November 25, 2020

Sent via email

Mr. Andrew Wheeler, EPA Administrator
United States Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Mail Code 50304-P
Washington DC, 20460

RE: Request for Site-Specific Alternative Deadline to Initiate Closure, Permanent Cessation of Coal-Fired Boilers by a Date Certain
DTE Electric Company St. Clair Power Plant
Bottom Ash Basins Coal Combustion Residual Unit
4901 Pointe Drive, East China Township, Michigan

Dear Administrator Wheeler:

The DTE Electric Company (DTE Electric) is submitting this request to the US. Environmental Protection Agency for approval of a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. §257.103(f)(2) for the Bottom Ash Basins located at the St. Clair Power Plant located in East China Township, Michigan. DTE Electric is requesting an extension pursuant to 40 C.F.R. §257.103(f)(2) to enable the Bottom Ash Basins to continue to receive CCR and non-CCR waste streams after April 11, 2021, and complete closure no later than October 17, 2023.

Enclosed is a demonstration prepared by TRC that addresses the criteria in 40 C.F.R. §257.103(f)(2)(i) through (iv) and contains the documentation required in 40 C.F.R. §257.103(f)(2)(v). As allowed by the agency, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email. If you have any questions regarding this submittal, please contact me at 313.235.0153 or christopher.scieszka@dteenergy.com

Sincerely,

Christopher Scieszka
Project Manager, Environmental Management and Safety, DTE Energy

Enclosure

cc: Kirsten Hillyer, Frank Behan, and Richard Huggins

One Energy Plaza, Detroit, MI 48226-1221
dteenergy.com

Request for Site-Specific Alternative Deadline to Initiate Closure, Permanent Cessation of Coal Fired Boilers by a Date Certain

St. Clair Power Plant
Bottom Ash Basins Coal Combustion Residuals Unit, 4901 Pointe Drive, East China Township, Michigan 48054

November 2020

Prepared For:

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Executive Summary

On behalf of DTE Electric Company (DTE Electric), TRC has prepared this request for approval of a site-specific alternative deadline to initiate closure pursuant to the United States Environmental Protection Agency (EPA) August 28, 2020, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part A: Deadline To Initiate Closure (Part A Rule) alternative closure provision for the permanent cessation of coal-fired boiler(s) by a date certain (CFR §257.103(f)(2)). DTE Electric is requesting EPA allow the St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) to continue to receive CCR and non-CCR waste streams after April 11, 2021, and complete closure no later than October 17, 2023.

This report demonstrates how DTE Electric qualifies for and should be granted an alternative closure provision for the SCPP BABs based on the planned cessation of operation of the coal-fired boilers at the SCPP by late spring/early summer 2022. DTE Electric must continue operation of the SCPP BABs for management of both CCR and non-CCR waste streams until at least late spring/early summer 2022 based on the lack of on and off-site alternative disposal capacity. The following conditions at the site support the continued operation of the SCPP BABs and demonstrate that potential risks to human health and the environment have been adequately mitigated:

- The presence of a contiguous, at least 120-feet thick, glacially compacted natural clay liner. This clay liner performs as a geologic barrier that mitigates risks to human health and the environment;
- Compliance with all provisions of the CCR Rule, including, no release to groundwater as documented by ongoing detection monitoring since 2017; and
- Planned cessation of coal-fired boiler operations by late spring/early summer 2022 and completion of the closure of the BABs by October 17, 2023.

1.0 Site Background and Regulatory Framework

On behalf of DTE Electric Company (DTE Electric), TRC has prepared this request for approval of a site-specific alternative deadline to initiate closure of a CCR surface impoundment pursuant to the United States Environmental Protection Agency (EPA) August 28, 2020, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part A: Deadline To Initiate Closure (Part A Rule) alternative closure provision for the permanent cessation of coal-fired boiler(s) by a date certain (CFR §257.103(f)(2)). DTE Electric is requesting that the EPA allow the St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) to continue to receive CCR and non-CCR waste streams after April 11, 2021, and complete closure no later than October 17, 2023.

Site Background - The SCPP is located in Section 19, Township 4 North, Range 17 East at 4901 Ponte Drive in East China Township in St. Clair County, Michigan **(Figure 1)**. The SCPP, including the east BAB was constructed in the early 1950s and the west BAB was constructed in 1996. The power plant is located approximately three miles south of St. Clair, Michigan, immediately to the west of the St. Clair River.

The property has been used continuously as a coal fired power plant since the Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953. The BABs are designed to manage sluiced bottom ash and other waste streams. The BABs are routinely cleaned out and CCR is disposed at the Range Road Landfill (RRLF).

The SCPP BABs consists of two adjacent sediment basins that are incised CCR surface impoundments **(Figure 2)**. The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (bgs) into an at least 120-foot-thick native clay-rich soil liner. The BABs are located south of the SCPP and approximately 30 feet west of the St. Clair River and are used for receiving sluiced bottom ash and other process flow water from the power plant silos and stormwater. The process water is first sent to the East BAB then to the West BAB through a connecting concrete canal. The West and East BABs are situated north to south with the following approximate dimensions:

- The West BAB is approximately 300 feet long by 90 feet wide (total acreage is approximately 0.55 acres) with a bottom elevation of approximately 572 feet (when fully cleaned out) and an outflow weir elevation of approximately 579.3 feet; and
- The East BAB is approximately 400 feet long by 70 feet wide (total acreage is approximately 0.56 acres) with a bottom elevation of approximately 572 feet (when fully cleaned out) and an outflow weir elevation of approximately 579.4 feet.

The BABs are underlain by at least 120 feet of very low hydraulic conductivity natural clay liner. In addition, groundwater detection monitoring that has been performed since 2017 in accordance with 40 CFR §257.93 and §257.94, has demonstrated detection monitoring compliance, as described below.

Regulatory Framework – On April 17, 2015, the EPA issued the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule), 40 CFR 257, Subpart D, to regulate the management and disposal of CCR materials generated at coal-fired units. The rule is being administered under

Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. § 6901 et seq.). On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule with the Part A Rule. This revision requires all unlined surface impoundments including the SCPP BABs (an eligible unlined CCR surface impoundment) to initiate closure by April 11, 2021, unless an alternative deadline is requested and approved (40 CFR 257.101(a)(1)). Specifically, owners and operators of a CCR surface impoundment may continue to receive CCR and non-CCR waste streams if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundment within certain specified timeframes (40 CFR §257.103(f)(2)). To qualify for an alternative closure timeline under §257.103(f)(2), a facility must meet the following criteria:

1. **§257.103(f)(2)(i)** - No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification;
2. **§257.103(f)(2)(ii)** - Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated;
3. **§257.103(f)(2)(iii)** - The facility is in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and
4. **§257.103(f)(2)(iv)** - The coal-fired boiler ceases operation and closure of the impoundment must be completed within the following timeframes:
    a) For a CCR surface impoundment that is 40 acres or smaller the coal fired boiler(s) must cease operation and the CCR surface impoundment must complete closure by no later than October 17, 2023 (the SCPP BABs are less than 40 acres).
    b) For a CCR surface impoundment that is larger than 40 acres the coal fired boiler(s) must cease operation and the CCR surface impoundment must complete closure by no later than October 17, 2028.

The documentation that must be provided to the EPA per §257.103(f)(2)(v) to demonstrate that the above criteria has been met by the SCPP BABs is provided within this report.

2.0 SCPP Permanent Cessation of Coal Fired Boilers

Per 40 CFR §257.103 (f)(2), site-specific alternative deadlines to initiate closure of CCR surface impoundments, a CCR surface impoundment may continue to receive CCR and/or non-CCR wastewaters if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundment by October 17, 2023 for surface impoundments less than 40 acres (the BABs are less than 40 acres). DTE Electric included the 2022 planned closure of the SCPP in their 2019 Integrated Resource Plan (IRP) presented to and approved by the Michigan Public Service Commission (**Appendix A**). DTE Electric plans to cease operation of the coal fired boilers at the SCPP in late spring/early summer 2022, and complete closure of the BABs by late 2022.

3.0 No Alternative Disposal Capacity Demonstration

Per 40 CFR §257.103(f)(2)(i), the owner must submit documentation to demonstrate that no alternative disposal capacity is currently available on-site or off-site to manage each CCR and non-CCR waste stream that the owner seeks to continue routing to the CCR surface impoundment after April 11, 2021.

As documented herein, DTE Electric does not have alternative capacity for each CCR or non-CCR waste stream currently managed in the BABs on or off-site. Consistent with the regulations, the costs or the inconvenience of potential alternative disposal capacity was not considered as part of determining whether there is adequate alternative disposal capacity for the SCPP BABs.

The following discussion regarding the alternative disposal capacity analysis for the SCPP BABs includes a discussion of the BAB system layout, a summary of the CCR and non-CCR waste streams currently managed in the BABs, and a discussion regarding the various alternative disposal capacity options reviewed by DTE Electric. In addition, DTE Electric also considered retrofitting the current CCR BABs to serve as onsite alternative disposal capacity. However, retrofitting is not possible and a full replacement of the BABs would be required to meet the required capacity needed for the high volume of flow routed into the BABs. Also, other existing surface impoundments that could be used during a retrofit do not exist.

Furthermore, by the time an alternative capacity technology (e.g. conversion to dry handling, wastewater treatment system, new CCR surface impoundment with an engineered liner, or multiple technology system(s)) for CCR and non-CCR waste could be designed, permitted, and constructed, the SCPP coal-fired boilers will have ceased operation. As presented in Table 2 on page 53523 in the Part A Rule preamble, the average time to complete an alternative capacity technology ranges from 16 to 36 months. Specifically, because the coal-fired boilers at the SCPP will cease operation by late spring/early summer 2022, as presented in the Part A Rule preamble, page 53547, "In contrast to the provision under §257.103 (f)(1), the owner or operator does not need to develop alternative capacity because of the impending closure of the coal fired boiler. Since the coal-fired boiler will shortly cease power generation, it would be illogical to require these facilities to construct new capacity to manage CCR and non-CCR waste streams." Therefore, the development of alternative capacity will not be completed for the SCPP BABs CCR unit for any of the waste streams discussed below.

3.1 Existing Bottom Ash Basins System Layout

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments. The BABs are located south of the SCPP and approximately 30 feet west of the St. Clair River and are used for receiving sluiced bottom ash and other non-CCR process flow water and area stormwater, that is first routed to the East BAB then to the West BAB through a connecting concrete canal. The east basin has a capacity of 1.1 million gallons and the west basin has a capacity of 1.5 million gallons. Discharge water from the basins flows with other site wastewater into the Overflow Canal for discharge to the St. Clair River in accordance with a National Pollution Discharge Elimination System (NPDES) permit. Collected CCR bottom ash is routinely cleaned out and either sold for beneficial reuse or disposed of off-site at the RRLF.

The other onsite impoundments (Auxiliary Basin, Low Volume Waste Basins, Chemical Waste Basins, Oily Waste Basin, the Coal Pile Runoff Basins) shown on **Figure 3** are not authorized to receive the CCR material as they do not have an engineered liner that meets the requirements of §257.71(a)(1) and are not permitted to receive bottom ash under the NPDES permit. Additionally, the other onsite impoundments were designed to treat their current waste streams and are not large enough and/or do not have sufficient infrastructure to treat additional plant process water flows that are currently routed through the BABs.

3.2 CCR Waste Streams

DTE Electric evaluated each CCR waste stream currently routed to the East and West BABs. Table 3.1 below identifies each CCR waste stream and an evaluation/justification for why each waste stream must continue to be routed to the BABs due to lack of alternative capacity.

Table 3.2 - SCPP BABs CCR Waste Streams

CCR Waste Stream	Flow (MGD)	Alternative Disposal Capacity Available (YES/NO)	Description
Sluiced Bottom Ash	~1.67 million gallons per day (MGD) average, ~3.45 MGD maximum	No	Infrastructure for alternative disposal on-site or off-site does not exist. There is no viable alternative for on-site or off-site disposal of this wet-CCR waste stream. The time for conversion to develop alternative capacity technology will be longer than the boilers will continue to operate.
Air Wash Sluice	Intermittent (~0.4 MGD maximum)	No	This waste stream is comingled with sluiced bottom ash. Infrastructure for alternative disposal on-site or off-site does not exist. Management alternatives would require design, permitting, and installation of new piping/pumps to a new treatment pond and routed to the existing or a new permitted outfall.

Table 3.2 - SCPP BABs CCR Waste Streams

CCR Waste Stream	Flow (MGD)	Alternative Disposal Capacity Available (YES/NO)	Description
Economizer Wash	Intermittent (~0.5 MGD maximum)	No	This waste stream is comingled with sluiced bottom ash. Infrastructure for alternative disposal on-site or off-site does not exist. Management alternatives would require design, permitting, and installation of new piping and pumps to a new treatment pond with and routed to the existing or a new permitted outfall.

Alternative Disposal Capacity Review

- **Dry Handling Systems**: Alternative disposal options for sluiced CCR are greatly limited as EPA noted in the preamble in the 2015 CCR Rule on page 21423, which states, "While it is possible to transport dry ash off-site to an alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems." The SCPP does not currently have infrastructure or equipment in place to support dry handling of the wet CCR waste streams.
- **Other Impoundments:** Other onsite impoundments such as the Auxiliary Basin, Low Volume Waste Basins, Chemical Waste Basins, Oily Waste Basins, and the West Coal Pile Runoff Basins are not authorized to receive the CCR material because they do not have an engineered liner that meets the requirements of §257.71(a)(1) and are not permitted to receive bottom ash under the NPDES permit.
- **Storage/Holding Tanks:** The use of tanks to manage the sluiced CCR and other CCR waste streams on or offsite is also not feasible due to multiple factors. Sluiced CCR is currently comingled with non-CCR waste streams and would require significant reconfiguration of process piping to segregate the high flow volumes of CCR waste streams from non-CCR waste streams. Based on actual flow readings over the past three years, anticipated mean flow volume of sluiced CCR is approximately 1.67 MGD with total flow to the BABs as high as 12.83 MGD when significant intermittent waste stream discharges are occurring and/or significant stormwater inflow is occurring. The total storage capacity of the BABs is approximately 2.6 million gallons and is required to provide adequate residence time and treatment prior to discharge. Therefore, a total of 130 Frac tanks (20,000-gallon capacity mobile tanks meant for temporary storage) would be required to provide an equivalent capacity to the existing BABs and the land required to stage temporary storage tanks would be approximately 2 to 3 acres. There is insufficient space at the SCPP to place the estimated 130 Frac tanks near the BABs (**Figure 4**). Additionally, as shown on **Figure 4**, tanks could potentially be staged on DTE Electric-owned property to the west of the SCPP, that is currently being managed as a wildlife habitat project area. However, the significant amount of piping and trucking that would be required as presented below make this option technically infeasible.

> The addition of off-site management of Frac tanks would require construction of a staging area located on DTE Electric-owned property west of the SCPP and would result in significant daily tanker truck traffic to transfer the waste stream. It's anticipated that approximately 223 truckloads per day would be required to manage the CCR waste streams offsite during normal SCPP operations and may require significant permitting requirements to discharge the effluent if not transferred back to existing permitted outfalls. In addition, regular inspections and monitoring for leaks would be required. The increase in daily traffic would be impractical to plan for and reliably complete and would also create additional safety, noise, and fugitive dust concerns.
>
> Frac tank removal and replacement, due to accumulation of solids, would be required to maintain proper treatment for any on-site or off-site option. Additionally, it would not be feasible to manage the required pumps, hoses, and maintain freeze protection during the winter months to implement a temporary storage tank alternative.

Therefore, the lack of alternative capacity both on and off-site for sluiced/wet CCR waste streams at the SCPP is demonstrated per the requirements of 40 CFR §257.103(f)(2)(i).

In addition, as documented in Section 2.0, DTE Electric plans to cease operation of the coal fired boilers at the SCPP by late spring/early summer 2022. By the time alternative capacity for the CCR waste streams using an alternative capacity technology (e.g. conversion to dry handling, wastewater treatment system, new CCR surface impoundment with an engineered liner, or multiple technology system(s)) for CCR and non-CCR waste could be designed, permitted, procured and constructed, the SCPP boilers will have ceased operation. As presented in Table 2 on page 53523 in the Part A Rule preamble, the average time to complete an alternative capacity technology ranges from 16 to 36 months. Based on the information presented, as the EPA stated, it would be considered "illogical" to construct new capacity to manage the CCR waste streams identified in this demonstration. Therefore, all CCR waste streams must continue to be placed in the BABs due to lack of alternative capacity both on and off-site in order to keep the SCPP operational until the boilers cease operation in late spring/early summer 2022.

3.3 Non-CCR Waste Streams

DTE Electric evaluated each non-CCR waste stream currently routed to the East and West BABs. Table 3.2 below identifies each non-CCR waste stream and justification for why each waste stream must continue to be routed to the BABs due to lack of alternative capacity.

Table 3.3 - SCPP BABs Non-CCR Waste Streams

Non-CCR Waste Stream	Flow (MGD)	Alternative Disposal Capacity Available (YES/NO)	Description
Stormwater Runoff	Intermittent (~5.9 MGD 25-year storm)	No	In some areas stormwater is comingled with CCR waste streams. Management alternatives would require design, permitting, and installation of new piping to a new stormwater pond with surge capacity and routed to the existing or a new permitted outfall.
Air Pre-Heater Wash	Intermittent (~0.4 MGD maximum)	No	Currently comingled with CCR waste streams. Management alternatives would require design, permitting, and installation of new piping and pumps to a new tank or treatment pond and routed to the existing or a new permitted outfall. The portion that goes to the low volume waste basin is separately piped/pumped.
Silo Drains	Intermittent (~1.6 MGD maximum)	No	Currently comingled with CCR Waste Streams. Management alternatives would require design, permitting, and new installation of piping and pumps to a treatment pond and routed to the existing or a new permitted outfall. The portion that goes to the low volume waste basin is separately piped/pumped.

Alternative Disposal Capacity Review

- **Rerouting non-CCR Waste Stream(s):** Based on an evaluation of the current SCPP infrastructure, rerouting non-CCR waste streams to other locations is not a feasible alternative. There is currently no alternative infrastructure at the plant on or off site to support the higher end surge conditions of these flows. In addition, non-CCR waste streams are currently comingled with CCR waste streams and would require significant reconfiguration of process and stormwater piping to segregate waste streams and to send the non-CCR waste streams to the local publicly owned treatment works (POTW); therefore, this alternative is not feasible.
- **Non-CCR Waste Stream Treatment System:** Any alternative management approach not using an existing basin would require DTE Electric to design, permit, procure and construct new pumping and/or piping, and a new treatment system (e.g., non-CCR ponds,

clarification, and/or large permanent storage tank(s)) that can account for surges (especially for waste streams that have a stormwater component). The timeframe to complete a new non-CCR waste stream treatment system would be beyond the timeframe for shutdown of the SCPP coal-fired boilers. Specifically, as presented in Table 2 on page 53523 in the Part A Rule preamble, the average time to complete a new non-CCR wastewater basin is 21 months; therefore, this alternative is not feasible to be completed before the SCPP boilers will cease operation.

- **Storage/Holding Tanks:** The use of temporary storage tanks to manage stormwater runoff that gravity drains to the BABs is not feasible, primarily due to the high volume of flow anticipated. Stormwater flows that require management are anticipated to be 5.9 MGD (25-year event) or greater. The total storage capacity of the BABs is approximately 2.6 million gallons and is required to provide adequate residence time and treatment prior to discharge.

  A total of 130 Frac tanks (20,000-gallon capacity) would be required to provide an equivalent capacity to the existing BABs and the land required to stage temporary storage would be approximately 2 to 3 acres. There is insufficient space at the SCPP to place the estimated 130 Frac tanks near the BABs (**Figure 4**). Additionally, as shown on **Figure 4**, tanks could potentially be staged on DTE Electric-owned property to the west of the SCPP, that is currently being managed as a wildlife habitat project area. However, the significant amount of piping and trucking that would be required as presented below make this option technically infeasible. Off-site management in Frac tanks would require construction of a staging area located on DTE Electric-owned property west of the SCPP and would result in significant daily tanker truck traffic to transfer the waste stream. It's anticipated that approximately up to 790 truckloads per day would be required to manage flows during storm events offsite and may require significant permitting requirements to discharge the effluent if not transferred back to existing permitted outfalls. In addition, regular inspections and monitoring for leaks would be required. The increase in traffic during rain events would be impractical to plan for and reliably complete and would also create additional safety, noise, and fugitive dust concerns.

  Frequent Frac tank removal and replacement, due to accumulation of solids, would be required to maintain proper treatment. Given all stormwater flow currently flows via gravity in below-ground infrastructure, this alternative would also require additional pump stations to lift all stormwater flow to above-grade systems. Additionally, it would not be feasible to manage the required pumps, hoses, and maintain freeze protection during the winter months to implement a temporary storage tank alternative.

Therefore, the lack of alternative capacity both on and off-site for non-CCR waste streams at the SCPP is demonstrated per the requirements of 40 CFR §257.103(f)(2)(i).

As coal fired boilers at the SCPP will cease operation by late spring/early summer 2022, and no alternative capacity is available, the BABs must continue to be utilized for CCR waste streams and non-CCR waste streams to keep the SCPP operational until the planned closure in 2022. As presented in the Part A Rule, page 53547, "In contrast to the provision under §257.103 (f)(1), the owner or operator does not need to develop alternative capacity because of the impending closure of the coal fired boiler. Since the coal-fired boiler will shortly cease power generation, it would be illogical to require these facilities to construct new capacity to manage CCR and non-CCR waste streams."

4.0 Mitigation of Risks

Per 40 CFR §257.103(f)(2)(v)(B), the owner must submit a risk mitigation plan describing the measures that will be taken to expedite any required corrective action, and that contains the following elements:

- A discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation.
- A discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed to current or future groundwater contamination; and how such exposures could be promptly mitigated.
- A plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the Units.

The geologic and hydrogeologic conditions at the site will prevent releases of contaminants to groundwater during ongoing operation of the SCPP BAB CCR units. The natural clay lined impoundments are operating as designed to protect groundwater and prevent any risk of a release to groundwater. Approximately 120 feet of low permeability clay-rich deposits vertically isolate the BABs from the underlying uppermost aquifer as evidenced by the SCPP BABs CCR unit groundwater detection monitoring since 2017. Therefore, there is no risk posed by the continued short-term operation of the SCPP BAB CCR units. The following paragraphs document the existing site conditions, identification of potential receptors, and measures taken to mitigate risks.

4.1 BABs Operational Measures That Limit Future Releases to Groundwater

The SCPP BABs CCR unit surface impoundments receive sluiced bottom ash, non-CCR process water from the ash silos and stormwater after wastewater treatment through settling, before discharge to the St. Clair River under an NPDES Permit. The SCPP BABs CCR unit has not had any detections of Appendix III groundwater monitoring constituents with statistically significant increases (SSIs). Therefore, the native clay liner is an effective liner (as discussed below) in the protection of groundwater. Additional measures to prevent releases to groundwater include, the physical treatment within the BABs by regular removal of CCR from the eastern BAB, generally on one to two-week intervals to maintain capacity. The removed CCR is disposed of at the off-site Range Road CCR Landfill.

4.2 Regional and Site Geology

The geology of St. Clair County consists of approximately 101 to 400 feet of glacial deposits, primarily lacustrine deposits, till, and, to a lesser extent, sand and gravel outwash, overlying a variety of bedrock surfaces[1]. The thicker glacial deposits, predominantly low permeability deposits, are present toward the central portion of the county. These thick low permeability subsurface conditions are present on a regional basis due to continental glaciation. The *Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six*

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[1] Beth A. Apple and Howard W. Reeves, 2007, Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p.

Southeast Michigan Coal Combustion Residual Units (Natural Clay Liner Equivalency Report)*,* previously submitted to the EPA in December of 2018 **(Appendix B)** also contains additional information on the natural clay liner evaluation including hydraulic head data, cross-sections, site-specific clay hydraulic conductivity values and leakage rate calculations.

As part of this study, TRC evaluated Multiple CCR impoundments in southeast Michigan, including the SCPP. Using recognized and generally accepted good engineering practices, TRC concluded that the natural soils below six CCR impoundment units at four sites in southeast Michigan perform better than composite liners. In summary:

- TRC calculated leakage rates for six Southeast Michigan CCR units and compared these to the anticipated leakage rates for a single composite liner system. For all six units, the leakage rates were generally within an order of magnitude of the composite liner system. These data show that anticipated leakage rates between the natural soil barriers and the single composite liners are comparable. Data are summarized on Table 1 of the Natural Clay Liner Equivalency Report. Data also show that other site specific factors contribute more significantly to the protectiveness of natural soil barriers when compared to single composite liner system, including thickness of the natural soil barrier, hydraulic conductivity of the soil barrier, and the hydraulic gradient between the CCR unit and the underlying aquifer, which can result in significantly greater times of travel to the uppermost aquifer. The results of the time of travel calculations are summarized on Table 1 of the Natural Clay Liner Equivalency Report. As shown, all the six evaluated Southeast Michigan CCR units have natural clay liners that are more protective than a single composite liner system.
- The travel time results from this study exceed the USEPA’s vulnerability criterion indicating that site-specific evaluation can demonstrate protectiveness. The sites presented in this study and the methods and criteria used to evaluate the competency of the liner systems meet the regulatory standard “does not pose a reasonable probability of adverse effects on health or the environment.”

Bedrock in the county includes the Michigan Formation, Marshall Sandstone, Coldwater Shale, Sunbury Shale, Berea Sandstone, Bedford Shale, and Antrim Shale. In the vicinity of the site, the Devonian Bedford and/or Antrim Shale bedrock dips to the northwest and is generally covered by more than 100 feet of unconsolidated clay, silt, sand, and gravel. In this area, generally on the eastern side of the county, the glacial deposits are predominantly silty-clay till and lacustrine deposits with lenses of sand and gravel. Where present, unconsolidated sand and gravel deposits within the till and lacustrine deposits are generally used for water supply throughout the county.

The current topography of the St. Clair area gently undulates consisting of floodplain, stream terrace, and lakeshore deposits. The St. Clair River is the major surface water body in the county and runs along the eastern boundary of the county. Regional groundwater and surface water flow would be expected to be to the east towards the St. Clair River.

The SCPP BABs CCR Unit is located within 30 feet to the west of the St. Clair River. The site subsurface geology is based on information from historical borings advanced during initial design and later expansion of the SCPP in the 1950s through 1990s, in addition to the soil boring data collected from around the BABs during the March 2016 groundwater monitoring system installation. This information documents that the SCPP CCR unit are underlain by glacial silty-clay till, with few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale) at around 130 feet bgs. The SCPP BABs CCR Unit is underlain by a naturally deposited, vertically thick and laterally continuous silty-clay rich deposit that serves as a hydraulic barrier to groundwater migration. These subsurface conditions have been verified by numerous historical soil borings and further confirmed by the four soil borings installed as part of the CCR monitoring well installation program. Groundwater present within the deep confined potential uppermost aquifer is protected from CCR constituents by the approximately 120 feet thick clay-rich aquitard with low hydraulic conductivity **(Appendices C and D and Figures 5 through 7)**.

In March 2016, soil borings were advanced to evaluate the subsurface geology and to allow monitoring well installation using sonic drilling techniques with 4-inch and 6-inch tooling along the perimeter of the SCPP BABs Unit area. Soil samples were collected continuously in ten-foot sections from the ground surface to the termination of the soil boring. A TRC geologist was present to log each boring and describe the soil samples in accordance with the Unified Soil Classification System (USCS). The soil borings were advanced to depths of approximately 138 feet-bgs into the top of the underlying shale bedrock (likely the Bedford Shale) lower confining unit that was encountered between 130.5 feet bgs and 132 feet bgs beneath the SCPP in the area of the BABs.

No significant sand or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well installations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock that was encountered between 130.5 and 132 ft bgs. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer). Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first uppermost saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, it exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone.

Therefore, MW-16-01, MW-16-02, MW-16-03 and MW-16-04 monitoring wells were installed and screened within this uppermost aquifer interval just above the shale bedrock interface as shown on **Figures 2 and 5 through 7 and Appendices C and D**. Once groundwater elevations stabilized, it was confirmed that the well installed to the west of the BABs (MW-16-01) is an up hydraulic gradient well and the three wells installed to the east of the BABs between the BABs and the St. Clair River (MW-16-02 through MW-16-04) are down hydraulic gradient wells. Therefore, MW-16-01 through MW-16-04 complete an appropriate groundwater monitoring system for the SCPP BABs CCR Unit (**Appendices C and D**).

4.3 Site Hydrogeology

As described in Section 4.2 above, the uppermost aquifer consists of a confined zone of saturation along the shale bedrock interface that is confined by more than 120 feet of overlying clay-rich very low hydraulic conductivity soil (**Figures 5 through 7**). Groundwater flow within this "uppermost aquifer" is generally to the east-southeast based on potentiometric surface data measured during the collection of numerous independent samples from the groundwater monitoring system in accordance with the CCR Rule since August 2016. The site potentiometric groundwater elevations suggest that overall, beneath the more than 120 feet of clay-rich confining till, there is a potential horizontal groundwater flow direction to east-southeast towards the St. Clair River with a mean hydraulic gradient on the order of 0.0036 foot/foot in the area of the BABs CCR unit **(Appendix E and Figures 8 and 9)**.

The water level in the BABs is maintained at an elevation of approximately 580 feet. The hydraulic head in the aquifer below the BABs is approximately 579 feet. The bottom of the BABs is at an elevation of approximately 572 feet and the bottom of the clay underlying the BABs is at an elevation of approximately 452 feet, thus approximately 120 feet of clay separate the bottom of the BABs CCR unit from the underlying aquifer. The elevation of CCR-affected water maintained within the SCPP BABs is approximately one foot above the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR-affected surface water in the BABs was able to penetrate the silty clay-rich underlying confining unit, the head on that release could travel radially away from the BABs within the uppermost aquifer. However, due to the very thick continuous silty clay-rich confining unit with hydraulic conductivity values ranging from 2.3 x 10^{-8} cm/s to 3.1 x 10^{-8} cm/s beneath the SCPP BABs, there is no reasonable probability for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s. Under pre-existing solid waste rules in Michigan, solid waste facilities with similar geology to the SCPP BABs CCR unit have been granted waivers from groundwater monitoring based on the environmental protectiveness of the native thick clay-rich geology.

The *Groundwater Monitoring System Summary Report, DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, East China Township, Michigan* – October 2017 (**Appendix D**), contains additional details related to the site hydrogeology. Per § 257.103 (f)(2)(ii), potential risks to human health and the environment from the continued operation of the CCR BABs have been adequately mitigated by the natural clay-rich liner.

No water supply wells are present within the unconsolidated sediment or bedrock within one mile of the SCPP. Surface water bodies present in the area of the SCPP include the Belle River (as close as 3,000 feet southwest of SCPP) and the St. Clair River (located approximately 30 feet to the east of the SCPP BABs CCR unit). The nearest drinking water intake in the St. Clair River is located more than three miles upstream from the SCPP BABs CCR unit. The extensive natural clay-rich liner at the SCPP BABs protects the groundwater and surface water at and adjacent to the SCPP.

Hydraulic conductivities measured within the CCR monitoring wells using single well hydraulic conductivity tests (e.g., slug tests) in 2016 range from approximately 0.009 to 0.017 feet/day with a mean of approximately 0.013 feet/day (**Appendix F**). These low hydraulic conductivities further demonstrate the low groundwater yield potential across the conservatively interpreted, potential uppermost aquifer encountered at the site.

Assuming an average porosity of 0.4 for the silt/clay-rich soil within the uppermost aquifer, the mean hydraulic conductivity of 0.013 feet/day and a hydraulic gradient of 0.0036 foot/foot for the potential uppermost aquifer, the potential horizontal groundwater flow rate is approximately 0.00012 feet/day or 0.044 feet/year. This very low hydraulic conductivity and very low potential groundwater flow rate further demonstrates the very low groundwater yield potential across the conservatively interpreted, potential uppermost aquifer encountered at the SCPP BABs CCR unit.

4.4 Vertical Flow Potential to Uppermost Aquifer

As stated previously, the deposits underlying the SCPP predominantly consist of vertically thick and laterally continuous silty-clay rich deposit that that has been verified by regional geological studies and at the SCPP by numerous historical soil borings and further confirmed by the four soil borings installed as part of the CCR monitoring well installation program. Groundwater present within the deep confined potential uppermost aquifer is protected from CCR constituents by the over 120 feet thick clay-rich aquitard with low hydraulic conductivity. Using the hydrogeologic information for the site, the time of travel for water from the base-grade elevation of the SCPP CCR unit down to the uppermost aquifer can be calculated using the following seepage velocity formula:

$$V = Ki/Ne$$

Where:

V = Velocity (feet/day)

K = Hydraulic Conductivity (3 x 10^{-8} cm/s based on high end silty clay-rich soil geotechnical measurements)

i = Downward Vertical Gradient (conservatively assumed to be one foot/foot)

Ne = Effective Porosity (0.5 for clay-rich soil)

From the above formula, the maximum downward flow velocity through the silty-clay confining till unit to the uppermost aquifer is 6 x 10^{-8} cm/sec, or 0.063 feet/year. Therefore, the time of travel for liquid from the base of the SCPP through at least 120 feet of silty-clay (thinnest section of silty-clay confining unit found at the SCPP above the potential uppermost aquifer) to the potential uppermost aquifer, is approximately 1,900 years and more than 1,000 years to the uppermost sand seam at MW-16-01 encountered deeper than 80 feet below ground surface using conservative assumptions. The calculated travel time presented in the Natural Clay Liner Equivalency Report resulted in a travel time of greater than 150,000 years as the actual vertical hydraulic gradient used in these calculations was much lower (0.009 ft/ft) as detailed in **Appendix B** compared to the 1 ft/ft used in the above conservative seepage velocity calculation.

Therefore, given that SCPP operations began in 1953, and the fact that the SCPP will cease operation by late spring/early summer 2022 and BABs will be closed by removal, there is no reasonable probability for the uppermost aquifer to be affected by the SCPP CCR unit. The natural soil underlying the BABs unit consists of thick, low hydraulic conductivity clay, that provides at least the same level of protection from potential migration of contaminants than the composite liner defined in 40 CFR §257.70(b). Using recognized and generally accepted good engineering practice, TRC concludes that the natural soils below the SCPP BABs unit performs as good or better than composite liners.

4.5 Advanced Engineering Measures

The impoundments are sheet piled around the perimeters to approximately 13 feet bgs into native clay-rich soil. This acts as an additional lateral barrier between the SCPP BABs and the adjacent native clay liner.

4.6 Groundwater and Surface Water Use

No water supply wells are present within the unconsolidated sediment or bedrock within one mile of the SCPP. Surface water bodies present in the area of the SCPP include the Belle River (as close as 3,000 feet southwest of SCPP) and the St. Clair River (located approximately 30 feet to the east of the SCPP BABs CCR unit). Drinking water intakes in the St. Clair River are three miles upgradient of the SCPP BABs. The extensive natural clay-rich liner at the SCPP BABs protects the groundwater and surface water at and adjacent to the SCPP.

4.7 Detection Monitoring

A groundwater monitoring system has been established for the SCPP BABs CCR unit (Refer to **Appendix D**). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on **Figure 2.** Detection monitoring at the monitoring well system has been performed since 2017. No Appendix III SSIs have been recorded for the SCPP BABs since groundwater monitoring began in 2017, as documented in the Annual Reports prepared for the site (attached as **Appendix E**).

4.8 Future Contaminant Plume Containment

Based on studies, monitoring, and data that has been collected from the SCPP site to date, there has not been a release from the CCR unit and there is not a contaminant plume within the uppermost aquifer at the SCPP BABs CCR unit. As discussed in this report, the natural clay liner that is present beneath the SCPP BABs CCR unit has served to adequately protect groundwater. However, in the unlikely event that the uppermost aquifer is affected by an Appendix IV constituent within groundwater at a concentration above its groundwater protection standard (GWPS), an Assessment of Corrective Measures (ACM) would be triggered under 40 CFR §257.96. While the ACM would consider several options, given the short time frame to ceasing use of the BABs and closure by removal the most appropriate short-term response would be to implement groundwater extraction within the uppermost aquifer to contain the release and prevent plume migration to the St. Clair River. The long term corrective measure after the closure of the BABs by removal would likely be monitored natural attenuation (MNA) if an Appendix IV GWPS is still exceeded.

5.0 Facility Compliance

DTE Electric has a public repository of documents in accordance with 40 CFR §257.107 and can be found here: DTE CCR Compliance Data and Information. This repository demonstrates that the SCPP BABs CCR unit is in compliance with all record keeping, notification and internet posting requirements as required by 40 CFR 257 Subpart D. DTE Electric retained TRC to audit their records to verify if there were any gaps in compliance; none were identified. DTE Electric's certification of compliance as requested per 257.103 (b)(2)(v)(C)(1) has been included as **Appendix G**. A summary of the key compliance metrics for the SCPP BABs CCR unit are discussed below.

5.1 Groundwater Monitoring System

In accordance with 40 CFR §257.91, a P.E. certified groundwater monitoring system was established for the SCPP BABs CCR unit (**Appendix D**) as described earlier in Section 4.2. The detection monitoring well network for the BABs CCR unit consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring network consists of three down gradient (MW-16-02, MW-16-03 and MW-16-04) and one up gradient monitoring well (MW-16-01), with the stabilized groundwater potentiometric surface showing flow to the east towards the St. Clair River. The monitoring well locations are shown on **Figure 2**. Well Construction and Soil Boring Logs for the monitoring network are attached as **Appendix C**.

Groundwater elevation data collected during the March and September 2019 sampling events show that groundwater within the uppermost aquifer flows to the east-southeast across the SCPP BABs CCR unit towards the St. Clair River. Groundwater potentiometric surface elevations measured across the SCPP BABs CCR unit during the March and September 2019 sampling events were used to construct the groundwater potentiometric maps shown on **Figure 8 and Figure 9**.

There is a horizontally expansive clay with substantial vertical thickness (at least 120 feet) that isolates the uppermost aquifer from the SCPP BABs CCR unit (refer to **Figures 5, 6 and 7** for geologic cross sections). The general flow rate and direction in the uppermost aquifer has been consistently to the east towards the St. Clair River in all monitoring events completed since 2017. The groundwater has been demonstrated to flow at a very low rate as discussed in Section 4.3 and the compliance wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the SCPP BABs CCR unit (**Appendix E**).

5.2 Groundwater Statistical Analysis

The CCR Rule allows a variety of methods for conducting statistical evaluations. The certified Groundwater Statistical Evaluation Plan for the SCPP BABs CCR unit is attached as **Appendix H**. This plan was developed using USEPA's *Unified Guidance* and other available guidance (e.g., ASTM). In addition to using applicable guidance documents, commercially available statistical evaluation tools were utilized to establish statistically derived limits so that detection monitoring data could be evaluated. Statistical methods were also selected based on the geology and hydrogeology at the SCPP BABs CCR unit.

TRC considered interwell and intrawell methods as part of the selection criteria. These methods are fundamentally different, but both have their advantages and disadvantages. While the interwell analysis compares compliance wells against a background composed of upgradient well data, it typically relies on uniform hydrogeologic conditions and the presence of consistently upgradient and downgradient hydraulic flow conditions. By contrast, the intrawell analysis compares each compliance well against a background composed of its own historical data such that individual wells serve as both the background and downgradient compliance wells. Intrawell statistical methods for the SCPP BABs CCR unit were selected due to:

- The relatively small footprint of the BABs;
- The extremely low vertical and horizontal groundwater flow velocity as well as the diffusive properties of the clay;
- The potential for radial flow from the BABs if they leaked; and
- The saturated unit being monitored is isolated by an approximately 120-ft-thick laterally contiguous silty-clay unit native clay liner, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR from the BABs.

When an intrawell analysis is used, the base assumption is that the data used as background have not been impacted by the CCR unit. Given the significant clay isolation thickness between the BABs and the uppermost aquifer, and the low permeability of the underlying soil, the potential for water quality to be impacted from the BABs CCR Unit is extremely unlikely as described in detail in Section 4.0 of this report. On this basis, the intrawell methods are appropriate for detection monitoring at the SCPP BABs CCR unit. Based on the hydrogeologic conditions, including the small size of the BABs, the limited presence of the aquifer beneath the BABs, the background/downgradient monitoring wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the SCPP BABs CCR unit. The SCPP BABs CCR unit has remained in detection monitoring since the monitoring system was established as described further below. Since establishment of the system, DTE Electric performs groundwater sampling semi-annually in accordance with the *Groundwater Statistical Evaluation Plan DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins* – October 2017 **(Appendix H).**

Statistical evaluation of groundwater data is completed each time samples are collected in accordance with 40 CFR §257.93. Statistical methods for the BABs CCR unit was selected based on the geology and hydrogeology at the Site (primarily the presence of a significant clay/hydraulic barrier, the relatively small footprint of the BABs, and the low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). Refer to **Appendix H** for the *Groundwater Statistical Evaluation Plan, DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins* – October 2017 for further details on the statistical analysis.

No SSIs have been recorded for the SCPP BABs since monitoring began in 2017 (refer to Annual Reports included as **Appendix E** and the 2017 through 2019 detection monitoring data summarized in **Tables 1.1 through 1.5**) and detection monitoring will be continued at the SCPP BABs CCR unit in accordance with 40 CFR §257.94. In addition, based on the hydrogeology at the Site, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the SCPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from the SCPP operations. Refer to **Tables 1.1 through 1.5** for summary tables of constituent concentrations at each groundwater monitoring well monitored during each sampling event.

5.3 Location Standards

The SCPP BABs are compliant with the location restrictions of 40 CFR §257.60-64 as described below.

<u>§ 257.60 – Placement above the Uppermost Aquifer</u>

The federal CCR rule **<u>§ 257.60</u>** requires that CCR units such as the SCPP BABs must be constructed with a base that is located no less than 1.52 meters (5 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). The perimeter of each BAB is constructed of steel sheet piling installed to a depth of approximately 13 ft bgs (approximately 570.5 feet bgs based on site-specific datum). Pond bottom is maintained, by periodic dredging, at an elevation of approximately 572 feet bgs. The BABs are underlain by approximately 130 ft of silty clay with no significant zones of saturation. The uppermost aquifer is the silty clay hardpan/shale bedrock interface, located approximately 130.5 to 132 ft bgs. The base of the BABs and the uppermost aquifer are separated by approximately 120 ft of silty clay. Cross-sections showing the approximate bottom elevation for each BAB, and the depth to the uppermost aquifer are attached as **Figures 6 and 7.**

Based on this demonstration, the base of each BAB is located greater than 5 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 fluctuations in groundwater level. Therefore, each of the SCPP BABs is in compliance with the requirements of <u>§257.60.</u>

<u>§ 257.61 – Wetlands</u>

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 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 SCPP BABs are located in wetlands.

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 350 ft south-southwest of the BABs as a wetland. This area is not immediately adjacent to the BABs and is hydraulically separated by the silty clay confining layer surrounding and underlying the BABs, and therefore, there is no risk of impact to this area from the BAB operations.

Based on TRC's review of wetland inventory resources and current site conditions, the SCPP 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 and are in compliance with §257.61.

§ 257.62 – Fault Areas

The federal CCR rule **§ 257.62** 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 SCPP BABs.

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

§ 257.63 – Seismic Impact Zones

The federal CCR rule **§ 257.63** 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 existing SCPP BABs are located in a seismic impact zone, the USGS Earthquake Hazards Program was consulted to determine the earthquake hazard for the SCPP. 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 SCPP 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 SCPP BABs are not located in a seismic impact zone, and therefore, the BABs are in compliance with the requirements of §257.63.

§ 257.64 – Unstable Areas

The federal CCR rule **§ 257.64** 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, topography, and evaluating human-made features in the area of the SCPP BABs.

Geotechnical explorations performed at the SCPP BAB area identified silty clay with traces of sand and gravel overlying an approximately 5-ft thick saturated hardpan which overlies a low permeability shale bedrock at a depth of approximately 130 ft bgs. These observations suggest that there are no unstable soil or underlying bedrock conditions proximal to the BABs. Additionally, the perimeter walls of the BABs are constructed of steel sheet pile driven into the stable clay-rich soils, and these perimeter walls are tied back to driven steel sheets located 15 feet behind the perimeter walls. These tie-backs further serve to stabilize the BAB walls and minimize potential for sidewall collapse.

Human-made features surrounding the BAB area include concrete pavement and a steel seawall along the St. Clair River shoreline. Both of these features significantly reduce any erosional forces on surficial and near-surficial soils caused by surface water drainage and river flow adjacent to the BABs. Geological and geomorphological changes near the SCPP were primarily caused by hydrologic forces imparted by the St. Clair River flow. These ongoing forces and any impact they might have on the BABs are negated by the facility's shoreline sea wall and are not contributing to any 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 SCPP BABs are not located in unstable areas. The BABs are in compliance with the requirements of §257.64.

Refer to **Appendix** I for the Location Restrictions Demonstrations, DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins – October 2018 for further details.

5.4 Annual Reporting

In accordance with rule 40 CFR §257.90, DTE Electric has submitted the annual reports for 2017-2019. Copies of these reports are attached as **Appendix E**. These reports demonstrate compliance with 40 CFR §257.90.

5.5 Structural Stability

Structural stability assessment and safety factor assessments as required per 40 CFR §257.103 (f)(2)(v)(C)(7) and (8) are not required for incised impoundments and have therefore not been included with this submittal.

5.6 Closure Plans

Updated Closure Plans for each of the BABs have been attached as **Appendix H**. These have been prepared in accordance with 40 CFR §257.102 and document the proposed impoundment closure timeframes with the SCPP ceasing operations by late spring/early summer 2022 and closure by removal completed by the end of 2022. Currently DTE Electric maintains capacity within the BABs by removing approximately 750 cubic yards of CCR on a weekly to biweekly basis from the eastern BAB depending upon run time of the SCPP units. Both BABs are fully cleaned out less than once a year (removing approximately 4,500 cubic yards of CCR in a full cleanout). It is estimated that approximately 5,000 to 6,000 cubic yards of CCR material will need to be removed after the SCPP boilers have ceased operation in spring/summer 2022 in the final closure by removal effort that is planned to be completed by the end 2022.

The major tasks and estimated durations associated with closing the SCPP BABs by removal are summarized below. The design, permitting, and procurement efforts are anticipated to take place while the SCPP BABs CCR unit is still in operation. Assuming that construction work is completed on a fifty hours per week schedule (10 hours per day, 5 days per week), construction to remove CCR from the SCPP BABs is anticipated to take 3 to 4 months to complete and would include the following major tasks:

- Mobilization of construction equipment and temporary facilities (1 to 2 weeks);
- Installation of erosion controls and completion of site preparation, including the installation of silt fence and access road improvements, as required (1 to 2 weeks);
- Abandonment of CCR process-related piping, removal of stored water with the CCR surface impoundment utilizing temporary high-capacity diesel or electric pump(s), and dewatering of CCR material contained within the confines of the BABs utilizing temporary excavated sumps, temporary pumps, and filtration equipment, as required (4 to 6 weeks);
- Completion of CCR removal and decontamination within the BABs utilizing a long reach excavator(s) to remove material, transfer to articulated dump trucks, and relocate to an on-site staging area prior to offsite transportation and disposal at the RRLF (4 to 6 weeks); and,
- Completion of site restoration activities, including final grading to restore adjacent areas to pre-construction grades (1 to 2 weeks).

6.0 Conclusions

This document demonstrates how the SCPP BABs CCR unit meets the alternative closure provision for the permanent cessation of coal-fired boiler(s) by a date certain (CFR §257.103(f)(2)). This has been demonstrated by:

- Planned cessation of the coal fired boilers is late spring/early summer 2022.
- Alternative disposal capacity is unavailable and implementation of one or more of the alternative capacity technologies evaluated by the EPA is not required since the coal fired boilers will cease operation by late spring/early summer 2022.
- The natural clay liner (approximately 120 feet thick) at the SCPP is protective of the uppermost aquifer at the SCPP BABs CCR unit. No Appendix III SSIs have been recorded for the SCPP BABs since detection groundwater monitoring began in 2017 to the present. There is no complete receptor pathway to the uppermost aquifer or surface water. Consequently, there are no current or anticipated unacceptable risks to human health and the environment by the short-term continued operation of the SCPP BABs CCR unit.
- The SCPP BABs CCR unit is in compliance with the CCR Rule and will remain in compliance with all requirements of the CCR Rule.

Therefore, it is requested that the EPA approve DTE Electric's demonstration and authorize the SCPP BABs CCR unit at the SCPP to continue to receive CCR and non-CCR waste streams and to grant the alternative deadline of October 17, 2023 to complete closure of the BABs surface impoundments. Until the SCPP BABs CCR unit is closed, DTE Electric will include in the annual progress reports a documentation of closure progress and a demonstration that compliance is maintained.

7.0 References

ASTM. 2012. *Standard Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs*. D6312-98(2012)e1. West Conshohocken, PA: ASTM International.

Beth A. Apple and Howard W. Reeves, 2007, Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p

DTE Electric Company website: DTE CCR Compliance Data and Information

DTE Electric Company. 2019. 2019 Integrated Resource Plan Case No: U-20471, Exhibit A-3 submitted to the Michigan Public Service Commission.

TRC Environmental Corporation. January 2020. 2019 Annual Groundwater Monitoring Report - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

TRC Environmental Corporation. January 2019. 2018 Annual Groundwater Monitoring Report - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

TRC Environmental Corporation. December 2018. Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six Southeast Michigan Coal Combustion Residual Units

TRC Environmental Corporation. October 2018. Location Restrictions Demonstrations - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

TRC Environmental Corporation. January 2018. 2017 Annual Groundwater Monitoring Report - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

TRC Environmental Corporation. October 2017. Groundwater Monitoring Systems Summary Report - DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan 48054

Tables

Table 1.1

Comparison of Appendix III Parameter Results to Background Limits – October 2017
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
Sample Date:		10/6/2017		10/6/2017		10/6/2017		10/6/2017	
Constituent	Unit	Data	PL	Data	PL	Data	PL	Data	PL
Appendix III									
Boron	ug/L	2,000	2,600	2,000	2,400	1,900	2,300	2,100	2,600
Calcium	ug/L	19,000	24,000	40,000	69,000	56,000	61,000	38,000	57,000
Chloride	mg/L	1,200	1,400	1,900	2,100	2,100	2,200	2,500	2,800
Fluoride	mg/L	2.0	2.1	1.6	1.6	1.5	1.6	1.7	1.7
pH, Field	SU	8.2	7.2 - 8.6	8.1	7.5 - 8.3	7.9	7.3 - 8.5	8.0	7.3 - 8.4
Sulfate	mg/L	7.1	62	<2.0	25	<2.0	25	<5.0	25
Total Dissolved Solids	mg/L	2,000	2,500	2,700	3,600	3,200	4,000	3,600	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT	Shading and bold font indicates a confirmed exceedance of the Prediction Limits (PL).

Table 1.2

Comparison of Appendix III Parameter Results to Background Limits – April 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
Sample Date:		4/13/2018	PL	4/13/2018	PL	4/13/2018	PL	4/13/2018	PL
Constituent	Unit	Data		Data		Data		Data	
Appendix III									
Boron	ug/L	2,100	2,600	2,000	2,400	2,100	2,300	2,400	2,600
Calcium	ug/L	19,000	24,000	39,000	69,000	61,000	61,000	56,000	57,000
Chloride	mg/L	1,300	1,400	2,000	2,100	2,100	2,200	2,500	2,800
Fluoride	mg/L	2.1	2.1	1.6	1.6	1.5	1.6	1.7	1.7
pH, Field	SU	7.9	7.2 - 8.6	8.0	7.5 - 8.3	7.7	7.3 - 8.5	7.7	7.3 - 8.4
Sulfate	mg/L	3.4	62	<2.0	25	<2.0	25	<2.0	25
Total Dissolved Solids	mg/L	2,200	2,500	3,200	3,600	3,400	4,000	4,000	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

🟩 **RESULT**	Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

Table 1.3

Comparison of Appendix III Parameter Results to Background Limits – October 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-01		MW-16-02		MW-16-03		MW-16-04		
Sample Date:		10/5/2018	PL	10/5/2018	PL	10/5/2018	PL	10/5/2018	1/8/2019(1)	PL
Constituent	Unit	Data		Data		Data		Data	Data	
Appendix III										
Boron	ug/L	2,400	2,600	2,200	2,400	2,200	2,300	**2,700**	2,400	2,600
Calcium	ug/L	20,000	24,000	38,000	69,000	54,000	61,000	46,000	--	57,000
Chloride	mg/L	1,300	1,400	2,000	2,100	2,100	2,200	2,600	--	2,800
Fluoride	mg/L	1.9	2.1	1.5	1.6	1.4	1.6	1.6	--	1.7
pH, Field	SU	8.3	7.2 - 8.6	8.1	7.5 - 8.3	8.0	7.3 - 8.5	8.1	--	7.3 - 8.4
Sulfate	mg/L	2.9	62	< 1.0	25	< 2.0	25	< 2.0	--	25
Total Dissolved Solids	mg/L	2,000	2,500	2,300	3,600	3,200	4,000	3,700	--	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

-- = not analyzed

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

(1) Results shown for verification sampling performed on 1/8/2019.

Table 1.4

Comparison of Appendix III Parameter Results to Background Limits – March and May 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-01		MW-16-02		MW-16-03			MW-16-04	
Sample Date:		3/21/2019	PL	3/21/2019	PL	3/21/2019	5/8/2019(1)	PL	3/21/2019	PL
Constituent	Unit	Data		Data		Data			Data	
Appendix III										
Boron	ug/L	2,200	2,600	2,200	2,400	2,200	--	2,300	2,500	2,600
Calcium	ug/L	19,000	24,000	37,000	69,000	51,000	--	61,000	40,000	57,000
Chloride	mg/L	1,400	1,400	2,100	2,100	**2,300**	2,100	2,200	2,800	2,800
Fluoride	mg/L	1.9	2.1	1.3	1.6	1.2	--	1.6	1.4	1.7
pH, Field	SU	8.0	7.2 - 8.6	7.9	7.5 - 8.3	7.9	7.8	7.3 - 8.5	8.1	7.3 - 8.4
Sulfate	mg/L	<5.0	62	<5.0	25	<5.0	--	25	<5.0	25
Total Dissolved Solids	mg/L	2,000	2,500	2,800	3,600	3,100	--	4,000	3,900	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

(1) - Results shown for verification sampling performed on 5/8/2019.

Table 1.5

Comparison of Appendix III Parameter Results to Background Limits – September 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

	Sample Location:	**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
	Sample Date:	9/19/2019	PL	9/19/2019	PL	9/19/2019	PL	9/19/2019	PL
Constituent	Unit	Data		Data		Data		Data	
Appendix III									
Boron	ug/L	2,200	2,600	2,100	2,400	2,000	2,300	2,400	2,600
Calcium	ug/L	21,000	24,000	41,000	69,000	51,000	61,000	43,000	57,000
Chloride	mg/L	1,200	1,400	1,800	2,100	2,000	2,200	2,400	2,800
Fluoride	mg/L	1.8	2.1	1.4	1.6	1.2	1.6	1.4	1.7
pH, Field	SU	8.2	7.2 - 8.6	8.2	7.5 - 8.3	8.1	7.3 - 8.5	8.2	7.3 - 8.4
Sulfate	mg/L	< 5.0	62	< 5.0	25	< 5.0	25	< 5.0	25
Total Dissolved Solids	mg/L	2,100	2,500	2,900	3,600	3,800	4,000	3,900	4,400

Notes:

ug/L - micrograms per liter.

