet.				
2 CS	50		10	Change to no gravel, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very soft at 10.0 feet.				
			15	▼				
3 CS	100		20	Change to dark gray (10YR 4/1) at 20.0 feet.	CL			
			25					
4 CS	100		30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: Chris Scieszka

Firm: TRC Environmental Corporation
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Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, soft.				
6 ST	100		50					
7 CS	100		55					
8 CS	80		60					
9 CS	100		65		CL			
10 CS	100		70					
11 CS	100		75					
			80					
			85					
			90	**SAND** mostly fine sand, dark gray (10YR 4/1), saturated.	SP			
			95					
			100	End of boring at 100.0 feet below ground surface.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/14/16	3/15/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	586.27	588.94	100.0	6/4

Boring Location: 325 feet W of haul road, 5 feet N of road, N of bottom ash basins.

N: 471409.06 E: 13625991.78

Personnel
Logged By - A. Knutson
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time
After Drilling: Date/Time 4/13/16 09:24 Depth (ft bgs) 16.07

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	80		5	**CLAY** mostly clay, few silt, few coarse gravel, medium plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				Change to no gravel at 7.0 feet.				
2 CS	80		10	Change to high plasticity, dark gray (10YR 4/1), moist, very soft at 10.0 feet.				
			15 ▼					
3 CS	100		20		CL			
			25					
4 CS	90		30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature:

Checked By: C. Scieszka

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WELL CONSTRUCTION LOG

WELL NO. MW-16-02

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 CS	100		50	**SILTY CLAY** mostly clay, little to some silt, few fine sand, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1), very soft.	CL-ML			
7 CS	50		55					
			60					
8 CS	100		65					
			70					
9 CS	100		75					
			80					
10 CS	100		85					
			90	**CLAYEY SILT** mostly silt, some clay, few fine sand, few coarse gravel, low plasticity, dark gray (10YR 4/1), moist, very soft.	ML-CL			
			95	**SAND** mostly fine to coarse sand, dark gray (10YR 4/1), saturated. Change to fine sand at 96.0 feet.	SW			
			100	End of boring at 100.0 feet below ground surface.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	5/25/16	5/31/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.03	590.66	150.0	6/4

Boring Location: Approximately 100 feet W of haul road, N of bottom ash basins.

N: 471391.78 E: 13626202.49

Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time — Depth (ft bgs)
After Drilling: Date/Time 6/8/16 14:30 — Depth (ft bgs) 12.82

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	100		0	**TOPSOIL**				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				SILTY CLAY mostly clay, some silt, few fine to medium sand, trace gravel, low to medium plasticity, dark gray (10YR 4/1) with trace orange mottling, moist, medium stiff to stiff.	CL-ML			
			5					
			10	Change to gray (10YR 5/1) at 10.5 feet.				
2 CS	100			**CLAY** mostly clay, few silt, trace to few fine to medium sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.				
			15					
			20					
3 CS	100		25	Change to trace to few fine to coarse sand at 25.0 feet.	CL			
			30					
4 CS	100		35					
			40	Change to trace fine to coarse sand at 41.5 feet.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature:

Checked By: M. Powers

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SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, trace fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.				
			50					
6 CS	90		55		CL			
			60	Change to stiff at 60.5 feet. Change to medium stiff at 62.0 feet.				
7 CS	100		65	**SANDY CLAY** mostly clay, little to some sand, few silt, gray (10YR 5/1), moist, soft to medium stiff.	CL			
				CLAY mostly clay, few silt, few fine to coarse sand, gray (10YR 5/1), moist, stiff. Change to coal fragments present at 67.5 feet. Change to no coal fragments present at 68.0 feet.				
			70		CL			
8 CS	90		75	1-inch thick interval of silty fine to coarse sand at 75.0 feet.				
			80	**SANDY SILT** mostly silt, little to some fine to medium sand, gray (10YR 5/1), moist, medium dense.	ML			
				CLAY mostly clay, few silt, few fine to coarse sand, low to medium plasticity, gray (10YR 5/1), moist, stiff.				
9 CS	100		85					
			90	Change to medium soft at 90.0 feet.	CL			
10 CS	100		95	Change to few fine gravel from 94.0 to 95.0 feet. Change to trace fine gravel, medium stiff to stiff at 95.0 feet.				
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY** mostly clay, few silt, few fine to coarse sand, trace fine gravel, medium plasticity, gray (10YR 5/1), medium stiff to stiff.				
			110	Change to low plasticity, soft to medium stiff at 111.0 feet.				
12 CS	100		115		CL			
			120					
13 CS	100		125					
				SANDY CLAY mostly clay, little to some fine to medium sand, few silt, trace to few fine gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff.	CL			
			130	**SILTY SAND** mostly fine to medium sand, little silt, gray (10YR 5/1), moist, loose.	SM			
14 CS	90		135	**SAND** mostly fine to medium sand, trace silt, gray (10YR 5/1), moist, loose.	SP			
				SILTY SAND mostly fine to medium sand, little silt, few clay, gray (10YR 5/1), moist, loose.	SM			
			140	**SAND** mostly fine to coarse sand, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.				
15 CS	100		145		SW			
				SILT mostly silt, few clay, trace coarse sand to fine gravel, gray (10YR 5/1), dry to moist, dense to very dense.	ML			
			150	**SHALE** weathered shale bedrock, dark gray.				
				End of boring at 150 feet below ground surface.				
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/7/16	3/8/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	587.50	590.51	130.0	6/4

Boring Location: 200 feet from W corner of road, S of bottom ash basins.	Personnel	Drilling Equipment:
N: 470893.74 E: 13625876.34	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time — Depth (ft bgs) After Drilling: Date/Time 4/13/16 09:31 — Depth (ft bgs) 13.91

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	80		5	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very stiff. Change to no gravel at 1.0 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	Change to stiff at 10.5 feet.				
3 CS	100		15	Change to dark gray (10YR 4/1), very soft at 12.0 feet. ▼				
4 CS	100		20					
			25					
			30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

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WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), very soft.				
			50					
6 CS	100		55		CL			
			60	Change to few coarse gravel at 60.0 feet.				
7 CS	100		65					
			70					
8 CS	100		75	**SILTY CLAY** mostly clay, little to some silt, trace fine sand, medium plasticity, dark gray (10YR 4/1), very stiff.	CL-ML			
				SILT mostly silt, trace to few fine sand, non plastic, dark gray (10YR 4/1), saturated, stiff.	ML			
			80	**SAND** mostly fine sand, few medium to coarse sand, dark gray (10YR 4/1), moist.	SP			
				SANDY CLAY mostly clay, some fine sand, high plasticity, dark gray (10YR 4/1), moist.	CL			
9 CS	100		85	**SILTY CLAY** mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.	CL-ML			
				CLAYEY SILT mostly silt, some clay, low plasticity, dark gray (10YR 4/1), stiff.	ML-CL			
			90	**SILTY CLAY** mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.				
10 CS	100		95		CL-ML			
			100	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			
			110					
12 CS	100		115	**SILT** mostly silt, few fine sand, nonplastic, dark gray (10YR 4/1), saturated, stiff.	ML			
			120	**SAND** mostly fine sand, dark gray (10YR 4/1), saturated.				
13 CS	100		125		SP			
			130	End of boring at 130.0 feet below ground surface.				
			135					
			140					
			145					
			150					
			155					

WELL CONSTRUCTION LOG

WELL NO. MW-16-05

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/3/16	3/4/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.32	590.82	150.0	6

Boring Location: S end of haul road, W of diversion basin.	Personnel	Drilling Equipment:
N: 470378.15 E: 13626342.79	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time After Drilling: Date/Time 4/13/16 09:55 ▼ Depth (ft bgs) 14.37

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	80		0	**CLAY WITH GRAVEL** mostly clay, few to some coarse gravel, high plasticity, dark grayish brown (10YR 4/2), moist, very stiff.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			5	**CLAY** mostly clay, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, hard. Change to no gravel, very stiff at 4.0 feet.				
2 CS	100		10	Change to dark gray (10YR 4/1), very soft at 10.0 feet.				
			15	▼				
3 CS	100		20		CL			
			25	Change to medium stiff at 26.0 feet. Change to very soft at 28.0 feet.				
4 CS	100		30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Firm: TRC Environmental Corporation 734.971.7080
1540 Eisenhower Place Ann Arbor, Michigan Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
				SILTY CLAY mostly clay, little to some silt, medium plasticity, dark gray (10YR 4/1), very soft.	CL-ML			
6 ST	100		50	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.				
7 CS	100		55					
			60	Change to few fine to coarse gravel at 60.0 feet.	CL			
8 CS	100		65	Change to medium stiff at 65.0 feet.				
				Change to stiff at 67.5 feet.				
			70	**SILTY CLAY** mostly clay, some silt, few fine to coarse gravel, high plasticity, very dark gray (10YR 3/1), very stiff.				
9 CS	100		75	Change to low plasticity, black (10YR 2/1), hard at 77.0 feet.				
			80		CL-ML			
10 CS	60		85	Change to few to little fine sand at 85.5 feet.				
			90	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.				
11 CS	100			Change to medium stiff at 93.5 feet.				
			95		CL			
				Change to soft at 97.5 feet.				
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-05

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
12 CS	100		105	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL			
13 CS	100		110					
14 CS	100		115					
15 CS	100		120					
16 CS	90		125					
			130					
			135	**CLAYEY SILT** mostly silt, some clay, medium plasticity, dark gray (10YR 4/1), wet, medium stiff.	ML-CL			
			140	**SHALE** dark gray (10YR 4/1), dry.				
			145					
			150	End of boring at 150.0 feet below ground surface.				
			155					

WELL CONSTRUCTION LOG

WELL NO. MW-16-06

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/10/16	3/11/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.98	593.21	140.0	6

Boring Location: 123 feet S of road connecting to haul road, E of diversion basin.

N: 470439.03 E: 13626796.04

Personnel
Logged By - A. Knutson
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time
After Drilling: Date/Time 4/13/16 10:01 Depth (ft bgs) 14.45

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	50		5	**GRAVEL WITH SAND** mostly gravel, some fine to coarse sand, brown (10YR 5/3), moist, dense. **CLAY** mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	Change to few coarse gravel at 10.0 feet. Change to dark gray (10YR 4/1), stiff at 12.0 feet. Change to very soft at 13.0 feet.				
3 CS	100		15					
4 CS	100		20		CL			
			25					
			30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature:

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-06

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.				
			50					
6 CS	100		55		CL			
			60					
7 CS	100		65					
			70	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
				SAND mostly fine sand, few coarse sand, dark gray (10YR 4/1), moist.	SP			
8 CS	100		75	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.				
			80		CL-ML			
9 CS	80		85					
			90	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.				
10 CS	70		95		CL			
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-06

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.				
12 CS	100		110		CL			
13 CS	100		115					
14 CS	100		120					
			125	**SILTY CLAY** mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
			130					
			135	**SILT** mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
				SHALE dark gray (10YR 4/1), hard, brittle.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

WELL CONSTRUCTION LOG

WELL NO. MW-16-07

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/8/16	3/9/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.89	592.58	140.0	6

Boring Location: 326 feet S of road connecting to haul road, E of diversion basin.	Personnel	Drilling Equipment:
N: 470233.47 E: 13626858.79	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time After Drilling: Date/Time 4/13/16 11:56 ▼ Depth (ft bgs) 14.13

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	60		5	**CLAY** mostly clay, few coarse gravel, high plasticity, brown (10YR 5/3) mottled with dark gray (10YR 4/1), very stiff. Change to dark gray (10YR 4/1) mottled with brown (10YR 5/3) at 5.0 feet.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10 15	Change to dark gray (10YR 4/1) at 11.0 feet. ▼ Change to moist, very soft at 13.0 feet.				
3 CS	100		20 25		CL			
4 CS	100		30 35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Checked By: C. Scieszka

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
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WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-07

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 ST	100		50					
7 CS	100		55	**SILTY CLAY** mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
8 CS	100		60					
			65	**CLAYEY SILT** mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML-CL			
				SAND mostly fine to coarse sand, dark gray (10YR 4/1), moist, loose.	SW			
				CLAYEY SILT mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML-CL			
9 CS	100		70	**SILTY CLAY** mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft. Change to few coarse gravel at 70.0 feet.				
			75					
10 CS	100		80					
			85		CL-ML			
11 CS	100		90					
			95					
			100					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-07

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
12 CS	100		105	**SILTY CLAY** mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
13 CS	80		110					
14 CS	100		115					
15 CS	100		120					
			125					
			130	**SILT** mostly silt, no plasticity, dark gray (10YR 4/1), saturated, loose.	ML			
			135	**SHALE** dark gray (10YR 4/1), brittle, hard.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-08

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/9/16	3/10/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.31	591.88	140.0	6

Boring Location: 566.6 feet S of road connecting to haul road, E of diversion basin.

N: 470002.90 E: 13626846.85

Personnel
Logged By - A. Knutson
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time
After Drilling: Date/Time 4/13/16 12:00 ▼ Depth (ft bgs) 13.19

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	50		5	**CLAY WITH GRAVEL** mostly clay, little coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff. Change to dark gray (10YR 4/1), very soft at 10.0 feet. ▼				
3 CS	100		15					
4 CS	100		20		CL			
			25					
			30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: Chris Scieszka

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
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Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 CS	100		50					
7 CS	80		55					
8 CS	100		60					
9 CS	100		65					
10 CS	60		70	**SILTY CLAY** mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
			75					
			80					
			85					
			90					
			95					
			100					

WELL CONSTRUCTION LOG

WELL NO. MW-16-08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**SILTY CLAY** mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
				Change to few fine sand at 105.5 feet.				
			110	Change to no sand at 110.0 feet.				
12 CS	100		115					
13 CS	100		120					
			125					
14 CS	100		130					
				SILT mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
			135	**SHALE** dark gray (10YR 4/1), brittle, hard.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

WELL CONSTRUCTION LOG

WELL NO. MW-16-09

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/1/16	6/1/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.28	590.80	150.0	6

Boring Location: E of bottom ash basins, E of haul road. N: 471284.45 E: 13626365.84	Personnel: Logged By - J. Reed; Driller - A. Goldsmith	Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations: While Drilling: Date/Time; After Drilling: Date/Time 6/9/16 15:13
China Township	St. Clair	MI	Depth (ft bgs); Depth (ft bgs) 14.36

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	75		0	**TOPSOIL**				
				SILTY CLAY mostly clay, little to some silt, few fine to coarse sand, trace to few fine gravel, low plasticity, dark grayish brown (10YR 4/2), moist, stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			5	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft.				
2 CS	85		10					
			15	▼				
3 CS	100		20		CL			
			25					
4 CS	100		30	Change to trace to few fine gravel at 30.0 feet.				
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Firm: TRC Environmental Corporation, 1540 Eisenhower Place Ann Arbor, Michigan 734.971.7080 Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			45	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, soft.	CL			
5 CS	100		50	Change to soft to medium stiff at 50.0 feet.				
			55					
			60					
			65					
6 CS	100		70	Change to soft at 70.0 feet.				
			75					
			80	Change to medium stiff to stiff at 80.0 feet.				
			85	Change to stiff at 85.0 feet.				
7 CS	100		90					
			95					
			100					

WELL CONSTRUCTION LOG

WELL NO. MW-16-09

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
8 CS	75		105	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, stiff. Change to medium stiff at 105.0 feet.	CL			
9 CS	80		110					
			115					
			120					
10 CS	100		125					
			130					
			135	**SAND** mostly fine sand, trace silt, dark gray (10YR 4/1), moist, loose.	SP			
			140	**SAND WITH GRAVEL** mostly fine to coarse sand, little to some fine to medium gravel, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.	SW			
11 CS	80		145	**SHALE** weathered, gray (10YR 5/1), brittle.				
			150	End of boring at 150.0 feet below ground surface.				
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-10

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/2/16	6/3/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.25	592.26	150.0	6

Boring Location: S end of haul road, W/NW of diversion basin.