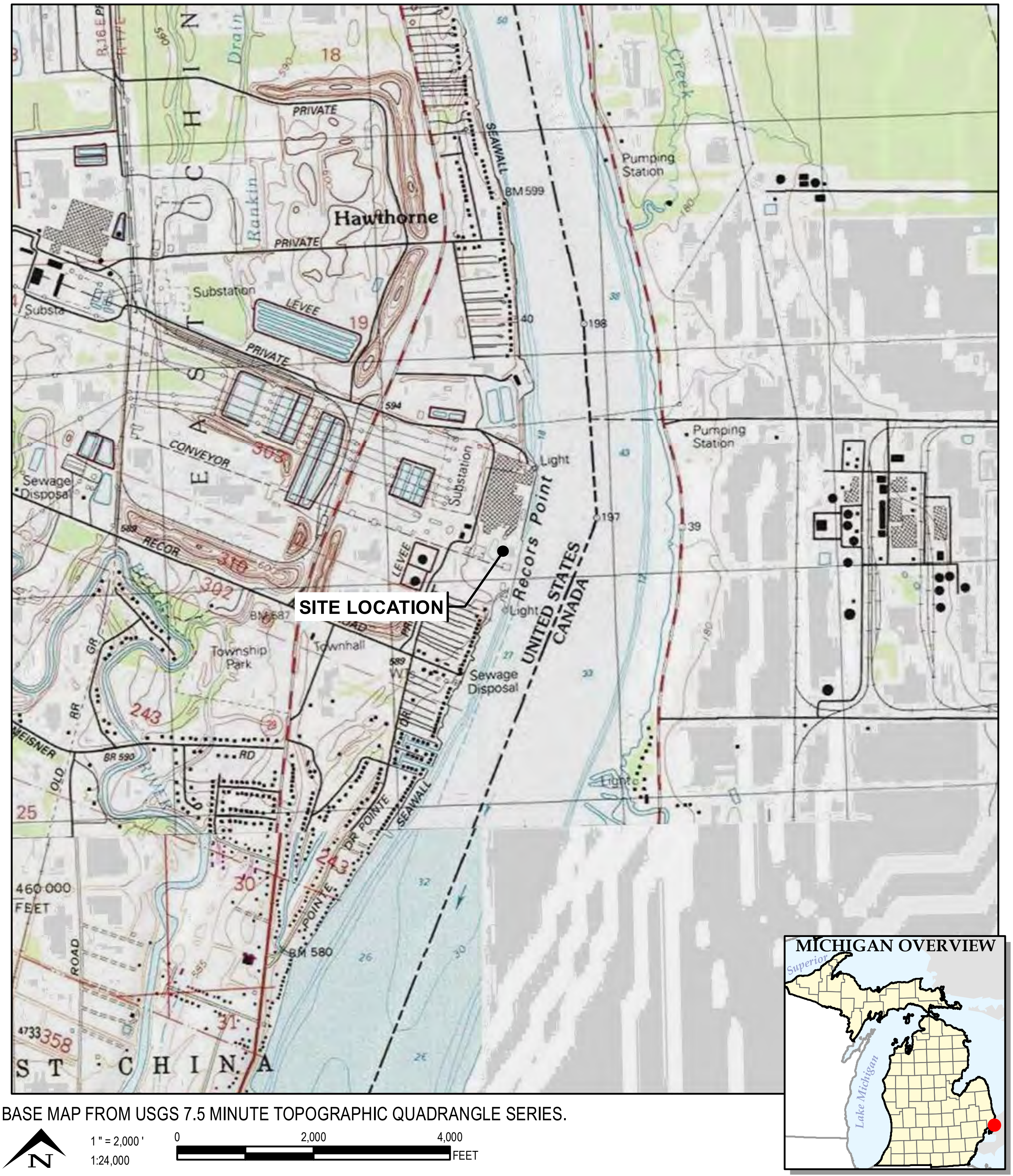
mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

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TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	S. MAJOR
CHECKED BY:	J. KRENZ
APPROVED BY:	V. BUENING
DATE:	JANUARY 2020
PROJ. NO.:	320511.0004
FILE:	320511-0003-002slmMB.mxd

FIGURE 1

LEGEND

⌖	MONITORING WELLS
▤	SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200
Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT BOTTOM ASH BASINS
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	S. MAJOR	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ		**FIGURE 2**
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		

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FILE NO.: 320511-0004-006.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/27/2020, 11:01:42 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
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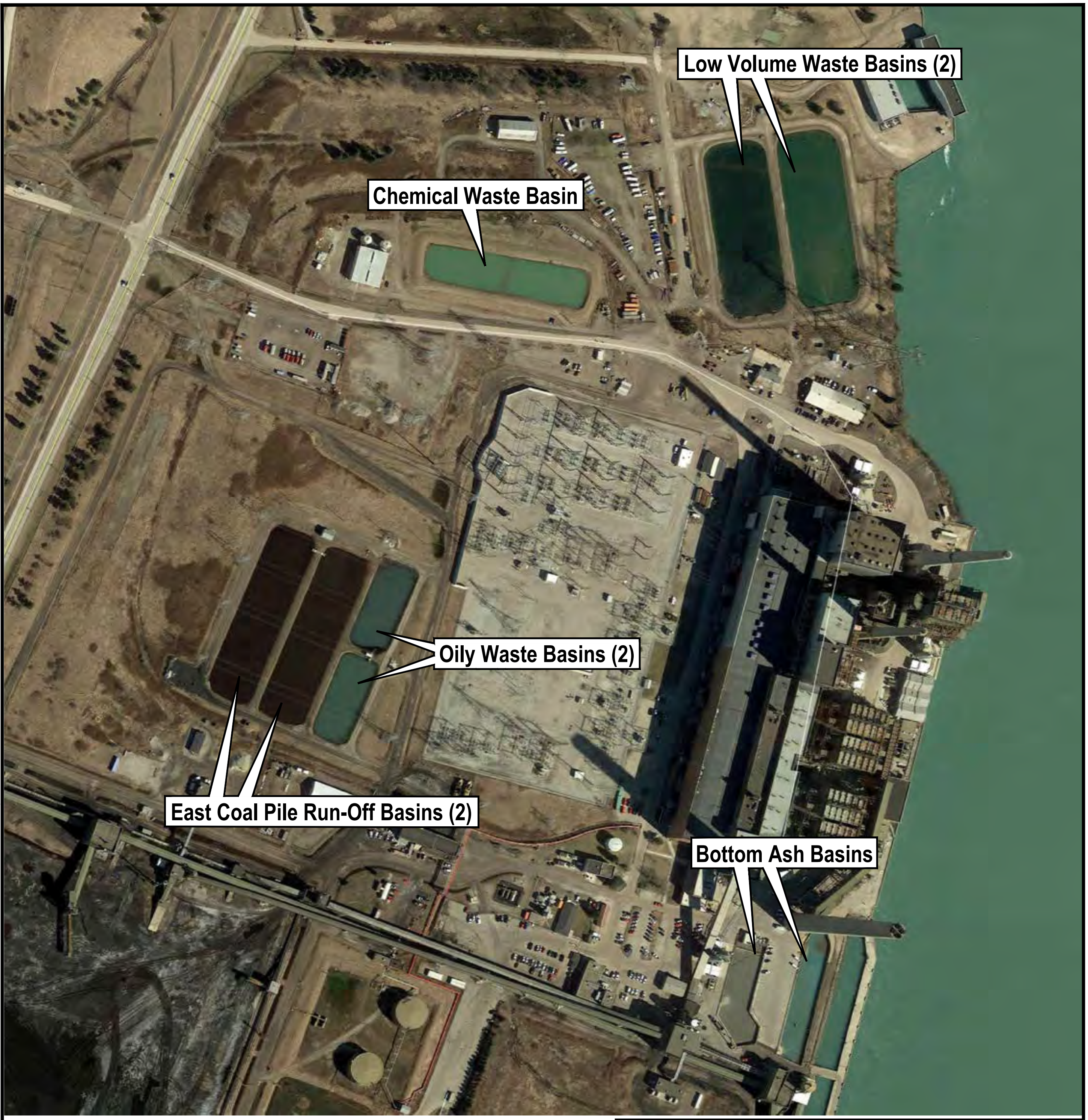

N

0 400' 800'

APPROXIMATE SCALE IN FEET

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

SURFACE IMPOUNDMENT LOCATIONS

DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0004.01.01
CHECKED BY:	K.CRATSENBURG	**FIGURE 3**	
APPROVED BY:	V.BUENING		
DATE:	NOVEMBER 2020		

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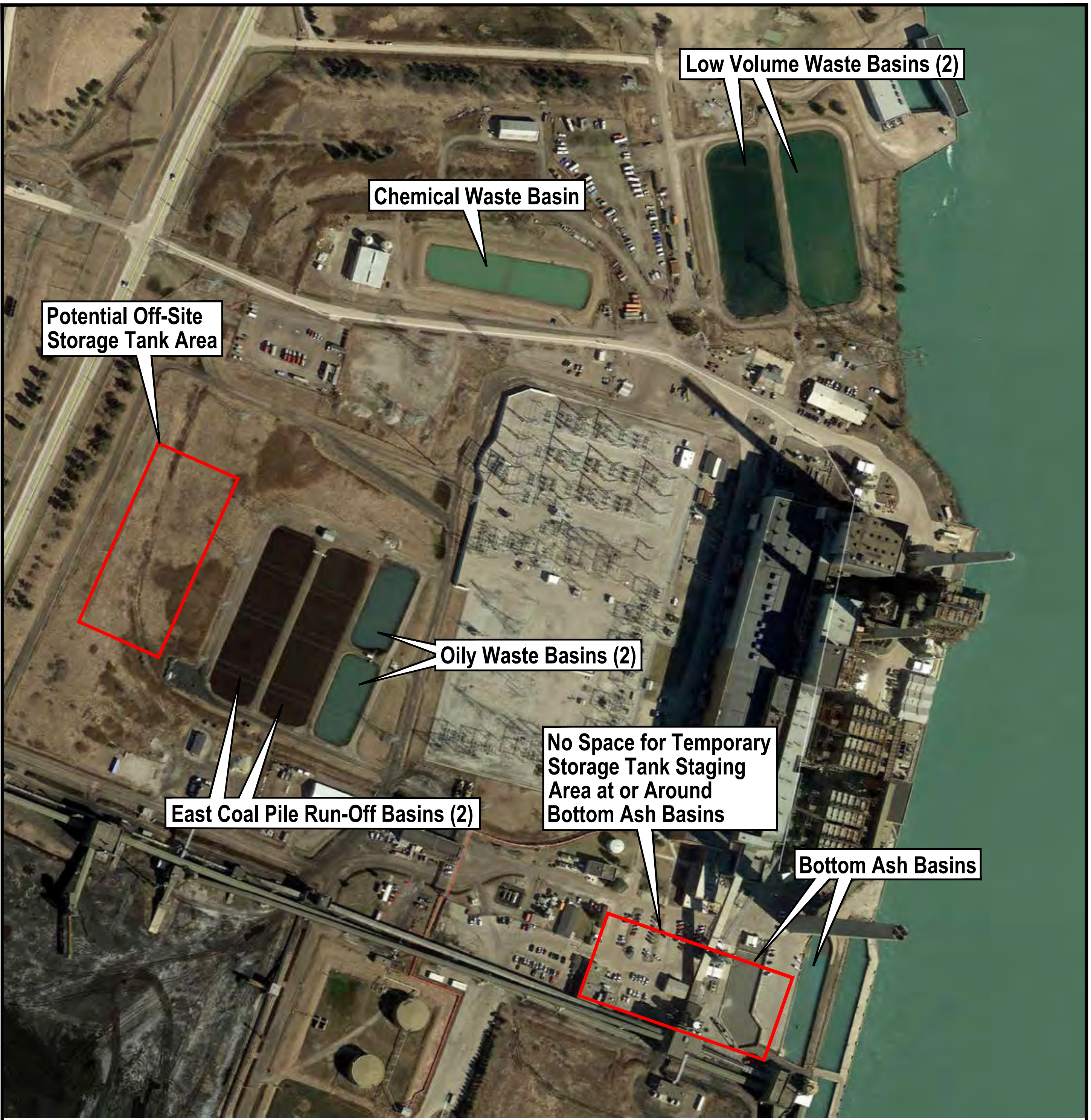
FILE NO.: 370029.0004.01.01.03 SI.dwg

8.5x11 --- USER: DStehle --- ATTACHED XREFS: --- ATTACHED IMAGES: SCPP 1000_2019-03-24 GEP;
DRAWING NAME: \\Annarbor-fp2\cadd\PJT\00_TRC\DTE\St Clair PP\370029\0004\01\01\01_Surface Impoundments\370029.0004.01.01.03 SI.dwg --- PLOT DATE: November 13, 2020 - 8:56AM --- LAYOUT: FIG03 Surf Impoundments

Version: 2017-10-21



PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

POTENTIAL TEMPORARY ABOVE GROUND STORAGE TANK AREAS

DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0004.01.01
CHECKED BY:	K.CRATSENBURG		
APPROVED BY:	V.BUENING	**FIGURE 4**	
DATE:	NOVEMBER 2020		

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FILE NO.: 370029.0004.01.01.05 SI.dwg

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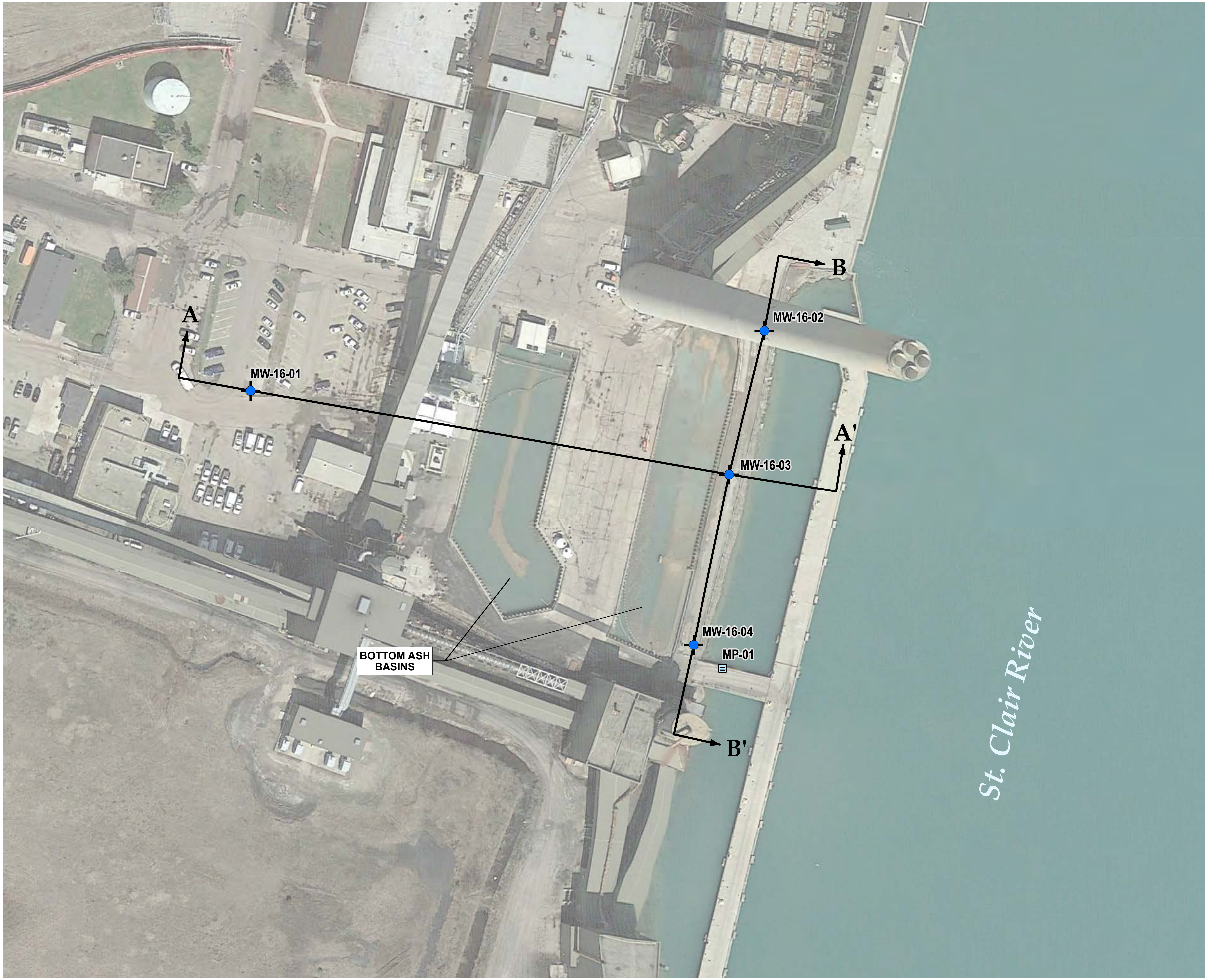
DRAWING NAME: J:_TRC\DTE\St Clair PP\370029\0004\01\01_Surface Impoundments\370029.0004.01.01.05 SI.dwg --- PLOT DATE: November 24, 2020 - 7:27AM --- LAYOUT: FIG04 Pot Temp AG Storage Tank Areas

Version: 2017-10-21



LEGEND

- ⌖ MONITORING WELLS
- ⊟ SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
CROSS SECTION LOCATOR MAP

DRAWN BY:	S. MAJOR	PROJ NO.:	370029.0004
CHECKED BY:	S. HOLMSTROM	**FIGURE 5**	
APPROVED BY:	V. BUENING		
DATE:	SEPTEMBER 2020		

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Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

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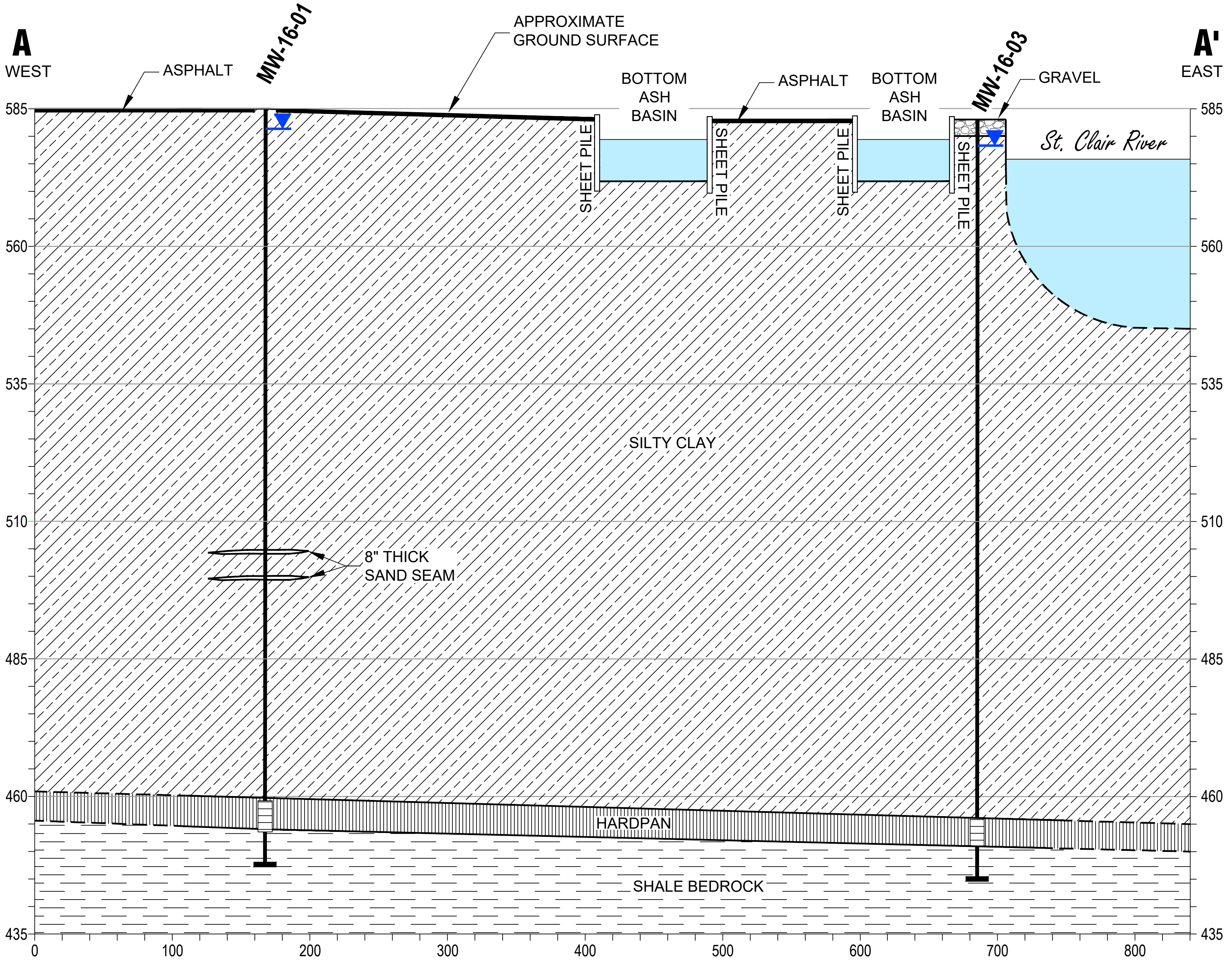
Path: E:\DTE\CCR_Sites\2017_265996\370029-0004-006.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'

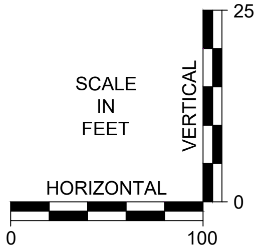


LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
GROUNDWATER ELEVATION (COLLECTED 02/28/2017)
SOIL BORING
WELL SCREEN INTERVAL
END OF BORING

Lithology Key

▥ HARDPAN
▨ SILTY CLAY
▤ SHALE BEDROCK



PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0004.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 6**	
APPROVED BY:	V.BUENING		
DATE:	JULY 2020		

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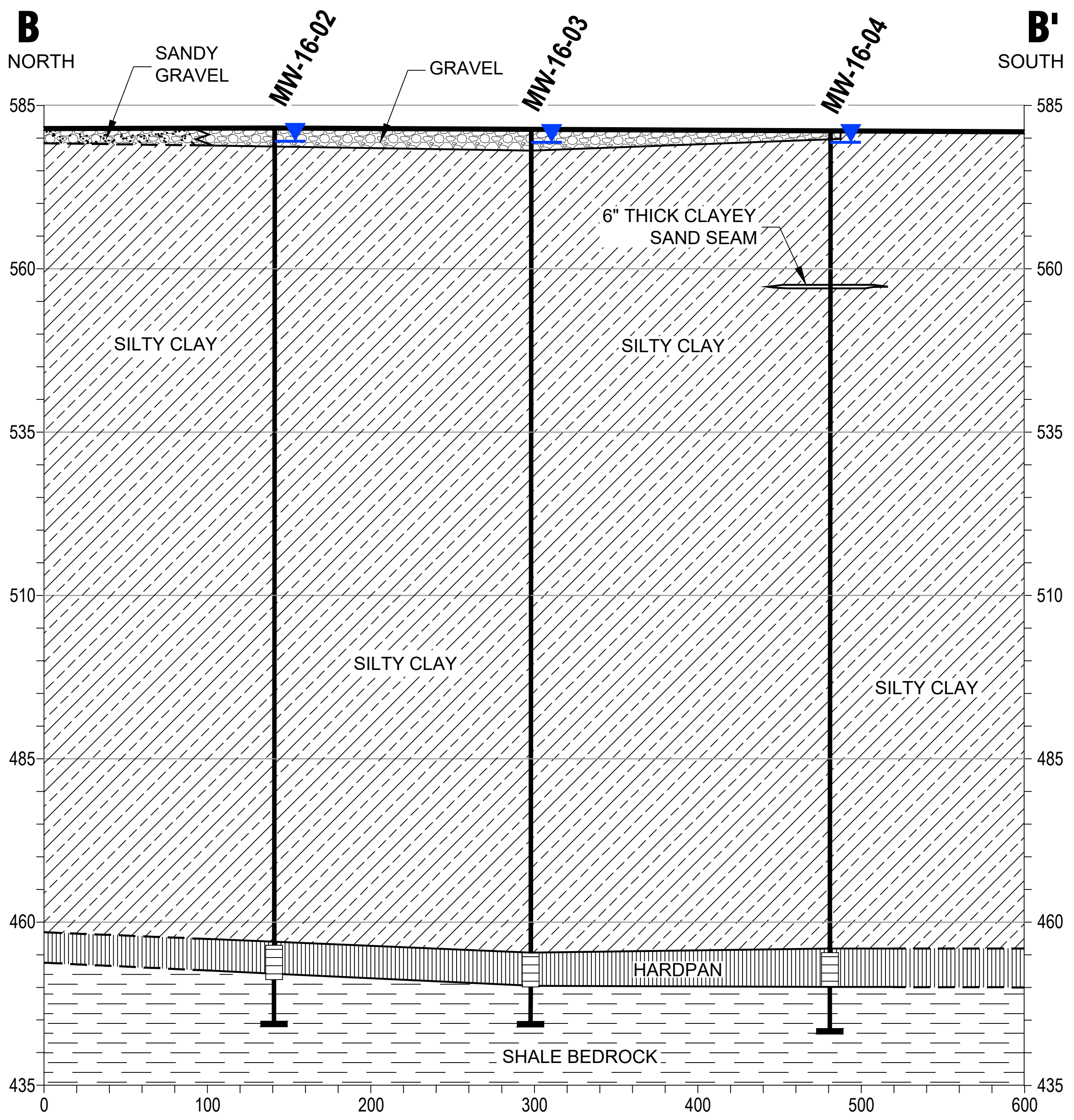
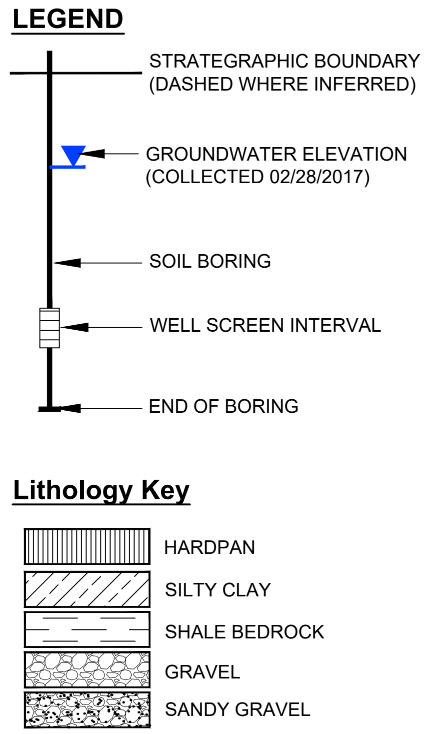
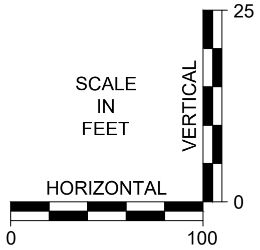
FILE NO.: 370029.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\370029\0004\01\01\2020 July WIR Update\ 370029.0004.01.01.04-05.dwg --- PLOT DATE: November 12, 2020 - 4:49AM --- LAYOUT: FIG06 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'







PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION B-B'

DRAWN BY:	D.STEHLE	PROJ NO.:	370029.0004.01.01
CHECKED BY:	S.HOLMSTROM		**FIGURE 7**
APPROVED BY:	V.BUENING		
DATE:	JULY 2020		

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FILE NO.: 370029.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\370029\0004\01\01\2020 July WIR Update\ 370029.0004.01.01.04-05.dwg --- PLOT DATE: November 12, 2020 - 8:14AM --- LAYOUT: FIG07 XS BB

LEGEND

✛	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC
SURFACE MAP
MARCH 2019

DRAWN BY:	S. MAJOR	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ		**FIGURE 8**
APPROVED BY:	V. BUENING		
DATE:	NOVEMBER 2019		

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FILE NO.: 320511-0004-001.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 11/1/2019, 10:30:29 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0004-001.mxd

LEGEND

✛	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT BOTTOM ASH BASINS
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC
SURFACE MAP
SEPTEMBER 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ	**FIGURE 9**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		

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FILE NO.: 320511-0004-005.mxd

Plot Date: 1/3/2020, 11:04:59 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\DTE_Energy\320511_StClair\MXD\320511-0004-005.mxd

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

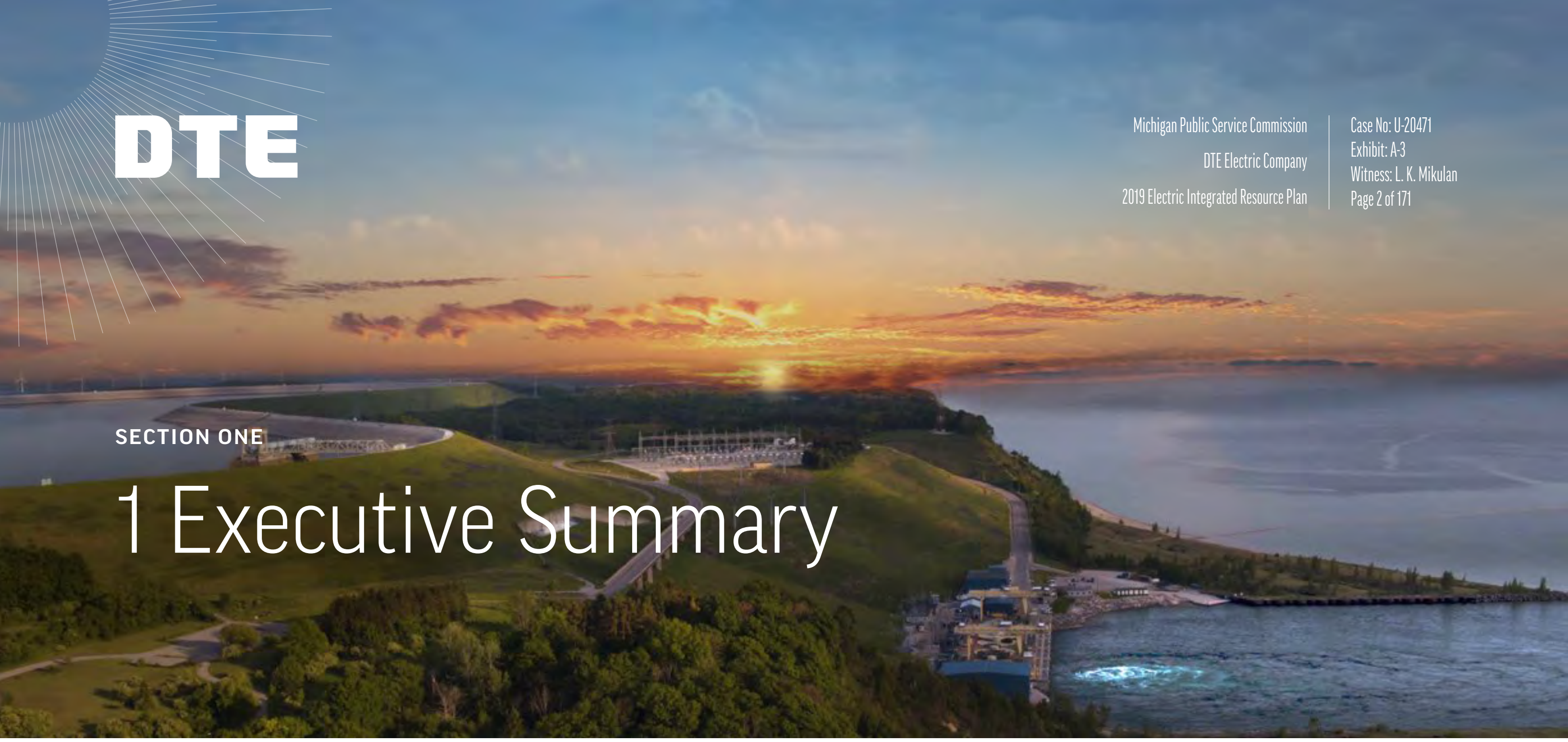
TRC - GIS

Appendix A
DTE Electric Company 2019 Integrated Resource Plan

DTE

2019 INTEGRATED RESOURCE PLAN

Clean, Reliable Solutions to Power Michigan's Future



SECTION ONE

1 Executive Summary

Introduction

Michigan is in the midst of an energy transformation. We are reimagining and restructuring how we power our homes, our businesses and our vehicles.

The drivers of that transformation – a desire for safe, clean, affordable and reliable power; an aging power infrastructure; and the need to minimize our impact on the environment – each require thoughtful consideration and balance. DTE has 11,770 megawatt system capacity, and uses coal, nuclear fuel, natural gas, hydroelectric pumped storage, wind, and solar to generate its electrical output. The Company also holds a variety of power purchase agreements with independent power producers throughout Michigan.

At DTE Energy – a Michigan-based company serving 2.2 million electric customers and 1.3 million gas customers – we have been at the forefront of successfully striking that balance. In 2017, DTE announced plans to reduce our carbon emissions by more than 80 percent by 2050, making it one of the most aggressive plans in the country. And last year, we committed to producing 50 percent of our energy from clean sources by 2030. This clean energy commitment includes a minimum of 25 percent renewables and at least a 1.5 percent improvement in energy efficiency each year.

With this integrated resource plan, we're going even further – a lot further. **We're moving up our carbon-emissions goal by a full decade, pledging to reduce emissions by 80 percent by 2040. And in the near term, we have committed to a 50 percent carbon emissions reduction by 2030[1].** And we're doing so in a way that ensures our energy sources remain reliable and the power they produce affordable.

In order to achieve our bold new goal, we're expanding our energy-efficiency programs to reduce even more consumption and help our customers - especially our low-income customers - save energy and money. And we've expanded our voluntary renewables program, MIGreenPower, to our large business and industrial customers, which will accelerate our state's transition to renewable energy and empower companies to meet their sustainability goals through voluntary investments.

We're also moving our previously announced closures of the Trenton Channel Power Plant and the final generation unit at St. Clair Power Plant up one year, to 2022.

We're committed to our communities – to creating jobs for the people who live in them and to providing a balanced mix of safe, clean, reliable and affordable energy. In fact, reducing carbon is the greatest opportunity we have as an energy company. And we're already doing it – by building the clean energy sources that our customers are asking us to build.

This integrated resource plan (IRP), submitted to the Michigan Public Service Commission, lays out our vision for ensuring Michigan continues to lead in creating clean, reliable, affordable, home-grown energy that its residents and businesses can depend on. It provides both a high-level and detail-rich strategy for powering Michigan's homes and businesses over the next five years, as well as a flexible long-term plan that can evolve as our technological options and the needs of our state evolve.

> "Not only is our 80% carbon reduction goal achievable – it is achievable in a way that keeps Michigan's power affordable and reliable. There doesn't have to be a choice between the health of our environment or the health of our economy; we can achieve both."
>
> **Gerry Anderson,** chairman and CEO, DTE Energy

More Clean Energy, Less Coal

Climate change is one of the defining public policy issues of our time. At DTE, we are passionate about being central to the solution. That's why we have set ambitious new goals of reducing carbon emissions by 80 percent by 2040 and 50 percent by 2030. Those goals align with the target scientists have identified as necessary to help address climate change, and we will achieve them through aggressive investment in energy efficiency, renewables, the Blue Water Energy Center and our voluntary renewables programs, as well as through earlier coal retirements.

Coal Plant Retirements

In 2016, DTE announced the retirements by 2023 of three aging power plants – River Rouge, St. Clair and Trenton Channel– that account for nearly 20 percent of our total generation. Those retirements follow the closure of two other plants – Marysville and Harbor Beach – between 2011 and 2013, and generation units at our St. Clair, Trenton Channel and River Rouge plants between 2011 and 2017.

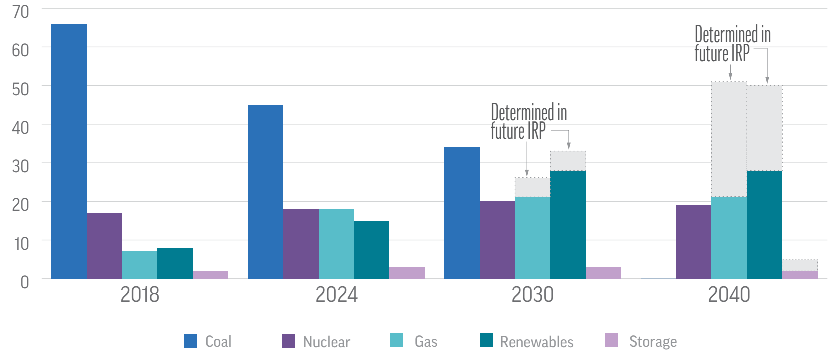
---

[1] Compared to 2005 baseline; CO2 emissions associated with energy generated for DTE Electric customers.

We're now planning to close our Trenton Channel Power Plant and St. Clair Power Plant in 2022 – one year earlier than we originally intended.[2] We want to move forward as quickly as possible to achieve our carbon-reduction goal, and need to do it in a way that balances the reliability of the energy grid while also working closely with the impacted communities and employees during this transition.

We're now planning to close our coal-burning Trenton Channel Power Plant and the last operating unit at St. Clair Power Plant in 2022 – one year earlier than we originally intended. The Midcontinent Independent System Operator (MISO), the regional grid operator, must complete a reliability assessment before these dates are finalized. We want to move forward as quickly as possible to achieve our carbon reduction goal, and need to do it in a way that balances the reliability of the energy grid while also working closely with the impacted communities and employees during this transition.

FIGURE 1.1 2018-2040 Generation Mix



*Based on current projections. Final percentages to be determined in future IRPs.

Our coal plants have served our communities and employees well for nearly 75 years. We're proud of that legacy of service and will continue to build upon it for generations to come. We are working closely with municipal leaders in River Rouge, Trenton and St. Clair County to find meaningful ways to turn the coal plant properties into viable economic contributors after our facilities close. We are collaborating with union leadership on developing retraining programs and an employee transition strategy that is committed to no layoffs while maintaining affordable and reliable 24/7 power for our customers.

4,000

Michigan jobs created

2040

Our renewable energy will quadruple by 2040

---

[2] contingent on resolution of grid reliability concerns

Building Renewables

DTE is Michigan's largest renewable-energy provider. By 2024, we will more than double our renewable energy, generating enough clean energy to power 800,000 Michigan homes. By the time we remove all coal from our generation fleet in 2040, our renewable-energy portfolio will have quadrupled.

Since 2009, we've driven investments of $2.8 billion in renewable energy – a figure that will increase to $4.8 billion by 2024. The vast majority of that investment is supporting Michigan communities and creating Michigan jobs.

DTE's Renewables Mix Today

Solar

DTE currently operates more than 30 solar parks in Michigan, with plans to increase solar capacity by 25 percent over the next five years. In 2017, DTE commissioned the O'Shea Solar Park in Detroit, repurposing 10 acres of previously vacant land, and the Lapeer Solar Park, the largest universal solar park in the state. The Lapeer site includes 200,000 solar panels, making it one of the largest solar parks east of the Mississippi, and its arrays produce enough clean energy to power 11,000 homes.

30
30 solar parks in Michigan

200K
200,000 solar panels in Lapeer

11K
11,000 homes can be powered by the Lapeer Solar Park

Wind

Wind is currently our lowest-cost and most abundant renewable resource, which is why we've already invested in the building of 14 wind parks. In early 2019, DTE commissioned Pine River, its largest operating wind park to date. Its 65 turbines generate enough energy to power more than 54,000 homes. Pine River will offset nearly 300,000 metric tons of CO2 annually – the greenhouse-gas equivalent of taking more than 63,000 cars off the road. In early 2020, we'll commission an additional wind park that will be even larger than Pine River.

14
We've invested in 14 wind parks

300K
Pine River will offset nearly 300,000 metric tons of CO2

2020
In 2020 we'll commission an additional wind park

Partnering with Michigan residents, business and industry

We're proud of our investment in renewables, of DTE's leadership in this critically important area and of the fact that we align with scientific consensus about the steps needed to protect our planet. And we're determined to go further.

Combating climate change must be a cross-industry effort, so we've expanded our MIGreenPower program to our large business and industrial customers. Introduced in 2017, MIGreenPower is a voluntary renewable energy program that provides DTE's residential and business customers with an easy and affordable way to reduce their carbon footprint by increasing the percentage of their energy use attributable to local wind and solar energy sources, up to 100 percent. Participating customers – who now number more than 5,000 – see a slight increase in their monthly bill while knowing they're helping to support Michigan's clean energy future.

We're expanding this voluntary initiative to meet the needs of our largest business and industrial customers who are working to meet their own sustainability goals, enabling them to invest in renewable energy, which will help drive our state toward an even cleaner future. The program is designed to grow and represents a progressive approach to fill market demand. In fact, we've already partnered with Ford and GM to provide renewable energy to support their sustainability goals.

Ford has committed to procuring 500,000 MW hours annually of wind energy to power several of its Michigan facilities, including the plant that makes its popular F-150 truck. GM has partnered with DTE to procure 300,000 MW hours annually of wind energy to power its technical center in Warren, Mich., and its headquarters in Detroit.

DTE also is exploring opportunities to expand its residential offerings to those interested in more local, community renewable energy.

Improving Energy Efficiency

Energy efficiency works hand-in-hand with renewable energy sources to ensure we meet our clean energy goals. In short, when homes and businesses reduce their energy use, we can generate less electricity, benefiting both customers' pocketbooks and the environment.

DTE previously committed to increasing energy efficiency at a level equivalent to 1.5 percent of sales annually. Our efforts already have resulted in nearly 700 MW annually of reduced energy demand since 2009, equivalent to the energy produced by one large power plant. Improving energy efficiency also results in lower bills for customers; for every dollar invested in energy efficiency, customers save $5.

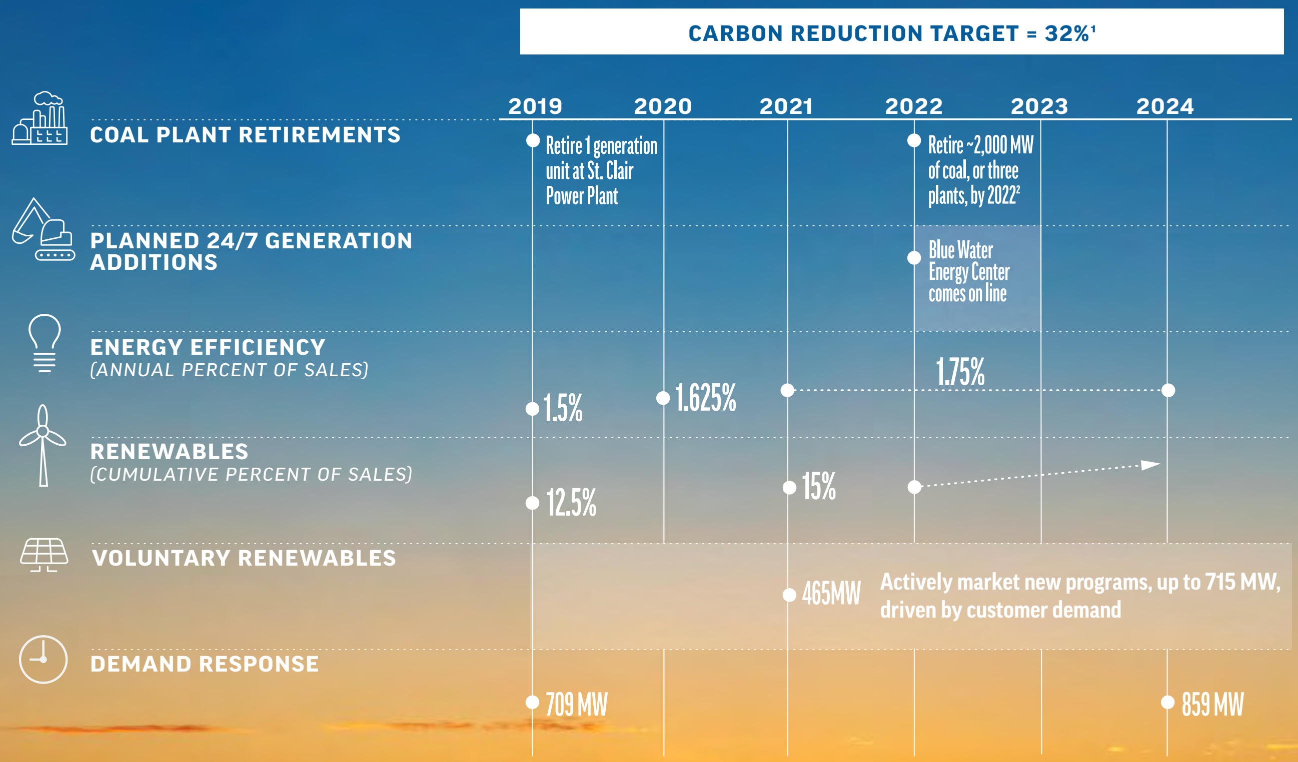
With this plan, we're building on the success of these efforts by committing to a 1.75 percent annual improvement in energy efficiency - 75 percent more than the level required by law. Improving energy efficiency will reduce our carbon emissions even further – meaning we need to generate even less energy. The expansion of those programs also will mean more jobs and business for the Michigan firms that support them.

DTE also is a leader in demand response, rewarding residential and business customers who reduce or shift electricity usage during peak periods. We offer our customers the opportunity to reduce their energy use and lower their bills through multiple programs. Our demand-response program is in the top 25 percent nationwide and is the largest in Michigan, with more than 700 MW of program capacity.

Powering Michigan's Future

The plan we are submitting focuses on the next five years and considers the most affordable and reliable mix of generation sources that are available today. However, these technologies are improving rapidly, so we also have created a flexible long-term plan that allows us to review technological advancements as they become feasible and affordable. We've developed four alternate long-term options, modeling different costs and technology assumptions for each. We will continue to revisit and refine our plan as technology develops, customer desires and trends become more clear, and costs decline. For more information on demand-side rates and resources, see Section 8: Demand-Side Resources

The Defined Short Term: 2019-2024



CARBON REDUCTION TARGET = 32%[1]

2019 2020 2021 2022 2023 2024

COAL PLANT RETIREMENTS
2019: Retire 1 generation unit at St. Clair Power Plant
2022: Retire ~2,000 MW of coal, or three plants, by 2022[2]

PLANNED 24/7 GENERATION ADDITIONS
2022: Blue Water Energy Center comes on line

ENERGY EFFICIENCY
(ANNUAL PERCENT OF SALES)
2019: 1.5%
2020: 1.625%
2021–2024: 1.75%

RENEWABLES
(CUMULATIVE PERCENT OF SALES)
2019: 12.5%
2021: 15%

VOLUNTARY RENEWABLES
2021: 465MW
Actively market new programs, up to 715 MW, driven by customer demand

DEMAND RESPONSE
2019: 709 MW
2024: 859 MW

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1. Compared to 2005 baseline; CO2 emissions associated with energy generated for DTE Electric customers

2. Retirements of St. Clair, River Rouge and Trenton Channel plants are contingent on the successful start up of Blue Water Energy Center and resolution of grid reliability concerns

The Flexible Future: 2025-2030

CARBON REDUCTION TARGET = 50%[1]

- Retire Belle River Power Plant by 2030
- Increase renewables to at least 25%
- Continue 1.75% energy efficiency and review biannually
- Maintain or increase demand response
- Continue to market and add voluntary renewables based on customer demand

Possible pathways that could meet future generation needs:

A Achieve 1,390 MW of voluntary renewables Increase demand response Maintain 1.75% energy efficiency	**B** Achieve 1,390 MW of voluntary renewables Construct new natural gas-fueled power plant Maintain 1.75% energy efficiency
C Achieve 465 MW of voluntary renewables Increase demand response Increase energy efficiency to 2.00% in 2026	**D** Achieve 465 MW of voluntary renewables Construct new natural gas-fueled power plant Maintain 1.75% energy efficiency

The Flexible Future: 2031-2040

CARBON REDUCTION TARGET = 80%[1]

- Retire Monroe Power Plant by 2040
- Increase renewables, energy efficiency and demand response consistent with carbon reduction goals

There are multiple pathways to meet carbon goals and generation needs in 2030 and beyond; we will remain flexible and present potential future options in our next IRP.

Balanced, Reliable, Customer-Focused

As we embrace renewable energy, our IRP provides a clear and balanced path for meeting our carbon-reduction goals while ensuring energy remains affordable and reliable.

Michigan's unique peninsular geography and the physical limitations of the transmission system mean that 95 percent of Michigan's power generation must be physically located in the Lower Peninsula to meet regional capacity reliability standards. So while some power can be imported from out of state, the vast majority must be locally produced in order to maintain a reliable energy grid.

Even as three coal plants are going away, the demand for around-the-clock electricity is not. And since the weather and the economy are both prone to change, we need a flexible, nimble mix of energy sources that can meet our customers' changing needs, 24 hours a day, seven days a week. Because renewable energy is variable, the need to carefully plan for and balance local supply for every hour of the year is absolutely critical. We cannot rely on purchasing energy on the market when demand is high – if every energy company in our region did that, reliability would be undermined. That's why we're pushing hard to both meet our ambitious clean-energy goals and to ensure our regional energy grid remains reliable.

Key to balancing these commitments are the Blue Water Energy Center and the Ludington Pumped Storage Power Plant.

850K

In 2022 BWEC will provide enough energy to power 850,000 homes

Blue Water Energy Center

Natural gas will help us make the transition to renewables in a way that provides the reliability Michigan residents need, while significantly reducing our carbon footprint. Natural gas plants are a highly efficient, low-emission energy source that provide reliable, on-demand, 24/7 electricity.

The Blue Water Energy Center (BWEC), approved by the Michigan Public Service Commission in 2018, will be a state-of-the-art, natural gas combined-cycle plant and one of the most efficient plants in the United States. It will replace three retiring coal plants, allowing Michigan to have both a sharp reduction in carbon emissions and an always-available energy source, helping us create a cleaner energy future. It will be capable of ramping up quickly to accommodate changes in demand and fluctuations in renewables and other energy sources, ensuring our state's homes and businesses have a reliable power source and giving them peace of mind.

This plant will provide enough 24/7, affordable and reliable energy to power 850,000 homes beginning in 2022. BWEC will reduce CO2 emissions by 70 percent compared with the three coal plants it is replacing. It also will reduce sulfur dioxide (SO2), and nitrous oxide (NOx) emissions by more than 95 percent compared with the coal plants slated for retirement, while supporting Michigan's manufacturing operations and residential customers. The plant represents a nearly $1 billion investment in Michigan. Construction jobs will peak at about 520 full-time positions during construction and will provide about 35 full-time positions once the plant is in operation.

Ludington Pumped Storage Power Plant

The Ludington Pumped Storage Power Plant, which DTE co-owns with Consumers Energy, is located on a 1,000-acre site on Lake Michigan in Mason County. The plant generates hydroelectric power and supports our renewables generation because it acts like a giant battery that can be tapped when renewable output drops.

The Ludington plant consists of a man-made reservoir located above six 300-ton turbines. The reversible turbines work as pumps when energy is plentiful and low-cost, such as when the sun is shining and the wind is blowing, and as power generators when demand is higher and renewable sources less abundant. The plant pumps water from Lake Michigan uphill to the 27 billion-gallon reservoir at low-demand times, and releases the stored water downhill through the turbines to generate electricity when energy demand is higher.

Ludington can ramp up to peak output in just 30 minutes. It provides a sustainable, clean, reliable energy source that quickly responds to the daily, weekly and seasonal highs and lows of Michigan's energy demand. It also helps keep energy bills lower because it allows DTE to avoid having to buy expensive out-of-state electricity when demand peaks.

An $800 million upgrade project to replace each of the six turbines is on schedule to be completed in 2020. Ludington, the second-largest pumped storage facility in the United States, will then support power for 175,000 DTE households.

$800M

An $800 million upgrade project to replace each of the six turbines is on schedule to be completed in 2020.

DTE has listened carefully to that input. We are confident this IRP incorporates the needs and concerns of Michigan residents and businesses and provides a safe, affordable, reliable and effective course of action.

We appreciate the participation and feedback that was provided and engagement from our technical and public stakeholders. We will continue to communicate with our stakeholders as part of our commitment to engagement..

A Collaborative Vision: Stakeholder Input

We must work together collaboratively to secure Michigan's energy future. DTE spent months seeking input on this IRP from members of the public, consumer and environmental advocates, and other stakeholders at numerous forums and open houses across the state.

We believe everyone benefits from the exchange of information and open dialogue, and so we worked to implement a comprehensive, transparent and participatory stakeholder engagement process. Outreach was designed to create awareness of the IRP process, encourage honest communication, and obtain and incorporate feedback. We hosted four technical workshops and three public open houses, and created a DTE IRP email account for electronic comment submission and response.

Registration for the open houses was not required, and we publicized them through social media, the DTE newsroom, emails to stakeholders and through our blog, EmpoweringMichigan.com. We also included open house content on the site for easy access.

At each technical meeting and open house, we worked to understand and respond to stakeholder suggestions and concerns. Here's what we heard at those meetings:

- Michiganders want their power sources to be safe, affordable and reliable.
- They care about climate issues and want to make sure we're doing everything we can to transition to cleaner energy, including renewable energy, energy efficiency and demand response.
- They want more information on how to engage with DTE on everything from energy-efficiency audits to tree trimming..

SECTION TWO

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SECTION THREE

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SECTION FOUR

4 Introduction

4.1 Company Overview

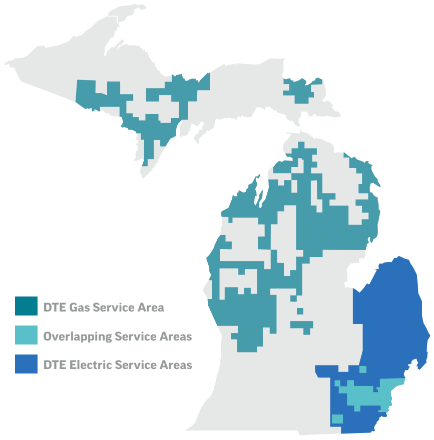
DTE (NYSE: DTE) is a Detroit-based diversified energy company involved in the development and management of energy-related businesses and services nationwide. Its operating units include an electric utility serving 2.2 million customers in Southeastern Michigan and a natural gas utility serving 1.3 million customers in Michigan. The DTE portfolio includes non-utility energy businesses focused on power and industrial projects, natural gas pipelines, gathering and storage, and energy marketing and trading.

At DTE, we are reimagining and restructuring how we power our customers' homes, businesses, and vehicles. The drivers of that transformation – a desire for safe, clean, affordable and reliable power, an aging power infrastructure, and the need to minimize our impact on the environment – each require thoughtful consideration and balance. DTE announced plans in 2017 to reduce our carbon emissions by more than 80 percent by 2050, making it one of the most aggressive plans in the country. With this integrated resource plan, we are going even further. We are moving up our carbon-emissions -eduction goal by a full decade, pledging to reduce emissions by 80 percent by 2040.

DTE is also committed to being a force for good in the communities where it serves through volunteerism, education and employment initiatives, philanthropy, and economic progress. Information about DTE is available at dteenergy.com, empoweringmichigan.com, twitter.com/dte_energy and facebook.com.

DTE has more than 10,000 employees in utility and non-utility subsidiaries involved in a wide range of energy-related businesses. Founded in 1903, DTE Electric (DTEE or Company) is the largest electric utility in Michigan and one of the largest in the nation. With an 11,770 megawatt (MW) system capacity, the Company uses coal, nuclear fuel, natural gas, hydroelectric pumped storage, wind, and solar to generate its electrical output.

FIGURE 4.1.1: DTE Service Areas



Just as the generation fleet is diverse, so too is the customer base we serve each hour of the day. DTEE's customer mix spans three primary classes: residential, commercial, and industrial. Several business sectors comprise the commercial class, while the industrial class consists of three primary sub-classes: automotive, steel, and other manufacturing. The figures to the right highlight the 2019 forecasted service area sales and allocation of peak load by customer class. Further details regarding the Company's load forecast methodology and customer classes are provided in Section 10.

FIGURE 4.1.2: Forecasted 2019 Service Area Sales

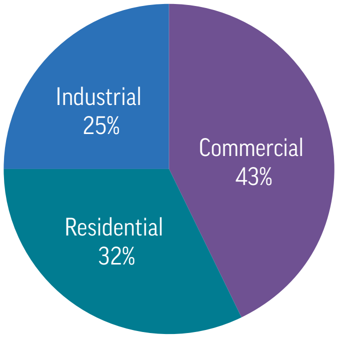
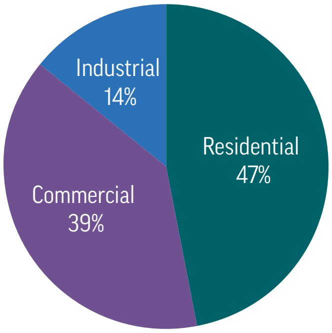


FIGURE 4.1.3: Forecasted 2019 Service Area Peak



4.2 Existing Resource Portfolio

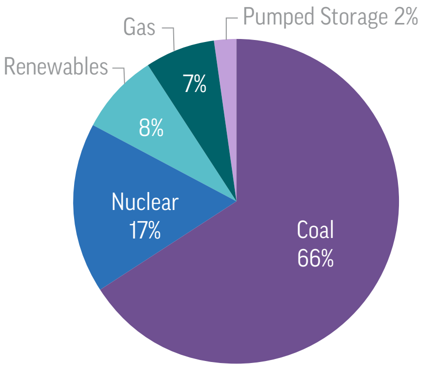
DTEE's generation assets include a diverse mix of owned and contracted sources of energy. The Company owns and operates a collection of generating units including coal, natural gas, oil, nuclear, wind, solar, and hydroelectric energy-storage facilities. The Company also holds a variety of power purchase agreements (PPAs) with independent power producers throughout Michigan. These PPAs are primarily for renewable energy resources, including wind, hydro, biomass, landfill gas, and waste recovery (Section 7 provides a breakdown of the Company's existing supply-side resource fleet). In addition to supply-side resources to meet customer energy needs, the Company offers a wide range of demand-side resources. These resources, described in Section 8, include demand response programs and energy waste reduction programs.

DTEE-owned generation, based on summer capacity ratings, is 11,772 MW, as shown in Table 4.2.1 below. The 2018 generation mix is shown in Figure 4.2.2.

TABLE 4.2.1: 2018 Current Owned Generation Resources

Summer Capacity Rating (MW)[1]	
Fossil Steam	6,868 MW
Peaking Plant	2,033 MW
Pumped Storage	1,054 MW
Total Fossil/Hydraulic System	9,955 MW
Nuclear	1,141 MW
Renewables[2]	676 MW (612 MW wind, 64 MW solar)
Total Owned Generation	11,772 MW

FIGURE 4.2.2: 2018 Fleet Generation Mix



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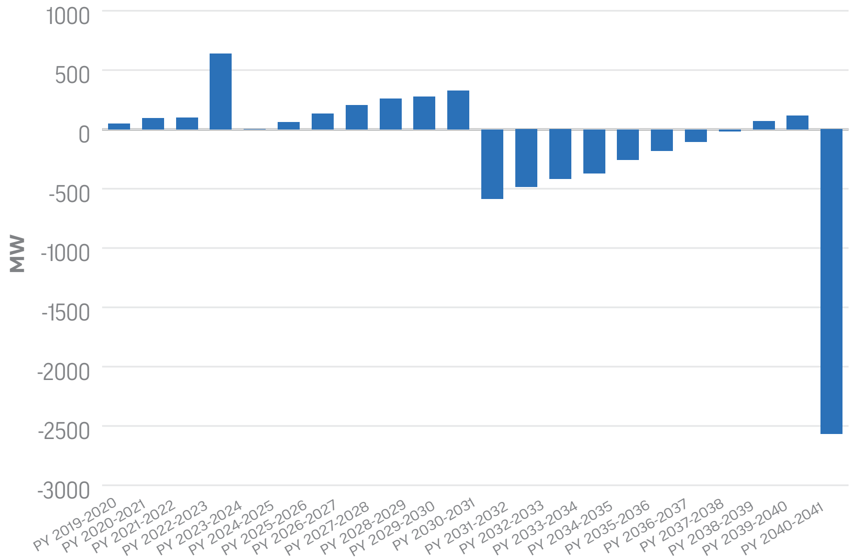
[1] Renewables based on MWac installed
[2] Revenue requirement of existing generation and power purchase agreements can be found in the IRP Appendix R (Exhbit A-4)

4.3 Capacity Outlook

Developing the Company's capacity outlook projection was integral to the IRP process. When the IRP modeling began, in June 2018, an assessment of the current state of the Company's capacity position was completed as the optimization modeling's starting point. This included evaluating the balance between load requirements (including reserve margins) and the assumed demand-side and supply-side resources (including planned retirements and planned additions) throughout the study period to determine if, and when, there was a need for additional resources. Figure 4.3.1 below illustrates the Company's starting point capacity position throughout the IRP study period of 2019 through 2040.

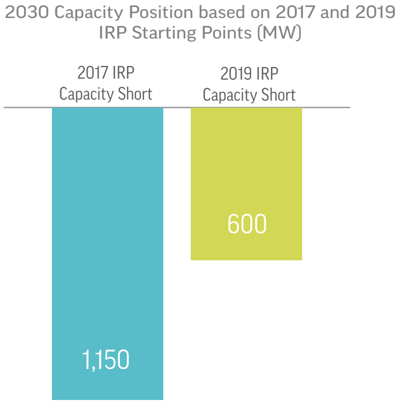
Figure 4.3.1: Starting Point Capacity Position



Starting capacity position notes: In April 2018, the Michigan Public Service Commission (MPSC) issued an Order approving the Company's request for Certificates of Necessity (CON) to construct the Blue Water Energy Center (BWEC), an 1,150 MW natural gas combined-cycle plant, to replace in part the loss of capacity associated with planned retirement of Tier 2 coal units between 2020 and 2023, specifically: River Rouge Unit 3, St. Clair Units 1-3, 6 and 7, and Trenton Channel Unit 9. With the addition of BWEC and the Tier 2 retirements:

- the Company did not project a capacity need for the 10-year period of 2019 to 2028;
- a starting point capacity need was forecasted in 2029 and 2030 as a result of the assumed retirement of Belle River Units 1 and 2, respectively;
- the capacity need forecasted in 2030 was 550 MW less when compared to the need identified in the 2017 IRP filed in support of the CON, primarily due to an updated load forecast, planned renewables to meet 2030 clean-energy goals, and the expansion of existing demand response programs. See Figure 4.3.2 below.

Figure 4.3.2 - 2030 Forecasted Capacity Need (MW) – Walk from 2017 IRP to 2019 IRP



Reductions in capacity short was driven by:
- Reduced load forecast
- Additional renewables
- PURPA
- Increased demand response

4.4 Assumptions Across Scenarios & Sensitivities

The Michigan Integrated Resource Planning Parameters, developed pursuant to section 6(t) of 2016 PA 341, provided three required scenarios: Business as Usual (BAU), Emerging Technologies (ET) and Environmental Policy (EP). In addition to the required scenarios, DTEE created an additional scenario, Reference (REF), that incorporates DTEE's viewpoint of the future.

Each scenario assumed that certain market conditions would evolve over time, resulting in differing futures. For example, compared to the BAU scenario, the ET scenario assumes a 35 percent capital-cost reduction for solar, battery storage, energy waste reduction, demand response, and other emerging technologies. The future state assumed by the REF scenario aligns most closely to the required BAU scenario. However, inputs related to the natural-gas fuel price and carbon-emission costs in the REF scenario differ from the required scenarios. Although currently there are no taxes or cost on CO2 emissions, there is the possibility that in the future there will be a new version of the Clean Power Plan that will include a cost applied to CO2.

Figure 4.4.1 and Figure 4.4.2 highlight the natural-gas and CO2-emission cost forecasts for each scenario throughout the study period. Also shown are the forecasts used for the high gas price (200 percent of 2018 EIA) and CO2 sensitivities. The consultant company PACE Global

FIGURE 4.4.1: Annual Natural-Gas Price – MichCon Gas Hub

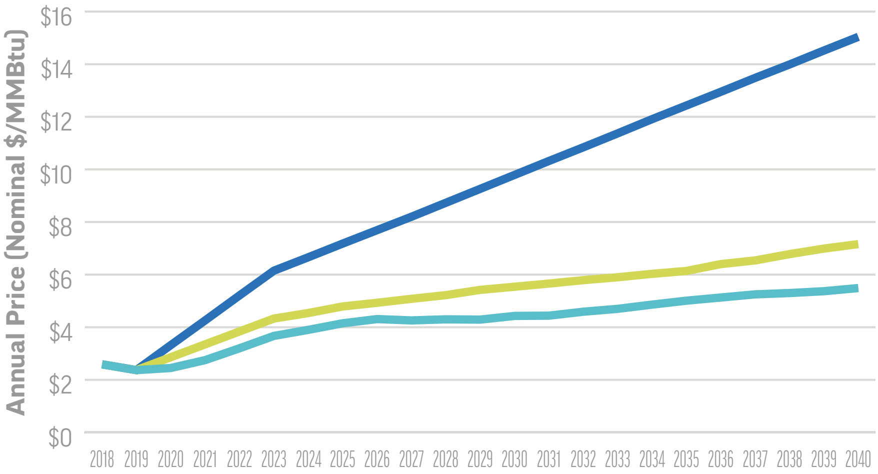
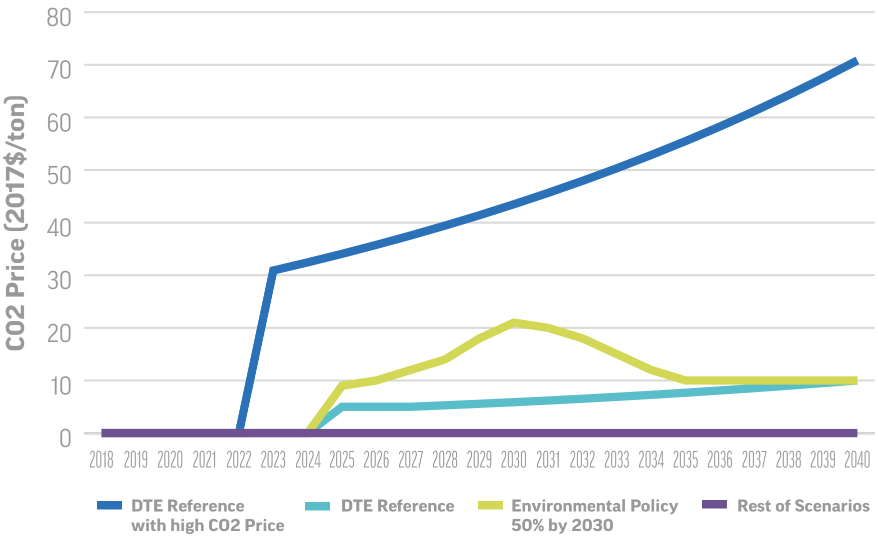


FIGURE 4.4.2: CO2 Price Forecasts

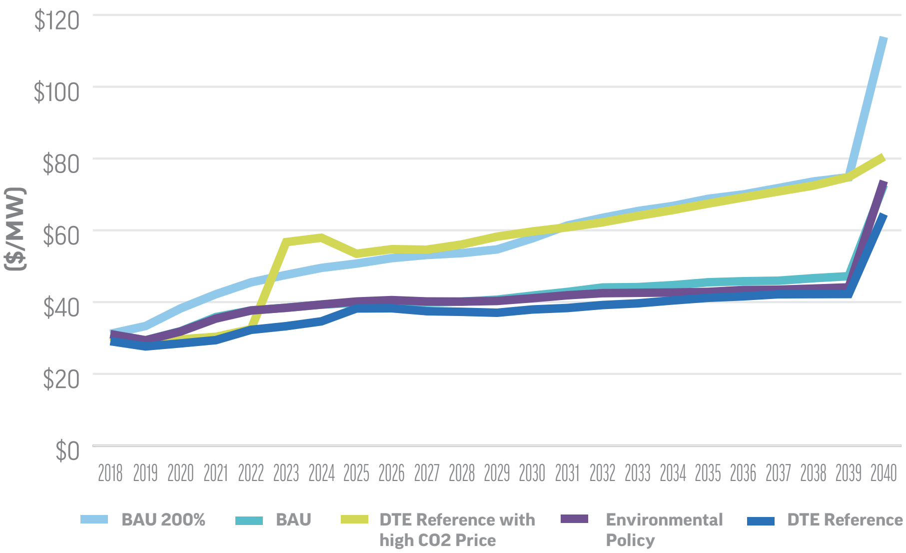


developed the long-term gas price forecast in the RER scenario. The other three scenarios used the publicly available 2018 EIA long-term gas-price forecast. The methodology utilized to develop the natural-gas fuel forecast is described in Section 13 and further explanation of the CO2 cost is included in Section 6.

Because each scenario, and certain sensitivities, had different market assumptions, the resulting forecasts for energy prices varied as well. DTEE utilized PACE Global to develop energy-price forecasts across the scenarios and specific sensitivities. PACE Global modeled the entire U.S. footprint to determine markets and interrelationships between energy markets, environmental rules, gas markets, build plans, and reserve margin/capacity price forecasts. Figure 4.4.3 illustrates the resulting energy forecast prices for the Midcontinent Independent System Operator (MISO) Michigan hub. The projected increase in modeled energy prices from 2039 to 2040 was caused by the planned retirement of a significant amount of 24/7 baseload coal resources by both DTEE and Consumers Energy.

The projected increase in modeled energy prices from 2039 to 2040 is caused by the planned retirement of a significant amount of baseload coal resources by both DTEE and Consumers Energy.

Figure 4.4.3: MISO Michigan Hub Power Prices



4.5 Regulatory Environment & Market Dynamics

Michigan set course in late 2016, with the passage of Public Act 341, to revamp the guidelines and requirements forIRPs to be filed with the MPSC. Throughout 2017, DTEE participated in several IRP stakeholder collaborative groups led by the MPSC staff. The collaborative groups called for the consideration of a broad range of perspectives as the MPSC staff developed recommendations for IRP modeling parameters and filing requirements. The MPSC issued two orders governing IRPs to be filed under the new legislation:

1. Michigan Integrated Resource Planning Parameters, Pursuant to Public Act 341 of 2016, Section 6t (Case No. U-18418; issued on Nov. 21, 2017)
2. Integrated Resource Plan Filing Requirements, Pursuant to Public Act 341 of 2016, Section 6t (Case No. U-18461; issued on Dec. 20, 2017)

The Company relied upon these orders, in combination with Section 6t of Public Act 341, to ensure the filed IRP is compliant with the current regulatory construct.

Potential Changes in the MISO Market

As a load serving entity in MISO Local Resource Zone 7 (LRZ 7), DTEE participates in ongoing stakeholder discussions concerning the capacity market's current and future state. Various MISO initiatives are underway in stakeholder forums that may affect future capacity requirements and/or resource accreditation. These initiatives include the Renewable Integration Impact Assessment and Resource Availability and Need, which are described in greater detail below:

Renewable Integration Impact Assessment (RIIA) – Designed to facilitate a broader conversation around renewable-energy-driven impacts on future system reliability, the RIIA is focused on identifying potential integration issues and mitigating solutions. The assessment's primary outputs will include resource adequacy considerations, including potential impacts to the effective load carrying capability (ELCC) assigned to renewable energy resources. The RIIA is being performed in phases, with findings being shared on a variable intermittent basis. To date the assessment has considered renewable penetration levels up to 40 percent. In this IRP, DTEE has assumed a declining ELCC for future solar installations consistent with assumptions in MISO's Transmission Expansion Plan (MTEP) 19 Futures process. The ELCC for future solar installations is assumed to be 50 percent through 2023 and then to decline at 2 percent per year until 2033.

Resource Availability and Need (RAN) – The RAN initiative is focused on developing market-based solutions for the efficient conversion of capacity to energy and was initiated in response to various observed trends that have resulted in an increased likelihood of capacity emergencies throughout the planning year. Potential outcomes include changes to load modifying resource registration requirements, alteration in outage coordination practices,

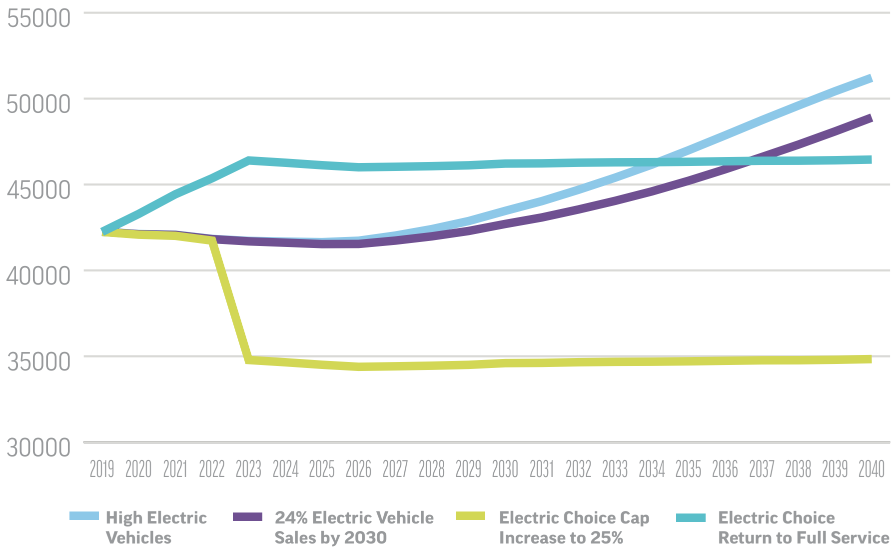
DTEE's commitment to customers is to continue providing reliable, affordable energy while reducing carbon emissions that affect climate change.

and the implementation of a seasonal resource adequacy construct (as opposed to the current one-year prompt market). Although this IRP doesn't include considerations of this initiative, DTEE will continue to monitor and evaluate potential changes to resource planning in the future.

Electric Customer Choice

The current regulatory construct in Michigan allows 10 percent of retail load to be served by alternative energy suppliers. Changes to the existing Electric Customer Choice construct would have an impact on the Company's potential long-term resource pathways, as load is a critical component to resource planning. In the majority of the scenarios and sensitivities analyzed, the IRP assumes the current 10 percent retail-load cap remains intact. However, the IRP does consider sensitivities in which the Electric Choice cap is expanded or returns to zero. The figure below highlights a sample of load sensitivities modeled in the IRP, including varying levels of Electric Choice. Descriptions of the Company's load-forecast methodology and sensitivities evaluated are included in Section 10.