N: 470532.54 E: 13626417.00

Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village:	County:	State:
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time — Depth (ft bgs)
After Drilling: Date/Time 6/9/16 07:45 — Depth (ft bgs) 15.30

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	50		0	**TOPSOIL**				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				CLAY mostly clay, few silt, trace to few fine to coarse sand, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.				
			5					
			10	Change to gray (10YR 5/1) at 11.0 feet. Change to soft to medium stiff at 12.0 feet.				
2 CS	90		15 ▼					
			20		CL			
3 CS	95		25	Change to soft at 25.0 feet.				
			30	Change to few fine to coarse sand, medium stiff at 30.0 feet. Change to dark gray (10YR 4/1) at 32.0 feet.				
4 CS	100		35	Change to soft at 35.0 feet.				
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: M. Powers

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, trace to few fine to coarse sand, dark gray (10YR 4/1), moist, soft.				
			50					
6 CS	100		55		CL			
			60					
7 CS	100		65					
			70	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, trace gravel, dark gray (10YR 4/1), moist, very stiff.				
8 CS	100		75	Change to few to little medium to coarse sand, low to medium plasticity, stiff at 75.0 feet.	CL			
			80	**CLAYEY SAND** mostly fine to coarse sand, some clay, dark grayish brown (10YR 4/2), moist, medium dense.	SC			
9 CS	100		85	**SAND** mostly fine to medium sand, dark grayish brown (10YR 4/2), moist, loose.	SP			
			90	**SANDY CLAY** mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.				
10 CS	100		95		CL			
			100	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			

WELL CONSTRUCTION LOG

WELL NO. MW-16-10

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		105	**CLAY WITH SAND** mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			
			110	**SANDY CLAY** mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff.	CL			
12 CS	100			**SAND** mostly medium to coarse sand, dark gray (10YR 4/1), moist, loose.	SP			
			115	**CLAY** mostly clay, little sand, few to little silt, dark gray (10YR 4/1), moist, stiff.				
13 CS	95		120					
			125					
14 CS	95		130		CL			
			135					
15 CS	50		140					
			145	**GRAVELLY SILT** mostly silt, some fine to coarse gravel, few clay, few sand, low to medium plasticity, dark gray (10YR 4/1), moist, soft.	ML			
				SILTY CLAY hard, dark gray (10YR 4/1), hardpan, brittle.	CL-ML			
			150	**SHALE** dark gray.				
				End of boring at 150.0 feet below ground surface.				
			155					
			160					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

WELL CONSTRUCTION LOG

WELL NO. MW-16-11

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	6/3/16	6/6/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.03	591.54	150.0	6

Boring Location: S of haul road, W of diversion basin.	Personnel	Drilling Equipment:
N: 470251.34 E: 13626438.92	Logged By - J. Reed Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time After Drilling: Date/Time 6/21/16 07:45 ▼ Depth (ft bgs) 14.47

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			0	**TOPSOIL**				
1 CS	50		5	**CLAY** mostly clay, few silt, trace to few sand, few gravel, low to medium plasticity, dark grayish brown (10YR 4/2), moist, stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
				Change to trace gravel at 8.0 feet.				
2 CS	70		10	Change to gray (10YR 5/1) at 12.0 feet.				
			15	Change to no gravel at 13.0 feet. ▼				
3 CS	90		20	Change to medium stiff at 21.0 feet.	CL			
			25					
4 CS	90		30					
			35	Change to soft to medium stiff at 34.5 feet.				
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: [signature]

Checked By: M. Powers

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-11

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	90		45	**CLAY** mostly clay, few silt, trace to few sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.				
				Change to medium stiff at 49.0 feet.				
6 CS	100		50					
			55					
			60	Change to soft at 60.0 feet.				
7 CS	100		65					
			70	Change to trace gravel, soft to medium stiff at 70.0 feet.	CL			
8 CS	100		75	Change to medium stiff at 75.0 feet.				
			80					
9 CS	90		85					
			90					
10 CS	90		95	Change to medium stiff to stiff at 95.0 feet.				
			100					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-11

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	85		105	**CLAY** mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff to stiff.				
			110	Change to medium stiff at 110.0 feet.				
12 CS	80		115					
			120		CL			
13 CS	85		125					
			130					
14 CS	90		135					
			140	**SANDY CLAY** mostly clay, some fine sand, few silt, dark gray (10YR 4/1), moist.	CL			
				CLAY mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff.	CL			
15 CS	90		145	**SHALE** dark gray.				
			150	End of boring 150.0 feet below ground surface.				
			155					

WELL CONSTRUCTION LOG

WELL NO. MW-16-11A

Facility/Project Name	Date Drilling Started	Date Drilling Completed	Project Number
DTE Electric Company Belle River Power Plant	5/11/17	5/12/17	231828.0003

Drilling Firm	Drilling Method	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	589.5	591.66	142.0	6

Boring Location: North of fuel oil tank number 2, between berm and fence.

Personnel
Logged By - J. Krenz
Driller - A. Goldsmith

Drilling Equipment: TSi 150cc

Civil Town/City/or Village	County	State
China Township	St. Clair	MI

Water Level Observations:
While Drilling: Date/Time
After Drilling: Date/Time 5/15/17 08:38 ▼ Depth (ft bgs) 17.79

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	90		0	**CLAY** mostly clay, trace gravel, medium plasticity, dark grayish brown (10YR 4/2), mottled with dark yellowish brown (10YR 4/6), medium stiff, moist, plant roots to 0.5 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	60		10					
3 CS	70		20	▼ Change to high plasticity, gray (10YR 5/1), soft at 19.0 feet.				
4 CS	70		30					
5 CS	100		40					
6 CS	100		50					
7			60					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 8/21/17

Signature: Jarl Krenz Firm: TRC Environmental Fax

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-11A

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
CS	100		70	**CLAY** mostly clay, trace fine to medium gravel, high plasticity, gray (10YR 5/1), medium stiff, moist.				
8 CS	100			Change to few fine to coarse gravel at 70.0 feet.				
9 CS	90		80	Change to trace fine sand at 80.0 feet.				
10 CS	70		90					
11 CS	100		100		CL			
12 CS	100		110					
13 CS	100		120	Change to trace medium to coarse gravel at 126.0 feet.				
14 CS	60		130	**SILT** mostly silt, trace clay, dark gray (10YR 4/1), dense, saturated.	ML			
15 CS	100		140	**SILTY CLAY** mostly clay, some silt, few to little fine to coarse gravel, medium to low plasticity, dark gray (10YR 4/1), moist, medium stiff, inclusions of shale bedrock.	CL-ML			
				BEDROCK shale, weathered, gray (10YR 4/1).				
			150	End of boring at 142.0 feet below ground surface.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 8/21/17

SOIL BORING LOG

BORING NO. SB-16-01

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE Electric Company Belle River Power Plant	3/1/16	3/1/16	231828.0003

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	588.69	---	150.0	6

Boring Location: Corner of E connecting road off haul road, E of bottom ash basins.	Personnel	Drilling Equipment:
N: 471096.38 E: 13626276.67	Logged By - A. Knutson Driller - A. Goldsmith	TSi 150cc

Civil Town/City/or Village:	County:	State:	Water Level Observations:
China Township	St. Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time Depth (ft bgs)

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
1 CS	50		5	**CLAY WITH GRAVEL** mostly clay, little fine to coarse gravel, few fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff. **CLAY** mostly clay, trace fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff.	CL		Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to total depth.
2 CS	100		10	Change to stiff at 10.0 feet.			
			15	Change to no sand, dark gray (10YR 4/1), very soft at 13.0 feet.			
3 CS	100		20		CL		
			25				
4 CS	100		30				
			35				
			40				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

Signature: _____

Checked By: M. Powers

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
5 CS	100		45	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.			
6 ST	100		50		CL		
7 CS	100		55				
				CLAY WITH SAND mostly clay, little fine to coarse sand, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
			60	**CLAY** mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
8 CS	100		65	**SANDY SILT** mostly silt, little to some fine to coarse sand, few clay, low plasticity, dark gray (10YR 4/1), moist, stiff.	ML		
			70	**CLAY** mostly clay, few fine to coarse gravel, dark gray (10YR 4/1), moist, medium stiff.			
9 CS	100		75	Change to no gravel, soft at 72.5 feet.			
			80	Change to few coarse gravel at 80.0 feet.			
10 CS	100		85		CL		
11 CS	100		90				
			95				
			100				

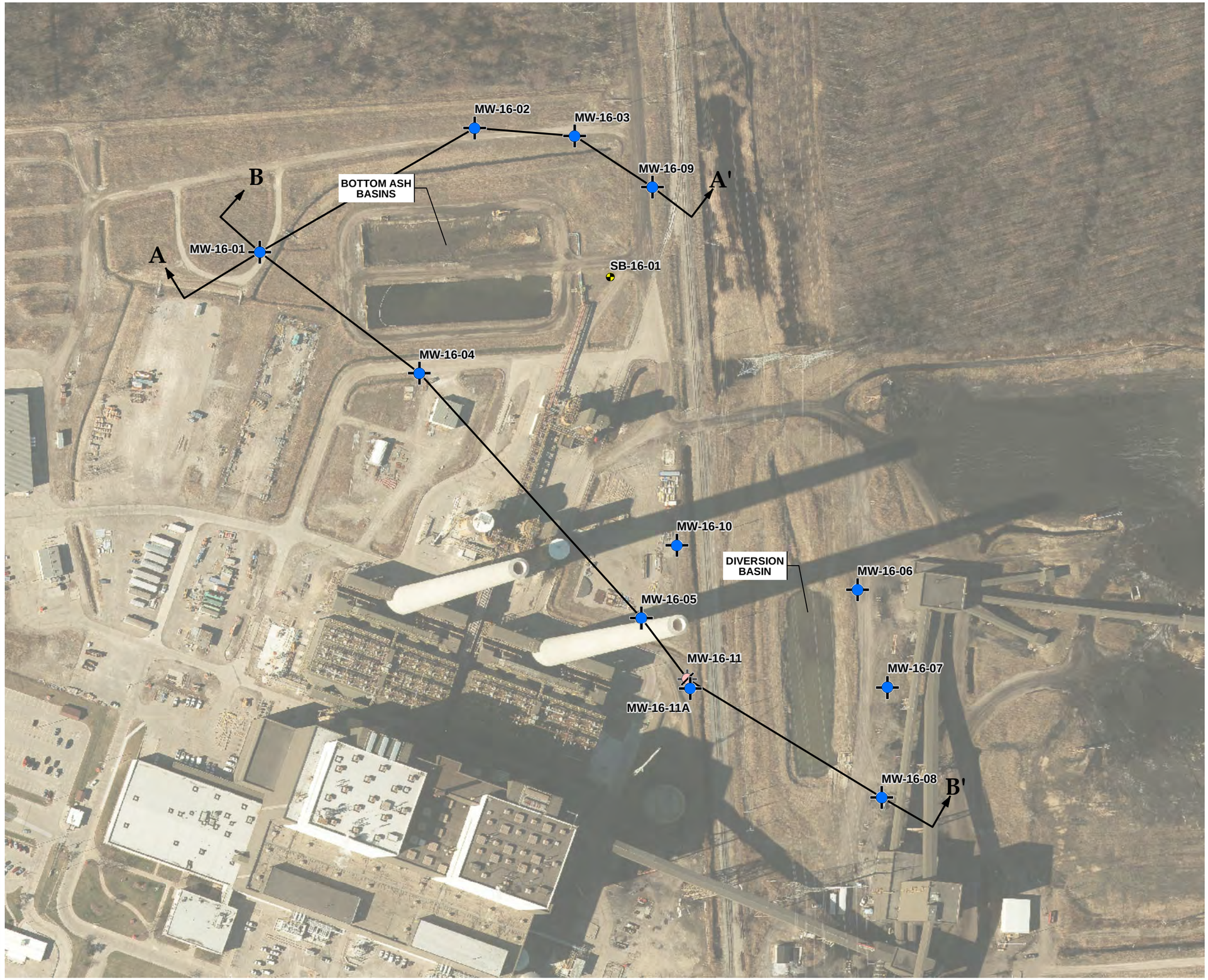
SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC_CORP.GDT 7/14/16

SOIL BORING LOG

BORING NO. SB-16-01

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
12 CS	100		105	**CLAY** mostly clay, few coarse gravel, dark gray (10YR 4/1), moist, soft.	CL		
13 CS	100		110				
14 CS	100		115				
15 CS	100		120				
16 CS	100		125				
			130				
			135	**SILT** mostly silt, few fine sand, non plastic, dark gray (10YR 4/1), moist.	ML		
			140				
			145	**SHALE** dark gray (10YR 4/1), dry.			
			150	End of boring at 150.0 feet below ground surface.			
			155				

Appendix B
Cross Sections



LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:
CROSS SECTION LOCATOR MAP

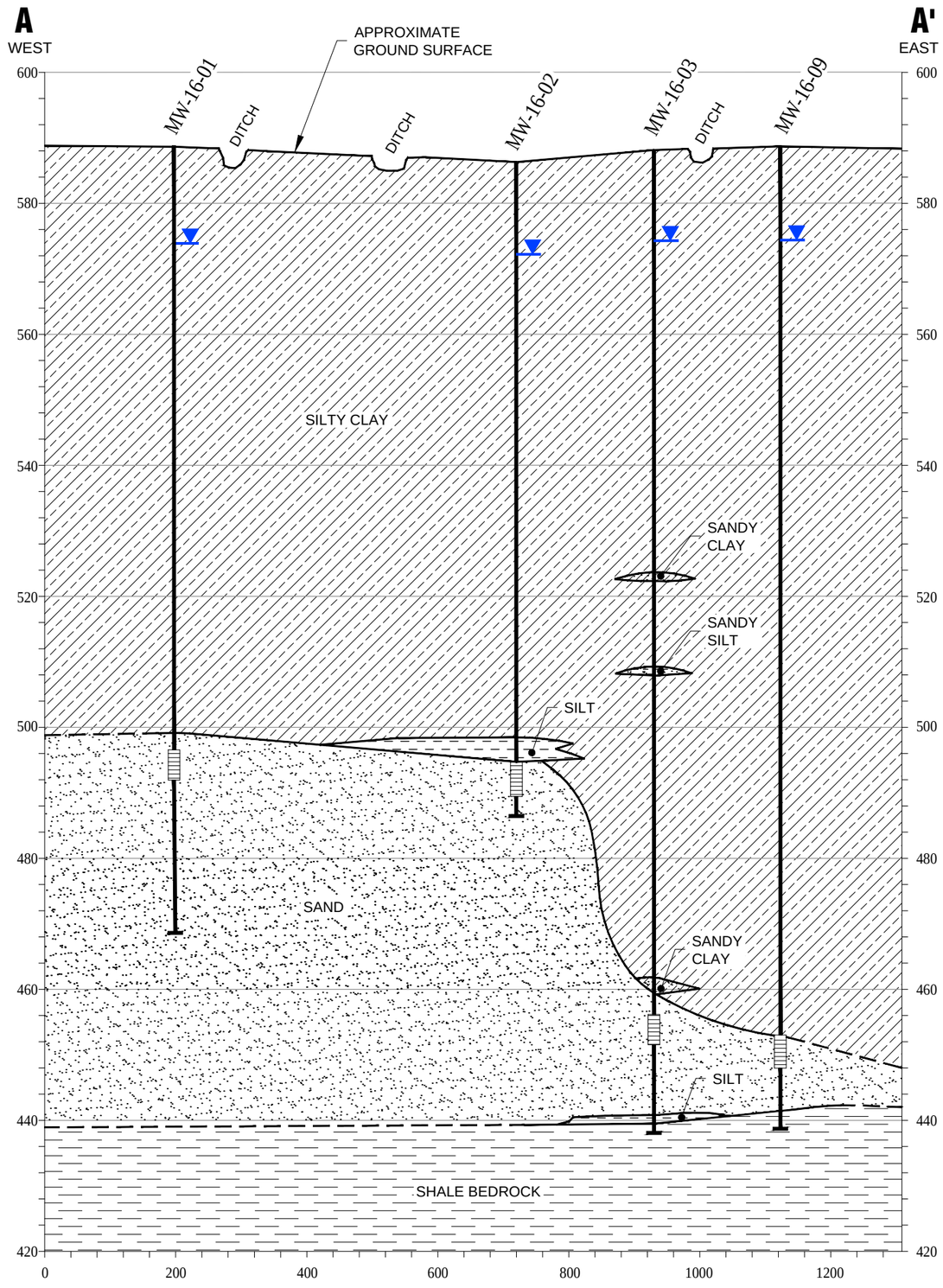
DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0003
CHECKED BY:	C SCIESZKA		
APPROVED BY:	V BUENING		**FIGURE B-1**
DATE:	SEPTEMBER 2017		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trcsolutions.com