FIGURE 4.5.1: Load Sensitivity Bundled Sales (GWh)



Environmental

DTEE's commitment to customers is to continue providing reliable, affordable energy while minimizing our impact on the environment, including reducing carbon emissions that affect climate change. In May 2017, DTEE was one of the first electric companies to announce a long-term carbon reduction target to reduce CO2 emissions by more than 80 percent by 2050, positioning the Company as an industry leader in reducing greenhouse gases. A plan for reducing DTEE's CO2 emissions makes business sense, ensures safe, reliable, affordable, and cleaner energy for its customers, and allows the Company to implement a long-term generation-transformation strategy in which more than half of the energy is generated from zero-emitting resources. With the plans laid out in this IRP, the Company is able to take the next step on our clean-energy journey, and is announcing that we are accelerating our carbon reduction goals to 50 percent by 2030, and more than 80 percent by 2040, a full decade ahead of the previous 2050 goal.

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released a special report on global warming. The report focused on movements away from fossil fuel generation and supplementing it with wind and solar energy. DTE'Es plan to reduce carbon emissions by 80 percent is consistent with the range of what the report says is necessary to combat climate change. DTEE reviewed what could be done within our system to minimize our contribution to climate change and established a plan to transition our generation fleet to low- and zero-emitting sources in a manner and timeframe that also continues to assure reliability and minimizes cost impact on our customers.

Currently in the United States no federal regulation requires reductions in CO2 emissions from electric generating units. Although the U.S. Supreme Court stayed the Clean Power Plan, there is a proposed EPA regulation called the Affordable Clean Energy (ACE) rule, which would direct states to develop plans establishing plant-specific standards of performance for CO2 based on applicable heat-rate-improvement technologies. Some states have established CO2 cap-and-trade programs to reduce greenhouse gas emissions from the electric sector, most notably the Regional Greenhouse Gas Initiative and the California cap-and-trade system. These state-wide systems require robust CO2 accounting methods to verify emissions, and stakeholders are driving the development of improved methods of accounting for the CO2 emissions associated with energy purchases and sales. In Michigan and in MISO, there is currently no accounting required for the CO2 associated with the purchase and sales of energy. However, this is under consideration in other jurisdictions, subject to emissions trading programs. This type of CO2 accounting would credit the seller of energy for a calculated average CO2 mass attributable to the CO2 intensity of the energy produced at the time of the sale, and similarly the purchaser would incur the CO2 associated with the purchase. While simple in concept, the calculations are complicated and would require coordination and data sharing across MISO, the sellers and purchasers, and other stakeholders. In this IRP, we have calculated the CO2 emissions both with and without an estimate of the carbon impact of energy purchases and sales. It is expected that the role of CO2 accounting in IRPs will evolve in future filings.

Our proposed course of action (PCA) is based on the low- and zero-emission technologies that are available and economic today and where we are confident in the trends going forward. Our PCA also focuses on demand-side resources, and reducing energy demand through reducing energy waste and expanding peak demand response technologies. As we developed this plan, we considered how the technologies' feasibility and economics could facilitate this generation transition to improve faster. In future IRPs, we will continue to develop and implement plans to transition our generation fleet in a manner and timeframe that also continues to assure reliability and minimizes financial impact on our customers.

Renewable Portfolio Standards

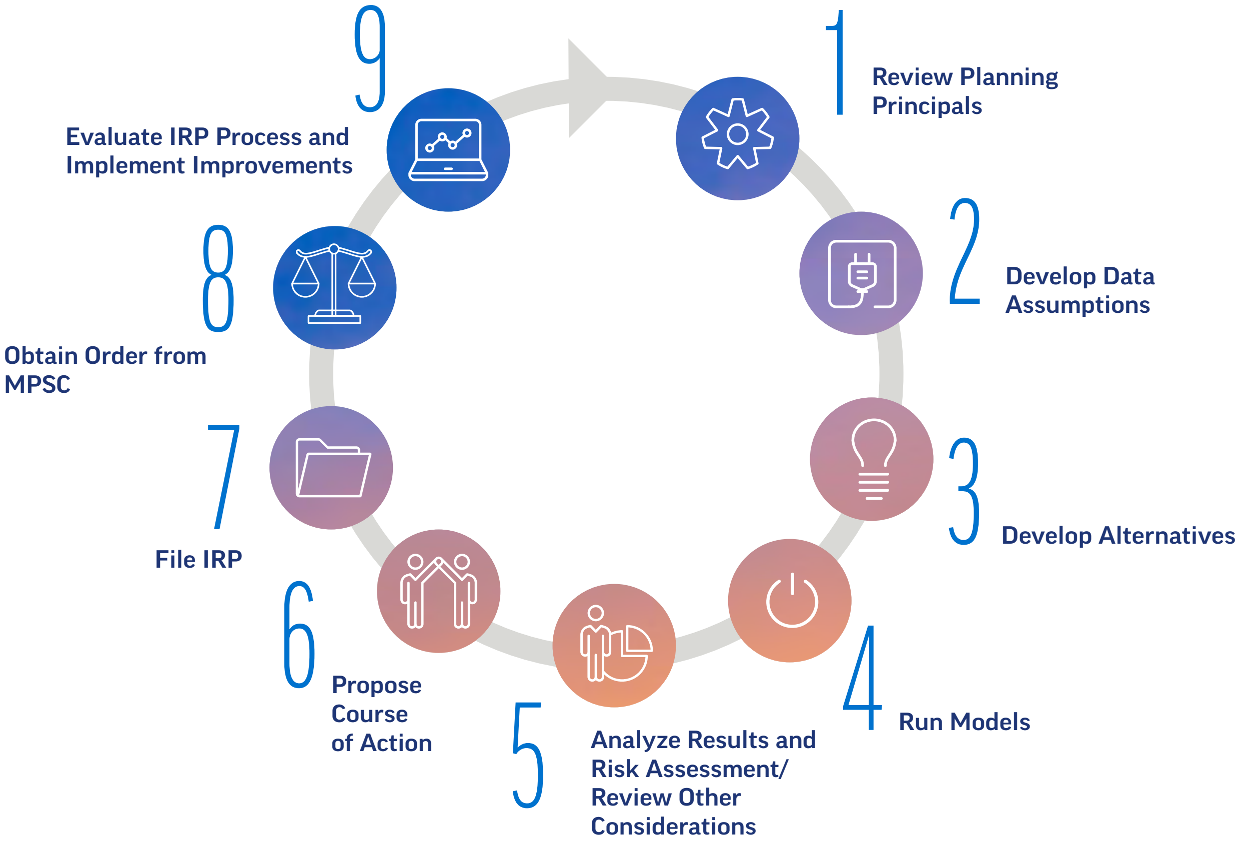
Public Act 342 of 2016 amended Public Act 295 of 2008 by increasing Michigan's Renewable Portfolio Standard from 10 percent by 2015 to 12.5 percent by 2019 and 15 percent by 2021. Public Act 342 required electric providers to file amended plans to meet the new standards within one year of its effective date; the Company filed its amended plan (Case No.: U-18232) in March 2018, demonstrating compliance with the new standards. In support of our carbon and clean energy goals, the renewable energy plans outlined in this 2019 IRP take DTEEI to renewable levels beyond those requirements.

4.6 IRP Planning Process

IRP Process

The Company's IRP process contains nine steps designed to ensure the completion of a comprehensive plan, as shown in Figure 4.6.1. Because assumptions and environmental and regulatory factors change, the integrated resource planning process must be continuous over time. Prior to filing the IRP with the MPSC, DTEE hosted four technical stakeholder workshops to share information regarding the IRP assumptions and preliminary modeling results. These workshops also provided stakeholders the opportunity to provide input into the IRP process, ask questions, and submit comments. Further details regarding stakeholder collaboration are included in Section 4.7.

FIGURE 4.6.1: IRP Planning Process



Review Planning Principles

The IRP planning principles, Figure 4.6.2, are based on the factors the Company has historically used in making resource decisions and were formally documented when the Company was developing the 2017 IRP.

As shown in the first step, before any modeling or analysis was undertaken, the Company reviewed the seven planning principles that would be used to ensure the IRP was appropriately balanced.

FIGURE 4.6.2: Planning Principles

Reliability	Each plan analyzed is required to meet the reliability planning requirements established by MISO and to encompass our desire to maintain a reliable fleet in the face of aging coal units.
Affordability	Affordability is measured by the yearly impacts to the revenue requirement.
Clean	Environmental sustainability, low carbon aspirations, and clean-energy goals are major factors in the determination of the recommended resource portfolio.
Flexible and Balanced	The resource plan needs to be flexible, having the ability to adapt to unforeseen changes int he market. Additionally, it must have a well balanced mix of resources so that it is not heavily reliant on the market or one source of generation.
Compliant	All resource plans are modeled to be compliant with the IRP filing requirements as well as with environmental regulations.
Reasonable Risk	The Company desires a portfolio that minimizes risks related to commodity and market pricing, fuel availability, grid reliability, capacity constraints, operations and evolving regulations.
Community Impact	The Company considers the aspects of employment, tax base, and other community impacts.

Develop Data Assumptions

After reviewing the planning principles, a broad set of scenarios and sensitivities were developed. Scenarios were made up of driving forces that shape and define different paths to the future. They contain key uncertainties that are critical components to help construct and differentiate among the scenarios. These are generally broad market assumptions that affect the entire country, such as commodity prices, technology costs, national load growth, and environmental regulations. As described previously, the MPSC developed the market assumptions for the three required scenarios (Business as Usual, Emerging Technology, and Environmental Policy) and the Company utilized some of its own assumptions in the Reference scenario.

Sensitivities, considered smaller changes from a modeling perspective, are specific variables that affect only the DTEE service territory and/or Michigan. Examples of sensitivities are changes in load, energy waste reduction, and fuel costs.

Develop Alternatives

To develop a reasonable and prudent plan, it was important to consider all feasible resource options to meet customer demand. The IRP process evaluated a multitude of alternative technologies including natural-gas units, coal units, nuclear units, renewable generation, and demand-side management resources.

FIGURE 4.6.3: Resource Screen Methodology

Preliminary Economic Analysis	• Resources screened on technical feasibility, practicality, and geographic limitations • Options were narrowed based on economics • Similar technologies were compared on a levelized cost of energy basis
Market Valuation	• An additional level of economic analysis was conducted that evaluated the benefit/cost ratio for each option against the market
Modeling	• Strategist® was then used to optimize the technologies and develop a series of build plans containing a combination of least-cost alternative • Strategist® computed a revenue requirement for each build plan • Modeling results were analyzed for each scenario and sensitivity
PCA	• Components from least-cost build plans from each scenario and sensitivity were considered for inclusion in the PCA • Planning principles were applied • Risk analyses were completed

Run Models / Analyze Results / Develop Proposed Course of Action

DTEE used various modeling methodologies as the IRP process progressed to refine the demand-side and supply-side technologies considered as options in the PCA. The evaluations ranged from simplistic economic screenings to increasingly complex analyses. The methods for screening and evaluating technology options are shown in Figure 4.6.3. Upon completing the layers of analysis, reviewing the modeling outputs, risk analysis, and planning principles, DTEE developed a proposed course of action.

File IRP / Regulatory Case Proceeding

The Company then filed an application and supporting testimony requesting MPSC approval of its IRP. Per Section 6t of Public Act 341, the MPSC will conduct a contested case proceeding in which an order shall be issued within 300 days (at most 360 days) of the date of filing.

Evaluate Process and Implement Improvements

DTEE strives to continuously improve all aspects of its work. After filing the IRP and receiving an order from the MPSC, we will spend time reviewing our processes to identify opportunities for improvement. Those improvement opportunities will then be implemented into the process for future IRPs.

Key to the IRP process was gaining input from our stakeholders and incorporating their feedback.

4.7 Stakeholder Involvement in the IRP

Overview

Key to the IRP process was gaining input from our stakeholders and incorporating their feedback. DTEE reached out to individuals and organizations who have had involvement in our regulatory cases in the past, had expressed interest in having input into our process, or who might be impacted by the Company's plan, in order to create awareness of the IRP process and to encourage honest communication. The intent was to implement a comprehensive, transparent, and participatory stakeholder-engagement process.

DTEE hosted four technical workshops for stakeholders expected to be involved in the IRP's technical aspects and regulatory processes, and three public open houses to serve customers and the general public. DTEE provided stakeholders with various opportunities to share their ideas on how to meet Michigan's future energy and capacity needs, including reviewing and commenting on IRP inputs, sensitivities and technology options. In addition, DTEE created a dedicated IRP email account for electronic comment submissions.

All public meetings were held in DTEE's service territory, with notice, including publishing full details on the Empowering Michigan website. The public meetings were held after normal business hours to ensure accessibility for members of the public. Invitees included the public in our service territory and other stakeholders including expected intervenors and MPSC staff.

Technical Workshops

DTEE hosted four technical workshops in various locations, as shown in Table 4.7.1, for technical stakeholders, who regularly participate in our regulatory filings. The technical presentations included:

- The IRP process's steps and timeline
- The assumptions, scenarios and sensitivities that would be analyzed to develop our plan
- Review of IRP models and how to interpret results
- The sharing of modeling results across a broad range of futures

TABLE 4.7.1: Technical Workshop Time and Location Details

Meeting	Date	Location	Time
Technical Workshop #1	June 11, 2018	Bad Axe, MI	1:00-4:00 pm
Technical Workshop #2	September 27, 2018	Detroit, MI	1:00-4:00 pm
Technical Workshop #3	November 12, 2018	Conference Call	1:00-2:00 pm
Technical Workshop #4	January 31, 2019	Conference Call/ Detroit, MI	1:00-3:30 pm

A total of 125 stakeholders attended the four technical workshops.

The Company invited participants to these workshops based on the parties that were granted intervention in the Company's last electric rate case and certificate of necessity case. A total of 125 stakeholders attended the four technical workshops. Participants included staff from MPSC and the Michigan Department of Environmental Quality, environmental organizations, ITC, special interest groups and DTEE employees.

DTEE notified technical stakeholders in advance of the workshops via email and sent participants the workshop presentation ahead of the meeting. Stakeholders were provided the opportunity to ask questions, and DTEE subject-matter experts were present to answer the questions. Comments were collected and questions and answers were documented and sent to stakeholders following the meeting.

DTEE encouraged stakeholders to submit technology options for consideration and invited each organization to submit a sensitivity. Four sensitivities were provided to the Company for modeling. The sensitivities were analyzed, and selected results were provided to stakeholders at the January technical workshop. Full results are provided in Section 15.

The workshop format allowed participants to hear questions from others and obtain answers from DTEE subject matter experts at the same time, which created consistency in sharing information, open dialogue and exchange of ideas.

Public Open Houses

DTEE hosted three public open houses for customers, the community, and other stakeholders to discuss the company's IRP process, as well as other DTEE topics of community interest. The open houses provided the public and DTEE an opportunity to have open dialogue, ask questions and obtain feedback. Registration was not required and the events were open to all interested parties. Each open house included eight booths where the public could learn about the various areas within the Company. A bilingual booth was available at the third open house based upon feedback from the previous open houses. An IRP landing page on our blog site was created to provide open house documents.

TABLE 4.7.3: Public Open House Times and Locations

Meeting	Date	Location	Time
Open House #1	July 26, 2018	Wayne County Community College Downriver Campus, Taylor MI	4:00 -7:00 pm
Open House #2	August 16, 2018	Schoolcraft Community College, Livonia, MI	4:00 -7:00 pm
Open House #3	October 23, 2018	Wayne County Community Downtown District, Detroit MI	4:00 -7:00 pm
Blue Water Energy Center Community Open House	September 25, 2018	Marine City High School, Marine City MI	4:00 - 8:00 pm

The open houses were publicized through:

- Social media
- DTEE newsroom postings
- DTEE internal news
- Emailing stakeholders in advance of the events

A total of 132 registered stakeholders attended the three public open houses. Participants included customers, community members, staff from the MPSC and the Michigan Department of Environmental Quality, environmental organizations, and special interest groups. Attendees could talk to subject-matter experts one-on-one. DTEE staff worked to understand stakeholders' concerns for the environment and assure them that we are focused on providing safe, clean, reliable energy to our customers as we work through this time of transitioning our generation fleet.

Stakeholders left feedback on comment cards. In addition to the three IRP public open houses, a Blue Water Energy Center open house was held near the site of the project for the local community to learn about the project. The stakeholder comments and questions from both the technical workshops and the public open houses were reviewed, and informed the Company's analysis and determination of components in the PCA, including higher levels of renewables and energy waste reduction.

Additional Stakeholder Communications

In addition to the IRP technical workshops and public open houses, DTEE conducted several meetings with the MPSC staff to review IRP sensitivities, modeling process and considerations, transmission considerations, updates from the energy waste reduction potential study, and long-term forecasting assumptions.

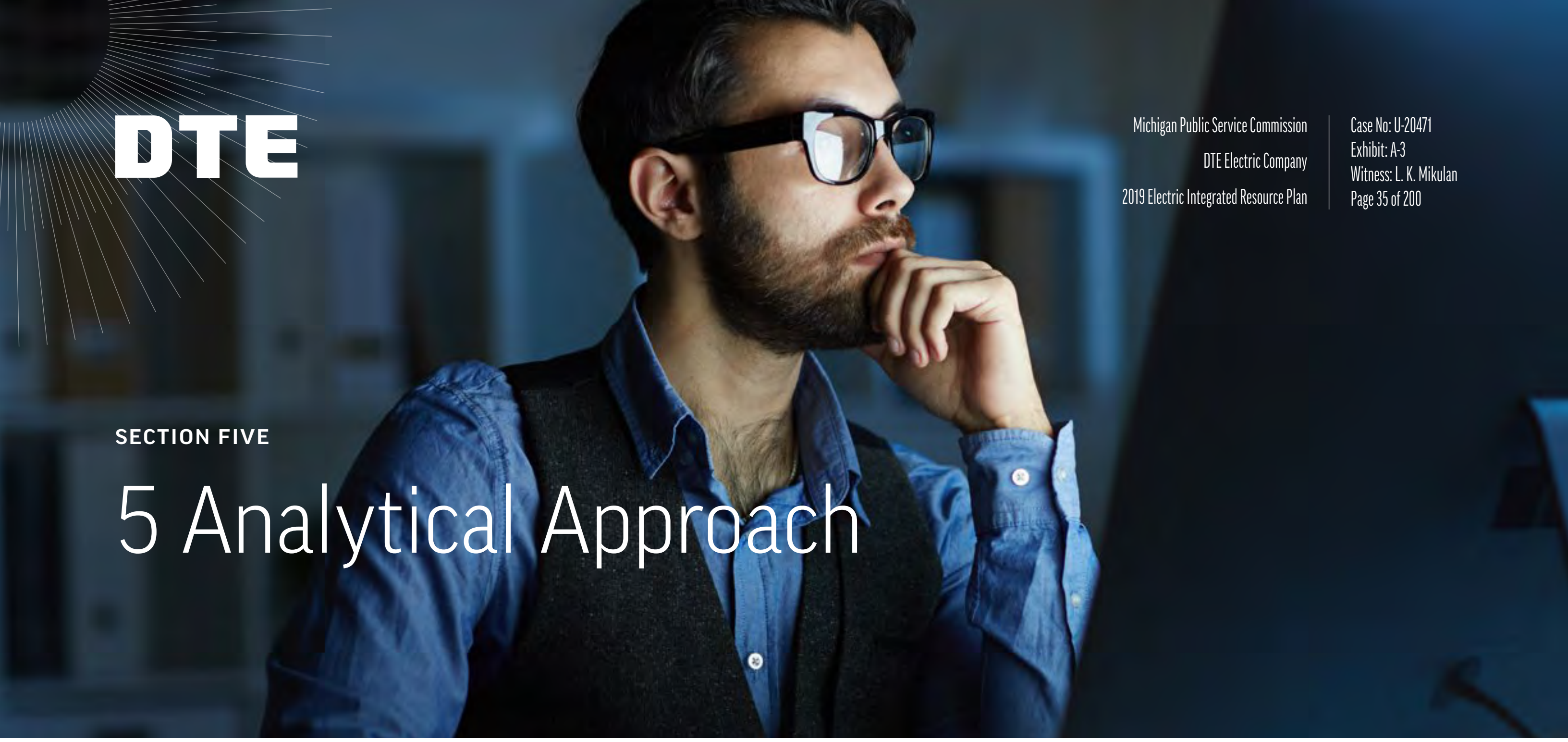
The Company also met with ITC to review IRP filing requirements, review ITC's transmission study scope and assumptions, and discuss modelling results of various scenarios under the study scope. DTEE also engaged MISO to review technical workshop presentations and communicated to MISO regarding our collaboration with ITC on this IRP filing.

DTEE has communicated about key aspects of the IRP with communities, employees, stakeholder organizations, investors, and local, state and federal leaders.

Conclusion

DTEE spent a great deal of time on the IRP outreach process in order to be transparent, obtain participation, gain feedback, and have open dialogue with our stakeholders. We appreciate the participation and feedback that was provided and the engagement from our technical and public stakeholders. It was beneficial to hear stakeholder inputs and concerns about Michigan's energy future as we developed our IRP and the PCA.

DTEE has communicated about key aspects of the IRP with communities, employees, stakeholder organizations, investors, and local, state and federal leaders.



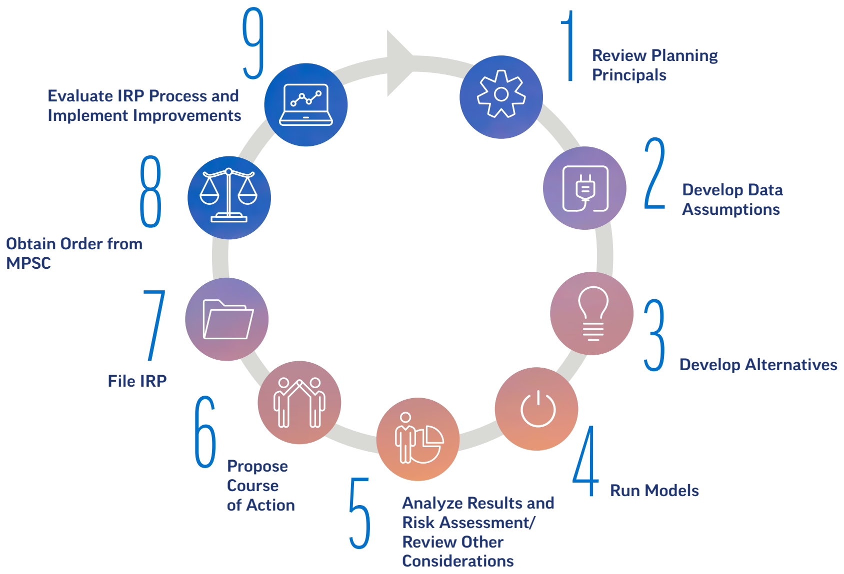
SECTION FIVE

5 Analytical Approach

5.1 Overview

Developing the IRP was a detailed, multi-step process that involved many subject matter experts both internal and external to DTEE. The IRP continuous process wheel, Figure 5.1.1, shows the analytical approach to developing, running, and analyzing the models. Steps two through five provide the modeling steps that were utilized to obtain the proposed course of action.

FIGURE 5.1.1: IRP Continuous Process Wheel



5.2 Modeling process

The modeling process started with determining the data assumptions and developing alternative technologies, which are steps two and three on the IRP continuous process wheel. The data assumptions were gathered utilizing several of the Company's subject matter experts (SMEs) as well as PACE Global, a consulting company. In addition, as discussed in Section 4.7, the Company shared data assumptions with and offered opportunities to IRP stakeholders to provide input. DTEE SMEs provided a range of data assumptions including load forecast, near-term fuel forecast, renewables plan, energy waste reduction level and cost sensitivities, demand response, and goals.

To satisfy the modeling requirements put forward in MPSC Case No. U-18418, the SMEs drew upon public data when available, and used industry expertise to develop assumptions that were unique to DTEE. PACE provided data assumptions that included long-term fuel prices[1], market prices, capacity prices, and emission prices. PACE determined these data assumptions by modeling a national footprint. The data assumptions changed depending on the scenario. Four scenarios were run, including three required by the Michigan Integrated Resource Planning Parameters, section 6t of 2016 PA 341, and one scenario developed by DTEE, as well as several sensitivities.

In step three of the IRP process, alternative technologies were developed which could potentially fill the Company's energy or capacity needs and meet customer demand.. The IRP process evaluated a multitude of technologies, including natural-gas units, coal units, nuclear units, renewable generation, and demand-side management resources. These were called "alternatives." Each alternative's costs and operating parameters were inputs to the analysis. The Company used technology-cost and operating data from publicly available data from a variety of sources (see Exhibit A-4, Appendix B). The alternatives were then sent through a screening process to limit the number of possible choices in the modeling programs. (Too many alternatives can significantly slow the modeling program down or even make the optimization unsolvable.) Once the data assumptions and alternative technologies were determined, they were then built into the modeling programs.

Step four in the IRP process was running the model. The IRP optimization modeling utilized the Strategist® program, an energy-market simulation that calculates the net present value revenue requirement for multiple plans that meet customers' forecasted energy and capacity demand. In this IRP, modeling runs start in 2018 and run through 2040. All scenarios and sensitivities, except for retirement of Tier 2 assets, were run through Strategist® to develop the least-cost build plans.

In the Tier 2 retirement analysis, short-term capacity purchases were assumed to replace the retired coal unit's energy and capacity. The analyses were run in both the PROMOD® and internal revenue requirement models because only one year of energy and capacity purchases is needed to replace the generation, prior to the start-up of its long-term

2 **Develop Data Assumptions**

3 **Develop Alternatives**

4 **Run Models**

5 **Analyze Results and Risk Assessment/ Review Other Considerations**

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[1] With respect to the gas price forecasts, PACE developed the long-term gas price forecast in the Reference scenario. The other three scenarios used the publicly available 2018 EIA long term gas price forecast.

replacement, the Blue Water Energy Center. PROMOD® is an hourly dispatch model that simulates the energy market. The revenue requirement model was used to represent the Company's financial structure and treatment of capital investments. The output of PROMOD® was put into the revenue requirement model.

Step five of the IRP process analyzed results of the completed Strategist® optimization model runs. Once the least-cost plans were generated for each scenario and sensitivity combination, they were reviewed with respect to the planning principles. A proposed course of action (PCA) was developed in step six of the IRP process by synthesizing the results of each least-cost plan output in conjunction with the Company's planning principles. (Development of the PCA is discussed in more detail in Section 16.) After the PCA was determined, the PROMOD® model was used to model the PCA across the four scenarios and operating characteristics, including capacity factors, fuel prices, rate impacts, and emissions.

5.3 Risk Assessment Methodology

Two types of risk need to be evaluated in an IRP: the quantifiable financial risks that could be computed using various analytical methods, and the non-financial aspects of the PCA that may not be easily quantifiable. When the DTEE planning principles were considered as part of risk assessment, affordability fell under financial risk, while the other six principles of reliability, flexible and balanced, clean, reasonable risk, compliant, and community impact fell into the non-financial evaluation of risk. Some of these risks could potentially be mitigated by a solution that has a cost, such as building a new transmission line to reduce reliability risk. However, most of the risks identified were more abstract, making it difficult to assign a financial impact. Therefore, the Company employed both quantitative analysis of the financial risks in the form of stochastic analysis and scenario and sensitivity analyses, and evaluation of the non-financial aspects of risk using change analysis and evaluation of relevant plans' planning principles. The evaluation of IRP inputs that may have changed since initial adoption in the IRP process addresses both categories. Each of the risk assessment methodologies are described below, while results from the risk assessment methodologies are included in Section 15.

In addition to scenario and sensitivity analysis DTEE employed multiple risk assessment methodologies

Risk Analysis Method 1: Stochastic Risk Assessment

A stochastic analysis is an advanced modeling technique that uses probability distributions of key assumptions to evaluate portfolios. Pace Global utilized the Aurora model to generate 200 different draws from the key drivers' probability distributions. The portfolio's average present value was determined. The economic risk, which represented the risk of having a high-cost portfolio, was calculated by taking the average cost of the highest 10 percent of the draws for each resource plan. The stochastic analysis's goal was to minimize both the average portfolio cost and the economic risk. The key drivers were characterized as probability distribution functions using a combination of historical measures of volatility, market correlations, and expected future relationships between the assumptions. In our stochastic modeling, load growth; natural gas and coal prices; the price of carbon used for analytic purposes; and the cost of generating technologies all were evaluated with probability distributions. More details are shown in Section 15.8.

Risk Analysis Method 2: Change Analysis

Many factors will change between the filing of this IRP in 2019 and 2030, when the first year of capacity need is expected. The change analysis examined the factors that could change between now and the next IRP filing, currently expected in 2025. The change analysis specifically addressed the flexible aspect of the 2019 IRP PCA from 2025 through 2030, ensuring that the PCA was robust across a range of potential futures. The change analysis looked at a list of outcomes, or "situations," that could arise from different drivers, or "causations." Each situation presents a likely adaptation of the PCA. The PCA has the flexibility to adapt to and accommodate the constant development of situations. The change analysis covered situations from multiple categories such as fuel, environmental, load, future technology development and evolution, and transmission. The change analysis's results are shown in Section 15.9.

Risk Analysis Method 3: Application of Planning Principles

The application of planning principles is a comparative qualitative analysis method that was used to rank plans by individual planning principles. In our analysis, 12 plans were analyzed and assigned rankings for five of the seven planning principles: reliability, clean, flexible and balanced, reasonable risk, and community impact. The plans were not ranked based on affordability, as each plan was identified as a "least-cost" plan, and the plans were not ranked on compliance, as each plan was compliant with current regulations.

Risk Analysis Method 4: Evaluation of key IRP Inputs

The IRP inputs (e.g. capital costs, market prices, fuel price forecasts, etc.) were adopted in May through August of 2018 before the optimization models were built. Before the filing, in February 2019, most of the inputs were considered again to see if they had changed materially since the initial adoption. If the inputs had materially changed, then a decision was made whether to update the modeling with the latest values. This process is described in detail in section 15.5.11.

Risk Analysis Method 5: Scenario and Sensitivity Analysis

Scenario and sensitivity analysis is a method of risk assessment. This is covered at length in section 6, with results provided in Section 15.1 through 15.5.

SECTION SIX

6 IRP Scenario & Sensitivities

6.1 Scenarios

Scenarios are made up of driving forces that shape and define different paths to the future. They contain key uncertainties that are critical to help construct and differentiate among them. These are generally broad market assumptions that affect the entire country, such as commodity prices, technology costs, national load growth, and environmental regulations. While scenarios help us to frame a particular future, the true future still remains uncertain and difficult to predict. The Michigan Integrated Resource Planning Parameters, section 6(t) of 2016 PA 341, provided three required scenarios, all of which utilize the 2018 EIA gas-price forecast: Business as Usual (BAU), Emerging Technologies (ET) and Environmental Policy (EP). DTEE developed an additional scenario, Reference, that incorporates DTEE's viewpoint of the future based on research and forecasts. Exploring these four scenarios, incorporated with numerous sensitivities, ensures that the resulting DTEE 2019 IRP provides the optimal solutions to DTEE's future demands for electricity in a range of potential futures.

All alternative technology costs for the scenarios were taken from publicly available sources. In each scenario, specific new units were modeled with their associated expected operating parameters (rather than using public sources) if already under construction or if the specific unit had received regulatory approval consistent with guidelines established in the Michigan Integrated Resource Planning Parameters, section 6(t) of 2016 PA 341. In terms of unit-retirement assumptions, the starting point for each scenario used DTEE's announced Tier 2 coal-retirement plan as of summer 2018 when the IRP modeling began. The starting point for renewable energy builds, energy waste reduction, and demand response levels across all scenarios is described in sections 8 and 9. Finally, in each scenario the starting point assumed renewal of all existing Public Utility Regulatory Policies Act of 1978 (PURPA) contracts.

Reference: This scenario most closely matches our internal planning assumptions, forecasts and goals/aspirations. It utilized DTEE's gas forecast and incorporated DTEE's CO2 and clean-energy goals as a starting point. It includes a CO2 price starting at approximately $5 per ton in 2025 continuing up to $15 per ton in 2040.

Business as Usual: Thermal and nuclear generation retirements in the modeling footprint were driven by a maximum-age assumption, public announcements, or economics. Demand and energy remained at low growth rates. The BAU gas forecast was based on the 2018 Annual Energy Outlook from the U. S. Energy Information Administration, "Natural Gas: Henry Hub Spot Price: Reference Case." (2018 EIA gas forecast). No CO2 price was applied.

Emerging Technology: This scenario assumed that technological advancements and economies of scale result in a 35 percent reduction in capital costs for demand response, energy waste reduction, storage, and solar, plus an assumed 17.5 percent reduction in capital costs for wind. Retirements of all coal units except the most efficient were considered. The 2018 EIA gas forecast was used for this scenario. No CO2 price was applied.

Environmental Policy: This scenario assumed tighter carbon regulation by targeting a 30 percent CO2 reduction by 2030. Coal units were retired based first on carbon emissions, then economics. The wind and solar capital costs were assumed to decline by 35 percent. All other technologies costs were unchanged from the BAU scenario. The 2018 EIA gas forecast was used, as well as no CO2 price, to achieve the specified 30 percent CO2 reduction.

All alternative technology costs for the scenarios were taken from publicly available sources.

TABLE 6.1.1 - Scenarios and Sensitivities

Scenarios	Reference (REF)	Business as Usual (BAU)	Emerging Technology (ET)	Environmental Policy (EP)
Description	Utilizes DTEE's forecast on fuel costs. Assumes current retirement schedule and Company's environmental goals.	Utilizes 2018 EIA as gas forecast and no CO2 price. Existing fleet is largely unchanged.	Same as BAU but utilizes optimistic views on capital costs of wind decreasing by 17.5 percent and solar and storage decreasing by 35 percent.	Same as BAU, but utilizes optimistic views on capital costs of wind and solar decreasing by 35 percent.
CO2 Assumption	CO2 price based on DTEE CO2 goals. $5/ton starting in 2025.	No CO2 price applied	No CO2 price applied	No CO2 price applied
Gas Prices	Utilizes DTEE fuel forecast and transitions to PACE forecast.	Utilizes DTEE fuel forecast and transitions to 2018 EIA gas-price forecast	Same as BAU	Same as BAU
Capital Costs	Public sources	Public sources	Public sources, but decrease wind by 17.5 percent and solar, storage, EWR, and DR by 35 percent	Public sources, but decrease renewables by 35 percent.
EWR Cost Assumptions	Tiered costs	Flat high; consistent with Potential Study	Flat low; capital costs are dropped by 35 percent from the Potential Study	Flat high; consistent with Potential Study
Renewables	50 percent clean energy goal (renewable and EWR)	35 percent clean energy goal (renewable and EWR)	35 percent clean energy goal (renewable and EWR)	35 percent clean energy goal (renewable and EWR)

Because each scenario has different market assumptions, the resulting forecast for energy and capacity prices varies. Described below is the methodology utilized to determine the energy and capacity-price forecasts associated with each scenario.

TABLE 6.1.2: Annual Energy Price Forecasts ($/MWH)

Year	Source of Forecast	REF	BAU (ET and EP similar)	High Gas BAU (high gas ET and EP similar)
2018	Forwards	29.68	29.68	29.68
2019	Forwards	29.46	29.46	29.46
2020	Transition	29.30	29.86	30.89
2021	Transition	31.28	34.04	37.41
2022	Transition	35.73	39.94	47.13
2023	PACE	38.99	44.19	54.68
2024	PACE	40.97	46.17	58.17
2025	PACE	46.29	47.79	60.88
2026	PACE	47.46	48.63	64.02
2027	PACE	47.23	49.84	66.44
2028	PACE	48.07	51.19	68.42
2029	PACE	48.56	52.98	71.18
2030	PACE	50.86	55.55	76.73
2031	PACE	52.61	58.09	83.20
2032	PACE	54.93	60.97	87.81
2033	PACE	56.77	62.43	92.31
2034	PACE	58.98	64.50	96.28
2035	PACE	61.26	67.02	101.14
2036	PACE	63.06	68.72	105.02
2037	PACE	65.25	70.45	109.98
2038	PACE	66.55	72.98	115.11
2039	PACE	68.09	75.39	119.32
2040[1]	PACE	104.69	118.41	185.44

Energy Price

Energy prices were determined by using energy price forwards for 2018 and 2019, and long-term fundamental data derived from PACE for 2023 and beyond, with a transition period in 2020-2022. The forwards are a short-range outlook that represents what is happening in markets today and for two to three years into the future. Energy price fundamental forecasts typically take a longer-term view and are more representative of what is forecasted to happen in the mid-to-long term (2023-2040). PACE bases the long-range fundamental forecast market prices on projected gas prices and changes in the generation fleet in various regions, based on economics and forecasted regulations for each scenario.

The forwards are the same for each scenario, but each has a separate set of long-term fundamental data. In all scenarios, years 2018 and 2019 utilize the market forwards. To shift smoothly from the 2019 forwards to the 2023 PACE long term data, a three-year transition is used for years 2020-2022. That 36-month period was adjusted each month by performing a 36-increment interpolation between the forwards for each month and the PACE long-term 2023 monthly forecast. On-peak, off-peak, and around-the-clock monthly locational marginal prices were determined using the 36-increment method. The resulting prices on an annual basis are shown in Table 6.1.2.

[1] The projected increase in modeled energy prices in 2040 is caused by the planned retirement of a significant amount of baseload coal resources by both DTEE and Consumers Energy.

TABLE 6.1.3: Capacity-Price Forecasts ($/kW)

Year	REF	BAU	BAU High Gas	ET	ET High Gas	EP	EP High Gas	REF High CO2
2018	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
2019	50.6	52.2	52.6	52.7	52.9	50.6	52.9	45.1
2020	52.7	55.1	56.3	55.7	55.2	54.3	55.2	46.6
2021	51.0	53.5	53.3	54.0	1.7	1.7	1.7	1.4
2022	56.3	58.3	58.1	59.1	58.9	59.0	58.7	48.9
2023	58.0	59.4	59.1	60.3	60.0	60.1	59.8	49.6
2024	1.8	1.8	1.8	2.9	1.8	15.8	1.8	1.6
2025	1.8	1.8	1.8	7.8	1.9	20.7	1.9	13.8
2026	14.8	2.5	1.8	8.5	1.9	18.8	1.9	23.8
2027	17.1	2.9	1.9	4.8	1.9	11.4	1.9	33.4
2028	19.2	6.9	1.9	1.9	1.9	5.7	1.9	34.3
2029	25.3	12.2	1.9	7.4	2.0	8.5	1.9	36.9
2030	35.4	19.8	1.9	15.3	2.0	9.5	2.0	41.4
2031	43.2	30.3	1.9	21.0	2.0	6.4	2.0	50.2
2032	43.5	29.7	2.0	12.7	2.0	2.0	2.0	49.6
2033	48.8	27.7	2.0	12.2	2.1	2.0	2.0	48.1
2034	52.8	37.8	2.0	16.5	2.1	2.1	2.1	54.3
2035	58.0	47.9	2.0	27.1	2.1	2.1	2.1	57.3
2036	60.0	49.3	2.0	19.1	2.2	2.1	2.1	55.7
2037	62.3	53.3	2.1	21.0	2.2	2.1	2.1	55.8
2038	64.1	55.9	2.1	18.9	2.2	2.1	2.2	59.6
2039	68.2	61.9	2.1	24.7	2.2	2.2	2.2	60.8
2040	72.5	73.3	70.7	74.9	75.7	73.0	74.1	70.8

Capacity Prices

PACE calculated the capacity-price forecast as part of the fundamental modeling for each scenario, or high-gas and high-CO2 market sensitivity. In the IRP optimization modeling, no credit was given when excess capacity was available to theoretically sell into the market. For more details, please see Appendix F, Exhibit A-4. Table 6.1.3 represents nominal $/kW capacity prices.

6.2 Sensitivities

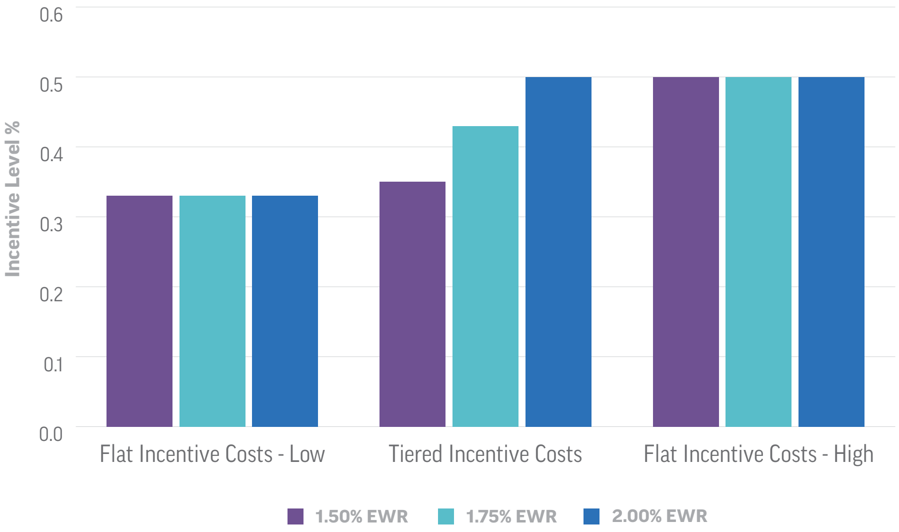
Sensitivities, as compared to scenarios, are generally designed to test one specific uncertainty. The Michigan Integrated Resource Planning Parameters, section 6t of 2016 PA 341, provided several required sensitivities. Each scenario has a starting point with no sensitivities applied. Then, each sensitivity was applied to the appropriate scenarios. A sensitivity typically changes one variable from the starting point. The sensitivities are described below.

Load: The starting point was the DTEE forecasted load. The load sensitivities included high-growth, 50 percent Electric Choice return by 2023, 100 percent Electric Choice return by 2023, and high electrical vehicle penetration assumption. The high-growth sensitivity assumed a 1.5 percent increase in the annual growth rate for energy and demand. The 50 and 100 percent choice return sensitivities assumed customers returned to DTEE, effectively increasing our load. The high electric vehicle penetrations assumed a large number of electric vehicles in our territory, which would increase our load.

Energy Waste Reduction: Several levels of energy waste reduction were tested as sensitivities. The starting point assumption was 1.5 percent EWR, with sensitivities increasing to 1.75 percent, 2.0 percent, 2.25 percent and 2.5 percent.

EWR Cost Levels: In the REF scenario, EWR costs were assumed to be tiered such that the 1.5 percent EWR sensitivity used historical costs that reflected incentives equal to 35 percent of the cost of the EWR measure. The 2 percent EWR sensitivity assumed incentives of 50 percent, consistent with the state-wide potential study. The 1.75 percent sensitivity assumed incentives of 42.5 percent, which is mid-way between the 1.5 percent and 2.0 percent sensitivities. These, collectively, are the tiered EWR incentive costs. The EP and the BAU scenarios assumed that incentives were offered at 50 percent of the measure cost, consistent with the Potential Study and regardless of what level of EWR was targeted. These are the flat-high EWR incentive costs. Finally, the ET scenario assumed a 35 percent reduction in EWR incentive levels from the Potential Study, regardless of what level of EWR is targeted. These are the flat-low EWR incentive costs. As sensitivities, the REF scenario's tiered pricing assumptions were applied to the BAU and EP scenarios, and the Potential Study's flat-high costs were likewise run on the Reference scenario.

FIGURE 6.2.1: Comparison of EWR Cost Sensitivities



Until higher levels (>1.5%) of EWR are achieved and sustained, there is uncertainty around the incentive costs required by the market to achieve the higher levels

Gas Prices: The BAU, ET, and EP scenarios all used the 2018 EIA forecast as their starting point. A sensitivity for each of these scenarios was to increase the EIA forecast by 200 percent to determine the impact of gas prices. The Reference scenario used the DTEE forecast as its starting point, with no additional sensitivity on gas prices.

Retirement: All scenarios used the announced DTEE retirement plan as their starting point. The Tier 2 retirement analysis was performed as a sensitivity in the ET scenarios. (Results of these sensitivities are covered in Section 15.)

Demand Response: The starting point for the REF scenario assumed DTEE's current demand response plan. A demand response sensitivity was run on all scenarios that allowed for only demand response programs to fill the capacity need before 2040.

Lithium-Ion Battery: A sensitivity was performed on the ET scenario that coupled a lithium-ion battery with a solar project. It was assumed that the solar project would charge the battery locally to take advantage of the investment tax credit, even though the Strategist model follows market price signals. Additionally, both projects were assumed to be behind-the-meter generators, which would result in additional benefits above resources located in the distribution system. Those benefits included scaling up the resources to account for distribution losses and an increase in firm capacity credit realized by behind-the-meter generation (Planning Reserve Margin adjustment).

Carbon Price: The REF scenario's starting point has a $5/ton price for carbon in 2025, which reaches $14/ton in 2040 (real $). The BAU, ET and EP scenarios' starting points have a constant $0/ton carbon price across all years. There was a carbon-price sensitivity on the EP scenario to achieve 50 percent carbon reduction by 2030. This sensitivity applied a $20/ton carbon price in 2030.

Available Replacement: The BAU scenario included a sensitivity where only combustion turbines were allowed as the replacement resource.

Additional Sensitivities: Additional sensitivities were run on relevant scenarios, including the impact of market purchases, transmission and distribution, and higher or lower utility discount rates, and an all-solar sensitivity. The details and the results of all these runs are in section 15.

A diverse set of sensitivities were considered in the IRP process, spanning 12 variable categories

TABLE 6.2.2: Summary of Sensitivities Modeled

Sensitivity	REF	BAU	ET	EP
Load	High Growth High EV Penetration Electric Choice Return	High Growth Electric Choice Return	High Growth	High Growth
EWR	4 levels	4 levels	4 levels	4 levels
EWR Incentive Cost	Flat High	Tiered	Flat Low	Tiered
Gas Price		200 percent of 2018 EIA forecast	200 percent of 2018 EIA forecast	200 percent of 2018 EIA forecast
Retirement			Adjust Tier 2 early	
Demand Response	Only DR programs before 2040	Only DR programs before 2040	Only DR programs before 2040	Only DR programs before 2040
Carbon Price				$20/ton in 2030 to achieve 50 percent CO2 reduction by 2030
Available Replacement		CT only		
T&D	$7/KW avoided T&D benefit	$7/KW avoided T&D benefit	$7/KW avoided T&D benefit	$7/KW avoided T&D benefit

Sensitivity	REF	BAU	ET	EP
No Gas	First plan without a gas unit	First plan without a gas unit	First plan without a gas unit	First plan without a gas unit
All Solar	Plan with solar as only resource	Plan with solar as only resource	Plan with solar as only resource	Plan with solar as only resource
Utility Discount Rate	5% utility discount rate		9% utility discount rate	
Market Purchase	Purchase capacity from market	Purchase capacity from market	Purchase capacity from market	Purchase capacity from market
Wind Congestion			Impact of market congestion on wind economics	

6.3 Sensitivities Submitted by Stakeholders

During its first technical conference, DTEE asked its stakeholders for input on sensitivities to run. Each stakeholder group could submit one sensitivity. Six stakeholders submitted a total of four sensitivities incorporating a range of variables.

The first sensitivity, submitted by three stakeholders, included an increased CO2 price and was applied to the REF scenario. The CO2 price starts at $30/ton in 2023 and escalates in the out years.

The second sensitivity was to retire Belle River sooner than the announced dates of 2029 and 2030. Specifically, Belle River Unit 1 would be retired on Dec. 31, 2025, and Unit 2 would be retired on Dec. 31, 2026. This sensitivity was requested to be run on the REF scenario.

The third sensitivity, referred to as sensitivity N, incorporated several changes in variables as opposed to a sensitivity that changes only one variable. This sensitivity was run on the REF scenario. The inputs specified for this sensitivity are shown in Table 6.3.1.

TABLE 6.3.1: Sensitivity N Inputs

Sensitivity N	
1. Load Growth	DTEE forecast plus 24% EV sales by 2030 (Bloomberg)
2. EWR	2.0% annually through all years unless more is required to meet no. 9
3. Capital Cost	DTE CCGT cost
4. Renewable	50% clean energy goal and 35% renewables by 2030 -additional 1,300 MW of renewables
5. Gas Price	Reference
6. Retirement	DTEE plan (starting point)
7. Demand Response	Full amount from 2017 State of MI Potential Study (high case) (974 MW DR by 2030)
8. Distributed Renewables	450 MW incremental solar
9. Available Replacement	Defer second CCGT with EWR, DR, and renewables
10. Conservation Voltage Reduction	150 MW by 2028

The fourth sensitivity asked for the Electric Choice current cap to increase from 10 percent to 25 percent. This sensitivity was asked to be run on the BAU scenario.

SECTION SEVEN

7 Existing Supply-Side Resources

7.1 Overview

DTEE has a diverse fleet of generation consisting of 24/7 baseload coal and nuclear power plants, natural-gas and oil-fired peaking units, pumped storage, and wind and solar parks. In addition, DTEE has entered into several power purchase agreements, most sourced with renewable generation. The following sections provide detail on the Company's existing supply-side resources.

7.2 Fossil-Fueled Generating Units

TABLE 7.2.1: Coal-Fired Units

Generation Unit Name	Commercial Operation Date	Age (Years)	Starting Point Planned Retirement Year	Planned Remaining Life (Years)	NCF (%) 2014 - 2018	Summer Capacity Rating (MW)
Belle River Power Plant - Unit 1	1984	35	2029	10	65.3	517
Belle River Power Plant - Unit 2	1985	34	2030	11	64.4	517
Monroe Power Plant - Unit 1	1971	48	2040	21	56.3	758
Monroe Power Plant - Unit 2	1973	46	2040	21	49.4	773
Monroe Power Plant - Unit 3	1973	46	2040	21	62.1	773
Monroe Power Plant - Unit 4	1974	45	2040	21	61.6	762
River Rouge Power Plant - Unit 3	1958	61	2020	1	42.8	272
St. Clair Power Plant - Unit 1	1953	66	2022	3	48.2	151
St. Clair Power Plant - Unit 2	1953	66	2022	3	43.1	154
St. Clair Power Plant - Unit 3	1954	65	2022	3	41.3	160
St. Clair Power Plant - Unit 6	1961	58	2022	3	35.2	311
St. Clair Power Plant - Unit 7	1969	50	2023	4	32.2	440
Trenton Channel Power Plant - Unit 9	1968	51	2023	4	40.3	495

Belle River Power Plant sits near the St. Clair River in both East China Township and China Township, Mich.. DTEE co-owns the plant with the Michigan Public Power Authority (MPPA), a consortium of 18 municipalities that aggregate together to provide for the electrical needs of their customers. Belle River is a two-unit plant; Unit 1 was placed into service in 1984 and Unit 2 began commercial operations in 1985. MPPA has an ownership position equal to 18.61 percent of the plant and so is entitled to 18.61 percent of the total plant electrical capacity and energy output and pays 18.61 percent of all costs. Each unit has a DTEE-owned net demonstrated capacity rating of 517 MW. The 2014-2018 average capacity factor for Unit 1 was 65 percent and for Unit 2 was 64 percent. Both units are coal-fired and utilize low-sulfur western (LSW) coal as their primary fuel source. Fuel oil is also utilized for unit startup and can be utilized as a supplemental fuel source during peak load conditions. The units are equipped with multiple emission-control technologies, including low NOX burners, over-fire air (OFA) systems, electrostatic precipitators (ESPs), dry sorbent injection (DSI), and activated carbon injection (ACI).

Monroe Power Plant is in the city of Monroe, Mich., along Lake Erie. It is a four-unit, supercritical coal-fired steam plant whose units were sequentially placed into service between 1971 and 1974. Unit net demonstrated capacity ratings for Units 1-4 are 758 MW, 773 MW, 773 MW, and 762 MW, respectively. The 2014-2018 average capacity factor for Unit 1 was 56 percent, for Unit 2 was 49 percent, for Unit 3 was 62 percent, and for Unit 4 was 62 percent. The units utilize coal as their primary fuel source, while also utilizing fuel oil for unit startup and as a supplemental fuel source during peak load conditions. Monroe blends various coal types based on electrical and fuel-market pricing dynamics. The units are equipped with multiple emission-control technologies, including low NOx burners, OFA systems, ESPs, flue gas desulphurization (FGD) scrubbers, and selective catalytic reduction.

River Rouge Power Plant is in the city of River Rouge, Mich., along the Detroit River. River Rouge Unit 2 was retired in 2016. River Rouge Unit 3, commissioned in 1958, has a net demonstrated capacity rating of 272 MW, utilizing coal as its primary fuel source and low-cost blast furnace gas and coke oven gas as additional fuel sources to the limit of their availability. Natural gas is also utilized as a fuel source for unit startup and as a supplemental fuel source during peak load conditions. River Rouge uses primarily LSW but also blends other coal types based on electricity and fuel market pricing dynamics. The unit is equipped with multiple emission-control technologies, including low NOx burners, OFA, ESPs, DSI, and ACI systems.

St. Clair Power Plant is in East China Township, Mich., along the St. Clair River. It is a five-unit, coal-fired steam plant. St. Clair Units 1-3 began service in 1953–1954, Unit

6 began commercial service in 1961, and Unit 7 began commercial service in 1969. The net demonstrated capacity ratings for Units 1-3, 6, and 7 are 151 MW, 154 MW, 160 MW, 311 MW, and 440 MW, respectively. St. Clair Unit 4 was retired in 2017 and St Clair Unit 5 was retired in 1979. The 2014-2018 average capacity factor for Unit 1 was 48 percent, for Unit 2 was 43 percent, for Unit 3 was 41 percent, for Unit 6 was 35 percent, and for Unit 7 was 32 percent. St. Clair utilizes coal as its primary fuel source. Fuel oil or natural gas is also utilized as fuel sources for unit startup and as supplemental fuel sources during peak load conditions on specific units. St. Clair uses primarily LSW but also blends other coal types based on electricity and fuel market pricing dynamics. The units are equipped with multiple emission-control technologies, including low NOX burners, OFA, ESPs, DSI, and ACI systems.

Trenton Channel Power Plant is in the city of Trenton, Mich., along the Detroit River. Trenton Channel Unit 9, which remains in service, was commissioned in 1968. The unit's net demonstrated capacity rating is 495 MW, and its 2014-2018 average capacity factor was 40 percent. Trenton Channel Unit 9 utilizes coal as its primary fuel source. Fuel oil is also utilized as a fuel source for unit startup and as a supplemental fuel source during peak load conditions. Trenton Channel uses primarily LSW but also blends other coal types based on electricity and fuel market pricing dynamics. The unit is equipped with multiple emission-control technologies, including low NOX burners, OFA, ESPs, DSI, and ACI systems.

DTEE owns both oil- and gas-fired peaking plants, which are shown in Tables 7.2.2 and 7.2.3 below.

TABLE 7.2.2: Oil Fired Peaking Units

Generation Unit Name	Fuel	Commercial Operation Date	Age (Years)	Number of Units	Summer Capacity Rating (MW)
Belle River Power Plant Peaker 11-1 / 11-5	Oil	1981	38	5	14
Colfax Peaker 11-1 / 11-5	Oil	1969	50	5	14
Enrico Fermi Power Plant - Peaker 11-1	Oil	1966	53	1	13
Enrico Fermi Power Plant - Peaker 11-2	Oil	1966	53	1	13
Enrico Fermi Power Plant - Peaker 11-3	Oil	1966	53	1	13
Enrico Fermi Power Plant - Peaker 11-4	Oil	1966	53	1	12
Monroe Power Plant - Peaker 11-1 / 11-5	Oil	1969	50	5	14
Northeast Peaker 13-1	Oil	1971	48	1	19
Northeast Peaker 13-2	Oil	1971	48	1	20
Oliver Peaker 11-1 / 11-5	Oil	1970	49	5	14
Placid Peaker 11-1 / 11-5	Oil	1970	49	5	14
River Rouge Power Plant Peaker 11-1 / 11-4	Oil	1967	52	4	11
Slocum Peaker 11-1 / 11-5	Oil	1968	51	5	14
St. Clair Power Plant - Peaker 12-1 / 12-2	Oil	1970	49	2	5
Superior Peaker 11-1	Oil	1966	53	1	13
Superior Peaker 11-2	Oil	1966	53	1	13
Superior Peaker 11-3	Oil	1966	52	1	12
Superior Peaker 11-4	Oil	1966	52	1	14
Wilmot Peaker 11-1 / 11-5	Oil	1968	50	5	14

Table 7.2.3: Gas-Fired Peaking Units

Generation Unit Name	Fuel	Commercial Operation Date	Age (Years)	Number of Units	Summer Capacity Rating (MW)
Belle River Power Plant Peaker 12-1	Gas	1999	20	1	75
Belle River Power Plant Peaker 12-2	Gas	1999	20	1	75
Belle River Power Plant Peaker 13	Gas	1999	20	1	74
Dean Peaker 11-1	Gas	2002	17	1	78
Dean Peaker 11-2	Gas	2002	17	1	78
Dean Peaker 12-1	Gas	2002	17	1	78
Dean Peaker 12-2	Gas	2002	17	1	78
Delray Peaker 11-1	Gas	2000	19	1	64
Delray Peaker 12-1	Gas	2000	19	1	63
Greenwood Energy Center - Peaker 11-1	Gas	1999	20	1	75
Greenwood Energy Center - Peaker 11-2	Gas	1999	20	1	75
Greenwood Energy Center - Peaker 12	Gas	1999	20	1	74
Greenwood Energy Center - Unit 1	Gas	1979	40	1	785
Hancock Peaker 11-1	Gas	1967	52	1	11
Hancock Peaker 11-2	Gas	1967	52	1	18
Hancock Peaker 11-3	Gas	1967	52	1	17
Hancock Peaker 11-4	Gas	1969	50	1	17
Hancock Peaker 12-1	Gas	1970	49	1	32
Hancock Peaker 12-2	Gas	1966	53	1	33
Northeast Peaker 11-1	Gas	1966	53	1	15
Northeast Peaker 11-2	Gas	1966	53	1	15
Northeast Peaker 11-3	Gas	1966	53	1	14
Northeast Peaker 11-4	Gas	1966	53	1	15
Northeast Peaker 12-1	Gas	1971	48	1	18
Renaissance 1	Gas	2002	17	1	163
Renaissance 2	Gas	2002	17	1	163
Renaissance 3	Gas	2002	17	1	163
Renaissance 4	Gas	2002	17	1	163
St. Clair Power Plant - Peaker 11-1	Gas	1968	51	1	19

The 2014–2018 average capacity factor for the peaking units was approximately five percent. All peaking units were assumed to remain operational throughout the study period (2019–2040).

7.3 Nuclear Generating Units

DTEE owns and operates the Enrico Fermi 2 Power Plant in Frenchtown Township, Mich. It is a boiling water reactor with a net demonstrated capacity rating of 1,141 MW. The plant was commissioned in 1988 and received a 20-year license renewal in 2016, allowing the unit to continue operating through at least 2045. During 2014-2018 the plant operated at an 80 percent average capacity factor.

7.4 Hydroelectric Generating Units

DTEE owns 49 percent of the Ludington Pumped Storage facility, which is discussed in more detail in Section 7.6. The Company also has contracts in place to purchase power from four small hydroelectric facilities within the state. Information regarding these facilities and the respective contracts are included in Section 7.7.

The Company also has contracts in place to purchase power from four small hydroelectric facilities within the state

7.5 Renewable Generating Units

As of 2019, DTEE's portfolio of owned and contracted renewable generating assets exceeds 1,150 MW, including assets to meet the renewable portfolio standard (RPS) and serve Voluntary Green Pricing (VGP) programs. Renewable energy resources owned by the Company are described in this section and those under contract are described in later sections. All company-owned renewable assets were assumed to remain in operation throughout the study period (2019–2040).

DTEE owns eight Michigan wind parks, with a combined capacity of 612 MW, which includes the assets for the RPS and those serving VGP programs. All of the parks are located in the state's Lower Peninsula, with six parks in the Thumb region and two in central Michigan. The parks' nameplate capacities range from 14 MW to 161 MW, and the fleet consists of 342 wind-turbine generators. An additional park, Polaris, is scheduled to be completed in 2020 in central Michigan, with an installed capacity of 168 MW and 68 installed wind turbines. Table 7.5.1 provides detailed information about DTEE-owned wind parks.

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TABLE 7.5.1: DTEE-Owned Wind Parks

Park Name	Location	Commercial Operation Date	Wind Turbines	Turbine Size	Capacity Factor (%)[1]	Installed Capacity (MW)
Gratiot Wind Park	Central, MI	2011	64	1.6	29.1	102.4
Minden	Thumb, MI	2013	20	1.6	41.5	32.0
McKinley	Thumb, MI	2013	9	1.6	41.5	14.4
Sigel	Thumb, MI	2013	40	1.6	41.5	64.0
ECHO	Thumb, MI	2014	70	1.6	39.8	112.0
Brookfield	Thumb, MI	2014	44	1.7	40.2	74.8
Pinnebog	Thumb, MI	2016	30	1.7	38.0	51.0
Pine River	Central, MI	2019	65	2.3 / 2.5	30 (est)	161.3
Polaris	Central, MI	2020	68	2.3 / 2.5	34 (est)	168.0

[1] Based on historical performance

DTEE owns eight Michigan wind parks, with a combined capacity of 612 MW

DTEE also has entered into six wind Power Purchase Agreements (PPAs) with renewable projects, with a combined capacity of 458 MW (the agreements are highlighted in Section 7.7). DTEE receives the renewable energy credits produced by these parks for use in complying with Michigan's renewable portfolio standard.

In addition to the wind portfolio, DTEE owns and operates a diverse set of solar assets across Michigan totaling 64 MWAC. Since 2010, DTEE has experimented with various technologies and approaches to building solar, and has worked with its partners at the arrays' host sites to help educate the community about solar energy. The sites in the Company's portfolio range in size from less than 100 kWAC to almost 28 MWAC. The sites' designs vary and include ground-mount, roof-mount, and carport panels. DTEE's owned solar parks are shown in Table 7.5.2.

TABLE 7.5.2: DTEE-Owned Solar Parks

Park Name	Location (County)	Commercial Operation Date	Capacity Factor (%)[1]	Capacity (MWAC)
SCIO Solar Array	Washtenaw	2010	14.3	0.056
Blue Cross Blue Shield	Wayne	2011	13.5	0.200
Monroe County Community	Monroe	2011	14.0	0.500
Ford Solar Array	Wayne	2011	11.7	0.500
Training and Development Center	Wayne	2011	13.4	0.380
General Motors Solar Array	Wayne	2011	12.7	0.500
DTE Headquarters (DECo Project #3)	Wayne	2012	10.7	0.081
Mercy High School	Oakland	2012	13.3	0.375
Warren Consolidated Schools	Macomb	2012	10.5	0.189
General Motors Orion Assembly	Oakland	2012	14.6	0.300
Huron Clinton Indian Springs Metro	Oakland	2012	13.5	0.495
Wil-Le Farms	Huron	2012	13.8	0.484
Immaculate House of Mary	Monroe	2012	14.4	0.500
University of Michigan - North Campus Center	Washtenaw	2012	13.5	0.430
University of Michigan - Institute of Science	Washtenaw	2013	14.3	0.241

The sites in the Company's portfolio range in size from less than 100 kWAC to almost 28 MWAC.

Park Name	Location (County)	Commercial Operation Date	Capacity Factor (%)[1]	Capacity (MWAC)
Riopelle Farms	Huron	2013	14.3	0.503
St. Clair RESA	St. Clair	2013	14.8	0.503
Leipprandt Orchards	Huron	2013	14.6	0.503
Hartland Schools	Livingston	2013	13.8	0.444
McPhail	Oakland	2014	14.4	0.750
Domino Farms	Washtenaw	2015	15.6	1.000
Thumb Electric Cooperative	Tuscola	2015	14.8	0.603
Ford World Headquarters	Wayne	2015	13.1	0.750
Ashley / Romulus	Wayne	2015	13.9	0.684
Brownstown	Wayne	2016	14.4	0.500
Greenwood Energy Center	St. Clair	2016	17.9	1.392
Ypsilanti	Washtenaw	2016	16.5	0.672
General Motors Transmission Plant	Macomb	2016	16.5	0.744
Demille Rd	Lapeer	2017	16.0	28.00
Turrill Rd	Lapeer	2017	15.5	20.00
O'Shea	Wayne	2017	16.4	2.00

[1] Based on 2017-2018 site performance; Demille, Turrill, and O'Shea based on 2018

7.6 Energy Storage Facilities

The Ludington Pumped Storage facility is in Ludington, Mich., alongside Lake Michigan. It is a six-unit hydroelectric power plant. The plant is co-owned by DTEE and Consumers Energy (CE); DTEE owns 49 percent and CE owns 51 percent. CE, as the majority owner, is also the operating authority. The units were commissioned in 1973 and their 2014-2018 average capacity factors were 13 percent, 10 percent, 13 percent, 12 percent, eight percent, and 11 percent, respectively. The current net demonstrated capacity of the plant portion owned by DTEE is 1,054 MW. Sthe units began going through a maintenance overhaul upgrade in 2015, one unit at a time. Four of the unit upgrades have been completed, the fifth will be completed in May 2019, and the last unit is expected to be completed in May 2020. These upgrades are providing 34 MW of increased generation (DTEE ownership) for each unit, for a total of 204 MW. When the upgrades are completed in 2020, DTEE-owned capacity in Ludington will be 1,122 MW.

Ludington can act as a 1,000 MW storage system, and provides a great opportunity to support the announced renewable energy resources that will grow in Michigan's bulk electric system. Ludington operates by pumping water up from Lake Michigan into a reservoir when power prices are low, and then generates energy by releasing the water through turbines back into Lake Michigan when customer demand increases or generation from intermittent resources decreases and electricity prices increase. When weather conditions disrupt renewables generation, Ludington can ramp up to provide generation quickly, thus smoothing the impact of renewable resources.

Ludington can act as a 1,000 MW storage system, and provides a great opportunity to support the announced renewable energy resources that will grow in Michigan's bulk electric system.

7.7 Power Purchase Agreements

In addition to owned resources, DTEE has entered into various PPAs that have been approved by the MPSC under PA 2/PURPA and PA 295/342:

- The Public Utility Regulatory Policies Act of 1978 (PURPA) requires electric utilities to purchase power from qualifying facilities (QFs) at the utilities' avoided cost, provide back-up power to QFs, interconnect with QFs, and operate with QFs under reasonable terms and conditions.
- PA 2 of 1989, enacted by Michigan, requires utilities with greater than 500,000 customers to enter into PPAs for both energy and capacity from certain landfill gas and solid waste QFs.
- PA 295 of 2008, enacted by Michigan, required utilities to meet certain renewable energy standards by 2015, and requires 50 percent of renewable energy credits used for compliance to be sourced from third parties.
- PA 342 of 2016, enacted by Michigan, increases the renewable energy standards from 10 percent by 2015 to 15 percent by 2021.

The Company currently has 11 PA 2/PURPA contracts and nine PA 295/342 contracts for both energy and capacity. The Company also receives capacity credit for customer-owned generation in the amount of 3.3 MW. The Company has capacity rights from both PURPA/PA 2 and 2008 PA 295/342 renewable-energy contracts, which are distinct from DTEE-owned renewable-energy systems. The Company will receive a total of 178 zonal resource credits in the 2019-20 planning year associated with PPAs (including customer-owned generation). If an existing contract term was set to mature prior to the end of the IRP study period (2040), for modeling purposes, it was assumed to be renewed and continues through 2040, at the respective contract price. The contracts are listed in Tables 7.7-1 and 7.7-2 with their corresponding expiration dates and UCAP values.

TABLE 7.7.1: PA 2 and PURPA Contracts

P.A. 2/ PURPA Facility	Expiration Date	Generation Type	UCAP (MW)
Ann Arbor - Barton Dam	4/1/2036	Hydro	0.2
Ann Arbor – Superior	5/1/2036	Hydro	0.0
STS French Landing	1/30/2039	Hydro	0.2
Charter Township Ypsilanti	1/1/2028	Hydro	0.4
Michigan Waste Energy	6/30/2024	Waste	42.8
Riverview Energy Systems	8/13/2027	Landfill Gas	4.8
Sumpter Energy Associates (Station #1)	7/13/2033	Landfill Gas	19.1
Lyon Electric Generating	9/21/2030	Landfill Gas	Combined with Arbor Hills
Turbine Power Limited Partnership - Arbor Hills	6/12/2031	Landfill Gas	14.4
Ann Arbor Landfill	4/29/2033	Landfill Gas	0.6

TABLE 7.7.2: P.A. 295 Agreements

P.A. 295 Agreement	Expiration Date	Generation Type	UCAP (MW)
Heritage Stoney Corners Wind Farm I, LLC	1/1/2030	Wind	3.2
Heritage's Garden Wind	1/1/2030	Wind	1.2
L'Anse Warden Electric Company, LLC	1/1/2032	Biomass	14.7
WM Renewable Energy, LLC	1/1/2032	Landfill Gas	2.8
Gratiot County Wind, LLC	1/1/2033	Wind	15.2
Blue Water Renewables, Inc.	1/1/2032	Biomass	2.8
Tuscola Bay Wind, LLC	1/1/2033	Wind	17.6
Tuscola Wind II, LLC	1/1/2034	Wind	16.8
Pheasant Run Wind, LLC	1/1/2034	Wind	13.4
Big Turtle Wind Farm, LLC	1/1/2035	Wind	3.0

7.8 Regional Transmission Operator; Unit Capacity Credits

In addition to energy, a key benefit of DTEE's generating units and PPAs is the provision of capacity. MISO, a Regional Transmission Operator (RTO), grants the Company's generating units and PPAs with capacity credits, also known as zonal resource credits (ZRCs). A summary of the current capacity credit for the Company's owned generating units is provided in the following table:

TABLE 7.8.1: RTO Capacity Credits, Company-Owned

Resource	2019/2020 Planning Year RTO Capacity Credit (ZRCs)
Fossil (Coal)	5,060
Fossil (Gas & Oil Peakers)	2,476
Nuclear	1,068
Pumped Storage	992
Owned Renewables	129

7.9 Spot market purchases and off-system sales

DTEE operates within the MISO energy market. As part of its function as a load-serving entity within MISO Local Resource Zone 7, the Company purchases wholesale energy from the MISO energy market, as required. The Company also sells energy to the MISO energy market when generating in excess of its customer demand.

SECTION EIGHT

8 Demand-Side Resources

8.1 Overview

Demand response (DR) programs are designed to help reduce enrolled customers' energy use during peak hours. DTEE's demand response programs have been part of its resource portfolio since the late 1960s. DTEE has developed a portfolio of demand response products, which include dispatchable programs, such as direct load control programs and interruptible tariffs, and non-dispatchable programs, such as time-varying rates. In 2017, DTEE ranked number one in the State of Michigan for potential peak-demand (MW) savings through utility demand response programs, number 11 (out of 411 utilities) nationally and number two (out of 126 utilities) in the Midcontinent Independent Service Operator (MISO) territory. [1] Currently, DTEE has more than 700 MW of enrolled capacity, which accounted for over six percent of the Company's 2018 peak load.

DR programs provide many benefits to DTEE, which ultimately flow through to its customer base. Those benefits include cost savings from potentially avoiding or deferring new generation needed to meet capacity requirements[2], reduced capacity purchases at costly times, risk reduction and energy security.

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[1] See 2017 data at https://www.eia.gov/electricity/data/eia861

[2] Avoided electric energy and capacity costs are based upon the costs an electric utility would incur to either construct or operate new electric power plants or other IRP alternatives, or to operate existing power plants. The energy component includes the costs associated with the production of electricity, while the capacity component includes costs associated with the capability to deliver electric energy during peak load periods.

The table below, Table 8.1.1, summarizes the Company's current demand response programs available as options for customers and the associated MWs each program claimed in the MISO 2019/2020 planning year as load modifying resources (LMRs) and in the IRP as the existing demand response levels.. Each program is described in more detail in sections 8.2 thru 8.4.

TABLE 8.1.1: Summary of Current Demand Response Programs

Demand Response Program	MW (UCAP)
R10 – Interruptible Supply Rider	336
D1.1 – Interruptible Space Conditioning	158
D8 – Interruptible Supply Base	98
R1.2 – Electric Process Heat	81
D3.3 – Interruptible General Service	23
R1.1 – Alternative Metal Melting	7
D5 – Interruptible Water Heating	6
R12 – Capacity Release	0
Total	**709**

Dispatchable programs provide the Company with zonal resource credits that can help it meet its Planning Reserve Margin Requirement (PRMR) for MISO planning purposes.

8.2 Dispatchable Programs

A dispatchable program is where an action is taken in response to requests or "calls" from a utility. The dispatch may be communicated directly to connected devices, such as a control switch or to designated energy managers, who modify their operations. Customers who wish to participate in direct load control programs permit the Company to install a device that allows the Company to cycle an appliance on and off during a time when electricity consumption is the highest. Typically, these programs do not offer an override option.

Dispatchable programs provide the Company with zonal resource credits that can help it meet its Planning Reserve Margin Requirement (PRMR) for MISO planning purposes. The PRMR is the amount of capacity above the weather-normalized peak demand needed to reliably serve load, while meeting events such as extreme weather and unplanned capacity outages.

Interruptible Space-Conditioning Rate (D1.1): This program consists of a separately metered service connected to the customer's central air conditioner (A/C) or heat pump and is available to residential and commercial customers. DTEE will cycle the A/C condenser by remote control on selected days for intervals of no more than 30 minutes in any hour and no more than eight hours in any day. Causes of interruptions may include, but are not limited to, maintaining system integrity, making an emergency purchase, economic reasons, or available system generation being insufficient to meet anticipated system load. Approximately 275,000 residential customers and 900 commercial customers take service under rate D1.1, providing a zonal resource credit of 158 MW for the 2019 planning year.

Interruptible General Service Rate (D3.3): Commercial secondary customers can elect to have separately metered service that is subject to interruption. This rate is not available to customers whose loads are primarily off-peak. 122 customers take service under this rate, providing the Company with 23 MW of zonal resource credits for the 2019 planning year.

Water Heating Service Rate (D5): This program is available to customers using hot water for sanitary purposes or other uses subject to the approval of the Company. A timer or other monitoring device controls the daily use of all controlled water heating service. Control of service shall not exceed four hours per day. Approximately 50,000 residential customers and 800 commercial customers take service under rate D5, providing the Company with six zonal resource credits for the 2019 planning year.

Interruptible Supply Base Service Rate (D8): Primary voltage customers who desire separately metered service for a specified quantity of demonstrated interruptible load of not less than 50 kW at a single location can take service under this rate. Participation in this rate is limited to 300 MW. For the 2019 planning year, D8 provides 98 MW of zonal resource credits.

Alternative Electric Metal Melting (Rider 1.1): Customers who operate electric furnaces for the reduction of metallic ores or metal melting can have that load separately metered, making it subject to interruption. Seventeen customers take service under this rate, providing the Company with seven zonal resource credits for 2019.

Electric Process Heat (Rider 1.2): Customers who use electric heat as an integral part of a manufacturing process, or electricity as an integral part of anodizing, plating or a coating process, who are willing to be subject to interruption, can take service under this rate through a separate meter. The 196 customers who take service under Rider 1.2 provide the Company with 81 zonal resource credits for 2019.

Interruptible Supply Rider (Rider 10): Rider 10 allows customers to elect the amount of interruption they are willing to take under a separate meter, up to 650 MW of enrolled load. Rider 10 is designed for customers of greater than 50 MW at a single location, but at DTEE's discretion and with available capacity, the minimum site requirements can be waived. 61 customers are enrolled in Rider 10, providing the Company with 336 zonal resource credits for 2019.

Capacity Release (Rider 12): Customers can be provided a voluntary capacity-release payment by subscribing at least 50 percent of their facility load to voluntary interruption during peak events. The capacity-release payment is a mutually negotiated rate between the customer and DTE. Zonal resource credits can be claimed under Rider 12, but currently no customers are taking service under this rate.

All dispatchable demand response resources are currently registered with MISO as load modifying resources. Load modifying resources are MISO registered resources that are used in the MISO Capacity Auction to help meet capacity requirements for the peak period. Most of the programs maintained by the Company may only be utilized to maintain system integrity (which would include MISO capacity shortages), thus preventing them from economic dispatch in the energy market. Two programs (D1.1 and D3.3) in the Company's demand response portfolio can also be deployed when interruption is economically preferable to purchasing energy.

8.3 Non-dispatchable Programs

A non-dispatchable program is where voluntary actions are taken by the customer to reduce or shift demand form peak to non-peak periods. Similar to how MISO treats non-dispatchable programs, these programs are treated as an offset to peak-load in the IRP.

Time-of-Use (TOU) Programs

DTEE's time-of-use programs shift load in time. Time-of-use programs play an increasingly integral part in the resource portfolio. DTEE has four residential time-of-use rates to encourage customers to shift their load to off-peak periods. While time-of-use programs provide value to customers and the Company, they do not qualify for any zonal resource credits in MISO. To qualify for zonal resource credits, a resource must be available to reduce demand with no more than 12 hours' advance notice from MISO, and a demand response program must have the capability to reduce demand to a targeted level or firm service level at the MISO coincident peak.

Residential Time-of-Day (D1.2): Residential customers can pay a lower energy charge for kWh during off-peak hours (7 P.M. to 11 A.M.) than on-peak hours (11 A.M. to 7 P.M.), Monday through Friday. While not a callable program, the time-of-day rate encourages customers to shift their energy usage patterns, which lowers overall system demand. There are approximately 9,000 residential customers taking service under this rate.

Geothermal Time-of-Day (D1.7): This rate is available, on an optional basis, to residential customers who desire separately metered service for approved geothermal space conditioning and/or water heating. The off-peak and on-peak schedule is the same as the residential time-of-day rate. Approximately 8,000 customers take service under this rate.

Dynamic Peak Pricing (D1.8): Residential and commercial customers can elect to have a tiered time-of-use rate with a critical-peak-event overlay. The rate is designed to allow customers to manage their electricity costs by reducing or shifting load during high-cost periods. The three-tiered rate has an off-peak period (weekdays between 11 P.M. to 7 A.M., Company recognized holidays and weekends), a mid-peak period (non-holiday weekdays from 7 A.M. to 3 P.M. and 7 P.M. to 11 P.M) and an on-peak period (non-holiday weekdays from 3 P.M. to 7 P.M.). During a critical peak event, the cost per kWh increases during the on-peak period. The Company is permitted to call up to 20 events per year. Though the events are callable, the dynamic peak pricing doesn't provide any zonal resource credits due to the amount of time required to notify a customer of an event. More than 5,000 residential customers and one commercial customer are enrolled on rate D1.8.

Electric Vehicle Time-of-Day (D1.9): Customers with electric vehicles have the option to take separately metered service to charge their vehicle. Rate D1.9 is a time-of-use rate designed to shift the time customers charge their vehicles to the off-peak period. The on-peak period is Monday through Friday from 9 A.M. to 11 P.M. while the off-peak period comprises the remaining hours. Nearly 2,000 customers take service under this rate.

Beginning in 2021, the Company expects to fully implement the mandatory time-of-use rate for all residential customers as order by the Commission in the Company's last ordered rate case, U-18255. The Company's proposed rate design includes a one cent differential between off and on-peak. The Company did not forecast any load shift resulting from the mandated TOU rate because of the small price differential between the off-peak and on-peak time periods. This resulted in the Company not adjusting the IRP peak load forecasts to reflect any impacts of the mandatory TOU rate.

Non-dispatchable programs are treated as an offset to peak-load in the IRP.

8.4 Demand Response Pilot Programs

DTE Electric is conducting additional demand side management pilots encompassing residential, commercial and industrial customers. Based on the results of these pilots and of utility benchmarking efforts, the Company expects to identify other alternative DR programs that may become economic and technically viable alternatives to generation capacity, have an appropriate level of customer adoption potential, and are cost effective for customers. While the Company intends to learn as much as possible through benchmarking of other pilots and programs and leverage the knowledge of vendors who have experience in implementing demand response programs, it is considered best practice to conduct actual internal pilots before launching a new full-scale program. These pilots seek to identify how our unique customer base will react to specific marketing tactics, program design features, and other characteristics that are dependent on DTE Electric's unique combination of systems, equipment, tariffs, programs and processes.

Residential Pilots

Bring Your Own Device (BYOD): In the BYOD program, the Company enrolls residential customers and who have a Wi-Fi-enabled smart thermostat already installed. Customers who are already enrolled in the Interruptible Air Conditioning or the Programmable Communicating Thermostat program are excluded from the BYOD pilot. In 2018, customers were offered a chance to win one of ten $500 gift cards as an incentive to enroll in the program. Customers' thermostats were then configured to allow the Company to send a control signal during BYOD events, which only occur on weekdays between 3 P.M. and 7 P.M. and are limited to 10 events per year. During such an event, the Company sends a pricing signal to a customer's thermostat to raise the set-point by four degrees. Customers can override the event if they choose. This program is considered a non-dispatchable program although the Company is assessing customer engagement levels and may recommend program modifications that would eventually allow the BYOD program to qualify as an LMR.

Programmable Communicating Thermostat (PCT): The PCT Pilot, also known as SmartCurrents™, requires customers to enroll or be enrolled on the Dynamic Peak Pricing (D1.8) tariff. Upon enrollment, customers are sent a free Wi-Fi enabled thermostat. Once the thermostat is installed, the Company sends a pricing signal to the thermostat during a critical peak event that raises the thermostat setpoint by four degrees. The customer has the option to override the temperature setpoint but by doing so could drive the customer's bill higher with increased energy usage during the peak period.

DTE Electric is conducting additional demand side management pilots encompassing residential, commercial and industrial customers

Commercial & Industrial Pilots

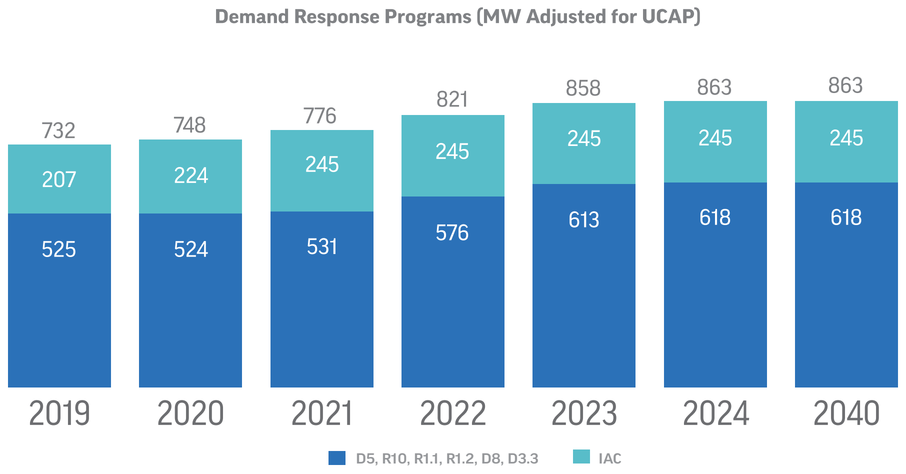
Building Automation Pilot: The Company partnered with NextEnergy (a facility space that incorporates an auditorium, meeting spaces, laboratories, microgrid and other areas) and Enbala (a cloud-based platform provider) to implement a cost-effective pilot encompassing multiple system assets at NextEnergy's commercial customer facility. The goal of the pilot was to specifically assess the performance of the Enbala's Symphony technology and the communication tool and platform during DR events. The Company was able to use the platform to select and manage specific customer assets for load controlling without a full facility shut-off or interruption. The pilot included various customer assets including chilled and chiller water pumps, air handler units (AHU), load bank (microgrid), a generator, and an electric vehicle charger that were all interconnected through Enbala's Virtual Power Plant software. The Company finalized the pilot in 2018 and expects to use the key insights to investigate future potential pilots or programs of similar nature in other individual commercial and industrial customers in 2019 and 2020.

Plug in Electric Vehicle (EV) Platform: The Company is conducting a pilot that involves a partnership with the Electric Power Research Institute (EPRI)'s Transportation Program. The pilot program will leverage EPRI's Plug-in Electric Vehicle (PEV) platform to develop a proof-of-concept to streamline the management of PEV charging. The Company is partnering with specific PEV automotive manufacturers in its territory in pilots so that the Company can assess the effectiveness of the open-standard-based platform concept to integrate PEV charging with grid objectives through demand response. The Company and the manufacturers hope to learn the responsiveness of the PEV owners and their willingness to participate in DR events specifically targeted at vehicle charging and the amount of demand that is curtailed through events. The planning stage of this pilot has concluded, and the first event was called on February 26, 2019.

Rider 12 Tariff – Capacity Release: The Rider 12 tariff (described above) is not new to the Company, but currently no customers take service under it. However, in the Demand Response Market Assessment Study that the Michigan Public Service Commission commissioned in 2017, commercial and industrial customers expressed interest in a capacity release-like program. As a result of that feedback, the Company plans to begin marketing this program and enroll large commercial and industrial customers in the second quarter 2019.

Battery Storage Pilots: The Company is evaluating various battery storage pilots and their applicability to demand response. These pilots are still in the exploratory phase but the Company considers it prudent to study the technology for future implications.

FIGURE 8.5.1 - Starting point demand response in IRP from 2019 to 2040



8.5 IRP Starting Point: Demand Response

The existing demand response programs included in the starting point consisted of both dispatchable and non-dispatchable programs. The starting point for demand response was 732 MWs and grew to 863 MWs by 2040. This was based on 2017 data and was consistent with the Company's capacity demonstration (case U-18197) that was filed on December 1, 2017, see Figure 8.5.1.

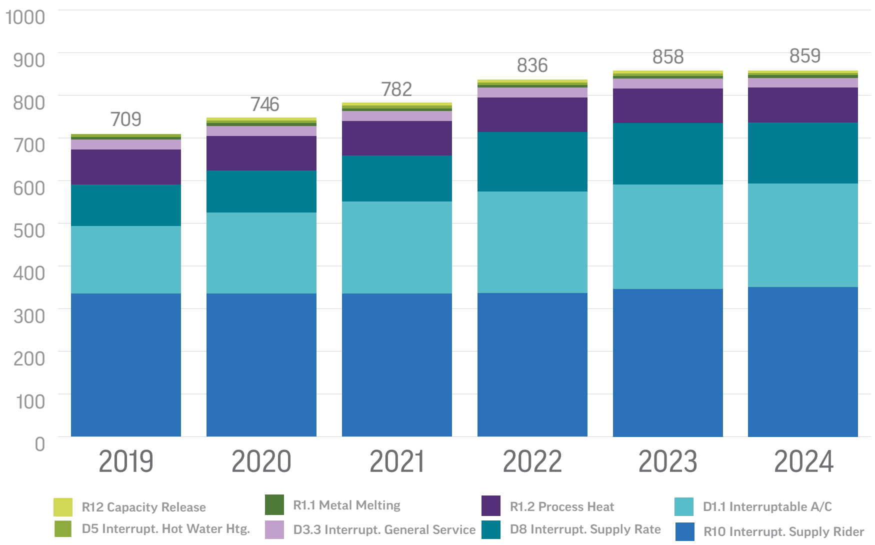
8.6 Proposed Course of Action: Demand Response

IRP Defined PCA: Demand Response

Since IRP modeling began in the summer of 2018, the demand response forecast has changed slightly and has been updated to reflect the Company's most recent capacity demonstration. Based on updated program data, the Company forecasts 709 MWs of demand response in 2019 with existing programs growing to 859 MWs in 2024, see Figure 8.6.1. This is consistent with the Company's latest capacity demonstration (Case U-20154) that was filed on December 3, 2018 and is based on the most current data. Beyond 2024, it was assumed that existing programs remain flat through 2040.

Based on updated program data, the Company forecasts 709 MWs of demand response in 2019 with existing programs growing to 859 MWs in 2024

FIGURE 8.6.1: Existing demand response capacity in IRP from 2019 to 2024



Flexible PCA: Demand Response

In regards to the flexible portion of the proposed course of action the Flexible PCA identifies four pathways (A, B, C, and D) with varying levels of demand response. Pathways A, B and D do not increase the levels of demand response from the Defined PCA. Pathway C increases the levels of demand response by an incremental 100 MWs. The makeup of the 100 MWs of incremental demand response in pathway C has not been decided although it is believed to come from the successful implementation of on-going and future pilot programs.

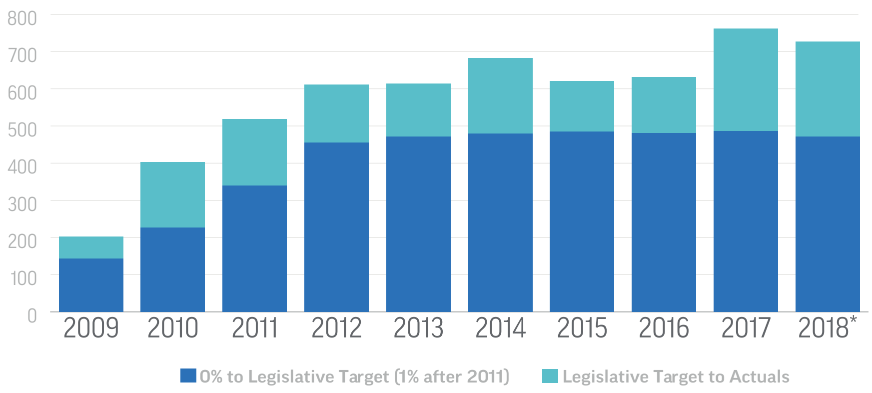
8.7 Energy Waste Reduction

DTEE's Energy Waste Reduction (EWR) program launched in June 2009 as a result of the Clean, Renewable, and Efficient Energy Act, also known as 2008 Public Act (PA) 295. In 2016, PA 342 was signed into law, amending PA 295. The EWR standards in PA 342 maintain the minimum energy savings standards developed in PA 295 of 1.0% of total annual retail electric sales per year through 2021.

DTEE's EWR programs are designed to help customers reduce their energy usage by increasing customer awareness and adoption of energy-saving technologies. This is accomplished by providing products and services such as rebates, tips, tools, strategies and energy-efficiency education to help customers make informed energy-saving decisions. DTEE has continued to build on its momentum from the 2009 launch by expanding the scope of existing programs and adding new program options to the portfolio. DTEE's EWR program has consistently exceeded savings targets and is expected to continue that trend through the future, as shown in Figure 8.7.1

DTEE's EWR programs are designed to help customers reduce their energy usage by increasing customer awareness and adoption of energy-saving technologies.

FIGURE 8.7.1: Summary of Annual EWR Savings (GWh)



*2018 savings are based on projections from the DTEE 2018/2019 EWR Plan Filing, Case No. U-18262

DTEE's ability to run the EWR programs effectively has continued to improve through further maturity of systems and back-office processes. DTEE is currently engaged in evaluating new programs, delivery, and results as it continues to evolve the EWR portfolio.

8.8 General Benefits of EWR

EWR programs have multiple benefits, including savings from the avoided cost of new generation capacity, non-electric benefits such as water savings, environmental benefits, economic stimulus, job creation, risk reduction and energy security. EWR programs help reduce the Company's reliance on fossil-fueled generation from existing plants, mitigate the need to build new generation resources in the future, help reduce reliance on power purchases from other suppliers, and ease utility bill pressures by providing benefits to consumers and the DTEE system.

At the consumer level, energy-efficient products often cost more than their standard counterparts, but the higher up-front cost is balanced by lower energy consumption, resulting in lower energy bills. Over time, the money saved on electric bills as a result of energy-efficient products may pay consumers back for their initial investment. Although some energy-efficient technologies are complex and expensive, such as installing high-efficiency windows or a high-efficiency boiler, many are simple and inexpensive. Installing light-emitting diode (LED) lighting or low-flow water devices, for example, can be done by most individuals.

DTEE's EWR programs include residential programs, commercial and industrial programs, pilot programs, and general education and awareness programs.

8.9 EWR Program Offerings

DTEE's EWR programs include residential programs, commercial and industrial programs, pilot programs, and general education and awareness programs. In addition, the Evaluation, Measurement and Verification requirement verifies net energy savings reported by the EWR programs. The programs are managed by DTEE program managers and operated by expert implementation contractors, primarily utilizing local labor and products.

Each program offers a combination of EWR products, customer incentives or rebates, and education. Following is an overview of each program category:

Residential Programs offer customers products, services and rebates encompassing appliance recycling; lighting; heating, ventilating and air conditioning (HVAC); weatherization; home energy assessments; low-income programs; energy education; behavioral programs; school programs; an online marketplace; and direct install programs.

Commercial and Industrial Programs offer businesses products, services, and prescriptive rebates for specific equipment replacement such as lighting, boilers, pumps, and compressors; custom programs providing rebates per kilowatt hour (kWh) of electricity savings for a comprehensive system or industrial process improvement; business energy consultation programs; operational programs; and

energy education.

Pilot Programs focus on new and emerging experimental programs to fit longer-term portfolio needs, test the cost-effectiveness of new technologies, assess customer adoption of new technologies and market acceptance of existing technologies using new approaches.

Education and Awareness Programs are designed to raise customer EWR awareness to help save energy and to reduce energy costs. A secondary objective is to raise awareness of the DTEE website and social media, which provide channels for customers to engage in specific EWR programs.

EWR programs require independent verification of the utility claimed energy savings. An independent **Evaluation, Measurement and Verification** contractor performs this work to industry standards and guidelines developed by the MPSC EWR Collaborative's Evaluation Workgroup.

Refer to Figure 8.9.1 for a list of current programs offered. A complete description for each program may be found in the Company's 2017 Energy Waste Reduction Annual Report [3].

FIGURE 8.9.1: Current Energy Efficiency Program Offerings

Residential Programs	C&I Programs	Education & Awareness Programs	Pilot Programs
DTE INSIGHT & ENERGY BRIDGE	PRESCRIPTIVE	RESIDENTIAL	RESIDENTIAL
APPLIANCE RECYCLING	NON-PRESCRIPTIVE	COMMERCIAL & INDUSTRIAL	COMMERCIAL & INDUSTRIAL
MULTI FAMILY	SELF-DIRECT	EMPLOYEES	ENERGY MANAGEMENT TOOLS
ENERGY EFFICIENT ASSISTANCE			
HVAC & WATER HEATING	RETROCOMISSIONING		
ENERGY STAR	MID-STREAM LIGHTING		
AUDIT & WEATHERIZATION			
ON-LINE ENERGY AUDIT			
HOME ENERGY CONSULTATION			
SCHOOLS			
HOME ENERGY REPORTS			

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[3] https://newlook.dteenergy.com/wps/wcm/connect/e20de3d0-11df-41e5-bfbc-b41927e5a77c/2015-EO-Annual-Report.pdf?MOD=AJPERES

8.10 Historical EWR Performance

Since their inception in 2009, DTEE's EWR programs have resulted in the first-year energy savings, first-year capacity savings, and spend detailed in Table 8.10.1

TABLE 8.10.1: Annual Energy Savings, Capacity Savings and Spend (2009-2018)

Year	Incremental Annual Energy Savings (MWh)	Annual % Energy Savings	Incremental Annual Capacity Savings (MW)	Spend ($MM)[5]
2009	202,718[2]	0.42%	19[2]	$23
2010	402,995[2]	0.89%	46[1]	$47
2011	519,263[3]	1.15%	69[1]	$65
2012	610,655	1.34%	80[1]	$80
2013	613,528	1.30%	84[3]	$86
2014	681,638	1.42%	96[3]	$98
2015	620,850	1.28%	81[3]	$100
2016	630,920	1.31%	106	$102
2017	761,630	1.57%	116	$111
2018[4]	727,360	1.54%	95	$126

[1] Utility Reported Gross Savings

[2] Audited Gross Savings

[3] Verified Gross Savings

[4] Projected savings and spend

[5] Includes financial performance incentive

In 2018 EWR programs resulted in energy savings of more than 700,000 MWh.

From 2009 through 2018, DTEE customers saved approximately 5,772 gigawatt hours (GWh) and four billion dollars in avoided-cost savings. The savings achieved so far will continue into future years.

8.11 IRP Starting Point: EWR

Since the portfolio's inception in 2009, the Company has provided robust EWR programs to help customers reduce energy waste. However, it took time to develop and implement programs that deliver the high levels of energy savings the Company has recently achieved. In 2018, the Company increased its energy savings target to 1.5% as part of its commitment to reduce customer energy waste. The 1.5% EWR level was used as the starting point assumption in this IRP.

8.12 Proposed Course of Action: EWR

IRP Defined PCA: EWR

PA 342 as passed in December 2016 establishes a minimum energy savings requirement of 1 percent of total annual retail sales through 2021. DTEE's Defined PCA increases the level of EWR to 1.75%, starting with an increase to 1.625% in 2020 and full implementation of 1.75% in 2021 through 2024, thus exceeding the minimum energy savings requirement. The annual energy and capacity savings for DTEE's 2019-2024 EWR programs includes the forecasted amounts shown in Table 8.12.1.

Since the portfolio's inception in 2009, the Company has provided robust EWR programs to help customers reduce energy waste.

TABLE 8.12.1: Forecasted Annual MWh Savings, Capacity Savings and Spend (2019-2024)

Year	Forecasted Incremental Annual Energy Savings (MWh)	Forecasted Spend ($MM)
2019	702,851	$136
2020	759,276	$154
2021	818,016	$186
2022	817,273	$193
2023	814,027	$184
2024	811,246	$177

Flexible PCA: EWR

The Flexible PCA identifies four pathways (A, B, C, and D) with various levels of EWR. Pathways A, B, and D continue the 1.75% EWR level from 2025 through 2040. Pathway C increases the level of EWR to 2.00%, starting with an increase to 1.875% in 2025 and full implementation of 2.00% in 2026 through 2040.

Cumulative EWR Energy Savings: MWh

Figure 8.10.2 displays the forecasted cumulative MWh savings for both the Defined PCA and Flexible PCA pathways. Cumulative energy savings represent both the overall savings occurring in each year from new participants and that continuing to result from past participation with EWR measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as EWR measures have finite lives and, as a result, their savings decline over time.

When EWR levels are increased to 1.75% and maintained at that level (Flexible PCA A, B, and D), the cumulative energy savings is forecasted to be more than 7.2 million MWhs from 2019 through 2040 at a cost of $4.0 billion to DTEE's customers. When EWR levels are further increased to 2.0% by 2026 and maintained at that level (Flexible PCA C), the cumulative energy savings is forecasted to be more than 8.1 million MWhs from 2019 through 2040 at a cost of $4.8 billion to DTEE's customers.

TABLE 8.12.2: Flexible PCA (A, B, C, & D) Annual MWh Savings, Capacity Savings and Spend (2025-2040)

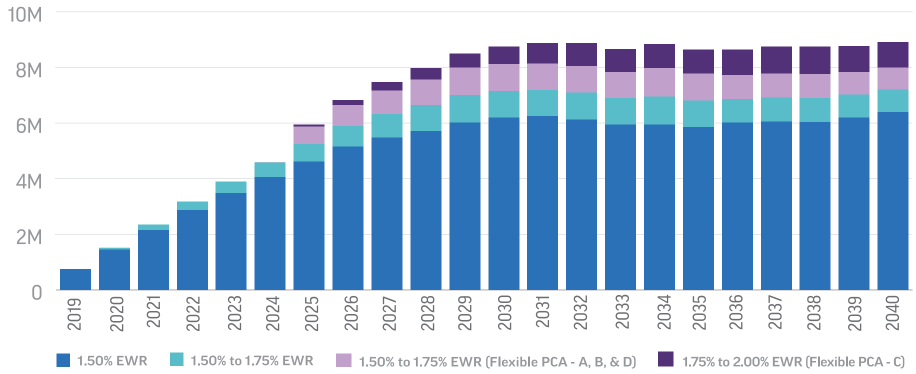
	Flexible PCA (A, B, & D): 1.75%		Flexible PCA (C): 2.00%	
Year	Forecasted Incremental Annual Energy Savings (MWh)	Forecasted Spend ($MM)	Forecasted Incremental Annual Energy Savings (MWh)	Forecasted Spend ($MM)
2025	808,399	$179	866,142	$207
2026	806,390	$178	921,589	$234
2027	804,684	$173	917,335	$224
2028	803,107	$181	913,363	$232
2029	802,147	$178	910,134	$231
2030	801,392	$178	907,325	$234
2031	800,659	$188	905,091	$237
2032	800,234	$192	903,600	$241
2033	799,603	$193	901,900	$246
2034	799,760	$192	901,041	$239
2035	799,607	$192	900,298	$237
2036	799,413	$188	899,150	$234
2037	799,455	$196	898,749	$240
2038	798,973	$194	897,315	$242
2039	798,634	$195	896,524	$243
2040	798,631	$197	896,317	$245

Cumulative Energy Savings: MWH

Figure 8.12.3 displays the forecasted cumulative MWh savings for both the Defined PCA and Flexible PCA pathways. Cumulative energy savings represent both the overall savings occurring in each year from new participants and that continuing to result from past participation with EWR measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as EWR measures have finite lives and, as a result, their savings decline over time.

When EWR levels are increased to 1.75% and maintained at that level (Flexible PCA - A, B, and D), the cumulative energy savings is forecasted to be more than 7.2 million MWhs from 2019 through 2040 at a cost of $4.0 billion to DTEE's customers. When EWR levels are further increased to 2.0% by 2026 and maintained at that level (Flexible PCA - C), the cumulative energy savings is forecasted to be more than 8.1 million MWhs from 2019 through 2040 at a cost of $4.8 billion to DTEE's customers.

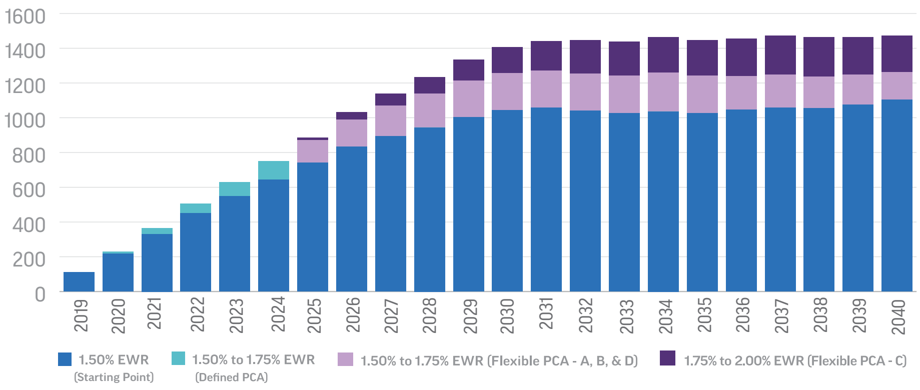
FIGURE 8.12.3: Forecasted Cumulative MWh Savings (2019-2040)



Cumulative Capacity Savings: MW

Although peak demand reductions are not the EWR programs' primary focus, when EWR levels are increased to 1.75% (Defined PCA) and maintained at that level (Flexible PCA - A, B, and D), the cumulative capacity savings is forecasted to be 1,264 MWs by the end of 2040. When EWR levels are further increased to 2.0% by 2026 and maintained at that level (Flexible PCA - C), the cumulative capacity savings is forecasted to be 1,474 MWs by the end

FIGURE 8.12.4: Forecasted Cumulative MW Savings (2019-2040)



of 2040. Figure 8.11.4 shows that the DTEE's EWR programs are projected to achieve significant cumulative MW savings from 2019 through 2040.

DTEE performed an analysis ensuring that the proposed course of action for EWR is cost-effective. Cost-effectiveness is measured by the results of the Utility Cost Test (UCT) as established in PA 342. Specifically, if the savings can be delivered at a UCT benefit-cost ratio greater than 1.0, then the EWR plan is considered cost-effective. When EWR levels are increased to 1.75% (Defined PCA) and maintained at that level (Flexible PCA - A, B, and D) through 2040, the resulting UCT benefit-cost ratio is 2.53. When EWR levels are further increased to 2.0% by 2026 and maintained at that level (Flexible PCA - C) through 2040, the resulting UCT benefit-cost ratio is 2.38.

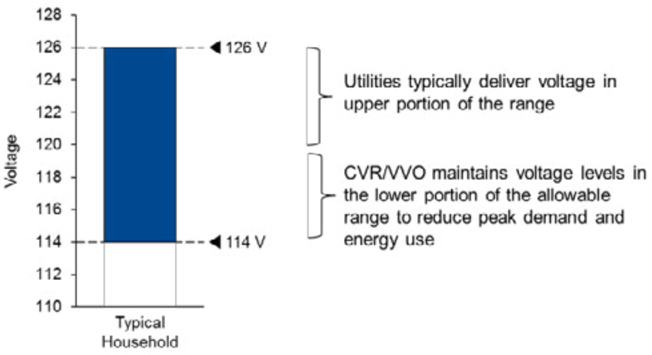
In summary, DTEE is well-positioned to continue to provide value to its customers and other stakeholders through a robust and well-run EWR program. Based on DTEE's experience implementing EWR programs since 2009 and the results of its electric energy-efficiency potential study, DTEE believes the EWR assumptions included in the proposed course of action are likely to deliver the projected energy savings.

8.13 Volt-Var Optimization (VVO) and Conservative Voltage Reduction (CVR)

Volt Var Optimization (VVO) manages system-wide voltage levels and reactive power flow to achieve one or more specific operating objectives. The objectives can include reducing losses, managing voltage volatility due to intermittent renewable generation, optimizing operating parameters and/or optimizing power factors, etc. Conservation Voltage Reduction (CVR), as one of the VVO options, is designed to maintain customer voltage levels in the lower portion of the allowable voltage ranges, thus reducing system losses, peak demand, or energy consumption.

CVR is achieved by utilizing various electrical equipment including transformer load tap changers (LTC), overhead line regulators, and capacitor banks. In addition, supervisory control and data acquisition (SCADA) monitoring devices and line sensors are used to ensure customer voltage levels are maintained in allowable voltage ranges; advanced telecommunication and optimization tool can also be used to achieve optimal savings in the system.

FIGURE 8.13.1 Allowable Voltage Range for a Typical Household



The American National Standards Institute (ANSI) Standard C84.1 provides allowable voltage ranges for electrical power systems and equipment. As illustrated in Figure 8.13.1, the allowable voltage range is 114 V – 126 V for a typical household. Utilities typically deliver voltage in the upper portion of the allowable voltage range, whereas CVR/VVO is to maintain customer voltages in the lower portion of the allowable range to reduce peak demand and energy consumption.

To understand the CVR/VVO potential in the DTEE system, a detailed study was performed on 12 sample circuits that belong to five circuit groups. The circuit groups were formed based on characteristics that could significantly affect how circuits react to CVR/VVO implementation, including 4.8 kV vs. 13.2 kV operating voltage, overhead vs. underground construction, load density, and mix of commercial vs. residential customers (See Table 8.13.2).

TABLE 8.13.2 - Circuit Group

Group ID	Group Definition
Group 1	13.2 kV underground, primarily in newer suburban areas
Group 2	13.2 kV residential and commercial, mixed overhead and underground
Group 3	13.2 kV with areas where the voltage was stepped down to 4.8 KV to serve customers at legacy voltage
Group 4	4.8 kV ringed circuits
Group 5	4.8 KV long circuits

The study indicates CVR/VVO is potentially economically feasible for Group 1 and Group 2, with cost estimates to implement CVR/VVO peaking at $500 per KW, whereas it is not economically feasible for the other three groups, with costs that are hundred to thousand times higher. Table 8.13.3 summarized the average benefits and costs for each of the circuit groups from the study.

TABLE 8.13.3 CVR/VVO Benefit Cost Analysis

Group ID	Average Circuit kW Reduction	Average Circuit Annual MWh Reduction	Average cost Per kW for CVR/ VVO ($)	Upgrades Required
Group 1	45-55	15-75	$300-500	Installation of sensors and communications, settings changes, and minor equipment reconfiguration
Group 2	70-90	40-200	$300-500	Installation of sensors and communications, settings changes, and minor equipment reconfiguration
Group 3	0-65	0-260	$64,000 – 90,000	25% of the circuits need voltage upgrades, otherwise regulator and capacitor bank additions
Group 4	15-35	30-65	$400,000-600,000	All circuits need to be upgraded to 13.2 kV (cost range does not include costs for substation upgrades)
Group 5	20-80	20-150	$500,000-650,000	All circuits need to be upgraded to 13.2 kV (cost range does not include costs for substation upgrades)

The two economically feasible groups (Groups 1 and 2) are composed of complete 13.2 kV circuits, where at least seasonal CVR/VVO is potentially feasible with the current configuration of the circuits. The other three groups (Groups 3-5) all involve circuits that are completely 4.8 kV or have areas of 4.8 kV. Without significant upgrades, these circuits do not have the ability to support CVR/VVO while operating according to ANSI standards. In most cases, the voltages for circuits in Groups 3-5 are too low at some locations to support further voltage reduction without converting to 13.2 kV circuit design.

After extrapolating results from the 12 sample circuits to the entire system, the total peak demand reduction and energy reduction were estimated in ranges for each circuit group, as shown in Table 8.13.4. The study suggests the circuits in Groups 1 and 2 can potentially produce a total peak demand reduction of approximately 40-60 MW and an annual energy reduction of approximately 55,000-75,000 MWh. The total capital cost to upgrade these circuits is estimated at $18-24 million based on an average cost per circuit of $30,000-40,000 and a total of 591 circuits in Groups 1 and 2.

TABLE 8.13.4 CVR/VVO Summary Benefits

Group ID	# of Circuits	Peak Demand Reduction (kW)	Energy Reduction (MWH)	Capital Cost Estimates ($ million)
Group 1	242	10,500 – 27,000	5,500 – 13,000	$7 - $10
Group 2	349	28,500 – 35,500	50,000 – 63,500	$11 - $14
Group 3	430	0 – 25,500	24,000 – 27,500	$815 - $1,150
Group 4	1,375	12,500 – 25,000	69,000 - 291,000	$7,500 - $ 11,250
Group 5	238	4,500 - 12,500	31,500 - 60,000	$4,250 - $5,525

The technology upgrades needed to implement CVR/VVO on Circuit Groups 1 and 2 include two major components. One is to enhance remote monitoring and control capability at substations and circuits. The technology upgrades could take the form of:

- Installing Remote Terminal Units (RTU) and SCADA at substations to enable remote voltage and current monitoring, and to enable remote control of transformer load tap changers when needed
- Installing advanced line sensors on circuits to enable remote monitoring of circuit voltage

The other technology enhancement is to install or upgrade line capacitor banks to improve voltage conditions, particularly at the tail ends of the circuits. The technology upgrades could take the form of:

- Installing remote controllable capacitor banks to improve circuit voltage profile during peak hours
- Upgrading existing capacitor banks to improve circuit voltage profile during peak hours

The exact technology installed at substations and on the circuits, could vary depending on detailed engineering and technology analysis prior to CVR/VVO implementation on individual circuits. The cost estimates, discussed above, average $30,000 - $40,000 per circuit for Groups 1 and 2. The cost estimates assume minimal upgrades are required to enable circuit CVR/VVO, and consider various upgrade situations including circuits that are ready for CVR/VVO without any upgrades and circuits that may need multiple technology upgrades to implement CVR/VVO.

The number of circuits for CVR/VVO implementation and their potential peak demand and energy reductions represent the best estimates based on the study results. With that said, due to the limited sample size, not all circuits within a Group will react to the CVR/VVO implementation in a similar manner as the sampled circuits. A result of the real-world heterogeneity, some targeted circuits may require more modifications, the cost of which may make the implementation of CVR/VVO uneconomic or otherwise infeasible.

In addition, the CVR/VVO potential was modeled assuming customers require constant currents, rather than constant energy. As voltage drops, a constant current load will consume less power, generating demand and energy reductions. In contrast, a constant energy load will increase current to compensate for the lower voltage, producing little to no demand and energy reductions.

To compensate for the study limitations, a range of savings was developed. This range will narrow as individual circuits are studied in detail prior to field implementation.

8.14 Proposed Course of Action: CVR/VVO

IRP Defined PCA: CVR/VVO

DTE Electric plans to execute a CVR/VVO pilot in 2019-2020 as part of the defined PCA. The pilot is expected to complete CVR/VVO implementation on 20 distribution circuits that are categorized as Groups 1 or 2.

Circuits will be randomly selected for the pilot, capturing a diverse portfolio of characteristics such as load density, mix of residential versus commercial, underground versus overhead construction, and remote control capability. The goal of the pilot is to verify the CVR/VVO implementation on a diverse portfolio of circuits to better understand program costs and benefits as well as any field execution constraints.

Flexible PCA: CVR/VVO

The flexible PCA identifies four pathways (A, B, C, and D) with different levels of CVR/VVO. Pathways A and C both have CVR/VVO beginning in 2026 and ramping up to 50 MW by 2030. Pathways B and D do not include any CVR/VVO in the flexible PCA.

SECTION NINE

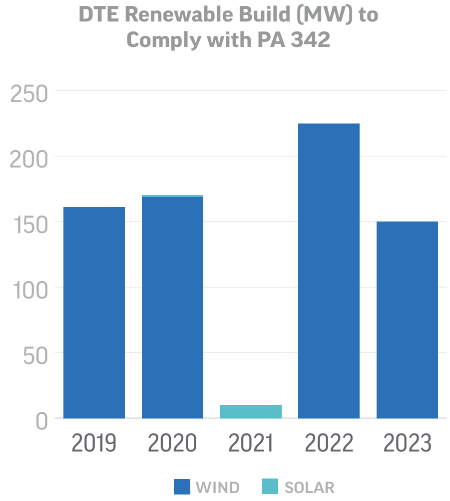
9 Future Renewable Planning

DTEE believes that renewables are a critical part of our plan to achieve our generation and carbon reduction goals. As the Company transitions its fleet to meet its commitment to reduce carbon by 80%, the future of renewables will certainly play a large role. Not only is DTEE embracing renewables, but the Company wants to support our customers, many of whom also have unique clean energy goals. That's why the Company has launched new customer-facing Voluntary Green Pricing (VGP) programs where customers can manage their own carbon footprints. The future of renewables is unfolding at a rapid pace and the Company stands ready to lead the change.

9.1 Existing Renewable Energy Standards

Pursuant to Public Act 342, the Company's 2018 amended Renewable Energy Plan (REP), included a renewable energy portfolio to meet the updated renewable energy targets. Those targets are 12.5 percent in 2019 and 2020, and 15 percent by 2021 through August 2029, the end of the REP's timeframe. The previous 12-month period of weather-normalized retail sales will be used to calculate the number of megawatt hours of electricity in the renewable energy credit portfolio. The Company's ability to comply with the renewable portfolio standard through the end of the REP is highly dependent upon the actual performance of the renewable assets closely matching the capacity factor projections among other assumptions. The total incremental cost of compliance forecasted in the Company's last filed amended REP for 2017 through August of 2029 is approximately $95.5 million. The 2018 REP filing includes a summary of the planned renewable energy credit portfolio, including incentive RECs, as well as the forecasted expected compliance levels by year to meet the renewable portfolio targets. The existing renewable energy fleet and the build plan shown in Figure 9.1.1 are forecasted to meet and sustain the updated renewable energy RPS targets, and are forecasted to have approximately two million RECs remaining at the end of the plan.

FIGURE 9.1.1: DTE Renewable Build

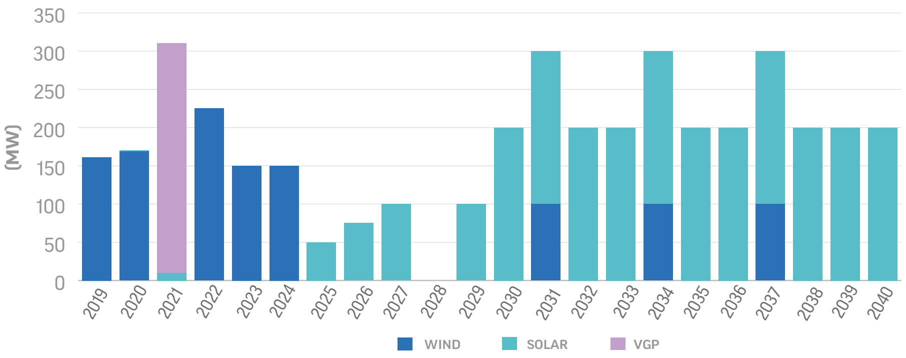


Public Act 342 also includes a Clean Energy Goal, encompassing a renewable energy and energy waste reduction goal of 35 percent in 2025. DTE's energy waste reduction team anticipates achieving at least a 35% reduction by 2025, with renewable energy contributing at least 15 percentage points of this goal.

9.2 IRP Starting Point: Renewable Energy

TThe IRP starting point, with respect to renewable energy, encompasses more than the Renewable Portfolio Standard mandated by PA 342 and the Michigan Energy Legislation 35% Clean Energy Goal. In addition, the IRP starting point included our commitment, announced in 2017, to an 80 percent carbon-reduction goal by 2050 reflecting our commitment to doing our part to mitigate the impact of climate change. The Company's plan to reduce carbon emissions by more than 80 percent was one of the first to be announced and among the most aggressive in the energy industry. Also, announced in 2018, we committed to a 50 percent clean energy goal, exceeding the Michigan RPS with aspirations to have at least 25 percent renewable energy and 25 percent energy waste reduction achieved by 2030. The starting point build plan below encompasses the additional amount of renewable energy needed to meet and sustain these commitments through the IRP study period of 2040.

FIGURE 9.2.1: Starting Point: Renewable Energy Build Plan



The Company's plan to reduce carbon emissions by more than 80 percent is among the most aggressive and was among the first to be announced in the energy industry.

9.3 Voluntary Green Pricing (VGP) Programs

In addition to the RPS and clean energy goals, the Company is growing its VGP programs. These programs will enable our customers who are pursuing their own carbon reduction efforts. The Company plans to actively market these programs and accommodate customer demand without setting program participation caps.

Residential and Small Commercial Customers

DTEE offers MIGreenPower, a VGP program, open to all 2.2 million full-service business and residential electric customers. Launched in April 2017, MIGreenPower provides interested customers with an easy and affordable way to reduce their carbon footprint by increasing the percentage of their energy usage that is attributed to specific renewable projects. Customers who subscribe to MIGreenPower can elect to increase the amount of renewable energy they use in five percent increments, up to 100 percent. Participating customers will see a slight increase to their monthly bill depending on the level of renewable energy they select while knowing they are helping to support Michigan's clean energy future.

Large Commercial and Industrial Customers

In an effort to expand DTEE's voluntary offerings, the Company received MPSC approval in January 2019 for a Large Customer VGP program. Enrollment in the program is voluntary and allows full-service large commercial and industrial customers to increase the portion of their electric usage attributable to renewable resources in five percent increments at a level beyond the renewable energy all customers receive from the Company's generation fleet, up to 100 percent, allowing customers to choose a participation level that aligns with their specific preferences and objectives. The Company will provide at least 15 percent renewable

Local

Joining the MIGreenPower program enables you to support renewable energy production in Michigan. The growth of renewable resources in our state creates local jobs in the clean energy industry and reduces your overall carbon footprint.

Flexible

Program participation is structured in five percent increments, giving you the power to choose the level of impact that works best for you. You can attribute anywhere from 17.5 to 100 percent of your energy use to renewable energy.

Affordable

Both residential and commercial customers can use an environmental impact calculator to find a participation level and financial contribution that works best for them energy under current PA 342 legislation by 2021 to all customers; therefore, the minimum participation match is 20 percent of monthly energy use, up to 100 percent.

The program and associated tariff are designed to grow with customer demand in phases. New assets will be added to ensure the program grows with our customers' needs. Initial program assets will be approved though the existing REP contract-approval process, ensuring fairness and cost competitiveness. Understanding that it would not be prudent to bring on excess resources without adequate demand, DTEE aims to manage both forecasted demand and renewable energy construction timelines to ensure that there is no extended gap in program availability to new subscribers. The build plan is designed to be flexible and accommodate growing demand over time for DTEE's VGP programs.

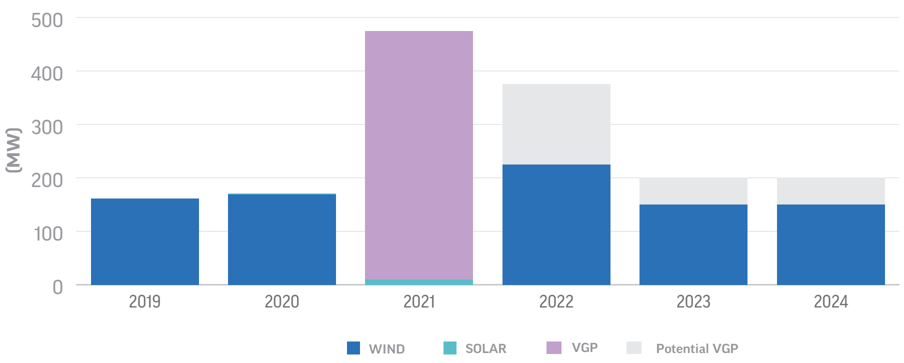
9.4 Proposed Course of Action: Renewable Energy

Defined PCA – Renewable Energy

With respect to renewables, the PCA is definitive in the near term to meet PA 342's RPS compliance and shared goal with EWR along with the Company's Clean Energy and Carbon Reduction commitments. In addition, the Company plans to install 465 MW of renewable energy sourced by wind to support the Large Customer VGP Program. Renewable energy sourced by solar or wind could be added from 2022 to 2024 to support future VGP programs. See Figure 9.4.1 below.

In addition, the Company plans to install 465 MW of renewable energy sourced by wind to support the Large Customer Voluntary Green Pricing Program.

FIGURE 9.4.1 – Defined PCA: Renewable Energy Build Plan

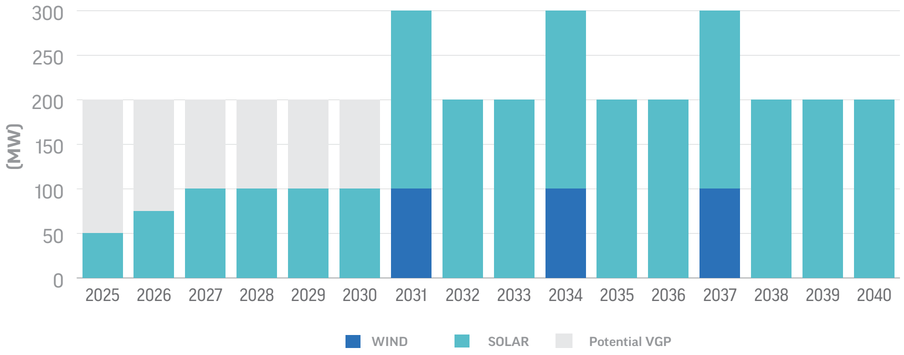


Flexible PCA – Renewable Energy

The flexible PCA contains the renewable resources between 2025 and 2040 to meet the company's Clean Energy and Carbon Reduction commitments. What remains less clear at the time of this IRP is how much demand for the VGP program will emerge in future years. Thus, the flexible component of the PCA identifies four pathways (A, B, C, and D) with two different levels of VGP program renewables. Pathways C and D maintain the VGP programs at 465 MW from 2025 through 2040. Pathway A and B increase the level of VGP programs to 1,390 MW, starting at a 2024 base of 715 MW and full implementation of 1,390 MW by 2030, maintained through 2040. This reflects an incremental 925 MW of VGP programs that could be sourced from wind or solar energy through 2030. As described above, more assets will be added as demand warrants. See Figure 9.4.2 below.

> The flexible component of renewable energy PCA reflects an incremental 925 MW of VGP that could be sourced from wind or solar energy through 2030.

FIGURE 9.4.2 – Flexible PCA: Incremental Voluntary Renewables (2022 – 2030)



SECTION TEN

10 Peak Demand & Energy Forecasts

10.1 Overview

An accurate load forecast for the planning period was a key input into the Integrated Resource Plan. DTEE developed its load forecast by analyzing historical data to identify the statistically significant factors in energy sales for each customer class. The resulting models included economic variables and projected increases in energy waste reduction to forecast annual DTEE service-area sales, bundled sales and peak demand.

The methodology to develop the annual DTEE service-area and bundled peak-demand forecast utilizes the hourly electric load model. DTEE also used this model to determine monthly peak demands in the forecast period. The Electric Power Research Institute (EPRI) developed the hourly electric load model, which aggregates hourly demand profiles from various sales categories or end-uses into a system annual load shape. The annual sales and hourly demand profiles for each end-use are inputs to this model.

Normal temperature on the day of the annual peak is assumed to be 83.0 F, which is the mean temperature from Detroit Metropolitan Airport. The value is based upon an average peak-day mean temperature for a 30-year period (1981 through 2010). The mean temperature is calculated as the average of the high and low temperatures for the day. The peak day is assumed to occur on a weekday in July or August. In addition, normal weather conditions were utilized for the projection of weather-sensitive sales.

The energy forecast was developed from the bottom up, utilizing a model for each customer class. The models' results were added together to obtain the total service-area sales forecast. The Electric Choice sales forecast was subtracted from the service-area sales forecast to obtain the bundled sales forecast. The residential class accounts for approximately 32 percent, commercial class 42 percent and industrial class 25 percent of the service area forecast sales. Service area forecast peak sales are comprised of approximately 47 percent residential class, 39 percent commercial class and 14 percent industrial class. The allocation of customer classes for both sales and peak demand is shown in the figures below.

10.2 Customer Classes

For most of the forecast's sectors, electricity sales levels are related to various economic, technological, regulatory and demographic factors that have affected them in the past. The process began with the gathering of historical data related to the forecast's various sectors. This data was examined, and the factors that were statistically significant in explaining electric sales were identified using regression techniques. Forecast models were developed employing the appropriate regression equations. Forecasts of economic variables or explanatory factors, such as motor vehicle production, steel production, employment and other economic indicators were entered in the forecast models to calculate projected future sales levels.

Residential

Electricity sales in the residential class were forecast by an end-use method including 39 different appliances or appliance groups. For each forecast year, three separate items were forecast: saturation of major appliances; number of residential customers; and average electricity use per appliance. For each appliance, the product of these three forecast values yielded the annual electricity sales.

The Company conducts a residential appliance saturation survey, the most recent survey used in this forecast was conducted in late 2016. The survey was sent to a representative sample of DTEE's residential customers. Some of the questions asked whether the customer had certain appliances and whether the appliances were last replaced. The responses helped the Company to understand the penetration of appliances in the DTEE's service area. These insights were then applied to the residential forecast model. The total for all appliances is the total annual residential-class electricity sales.

The federal government has enacted energy-efficiency standards for many appliances. The end-use approach incorporates projected increases in energy efficiency of the various appliances into the residential-class electricity sales. The Company uses federal energy-efficiency standards to determine the decrease in use per appliance. As most customers do not buy a new appliance just because a more energy-efficient one becomes available, the Company phases in the decrease in energy usage, which over time drives down residential customer electricity usage.

The number of residential customers was forecast using the annual percentage change in households. This percentage change was applied to the prior year's customer count to obtain the forecast of customers for that year.

FIGURE 10.1.1: Forecasted 2019 Service Area Sales

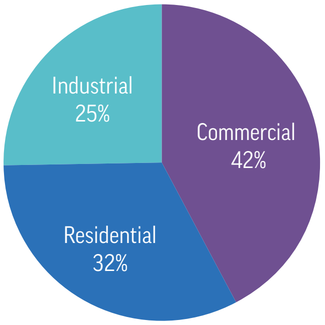


FIGURE 10.1.2: Forecasted 2019 Service Area Peak by Customer Class

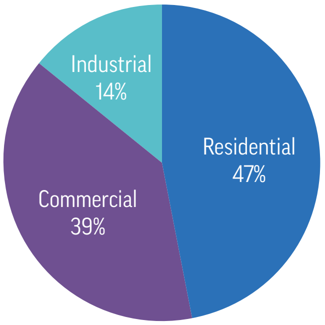
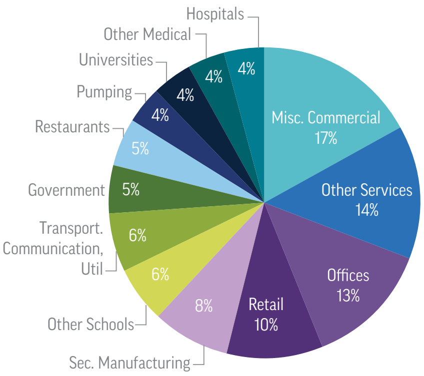


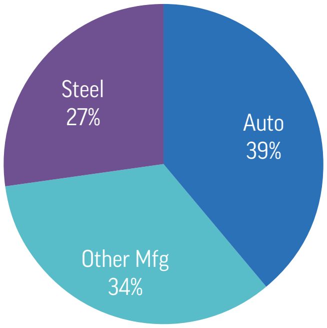
FIGURE 10.2.1: Forecasted 2019 Commercial Sales



Commercial

Sales for most commercial class sectors were forecast using regression models. Explanatory variables included population, employment and local automotive production. Other markets, such as agricultural supply, farming and apartments, were forecast with time trend models and were combined with the previous regression models to obtain total commercial-class electricity sales. The figure below shows the commercial class sectors and their respective percentage of the total commercial sales volumes in 2019.

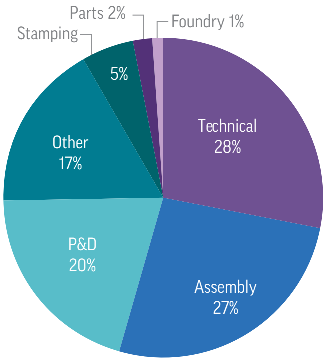
FIGURE 10.2.2: Forecasted 2019 Industrial Sales



Industrial

Industrial class sales consist of three large sub-classes: automotive, primary metals (steel) and other manufacturing sales. The sub-classes' relative sizes are shown in the figure below.