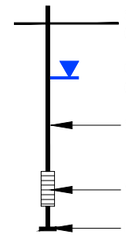
FILE NO.: 265996-0003-011.mxd

TRC - GIS
Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0
Plot Date: 9/6/2017, 15:16:32 PM by JPAPEZ -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0003-011.mxd

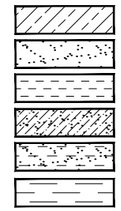
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

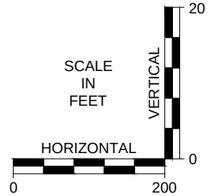


LEGEND



Lithology Key





PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0003.01
CHECKED BY:	S.HOLMSTROM		
APPROVED BY:	V.BUENING		**FIGURE B-2**
DATE:	SEPTEMBER 2017		

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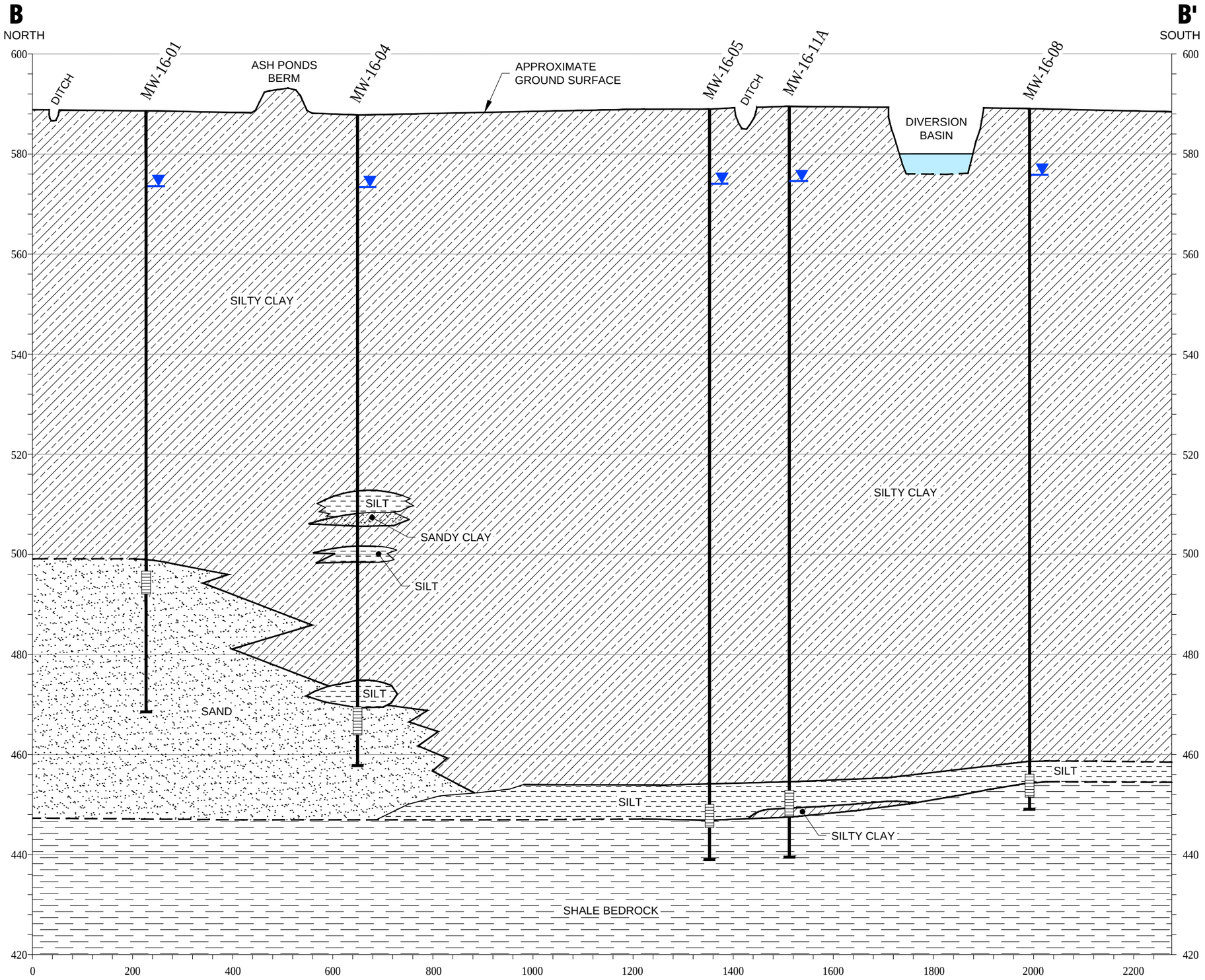
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 265996.0003.01.04-05.dwg

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



LEGEND

- STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

Lithology Key

- SILTY CLAY
- SAND
- SILT
- SANDY CLAY
- SHALE BEDROCK

SCALE IN FEET
VERTICAL: 20 to 0
HORIZONTAL: 0 to 200

PROJECT:
DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION B-B'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0003
CHECKED BY:	S.HOLMSTROM		
APPROVED BY:	V.BUENING		**FIGURE B-3**
DATE:	SEPTEMBER 2017		