FIGURE 10.2.3: Forecasted 2019 Automotive Sales



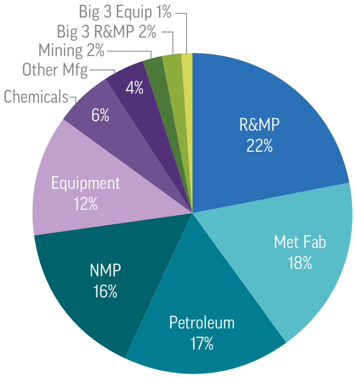
Auto

The automotive sector was disaggregated into seven groups of automotive facilities, as shown in the figure below: assembly plants, stamping plants, powertrain/drivetrain plants (P&D), research and administrative facilities (technical), other parts plants, part suppliers, foundries and other automotive plants. The automotive sector's electricity sales were forecast using regression-based models, with automotive production as the primary explanatory variable. Additional sales impacts from announced plant closings and expansions and/or plant-specific information also were factored into these models.

Steel

Three large producers account for almost 60 percent of steel sales. Because of the market's high concentration and volatility, forecasting steel sales can be challenging. Global market conditions can have a significant effect on local steel production.

FIGURE 10.2.4: Forecasted 2019 Other Manufacturing



Other Manufacturing

The other manufacturing sector of the industrial class was disaggregated into 10 markets and sub-markets: chemicals, petroleum, rubber and plastics (R&MP), mining, non-metal processing (NMP), metal fabrication, manufacturing equipment, other manufacturing, Big Three R&MP, and Big Three manufacturing equipment. Electricity sales for most of these markets were also forecast using regression-based models with automotive production, manufacturing employment and other economic indicators as variables. The markets' relative sizes are shown in the figure below.

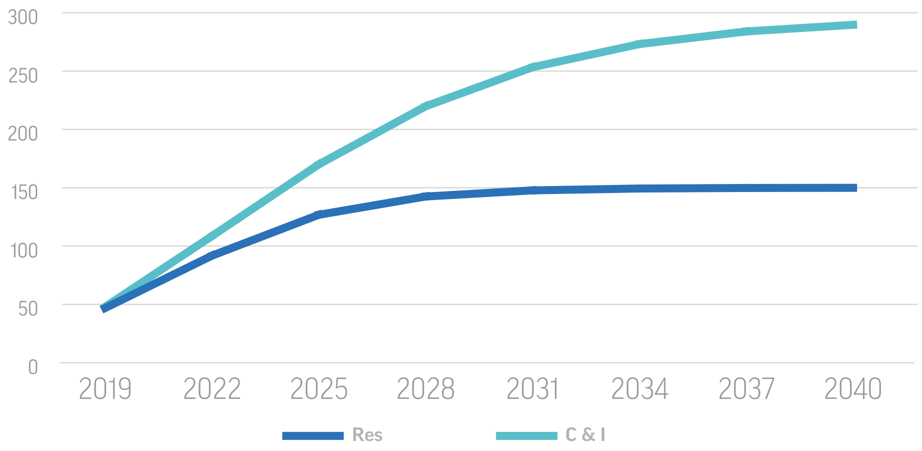
10.3 Demand Side Management & Emerging Technologies

Future demand side management and emerging technologies, including EWR, distributed generation and electric vehicles, were incorporated into the long-term load forecast as exogenous variables. Demand Response programs were not explicitly included in the forecast peak. However, demand response programs were included in determining the Company's required amount of unforced capacity need to meet the MISO Adequacy requirements for the forecast MISO coincident peak demand for the DTEE bundled load.

EWR

The base, or starting point, forecast assumes a 1.5 percent EWR savings level and was modeled in the three customer class models. Since the residential class's forecast was derived from an end-use method, the EWR savings were a direct input from the 1.5 percent EWR program for residential customers. The EWR in the residential model was divided into seven distinct categories: lighting, refrigeration, water heating, appliances, heating, cooling and miscellaneous. The historical sales in the regression models captured the impact of the Company's previous EWR programs and the incremental energy savings were applied to the commercial and industrial models.

FIGURE 10.3.1: Distributed Generation Forecast (GWh)

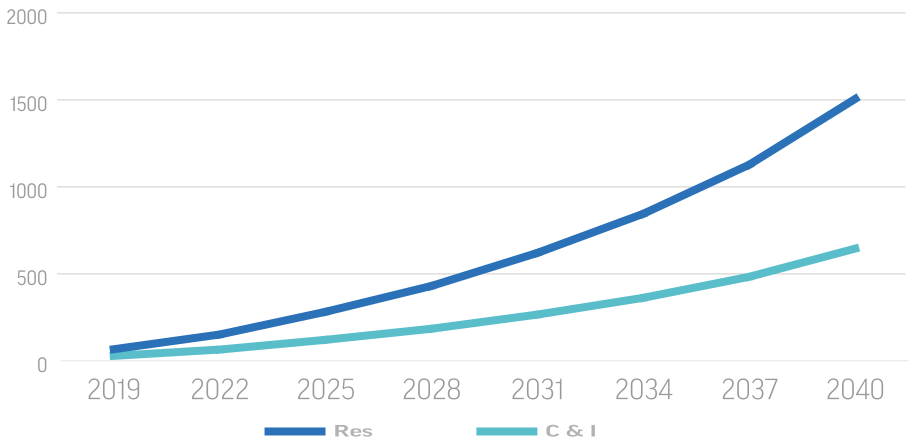


Distributed Generation

The long-term load forecast included an outlook of future distributed generation in the residential, commercial and industrial models. Photovoltaic systems were a large portion of the distributed generation forecast, which was based on the Company's existing interconnections. Utilizing the historical data, an S-shaped market adoption curve was applied to generate the distributed generation outlook. The growth rates between the three customer classes range from five to seven percent, which are aligned with PACE Consulting and EIA1 growth assumptions for distributed generation. The figure below displays each customer class's distributed generation projection.

Additionally, in the university sector, co-generation facilities have been developed which will reduce sales by approximately 250 GWh annually by 2020. The annual sales reduction was based on discussions with the customers and the Company's account managers. This information was then utilized to estimate the sales impact and subtracted from the universities market within the commercial model to account for the reduction in sales.

FIGURE 10.3.2: Electric Vehicle Forecast (GWh)



Electric vehicles represent about 1.5 percent of light-duty vehicle sales.

Electric Vehicles

Electric vehicles represent about 1.5 percent of light-duty vehicle sales. In early 2018, electric vehicle sales in Michigan reached 15,300 and total light-duty vehicle sales were approximately 600,000 units. Future electric-vehicle adoption, including both all-battery and plug-in hybrid light vehicles, were incorporated into the long-term forecast using this historical data. According to GTM Research, approximately 70 percent of electric vehicle charging is done at personal residences, while the other approximately 30 percent is done at a non-residential location[1] . Therefore, 70 percent of the electric vehicle sales forecast was applied to the residential model as an additional end use. The remaining 30 percent was applied to the commercial and industrial models. The outlook for electric-vehicle charging's impact to annual sales is displayed in the figure above.

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[1] "The Impact of Electric Vehicles on the Grid Customer Adoption, Grid Load and Outlook" GTM Research. GTM Research is the market analysis and advisory arm of Greentech Media.

10.4 Prior Year Load Forecasts

The compounded annual growth rate for 2014-2018 is -0.4 percent. The table below includes the previous five-year service-area load forecasts and actual weather-normalized sales

TABLE 10.4.1: Historical Growth in Electric Sales[1]

	Service Area Forecast	Service Area Actual TN Sales	Year Over Year CAGR
2014	48,535	47,737	
2015	48,103	46,962	-1.6%
2016	47,373	47,551	1.3%
2017	47,102	47,206	-0.7%
2018	46,759	47,072	-0.3%
		2014-2018 CAGR	-0.4%

[1] Actual sales are weather normalized

10.5 IRP Starting Point: Sales & Demand Forecast

The starting points for service-area sales and peak demand, over the forecast period 2019 through 2040, are expected to decline annually an average of 0.1 percent and 0.3 percent respectively. The growth rate for bundled sales was the same as the service area due to a steady Electric Choice sales forecast. The figures below show the starting point forecast sales and peak demand. The Electric Choice sales forecast was based on weather-normalized sales through May 2018 and forecasted sales for June through December 2018 which were expected to be 4,840 GWh. The forecast for Electric Choice sales were kept flat at that level. Market clearing prices are not expected to increase significantly from current levels, therefore, no other changes in Electric Choice sales were forecasted.

FIGURE 10.5.1: Annual Sales (GWh)

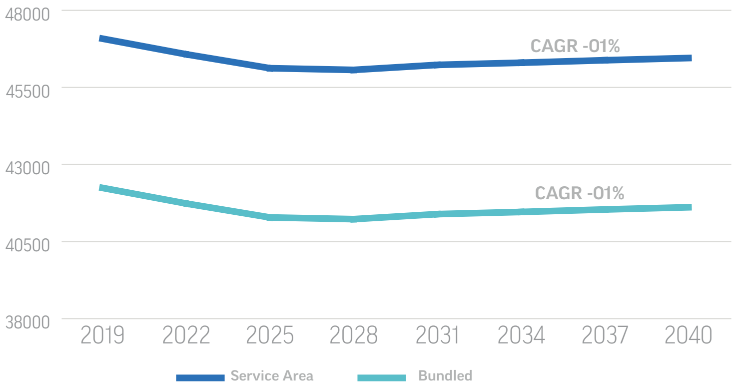


FIGURE 10.5.2: Annual Peak Sales (MW)

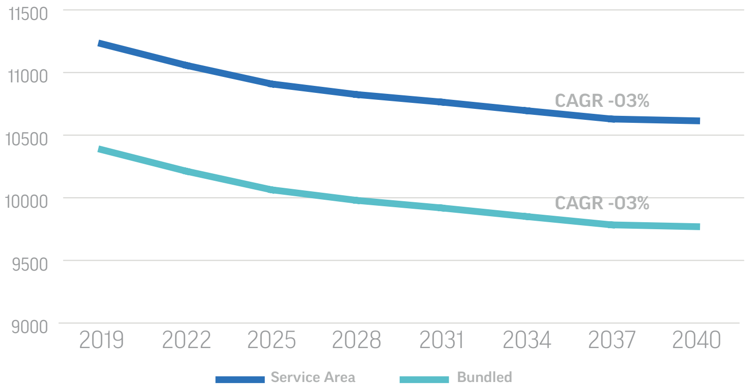


Table 10.5.3: IRP STARTING POINT - Service Area Electric Sales and Demand

	Sales		Losses	System Output		Load	Peak	
Year	(GWh)	% Change	(GWh)	(GWh)	% Change	Factor	(MW)	% Change
2010	50,706		3,541	54,248		53.0	11,687	
2011	51,006	0.6%	3,404	54,410	0.3%	49.5	12,547	7.4%
2012	48,643	-4.6%	3,640	52,282	-3.9%	48.9	12,201	-2.8%
2013	48,379	-0.5%	3,513	51,892	-0.7%	50.8	11,669	-4.4%
2014	47,480	-1.9%	3,579	51,059	-1.6%	53.1	10,970	-6.0%
2015	47,072	-0.9%	3,836	50,908	-0.3%	54.5	10,660	-2.8%
2016	48,601	3.2%	3,394	51,995	2.1%	51.8	11,422	7.2%
2017	47,142	-3.0%	3,203	50,345	-3.2%	54.5	10,554	-7.6%
2018	48,527	2.9%	3,644	52,172	3.6%	52.2	11,418	8.2%
2019	47,081	-3.0%	3,352	50,433	-3.3%	51.3	11,230	-1.6%
2020	46,920	-0.3%	3,344	50,264	-0.3%	51.3	11,188	-0.4%
2021	46,853	-0.1%	3,340	50,193	-0.1%	51.4	11,143	-0.4%
2022	46,574	-0.6%	3,326	49,900	-0.6%	51.5	11,057	-0.8%
2023	46,400	-0.4%	3,317	49,717	-0.4%	51.6	11,006	-0.5%
2024	46,268	-0.3%	3,311	49,579	-0.3%	51.6	10,959	-0.4%
2025	46,123	-0.3%	3,303	49,426	-0.3%	51.7	10,909	-0.5%
2026	46,003	-0.3%	3,297	49,300	-0.3%	51.8	10,865	-0.4%
2027	46,033	0.1%	3,300	49,333	0.1%	51.9	10,847	-0.2%
2028	46,068	0.1%	3,303	49,371	0.1%	52.1	10,824	-0.2%
2029	46,117	0.1%	3,307	49,424	0.1%	52.2	10,803	-0.2%
2030	46,218	0.2%	3,314	49,532	0.2%	52.4	10,796	-0.1%
2031	46,231	0.0%	3,315	49,546	0.0%	52.5	10,764	-0.3%
2032	46,271	0.1%	3,318	49,590	0.1%	52.7	10,743	-0.2%
2033	46,292	0.0%	3,320	49,612	0.0%	52.8	10,721	-0.2%
2034	46,301	0.0%	3,321	49,622	0.0%	53.0	10,695	-0.2%
2035	46,322	0.0%	3,323	49,645	0.0%	53.1	10,674	-0.2%
2036	46,352	0.1%	3,325	49,677	0.1%	53.2	10,652	-0.2%
2037	46,381	0.1%	3,327	49,708	0.1%	53.4	10,629	-0.2%
2038	46,386	0.0%	3,328	49,714	0.0%	53.5	10,601	-0.3%
2039	46,411	0.1%	3,330	49,741	0.1%	53.5	10,607	0.1%
2040	46,453	0.1%	3,332	49,785	0.1%	53.5	10,615	0.1%
Compound Annual Growth Rate 2019-2040								
	-0.06%			-0.05%			0.02%	

The table to the left shows DTEE's service-area sales, net system output, load factor and peak demand for the starting point. Data for 2010-2018 is actual, not weather-normalized. The forecast for 2019-2040 assumes normal weather, see Table 10.5.3.

Table 10.5.4: Service Area Weather-Normalized Electric Sales by Class (GWh)

Year	Residential	C & I	Other	Total	% Change
2010	14,980	31,401	3,210	49,591	
2011	15,213	31,544	3,136	49,894	0.6%
2012	15,062	31,483	958	47,503	-4.8%
2013	15,249	32,189	942	48,379	1.8%
2014	15,115	32,106	517	47,737	-1.3%
2015	15,055	31,617	291	46,962	-1.6%
2016	15,182	32,105	264	47,551	1.3%
2017	14,982	31,966	258	47,206	-0.7%
2018	14,955	31,893	224	47,072	-0.3%
2019	14,910	31,948	223	47,081	0.0%
2020	14,898	31,804	218	46,920	-0.3%
2021	14,851	31,787	215	46,853	-0.1%
2022	14,794	31,567	213	46,574	-0.6%
2023	14,764	31,421	214	46,400	-0.4%
2024	14,750	31,304	214	46,268	-0.3%
2025	14,735	31,173	215	46,123	-0.3%
2026	14,728	31,060	215	46,003	-0.3%
2027	14,717	31,100	216	46,033	0.1%
2028	14,703	31,149	216	46,068	0.1%
2029	14,690	31,211	216	46,117	0.1%
2030	14,683	31,319	216	46,218	0.2%
2031	14,667	31,348	216	46,231	0.0%
2032	14,657	31,398	216	46,271	0.1%
2033	14,646	31,429	216	46,292	0.0%
2034	14,636	31,448	216	46,301	0.0%
2035	14,628	31,478	216	46,322	0.0%
2036	14,620	31,516	216	46,352	0.1%
2037	14,612	31,554	216	46,381	0.1%
2038	14,604	31,566	216	46,386	0.0%
2039	14,597	31,598	216	46,411	0.1%
2040	14,589	31,648	216	46,453	0.1%
Compound Annual Growth Rate 2019-2040					
	-0.10%	-0.04%	-0.15%	-0.06%	

Table 10.5.4 shows DTEE's weather-normalized service-area sales by customer class for the starting point. Other historical class sales include wholesale for resale sales as various contracts expired through mid-2014. The total growth rate for 2019-2040 is -0.06 percent.

10.6 Forecast Sensitivities

To manage future uncertainties, sensitivities were developed exploring a range of higher and lower sales and peak demand levels. The alternative sensitivities, excluding the sensitivities completed in accordance with the Commission's final order in Case No. U-18418, include High Electric Vehicles, 24 percent Electric Vehicle Sales by 2030, Electric Choice Cap Increase to 25 percent, and Electric Choice Return to Full Service. The various sensitivities are displayed in the figures below.

High Electric Vehicles

The High Electric Vehicle sensitivity was based on the Bloomberg New Energy Finance (BNEF)3 2017 long term EV outlook. BNEF's outlook assumes high electric vehicle adoption rates resulting from assumed declining prices, enhanced autonomy technology and mobility. Battery electric vehicles are expected to dominate the market by 2025 due to an assumed production phase-out of plug-in hybrid electric vehicles due to the engineering complexity and dual powertrains. BNEF estimated the global annual electric-vehicle percentage of new sales for 2020 at 3.5 percent, for 2025 at 11 percent and for 2030 at 35 percent. The sensitivity's projected annual sales percentages between the identified years and after 2030 were developed using linear growth.

24 Percent Electric Vehicles Sales by 2030

This sensitivity was submitted through the stakeholder collaboration process and was defined as 24 percent of the new car fleet in the DTEE service area to be electric vehicles by 2030. The High Electric Vehicle sensitivity was used as a starting point and adjusted downward to get the market penetration in 2030 from 35 percent to 24 percent.

Electric Choice Cap Increases to 25 Percent

This sensitivity was also submitted through the stakeholder collaboration process to assess the impact of increasing the retail open access from 10 percent to 25 percent by 2023. A linear phase out of full-service customer load was assumed, beginning in 2020 until full 25 percent transfer to Electric Choice in 2023.

FIGURE 10.6.1: Load Sensitivity Bundled Sales (GWh)

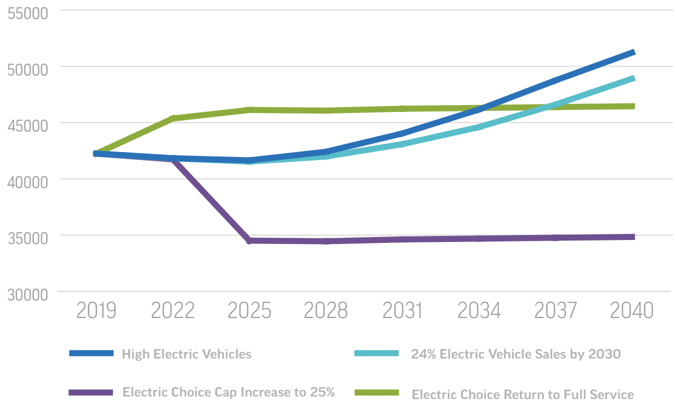
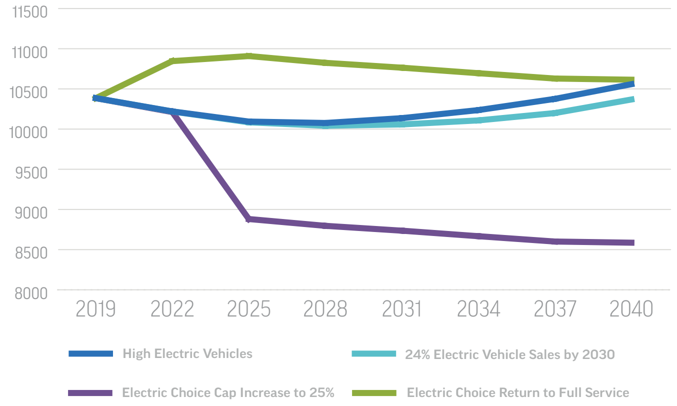


FIGURE 10.6.2: Load Sensitivity Bundled Peak Sales (MW)



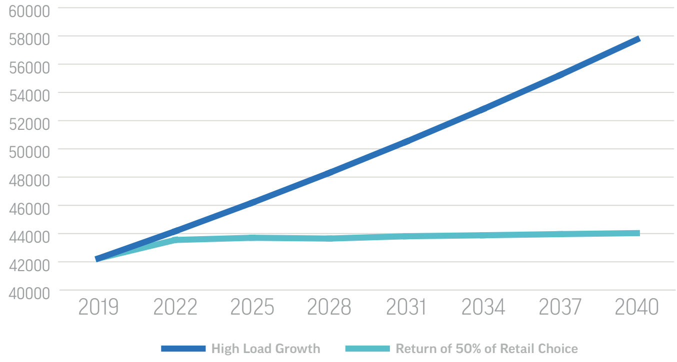
Electric Retail-Choice Return to Full Service

The Electric Choice Return to Full Service sensitivity assumes that all retail open access customers return as DTEE full service customers by 2023. A linear phase in was assumed, beginning in 2020 until all customers were full service in 2023.

High Load Growth and 50 Percent Electric Retail-Choice Return

The Commission's final Order, Case No. U-18418, specified the IRP modeling parameters and requirements. It also specified sensitivities within the parameters regarding the load projection. Under the business-as-usual scenario, two sensitivities were required: *(a) High load growth: Increase the energy and demand growth rates by at least a factor of two above the business-as-usual energy and demand growth rates. In the event that doubling the energy and demand growth rates results in less than a 1.5 percent spread between the business-as-usual load projection and the high-load sensitivity projection, assume a 1.5 percent increase in the annual growth rate for energy and demand for this sensitivity. (b) If the utility has retail-choice load in its service territory, model the return of 50 percent of its retail-choice load to the utility's capacity service by 2023*[2]. For the emerging technologies and environmental scenarios, the high load growth sensitivity was required as well. The alternative forecast sensitivities, in accordance with Case No. U-18418, are displayed in the figure below.

FIGURE 10.6.3: U-18418 Alternative Forecast Sensitivity Sales (GWh)



A comparison of the growth rates for all the sensitivities is shown in the table below.

From 2019-2040	Service Area Sales	Bundled Sales	Service Area Peak	Bundled Peak
Starting Point	-0.1%	-0.1%	-0.3%	-0.3%
High Electric Vehicles	0.8%	0.9%	0.1%	0.1%
24% Electric Vehicle Sales by 2030	0.6%	0.7%	0.0%	0.0%
Electric Choice Cap Increase to 25%	-0.1%	-0.9%	-0.3%	-0.9%
Electric Choice Return to Full Service	-0.1%	0.5%	-0.3%	0.1%
High Load Growth	1.5%	1.5%	1.5%	1.5%
Return of 50% of Retail Choice	-0.1%	0.2%	-0.3%	-0.1%

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[2] Exhibit A, Order issued 11/21/2017 in MPSC Case No. U-18418, page 16.

SECTION ELEVEN

11 Capacity & Reliability Requirements

11.1 Markets

Midcontinent Independent System Operator

DTEE is a market participant in the Midcontinent Independent System Operator (MISO), which is a Regional Transmission Organization (RTO) that was established to ensure reliability and grid stability across 15 U.S. states and Manitoba.

MISO Energy Market

MISO administers day-ahead and real-time markets for operating reserves where each of the three operating reserve products – regulating, spinning and supplemental – are bought and sold. Regulating reserve is the ability to generate resources to raise or lower output to follow the moment-to-moment changes in demand and frequency. Spinning reserve is synchronized unloaded resource capacity set aside to be available to immediately offset deficiencies in energy supply that result from a resource contingency or other abnormal event. Supplemental reserve is unloaded (possibly off-line) resource capacity set aside to be fully available within the contingency reserve deployment period (typically 10 minutes) to offset deficiencies in energy supply that result from a resource contingency or other abnormal event.

Reactive supply and voltage control is supplied by facilities that can be operated to produce or absorb reactive power to control voltage on the system. MISO/ITC administers this service, ensuring it is sold by qualified generators and purchased by transmission customers.

These products' current value in the MISO market is relatively small. However, their value may increase in the future as renewable generation penetration increases..

FIGURE 11.1.1 - MISO Service Territory

MISO Ancillary Service Market

MISO administers day-ahead and real-time markets for operating reserves where each of the three operating reserve products – regulating, spinning and supplemental – are bought and sold. Regulating reserve is the ability to generate resources to raise or lower output to follow the moment-to-moment changes in demand and frequency. Spinning reserve is synchronized unloaded resource capacity set aside to be available to immediately offset deficiencies in energy supply that result from a resource contingency or other abnormal event. Supplemental reserve is unloaded (possibly off-line) resource capacity set aside to be fully available within the contingency reserve deployment period (typically 10 minutes) to offset deficiencies in energy supply that result from a resource contingency or other abnormal event.

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These products' current value in the MISO market is relatively small. However, their value may increase in the future as renewable generation penetration increases.

MISO Capacity Market

MISO has a hybrid voluntary annual capacity construct that requires all available generation in the MISO region to participate in an annual planning resource auction and be available for all 8,760 hours of the following MISO planning year. Load-serving entities can either participate in the auction (bid their load into annual auction) or pay a capacity deficiency charge. The MISO Planning Year (PY) runs from June 1 to May 31. The forward capacity market is designed to ensure sufficient resources are in place to reliably serve load on a forward-looking basis. Load-serving entities can meet their Planning Reserve Margin Requirement (PRMR) by offering capacity resources and demand to the auction through one, or both, of the following methods:

- Offering or self-scheduling capacity resources and bidding load demand into the auction
- Opting out of the auction by submitting a Fixed Resource Adequacy Plan, which offsets capacity resources and load demand

DTEE sells generation and purchases energy from the wholesale power market in both the day-ahead and real-time energy markets, and participates in the MISO Resource Adequacy process.

11.2 Resource Adequacy Construct

Planning Reserve Margin Requirement (PRMR)

Under the MISO Resource Adequacy construct, MISO sets an annual capacity requirement for the following planning year – the PRMR – for load-serving entities based on their peak demand forecast coincident with the MISO peak, plus a planning reserve margin. The planning reserve margin is established to confirm there is sufficient generation resource capacity to ensure that interruption of firm customer demand – known as "loss of load expectation" – occurs no more frequently than one day in 10 years. MISO requires all market participants to secure resources to meet the PRMR and thus achieve the loss of load expectation.

In simpler terms, demand (load) must be balanced with supply (resources). If the two are unbalanced, there is either an excess of capacity and supply is greater than demand, or there is a capacity shortfall and demand is greater than supply. A market participant with a capacity shortfall to its PRMR is required to purchase sufficient zonal resource credits for the entirety of the MISO planning year to avoid paying a capacity deficiency charge. In addition, MCL 460.6w (PA 341) requires the Company to demonstrate, annually, that it will have sufficient resources to meet its projected planning reserve margin on a four-year forward basis. This Michigan requirement is intended to ensure proper

longer-term planning for resource adequacy, which is different from MISO's annual planning cycle which focuses on one-year

FIGURE 11.2.1: MISO Local Resource Zones (LRZs)

Local Resource Zone	Local Balancing Authorities
1	DPC, GRE, MDU, MP, NSP, OTP, SMP
2	ALTE, MGE, MIUP, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, SIPC
5	AMMO, CWLD
6	BREC, CIN, HE, IPL, NIPSCO, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA
10	EMBA, SME

MISO has divided its region into 10 sub-regions known as local resource zones to support regional transmission and system constraints. DTEE's load demand rests entirely within Zone 7; all company-owned and contracted generation-capacity resources, with the exception of L'Anse Warden PPA (Zone 2), are also in Zone 7. Zone 7 PRMR for the 2019-20 MISO planning year is 21,976 MW using MISO preliminary PRA data published 3/22/19.

MISO has divided its region into 10 sub-regions known as local resource zones – DTEE's load demand rests entirely within Zone 7

Local Reliability Requirement

The MISO local reliability requirement is the minimum amount of unforced capacity (the amount of installed capacity available at any time, after accounting for unit forced outage rate) that must be physically located in a local resource zone to maintain a loss of load expectation of one day in 10 years, without consideration of the benefit of imports from other zones by use of the electric transmission system. The MISO Loss of Load Expectation Working Group (LOLEWG) analysis determines the minimum local reliability requirement by either adding or removing planning resources (electric generation) until the loss of load expectation reaches the target of interruption of firm demand no more frequently than one day in 10 years.

Capacity Import Limit and Capacity Export Limit

The LOLEWG determines the capacity import limit and capacity export limit to and from each MISO local resource zone. The limits are effectively the electric transmission import and export capability that can be reliably depended upon to transport power between zones. The LOLEWG updates the limits annually in order to capture changes in these capabilities as a result of modifications to the electric system.

MISO has determined a Zone 7 capacity import limit of 3,211 MW and export limit of 1,358 MW for the 2019/20 PY.

Local Clearing Requirement

To ensure adequate supply and reliability, each zone has a local clearing requirement, or the minimum amount of resources that must be physically located within the zone taking electric transmission import capability into consideration. The local clearing requirement is equal to the local reliability requirement less the capacity import limit for the zone and less non-pseudo tied exports for the zone. The PRMR for the zone less the local clearing requirement equals the effective capacity import limit (ECIL) for that zone. Non-pseudo tied exports are those exports in which MISO maintains dispatch control of the generating resource.

DTEE Capacity Meets PRMR

For the 12-month period beginning June 1, 2019 (MISO PY 2019/20), MISO determined an unforced capacity planning reserve margin (PRMUCAP) of 7.9 percent. Applied to DTEE's adjusted peak demand (plus transmission losses) of 9,960 MW, this results in a DTEE PRM of 787 MW. As discussed in Section 7, DTEE's generation assets include a diverse mix of owned and contracted sources of energy to ensure reliable and economical capacity adequacy for its customers. The Company is meeting its 787 zonal resource credits (ZRCs) of PRM using a combination of baseload, cycling, peaking, intermittent, demand-side and storage resources.

> To ensure adequate supply and reliability, each zone has a local clearing requirement, or the minimum amount of resources that must be physically located within the zone taking electric transmission import capability into consideration.

SECTION TWELVE

12 Transmission Analysis

12.1 Transmission Overview

In 2003, DTEE sold its transmission system to ITC Holdings Corp ("ITC"), which became responsible for the ownership, operation, maintenance, and planning of the transmission system in DTEE's service territory. ITC subsequently joined MISO and thereby became bound by its tariff provisions and business practice manuals, which define processes through which the transmission system is operated and planned. Thereafter, MISO became responsible for providing transmission service to the Company.

MISO is a Regional Transmission Organization (RTO) that manages the electric power system in several American states and one Canadian province and is regulated by the Federal Energy Regulatory Commission (FERC). This management includes transmission system planning. The MISO Transmission Expansion Plan (MTEP) process evaluates the need for upgrades to the transmission system for reliability, economic, or policy-driven purposes and establishes a framework for MISO stakeholder input. Although transmission owners are obligated to propose solutions to identified reliability issues on the transmission system, MISO will consider other stakeholder input in its determination of the final project implemented. After stakeholder review, MISO's board of directors approves justified projects to MTEP appendix A, at which point the appropriate transmission owner must make a good-faith effort to construct the project.

12.2 Collaboration with ITC

As part of a joint planning approach, the Company met with ITC to examine the transmission system implications of DTEE's IRP. DTEE met with ITC on six occasions to establish and discuss the studies' scope, the specific scenarios likely most relevant to the IRP, and the studies' results and significance. ITC performed two main analyses: an analysis of the transmission upgrade costs needed to accommodate the Company's IRP and an analysis of the capacity import limit (CIL) under conditions similar to those contemplated in the Company's IRP.

TABLE 12.2.1: ITC Studied Scenarios[1]

Scenario	Case	Imports from Ontario	Ludington Status	Renewables (Incremental in LRZ 7)	New Generation	Retirements
2023 Base	70% Peak Load	1,800 MW	Pumping	2,000 MW Wind; 500 MW Utility Scale Solar; No new DG	1,175 MW at BWEC	TC9, RR3, SC1-3,6,7
	100% Peak Load	-200 MW	Generating			
2023 Base	70% Peak Load	1,800 MW	Pumping	2,000 MW Wind; 500 MW Utility Scale Solar; No new DG	1,175 MW at BWEC	TC9, RR3, SC1-3,6,7
	100% Peak Load	-200 MW	Generating			
2028 Base	70% Peak Load	1,800 MW	Pumping	2,200 MW Wind; 1,500 MW Utility Scale Solar; No new DG	1,175 MW & 500 MW at BWEC	TC9, RR3, SC1-3,6,7, BLRPP 1&2
	100% Peak Load	-200 MW	Generating			
2028 Medium Renewables	70% Peak Load	1,800 MW	Pumping	2,200 MW Wind; 3,500 MW Utility Scale Solar; No new DG	1,175 MW at BWEC	TC9, RR3, SC1-3,6,7, BLRPP 1&2
	100% Peak Load	-200 MW	Generating			
2028 High Renewables	70% Peak Load	1,800 MW	Pumping	2,200 MW Wind; 6,000 MW Utility Scale Solar; 0 MW DG	1,175 MW at BWEC	TC9, RR3, SC1-3,6,7, BLRPP 1&2
	100% Peak Load	-200 MW	Generating			
2028 High Renewables/ D.G.	70% Peak Load	1,800 MW	Pumping	2,200 MW Wind; 4,500 MW Utility Scale Solar; 1500 MW DG	1,175 MW at BWEC	TC9, RR3, SC1-3,6,7, BLRPP 1&2
	100% Peak Load	-200 MW	Generating			
2028 Base + South CT	70% Peak Load	1,800 MW	Pumping	2,200 MW Wind; 1,500 MW Utility Scale Solar; No new DG	1,175 MW & 500 MW at BWEC + 320 MW at Trenton	TC9, RR3, SC1-3,6,7, BLRPP 1&2
	100% Peak Load	-200 MW	Generating			

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[1] Abbreviations used in Table 12.2.1: CT = Combustion Turbine, DG = Distributed Generation, BWEC = Blue Water Energy Center, TC9 = Trenton Channel Unit 9, RR3 = River Rouge Unit 3, SC = Saint Clair, BLRPP = Belle River Power Plant

In order to identify likely transmission system challenges and opportunities related to its IRP, DTEE requested that ITC study scenarios with varying assumptions about new generation, renewables, and distributed generation. Ultimately, ITC and DTEE agreed upon the seven scenarios documented in Table 12.2.1.

All scenarios assumed 1,175 MW of new generation at the Blue Water Energy Center and the retirements of all existing units at Trenton Channel, River Rouge, and Saint Clair. The 2028 scenarios assumed the retirement of Belle River units 1 and 2.

TABLE 12.2.2: ITC Estimated Scenario Costs

Scenario	Retirements	Additions	Estimated Cost (in Millions)
2023 Base	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7	1175 MW at Blue Water Energy Center, 2000 MW Wind, 500 MW Utility Scale Solar, No new DG	$20-$25
2023 Base + South CT	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7	1175 MW at Blue Water Energy Center, 2000 MW Wind, 500 MW Utility Scale Solar, No new DG, 220 MW CT at Trenton Channel	$20-$25
2028 Base	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7 Belle River 1 & 2	500 MW & 1175 MW at Blue Water Energy Center, 2200 MW Wind, 1500 MW Utility Scale Solar, No new DG	$25-$30
2028 Medium Renewable	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7 Belle River 1 & 2	1175 MW at Blue Water Energy Center, 2200 MW Wind, 3500 MW Utility Scale Solar, No new DG	$25-$30
2028 High Renewables	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7 Belle River 1 & 2	1175 MW at Blue Water Energy Center, 2200 MW Wind, 6000 MW Utility Scale Solar, No new DG	$25-$30
2028 High Renewables/ DG	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7 Belle River 1 & 2	1175 MW at Blue Water Energy Center, 2200 MW Wind, 4500 MW Utility Scale Solar, 1500 MW DG	$25-$30
2028 Base + South CT	Trenton Channel 9 River Rouge 3 St. Clair 1-3,6,7 Belle River 1 & 2	500 MW & 1175 MW at Blue Water Energy Center, 2200 MW Wind, 1500 MW Utility Scale Solar, No new Purpa or DG, 320 MW CT at Trenton Channel	$20-$25

12.3 ITC's Transmission Evaluation

After evaluating all relevant single point of failure outages for each scenario, ITC estimated that the minimum level of incremental transmission investment needed to accommodate the studied scenarios was between $20 million and $30 million, as shown in Table 12.2.2. This amount was considered immaterial by DTEE for purposes of comparing economic alternatives and was not specifically included in the net present value of revenue requirements modeled in the IRP. ITC's cost estimate does not include the potential cost of upgrades outside of ITC's service territory. Also, ITC did not perform transient stability analysis or consider multiple point of failure outages due to the high level of complexity required.

Import capacity is a measure of the transmission system's ability to transfer power from another zone. In MISO's resource adequacy construct, the Capacity Import Limit (CIL) and Capacity Export Limit (CEL) represent the amount of power that can be transferred between zones during the system coincident peak load. The Company's assumptions about the CIL and CEL were based upon public reports from MISO. Specifically, the Company used the 2019/2020 values of 3,211 MW for the CIL and 1,358 MW for the CEL contained in MISO's Loss of Load Expectation (LOLE) Study Report for Planning Year 2019 – 2020.

The Company requested that ITC perform an analysis of capacity imports into Michigan to understand the effects that generation additions and retirements contemplated in the Company's IRP may have on future CIL values. ITC performed this analysis using a methodology consistent with MISO's annual LOLE analysis for six scenario/sensitivity combinations. In order to understand the effects of integrating solar into the state's generation portfolio, ITC evaluated three scenarios of incremental instate solar generation - no solar (0 MW), mid solar (3,500 MW), and high solar (6,000 MW) - comparable to the amount of incremental solar contemplated in the 2028 Base, 2028 Medium Renewable, and 2028 High Renewable scenarios identified in Table 12.2.2. These three scenarios cover the range of solar studied by ITC to determine the amount of incremental transmission investment needed, shown in Table 12.2.2. To understand the effect of alleviating a voltage constraint at the Fermi 345 kV switchyard that was identified in a MISO study of the suspension of Trenton Channel Unit 9, ITC evaluated two sensitivities for each scenario, one using the current voltage criteria and the other that relaxes the criteria at this switchyard to ITC's system-wide criteria under emergency conditions, or 92 percent of the nominal voltage.

Results from ITC's analysis are provided in Table12.2.3 .

TABLE 12.2.3: ITC Capacity Imports Analysis

Scenario	Fermi	DG Solar Installation (CE/DTE load MW)	Utility Wind (MW)	Utility Solar Installation (MW)	Total CIL (MW)
No Solar	0.92 per unit	0	2,200	0	4,283
Mid Solar		750/750	2,200	2,000	4,975
High Solar		1,500/1,500	2,200	3,000	5,437
No Solar	Current Voltage Criteria	0	2,200	0	N/A
Mid Solar		750/750	2,200	2,000	2,494
High Solar		1,500/1,500	2,200	3,000	2,985

As can be seen from this analysis, the Company's plan to integrate solar energy in its IRP would not adversely affect the system's ability to import power from neighboring regions. ITC's analysis also demonstrates the importance of resolving known voltage issues identified at the Fermi 345 kV switchyard. Allowing these issues to remain unmitigated would reduce the CIL to at most 2,985 MW in the scenario with 6,000 MW of additional solar output in the state. In the unmitigated scenario with no additional solar output, the state would have insufficient access to resources to serve load, via instate resources or imports, indicated by "N/A" in the Total CIL column.

Through the MISO stakeholder process, ITC and DTEE have proposed multiple potential solutions to mitigate the voltage issues at Fermi. ITC proposed a Static VAR Compensator (SVC), and DTEE proposed non-transmission alternatives that would leverage Company assets. ITC has indicated that their proposed SVC solution would have a total capital cost of $62 million. The costs associated with the Company's proposed solutions are still under development. ITC and DTEE will continue working through the MISO stakeholder process to find the best solution for the Company's customers.

SECTION THIRTEEN

13 Fuel

13.1 Overview

DTEE has several existing fossil-fuel-generating facilities. The largest portion of DTEE's current capacity mix is coal generators, including those at Monroe, Belle River, St. Clair, River Rouge, and Trenton Channel power plants. DTEE also has gas-fired generating capability at Greenwood, Renaissance, Dean, Belle River Peakers, Delray, Hancock and Northeast, St. Clair, and River Rouge. Furthermore, the Company has oil-fueled over-fire capabilities at its Monroe, Trenton Channel, Belle River, and St. Clair power plants, along with a number of oil-fueled peaking units.

13.2 Natural Gas

Natural gas overview

DTEE currently uses natural gas as the primary fuel at Greenwood, Renaissance, the Belle River Peakers, and Dean sites as well as at other smaller peaking units. Natural gas is also used as a supplemental fuel at the River Rouge and St. Clair coal plants. The Company's Blue Water Energy Center (BWEC), which is expected to be operational in 2022, is a natural-gas-fired 24/7 baseload combined-cycle gas turbine. Depending on the location, natural gas and natural-gas transportation are procured from supply and transportation providers, via third-party marketers, or from local distribution companies.

The Company expects that natural gas will become a more critical fuel for baseload electricity generation for MISO in the future. As this occurs, DTEE will enter into firm gas-supply and gas-transportation contracts, as needed, to ensure fuel-supply reliability. To this end, DTEE entered into an agreement with NEXUS Gas Transmission to provide firm natural-gas transportation from the Utica and Marcellus shale region starting in November 2018. Similar to DTEE's approach to coal and coal-transportation procurement, future gas-supply and firm transportation contracts will be secured to ensure reliability.

Delivered natural-gas prices to existing and planned utility-owned generating plants

Forecast methodology

When forecasting natural-gas prices, the commodity costs are added to the applicable transportation costs to determine the delivered cost of natural gas to each generation facility.

Forecasted natural gas prices

The forecast methodology was based on the forecasted prices at the applicable natural-gas hub locations in or around Michigan, including MichCon CityGate and Dawn. For 2018 and 2019, these prices were determined by using the Chicago Mercantile Exchange (CME) Group/New York Mercantile Exchange (NYMEX) near-term futures prices. A transition period that, starts in 2020 and continues through 2022, draws on a combination of near-term futures prices and the long-term gas-price forecasts from PACE Global. During this transition period, there was a ratable adjustment between the two forecast methodologies; the PACE Global forecast is used exclusively starting in 2023. The transition period is described in further detail in the natural-gas price forecasts under the various scenarios section.

Forecasted transportation prices

Next, forecasted transportation costs were added to the forecasted natural gas prices, as applicable, to represent the costs associated with transporting the gas from the relevant hub to the power plant. Depending on the plant and location, transportation costs may have been based on existing agreements or general service tariff rates.

A brief summary of how natural gas is supplied to each of the Company's gas-fired generators is provided below.

Renaissance

DTEE purchases gas at MichCon CityGate from a third-party gas marketer. DTEE has a firm gas-transportation agreement with DTE Gas to transport that gas on its system to the plant. DTEE's agreement with DTE Gas includes approximately 1.2 Bcf of summer storage capacity and 0.8 Bcf of winter storage capacity.

Greenwood and Greenwood Peakers

Greenwood gas supply and transportation is provided by a third-party gas marketer. The marketer-delivered gas is transported to the ANR Pipeline interconnect with the SEMCO lateral. DTEE has a firm gas-transportation agreement with SEMCO to transport gas from the ANR Pipeline interconnect to the plant. DTEE pays for gas based on prices at the Dawn hub, plus applicable transportation costs.

Dean

DTEE purchases gas at MichCon CityGate and Dawn from a third-party gas marketer. DTEE has a firm transportation agreement with DTE Gas to transport that gas to the plant. DTEE also has an agreement with DTE Gas for balancing services, which includes approximately 0.3 Bcf of storage capacity.

Belle River Peakers

DTEE purchases gas from third-party marketers at the China Township point on the Great Lakes Gas Transmission pipeline. DTEE has a firm transportation agreement with SEMCO to transport gas from Great Lakes Gas Transmission to the Belle River Peakers.

Delray and River Rouge

DTEE purchases gas at MichCon CityGate from third-party gas marketers. DTEE has a firm transportation agreement with DTE Gas to transport that gas to the plants. DTEE's transportation agreements with DTE Gas include approximately 0.14 Bcf of storage capacity.

Hancock and Northeast

DTEE purchases delivered natural gas from Consumers Energy under LDC tariff service.

St. Clair Power Plant and Peakers

DTEE purchases delivered natural gas from SEMCO Energy under LDC tariff service.

Blue Water Energy Center

For a 24/7 baseload generator such as BWEC, the Company expects to enter into firm transportation and storage agreements to ensure supply reliability. Three large natural-gas transmission pipelines - Vector Pipeline, DTE Gas Co. and Great Lakes Gas Transmission - run approximately one mile north of the site. The site is further advantaged by several nearby natural gas storage facilities. DTE Gas, Washington 10 Storage Corp., Enbridge Gas, ANR Pipeline Co., and Bluewater Gas Storage have more than 400 Bcf of storage capacity within approximately 50 miles of the site. In addition, natural gas hubs at MichCon (upstream) and Dawn (downstream) provide liquid markets for procuring natural-gas supplies. This IRP assumes estimated annual fixed fuel costs of $15.7 million for transportation and $4.5 million for storage.

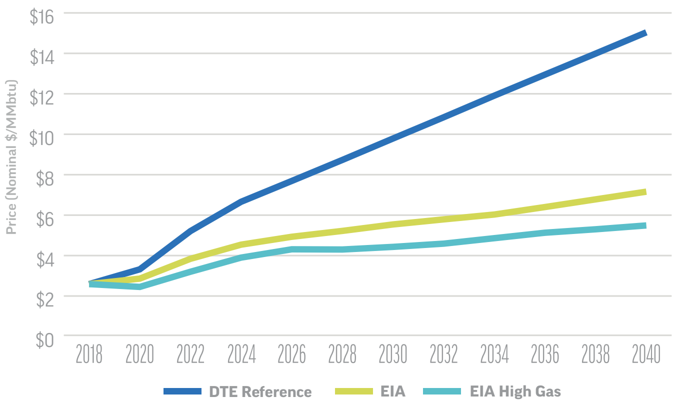
Assumptions for New Gas Sites

For modeling of potential new gas-fired combustion turbines, the Company assumed that the natural-gas price forecast would be the same as for the Belle River Peakers site. For any potential new gas-fired combined-cycle gas turbines, the BWEC costs were applied to the potential CCGT supply resources evaluated in the IRP process by scaling the costs based on the plant capacity. The firm services estimated provide for a high level of natural gas supply reliabiltiy to a power plant.

Natural gas price forecasts utilized for IRP modeling

Three natural-gas price forecasts, at each relevant gas hub, were utilized for modeling; Reference, 2018 EIA, and 2018 EIA High Gas. Figure 13.2.1 shows these natural-gas price forecasts based on the MichCon gas hub and reflects the commodity price used for modeling a combined-cycle gas-turbine alternative. The natural-gas forecast for the Dawn gas hub, also used in IRP modeling, is included in Exhibit A-4 Appendix I.

Figure 13.2.1: Annual Natural Gas Price – MichCon Gas Hub



The DTE Reference natural-gas forecast was used in the REF scenario. As the forecast methodology section states, the first two years were based on forecasted prices at each applicable hub. The next three years were a transition from these forecasted prices to the long-term gas price forecast from Pace Global.

The 2018 EIA natural-gas forecast was used in the three required scenarios, with the 2018 EIA High Gas being used in the high-gas sensitivities. The first two years are again based on forecasted prices at each applicable hub, with the following three years as a transition from these prices to the long-term gas price forecast from the 2018 EIA.

Lastly, the 2018 EIA High Gas natural-gas forecast was used in all the high-gas sensitivities. The first two years were again based on forecasted prices at each applicable hub. However, the next three years were a transition from these prices to the long-term 200 percent gas price based on the forecast from the 2018 EIA.

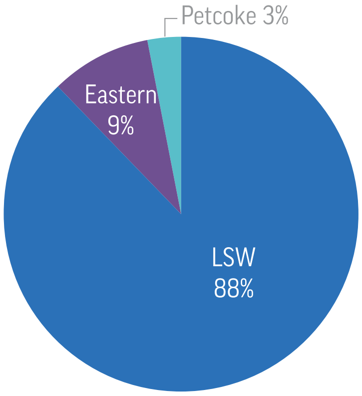
13.3 Coal

Coal Overview

DTEE's coal-fueled power plants consume a combination of Low Sulfur Western coal (LSW), High Sulfur Eastern coal (HSE), and Low Sulfur Southern coal (LSS), along with petroleum coke, as shown in Figure 13.3.1. LSW accounts for approximately 88 percent of the Company's coal consumption annually, due to its favorable pricing and emissions when compared to the eastern (HSE and LSS) coal types. Although LSW is historically lower in cost on a per-ton delivered basis, most of the Company power plants have the ability to blend the previously mentioned eastern coal types with LSW in an effort to utilize their higher heat content and maximize production during high-market opportunities.

Blending of LSW and eastern coal types provides operational flexibility, maximizes customer value, and maintains environmental and regulatory compliance.

FIGURE 13.3.1 - DTE Electric 2018 Coal Consumption



Delivered coal prices to existing utility generating plants

Forecast methodology

Coal commodity costs were added to the applicable transportation rate (including railcar costs if applicable) to determine the delivered cost of coal by route to each generation facility. Beyond the forecast's first five years, the Company utilized the PACE Global forecast.

Forecasted coal prices

The forecasted coal cost was developed by utilizing existing contract prices and forecasted forward-market prices. Forecasted forward-market coal prices for the first three years were based upon existing contract rates and market information obtained from an over-the-counter coal broker. For forecast years four and five, the forecasted coal cost was derived by applying an inflation index factor to the forward-market coal prices. Beyond the five-year forecast, LSW prices from the forecast's last year were escalated by the annual year-over-year change in the PACE Global forecast. For HSE price forecasting, there was a direct switch to the PACE Global forecast after the end of the five-year forecast period.

Forecasted transportation prices

The near-term transportation rates were computed by applying adjustments to the existing contract rates using either prescribed periodic rate increases, or rate increases based upon contractually defined indices. In the latter case, historical data was utilized to project future rate adjustments.

A brief summary of how coal is supplied to each of the Company's coal-fired generators is provided below.

Belle River Power Plant

Belle River consumes exclusively LSW from Montana, which is transported via rail to DTEE's subsidiary, Midwest Energy Resources Co. (MERC), in Superior, Wisc., which provides trans-shipment services to DTEE and other third-party customers. The coal is then held in inventory and subsequently loaded into lake freighters for transportation to the power plant.

Monroe Power Plant

Monroe consumes a combination of LSW from Wyoming, HSE from the Northern Appalachia region, and petcoke. All three of these fuels can be delivered via rail and vessel; petcoke also has a truck delivery option. LSW and petcoke vessel shipments utilize MERC as a trans-shipment facility while HSE vessel shipments utilize various Lake Erie docks for trans-shipment. Monroe also blends petcoke with coal. Petcoke is an economic fuel that provides higher heat content when compared to coal. It is consumed only at Monroe Power Plant due to its emissions-control equipment

River Rouge Power Plant

River Rouge consumes a combination of LSW from Wyoming and LSS from the Central Appalachia region. Both fuels are delivered via rail.

St. Clair Power Plant

St. Clair consumes a combination of LSW from Montana and HSE coal from the Northern Appalachia region. The LSW is transported via rail to MERC and is loaded into lake freighters for transportation to the power plant. HSE deliveries are primarily made via rail.

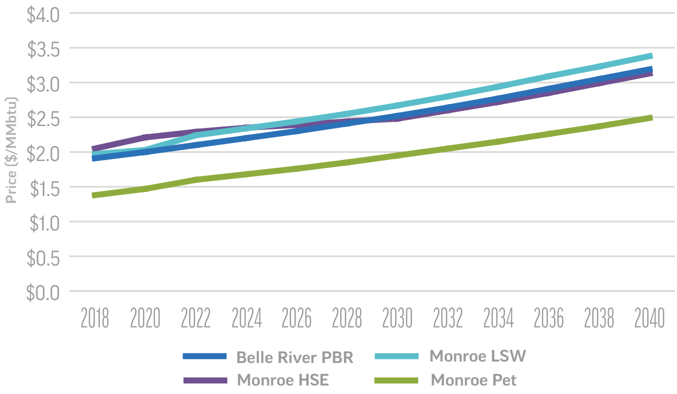
Trenton Channel Power Plant

Trenton Channel consumes a combination of LSW from Wyoming and HSE from the Northern Appalachia region. Both fuels can be delivered via rail or vessel, in the latter case utilizing MERC (LSW) and/or Lake Erie docks (HSE and LSW).

Coal-price forecasts utilized for IRP modeling

The coal-price forecast utilized for the modeling was constant among all scenarios. Please refer to figure 13.3.2 below, which shows the coal prices for Belle River Power Plant LSW, Monroe Power Plant LSW, Monroe Power Plant HSE, and Monroe Power Plant petcoke.

FIGURE 13.3.2 – Annual Delivered Coal Price



13.4 Oil

Oil Overview

The Company uses diesel fuel oil for start-up and over-fire capabilities of its coal-fired generating units. Diesel is also the primary fuel at the Company's diesel peaking generator units.

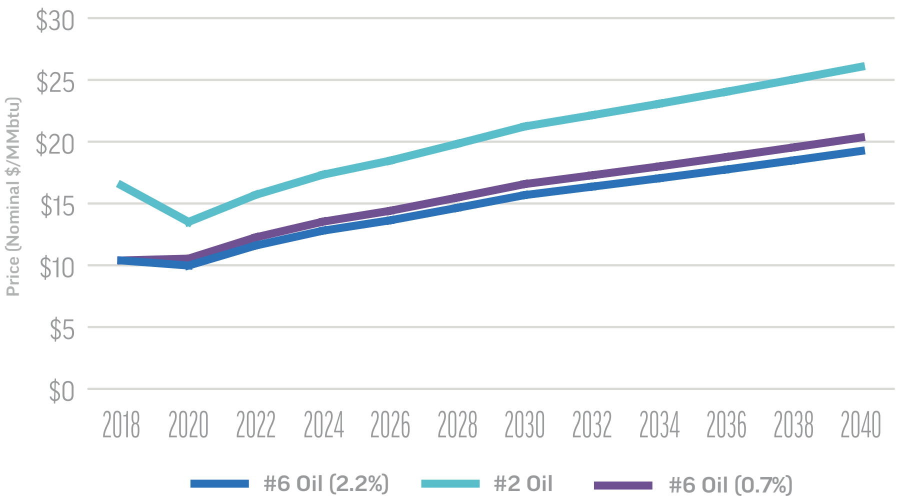
Delivered oil prices to existing utility generating plants

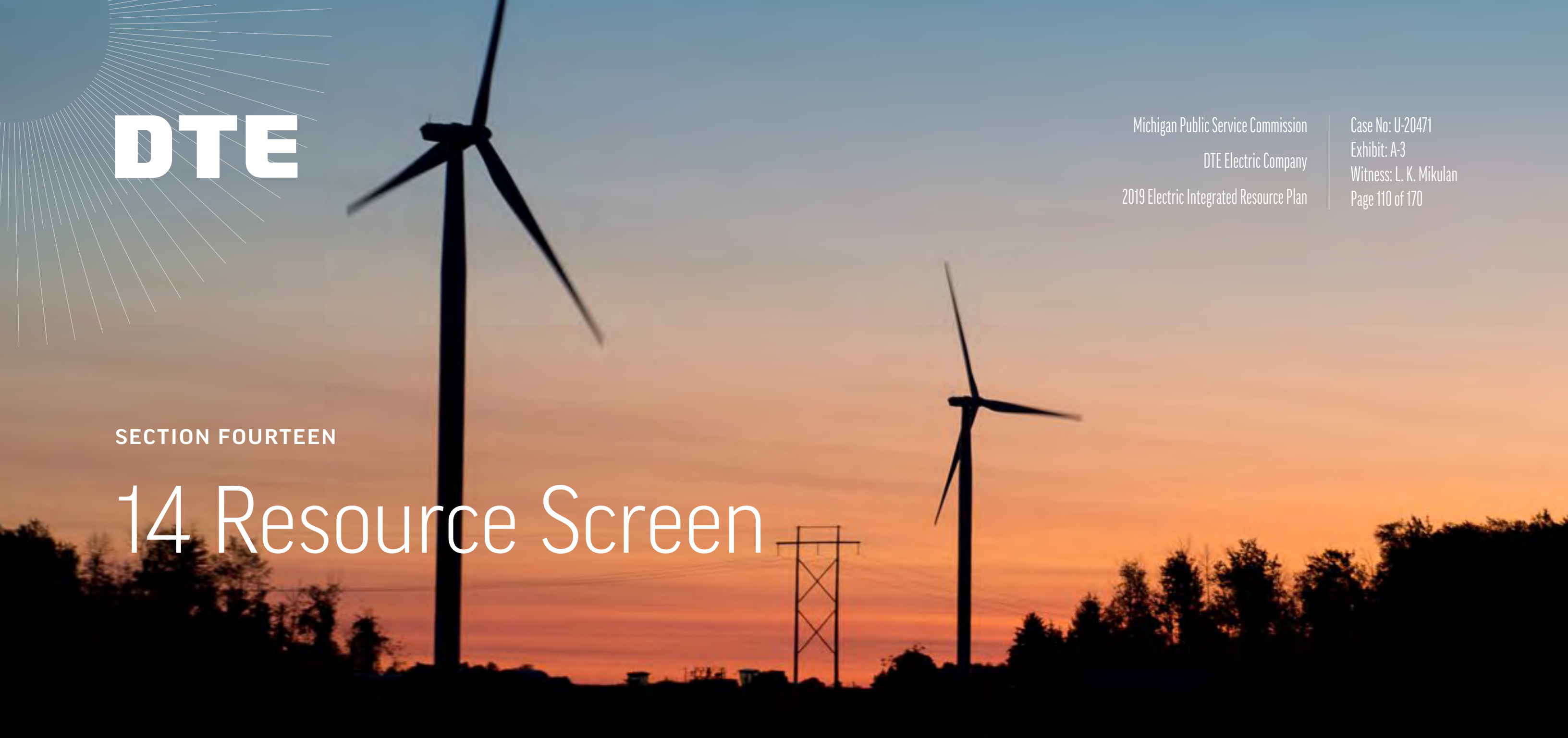
Fuel oil's forecasted delivered cost was determined by using the NYMEX futures prices, in addition to expected transportation costs. Agreements are in place for fuel-oil supply and transportation. Fuel oil is held in inventory and ordered as needed, and delivered via truck to the respective site. For the forecast's first two years, fuel-oil supply and transportation pricing were market-index-based, with a markup applied by the supplier. Starting in the forecast's third year, the PACE Global forecast was utilized exclusively for forecasted fuel-oil pricing.

Oil-price forecasts utilized for IRP modeling

The oil-price forecast used for the modeling was constant among all the scenarios. Please refer to Figure 13.4.1 below, which shows the oil prices for no. 2 oil, no. 6 oil (0.7 percent), and no. 6 oil (2.2 percent).

FIGURE 13.4.1: Delivered Annual Oil Prices





SECTION FOURTEEN

14 Resource Screen

14.1 Overview

The goal of resource screening is to ensure the modeling includes only technologies that are economical or provide a market value benefiting customers. The model was designed to identify the lowest-cost resource options, so including a resource that is uneconomical or is low in market value when compared with other resource alternatives would only result in the model never selecting that resource. Therefore, screening out the uneconomical or low-market-value resources maximizes the modeling effort to identify economical resources.

The IRP considered a multitude of potential supply-side and demand-side resources. DTEE performed a screening process using technical feasibility, levelized cost of energy, and market evaluation to whittle down the number of alternative technologies included in the Strategist® optimization modeling. Reducing the number of alternative technologies available in optimization runs is an important step, as too many alternatives in the model can increase the problem size exponentially and render it unsolvable. (See illustrative example next page).

TABLE 14.1.1: Model Decision Tree Example

	50 Alternatives	10 Alternatives
Model Year	**# of Decision Trees**	**# of Decision Trees**
Year 1	50	10
Year 2	2,500	100
Year 3	125,000	1,000
Year 4	6,250,000	10,000
Year 5	312,500,000	100,000

The methods for screening and evaluating technology options are described below.

14.2 Existing & Planned Resources

As described in Sections 7 and 8, the Company has a diverse portfolio of existing supply-side and demand-side resources to meet our customers' energy needs. In addition to existing resources, the Company has planned resources that are included in the study period, including specific projects approved, or submitted with requests for approval, in prior regulatory proceedings with the Michigan Public Service Commission. As discussed in Section 9, the Company has developed a build plan of future wind and solar assets to meet Michigan's Renewable Portfolio Standards as well as its commitment to achieve 50 percent clean energy by 2030 and an 80 percent CO2 reduction by 2050. Below is a summary of planned resources that were included in the IRP modeling's starting point:

TABLE 14.2.1: Planned Resources Included in Modeling

Resource	Technology	MW	Status
Blue Water Energy Center	Combined Cycle	1,150	Under construction, COD in 2022
Dearborn Energy Center	Combined Heat & Power	34	Under construction, COD in 2019
Ludington	Pumped Storage	~90	On-going upgrades to units 1 & 3
Demand Response	IAC / Existing Programs	~130	To be added from 2019 - 2025
Future Wind	Renewable	~1,150	To be added from 2019 – 2040
Future Solar	Renewable	~2,550	To be added from 2019 – 2040

14.3 Technical Feasibility Screening

The Company relied upon publicly available data to identify supply-side technology alternatives and their respective costs and operating characteristics (see Table 14.3.1). The screening process's first step evaluated these alternatives based on technical feasibility, which allowed the elimination of alternatives that were impractical, uneconomical, or had geographic limitations. Based on this methodology, three resource alternatives were filtered out of further analysis in the IRP: hydropower, geothermal, and solar-thermal. Each has limitations based on Michigan's geography and are costly options on a $/kW basis compared to other technologies.

TABLE 14.3.1: Alternative Technology Costs Across Scenarios

Technology Alternatives, Based on Publicly Available Information				Scenarios		
				REF and BAU	ET	EP
Unit Type	Abbreviation	Technology Source	Source Year	Overnight Cost ($/kW)[1]		
Combined Cycles						
Advanced Combined Cycle	AdvCC	EIA	2018	1133	No Change	
Combined Cycle with Carbon Capture Sequestration	CCwCCS	EIA	2018	1981	No Change	
DTE Combined Cycle	DTECC	DTE		860	No Change	
Combustion Turbines						
Advanced Combustion Turbine	AdvCT	EIA	2018	663	No Change	
Combined Heat and Power	CHP	EPA	2017	1686	1096	1686
Micro Turbine	MT	EPA	2017	2776	No Change	
RICE (5 units at 17MW ea.)	RICE	EIA	2016	1400	No Change	
Renewables						
Wind	Wind	NREL	2018	1712	1412	1113
Solar PV-1 axis tracking	SolarTr	NREL	2018	1434	932	932
Solar PV-fixed tilt	SolarFix	NREL	2018	1325	861	861
Biogas	Bio	NREL	2017	3700	No Change	

Technology Alternatives, Based on Publicly Available Information				Scenarios		
				REF and BAU	ET	EP
Unit Type	**Abbreviation**	**Technology Source**	**Source Year**	**Overnight Cost ($/kW)[1]**		
Base Load						
Coal with 90% CCS	PCwCCS	EIA	2018	5250	No Change	
Advanced Nuclear	AdvNuc	EIA	2018	5266	No Change	
IGCC with Carbon Capture Sequestration	IGCCwCCS	EPRI	2017	5214	No Change	
Screened out on Feasibility						
Hydropower		NREL	2017	6040		
Geothermal		NREL	2017	4648		
Solar – Thermal		NREL	2017	6893		

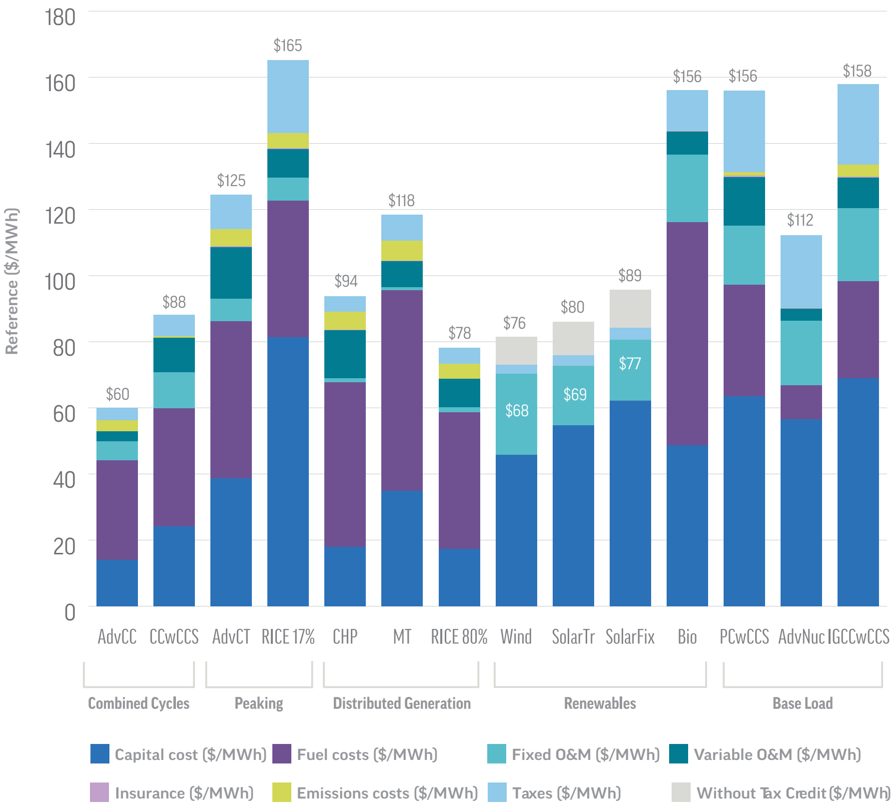
[1] Overnight cost is the cost of a construction project if no interest accrued during construction, as if the project was completed "overnight." In table 14.3.1, overnight costs are used to compare the cost of each technology across the IRP scenarios.

See the Master Technology Inputs in Exhibit A-4 Appendix B for additional detail regarding the technology alternatives, operational costs, and operating characteristics.

14.4 Levelized Cost of Energy Screening

The second step in the IRP technology screening process was comparing the levelized cost of energy (LCOE) between alternatives on a consistent basis. This step was particularly helpful when comparing technologies that have common attributes. The LCOE was calculated by forecasting the annual costs to operate a technology over its useful life, dividing it by that technology's forecasted generation, and then levelizing the result. The levelizing function takes a varying stream of numbers over a period and simplifies them to one value, typically represented in $/MWh. Usually costs will increase over time; levelization takes these increasing values, discounts them, and expresses the result as one number, usually in current-year dollars. LCOE results from the Reference Scenario are shown below in figure 14.4.1. Each technology's resulting $/MWh value consists of capital, fuel, fixed O&M, variable O&M, insurance, emissions, and tax costs.

FIGURE 14.4.1: Reference 2024 Levelized Cost of Energy



The other IRP scenarios' key LCOE assumptions and results can be found in Exhibit A-4 Appendix M and N respectively.

The technologies screened out in this step had significantly higher costs compared to similar technologies (i.e. peaking, distributed generation, renewables). Table 14.4.2 highlights the technologies screened out in the LCOE analysis.

TABLE 14.4.2: LCOE Screened Out Technologies

Category	Screened Out Technologies
Peaking	Reciprocating internal combustion engine w/ 17% capacity factor
Distributed Generation	Micro turbines, combined heat & power
Renewables	Solar fixed tilt[1], biogas
Base Load	Pulverized coal and integrated gasification combined cycle w/CCS, advanced nuclear

1 For the purpose of modeling only solar single-axis tracking was modeled.

The LCOE was useful in comparing like technologies to each other i.e. baseload, non-dispatchable, peaking, etc., to illustrate cost-based differences within a category. However, it has shortcomings as a stand-alone screening tool. While LCOE is a representation of costs, it does not show how much market value the technology is creating - either in the energy market or the capacity market. Therefore, the IRP process utilizes a third screening step, known as market valuation, which is performed in Strategist®.

14.5 Market Valuation Screening

After screening IRP alternatives by LCOE, the next step in the IRP process is to analyze an alternative's market value. An associated market value calculated for each alternative was useful in screening out options and providing a standard basis for comparing technologies.

The market valuation step included battery storage, energy waste reduction (EWR), and demand response programs, which typically are not evaluated in an LCOE for the following reasons:

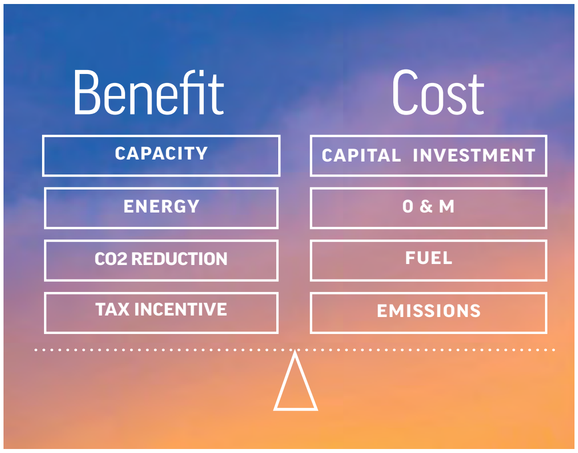
Battery storage - Both charges and generates, making it close to a net-zero energy generator.

Demand response – These programs tend to produce little energy, which will result in a very high LCOE relative to other technologies. A more reasonable comparison tool for DR programs is a levelized cost of capacity (LCOC), or a market valuation.

EWR – EWR savings are made up of a mix of end-uses that are delivered in different years, at different savings levels and costs, and persist for different lengths of time. Thus, an EWR LCOE calculation would not be performed on the same basis with the other alternatives. Instead, the EWR group uses the Utility System Resource Cost Test (USRCT) to calculate each EWR level's cost-effectiveness in the development step.

A market valuation was created by comparing the outputs of two Strategist® runs. The first Strategist® run purchases future energy and capacity needs from the market. The second run places the desired resource being evaluated into service. These runs were conducted with the scenario market data loaded into the Strategist® modeling tool, but prior to resource optimization. The benefits and costs of the resource being evaluated (Figure 14.5.1) were then compared to the benefits and costs of purchasing the equivalent energy and capacity from the market. A benefit-cost ratio is determined by dividing the discounted benefit by the asset's discounted cost.

FIGURE 14.5.1: Market Valuation Benefit Cost



Given the market energy and capacity price forecast, a value of greater than one would indicate that an alternative's total benefits outweigh its total cost. Numbers below one could indicate that purchasing energy and capacity from the market is more cost-effective than offsetting those purchases with an alternative resource. Table 14.5.2 summarizes the benefit-cost ratios for the DTEE Reference scenario market valuation. Market valuation results for the remaining scenarios and select sensitivities are included in appendix O.

DR real-time pricing: Although this alternative had the highest benefit-cost ratio its assumed capacity benefit of approximately 3 MW was the smallest of the resource alternatives. Due to its very small program size, it would not be selected in an optimization. Its exclusion from the optimization runs does not preclude the Company from investigating the program.

Reciprocating Internal Combustion Engine (RICE) 80 percent (CT): This alternative was excluded for modeling purposes as it is similar technology to the Advanced CT, which was

TABLE 14.5.2: Reference Case Market Valuation Results

Rank	Technology	Benefit/ Cost[2]
1	DR - Real Time Pricing	2.88
2	DR - Conservative Volt Reduction	2.81
3	DR - Variable Peak Pricing	2.65
4	DR - Time of Use	1.71
5	DR - Demand Buyback	1.36
6	Advanced CCGT (1x1)	1.12
7	EWR 1.75	0.99
8	Wind with 40% PTC	0.96
9	Solar with 30% ITC	0.93
10	Advanced CT	0.89
11	EWR 2.0	0.88
12	RICE 80% (CT)	0.87
13	CC-CCS	0.76
14	DR - Voltage Optimization	0.61
15	EWR 2.25	0.49
16	DR - DLC Smart Thermostats	0.39
17	DR – Capacity Bidding	0.35

included in the optimization runs.

Other DR programs: Demand response programs that performed well in the market evaluation had sufficient capacity among them to fulfill the forecasted capacity need in 2029 and 2030. Therefore, the other less-economical demand response programs were excluded from the optimization runs.

14.6 Energy Storage Technologies

Grid-scale energy storage systems (ESS) are a collection of methods used to store electrical energy on a large scale within an electrical power grid. Grid-scale ESS help stabilize the grid by balancing electricity supply and demand over short (sub-seconds to minutes) to longer-term (hours, days, weeks, etc.) durations. The three ESS applications that can provide value to the grid in terms of generation application are:

1. **Ancillary services:** ESS can help maintain the grid's performance by providing ancillary services (e.g., frequency regulation, and/or balancing voltages on the grid). As the level of renewable deployment on the electric system increases, the need for these services may also increase. The extent to which the ESS are compensated for these services depends on the market in which they are operating.

2. **Capacity:** ESS can be used as a peak shaving resource to reduce or defer investments in additional generation capacity. This includes the use of an ESS as a capacity resource.

3. **Price arbitrage:** ESS can store energy produced during periods of low demand/prices and sell during periods of higher demand/prices. In the same context, ESS can also increase the value of renewable energy systems by storing and shifting renewable energy output to times of greater system need or to avoid curtailment (i.e., firming renewable energy capacity).

The two ESS applications that can provide value to the grid in terms of distribution application are:

1. **Investment deferral in transmission and distribution:** ESS can be used as a peak shaving resource on the distribution system to reduce or defer investments in additional distribution assets.

2. **Emergency backup:** ESS can provide electricity supply during planned or unplanned outage situations.

While batteries are technically capable of providing all of these benefits, the extent to which a single battery can provide all of these services (i.e., the ability to "stack" the available values) will be dependent upon the specifics of the project. For example, a common application for grid-scale battery storage is for peak-shaving, thus deferring or eliminating

Rank	Technology	Benefit/ Cost[2]
18	DR – Behavioral	0.35
19	DR - AC	0.31
20	LITH-ION Battery	0.30
21	DR - DLC Water Heating	0.28
22	EWR 2.5	0.17

[2] The higher the number, the greater the benefit.

[1] Shaded technologies were excluded from Strategist® optimization modeling runs.

Source: Lazard Levelized Cost of Storage 3.0 (size range and maturity); B. Zakeri & S. Syri Electrical energy storage systems: A comparative life cycle cost analysis (non-lithium-ion cycle life); OEM brochures (lithium-ion cycle life) the need for a conventional wires investment. In this use case, the battery would charge during a time when load on a distribution circuit is low and discharge when load on the circuit is high. However, this usage pattern can potentially conflict with the usage pattern required to maximize energy and capacity benefits. For example, a circuit's peak hours may not be coincident with the peak hours MISO uses for determining capacity credit. If the battery is not sufficiently oversized to serve both peaks, then the operator must choose whether to discharge the battery to serve the distribution system or to provide system capacity. The same logic applies for the energy arbitrage opportunities that exist on a given day. As such, the battery operator may be unable to capture all of the theoretically available values due to the conflicts that exist between them. As indicated previously, some ESS technologies are more suitable for certain applications than others. The following ESS technology categories comprise most of the ESS technologies commercially available today:

- Pumped hydroelectric power
- Compressed air energy storage (CAES)
- Battery storage (e.g., lithium-ion, sodium-sulfur, lead acid, and flow batteries)

In order to determine which storage technologies to incorporate into its modeling, DTEE performed an initial technical screening to assess each technology's feasibility for deployment. The results of this screening exercise are described below.

New Pumped Hydroelectric Storage

Pumped hydroelectric storage uses electricity to pump water to a higher elevation. When required, water is released to drive a hydroelectric turbine. Beyond the existing Ludington facility, deployment of pumped hydro was screened out due to the geographical limitations of siting a new facility.

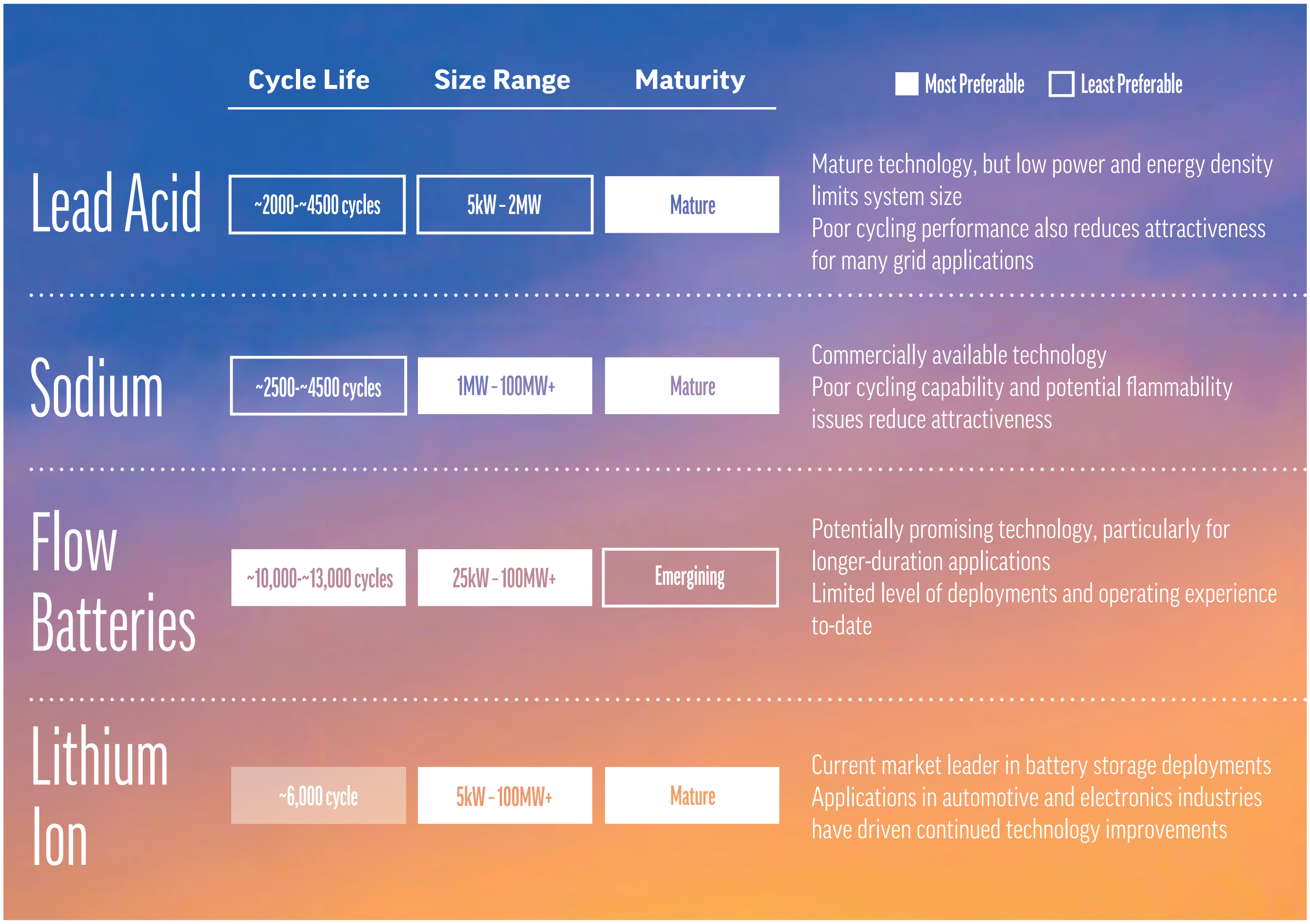
Compressed Air Energy Storage

CAES uses electricity to compress air into confined spaces. When required, air is released to drive the compressor of a natural gas turbine. CAES was screened out since its deployment is limited by the availability of suitable geologic formations and because there is limited commercial experience in the United States.

Battery storage

Batteries use electricity to store chemical energy, which can later be converted back into electrical energy when required. There is a range of different battery chemistries, which have the potential to operate in grid applications with varying operating characteristics and levels of technology maturity. In Table 14.6.1 below, each technology was ranked based on its cycle life, size, and technology maturity.

TABLE 14.6.1: Battery Technology Comparison Summary



■ Most Preferable ☐ Least Preferable

	Cycle Life	Size Range	Maturity	
Lead Acid	~2000-~4500 cycles	5kW - 2MW	Mature	Mature technology, but low power and energy density limits system size Poor cycling performance also reduces attractiveness for many grid applications
Sodium	~2500-~4500 cycles	1MW - 100MW+	Mature	Commercially available technology Poor cycling capability and potential flammability issues reduce attractiveness
Flow Batteries	~10,000-~13,000 cycles	25kW - 100MW+	Emergining	Potentially promising technology, particularly for longer-duration applications Limited level of deployments and operating experience to-date
Lithium Ion	~6,000 cycle	5kW - 100MW+	Mature	Current market leader in battery storage deployments Applications in automotive and electronics industries have driven continued technology improvements

Based on this technical assessment, lithium-ion batteries have the most desirable combination of operating parameters, system size, and technology maturity.

DTEE also looked at each of these battery technologies' historical costs and future cost trajectories in order to further distinguish which technologies were most suitable for further inclusion in this IRP. Costs for lithium-ion batteries have declined significantly in recent years and the trend is expected to continue in the near term, driven in part by its applications in other sectors, such as electronics and transportation.

Given their superior combination of cost, cycle life, system size, and technology maturity, lithium-ion batteries were selected for further evaluation in this IRP. See Exhibit A-4 Appendix C for the lithium-ion battery assumed operating characteristics considered for modeling.

The battery storage units evaluated were assumed to have an installed capacity of 100 MW and 400 MWh, which equates to a four-hour duration. The objective for selecting this configuration was to create an asset that can provide both energy arbitrage and capacity value, with the full power rating qualifying for capacity credit in MISO. Given the four-hour duration, capacity credit was assumed to be nearly 100 percent.

While lithium-ion is the most suitable technology in the near-term, DTEE continues to monitor the other battery storage technologies' development, as well as other non-battery storage options, and may update its assessment of these technologies as costs decline, performance improves, and the market framework for storage evolves.

14.7 Distributed Generation Resources

Through 2017, the Company had just over 1,700 net metering sites with approximately 13.6 MW of installed capacity. More than 98 percent of installed net metering capacity is solar. Table 14.7.1 summarizes the total net metering sites and capacity as of the end of 2017, by category. Category 1 is limited to sites with renewable generation less than 20 kW of installed capacity; category 2 is limited to sites with renewable generation of more than 20 kW but less than 150 kW; category 3 is limited to methane digesters between 150 kW and 550kW. Table 14.7.1 also shows the percentage of the statutory cap each category has reached; category 1 is capped at 0.5 percent of the Company's peak; categories 2 and 3 are each capped at 0.25 percent of the Company's peak.

TABLE 14.7.1: Total Net Metering Sites and Capacity

	Sites	Capacity (MW)	Capacity Cap (MW)	Percent of Cap
Category 1	1,675	11.8	54.3	21.8%
Category 2	30	1.8	27.2	6.5%
Category 3	0	0	27.2	0.0%
Total	1,705	13.6	114.2	12.5%

As discussed in Section 10, the Company's load forecast assumes a five to seven percent growth rate for distributed generation through the study period.

14.8 Market Capacity Purchases

As discussed in Section 4 a capacity need is not identified until the 2029 and 2030 timeframe with the retirement of Belle River. It is uncertain how much, if any, capacity will be available in the market for the Company to purchase 10 years from now. Due to this uncertainty in the capacity market, zero capacity purchases was the general assumption for optimization modeling. However, as discussed in Section 15 the IRP modeling did consider an all market purchase sensitivity performed on each scenario. The higher load sensitivities also considered capacity purchases in some years; this is discussed in Exhibit A-4 Appendix F.

14.9 Long-term Power Purchase Agreements

For the purposes of the resource screen within the IRP planning process, the Company's existing long-term power purchase agreements (PPAs) were assumed to be renewed.

SECTION FIFTEEN

15 Modeling Results

15.1 Strategist® Optimization modeling results

The four IRP scenarios were optimized through the Strategist® optimization model. Each optimization model run typically generated from 30 to 1,100 different build plans as outputs, ranked from least-cost to highest-cost. The least-cost plans output from each scenario varied considerably from each other. The least-cost build plans from each of the four scenarios output from the Strategist® optimization are shown in table 15.1.1.

Table 15.1.1: Least-cost plans from each scenario

	REF	BAU	ET	EP
EWR starting in 2020/2021	1.5% EWR	2% EWR	2% EWR	1.75% EWR
2029/2030 build	414 MW 1x1 CC 259 MW DR	414 MW 1x1 CC	1050 MW WIND	3,150 MW wind

Considering the least-cost plan results from the Strategist® optimization, three different levels of EWR were least-cost (or selected) across the four scenarios. In addition, a gas CCGT was selected in two of the four scenarios, while additional renewables energy was selected in the other two. For modeling purposes, if selected, the increased EWR level started in 2020 for 1.75 percent EWR. Similarly, for the least-cost plans that selected 2 percent EWR, the level increased to 1.75 percent in 2020 and then to 2 percent in 2021. The other builds shown all come on in the Strategist® optimization in either 2029 or 2030, when replacement for Belle River is planned.

The Company's Strategist® modeling optimized each level of EWR separately. The following table shows the compilation of the optimization's results.

Figure 15.1.2 shows the build plans of the least-cost plan at the different EWR levels (1.5 percent, 1.75 percent, and 2 percent). Note that REF/BAU have the same least-cost build plans for both the 1.75 percent and 2.0 percent EWR levels. Additionally, ET and EP have the same least-cost plan for the 2.0 percent EWR level. Therefore, the optimization modeling produced nine distinct least-cost build plans across the four scenarios.

Figure 15.1.2 - Least-cost build plans from three EWR levels across four scenarios

REFERENCE			
EWR	**1.50%**	**1.75%**	**2.00%**
CCGT	414	414	414
DR	259	-	-
Wind	-	-	-
	A Comparison Build Plan	**E**	**H**

BUSINESS AS USUAL			
EWR	**1.50%**	**1.75%**	**2.00%**
CCGT	414	414	414
DR	167	-	-
Wind	150	-	-
	B	Same as **E**	Same as **H**

EMERGING TECHNOLOGY			
EWR	**1.50%**	**1.75%**	**2.00%**
CCGT	414	-	-
DR	-	167	-
Wind	1,500	1,800	1,050
	C	**F**	**I**

ENVIRONMENTAL POLICY			
EWR	**1.50%**	**1.75%**	**2.00%**
CCGT	-	-	-
DR	216	-	-
Wind	3,300	3,150	1,050
	D	**G**	Same as **I**

Each of the nine build plans seen in Figure 15.1.2 was extracted from the outputs from each of the four scenarios. The Strategist® model calculated the Net Present Value Revenue Requirement (NPVRR) for each of these plans and compared it against a comparison plan. In order to maintain consistency when evaluating build plans across the scenarios, the 1.5 percent EWR plan with a CCGT and DR in 2029-2030 was used as the sole comparison build plan.

Table 15.1.3 shows the same nine build plans from Figure 15.1.2 along with the delta NPVRR against the comparison plan by scenario. To create this table, each of the nine unique build plans from Figure 15.1.2 was found among the resultant build plans in each of the four scenarios. This comparison shows how each build plan's economics change by scenario.

Table 15.1.3 - Nine least-cost plans across four scenarios

EWR Level	2029/30 Build	REF	BAU	ET	EP	Commentary
		TIERED	FLAT HIGH	FLAT LOW	FLAT HIGH	EWR Cost Level used in the scenario
		Delta NPVRR back to Comparison Plan (Millions) 2019-2040				
1.5% 414 MW 1x1 CC 259 MW DR Plan A		-	-	-	-	**REF - Least Cost Plan**. Considered a comparison plan across all scenarios. **All the deltas below are compared back to this plan.**
1.5%	414 MW 1x1 CC 167 MW DR 150 MW WIND	$1	($8)	($17)	($30)	DR was preferred over wind in DTE REF and BAU whereas wind gains value in ET and EP scenarios.
1.5%	414 MW 1x1 CC 1500 MW WIND	$66	($3)	($114)	($254)	The preference of DR over wind in REF and the value of wind in ET and EP was more pronounced in this case. Additionally, wind was preferred over solar in ET because of the significant energy value it produces in the sales market
1.5%	216 MW DR 3300 MW WIND	$316	$206	($75)	($366)	Wind has 17.5 percent Capex reduction in ET vs. 35 percent reduction in EP. So, it's economical in ET and more so in EP because of the discount. Similarly, it was very uneconomical due to absence of these discounts in REF and BAU.
1.75%	414 MW 1x1 CC	$18	($162)	($212)	($157)	With a tiered cost view, 1.75 percent EWR is marginally worse than 1.5 percent EWR, whereas in the flat high and flat low views, 1.75 percent EWR is significantly better.
1.75%	167 MW DR 1800 MW WIND	$154	($93)	($286)	($379)	Wind is preferred over solar in ET because of the significant energy value it produces in the sales market
1.75%	3150 MW WIND	$324	$46	($256)	($463)	EP - Least Cost Plan. Wind is preferred over solar and EWR in EP because of the significant energy value it produces in the sales market
2.0%	414 MW 1x1 CC	$93	($308)	($419)	($294)	BAU - Least Cost Plan. Note that REF and BAU are similar scenarios. The big difference in delta is due to difference in EWR costs where the flat high cost selects the 2 percent EWR and the tiered cost selects the 1.5 percent EWR.
2.0%	1050 MW WIND	$181	($252)	($453)	($416)	ET - Least Cost Plan. Wind is preferred over solar in ET because of the significant energy value it produces in the sales market. Two percent EWR is selected in ET due to the flat low EWR costs.

Under each scenario, multiple sensitivities were run through the Strategist® optimization model. The sensitivity analyses' results are presented in the following sections.

15.2 Reference Scenario Results

Sensitivities under the Reference scenario included: EWR incentive-cost sensitivities, a high CO2 price, high electric-vehicle penetration, high load, assumed retirement of Belle River coal units in 2025/2026, sensitivity N (submitted by an external stakeholder), non-fossil alternative(s) in 2029/2030, addition of CVR, and an alternative discount rate. The sensitivity analyses' results are summarized in the tables below.

Results of the EWR incentive-cost sensitivity

The EWR flat high costs were run on the REF scenario to see how they affected the least-cost plan. The starting-point tiered costs used in the REF scenario assumed higher levels of incentives were needed as the level of EWR increased, whereas the flat high EWR costs assumed 50 percent incentives, regardless of EWR level. Table 15.2.1 summarizes the results.

With the flat high cost assumption, the least-cost plan has 2 percent EWR. With the tiered-cost scenario, the 1.5 percent EWR level is selected as least-cost.

Results of the high CO2 price and high electric-vehicle penetration sensitivities

TABLE 15.2.1: REF Scenario: EWR Incentive-Cost Results

	EWR Level	1.50%	1.75%	2.00%
REF flat high	2029/30 BUILD	414 MW 1x1 CCGT 259 MW DR	414 MW 1x1 CCGT	414 MW 1x1 CCGT
	DELTA, $M	-	($133)	($245)
REF tiered costs	2029/30 BUILD	414 MW 1x1 CCGT 259 MW DR	414 MW 1x1 CCGT	414 MW 1x1 CCGT
	DELTA, $M	-	$18	$93

TABLE 15.2.2: Ref Scenario: High CO2 price and high electric-vehicle penetration results

REF Sensitivities - Least Cost Plan - Tiered Cost			
Sensitivity	**EWR Level**	**2029/30 Build**	**Comments**
Starting Point	1.5%	414 MW 1x1 CCGT 259 MW DR	CCGT is the most economic and efficient unit, hence preferred as first option with assumed inputs.
High CO2	1.5%	4500 MW WIND 200 MW SOLAR	Has higher energy market, hence prefers higher energy renewable source
High EV	1.5%	414 MW 1x1 CCGT 150 MW WIND 167 MW DR	The EV penetration in the market shifts the peak hour from the conventional spot, so a CCGT is preferred to cover the need along with DR to reduce the peak.

The results indicated that the high-CO2 sensitivity selected high levels of renewables in the least-cost plan. It is noteworthy that 4,700 MW of renewables were selected instead of increasing the EWR level. This was due to the large amount of value created through selling excess wind energy into the extremely high market (high due to $30-70/ton CO2 adder).

TABLE 15.2.3: REF Scenario: High-load results

Sensitivity	EWR Level	2021-24 Build	Purchases	Comments
High Load	0.015	1800 MW WIND 50 MW SOLAR 358 MW DR 414 MW CCGT	2020-24 - 0-300 MW 2025-28 - 200-700 MW 2029-40 - 1300-5000 MW	Higher load resulted in the early need of capacity. With the early build constraint of CCGT, renewables were favored

Results of the high load sensitivity

The high-load sensitivity selected a combination of wind, solar, DR, and CCGT by 2024 to fill the capacity required in the near-term years.

Results of the Belle River early retirement sensitivity

In this sensitivity, the Belle River coal units were retired in the Strategist® optimization in 2025 and 2026, instead of 2029 and 2030 as planned. The Strategist® model had the option to "replace" the capacity with the coal units themselves (until 2029 and 2030) or the other IRP alternatives.

The least-cost plan replaced the 2025-2026 retirement of Belle River with coal units at Belle River that retired in 2029 and 2030, which means it's more economical to leave the retirement dates as currently planned. An important point is that Belle River is co-owned with the Michigan Public Power Agency (MPPA). The optimization results shown above include only DTEE's costs, which are 81.39 percent of the total. MPPA's portion of the cost increase is not included. It will also have costs to replace its capacity when Belle River retires. No capacity sales were assumed when capacity was long.

Table 15.2.4 : REF Scenario: Belle River Early Retirement Results

Belle River Retirement Sensitivities					
Sensitivity	**EWR Level**	**Purchase/ Build 2025/2026**	**PVRR, $M**	**Delta, $M**	**Comments**
Least Cost Plan	1.75 %	BLR 1 (coal from 25 to 29) BLR 2 (coal from 26 to 30)	$13,453	-	Least-cost plan prefers to keep Belle River running past 2025
2nd Least Cost Plan	1.75 %	217 MW DR 414 MW 1x1 CCGT	$13,492	39	Plan no. 2 is replacing BLR with CCGT & DR in 2025-2026
First non-CCGT plan	1.75 %	1200 MW WIND 300 MW SOLAR 358 MW DR	$13,663	209	First non CCGT plan requires Renewables build and DR in 2025-2026
Purchase until 2029	1.75 %	414 MW 1x1 CCGT in 2030	$13,510	57	Purchase allowed until 2029 and CCGT built in 2030
Purchase until 2040	1.75 %	PURCHASE	$13,585	131	Purchase allowed all the way to 2040
Least Cost Plan	2%	BLR 1 BLR 2	$13,528	74	Optimization using 2 percent EWR least-cost plan is keeping BLR 2 % less economical than 1.75 percent
2nd Least Cost Plan	2%	167 MW DR 414 MW 1x1 CCGT	$13,578	125	Plan no. 2 is replacing BLR with CCGT and DR in 2025-2026

Results of Sensitivity N

Sensitivity N was submitted by an external stakeholder as a result of the Company's stakeholder engagement process in the months leading up to the IRP filing. This sensitivity was run with the below inputs specified by the stakeholder:

TABLE 15.2.5: Sensitivity N Inputs

Sensitivity N	
1. Load Growth	DTEE forecast plus 24 percent EV sales by 2030 (Bloomberg)
2. EWR	2 percent annually through all years unless more is required to meet no. 9
3. Capital Cost	DTEE CCGT cost
4. Renewable	50 percent clean energy goal and 35 percent renewables by 2030-additional 1,300 MW of solar
5. Gas Price	Reference
6. Retirement	DTEE plan (starting point)
7. Demand Response	Full amount from 2017 State of MI Potential Study (high case)
8. Distributed renewables	450 MW incremental solar
9. Available replacement	Defer second CCGT with EWR, DR, and renewables
10. Conservation Voltage Reduction	150 MW by 2028

A plan similar to the Reference scenario least-cost plan was run with the 24 percent increase in EV loads. This comparison plan was lower-cost than sensitivity N, as shown in Table 15.2.6.

TABLE 15.2.6: REF Scenario: Sensitivity N results

Sensitivity	EWR Level	PURCHASE/ BUILD	PVRR, $M	Delta, $M	Comments
SENSITIVITY N	2.00%	1300 MW SOLAR 974 MW DR 450 MW DG 50 MW CVR/VVO	$14,855	-	Sensitivity ran according to the NRDC request inputs
Comparsion plan same load	1.50%	259 MW DR 414 MW 1x1 CCGT 50 MW CVR/VVO	$14,340	($516)	NRDC sensitivity cannot be compared to the starting point comparison plan because of different loads, comparison build plan is forced in with sensitivity N load to provide a consistent comparison

TABLE 15.2.7 - REF Scenario: Non-fossil Alternative(s) in 2029/2030 Results

Scenario	EWR level	LEAST COST BUILD PLAN	First 'NO GAS' plan	delta, $M 'No Gas - LCP' same EWR level	delta, $M (No gas plan - 1.5% EWR LCP)
REF	1.5%	414 MW 1x1 CCGT 259 MW DR	450 MW WIND 500 MW SOLAR 358 MW DR	$143	$143
REF	1.75%	414 MW 1x1 CCGT	358 MW DR	$84	$102
REF	2.0%	1050 MW WIND	1050 MW WIND	$0	$93

As shown in Table 15.2.7, the least-cost plan in the REF scenario that does not contain a gas-fired unit is the 2 percent EWR and 1,050 MW wind plan, with a cost that is $93 million NPVRR higher than the REF least-cost plan.

Sensitivity N was run exactly as requested with one exception. The request was for 150 MW of CVR/VVO. The costs we used for CVR/VVO came from Table 8.14.3 CVR/VVO Summary Benefits. Here, the first 50 MW of CVR/VVO for groups 1 and 2 have costs in an economic range of $7 million-$10 million for group 1 and $11 million-$14 million for group 2. The other three groups, which don't even reach a total of 150 MW, have extremely high costs that range from $815 million to more than $11 billion. Due to these high costs, the first economic 50 MW of CVR/VVO was included and not the full 150 MW. If the additional 100 MW of CVR/VVO had been included, the NPVRR for sensitivity N would have been more than $1 billion higher. Sensitivity N was higher cost than the comparison plan by $516 million NPVRR.

Results of the no-gas-build in 2029-2030 sensitivity

The Commission requested a sensitivity in the Company's CON order in Case No. U-18419 to model a circumstance where Belle River Power Plant, when retired, was replaced with an alternative other than a combined-cycle gas turbine, including potentially EWR, DR, and renewable energy. The Company determined that reviewing the least-cost build plans and selecting the first plan that did not include a gas unit in 2029-2030 met the requirements. Table 15.2.7 summarizes the results.

Results of the CVR/VVO sensitivity

A sensitivity was run to obtain the CVR/VVO's economic performance. We expect that it would have similar results in the other three scenarios, since the CVR/VVO market valuation was very similar in all scenarios. Table 15.2.8 below summarizes the results.

TABLE 15.2.8: REF Scenario: CVR/VVO Sensitivity Results

	Least Cost Plan (Comparison build)	CVR/VVO sensitivity		Forced in 1x1 and CVR/ VVO
EWR Level	1.5 %	1.5 %	1.75 %	1.75 %
29/30 Build	414 MW CCGT 259 MW DR	414 MW CCGT 167 MW DR 50 MW CVR/ VVO	414 MW CCGT	
Delta, $M		(14)	$18	

The results indicated that CVR/VVO was an economical program at 50 MW in size at both the 1.5 percent EWR and 1.75 percent EWR levels. In the optimization modeling shown above, there was not a capacity need until the 2029-2030 timeframe. However, the Company plans to pursue a CVR/VVO pilot program starting in 2019 based on the encouraging results of the CVR/VVO program when analyzed in the IRP optimization against other alternatives. Data will be gathered during the pilot which will be used to clarify the assumptions either for the next IRP or in a separate project evaluation before the next IRP.

Results of alternative discount rate sensitivity

Tables 15.2.9 shows the results of the analysis using an alternate discount rate of 5 percent, which was subjectively selected. As expected, the NPVRR is higher with an assumed lower utility discount rate. The results are summarized in Table 15.2.9 below.

TABLE 15.2.9: REF Scenario: Alternative discount rate sensitivity results

EWR level	LCP 6.63 % discount rate	LCP 5 % discount rate	Delta, $M (5 %t- 6.63%)
1.5 %	414 MW 1x1 CCGT 259 MW DR	2850 MW WIND 259 MW DR	$1,546
1.75 %	414 MW 1x1 CCGT	3150 MW WIND	$1,515
2.0 %	414 MW 1x1 CCGT	1050 MW WIND	$1,557

The results showed a significant change in NPVRR and the build plan with a lower utility discount rate. It should be noted that lower discount rates play a major role in the economics of the outer years in the optimization. Hence, the model prefers wind over a CCGT since wind was more expensive in the first few years compared to CCGT.

15.3 Business as Usual Scenario Results

Sensitivities under the Business as Usual scenario included: EWR incentive-cost sensitivities, high gas (200 percent of the 2018 EIA), high load, 25 percent Electric Choice cap, 50 percent Electric Choice return, 100 percent Electric Choice return, non-fossil alternatives in 2029/2030, and combustion-turbine-only replacement. The sensitivity analyses' results are summarized in the tables below.

Results of the EWR incentive-cost sensitivity

The EWR tiered costs were run on the BAU scenario to see the impact on the least-cost plan. The tiered costs assumed higher levels of incentives are needed as the level of EWR increases, whereas the flat high EWR costs assumed in the BAU scenario's starting point assume 50 percent incentives, regardless of EWR level. Table 15.3.1 summarizes the results.

TABLE 15.3.1: BAU Scenario: EWR incentive-cost-results

	EWR Level	1.50%	1.75%	2.00%
BAU tiered costs	2029/30 BUILD	414 MW 1x1 CCGT 167 MW DR 150 MW WIND	414 MW 1x1 CCGT	414 MW 1x1 CCGT
	DELTA, $M	-	($4)	$38
BAU flat-high costs	2029/30 BUILD	414 MW 1x1 CCGT 167 MW DR 150 MW WIND	414 MW 1x1 CCGT	414 MW 1x1 CCGT
	DELTA, $M	-	($155)	($300)

The tiered-cost sensitivity resulted in a significant tightening of the deltas between the three EWR levels. With the tiered-cost assumption, the least-cost plan has 1.75 percent EWR. The 2 percent level, selected as least-cost in the scenario, had the flat-high costs.

Results of the high gas and 25 percent Electric Choice cap sensitivities

TABLE 15.3.2: BAU Scenario: High gas and 25 percent Electric Choice cap results

BAU Sensitivities - Least Cost Plan - Tiered Cost			
Sensitivity	**EWR Level**	**2029/30 Build**	**Comments**
Starting Point	2 percent	414 MW 1x1 CCGT	.
High CO2	1.75 percent	3150 MW WIND	High gas market leads to higher energy market, which prefers high-energy renewables to be built, hence it picks the lower EWR level and build wind.
High EV	2 percent	-	Lower load leads to no need to build.

The 25 percent Electric Choice cap sensitivity maintained the 2 percent EWR level with no additional build, while the high-gas sensitivity selected the 1.75 percent EWR level in order to maximize the amount of wind built to sell into the high-value energy market the high gas prices created.

Results of the other load sensitivities

Other load sensitivities run on the BAU scenario include high load, the 50 percent Electric Choice return, and the 100 percent Electric Choice return. Earlier build was required in the 2021-2024 timeframe, similar to the higher load sensitivities run on the REF scenario. Table 15.3.3 summarizes the results.

TABLE 15.3.3: BAU Scenario: Other load sensitivity results

Sensitivity	EWR Level	2021-2024 Build	Purchases	Comments
50% Choice Returns	2%	167 MW DR 414 MW 1x1 CCGT	2022 PUR - 54 MW 2023 PUR - 272 MW	Slightly higher load compared to Reference level. Prefers some capacity from market in early years and builds DR in 2024 and a CCGT in 2030. Optimized for years 2024-2039
100% Choice Returns	2%			
High Load	2%	2250 MW WIND 167 MW DR 414 MW 1x1 CCGT	2020-24: 0-300 MW 2025-28: 100-500 MW 2029-39: 1100-5000 MW	Very high load leads to heavy and early renewable build along with DR to reduce peak in 2023. Adds a CCGT in 2024. Partially optimized in years 2020-2023.

In the BAU scenario, the least-cost no-gas plan is the 2 percent EWR level with 1,050 MW wind build. This plan is $56 million higher than the BAU LCP, and is the same least-cost no-gas plan selected in the REF scenario.

Results of the no-gas build in 2029-2030 sensitivity

Similar to the REF scenario, a sensitivity assuming the replacement of the Belle River plant with only non-fossil alternatives was run on the BAU scenario. Table 15.3.4 summarizes the results.

TABLE 15.3.4: BAU Scenario: Non-fossil alternatives in 2029-2030 results

EWR level	Least-cost build plan	First no-gas plan-cost build plan	delta, $M no gas - LCP' same EWR level	delta, $M (no-gas plan - 1.5% EWR LCP)
1.5%	414 MW 1x1 CCGT 167 MW DR 150 MW WIND	1950 MW WIND 358 MW DR	$65	$65
1.75%	414 MW 1x1 CCGT	216 MW DR 1350 MW WIND	$62	-$92
2%	414 MW 1x1 CCGT	1050 MW WIND	$56	-$244
1.75%	414 MW 1x1 CCGT	216 MW DR 1350 MW WIND	$62	-$92
2%	414 MW 1x1 CCGT	1050 MW WIND	$56	-$244

In the BAU scenario, the least-cost no-gas plan is the 2 percent EWR level with a 1,050 MW wind build. This plan is $56 million higher than the BAU LCP, and is the same least-cost no-gas plan as selected in the REF scenario.

15.4 Emerging Technology Scenario Results

Sensitivities under the Emerging Technology scenario included: high gas (200 percent 2018 EIA), high load, combined solar and storage, wind congestion, an alternative discount rate, and early retirement of the Company's Tier 2 coal units. The results of the sensitivity analyses are summarized in the tables below.

Results of the high-gas sensitivity

TABLE 15.4.1: ET Scenario: High-gas results

Sensitivity	EWR Level	2029/30 Build	Comments
Starting Point	2%	1050 MW WIND	Wind was the preferred technology because of high capacity factor and value provided for higher energy in the market
High Gas	1.75%	3150 MW WIND	High-gas market led to higher energy market, which preferred high energy renewables to be built, hence it picked the lower EWR level and built wind.

Results of the high load sensitivity

Table 15.4.2 shows the results of the high load sensitivity. The significant increase in load increases the amount of resources required to fill the need. This sensitivity prefers a combination build of wind and solar in the early 2021-2023 timeframe.

Table 15.4.2 – ET Scenario: High load results

Sensitivity	EWR Level	2029/30 Build	Purchases	Commentary
High Load	2%	1050 MW WIND	2020-24: 0-300 MW 2025-28: 400-800 MW 2029-39: 1400-5000 MW	Very high load leads to heavy and early renewable build. Prefers wind in 2021. Solar and additional wind in 2023 Optimized for years 2020-2024.

Results of the combined solar and storage sensitivity

A sensitivity was run on the ET scenario that added an option to the Strategist® optimization tying a 100 MW block of solar together with a 30 MW lithium ion battery. The results are shown in Table 15.4.3.

TABLE 15.4.3: ET Scenario: Combined solar and storage results

EWR level	29/30 Build	PVRR, $M	delta, $M	
1.75%	167 MW DR 1,800 MW wind	$12,063	-	
1.75%	2,550 MW wind 100 MW solar 30 MW battery	$12,078	$15.5	solar-battery tied
1.75%	2550 MW wind 100 MW solar 30 MW battery	$12,079	$16.1	Not tied to solar battery

The solar and storage combination is $14 million NPVRR higher than the least-cost plan. It was run on the ET scenario, where solar and battery costs were assumed to be the lowest. Additionally, another sensitivity was run that forced a solar block and a battery block into the Strategist® model not tied together. This resulted in approximately $2 million-$3 million NPVRR additional cost over the solar and storage combination. Based on this result, the Company will continue to monitor battery technology costs and characteristics.

Results of the wind-congestion sensitivity

TABLE 15.4.4: ET Scenario: Wind congestion results

EWR level	29/30 Build	PVRR, $M	delta, $M
1.75%	308 MW DR 600 MW Wind	414 MW 1x1 CCGT	-
1.75%	414 MW 1x1 CCGT	3150 MW WIND	-70

Results of alternative discount rate sensitivity

Tables 15.4.5 shows the analysis's results using an alternate different discount rate of 9 percent, which was subjectively selected. As expected, the NPVRR was lower with a higher utility discount rate. The results are summarized in Table 15.4.5.

TABLE 15.4.5: ET Scenario: Alternative discount rate sensitivity results

EWR level	LCP 6.63% discount rate	LCP 9% discount rate	Delta, $M (9%-6.63%)
1.5%	414 MW 1x1 CCGT 1500 MW WIND	259 MW DR 414 MW 1x1 CCGT	($1,663)
1.75%	1800 MW WIND 167 MW DR	414 MW 1x1 CCGT	($1,606)
2.0%	1050 MW WIND	167 MW DR	($1,537)

The higher discount rate sensitivity decreased the least-cost plan's overall cost. This sensitivity's results indicated a CCGT and preferred higher DR over wind.

Results of Tier 2 early retirement sensitivities

As part of the Michigan Integrated Resource Planning Parameters, section 6(t) of 2016 PA 341, the Company performed an analysis to evaluate the effects of the earlier retirement of coal units at the St. Clair and Trenton Channel plants. Table 15.4.6 below highlights the planned retirement years and the sensitivities in which retirements were pulled ahead to earlier years.

TABLE 15.4.6: Tier 2 Early Retirement Sensitivities

Unit	Announced Retirement	Sensitivity 1	Sensitivity 2
River Rouge 3	2020	2020	2020
St. Clair 1	2022	2022	2021
St. Clair 2	2022	2022	2021
St. Clair 3	2022	2022	2021
St. Clair 6	2022	2022	2021
St. Clair 7	2023	2022	2022
Trenton 9	2023	2022	2022

All the Tier 2 units are expected to retire over the next four years. The capacity loss associated with the planned retirement of Tier 2 coal units was addressed in the Company's request for a Certificate of Necessities to construct an 1,150 MW natural gas combined cycle plant, which the MPSC approved in April 2018. Therefore, the analysis for Tier 2 units assumed any capacity shortfall resulting from a retirement pull ahead would be filled by short-term purchases from the market.

The Tier 2 early retirement analysis, from an economic standpoint, compared a case in which the units were retired on the announced dates versus a case that assumed the earlier dates considered in sensitivities 1 and 2. In each case, a net present value was calculated based on cost assumptions to operate the units, dispatch of the units, and any capacity purchases needed to meet reserve margin requirements. The net present values were then compared to determine which case would be more economical for customers. Due to the uncertainty of capacity prices, the analysis considered price sensitivities, as shown in Table 15.4.7.

TABLE 15.4.7: Tier 2 Retirement Analysis, Capacity Price Sensitivities

Capacity Price Sensitivity ($/kW-yr)	2019	2020	2021	2022
$0	-	-	-	-
PACE Forecast	52.7	55.7	54.0	59.1
50 percent of CONE	44.4	44.4	44.4	44.4
CONE	88.8	88.8	88.8	88.8

The results of the analysis across the capacity price assumptions are highlighted in Table 15.4.8. The number in the table represents the net present value delta between the case with the retirement dates considered in the sensitivities versus the case to keep the announced retirement dates.

TABLE 15.4.8: Early Retirement vs. Announced Dates; Delta Net Present Value ($M)

	Capacity Price Assumptions			
	$0	PACE Forecast	50 percent of CONE	CONE
Sensitivity 1 (Pull ahead SC-7 and TC-9 to 2022)	12	17	16	19
Sensitivity 2 (Pull ahead SC-1 thru 6 to 2021, SC-7 and TC-9 to 2022)	13	45	39	65

A positive number in the table means that, from an economic standpoint, it would be more expensive to retire units ahead of the announced retirement dates. The results shown above support keeping the retirement dates as currently planned. The four capacity price sensitivities ranged from $12 million to $65 million.

After considering the results of economic modeling with sensitivity analysis and the Company's planning principles, the Company has decided to retire St. Clair unit 7 and Trenton Channel unit 9 one year earlier than planned, in 2022. This decision is conditional upon two factors: BWEC must successfully start up as planned in 2022, and transmission issues that MISO identified related to the retirement of Company plants in the southern portion of its service area must be successfully resolved.

15.5 Environmental Policy Scenario Results

Sensitivities under the Environmental Policy scenario included: high gas (200 percent 2018 EIA), 50 percent CO2 reduction, and high load. The sensitivity analyses' results are summarized in the tables below.

Results of the high gas and 50 percent CO2 reduction sensitivity

Sensitivity	EWR Level	2029/30 Build	Comments
Starting Point	1.75%	3150 MW WIND	The combination of higher capacity factor and 35 percent reduction of Capex on wind makes it a preferred option
High Gas	1.5%	5100 MW WIND	High gas market led to higher energy market, which preferred high-energy renewables to be built. Hence, it picked the lower EWR level and built wind.
50 percent CO2 Reduction	1.75%	3150 MW WIND	The combination of higher capacity factor and 35 percent reduction of Capex on wind made it a preferred option.

Results of the high load sensitivity

TABLE 15.5.2: EP Scenario: High load results

Sensitivity	EWR Level	2029/30 Build	Purchases	Commentary
High Load	1.75%	2250 MW WIND 900 MW SOLAR	2020-24 – 0-300 2025-29 – 400 -1000 2026-39 – 1500-5000	Very high load leads to heavy and early renewable build. It prefers solar and wind in 2023, followed by additional solar in 2024. Optimized for years 2020-2024.

15.6 Additional Sensitivity Results Across all Scenarios

Additional sensitivities run across all scenarios included: market purchase only, all-solar build plan, demand response only, high EWR levels (>2.0 percent), and avoided transmission and distribution. The sensitivity analyses' results are summarized in the tables below.

Results of the market purchase only sensitivity

TABLE 15.6.1: Market purchase only results

Scenario	EWR level	Least cost plan	Market Purchase (MW)	delta, $M (Mkt Purchase - LCP)
REF	1.5%	414 MW 1x1 CCGT 259 MW DR	2029 – 159 2030 – 585 2031 – 486 2032 – 418 2033 – 370 2034 – 256 2035 – 182 2036 – 105 2037 – 15	$109
BAU	2%	414 MW 1x1 CCGT	2030 – 113	$86
ET	2%	1050 MW WIND	2030 – 113	$98
EP	1.75%	3150 MW WIND	2030 – 364 2031 – 266 2032 – 198 2033 – 150 2034 – 32	$376

The results shown in Table 15.6.1 demonstrate that allowing an all-purchase plan, even if feasible, would be higher cost than the least-cost plan under all of the scenarios.

Results of the solar only build plan sensitivity

TABLE 15.6.2: Solar-only build results

Scenario	EWR level	Least cost plan	All-solar build plan	delta, $M (Solar - LCP)
REF	1.5%	414 MW 1x1 CCGT 259 MW DR	1800 MW SOLAR	$282
BAU	2%	414 MW 1x1 CCGT	400 MW SOLAR	$109
ET	2%	1050 MW WIND	400 MW SOLAR	$126
EP	1.75%	3150 MW WIND	1100 MW SOLAR	$469

An item of note is that the all-solar plan for the REF scenario was lower cost than an-all wind plan or 3300 MW wind/216 MW DR plan, which cost $317M NPVRR. This demonstrates that wind does not always cost less than solar across scenarios, and the competition between the renewable technologies depends on market prices and capital costs.

Results of the demand response only sensitivity

TABLE 15.6.3 – Demand response only results

Scenario	EWR level	Least cost plan	All DR build plan	delta, $M (DR - LCP)
REF	1.5%	414 MW 1x1 CCGT 259 MW DR	572 MW DR	$129
BAU	2%	414 MW 1x1 CCGT	142 MW DR	$84
ET	2%	1050 MW WIND	142 MW DR	$95
EP	1.75%	3150 MW WIND	359 MW DR	$387

The demand response only results show that allowing the optimization to select large amounts of DR did not lead to lower cost plans under any of the scenarios

EWR sensitivity results

The economic viability of the higher levels of EWR, the least-cost plan for the 2.25 percent and 2.5 percent EWR levels, was compared to the least-cost plan from each scenario. The higher levels of EWR (2.25 percent and 2.5 percent) were not economical in any scenario, as shown in Table xxxx

Scenario	EWR LEVELS	2029/30 BUILD	DELTA, $M
REF LCP	1.5%	414 MW 1x1 CC 259 MW DR	-
REF	2.25%	414 MW 1x1 CC	$359
REF	2.5%	-	$1,814
BAU LCP	2%	414 MW 1x1 CC	-
BAU	2.25%	414 MW 1x1 CC	$323
BAU	2.5%	-	$2,116
ET LCP	1.5%	1050 MW WIND	-
ET	2.25%	414 MW 1x1 CC	$219
ET	2.5%	-	$1,429
EP LCP	1.75%	3150 MW WIND	-
EP	2.25%	450 MW WIND	$468
EP	2.5%	-	$2,270

Avoided transmission and distribution sensitivity results

A sensitivity was run on each scenario that applied $7/kW for avoided transmission and distribution (T&D) to the EWR costs. The least-cost plans before and after the avoided T&D benefit is applied are highlighted red in the table. In all four scenarios, the least-cost plan was the same before and after the T&D benefit was applied. The results are shown in Table 15.X.X.

Reference	**1.50%**	**1.75%**	**2.00%**
NPVRR, $M	$13,278	$13,296	$13,371
Total T&D benefits, $M	$72	$85	$101
T&D impact on NPVRR, $M	$13,206	$13,211	$13,270
BAU	**1.50%**	**1.75%**	**2.00%**
NPVRR, $M	$12,687	$12,533	$12,387
Total T&D benefits, $M	$72	$85	$101
T&D impact on NPVRR, $M	$12,615	$12,448	$12,286
ET	**1.50%**	**1.75%**	**2.00%**
NPVRR, $M	$12,303	$12,132	$11,965
Total T&D benefits, $M	$72	$85	$101
T&D impact on NPVRR, $M	$12,231	$12,047	$11,864
EP	**1.50%**	**1.75%**	**2.00%**
NPVRR, $M	$12,398	$12,300	$12,347
Total T&D benefits, $M	$72	$85	$101
T&D impact on NPVRR, $M	$12,326	$12,215	$12,246

15.7 Risk assessment of each scenario

The PCA needs to be a reasonable plan in the face of an uncertain future, especially given the dynamic nature of the energy industry and emerging technologies. Risk analysis helps to hedge the uncertainties by evaluating how different build plans would perform given a range of unexpected possible futures. All seven DTE Electric planning principles (reliability, affordability, clean, flexible and balanced, compliant, reasonable risk, and community impact) were considered when designing the five risk analysis approaches used in this IRP.

Affordability was partially addressed through the modeling optimization. Reliability and compliance were fulfilled through setting the proper constraints in the modeling scenarios to satisfy the MISO reserve margin requirements and comply with all regulations, and ensuring the Strategist® optimization met both of these constraints. The other planning principles of clean, flexible and balanced, reasonable risk, and community impact had to be handled more qualitatively outside of the Strategist® model or by using techniques that quantified these principles and compared alternative portfolios against each other based on how they ranked in each category. The Company used the latter approach.

As the PCA was being determined, multiple risk analyses were conducted to ensure the plan's prudency and robustness considering the planning principles. DTE Electric wanted to minimize risk; therefore, the risk analyses were an essential part of the IRP process. Over time, commodity markets and environmental and regulatory conditions may pan out differently than what was forecasted. Considering the market's uncertainty, the selected portfolio plan should be flexible enough to accommodate changes as they occur.

Stochastic Risk Assessment

For the stochastic risk analysis, several steps were undertaken.

- **Step 1: Formulate assumptions.** A probability distribution used in the Stochastic analysis served to measure the likelihood of possible outcomes given reasonable changes in assumptions. The mean of the probability distributions was generally represented by the underlying assumptions in the BAU and DTE Reference scenarios. PACE Global constructed probability distributions for key drivers, including load growth; gas and coal prices; the price of carbon used for analytic purposes; and the cost of generating technologies. These distributions encompass the other scenarios and generally the sensitivities studied. The key drivers' probability distribution was developed from historical variance and a range of future forecasts. These assumptions are detailed in Appendix Q.
- **Step 2: Set up specific DTEE portfolio builds.** Because this work was used to look at 13 different DTEE resource plans in a probabilistic framework, the assumption was that each specific resource plan would be treated as comprising firm resources that remained online regardless of the probabilistic case (200 iterations). The 13 plans evaluated through stochastic analysis represented a diverse mix of resources that met the reserve margin requirement through 2040, with a focus on a 2029-2030 capacity replacement. Each of the 13 plans was set up, in turn, as a firm, specific resource plan that did not change with market and other uncertainties. It should be noted that the stochastic risk assessment and the IRP scenario modeling were conducted in parallel, therefore the 13 portfolios considered in the stochastic risk assessment do not exactly match the nine least-cost portfolios generated by the IRP scenario modeling and the resultant PCA with its four potential pathways. The purchase listed in the stochastic resource plans can be considered equivalent to DR for modeling purposes. The costs of the capacity purchase and DR are similar and both will be obtaining market purchases for the energy portion of the DR or purchase.
- **Step 3: Run Pace Global' s stochastic version of AURORA Model for the DTEE footprint.** Pace Global ran its proprietary stochastic version of AURORA for the DTEE footprint, with the resources shown in Table 15.5.1 treated as firm resources in each of 13 build plans.
- **Step 4: Compare the 13 build plans**. The analysis provided output probability distribution functions for key outputs, such as electric energy prices.

Because the analysis was probabilistic, each case could be stated in terms of an expected cost and the standard deviation of that cost or associated risk. This allowed a ranking of the cases in terms of expected cost and risk.

Portfolio	Resource Plans
1	1.5 percent EWR + 430MW CCGT + 170 MW purchase
2	1.5 percent EWR + 2,550 MW Wind + 290 MW purchase
3	1.5 percent EWR + 800 MW Solar + 260 MW purchase
4	1.5 percent EWR + 309 MW DR + 280 MW purchase
5	1.75 percent EWR + 600 MW Wind + 290 MW purchase
6	1.75 percent EWR + 200 MW Solar + 290 MW purchase
7	1.75 percent EWR + 92 MW DR Only + 270 MW purchase
8	1.75 percent EWR + 430 MW CCGT
9	2 percent EWR + 110 MW purchase
10	2 percent EWR + 1,090 MW voluntary renewables
11	1.5 percent EWR + 1,090 MW voluntary renewables + 430 MW CCGT
12	1.75 percent EWR + 1,090 MW voluntary renewables + 30 MW purchase
13	1.75 percent EWR + 1,090 MW voluntary renewables + 430 MW CCGT

Interpretation of the Results of the Stochastic Risk Assessment

The goal of determining the expected (mean) portfolio cost and the 90th percentile NPV (economic risk) is to select a portfolio that is both lowest-cost and lowest-risk. These portfolios are grouped together in the graph's bottom left. The portfolios are also grouped by EWR level, with the 1.5 percent EWR level in the lower left, the 1.75 percent EWR levels in the middle, and the 2 percent EWR levels inthe top right. The overall least-cost and least-economical risk portfolio is portfolio 11, consisting of 1.5 percent EWR, voluntary renewables, and a CCGT. This is not surprising because the 1.5 percent EWR level, CCGT, and some level of renewables had been getting selected as least-cost plans in the IRP Strategist® optimization.

The four IRP PCA pathways are closest to portfolios 8, 12, and 13. They are all in the 1.75 percent EWR middle grouping. This illustrates that the EWR program levels' costs are quite uncertain and have a high level of risk associated with selecting the higher EWR level of 1.75 percent over 1.5 percent. The Company can mitigate this risk by monitoring EWR costs and evaluating whether 1.75 percent EWR remains competitive compared to other IRP alternatives. If EWR costs are found to be higher than what is projected in the defined PCA, then the Company may refine its EWR spend and/or savings as part of its EWR plan filed with the Commission every two years. Portfolios 12 and 13 have slightly higher expected costs than portfolio 8, however portfolio 8 has higher economic risk than 12 and 13. The portfolios containing DR had the highest expected costs and economic risks of their grouping, in both 1.5 percent EWR or 1.75 percent EWR groupings.

The Stochastic results focus on risk's affordability aspect in a quantitative fashion. This will be balanced by the other risk assessments that will focus on non-economic areas of risk using a qualitative approach.

Change Analysis Results

The change analysis, which is summarized in Table 15.7.3, contains a list of outcomes or "situations" that can arise from different drivers or "causations." Each situation presents a likely adaptation of the PCA. The PCA has the flexibility to adapt and accommodate to the constant development of situations. The change analysis covers situations from multiple categories such as fuel, environmental, load, future technology development and evolution, and transmission. In some cases, multiple drivers can lead to similar outcomes. For instance, in the case of fuel prices, increases to gas could result from several drivers listed under causation. The PCA could adapt by reducing the use of gas units in the fleet and considering other options, such as adding renewables in the next IRP. In each case, the PCA's adaptability is demonstrated. The PCA is proven to be flexible and able to adapt to changes of assumptions and new inputs. The change analysis is a qualitative mechanism that demonstrates that there exists an attainable and realistic range of adaptions to the PCA from a diverse set of potential situations that may develop in time.

TABLE 15.7.3: Risk Assessment no. 2: Change analysis

	Situation	Causation	PCA Adaptation
1	Increase in commodity prices (gas)	-Increased regulatory scrutiny on fracking and/or pipeline construction -LNG and pipeline exports increase more than expected -Domestic gas demand increases more than expected	Gas units in fleet run less, additional renewables likely selected in next IRP. The impact on dispatch would be less for BWEC than for our other units (or for other less-efficient CCGTs in MISO) given its high efficiency. A high gas price is more detrimental to inefficient gas units.
2	Stricter environmental rules	U.S. signs on to Paris Agreement, new legislation, CO2 trading is introduced	Fleet dispatches to new paradigm of CO2 prices, additional renewables likely selected in next IRP.
3	Increase load	EV, greenhouse expansions or changes to the Electric Choice program	Evaluate capacity position to determine if a new IRP is warranted before 2024 to fill emerging persistent capacity need.
4	Decrease load	Recession, increased adoption of behind-the-meter generation, or changes to Electric Choice program	Decrease pace of modular builds (renewables, EWR, DR) and decide if new IRP is warranted before 2024.
5	Solar preferred over wind	Saturated wind siting or possible community resistance	Shift to solar over wind in renewables build.
6	Wind preferred over solar	Hub heights increase	Shift to wind over solar in renewables build.
7	Capacity credit for solar reduced	High solar growth throughout MISO	Evaluate capacity position and decide if a new IRP is warranted before 2024 to fill emerging persistent capacity need.
8	EWR decreases from potential study	Technology baseline changes and customer adoption trends	Evaluate EWR levels in semi-annual EWR filings and next IRP. Decrease EWR level accordingly. Utilize MISO capacity auction if needed.
9	EWR costs increase at higher levels	Saturation of low-cost EWR measures, including lighting	Evaluate EWR levels in semi-annual EWR filings and next IRP. Decrease EWR level accordingly. Utilize MISO capacity auction if needed.
10	Demand response lack of customer adoption	The risk of interruption does not outweigh the cost benefits for the customer	Evaluate DR levels and programs annually and in next IRP. Decrease DR level accordingly and explore additional pilots for increased customer engagement.
11	Demand response committed MWs are not reached	Solar resources move the net peaks, DR programs/tariffs aren't adjustable	Evaluate DR levels annually and in next IRP. Decrease DR level accordingly and explore additional pilots that are more flexible.
12	Storage technologies become preferred	Storage technologies experience technology breakthrough and possible cost breakthrough	Accelerate testing and studies of storage technologies. Additional storage could be selected in next IRP.
13	DG technologies experience growth	Policies and pricing constructs that advantage DG, significant decreases in DG costs	Decrease pace of modular utility builds (renewables, EWR, DR) and decide if new IRP is warranted before 2024.
14	Difficulty in executing CVR/VVO to realize the savings	Customers, particularly those at end of feeders, experience low-voltage conditions, in violation of allowable voltage ranges	Re-evaluate the potential savings from CVR/VVO in the next IRP.
15	Transmission import limit declines	MISO system changes	Evaluate impact of resource procurement internal and external to Zone 7.
16	Transmission import limit increases	MISO system changes	Evaluate impact of resource procurement internal and external to Zone 7.

Evaluation of Planning Principles

The application of planning principles is a comparative analysis method that is used to rank each plan by individual planning principles. In our analysis, 12 plans were analyzed and assigned rankings for five of the seven planning principles: reliability, clean, flexible and balanced, reasonable risk, and community impact. The plans were not ranked based on affordability as each plan was identified as a "least-cost" plan, and the plans were not ranked on compliance, as each plan is compliant with current regulations. The 12 plans selected for analysis consisted of the nine least-cost plans and the four pathways, with one pathway and least-cost plan overlapping. The application of planning principles allows for a comprehensive view of each plan's ranking on the individual principles.