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Phone: 734.971.7080
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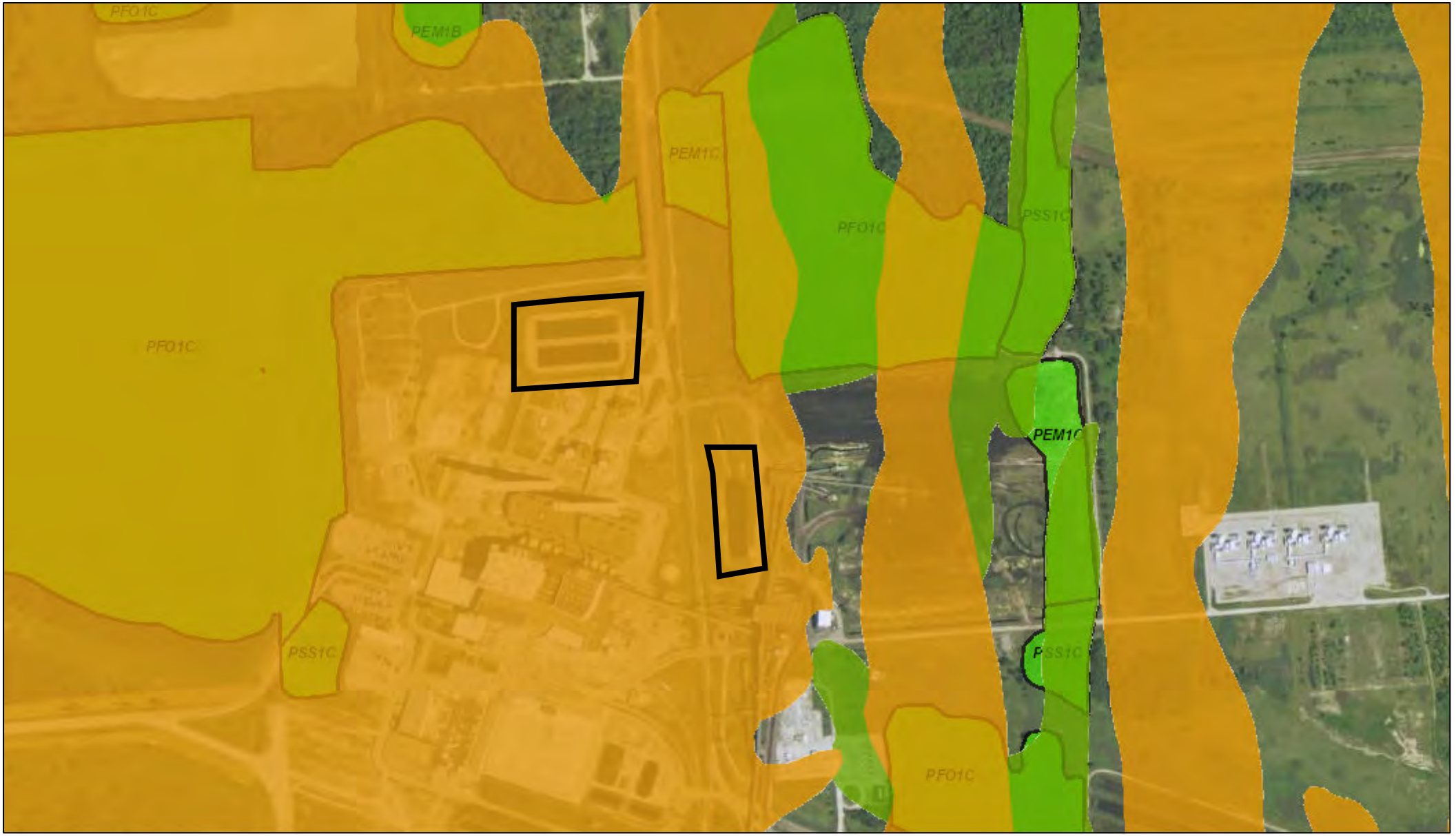
FILE NO.: 265996.0003.01.04-05.dwg

Appendix C
National Wetland Inventory Map

Wetlands Map Viewer



August 17, 2018

Part 303 Final Wetlands Inventory

- Wetlands as identified on NWI and MIRIS maps
- Soil areas which include wetland soils
- Wetlands as identified on NWI and MIRIS maps and soil areas which include wetland soils
- Gage Stations
- National Wetlands Inventory 2005

1:7,628

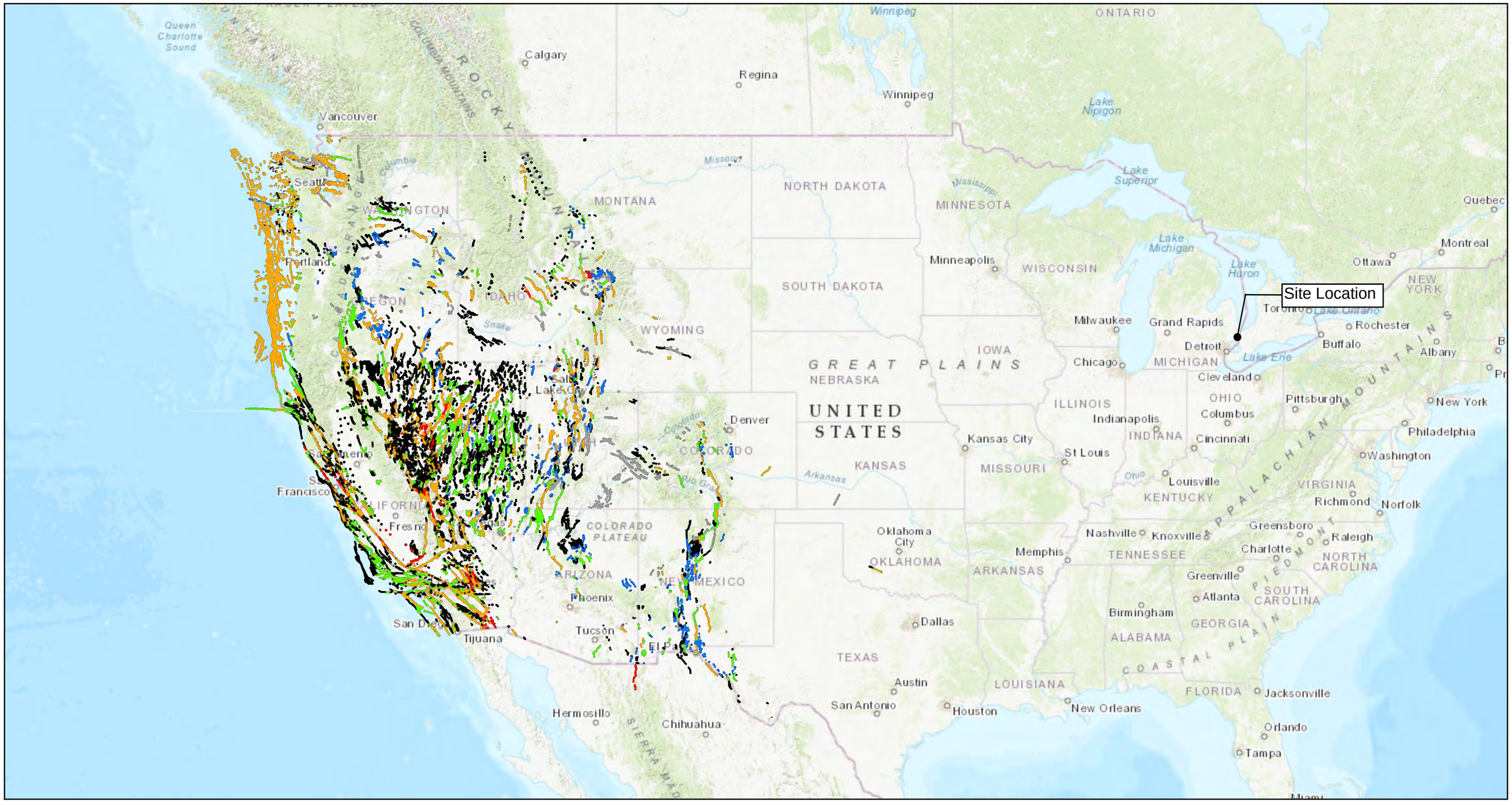
0 0.05 0.1 0.2 mi

0 0.1 0.2 0.4 km

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Appendix D
U.S. Quaternary Faults and Folds Map

US Quaternary Faults and Folds



9/7/2018, 3:20:39 PM

1:18,489,298

0 175 350 700 mi

0 275 550 1,100 km

Quaternary faults

- unspecified age, well constrained location
- unspecified age, moderately constrained location
- unspecified age, inferred location
- undifferentiated Quaternary (< 130,000 years), well constrained location
- undifferentiated Quaternary (< 130,000 years), moderately constrained location
- undifferentiated Quaternary (< 130,000 years), inferred location
- middle and late Quaternary (< 1.6 million years), well constrained location
- middle and late Quaternary (< 1.6 million years), moderately constrained location
- middle and late Quaternary (< 1.6 million years), inferred location
- latest Quaternary (<15,000 years), well constrained location
- latest Quaternary (<15,000 years), moderately constrained location
- latest Quaternary (<15,000 years), inferred location
- late Quaternary (< 130,000 years), well constrained location

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community, USGS

Web AppBuilder for ArcGIS
USGS | Esri, FAO, NOAA |

Appendix E
U.S. Seismic Design Maps

U.S. Geological Survey - Earthquake Hazards Program

Due to insufficient resources and the recent development of similar web tools by third parties, this spring the USGS will be streamlining the two U.S. Seismic Design Maps web applications, including the one below. Whereas the current applications each interact with users through a graphical user interface (GUI), the new web services will receive the inputs (e.g. latitude and longitude) in the form of a web address and return the outputs (e.g. S_{DS} and S_{D1}) in text form, without supplementary graphics. Though designed primarily to be read by the aforementioned third-party web GUIs, the text outputs are also human-readable. To preview the new web services, please click here. Step-by-step instructions for using one of these web services, namely that for the recently published 2016 ASCE 7 Standard, are posted here.

BRPP BABs – Seismic Impact Zone

Latitude = 42.772°N, Longitude = 82.512°W

Location

Reference Document

2015 NEHRP Provisions

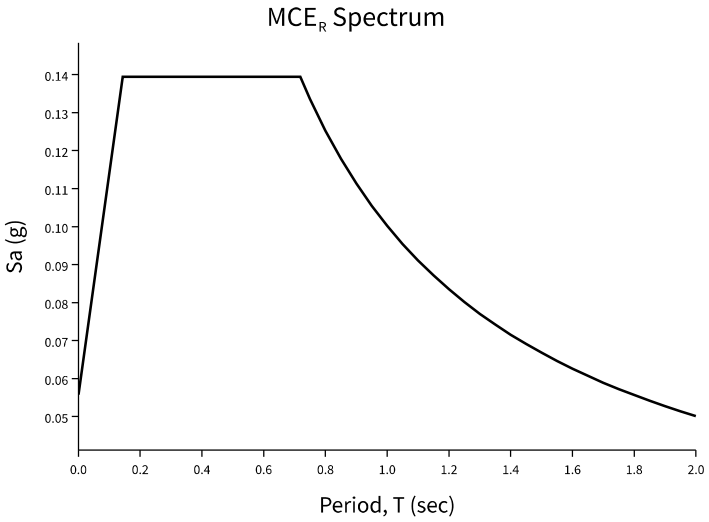
Site Class

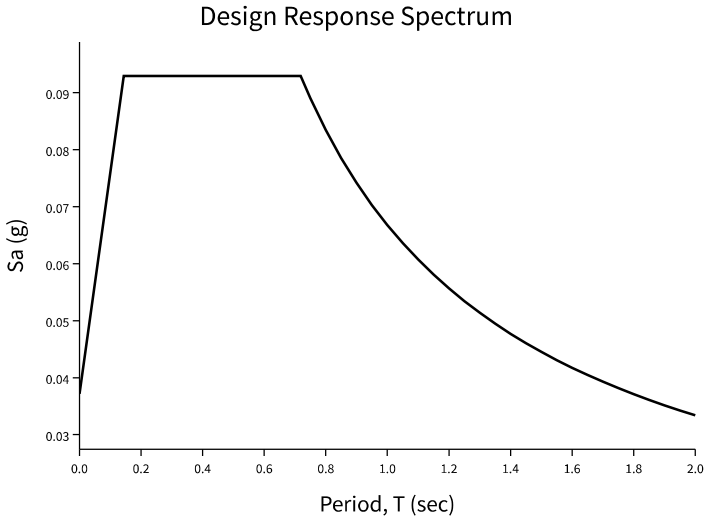
D (default): Stiff Soil

Risk Category

I or II or III

S_S =	0.087 g	S_{MS} =	0.139 g	S_{DS} =	0.093 g
S_1 =	0.042 g	S_{M1} =	0.100 g	S_{D1} =	0.067 g


MCE$_R$ Spectrum
Sa (g)
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Period, T (sec)


Design Response Spectrum
Sa (g)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Period, T (sec)

Mapped Acceleration Parameters, Long-Period Transition Periods, and Risk Coefficients

Note: The S_S and S_1 ground motion maps provided below are for the direction of maximmum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) 1.3 (to obtain S_1).

- FIGURE 22-1 S_S Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-2 S_1 Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-9 Maximum Considered Earthquake Geometric Mean (MCE_G) PGA, %g, Site Class B for the Conterminous United States
- FIGURE 22-14 Mapped Long-Period Transition Period, T_L (s), for the Conterminous United States
- FIGURE 22-18 Mapped Risk Coefficient at 0.2 s Spectral Response Period, C_{RS}
- FIGURE 22-19 Mapped Risk Coefficient at 1.0 s Spectral Response Period, C_{R1}

Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site class as Site Class , based on the site soil properties in accordance with Chapter 20.

Table 20.3-1 Site Classification

Site Class	$\bar{v}_S$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20 • Moisture content w ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		
For SI: 1ft/s = 0.3048 m/s 1lb/ft^2 = 0.0479 kN/m^2			

Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Risk-targeted Ground Motion (0.2 s)	$C_{RS}S_{SUH} = 0.935 \times 0.093 = 0.087$ g
Deterministic Ground Motion (0.2 s)	$S_{SD} = 1.500$ g
	$S_S \equiv$ "Lesser of $C_{RS}S_{SUH}$ and S_{SD}" = 0.087 g
Risk-targeted Ground Motion (1.0 s)	$C_{R1}S_{1UH} = 0.910 \times 0.046 = 0.042$ g
Deterministic Ground Motion (1.0 s)	$S_{1D} = 0.600$ g
	$S_1 \equiv$ "Lesser of $C_{R1}S_{1UH}$ and S_{1D}" = 0.042 g

Table 11.4-1: Site Coefficient F_a

Site Class	Spectral Reponse Acceleration Parameter at Short Period					
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S = 1.25$	$S_S \geq 1.50$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.3	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.2	1.1	1.0	1.0
D (default)	1.6	1.4	1.2	1.2	1.2	1.2
E	2.4	1.7	1.3	1.2 *	1.2 *	1.2 *
F	See Section 11.4.7					

* For Site Class E and $S_S \geq 1.0$ g, see the requirements for site-specific ground motions in Section 11.4.7 of the 2015 NEHRP Provisions. Here the exception to those requirements allowing F_a to be taken as equal to that of Site Class C has been invoked.

Note: Use straight-line interpolation for intermediate values of S_S.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_a shall be taken as 1.0 per Section 11.4.2.

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_a shall not be less than 1.2 per Section 11.4.3.

For Site Class = D (default) and S_S = 0.087 g, F_a = 1.600

Table 11.4-2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1-Second Period					
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 = 0.50$	$S_1 \geq 0.60$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.8	0.8	0.8	0.8	0.8	0.8
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.5	1.5	1.5	1.5	1.5	1.4
D (determined)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
D (default)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
E	4.2	3.3 [1]	2.8 [1]	2.4 [1]	2.2 [1]	2.0 [1]
F	See Section 11.4.7					

[1] For Site Class D or E and $S_1 \geq 0.2$ g, site-specific ground motions might be required. See Section 11.4.7 of the 2015 NEHRP Provisions.

Note: Use straight-line interpolation for intermediate values of S_1.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_v shall be taken as 1.0 per Section 11.4.2.