TABLE 15.7.4: Application of Planning Principles

Plan #	Description	Reliability	Clean	Flexible and Balanced	Reasonable Risk	Community Impact	
Plan 1	1.5 percent EWR, 216 MW DR, 3300 MW wind	12	3	12	12	2	Least-cost plan D
Plan 2	1.5 percent EWR, CC, 1500 MW wind	6	8	9	9	5	Least-cost plan C
Plan 3	1.5 percent EWR, CC, 167 MW DR, 150 MW wind	5	11	7	3	11	Least-cost plan B
Plan 4	1.5 percent EWR, CC, 259 MW DR	4	12	7	6	12	Least-cost plan A
Plan 5	1.75 percent EWR, 3150 MW wind	11	1	11	11	1	Least-cost plan G
Plan 6	1.75 percent EWR, 167 MW DR, 1800 MW wind	7	4	10	10	4	Least-cost plan F
Plan 7	1.75 percent EWR, 50 MW CVR/VVO, 1100 MW voluntary renewables	7	5	6	3	7	Pathway A
Plan 8	1.75 percent EWR, CC, 1100 MW voluntary renewables	2	7	1	1	3	Pathway B
Plan 9	1.75 percent EWR, CC	3	10	2	2	9	Pathway D
Plan 10	1.75 percent-2 percent EWR, 100 MW DR, 50 MW CVR/VVO	10	5	2	8	10	Pathway C
Plan 11	2 percent EWR, 1050 MW wind	7	1	5	7	6	Least-cost plan I
Plan 12	2 percent EWR, CC	1	9	4	5	8	Least-cost plan H

The four PCA pathways are represented by plans 7, 8,9, and 10 in Figure 15.5.3. All the Pathways have no. 1. to no. 10 rankings across the five evaluated planning Principles. Of the four pathways, B and D have three or more top rankings (1-3). Pathways C and D each have one top ranking. Additionally, the rankings for A and D are all below 7. Of the four pathways, B appears to be the best overall in this qualitative assessment, with its four top-three rankings and the fifth ranking being a 7. More details are shown in Exhibit A-4, Appendix XX.

Determination whether key IRP inputs have changed since initial adoption

The IRP inputs were adopted in May-August of 2018 before the optimization models were built. Right before the filing, in February 2019, most of the inputs were considered again to see if they had changed materially since initial adoption. Inputs considered for changes are shown and the result of whether the change was made is also shown. The decision on whether to update the input was based on how much the input changed, whether scenarios and sensitivities had been run that covered the uncertainty, and how easy it was to update. In general, easier updates included values that only affect the DTEE fleet capacity position, while difficult updates included market parameters that are included in the IRP optimization or that drive the fundamental modeling, because those inputs are incorporated at the beginning of the modeling process.

TABLE 15.7.5 – IRP Input Comparison; Starting Point to Recently Available

	Input	Original input (Starting Point)	Most Recent input	Decision
1	Gas prices	Forwards from 5.10.18	Forwards from 2.5.19	MichCon price 5 percent different, Dawn price 7 percent different: not material, not updated
2	Market prices	Forwards from 5.10.18	Forwards from 2.5.19	LMP RTC 4 percent different: not material, not updated
3	ELCC of wind	11.7%	16%	30 percent increase is a material change and roughly in line with prior history. Update made to wind in PCA runs and capacity position
4	Environmental regulations	As of May 2018	As of February 2019	Not material, not updated
5	Tier 2 retirement schedule	St. Clair 1 in 2022 River Rouge in 2020 St. Clair 7/ Trenton 9 in 2023	St. Clair 1 experienced a maintenance issue, requiring retirement in 2019 River Rouge retired on coal in 2020, extended to 2022 on waste gases St. Clair 7/Trenton 9 in 2022	Updated in PCA runs and capacity position
6	Capital cost of alternatives	Publicly available sources as of Aug 2018	Publicly available sources as of Feb 2019	Revisions of sources were within the 35 percent discount level covered in the EP and ET scenarios: not updated

	Input	Original input (Starting Point)	Most Recent input	Decision
7	EIA gas price forecast	2018 EIA forecast	2019 EIA forecast	Updated EIA forecast was 12 percent lower, but still above the DTEE forecast; it is encompassed within the spread of IRP scenarios: not updated
8	Coal prices	2018 forwards	2019 forwards	3 percent change in fuel supply forecast: not material, not updated
9	ELCC of solar	50 percent in 2018, lowering to 30 percent by 2033	50 percent in 2019, lowering to 30 percent by 2033	Not updated
10	UCAP of DTEE fleet other than wind	Max change in 2022 10,315 MW	Max change in 2020 10,256 MW	Changed by 58 MW: not material, not updated
11	Load forecast	Peak (bundled) in 2030 = 9,951 MW	No updated forecast created, peak (bundled) does not change	No material change to the economic drivers of the forecast based on new economic data
12	Demand response	2019: 731 MW	2019: 709 MW	Updated in PCA capacity position
13	MISO PRMR parameters			Updated in PCA capacity position

After considering the 11 different inputs listed above for potential revision, the Company decided to update just three: the wind ELCC, the demand response forecast, and the Tier 2 retirement dates based on emerging knowledge. These updates affected only the DTEE capacity position. The IRP optimization modeling results were not affected.

Scenarios and Sensitivities

Consideration of scenarios and sensitivities make up the fifth risk assessment. The results are discussed in Sections 15.2 to 15.5.

SECTION SIXTEEN

16 Proposed Course of Action

16.1 Overview

As highlighted in Section 15, modeling results were quite varied. There were wide variances in the least-cost portfolios, depending on which input assumptions were used in each of the four scenarios. The four key drivers of these variances were:

- Future CO2 regulation and resulting CO2 prices
- EWR incentive cost
- Gas-price forecast uncertainty
- Wind and solar power's assumed cost and operating characteristics

A variance in any one of the above four drivers was capable of changing the least-cost plan results on its own. With the exception of the renewables characteristics, the Company had its own view of the key drivers, which were contained in the Reference scenario assumptions. However, the drivers' costs are changing rapidly, leading to future uncertainty. Therefore, the Company does not believe it is prudent to lay out a definite plan in 2019 for what DTE Electric will do in 2030. Instead, the Company will focus on the near-term and will review inputs and assumptions in the next IRP, expected to be filed by January 2025, and in doing so, will not close off any one pathway prematurely. Before the next IRP is filed, the Company expects the four key drivers to evolve, leading us to make an informed, prudent decision, at that time, to replace Belle River. expected to be filed by January 2025, and in doing so, will not close off any one pathway prematurely. Before the next IRP is filed, the Company expects the four key drivers to evolve, leading us to make an informed, prudent decision, at that time, to replace Belle River.

16.2 Proposed Course of Action Defined Component

AAfter reviewing the modeling results, the assumptions about the key drivers, and the planning principles, the Company selected the following resource plan for the PCA's five-year, short-term defined component:

- Adding 11 MW of solar and 855 MW wind by 2024
- Adding a minimum of 465 MW of VGP renewables in 2021, which may ramp up to 715 MW by 2024 depending on customer demand.

Maintaining existing and adding more customers to the established Demand Response tariffs in order to achieve 859 MW by 2024.

- Continuing to make strides toward our CO2 reduction goals by proceeding with an orderly retirement of our Tier 2 coal units, contingent on maintaining current timelines for replacement capacity (BWEC start-up in 2022) and the resolution of transmission issues caused by Trenton's retirement. In 2020, we will retire River Rouge on coal, and implement a project to transition the River Rouge Unit 3 to utilize recycled industrial gases until 2022; in 2022 we will retire the remaining St. Clair units as well as Trenton Unit 9.
- Increasing the level of EWR to 1.75%, starting with an increase to 1.625% in 2020, with full implementation of 1.75% in 2021 through 2024.
- Continuing to explore and implement pilots in the areas of batteries and CVR/VVO and continue to keep up with new technology developments in all areas.

Consistent with the timing of IRP filings specified in U-18461, the Company estimates that we will file our next IRP no later than January 2025. This future filing will take into consideration updates to technology parameters and costs, as well as new risks or opportunities, that emerge in the next five years. The next IRP is the right point in time to make decisions on what is appropriate, reasonable, and prudent to replace the Belle River coal plant and set ourselves up for the rest of the 2030s.

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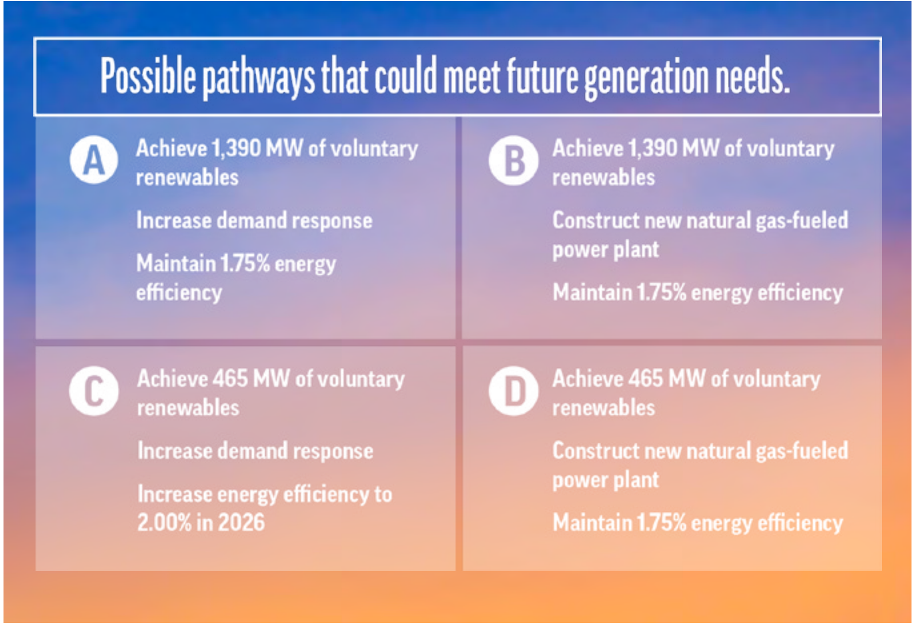
16.3 Proposed Course of Action Flexible Component

The PCA was defined in the near term as discussed above. However, by deferring the 2030 build decision to the next IRP filing, the Company remains flexible, recognizing that there are numerous potential pathways that may evolve into the plan developed by 2025, depending, in part, on the amount of VGP programs subsricbed to. Four of the possible pathways are listed below:



Possible pathways that could meet future generation needs.

A
- Achieve 1,390 MW of voluntary renewables
- Increase demand response
- Maintain 1.75% energy efficiency

B
- Achieve 1,390 MW of voluntary renewables
- Construct new natural gas-fueled power plant
- Maintain 1.75% energy efficiency

C
- Achieve 465 MW of voluntary renewables
- Increase demand response
- Increase energy efficiency to 2.00% in 2026

D
- Achieve 465 MW of voluntary renewables
- Construct new natural gas-fueled power plant
- Maintain 1.75% energy efficiency

There are additional potential pathways. However, the four listed above were used to narrow the scope of possibilities to present in the PCA modeling.

DTE is planning to retire the Monroe Power Plant by 2040 and continue expanding renewables to stay on track with clean energy and CO2 reduction goals.

16.4 Proposed Course of Action Modeling Results

Table 16.4.1 compares the four PCA pathways to the least-cost plan identified in the REF scenario. The total cost of these resource plans range from $69 M to $565 M more than the least-cost plan in the REF scenario, as shown in column (i). It is important to note, however, that these additional costs would be borne by those customers who choose to pay extra to increase the portion of renewable resources that serve their energy needs. The amount paid by non-VGP subscribers through general rates under the four PCA pathways would be less than the least-cost plan identified through Strategist modeling, as shown by the negative numbers in column (f). This can be explained by the fact that it takes significantly more nameplate MW of wind and solar assets to achieve the same capacity credit as the CCGT which was selected in the least-cost plan. These additional MW of nameplate wind and solar capacity produce significant energy which is assumed to be sold into the market, which tends to drive down market prices which reduces costs for all customers within the region.

TABLE 16.4.1: Reference Scenario PCA Pathways

Reference PCA Runs								
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Sensitivity	**EWR Level**	**VGP Programs**	**2029/2030 BUILD**	**PVRR includes renewables but not cost to build, $M**	**Delta Back to Least Cost plan, $M**	**VPG Program Cost PVRR[1], $M**	**PVRR with cost of VPG Program added in $M**	**Delta Back to Least Cost Plan, Including VGP Programs Cost, $M**
Least Cost Plan	1.50%	300 MW	414 MW 1x1 CCGT 259 MW DR	$13,278		$447	$13,725	
PCA A	1.75% Ramped	Significant	50 MW DR	$12,501	($777)	$1,789	$14,290	$565
PCA B	1.75% Ramped	Significant	414 MW 1x1 CCGT	$12,451	($828)	$1,789	$14,240	$515
PCA C	2% in 2026	Modest	150 MW DR	$13,211	($67)	$693	$13,904	$179
PCA D	1.75% Ramped	Modest	414 MW 1x1 CCGT	$13,102	($177)	$693	$13,794	$69

PCA Results in the Business as Usual Scenario

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[1] VPG Program Costs in Reference and BAU scenarios

Table 16.4.2 compares the four PCA pathways to the least-cost plan identified in the BAU scenario. The total cost of these resource plans range from $206 M to $681 million more than the least-cost plan in the BAU scenario, as shown in column (i). As in the REF scenario, these incremental costs would be borne by subscribers to VGP renewable programs, while the remaining bundled customer who do not subscribe to VGP renewable programs would pay less as shown by the negative numbers in column (f).

The NPVRR numbers in column (g) are exactly the same for the BAU scenario as in the REF scenario, since the cost assumptions for renewables and the assumed level of VGP renewable subscriptions are the same between those two scenarios. The NPVRR numbers in column (e) for the BAU scenario are lower than those in the REF scenario, due to carbon adder in the REF scenario which more than offsets the higher gas costs and higher EWR incentive costs assumed in the BAU case.

TABLE 16.4.2: BAU Scenario PCA Pathways

BAU PCA Runs								
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Sensitivity	EWR Level	VGP Programs	2029/2030 BUILD	PVRR includes renewables but not cost to build, $M	Delta Back to Least Cost plan, $M	VPG Program Cost PVRR[2], $M	PVRR with cost of VPG Program added in $M	Delta Back to Least Cost Plan, Including VGP Programs Cost, $M
Least Cost Plan	2.00%	300 MW	414 MW 1x1 CCGT	$12,387		$447	$12,834	
PCA A	1.75% Ramped	Significant	50 MW DR	$11,726	($661)	$1,789	$13,516	$681
PCA B	1.75% Ramped	Significant	414 MW 1x1 CCGT	$11,660	($728)	$1,789	$13,449	$615
PCA C	2% in 2026	Modest	150 MW DR	$12,348	($39)	$693	$13,041	$206
PCA D	1.75% Ramped	Modest	414 MW 1x1 CCGT	$12,353	($34)	$693	$13,046	$211

[2] 1VPG Program Cost in Reference and BAU scenarios

PCA Results in the Emerging Technology Scenario

Table 16.4.3 compares the four PCA pathways to the least-cost plan identified in the ET scenario. The total cost of these resource plans range from $223 M to $477 M more than the least-cost plan in the ET scenario, as shown in column (i). In this scenario, only the PCA pathways with significant volumes of VGP renewable program subscriptions (pathways A and B) result in lower costs for the remaining bundled customer who do not subscribe to VGP renewable programs, as shown by the negative numbers in column (f). When only modest levels of additional VGP subscriptions occur under PCA pathways C and D, all customers -- whether subscribing to VGP renewable programs or not – face higher costs under these PCA pathways than under the least-cost plan identified by the Strategist modeling. The incremental costs for the non-subscribers of VGP renewable programs are very modest, however, with the NPVRR for these PCA pathways being less than 1% higher than the least-cost plan. We consider this small amount of incremental cost to be immaterial and well within the margin of error, given all of the forecast assumptions inherent in long-term IRP modeling.

TABLE 16.4.3: ET Scenario PCA Pathways

ET PCA Runs								
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Sensitivity	EWR Level	VGP Programs	2029/2030 BUILD	PVRR includes renewables but not cost to build, $M	Delta Back to Least Cost plan, $M	VPG Program Cost PVRR[3], $M	PVRR with cost of VPG Program added in $M	Delta Back to Least Cost Plan, Including VGP Programs Cost, $M
Least Cost Plan	2.00%	300 MW	1050 MW WIND	$11,885		$375	$12,260	
PCA A	1.75% Ramped	Significant	50 MW DR	$11,328	($557)	$1,409	$12,737	$477
PCA B	1.75% Ramped	Significant	414 MW 1x1 CCGT	$11,280	($604)	$1,409	$12,689	$430
PCA C	2% in 2026	Modest	150 MW DR	$11,901	$17	$581	$12,482	$223
PCA D	1.75% Ramped	Modest	414 MW 1x1 CCGT	$11,964	$80	$581	$12,545	$286

[3] 1VPG Program Costs in ET scenarios - Solar capital decreased by 35%, Wind Capital decreased by 17.5%

PCA Results in the Environmental Policy Scenario

Table 16.4.3 compares the four PCA pathways to the least-cost plan identified in the EP scenario. The total cost of these resource plans range from $271 M to $449 M more than the least-cost plan in the EP scenario, as shown in column (i). Similar to the ET scenario, only the PCA pathways with significant volumes of VGP renewable program subscriptions (pathways A and B) result in lower costs for the remaining bundled customer who do not subscribe to VGP renewable programs, as shown by the negative numbers in column (f). Under PCA pathways C and D in this EP scenario, the incremental costs for the non-subscribers of VGP renewable programs -- as shown in column (f) -- are very modest, approximately 1% higher than the least-cost plan. We consider this small amount of incremental cost to be immaterial and well within the margin of error, given all of the forecast assumptions inherent in long-term IRP modeling.

TABLE 16.4.4: EP Scenario PCA Pathways

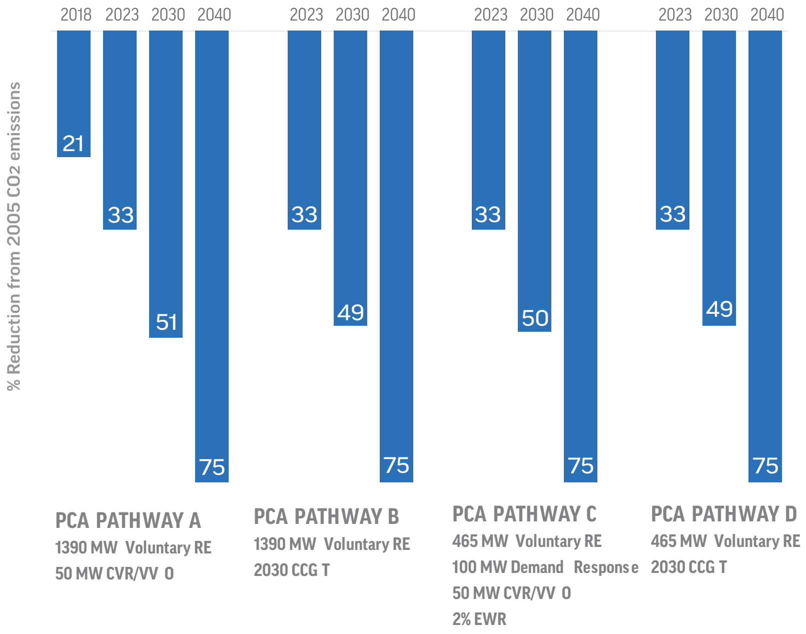
EP PCA Runs								
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Sensitivity	EWR Level	VGP Programs	2029/2030 BUILD	PVRR includes renewables but not cost to build, $M	Delta Back to Least Cost plan, $M	VPG Program Cost PVRR[4], $M	PVRR with cost of VPG Program added in $M	Delta Back to Least Cost Plan, Including VGP Programs Cost, $M
Least Cost Plan	2.00%	300 MW	1050 MW WIND	$11,885		$375	$12,260	
PCA A	1.75% Ramped	Significant	50 MW DR	$11,328	($557)	$1,409	$12,737	$477
PCA B	1.75% Ramped	Significant	414 MW 1x1 CCGT	$11,280	($604)	$1,409	$12,689	$430
PCA C	2% in 2026	Modest	150 MW DR	$11,901	$17	$581	$12,482	$223
PCA D	1.75% Ramped	Modest	414 MW 1x1 CCGT	$11,964	$80	$581	$12,545	$286

[4] VPG Program Costs in ET scenarios - Solar capital decreased by 35%, Wind Capital decreased by 17.5%

16.5 CO_2 Reduction Across the Potential PCA Pathways

TThe four PCA pathways were run on the REF scenario in the PROMOD® model to determine the CO2 emissions from the Company's owned generation fleet for each pathway. Figure 16.5.1 shows the Company owned fleet CO2 emissions reduction from 2005 of the four PCA pathways.

FIGURE 16.5.1: CO2 Emissions from Company Owned Electric Fleet



CO2 Accounting Methodology

The Company continues to report all fleet direct emissions from DTEE owned generating assets to the EPA and the MDEQ, as required, and has also accounted for CO2 from market purchases and sales in some previously published sustainability reports. With this IRP, the Company started to explore different methodologies to account for the CO2 associated with the electricity sold to our customers, whether sourced from DTEE owned generating assets, from the purchase of electricity in the market, or through purchased power agreements.

We worked with Electric Power Research Institute (EPRI) to understand different methods that could be used to account for indirect CO2 emissions. EPRI has completed a study which describes five methods of accounting for CO2 emissions. This study, "Methods to Account for Greenhouse Gas Emissions Embedded in Wholesale Power Purchases" will be published at the end of March and available on the EPRI website: https://www.epri.com/#/pages/product/000000003002015044/?lang=en-US

In this IRP, we are using an annual net short approach to CO2 accounting. The standard approach shown above in Figure 16.5.1, only counts CO2 from the Company's fleet, and any CO2 attributable to purchases or sales of power is ignored. In the annual net short method, the Company's generating units are divided into two groups: non-dispatchable and dispatchable.

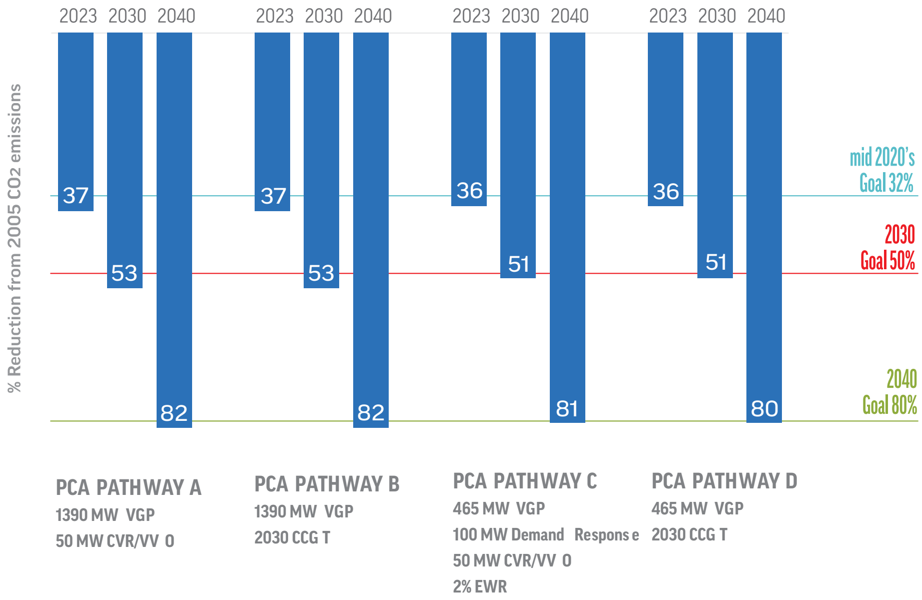
In the traditional sense, dispatchable refers to sources of electricity that can be used on demand and dispatched at the request of MISO, according to market needs. This is in contrast with non-dispatchable energy sources which cannot change their output in response to MISO, such as wind and solar, which are entirely dependent on the weather.

However, for the purposes of the annual net short carbon accounting method and using terminology consistent with EPRI's carbon accounting report discussed above, dispatchable refers to gas units, frequently on the margin serving the broader market ups and downs while non-dispatchable refers to the traditional baseload resources, renewables, and purchase contracts with specific assets. The non-dispatchable units' emissions are assumed to stay with the Company, as these resources are assumed to be serving our customers at all times. Therefore, DTEE's coal, nuclear, and renewable assets, and all PPAs are considered non-dispatchable for the purposes of carbon accounting. Dispatchable units are more likely to be on the margin and able to quickly ramp up and down to supply power to the MISO market and includes all gas units (CCGT and gas peakers).

The generation and the associated emissions from the non-dispatchable units are summed separately. Then the generation from the Company's non-dispatchable units are subtracted from the DTEE customers' load. The difference is what is required to serve our customers' load, beyond the output of the non-dispatchable units. This difference could be positive ("net short") when the Company needs to purchase additional electricity to serve its customers on annual basis, or this difference could be negative if the Company is a net seller of electricity over the course of the year. A CO2 intensity (pounds/MWh) corresponding to the U.S. natural gas fleet is applied to this difference. A gas fleet intensity was used as the basis for this carbon intensity calculation because gas units (CCGT and CT) are frequently marginal units supplying the market, meaning they are the next units to dispatch and thus set the market price. Renewables, base-load coal, and nuclear are not typically considered marginal units in the market

.The result fo applying this carbon accounting method fo forecast the CO2 emissions associated with serving the energy needs of DTEE's customers is shown in Figure 16.5.2.

Figure 16.5.2: CO2 Emissions DTE Electric Fleet – net short approach



With the addition of the renewables and other technologies in the PCA, the Company is forecasted to be in a net long position with respect to energy when an entire year is considered. In some hours, DTE Electric will buy from MISO, and in some hours will sell according to the MISO dispatching operation. Using the annual net short method, the CO2 emissions associated only with our customers' energy needs will be counted. Under this CO2 accounting method, each of the 4 PCA pathways is projected to result in a reduction of CO2 emissions of more than 50% by 2030 and 80% or greater by 2040, when compared to 2005 levels.

By using this approach, the Company is holding itself accountable for the impact to the environment from the energy that we provide to our customers, regardless of whether that energy was produced by Company owned assets or secured through wholesale purchases. The Company is showing an adjustment from fleet direct emissions to estimate the total CO2 that is attributable to energy that our customers use. DTEE believes this is a better representation of the carbon intensity of delivered electricity. As our customers (industrial, commercial, and residential) move in the direction of their own sustainability goals, accounting for net market purchases gives them a more accurate assessment of their full carbon footprint. Because of the changing market dynamics (plant retirements, increasing amounts of variable resources, and changing reliance on markets), this is a more holistic view of environmental impact beyond the traditional fleet direct source approach. In the Company's view, this method aligns with the intent of the IRP – to take a more holistic approach to resource planning.

SECTION SEVENTEEN

Rate Impact and Financial Information

17.1 Customer Rate Impacts

The year over year revenue requirement associated with each of the Company's four potential PCA pathways were compared to the year over year revenue requirement of the Reference scenario least cost plan. The year over year revenue requirement is inclusive of rate base, fixed and variable O&M, fuel costs, and emission costs.

Based on the comparison above, of the potential PCA pathways modeled PCA C (2% EWR, 100 MW of demand response, & 50 MW of CVR/VVO) was determined to be the highest cost pathway. Comparing PCA C to the Reference scenario least cost plan showed a rate impact that ranged from a high of 0.08 cents per kilowatt-hour increase to a low of -0.11 cents per kilowatt-hour decrease, over the first fifteen-years of the study period, with an average incremental cost during the first five years of 0.04 cents per kilowatt-hour. The annual change in revenue requirement varies over time, but during the years from 2028 through 2039 the revenue requirement for PCA C is forecasted to be actually lower than the Reference scenario. The Compounded Annual Growth Rate (CAGR) of the change in revenue requirement associated with PCA C through 2040 was -0.13%. Keeping in mind that the proxy rate impact is based on PCA C (the highest cost pathway of the four possible pathways), the CAGR associated with the other potential PCA pathways would be lower.

17.2 Financial Assumptions

The Company utilized a levelized cost of energy (LCOE) model and revenue requirement model to provide inputs to the Strategist® optimization model for the resource alternatives considered in the IRP. Both of these models used the financial ratios approved in the U-20105 MPSC Rate Order. The pretax marginal cost of capital was used to calculate the return on rate base. The after tax weighted cost of capital was used to calculate the Allowance for Funds Used During Construction (AFUDC). The pre-tax weighted cost of capital was used as the discount rate in calculating the net present value of the annual revenue requirement streams. A complete list of the financial assumptions is shown in Table 17.2.1.

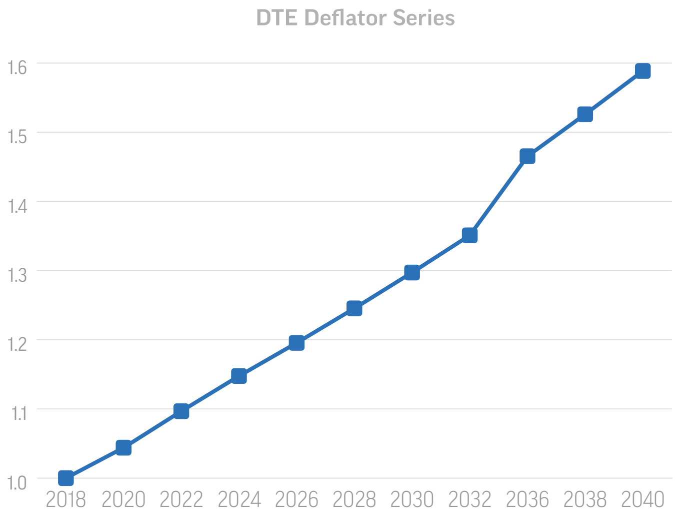
Table 17.2.1 - DTEE Financial Assumptions

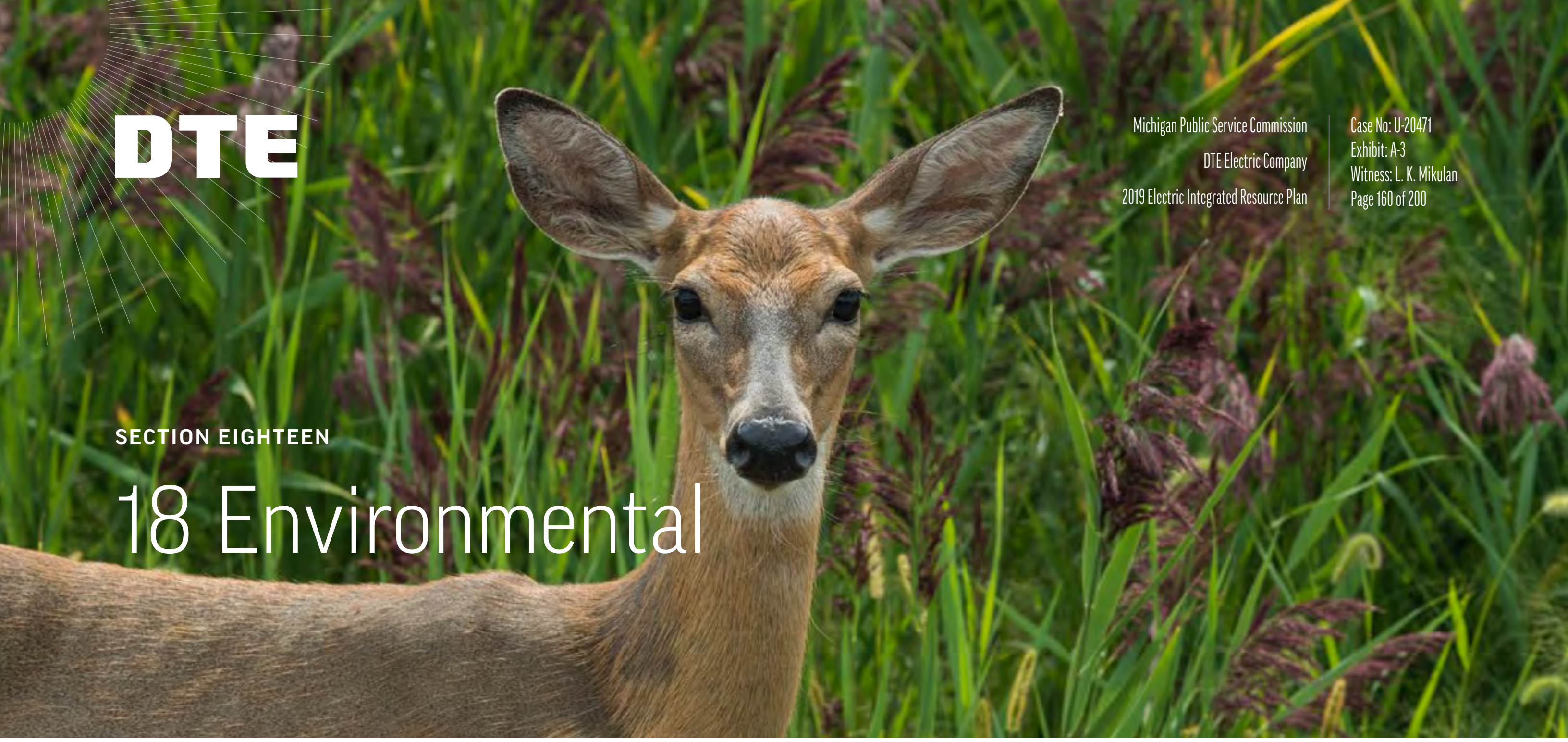
Financial Assumptions	U-20105
Long-term Debt	50.00%
Common Equity	50.00%
Cost of Debt (Pre-tax)	4.42%
Cost of Equity (After-tax)	10.00%
Marginal Cost of Capital (After Tax)	7.210%
Marginal Cost of Capital (Pre-Tax)	8.96%
Cost of Capital for AFUDC	5.34%
Discount Rate	6.63%
Tax Rate	25.90%

Escalation Rate

The modeling used the deflator series shown in Figure 17.2.2, based on the Unadjusted Consumer Price Index (CPI-U). This escalation rate was used throughout the scenario development and in the alternatives development, and was tied to the sales forecast developed by the Load Forecasting group. Fuel prices have their own escalation rates based on commodity supply and demand drivers.

Figure 17.2.2 - DTE Deflator Series





SECTION EIGHTEEN

18 Environmental

18.1 Overview

DTE Electric has a long history of environmental conservation and stewardship, and is committed to protecting its communities, employees, customers, and the planet. In May 2017, DTEE was one of the first energy companies to announce a long-term carbon reduction target to reduce CO_2 emissions by more than 80 percent by 2050, positioning the company as an industry leader in reducing greenhouse gases. In 2018, the clean energy goal was announced, with a 50 percent clean energy by 2030 goal. DTE Electric will accomplish this by using more natural gas, wind and solar, and by improving customers' energy-saving options. The company is also planning to account for the carbon we produce for our customers, and to include the carbon of the power we purchase. The plan for reducing DTEE's CO_2 emissions makes business sense, ensures safe, reliable, affordable, and cleaner energy for its customers, and allows the company to implement a long-term generation transformation strategy in which more than half of the energy produced is generated from zero-emitting resources. With the plans laid out in this IRP, the company is able to take the next step on our clean energy journey, and is able to announce that we are accelerating our carbon reduction goal a full decade, pledging to reduce carbon emissions by 80 percent by 2040. In the near term, we have committed to a 50 percent carbon emissions reduction by 2030. DTEE is committed to operating in a manner that complies with or exceeds federal, state, and local environmental regulations, rules, standards, and guidelines, which are described in this section.

18.2 Environmental Stewardship

DTEE works to take care of the air, land, water, and living creatures within its service territory and beyond. The Company maintains thousands of acres of land in their natural state, which provide habitat for hundreds of species of birds, mammals, fish, and insects. DTEE has 36 sites, including all the DTEE power plants, certified under the Wildlife Habitat Council, a nonprofit organization that helps companies manage their property for the benefit of wildlife. All the DTEE power plants are also ISO 14001:2015 third-party certified. The ISO 14001 standard sets criteria for a company's environmental management system, a set of processes for managing environmental programs. DTEE's system includes employee training, risk assessment and mitigation, monitoring, auditing, top management review, and periodic recertification. For DTEE, environmental stewardship starts with operating its facilities, land, and equipment in a manner that complies with or exceeds governmental standards and is protective of its employees, customers, and surrounding communities, while maintaining affordable service.

The electric power industry across the United States is undergoing a major transformation as the country seeks lower-carbon energy sources. DTEE is an industry leader in this transformation and recognizes its responsibility to conserve the earth's finite natural resources. DTEE is committed to environmental compliance and stewardship and protecting the land, water, and air. DTEE is transforming the way it supplies energy and is using more wind, solar, and cleaner natural gas as well as continuing to invest in energy efficiency and reducing peak loads. DTEE's broad sustainability initiative will reduce the Company's carbon emissions by 50 percent by 2030 and 80 percent by 2040. DTEE will continue to be at the forefront of emissions reductions while being mindful of its customers' needs for affordability and reliability, all of which are considered in the Company's integrated resource planning.

DTEE has 36 sites, including all the DTEE power plants, certified under the Wildlife Habitat Council

DTEE's environmental compliance includes completed environmental controls retrofits for existing coal-fired plants to operate in compliance with all applicable regulations while the plants continue to operate. This includes completion of installation of emission controls on all four units at the Monroe Power Plant in 2014 and at all remaining coal-fired power plant units in 2016 to comply with Mercury and Air Toxics Standards and other regulations.

In addition to the installations and large expenditures for environmental compliance over the last several years, several regulations under the Clean Air Act, Clean Water Act, and the Resource Conservation and Recovery Act will affect coal-fired power plants in the coming years. The regulations have different implementation timelines and will have various outcomes for DTEE. Regulatory compliance and the effects of some of these regulations are discussed further in this section.

18.3 Environmental Compliance

National Ambient Air Quality Standards

The Clean Air Act requires that the EPA set national ambient air quality standards (NAAQS) for six pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). The EPA sets NAAQS at levels deemed to be protective of public health and the environment. The standards are reviewed periodically and may be revised based on that review. Although all DTEE power plants are subject to NAAQS, two standards in particular are currently affecting its generation fleet: SO_2 and ozone.

In 2010, the EPA established a new one-hour SO_2 NAAQS, which resulted in an area in southern Wayne County being designated as non-attainment in 2013. This area included DTEE's River Rouge and Trenton Channel power plants. DTEE implemented significant SO_2 emissions reductions at both power plants to help provide for attainment in the area.

The same 2010 SO_2 NAAQS that affected the Wayne County plants also affects the future operation of the Belle River and St. Clair power plants in St. Clair County. An area of St. Clair County that includes the two DTEE power plants was designated as non-attainment in late 2016. DTEE is working with MDEQ to develop a plan to achieve attainment, while minimizing expense to its customers and maintaining reliable and efficient energy production in the area.

In 2015, the ozone NAAQS was also lowered from 75 parts per billion (ppb) to 70 ppb. As a result, a seven-county area of southeast Michigan has been designated as non-attainment for ozone. This area includes all DTEE coal-fired power plants. DTEE is working collaboratively with the state to develop a state implementation plan, as required.

For DTEE, environmental stewardship starts with operating its facilities, land, and equipment in a manner that complies with or exceeds governmental standards and is protective of its employees, customers, and surrounding communities, while maintaining affordable service.

Cross-State Air Pollution Rule

The Cross-State Air Pollution Rule (CSAPR) is the most recent EPA regulation targeting interstate and regional transport of air pollution and replaces the Clean Air Interstate Rule (CAIR). Like CAIR, CSAPR establishes a cap-and-trade program to limit SO2 and NOx emissions from electric utilities. It establishes emissions allocations to each generating unit in a group of Midwestern states, including Michigan. These allocations are reduced over time, through a phased approach. Although the allocations are made at the unit level, CSAPR allows for emissions allowance trading among utilities covered by the rule, compliant with CAIR/CSAPR.

In 2016, the EPA promulgated an update to the CSAPR aimed at reducing ozone transport to states downwind from the Midwestern states it covers. The update drastically reduced the ozone season (May through September) emissions allocations. In addition, the update restricted the amount of emissions credits that can be carried over from previous years.

Affordable Clean Energy Rule and Clean Power Plan

In August 2015, the EPA finalized performance standards for emissions of CO2 from existing fossil-fuel fired power plants under Section 111(d) of the Clean Air Act and new sources under Section 111(b) of the act as part of the Clean Power Plan. The rules underwent significant legal challenges and the existing source rule was stayed by a 2016 U.S. Supreme Court decision, pending judicial review. In 2017, an executive order was issued, which instructed the EPA to review the final rules. On Oct. 16, 2017, EPA published a proposal to repeal the Clean Power Plan in the Federal Register. The standards for new sources under Section 111(b) were not part of the stay and remained in effect.

In August 2018, EPA proposed the Affordable Clean Energy Rule. This rule would replace the Clean Power Plan rule for emissions of CO2 from existing sources, which never went into effect. Although the Affordable Clean Energy Rule does not propose state-specific standards as the Clean Power Plan did, states would set performance standards and would have discretion in establishing these standards for each affected unit. A final rule is expected to be published in 2019. The EPA also issued a proposed rule revision to the new source performance standards in December 2018 with changes to standards for new, reconstructed or modified coal-fired units.

Steam Electric Effluent Limitation Guidelines

In late-2015, the EPA issued its final rule related to wastewater discharge or Effluent Limitation Guidelines for steam electric power generators (SEEG or ELG). The new requirements covered some specific wastewater discharges from coal plants. In 2017, EPA agreed to reconsider the 2015 Rule, but only for Bottom Ash Transport Water (BATW) and FGD Wastewater (FGDWW) discharges. The requirements for Fly Ash Wastewater (FAWW) discharges are not being reconsidered. EPA issued a new rule, the “Postponement Rule,” to reconsider the 2015 Rule and delay the compliance dates for BATW and FGDWW set forth in the 2015 Rule. The 2015 Rule originally required compliance "as soon as possible," but provided a window of time between November 1, 2018 and December 31, 2023. The Postponement Rule pushed back the November 1, 2018 date which narrowed the window to achieve compliance to between November 1, 2020 and December 31, 2023, but did not extend the December 31, 2023 compliance deadline. Currently, there is no 2-year postponement of the December 31, 2023 compliance date, but rather a 2-year postponement of the earliest possible compliance date of November 1, 2018 for BATW and FGDWW compliance. The FAWW compliance timeframe remains as November 1, 2018 to December 31, 2023 as originally set in the 2015 ELG Rule as the Postponement Rule made no changes to the FAWW compliance dates. There is currently no extension or waiver available. The ELG rules will impact the Company's coal-fired units. Compliance would require significant modifications at all existing coal-fired power plants, however, plants which are planned for shutdown prior to the December 31, 2023 ELG compliance date will have no ELG requirements for compliance.

Cooling Water Intake (316b)

The EPA finalized regulations on cooling water intake for power plants and other facilities under Section 316(b) of the Clean Water Act in August 2014. Those regulations affect the Company's five coal-fired power plants along with its nuclear plant, Fermi 2. DTEE coal plants currently use once-through cooling, which entails taking water in for cooling, which is then discharged back to the body of water with no recirculation. The cooling water intake structures are equipped with screens that prevent debris from being taken into the plant systems. The regulations affect cooling water intake at existing facilities in two main areas: first, existing facilities are required to reduce fish impingement; second, existing facilities are required to conduct studies to determine whether and what controls would be required to reduce the number of aquatic organisms entrained by the cooling water system. The regulations also include requirements for new units that add electrical generation capacity.

Coal Combustion Residual Rule

The EPA published the Coal Combustion Residual (CRR) Rule in April 2015, with an effective date of Oct. 19, 2015. The EPA also revised the CCR rule in October 2016, which further affected closure plans for CCR units. Recent rule revisions and court action further affect operational and closure plans. On July 17, 2018, the EPA issued a new rule with provisions for state-approved programs that would allow for potential flexibility in groundwater monitoring requirements, among other things. An EPA-approved state program needs to be in place before any changes to the CCR groundwater monitoring programs can be realized. On Aug. 21, 2018, the D.C. Circuit Court of Appeals issued its decision in the CCR litigation addressing issues raised by both industry and environmental petitioners. Most applicable to the Company is the court's decision on the ability of unlined impoundments to continue operating. The actual consequences of the court decision will require the EPA to revisit elements of the CCR rule. However, the precise actions, timing and impact to the Company are unclear at this time. On March 13, 2019 the DC Circuit Court of Appeals issued its decision addressing issues raised by environmental petitioners, ordering EPA to undertake a new rulemaking to establish a new deadline for initiating closure of units subject to forced closure. The order remanded the closure deadline back to EPA without vacating the current rule date of October 31, 2020. DTEE has been and remains in compliance with all applicable standards currently in effect. Current CCR rule obligations at the DTEE plants vary based on plant retirement dates. Regardless of the timing of plant retirements, closure of ash basins, long-term ground water monitoring, potential mitigation, inspections and reporting obligations will continue for many years.

18.4 Capital Cost to Comply with Environmental Regulations

The table below summarizes the costs associated with ELG and 316(b) for the Belle River and Monroe Power Plants. No ELG/316(b) costs are expected for the other plants based on their planned retirements. As described above, costs associated with CCR are expected regardless of plant closure dates.

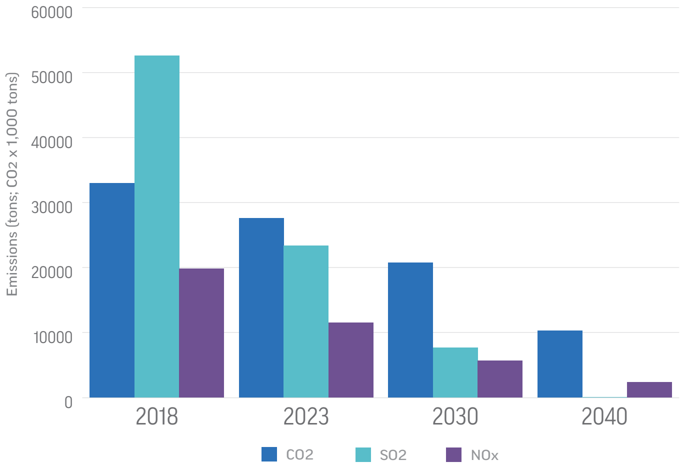
TABLE 18.4.1: Capital Cost Estimate for Environmental Compliance

		Monroe	Belle River
Capital (M$)	ELG	$55	$200
	316(b)	$1	$50

18.5 Emission Projections

The Company outlined four potential PCA pathways. While the details of the pathways are different, the modeling performed shows that all four pathways allow for the Company to meet its CO2 reduction goals. A summary of CO2, SO2, and oxides of nitrogen (NOx) for the PCA and 2018 is shown in Figure 18.4.1

FIGURE 18.5.1: Emissions Summary



The projections for 2023, 2030, and 2040 in this figure represent an average of the emissions from the four PCA pathways as all pathways provide similar emissions reductions. This figure represents mass emissions from DTE Electric sources and does not take into account the CO2 accounting parameters outlined above. Other pollutants not shown in the figure, such as particulate matter and mercury, will decline at similar levels as SO2. The Company's plan for carbon reduction included in this PCA will provide other significant emission reductions as well.

SECTION NINETEEN

19 DTEE IRP Report Summary

Summary

DTE Electric evaluated numerous resource options to determine the recommended combination of supply-side and demand-side options. DTE Electric performed robust scenario and sensitivity analyses, considering the uncertainty around environmental regulations, resource cost and performance, fuel prices, load, and other regulatory and legislative effects. In addition to scenario/ sensitivity analysis, the Company conducted four additional risk analyses. The IRP analysis identified that there is not a persistent capacity need until 2029-2030 to cover reserve margin requirements. The need in 2029-2030 arises because of the projected retirements of Belle River units in those same years. The Company's Proposed Course of Action focuses on the next five years (2019 – 2024) and considers the most affordable and reliable mix of supply-side and demand-side resources available today. Given the long-term uncertainty of technological advancements and key market drivers the Proposed Course of Action in the years beyond 2024 considers four alternate long-term options. While these four pathways provide a view into the future the Company will continue to revisit and refine the plan as technology develops, customer desires, and trends become more clear and costs decline.

Overall, the strength of the Company's PCA is the flexibly it affords to adapt to evolving markets, regulations, and technologies. It is both supportive of our environmental goals and requirements, as well as reliable, and balances those factors with minimizing cost impacts to our customers.

Glossary

The following definitions are not intended to set forth official Company policy or interpretation, but are provided solely to assist the reader in the understanding of this report.

ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION (AFUDC): The net cost for the period of construction of borrowed funds used for construction purposes and a reasonable rate on other funds when used.

AVAILABILITY: The percentage of time that a unit is available to generate electricity. It is determined by dividing the total hours the unit is available to generate by the total hours in the period.

CAPACITY FACTOR: A measure of how much a generating facility's capacity is used during a period. Expressed as a percentage, it is calculated by dividing the actual energy produced during a specific period by the unit's rated generating capacity over the same period.

% Capacity Factor = (energy produced) / (plant capacity x time)

COMBINED CYCLE: A generating unit that utilizes a combination of one or more combustion turbines in conjunction with heat recovery steam generator(s) (HRSG) and steam turbine(s), which typically burn natural gas as fuel.

COMBINED HEAT AND POWER: The concurrent production of electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy.

CONSUMER PRICE INDEX (CPI): A relative measure of the purchasing power of a dollar. It is a measure of inflation.

DEMAND: The energy required at the customer's meter.

DEMAND-SIDE MANAGEMENT (DSM): Programs designed to influence customer use of electricity in ways that will produce desired changes in a utility's load shape. The proposed programs support the objectives of conservation, load shifting, and peak clipping.

DEMAND-SIDE OPTION (DSO): A resource option which meets the objectives stated for a DSM program (see previous definition).

DISPATCHING: The assignment of load to specific generating units and other sources to affect the most reliable and economical supply as system load rises or falls.

DTEE 2019 IRP: A set of resources within the 2019 to 2040 study period that is the result of scenario and sensitivity analysis, and risk analysis and encompasses the DTEE's Planning Principles that represents DTEE's proposed course of action.

HEAT RATE: A measure of generating plant efficiency in converting the heat content of its fuel to electrical energy, expressed in BTU/kWh. It is computed by dividing the total BTU content of fuel burned for electric generation by the resulting net kilowatt-hour generation.

LEAST COST PLAN: A set of resources within the 2019 to 2040 study period that aligns with the Company's Planning Principles and selected as the optimal resource plan under a specific scenario.

LEVELIZATION: A mathematical operation whereby a non-uniform series of annual payments is converted into an equivalent uniform series considering the time value of money (discount rate).

LOAD FACTOR: The ratio of the average load supplied during a designated period to the peak or maximum load occurring in that period. It is expressed as a percent.

LOCAL CLEARING REQUIREMENT: A MISO requirement for how much generation must come from local sources.

LOSS OF LOAD EXPECTATION (LOLE): The frequency that there will be insufficient resources (native generation and purchases) to serve firm load. DTEE's reliability criterion is one day in ten years' loss of load expectation.

PLANNING PERIOD: The time during which resource options are added to meet the expected future electrical loads. For this IRP, the planning period is 2019-2040.

PROVIEW: The Strategist automatic expansion planning module, which determines the optimum expansion plan under a prescribed set of constraints and assumptions.

PUMPED STORAGE: The process of producing electricity during peak periods with water driven turbines. The water storage reservoir is filled by motor driven pumps during off-peak hours when inexpensive power is available.

RENEWABLES: An energy source that occurs naturally in the environment, such as solar energy, wind currents, and water flow.

RESERVE MARGIN: The difference between net system capability and system maximum load requirement (peak load). It is the margin of capability available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen loads. This is often expressed as a percentage of peak load.

Reserve margin = 100 x (Total System Capacity – Peak Load) / Peak Load

RESOURCE PLAN: A strategy for meeting the expected future electrical demand through the addition of supply-side and/or demand-side options. For this IRP, resource plans were developed for several different scenarios and sensitivities.

REVENUE REQUIREMENT: The revenue that must be obtained to cover all annual costs, including all fixed and variable cost components.

SCENARIO: A unique set of assumptions grouped to best represent the effect of some potential future occurrence.

SCENARIO STARTING POINT: A scenario with no sensitivities applied was run and was used to compare sensitivities against.

SENSITIVITY: A subset of a scenario in which the same basic assumptions are used as in the controlling scenario, but certain other parameters are modified to determine specific effects that might occur.

SHORTFALL: When the local resources can't meet the reserve margin requirement.

STARTING POINT: When the IRP modeling began, in June 2018, an assessment of the current state of the inputs at that time was completed. This set of resources throughout the 2019 to 2040 study period stayed consistent through the optimization modeling.

SUPPLY RELIABITY: Having sufficient capacity to meet customers' power demands.

SUPPLY-SIDE OPTION (SSO): Typically, any option which adds generating capacity to a system to produce electricity as needed to meet customer electrical demand.

TIME OF USE RATES: Tariffs that vary according to the time of day. They are used to help promote transfer of on-peak to off-peak electricity consumption.

Index Of Abbreviations

ACI – Activated Carbon Injection

AFUDC – Allowance for Funds Used During Construction

AHU – Air Handler Units

ANSI – American National Standards Institute

BAU – Business as Usual (scenario)

BNEF – Bloomberg New Energy Finance

BR – Belle River Power Plant

BWEC – Blue Water Energy Center

BYOD – Bring Your Own Device

CAA – Clean Air Act

CAES – Compressed Air Energy Storage

CAGR – Compound Annual Growth Rate

CAIR – Clean Air Interstate Rule

CC, CCGT – Combined Cycle Gas Turbine

CF – Capacity Factor

CHP – Combined Heat and Power

CME – Chicago Mercantile Exchange

CPP – Clean Power Plan

CO2 – Carbon Dioxide

COG – Coke Oven Gas

CRR– Coal Combustion Residual

CSAPR – Cross-State Air Pollution Rule

CT – Combustion Turbine

CWA – Clean Water Act

CVR – Conservation Voltage Reduction

DG – Distributed Generation

DR – Demand Response

DSI – Dry Sorbent Injection

DSM– Demand-Side Management

DTE – DTE Energy Company

DTEE – DTE Electric Company or The Company

ECIL – Effective Capacity Import Limit

EE – Energy Efficiency

EIA – Energy Information Agency

ELCC – Effective Load Carrying Capability

ELG – Effluent Limitation Guidelines

EO – Energy Optimization

EP – Environmental Policy (scenario)

EPA – Environmental Protection Agency

EPRI – Electric Power Research Institute

ESS – Energy Storage Systems

ESP – Electrostatic Precipitator

ET– Emerging Technologies (scenario)

EWR – Energy Waste Reduction, also referred to as Energy Efficiency

FERC – Federal Energy Regulatory Commission

FGD – Flue Gas Desulfurization

FOM – Fixed Operating and Maintenance

FosGen – Fossil Generation Business Unit

FRAP – Fixed Resource Adequacy Plan

GW – Gigawatt, One Billion Watts

GWh – Gigawatt Hours

HAP – Hazardous Air Pollutant

HELM – Hourly Electric Load Model

HRSG – Heat Recovery Steam Generator

HSE – High-Sulfur Eastern Coal

HVAC – Heating, Ventilation and Air Conditioning

ICAP – Installed Capacity

IGCC – Integrated Gasification Combined Cycle

IPP – Independent Power Producer

IRP – Integrated Resource Plan

ITC – International Transmission Company

ITC – Investment Tax Credit

kW – Kilowatt, One Thousand Watts

kWh – Kilowatt Hours

LCOE – Levelized Cost of Energy

LED – Light Emitting Diode

LF – Load Factor

LCP – Least Cost Plan

LCR – Local Clearing Requirement

LMP – Local Marginal Price

LOLE – Loss of Load Expectation

LOLEWG – Loss of Load Expectation Working Group

LRC – Local Resource Zone

LSS – Low-Sulfur Southern Coal

LSW – Low-Sulfur Western Coal

LTC – Load Tap Changers

MATS – Mercury and Air Toxics Standards

MBtu, mmBtu – Million British Thermal Units

MDEQ – Michigan Department of Environmental Quality

MERC – Midwest Energy Resources Co

MISO – Mid-Continental Independent Transmission System Operator, Inc.

MN – Monroe Power Plant

MPPA – Michigan Public Power Agency

MPSC – Michigan Public Service Commission

MSE – Mid-Sulfur Eastern Coal

MTEP – MISO Transmission Expansion Plan

MW – Megawatt, One Million Watts

MWh – Megawatt Hours

NAAQS – National Ambient Air Quality Standards

NGCC – Natural Gas Combined Cycle

NMP – Non-Metal Processing

NOX – Nitrogen Oxide

NPV – Net Present Value

NPVRR – Net Present Value Revenue Requirement

NYMEX – New York Mercantile Exchange

O&M – Operating and Maintenance

OFA – Over-Fire Air

PA – Public Act

Pace Global – Pace Global, a Siemens Business

PCA – Proposed Course of Action

PEV – Plug-in Electric Vehicle

PPA – power purchase agreement

PRMR – Planning Reserve Margin Requirement

PSCR – Power Supply Cost Recovery

PTC – Production Tax Credit

PURPA – Public Utility Regulatory Policies Act

QF – Qualifying Facility

R-10 – Rider 10 industrial interruptible tariff

RAN – Renewable Integration Impact Assessment

RCRA – Resource Conservation and Recovery Act

REC – Renewable Energy Credit

REF – Reference Scenario

REP – Renewable Energy Plan

RFP – Request for Proposal

RGGI – Regional Greenhouse Gas Initiative

RICE – Reciprocating Internal Combustion Engine

R&MP – Rubber and Plastics

ROR – Random Outage Rate

RPS – Renewable Portfolio Standard

RR – River Rouge Power Plant

SC – St. Clair Power Plant

SCR – Selective Catalytic Reduction

SIP – State Implementation Plan

SO2 – Sulfur Dioxide

TC – Trenton Channel Power Plant

UCAP – Unforced Capacity

UCT – Utility Cost Test

USRCT – Utility System Resource Cost Test

VVO – Volt Var Optimization

ZRC – Zonal Resource Credits

UCT – Utility Cost Test

VOM – Variable Operating and Maintenance (Cost)

Appendix B
Natural Clay Liner Equivalency Evaluation Report – December 2018

Natural Clay Liner Equivalency Evaluation Report

DTE Electric Company and
Consumers Energy Company
Six Southeast Michigan Coal Combustion Residual Units

December 2018

Natural Clay Liner Equivalency Evaluation Report

DTE Electric Company and
Consumers Energy Company
Six Southeast Michigan Coal Combustion Residual Units

December 2018

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Section 1
Introduction

1.1 Background and Objective

The minimum composite liner specified by federal regulations promulgated on April 17, 2015 (CCR Rule) for coal combustion residual (CCR) disposal units includes a geomembrane directly overlying two feet of compacted clay having a hydraulic conductivity no greater than 1 x 10^{-7} cm/s. For new and existing CCR disposal units, Michigan regulations define a natural soil barrier having a hydraulic conductivity no greater than 1 x 10^{-7} cm/s that may be permitted as a protective liner system in lieu of a constructed composite liner if it can be demonstrated that the natural soil liner meets the performance standards outlined in Rule 299.4307 of PA 451 of the Natural Resources and Environmental Protection Act (NREPA), Part 115 (Solid Waste Management). Michigan's Solid Waste Management Program codified in Part 115 is the state's equivalent Subtitle D permitting program for solid waste management, and is a United States Environmental Protection Agency (EPA) authorized program and consequently there is an inherent acknowledgement that natural soil liners can provide equivalent protection as composite liner systems by Michigan and the EPA.

On August 21, 2018 the United States Court of Appeals District of Columbia Circuit Court (DC Court) ruled on a number of CCR issues, some that have been pending since promulgation of the CCR Rule in 2015. The primary response from the DC Court was to rule on whether EPA's request to stay litigation pending anticipated court-mandated rulemaking from a settlement agreement entered on April 18, 2016 where EPA committed to addressing issues in a Remand Rule by June 2019. The court requested oral argument on all remaining issues of litigation at the time of the request for stay in order to weigh merits of the motion. The DC Court decision ultimately denies the motion and issues an opinion on all of the remaining issues of litigation which included vacatur and remand of:

- 257.101(a), which governed the conditions that would force an unlined surface impoundment to cease receiving CCR and non-CCR if a groundwater protection standard was exceeded unless strict conditions and timelines for alternative closure could be certified by the owner or operator pursuant to 257.103.
- 257.71(a)(1)(i), which defined 2 feet of compacted soil (K value of no more than 1x10^{-7} cm/s) for existing impoundments as meeting the liner standard (i.e., "clay lined" pond considered a lined pond).

By vacating 257.101(a) and 257.71(a)(1)(i), electric power generators who intended to continue using their existing ponds for CCR or non-CCR (assuming they met all of the remaining provisions/standards of 257.101), would potentially have to close or retrofit/reline these ponds.

Multiple CCR impoundments in southeast Michigan are documented to be constructed within thick (> 20 feet thick, in some cases more than 100 feet thick) laterally contiguous glacially compacted natural clay-rich soils with a hydraulic conductivity no greater than 1 x 10^{-7} cm/s prior to implementation of the CCR Rule requiring composite liners (§257.70) or demonstration of equivalent performance to alternative composite liners. As the natural soil underlying these CCR impoundment units consists of thick, low-hydraulic conductivity clay, it is likely that the natural soil is providing the same, or better level of protection from potential migration of contaminants than the composite liner defined in 257.70(b). The purpose of our study is to present existing site data to assess whether the natural soils below six CCR impoundment units at four sites in southeast Michigan are performing equivalently to a composite liner using recognized and generally accepted good engineering practices.

1.2 Description of CCR Units

Natural clay liners were evaluated for six CCR units at four power generation facilities in southeast Michigan:

- Bell River Power Plant (BRPP) Bottom Ash Basins (BAB) CCR Unit
- BRPP Diversion Basin (DB) CCR Unit
- St. Clair Power Plant (SCPP) BAB CCR Unit
- Monroe Power Plant (MONPP) Fly Ash Basin (FAB) CCR Unit
- J.R. Whiting Power Plant (JRWPP) Ponds 1 and 2 CCR Unit
- JRWPP Pond 6 Inactive CCR Unit

Data used for the natural clay liner evaluations were obtained from existing reports and Conceptual Site Models (CSMs) previously developed for each site. A summary of the CSM for each site is provided in the following sections.

1.2.1 BRPP Bottom Ash Basins CCR Unit

The 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 DB CCR unit. The North and South BABs run roughly east to west approximately 420 feet long by 120 feet wide with bottom elevations of approximately 580 feet and outflow weir elevations of approximately 590.25 feet (TRC 2017a).

1.2.2 BRPP Diversion Basin CCR Unit

The DB is an incised CCR surface impoundment located west of the BRPP. Water flows into the DB from the North and South BABs through a network of pipes and ditches. The DB discharges to the St. Clair River with other site wastewater in accordance with a National Pollution Discharge Elimination System (NPDES) permit. The DB has an approximately 300 foot long entrance channel that connects to the main portion of the basin that runs approximately north-south. The main portion of the DB is approximately 400 feet long by approximately 120 feet wide with a bottom elevation of approximately 576 feet with the water level being maintained at approximately 580 feet (TRC 2017a).

1.2.3 SCPP Bottom Ash Basins CCR Unit

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments. The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (bgs) into the native clay-rich soil. The BABs are located south of the SCPP and adjacent to the St. Clair River and are used for receiving bottom ash and other process flow water from the power plant, which is first sent to the East BAB then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a NPDES permit (TRC 2017b).

The West and East BABs run roughly north to south with the following approximate dimensions (TRC 2017b):

- The West BAB is approximately 300 feet long by 90 feet wide with a bottom elevation of approximately 572 feet (when fully cleaned out) with an outflow weir elevation of approximately 579.3 feet; and
- The East BAB is approximately 400 feet long by 70 feet wide with a bottom elevation of approximately 572 feet (when fully cleaned out) with an outflow weir elevation of approximately 579.4 feet.

1.2.4 MONPP Fly Ash Basin CCR Unit

The MONPP FAB CCR unit is approximately 410-acres with an original design storage capacity of 18,500 acre-feet at a maximum elevation of 614 feet. The FAB consists of an earthfill clay-rich soil embankment (raised surface impoundment) with a crest perimeter length of approximately 18,200 feet and a general height (from the lowest toe elevation to the top of embankment) of approximately 40 feet, with a maximum height of 44 feet. A road along the top of the crest has an elevation of approximately 614 feet with the typical water operational level being 609 feet. The FAB base is keyed into the existing natural clay-rich soil ground surface at an elevation of 563.4 feet. CCRs are placed into the FAB by use of a "wet" (sluiced) disposal method (TRC 2017c).

1.2.5 JRWPP Ponds 1 and 2 CCR Unit

The JRWPP Ponds 1 and 2 CCR unit is located east of the JRWPP adjacent to Lake Erie. The JRWPP is no longer an active power generating facility and Ponds 1 and 2 are no longer active. The ponds were constructed in the native clay soil and received ash by sluicing. Sluice water was discharged to Pond 2 and then flowed into Pond 1 via a connecting pipe. Discharge water from the basins flowed into the adjacent Forebay in accordance with a NPDES permit (Golder Associates 2017). The Pond 1 outlet had an elevation of 586.3 feet and a perimeter crest of approximately 590 feet (AECOM 2009).