For Site Class = D (default) and S_1 = 0.042 g, F_v = 2.400

Site-adjusted MCE_R (0.2 s)

$$S_{MS} = F_a S_S = 1.600 \times 0.087 = 0.139 \text{ g}$$

Site-adjusted MCE_R (1.0 s)

$$S_{M1} = F_v S_1 = 2.400 \times 0.042 = 0.100 \text{ g}$$

Design Spectral Acceleration Parameters

Design Ground Motion (0.2 s)

$S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.139 = 0.093$ g

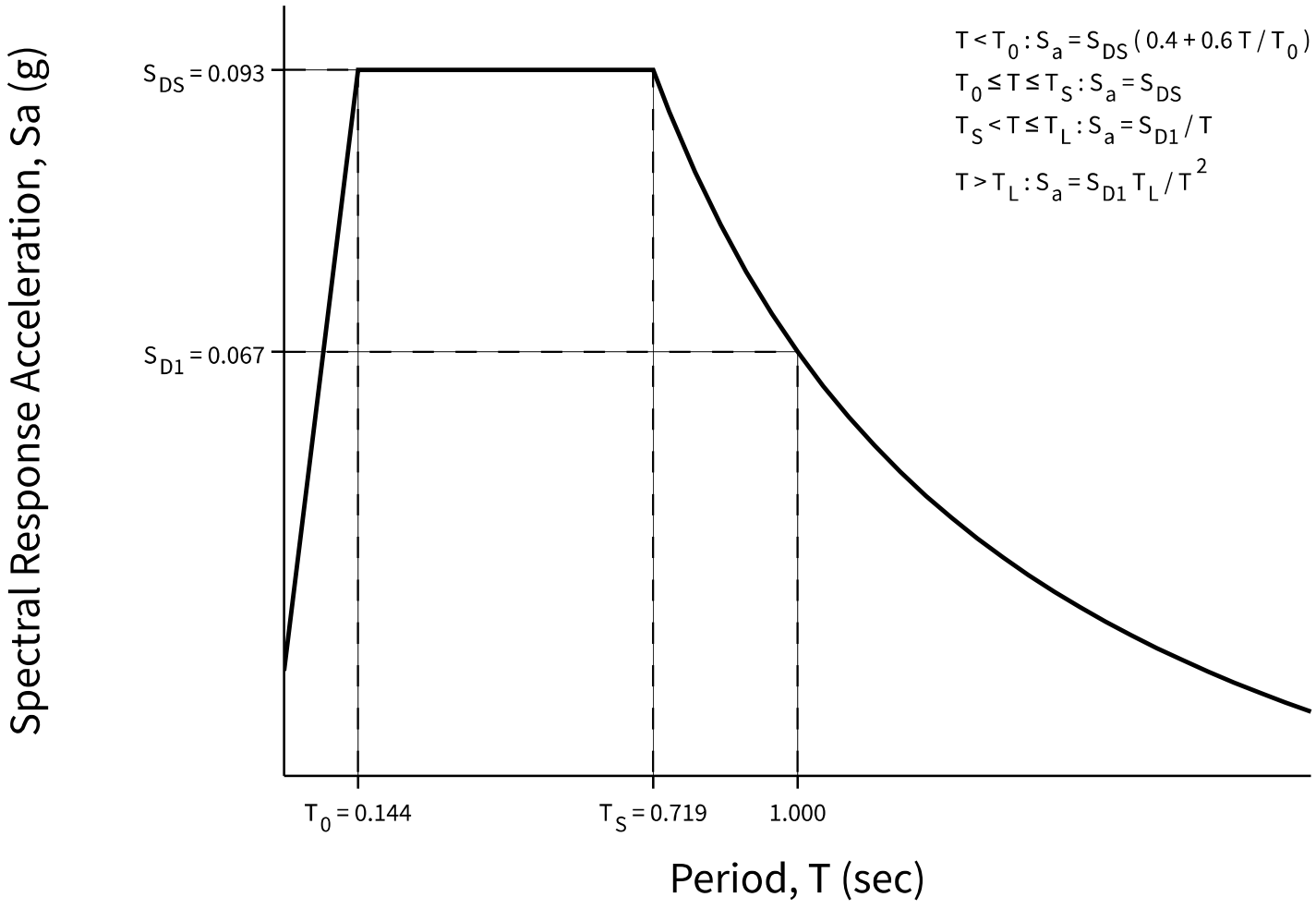
Design Ground Motion (1.0 s)

$S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.100 = 0.067$ g

Design Response Spectrum

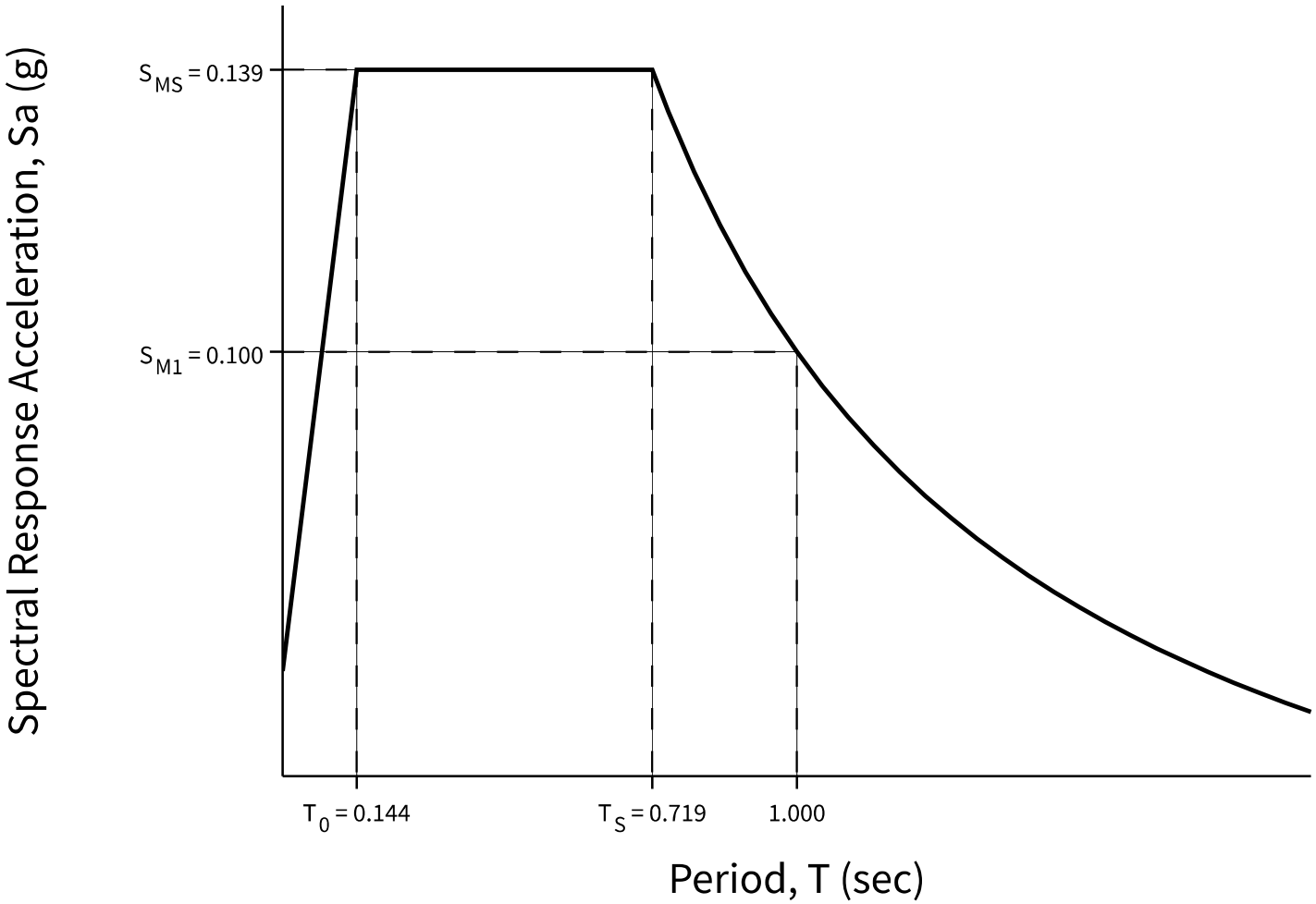
Long-Period Transition Period = T_L = 12 s

Figure 11.4-1: Design Response Spectrum



MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient for F_{PGA}

Site Class	Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration					
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA = 0.50	PGA ≥ 0.60
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.2	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.3	1.2	1.1	1.1
D (default)	1.6	1.4	1.3	1.2	1.2	1.2
E	2.4	1.9	1.6	1.4	1.2	1.1
F	See Section 11.4.7					

Note: Use straight-line interpolation for intermediate values of PGA

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_{pga} shall not be less than 1.2.

For Site Class = D (default) and PGA = 0.043 g, F_{PGA} = 1.600

Mapped MCE_G

PGA = 0.043 g

Site-adjusted MCE_G

$PGA_M = F_{PGA}PGA = 1.600 \times 0.043 = 0.068$ g