1.2.6 JRWPP Pond 6 CCR Unit

The JRWPP Pond 6 CCR unit is located north of the JRWPP. Pond 6 is no longer in operation and has received a final cap. Pond 6 was constructed in the native clay soil and received ash by sluicing. Discharge water from Pond 6 flowed into the adjacent LaPointe Drain in accordance with a NPDES permit. When in operation, the pool elevation in Pond 6 was maintained between elevations of 592.6 feet and 596.5 feet with a perimeter crest elevation of approximately 600 feet (AECOM 2009).

Section 2
Composite Liner Leakage Literature

2.1 Literature Review

A single composite liner specified by state and federal regulations for new CCR disposal units includes a geomembrane directly overlying two feet (0.61 meters) of compacted clay having a hydraulic conductivity no greater than 1 x 10^{-7} cm/s. These composite liners are intended to prevent advective flow of leachate through the liner. However, studies of installed composite liner systems have identified that composite liners leak through holes in the geomembrane that result from manufacturing defects, damage during installation, or degradation of the membrane over time (Rowe 2012). Holes in the geomembrane allow migration of leachate from the liner cell into the compacted clay portion of the liner. Once in the clay, leachate can migrate through the clay via porous media flow, eventually exiting the clay liner as leakage.

The amount of leakage through a composite liner is controlled in part by the number of holes in the geomembrane, the size of the holes, and the quality of contact between the geomembrane and the underlying clay. Based on a review of available literature, Rowe (2012) reports that the median radius of geomembrane holes is greater than 5 mm (meaning geomembrane holes at a scale of millimeters to centimeters are not uncommon) and the number of holes ranges from 2.5 to 12 holes per hectare of liner. Gaps between the geomembrane and the underlying clay also influence leakage rates by increasing the surface area through which leachate can penetrate the underlying clay (Rowe 2012).

Liner performance can be quantified in terms of the rate of leakage of leachate through the liner into the underlying soils. Researchers have quantified leakage rates for composite liners through the use of leak detection systems (e.g., Bonaparte et al. 2002) and calculations (e.g., Giroud et al. 1998; Rowe 2012). Leakage rates are measured in terms of the volume of liquid (liters or gallons) leaking through the liner each day over the surface area of the liner (hectares or acres) e.g. liters per hectare per day (lphd).

Leakage through the compacted clay portion of a composite liner or through a natural clay liner is controlled by several factors, including the hydraulic conductivity of the clay, the hydraulic head gradient across the liner, and the thickness of the clay. Flow through clay liners can be calculated using physical parameters of the system in question and applying Darcy's Law. The performance of natural clay liners can be assessed by comparing calculated leakage rates for natural clay liners with calculated leakage rates for composite liners.

Section 3
Site Conceptual Models

3.1 Belle River Power Plant

The BRPP CCR units are underlain by more than 130 feet of unconsolidated sediments, consisting mostly of silty clay-rich till. The silty clay-rich till is present from the surface to depths of 86 to 130 feet bgs at the BRPP CCR units. Falling head permeameter tests were completed on four samples of the site clay, producing hydraulic conductivity values ranging from 2.1 x 10^{-8} cm/s to 2.9 x 10^{-8} cm/s. Saturated silts and sands underlie the clay and form the shallowest aquifer below the CCR units. The unconsolidated sand and silt aquifer is underlain by the uppermost bedrock consisting of the Bedford Shale, which is generally encountered from 135 to 145 feet bgs (TRC 2017a).

3.1.1 Bottom Ash Basins CCR Unit

As described above, the uppermost aquifer units beneath the BABs CCR unit are hydraulically isolated by at least 80 feet of silty clay-rich till. The first observed sand-rich units that meet the 40 CFR §257.53 definition of uppermost aquifer is encountered at depths ranging from 90 to 136 feet bgs. The sand-rich unit rapidly thins to the south and east of the BABs and pinches out in the southeastern portion of the BABs CCR unit area (TRC 2017a).

The water level in the BABs is maintained at an elevation of approximately 590 feet. The hydraulic head in the aquifer below the BAB is approximately 574 feet (TRC 2018a). The bottom of the BABs is at an elevation of approximately 580 feet and the bottom of the clay underlying the BABs is at an elevation of approximately 500 feet, thus 80 feet of clay separate the bottom of the BABs CCR unit from the underlying aquifer.

3.1.2 Diversion Basin CCR Unit

The potential uppermost aquifer under the DB CCR unit is located at depths ranging from 131 to 145 feet bgs at the silt/shale bedrock interface. The DB CCR unit is isolated from the underlying potential uppermost aquifer by approximately 130 feet of silty clay-rich till. Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher hydraulic conductivity than the clay-rich soils between the bottom of the basin and the monitored zone (TRC 2017a).

The water level in the DB is maintained at an elevation of 580 feet or less. The hydraulic head in the aquifer below the DB is approximately 575 feet (TRC 2018b). The bottom of the DB is at an elevation of approximately 576 feet and the bottom of the clay underlying the DB is at an elevation of approximately 459 feet, thus 117 feet of clay separate the bottom of the DB CCR unit from the underlying aquifer.

3.2 St. Clair Power Plant BABs

The SCPP CCR unit is underlain by glacial silty-clay till, with few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock is generally encountered below 130 feet bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer). Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the uppermost aquifer, because it is saturated and exhibits higher hydraulic conductivity than the clay-rich soils between the bottom of the basin and the monitored zone (TRC 2017b).

The potential uppermost aquifer as defined in 40 CFR §257.53 is encountered at an elevation of approximately 462 feet. The bottom of the BABs is at an elevation of approximately 572 feet, thus 110 feet of vertically contiguous silty clay-rich till separates the BABs CCR unit from the underlying aquifer and serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer. The overlying silty clay-rich low-permeability soil has a hydraulic conductivity on the order of 2.3 to 3.1 x 10^{-8} centimeters per second (cm/s) as found in soil testing performed during the CCR monitoring well installation in the area of the BABs (TRC 2017b).

The water level in the BABs is maintained at an elevation between 579 feet and 580 feet. The hydraulic head in the aquifer below the BABs is approximately 580 feet (TRC 2018c), thus the little hydraulic head gradient between the BABs CCR unit and the underlying aquifer is very small.

3.3 Monroe Power Plant FAB

The MONPP FAB overlies unconsolidated clay-rich glacial till and/or lacustrine deposits with saturated limestone of the Bass Islands Group bedrock generally encountered from 37 to 53.5 feet below ground surface. The limestone aquifer encountered at the site is generally artesian except in the area of monitoring well MW-16-01. Monitoring well MW-16-01 is located within several hundred feet of several off-site domestic residential water supply wells located to the north along Dunbar Road adjacent to Plum Creek that likely lower the hydraulic head in the area of MW-16-01 (TRC 2017c).

The MONPP FAB CCR unit uppermost aquifer as defined in 40 CFR §257.53 consists of saturated limestone present beneath at least 37 feet and up to 53.5 feet of thick contiguous silty clay-rich soil that serves as a natural confining hydraulic barrier that isolates the underlying uppermost aquifer. At its deepest incised area the MONPP FAB has approximately 23 feet of clay-rich soil separating the bottom of the FAB from the uppermost aquifer. Near the north end of the FAB where the hydraulic gradient is steeper, the clay is at least 30 feet thick. The overlying low permeability silty clay-rich soil has a hydraulic conductivity of 2.7×10^{-8} cm/s calculated as the geometric mean of 33 hydraulic conductivity values obtained from testing of the clay. The water level in the FAB is maintained at an elevation of approximately 609 feet. The hydraulic head in the aquifer below the FAB is ranges from approximately 580 feet to 597 feet (TRC 2018d).

3.4 J.R. Whiting Power Plant

The JRWPP overlies more than 50 feet of unconsolidated clay-rich glacial till and/or lacustrine deposits overlying limestone bedrock. Bedrock is generally encountered from 52 to 64 feet below ground surface (elevations of 524 to 516 feet) (STS Consultants 1993). Permeameter tests completed on eight samples of the site clay produced hydraulic conductivity values ranging from 5.5×10^{-9} cm/s to 2.23×10^{-8} cm/s. The limestone bedrock aquifer underlying clay deposits forms the shallowest aquifer below the CCR units.

3.4.1 JRWPP Ponds 1 and 2 CCR Unit

As described above, the uppermost aquifer unit beneath the Ponds 1 and 2 CCR unit is limestone bedrock that is hydraulically isolated by the overlying clay-rich till. The shallowest bedrock is encountered at an elevation of approximately 520 feet (TRC 2016) and the bottom of the pond is at an elevation of approximately 555 feet (Golder Associates 2016), thus 35 feet of clay separate the bottom of the Ponds 1 and 2 CCR Unit from the underlying aquifer. The water level in Ponds 1 and 2 was maintained at an elevation of approximately 586 feet. The hydraulic head in the aquifer below Ponds 1 and 2 is approximately 575 feet (TRC 2018e).

3.4.2 JRWPP Pond 6 CCR Unit

As with Ponds 1 and 2, the shallowest bedrock is encountered at an elevation of approximately 520 feet below the Pond 6 CCR unit (TRC 2016). The bottom of Pond 6 is at an elevation of approximately 560 feet, thus 40 feet of clay separate the bottom of the Pond 6 CCR unit from the underlying aquifer. During its operational years, the water level in Pond 6 was maintained at elevations between approximately 592 feet to 597 feet. The hydraulic head in the aquifer below Pond 6 is approximately 575 feet.

Section 4
Leakage Rate Calculations

To assess the performance of the natural clay liners underlying the six CCR units at the sites discussed above, leakage rates were calculated for each of the units using site-specific parameters and Darcy's Law:

$$Q = -KA\frac{dh}{dl}$$

where Q is the leakage rate, K is the hydraulic conductivity of the clay, A is the cross-sectional area of flow, dh is the difference between the hydraulic head in the CCR unit and the hydraulic head in the aquifer below the natural clay, and dl is the thickness of the clay. This analysis assumes that flow through the liner is vertical and one-dimensional. Input parameters for K, dh, and dl for each CCR unit are summarized in Table 1. By assuming the cross-sectional area of flow to be one hectare, leakage rates are determined on a per hectare basis, consistent with the liner leakage literature. Calculated leakage rates (in lphd) are also summarized in Table 1. Calculation documentation is provided in Appendix B. Calculated leakage rates for the natural clay liners ranged from 2 lphd (SCPP BABs) to 227 lphd (MONPP FAB).

The calculated leakage rates represent the expected leakage through the natural clays below the CCR units under currently operating conditions, except for the JRWPP CCR units, which are no longer operating. For the JRWPP CCR units, the calculated leakage rates are conservatively based on conditions experienced while they were operating. Now that Pond 6 is capped, it is expected that the hydraulic head within the CCR unit is less than it was during operation, and therefore, the leakage rate under capped conditions is expected to be less than the calculated leakage rate. Ponds 1 and 2 are planned to be capped in the near future, which will also likely reduce the leakage rate associated with that CCR unit.

To compare the performance of the natural clay liners with the expected performance of a single composite liner, potential leakage rates were also calculated for a hypothetical composite liner meeting state and federal regulations. Giroud et al. (1998) provide an equation for calculating the expected leakage through a composite clay liner resulting from a geomembrane defect:

$$Q = 0.976C_{qo}\left[1 + 0.1\left(\frac{h}{T}\right)^{0.95}\right]d^{0.2}h^{0.9}K^{0.74}$$

where Q is the leakage rate (m^3/s), C_{qo} is a dimensionless coefficient that characterizes the quality of contact between the geomembrane and the clay, h is the hydraulic head of the leachate on the liner (m), T is the thickness of the compacted clay (m), d is the diameter of the defect (m), and K is the hydraulic conductivity of the compacted clay (m/s).

The composite liner leakage calculations assume that liner construction consists of two feet (0.61 m) of compacted clay having hydraulic conductivity of 1 x 10^{-7} cm/s (1 x 10^{-9} m/s) underlying a geomembrane. A leachate head of one foot (0.3 m) over the liner and head of zero below the liner is also assumed. As previously discussed, the composite liner leakage calculation also requires assumptions regarding the number of defects, the size of the defects, and the quality of contact between the geomembrane and the clay. To assess the effects of these assumed parameters on the calculated leakage rate, calculations were made using two different values for defect diameter (0.001 m and 0.00564 m), contact coefficient (per Giroud et al. 1998, $C_{qo} = 0.21$ for good contact, $C_{qo} = 1.15$ for poor contact), and defect frequency (2.5 defects per hectare and 5 defects per hectare). Using multiple inputs results in a range of potential leakage rates for the hypothetical composite liner in question.

Calculated leakage rates for a composite liner are shown in Table 2. Calculation documentation is provided in Appendix B. The calculated rates range from a low of 0.9 lphd (for 2.5 small defects per hectare and assuming good contact between the geomembrane and underlying clay) to 14 lphd (for 5 large defects per hectare and assuming poor geomembrane-clay contact). Thus a composite liner built in accordance with current regulations could be expected to leak up to 14 lphd.

Rowe (2012) suggests that calculated leakage rates actually underestimate actual leakage. As a result, actual leakage rates from composite liners may be higher than 14 lphd. Nevertheless, two of the investigated CCR units (BRPP DB and SCPP BABs) have leakage rates less than 14 lphd, indicating they are performing at least as well as a single composite liner. Three of the other four CCR units have leakage rates within one order of magnitude of 14 lphd indicating that these natural liners provide a fairly comparable, if not equal, level of protection as a composite liner.

In addition to leakage rate, leachate travel time can also be used to assess liner performance. To determine the amount of time required for leachate to travel through a clay liner the average linear velocity of the leachate must be calculated. Average linear velocity is calculated using a version of Darcy's Law:

$$v = -\frac{K}{n_e}\frac{dh}{dl}$$

where v is the average linear velocity of leachate advection, n_e is the effective porosity of the clay, and K, dh, and dl are as previously defined. Using the values for K, dh, and dl from

Table 1 and assuming an effective porosity for clay of 0.4, average linear velocity was calculated for each of the CCR units. Leachate travel time (t) was then calculated using:

$$t = \frac{dl}{v}$$

Travel times for the six natural clay liners are shown in Table 1. Calculation documentation is provided in Appendix B. Calculations for the MONPP FAB CCR Unit used average hydraulic conductivity due to the amount of historical hydraulic conductivity values. For all other units, calculations used the highest hydraulic conductivity value obtained at the site to produce conservative results. Travel times range from 441 years (MONPP FAB) to 150,800 years (SCPP BABs). All of the computed travel times suggest that the natural clay liners below the six CCR units will be protective of the underlying aquifers well into the future.

For comparison, the calculated time for leachate to travel through 2 feet of compacted clay in a composite liner (assuming leachate head of 1 foot (0.3 meters) above the liner and head of zero below the liner) after having penetrated through a geomembrane defect is only 5 years. Thus even for the natural liners that have higher leakage rates than a composite liner, the thickness of the natural clay results in protection over a much longer timeframe than can be provided by a composite liner.

An additional point of comparison relates to US EPA Statutory Interpretive Guidance – Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act (July 1986). This document develops criteria and a method for determining groundwater vulnerability at hazardous waste facilities. The method requires calculation of the travel time along a 100-foot flow line originating at the base of the hazardous waste unit. The intent is for the 100-foot flow line to represent a sample of the geologic material at the site representing an area of likelihood of investigation for release. The criterion established by this method relates a travel time along 100-ft of flow line on the order of 100 years is the threshold for vulnerability (US EPA, p. ES-3).

This analog is a very important concept for responding to the DC Court Opinion that found that the record evidence showed that the vast majority of existing impoundments are unlined and that unlined impoundments have a 36.2 to 57 percent chance of leaking at a harmfully contaminating level during their foreseeable use (DC Court, pg. 18). Based on this record, the DC Court found that it isn't reasonable to rely on leak detection followed by closure in order to address reasonable protectiveness of human health and the environment.

The travel time results from this study show travel times that far exceed the vulnerability criterion, demonstrating that site-specific evaluation can demonstrate protectiveness.

Interestingly, the DC Court also found that the self-implementing one-size-fits-all may have been necessary as a national minimum standard, but also acknowledged that more precise risk-based standards are both feasible and enforceable under the individualized permitting programs and direct monitoring provisions authorized by WIIN Act (DC Court, pg. 38). The sites presented in this study and the methods and criterion used to evaluate the competency of the liner systems meet the regulatory standard "does not pose a reasonable probability of adverse effects on health or the environment."

Section 5
Conclusions

Multiple CCR impoundments in southeast Michigan are documented to be constructed within thick (> 20 feet thick, in some cases more than 100 feet thick) laterally contiguous glacially compacted natural clay-rich soils with a hydraulic conductivity no greater than 1 x 10^{-7} cm/s prior to implementation of the CCR Rule requiring composite liners (§257.70) or demonstration of equivalent performance to alternative composite liners. The natural soil underlying these CCR impoundment units consists of thick, low-hydraulic conductivity clay, that provides the same, or better level of protection from potential migration of contaminants than the composite liner defined in 257.70(b). Using recognized and generally accepted good engineering practices, TRC concludes that the natural soils below six CCR impoundment units at four sites in southeast Michigan perform better than composite liners. In summary:

- TRC calculated leakage rates for six Southeast Michigan CCR units and compared these to the anticipated leakage rates for a single composite liner system. For all six units, the leakage rates were generally within an order of magnitude of the composite liner system. These data show that anticipated leakage rates between the natural soil barriers and the single composite liners are comparable. Data are summarized on Table 1. Data also show that other site specific factors contribute more significantly to the protectiveness of natural soil barriers when compared to single composite liner system, including thickness of the natural soil barrier, hydraulic conductivity of the soil barrier, and the hydraulic gradient between the CCR unit and the underlying aquifer, which can result in significantly greater times of travel to the uppermost aquifer. The results of the time of travel calculations are summarized on Table 1. As shown, all the six evaluated Southeast Michigan CCR units have natural clay liners that are more protective than single composite liner system.

- The travel time results from this study show times that exceed the USEPA's vulnerability criterion demonstrating that site-specific evaluation can demonstrate protectiveness. The sites presented in this study and the methods and criteria used to evaluate the competency of the liner systems meet the regulatory standard "does not pose a reasonable probability of adverse effects on health or the environment."

- Additionally, all of the studied CCR units have been in operation for decades. Although not the focus of this study, groundwater monitoring is currently being performed at all six of the CCR units that are the subject of this study. Based on review of this data, CCR-affected groundwater is not present at these facilities, which further supports the conclusions of this study. Groundwater data supporting this statement are available at:

Consumers Energy
https://www.consumersenergy.com/community/sustainability/environment/waste-management/coal-combustion-residuals

DTE Energy
https://newlook.dteenergy.com/wps/wcm/connect/dte-web/home/community-and-news/common/environment/coal-combustion-residual

Section 6
References

AECOM. 2009. Potential Failure Mode Analysis (PFMA) Report, J.R. Whiting Generating Facility Ash Dike Risk Assessment, Erie, Michigan. December 2009.

Bonaparte, R., Daniel, D.E., and Koerner, R.M. 2002. Assessment and Recommendations for Improving the Performance of Waste Containment Systems, EPA Cooperative Agreement Number CR-821448-01-0. December 2002.

EPA. 1986. Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act, Statutory Interpretive Guidance, July 1986.

Giroud, J.P., Soderman, K.L, Khire, M.V., and Badu-Tweneboah, K. 1998. New Developments in Landfill Liner Leakage Evaluation, in Proceedings of the Sixth International Conference on Geosynthetics, Vol. 1, ed: R.K. Rowe. March 1998.

Golder Associates. 2016. J.R. Whiting Generating Facility, Ash Pond Material Characterization. September 2016.

Golder Associates. 2017. J.R. Whiting Generating Facility, Ash Ponds 1 and 2 Liquefaction Assessment Report, Erie, Michigan. October 2017.

Rowe, R. K. 2012. Short- and long-term leakage through composite liners, the 7th Arthur Casagrande Lecture, Canadian Geotechnical Journal 49: 141-169, doi: 10.1139/T11-092.

STS Consultants. 1993. Monitor Well Installation and Hydrogeologic Report, J.R. Whiting Power Plant, Erie, Michigan. August 1993.

TRC. 2016. 2016 Monitoring Well Design, Installation, Development, and Decommissioning, JR Whiting Electric Generation Facility, Erie, Michigan. December 2016.

TRC. 2017a. Groundwater Monitoring Systems Summary Report, DTE Electric Company, Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units. October 2017.

TRC. 2017b. Groundwater Monitoring System Summary Report, DTE Electric Company, St. Claire Power Plant Bottom Ash Basins Coal Combustion Residual Unit. October 2017.

TRC. 2017c. Groundwater Monitoring System Summary Report, DTE Electric Company, Monroe Power Plant Fly Ash Basin Coal Combustion Residual Unit. October 2017.

TRC. 2018a. Annual Groundwater Monitoring Report, DTE Electric Company, Belle River Power Plant Bottom Ash Basins. January 2018.

TRC. 2018b. Annual Groundwater Monitoring Report, DTE Electric Company, Belle River Power Plant Diversion Basin. January 2018.

TRC. 2018c. Annual Groundwater Monitoring Report, DTE Electric Company, St. Clair Power Plant Bottom Ash Basins. January 2018.

TRC. 2018d. Annual Groundwater Monitoring Report, DTE Electric Company, Monroe Power Plant Fly Ash Basin Coal Combustion Residual Unit. January 2018.

TRC. 2018e. Annual Groundwater Monitoring Report, Former JR Whiting Power Plant Ponds 1 and 2 CCR Unit. January 2018.

Tables

Table 1
Summary of Velocity and Travel Time Calculations
Natural Clay Liner Equivalency Evaluation

CCR Units	Basin head (ft amsl)	Aquifer head (ft amsl)	dh	Basin Bottom (ft amsl)	Bottom of Clay (ft amsl)	Clay Thickness (dl, ft)	Vertical Hydraulic Gradient	Max K (cm/s)*	Q (lphd)	Velocity (ft/d)**	Travel time (yrs)
Two feet of clay***	--	--	3	--	--	2	1.5	1.0E-07	--	1.1E-03	5
Belle River PP BABs	590	574	16	580	500	80	0.20	2.9E-08	50	4.1E-05	5,329
Belle River PP DB	580	575	5	576	459	117	0.043	2.9E-08	11	8.8E-06	36,474
St. Clair PP BABs	580	579	1	572	462	110	0.009	3.1E-08	2	2.0E-06	150,800
Monroe PP FAB	609	580	29	563	533	30	0.97	2.7E-08	227	1.9E-04	441
Whiting Ponds 1&2	586	575	11	555	520	35	0.31	2.2E-08	61	5.0E-05	1,929
Whiting Pond 6	597	575	22	560	520	40	0.55	2.2E-08	106	8.7E-05	1,260

Created by: S. Sellwood 11/27/2018
Checked by: C. Olson 12/3/2018

Notes:
ft = feet
ft/d = feet per day
cm/s = centimeters per second
yrs = years
lphd = liters per hectare per day
amsl = above mean sea level
dh = difference between basin head and aquifer head
K = vertical hydraulic conductivity
Q = leakage rate
*The geometric mean of 33 available K values used for Monroe PP FAB, maximum K used for all other CCR units
**Velocity assumes effective porosity of 0.4
***Represents migration of leachate through a composite liner after passing through holes in the geomembrane, assumes 1 foot of head above the liner and head of zero below the liner

Table 2
Calculated Composite Liner Leakage Rates
Natural Clay Liner Equivalency Evaluation

			Size of Liner Defects		Quality of Contact				Q (lphd)		
h (m)	T (m)	K (m/s)	d_{sml} (m)	d_{lrg} (m)	$C_{qo(good)}$	$C_{qo(poor)}$	Q (m^3/s)	Q (L/day)	2.5 defects/hc	5 defects/hc	Assumptions
0.305	0.61	1.00E-09	0.001		0.21		4.07E-09	0.35	0.9	1.8	small defects, liner in good contact with clay
0.305	0.61	1.00E-09		0.00564	0.21		5.75E-09	0.50	1.2	2.5	large defects, liner in good contact with clay
0.305	0.61	1.00E-09	0.001			1.15	2.23E-08	1.92	4.8	9.6	small defects, liner in poor contact with clay
0.305	0.61	1.00E-09		0.00564		1.15	3.15E-08	2.72	6.8	14	large defects, liner in poor contact with clay

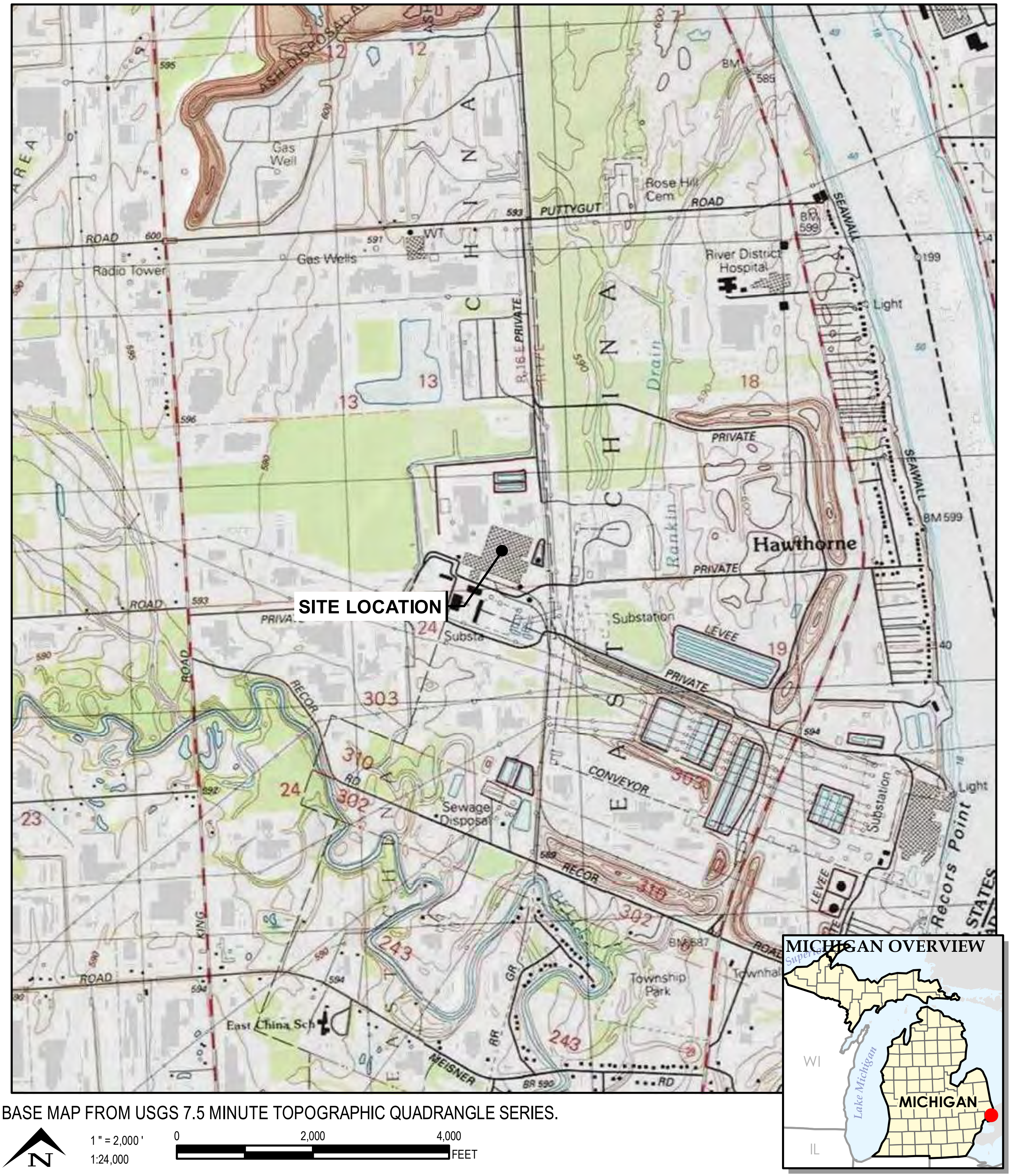
Created by: S. Sellwood 11/27/2018
Checked by: C. Olson 12/3/2018

Notes:
h = height of water above the geomembrane
T = thickness of the compacted clay liner
K = hydraulic conductivity of the compacted clay liner
d = diameter of geomembrane defects
C_{qo} = dimensionless coefficient characterizing the quality of the contact between the geomembrane and the underlying compacted clay liner (Giroud et al. 1998)
Q = leakage rate, calculated in accordance with Giroud et al. 1998
m = meter
s = second
L = liter
lphd = liter per hectare per day
hc = hectare

Appendix A
Site Data (Four Southeast MI CCR Unit Sites)

Table of Contents

BRPP BABs and DB CCR Units Site



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:

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

TITLE:

SITE LOCATION MAP

DRAWN BY:	J. PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	265996.0003
FILE:	265996-SLMMB.mxd

FIGURE 1

E:\DTE\CCR_Sites\2017_265996\265996-SLMMB.mxd -- Saved By: BDEEGAN on 10/9/2017, 14:49:39 PM

LEGEND

● SOIL BORING

⊕ MONITORING WELL

⊘ DECOMMISSIONED MONITORING WELL

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 BY BMJ ENGINEERS & SURVEYORS, INC.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

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

TITLE:

SITE PLAN

DRAWN BY: R SUEMNICHT
CHECKED BY: S HOLMSTROM
APPROVED BY: V BUENING
DATE: OCTOBER 2017
PROJ NO.: 265996.0003

FIGURE 2

TRC

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Ann Arbor, MI 48108-3284
Phone: 734.971.7080
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FILE NO.: 265996-0003-002.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:18:14 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0003-002.mxd

Table 1

Groundwater Elevation Summary
Belle River Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
China Township, Michigan

Well ID	MW-16-01		MW-16-02		MW-16-03		MW-16-04		MW-16-09	
Date Installed	3/17/2016		3/15/2016		6/1/2016		3/8/2016		6/2/2016	
TOC Elevation	590.06		588.94		590.66		590.51		590.80	
Geologic Unit of Screened Interval	Sand		Sand		Silty Sand		Sand		Sand	
Screened Interval Elevation	496.3 to 491.3		494.3 to 489.3		456.0 to 451.0		468.5 to 463.5		452.3 to 447.3	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
8/1/2016	16.21	573.85	15.30	573.64	16.53	574.13	16.89	573.62	16.70	574.10
9/19/2016	16.25	573.81	23.33	565.61	16.54	574.12	16.90	573.61	16.70	574.10
11/7/2016	16.58	573.48	19.91	569.03	16.82	573.84	17.15	573.36	16.95	573.85
1/9/2017	16.39	573.67	17.90	571.04	16.66	574.00	17.02	573.49	16.90	573.90
2/27/2017	16.11	573.95	16.65	572.29	16.43	574.23	16.75	573.76	16.56	574.24
4/17/2017	16.05	574.01	15.71	573.23	16.31	574.35	16.63	573.88	16.45	574.35
5/18/2017	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
6/5/2017	15.67	574.39	14.80	574.14	15.98	574.68	16.31	574.20	16.18	574.62
6/30/2017	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
7/24/2017	15.82	574.24	14.45	574.49	16.12	574.54	16.44	574.07	16.29	574.51

Notes:

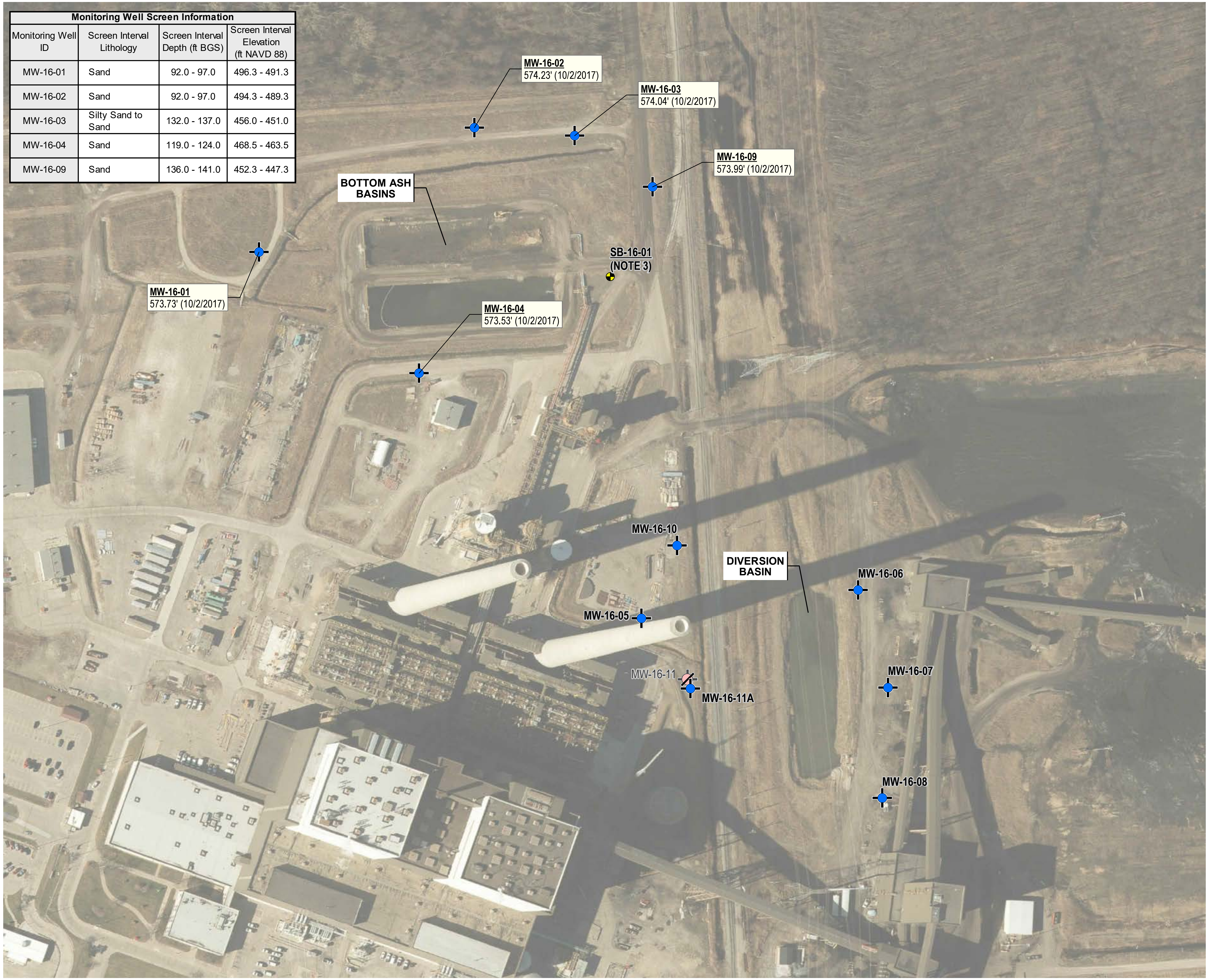
Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet Below top of casing

NM - Not Measured

Monitoring Well Screen Information

Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3



LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.

N

0 200 400
Feet

1 " = 200 '
1:2,400

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

TITLE:
BOTTOM ASH BASINS GROUNDWATER POTENTIOMETRIC ELEVATION SUMMARY OCTOBER 2017

DRAWN BY:	S. MAJOR	PROJ NO.:	265996.0003
CHECKED BY:	C. SCIESZKA		FIGURE 3
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

TRC

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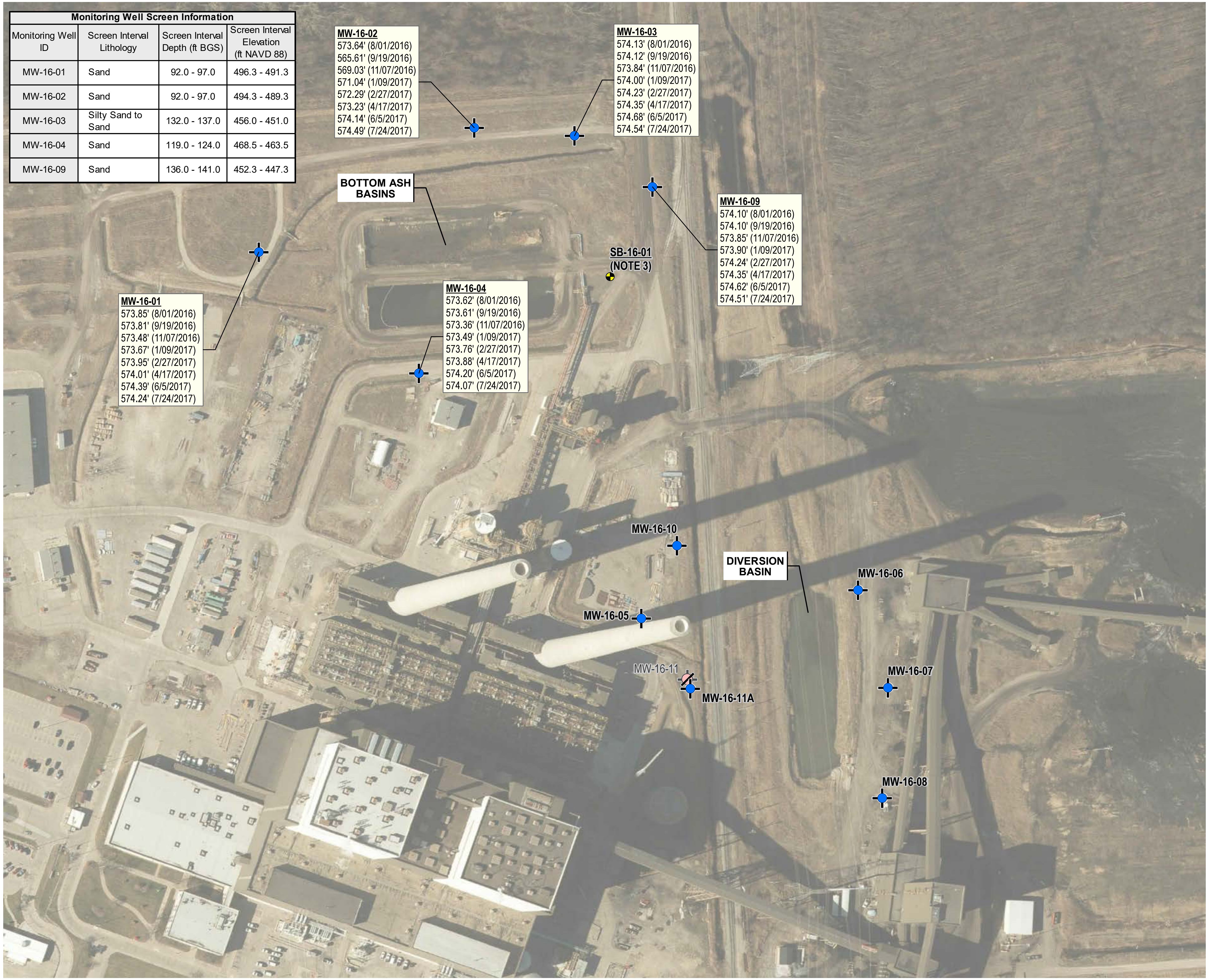
FILE NO.: 265996-0003-014.mxd

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/12/2018, 09:54:28 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0003-014.mxd

Monitoring Well Screen Information

Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-01	Sand	92.0 - 97.0	496.3 - 491.3
MW-16-02	Sand	92.0 - 97.0	494.3 - 489.3
MW-16-03	Silty Sand to Sand	132.0 - 137.0	456.0 - 451.0
MW-16-04	Sand	119.0 - 124.0	468.5 - 463.5
MW-16-09	Sand	136.0 - 141.0	452.3 - 447.3



LEGEND

SOIL BORING
MONITORING WELL
DECOMMISSIONED MONITORING WELL

MW ID
GROUNDWATER ELEVATION (DATE)
GROUNDWATER ELEVATION (DATE)
etc...

FT BGS
FEET BELOW GROUND SURFACE
FT NAVD 88
ELEVATION RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL AND JUNE 2016 AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.

N

0 200 400
Feet

1 " = 200 '
1:2,400

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

TITLE:
BOTTOM ASH BASINS
GROUNDWATER POTENTIOMETRIC
ELEVATION SUMMARY

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0003
CHECKED BY:	C. SCIESZKA		
APPROVED BY:	V. BUENING	**FIGURE 1**	
DATE:	JANUARY 2018		

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

FILE NO.: 265996-0003-003A.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/15/2018, 10:06:08 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0003-003A.mxd

Table 1

Groundwater Elevation Summary
Belle River Power Plant Diversion Basin – RCRA CCR Monitoring Program
China Township, Michigan

Well ID	MW-16-05		MW-16-06		MW-16-07		MW-16-08		MW-16-10		MW-16-11 (1)		MW-16-11A	
Date Installed	3/4/2016		3/11/2016		3/9/2016		3/10/2016		6/6/2016		6/7/2016		5/12/2017	
TOC Elevation	590.82		593.21		592.58		591.88		592.26		591.54		591.66	
Geologic Unit of Screened Interval	Clayey Silt/Shale Interface		Silt/Shale Interface		Silt/Shale Interface		Silt/Shale Interface		Gravelly Silt and Silty Clay		Sandy Clay		Silt and Silty Clay	
Screened Interval Elevation	449.3 to 444.3		455.0 to 450.0		456.9 to 451.9		456.3 to 451.3		444.3 to 439.3		452.0 to 447.0		452.5 to 447.5	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
8/1/2016	16.95	573.87	17.74	575.47	16.84	575.74	15.74	576.14	17.88	574.38	16.86	574.68	Not Installed	
9/19/2016	17.00	573.82	17.85	575.36	17.00	575.58	15.90	575.98	17.98	574.28	16.96	574.58		
11/7/2016	17.13	573.69	17.59	575.62	16.70	575.88	15.70	576.18	18.06	574.20	16.99	574.55		
1/9/2017	17.11	573.71	17.51	575.70	16.60	575.98	15.58	576.30	17.94	574.32	16.87	574.67		
2/27/2017	16.74	574.08	17.36	575.85	16.56	576.02	15.50	576.38	17.72	574.54	NU	NU		
4/17/2017	16.77	574.05	17.71	575.50	16.84	575.74	15.70	576.18	17.81	574.45	NU	NU		
5/18/2017	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	Decommissioned		16.69	574.97
6/5/2017	16.61	574.21	17.66	575.55	16.83	575.75	15.72	576.16	17.73	574.53			16.71	574.95
6/30/2017	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM			16.83	574.83
7/24/2017	16.74	574.08	18.01	575.20	17.13	575.45	15.99	575.89	17.93	574.33			16.91	574.75

Notes:

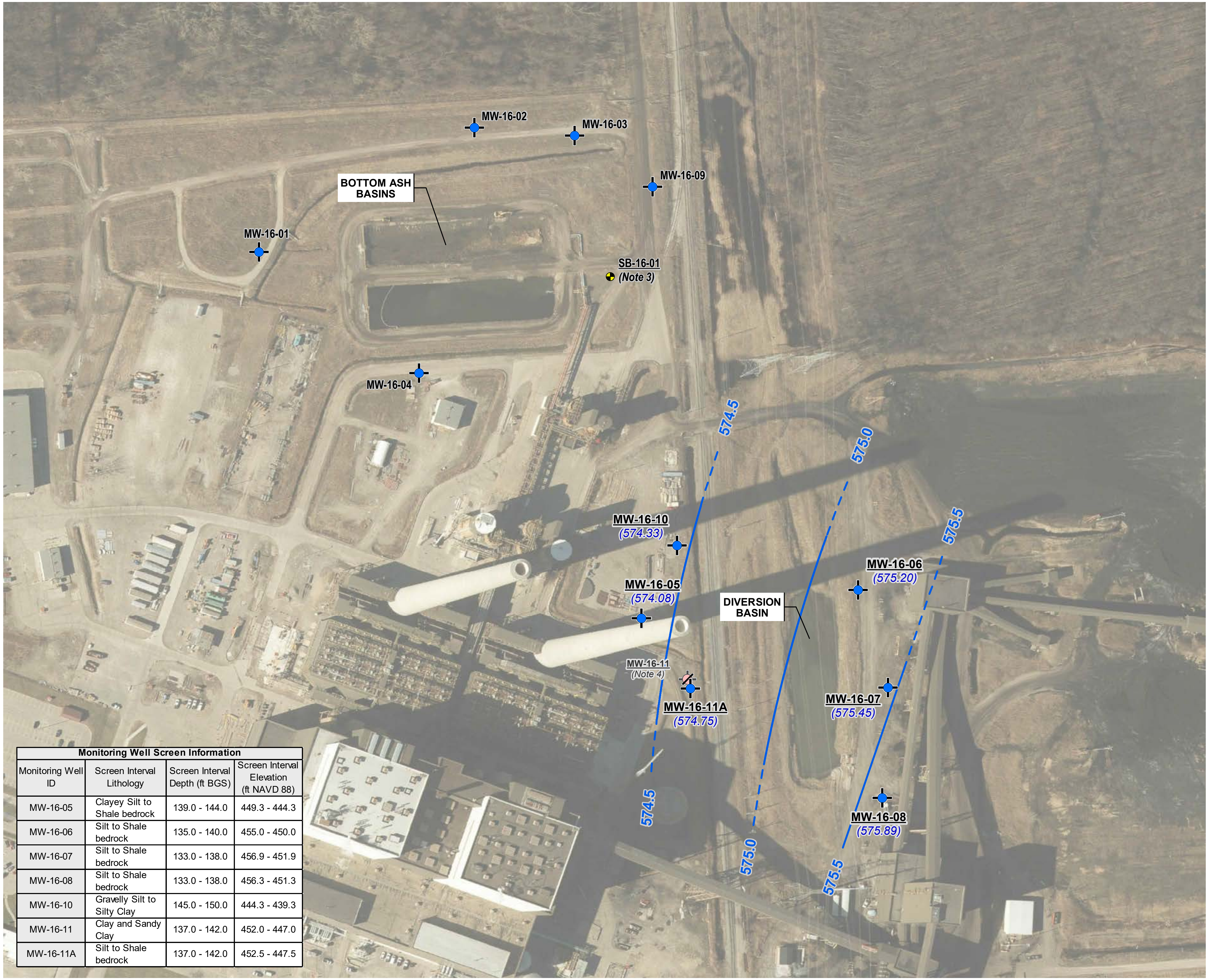
Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet Below top of casing

NU - Not Used; monitoring well was damaged at the time of data collection.

NM - Not Measured

(1) MW-16-11 decomissioned on 5/11/2017 and replaced with MW-16-11A.



Monitoring Well Screen Information

Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-05	Clayey Silt to Shale bedrock	139.0 - 144.0	449.3 - 444.3
MW-16-06	Silt to Shale bedrock	135.0 - 140.0	455.0 - 450.0
MW-16-07	Silt to Shale bedrock	133.0 - 138.0	456.9 - 451.9
MW-16-08	Silt to Shale bedrock	133.0 - 138.0	456.3 - 451.3
MW-16-10	Gravelly Silt to Silty Clay	145.0 - 150.0	444.3 - 439.3
MW-16-11	Clay and Sandy Clay	137.0 - 142.0	452.0 - 447.0
MW-16-11A	Silt to Shale bedrock	137.0 - 142.0	452.5 - 447.5

LEGEND

●	SOIL BORING
⌖	MONITORING WELL
⌖	DECOMMISSIONED MONITORING
(575.47)	GROUNDWATER ELEVATION (FT NAVD 88)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, AND JUNE 2016 BY BMJ ENGINEERS AND SURVEYORS. INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.
4. MONITORING WELL MW-16-11 WAS DECOMMISSIONED AND REPLACED BY MW-16-11A IN MAY 2017.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

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

TITLE:

DIVERSION BASIN GROUNDWATER POTENTIOMETRIC SURFACE MAP JULY 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0003
CHECKED BY:	C. SCIESZKA		FIGURE 8
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

TRC

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FILE NO.: 265996-0003-012.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/12/2018, 10:17:40 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
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TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:20:19 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
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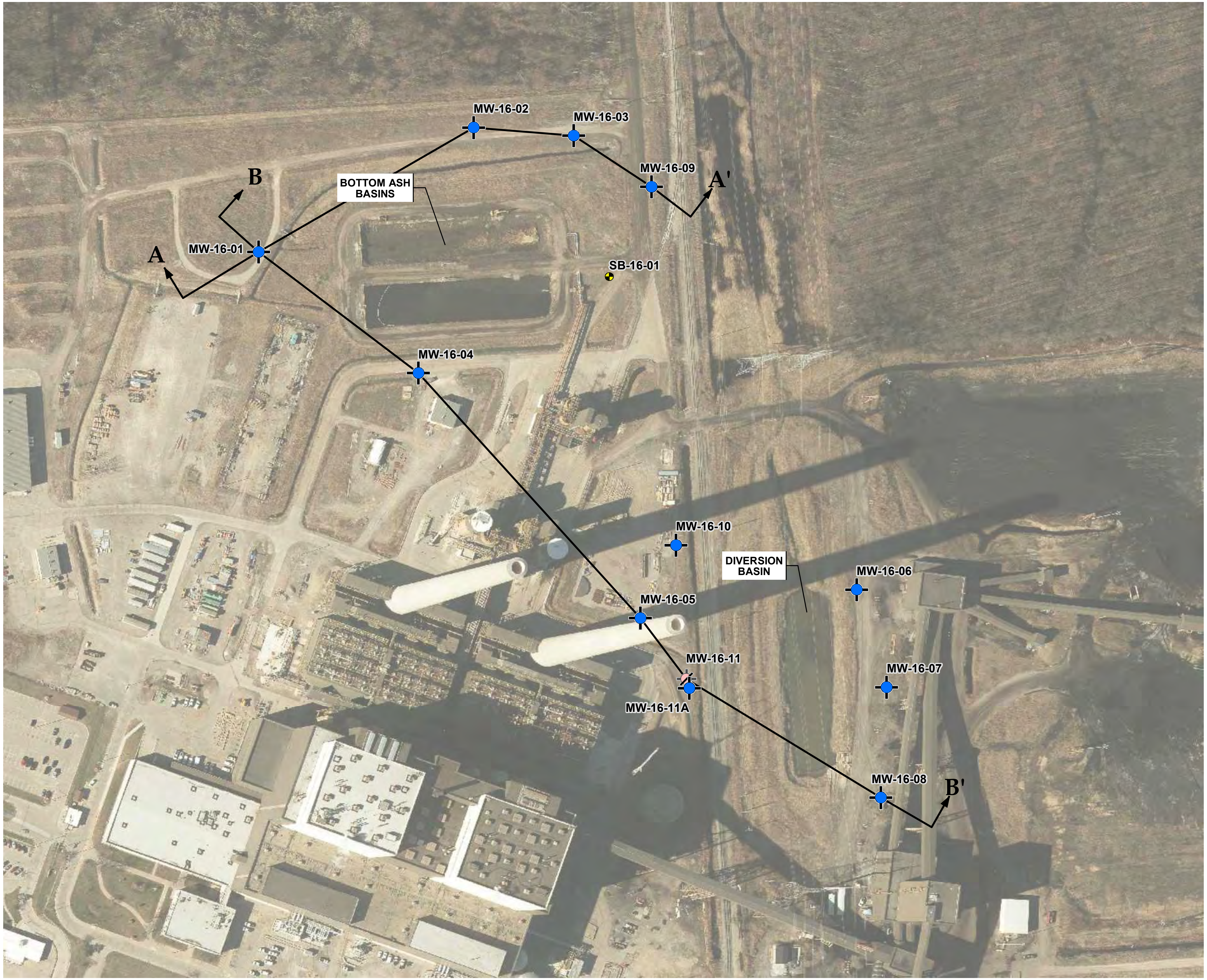

LEGEND

- ● 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.

N

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:	S. HOLMSTROM	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

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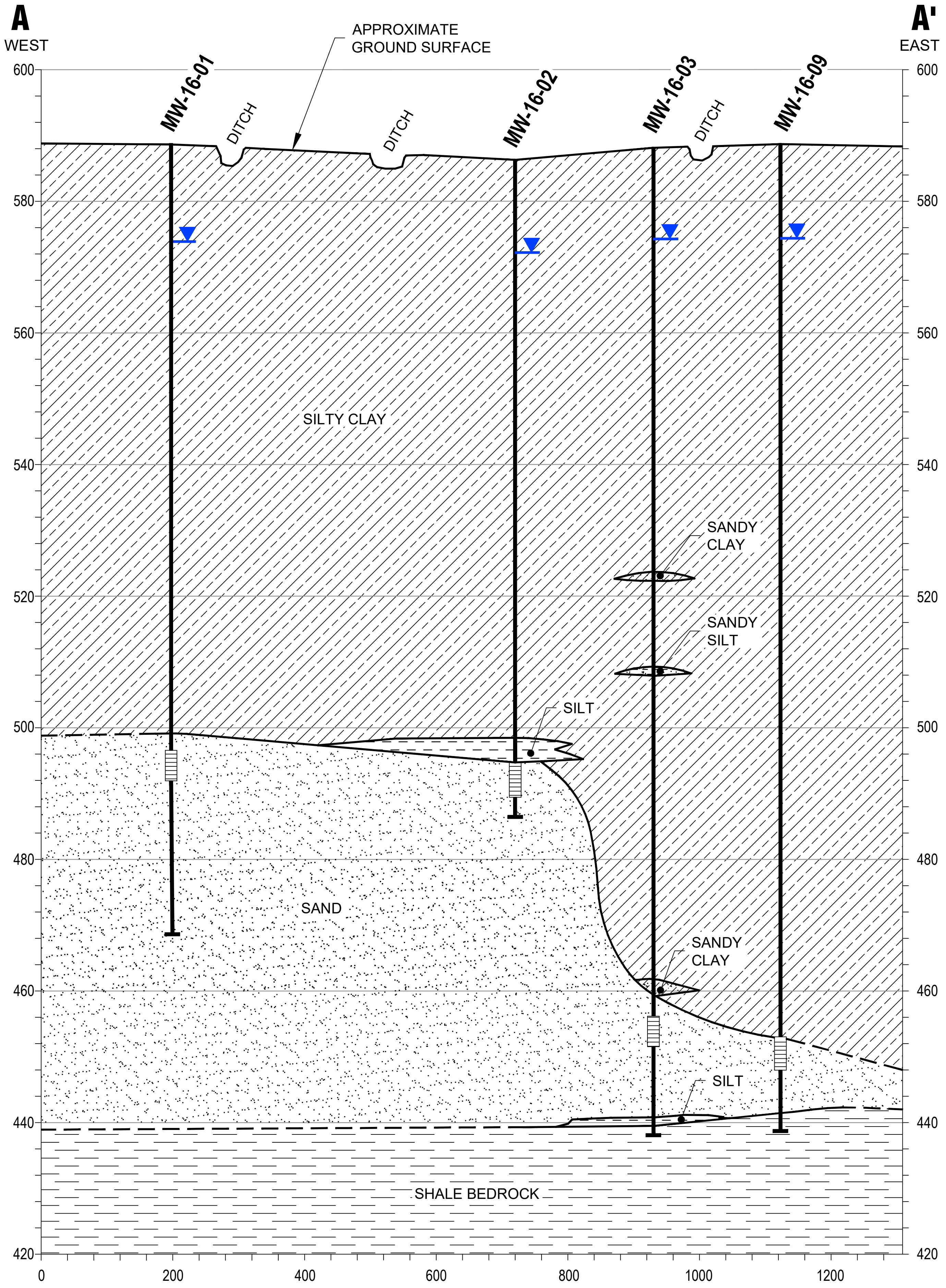
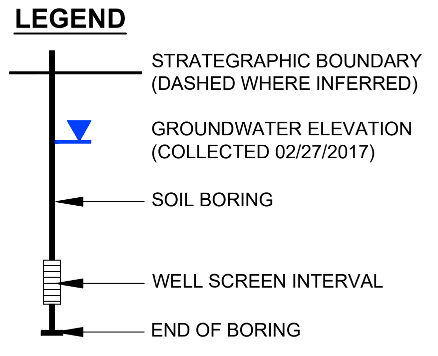
FILE NO.: 265996-0003-011.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'

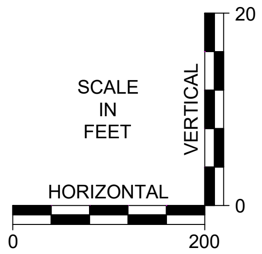


LEGEND



Lithology Key

▨	SILTY CLAY
░	SAND
☰	SILT
▩	SANDY CLAY
▒	SANDY SILT
☰	SHALE BEDROCK



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	FIGURE 4	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

TRC

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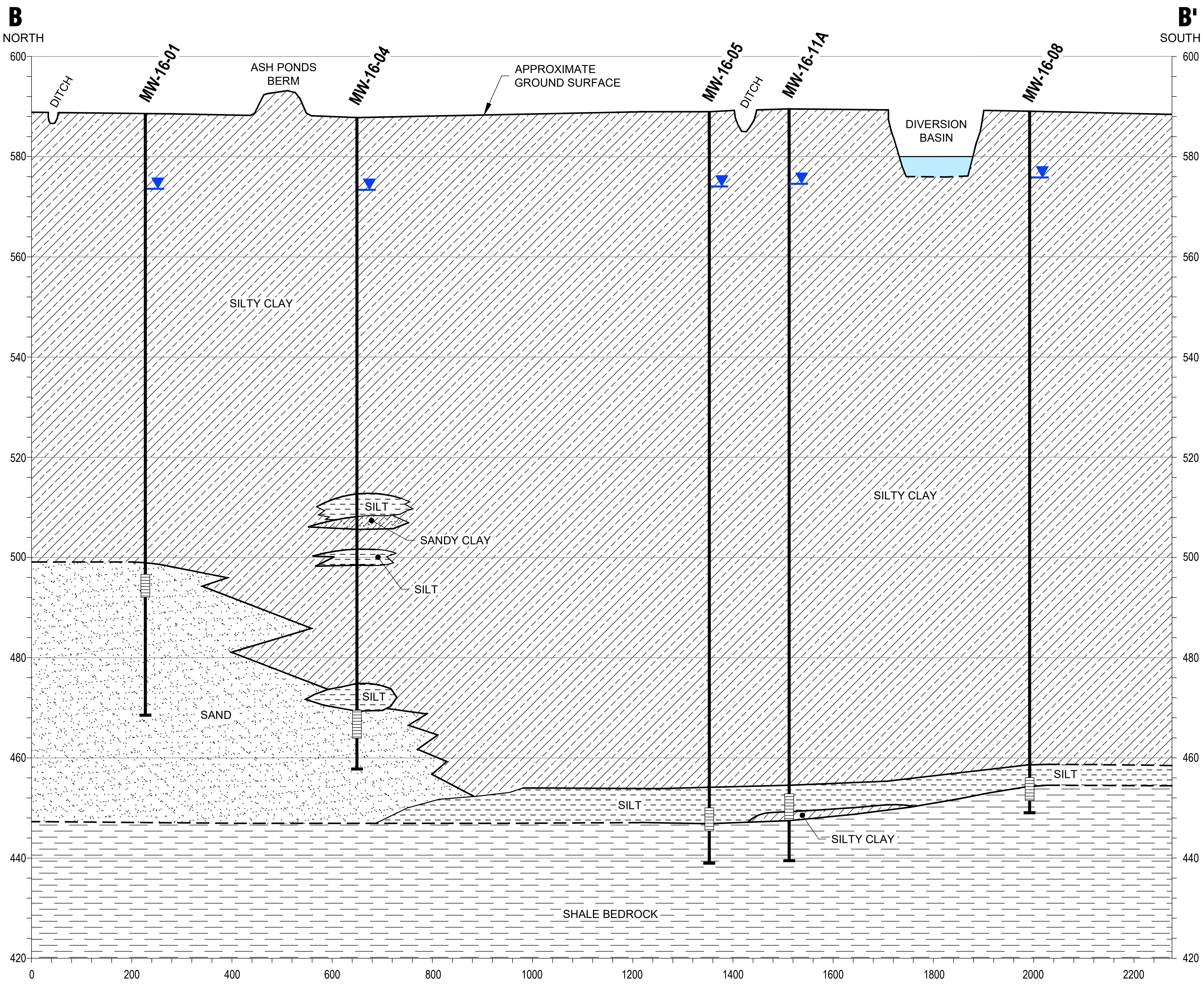
FILE NO.: 265996.0003.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES: DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_1; DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_2; XS aa wells; XS cc wells; XS DD wells;
DRAWING NAME: J:_TRC\DTE\Belle River PP\265996\0003\265996.0003.01.04-05.dwg --- PLOT DATE: October 10, 2017 - 6:47AM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

▼ GROUNDWATER ELEVATION (COLLECTED 02/27/2017)

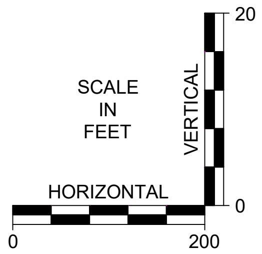
SOIL BORING

WELL SCREEN INTERVAL

END OF BORING

Lithology Key

▨	SILTY CLAY
⠿	SAND
☰	SILT
▨	SANDY CLAY
☰	SHALE BEDROCK



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		FIGURE 5
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

TRC

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Ann Arbor, MI 48108
Phone: 734.971.7080
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FILE NO.: 265996.0003.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES: DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_1; DTE BRPP XSs XXXXXXXXXX-02172017092213_Page_2; XS aa wells; XS cc wells; XS DD wells;
DRAWING NAME: J:_TRC\DTE\Belle River PP\265996\0003\265996.0003.01.04-05.dwg --- PLOT DATE: October 10, 2017 - 6:47AM --- LAYOUT: FIG05 XS BB

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - BRPP BAB and DB	Cell #:	8
Project #:	231828.0003.0000	USCS Description:	N/A
Sample Name:	MW-16-01, 50-52'	USCS Classification:	N/A
Visual Descript:	Gray lean clay	Average Kv =	2.9E-08 cm/s

	Initial Values	Final Values			
Sample Type: Undisturbed					
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	3.02	3.02	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	775.10	649.20	Sample Specific Gravity:	2.70	Est.
Tare & Dry (g)	562.60	471.50	Confining Pressure (psi):	100.0	
Tare (g)	88.86	88.64	Burette Diameter (in):	0.250	
Sample Wt. (g)	563.65	560.56	Burette Zero (cm):	100.0	

Moisture (%)	44.9	46.4	Maximum Gradient:	7.0
Wet Density (pcf)	109.9	109.5	Average Gradient:	6.5
Dry Density (pcf)	75.9	74.8	Max. Effect. Stress (psi):	5.7
Saturation (%)	99.2	100.0	Min. Effect. Stress (psi):	4.3
			Ave. Effect. Stress (psi):	4.8

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	15	8	10.00		0.0	95	95	55.40		3.45		102.60				
2	2016	3	15	11	15.00	11100	23.0	95	95	56.10	0.70	4.05	0.60	101.30	1.30	-36.8	4.7E-08	
3	2016	3	15	14	16.00	10860	23.0	95	95	57.00	0.90	4.75	0.70	100.60	0.70	0.0	3.6E-08	
4	2016	3	15	18	15.00	14340	23.0	95	95	57.75	0.75	5.55	0.80	99.75	0.85	-3.0	3.3E-08	
5	2016	3	16	4	55.00	38400	22.0	95	95	59.30	1.55	7.65	2.10	97.50	2.25	-3.4	3.4E-08	
6	2016	3	16	8	38.00	13380	23.0	95	95	59.80	0.50	8.35	0.70	96.80	0.70	0.0	3.2E-08	
7	2016	3	16	11	56.00	11880	23.0	95	95	60.35	0.55	9.05	0.70	96.30	0.50	16.7	3.1E-08	
8	2016	3	16	15	1.00	11100	23.0	95	95	60.40	0.05	9.60	0.55	95.70	0.60	-4.3	3.2E-08	
9	2016	3	17	5	14.00	51180	22.0	95	95	61.30	0.90	12.10	2.50	93.20	2.50	0.0	3.2E-08	
10	2016	3	17	8	17.00	10980	24.0	95	95	62.05	0.75	12.65	0.55	92.75	0.45	10.0	3.0E-08	
11	2016	3	17	12	19.00	14520	23.0	95	95	62.15	0.10	13.25	0.60	92.05	0.70	-7.7	3.0E-08	
12	2016	3	17	17	49.00	19800	23.0	95	95	62.60	0.45	14.15	0.90	91.30	0.75	9.1	2.9E-08	
13	2016	3	18	5	23.00	41640	22.0	95	95	63.15	0.55	16.00	1.85	89.40	1.90	-1.3	3.3E-08	
14	2016	3	18	8	58.00	12900	24.0	95	95	63.60	0.45	16.55	0.55	88.90	0.50	4.8	3.0E-08	
15	2016	3	18	12	55.00	14220	23.0	95	95	63.80	0.20	17.10	0.55	88.30	0.60	-4.3	3.0E-08	
16	2016	3	18	16	30.00	12900	23.0	95	95	64.10	0.30	17.65	0.55	87.90	0.40	15.8	2.8E-08	
17	2016	3	21	4	58.00	217680	22.0	95	95	67.20	3.10	25.35	7.70	80.20	7.70	0.0	3.1E-08	
18	2016	3	21	8	1.00	10980	24.0	95	95	67.60	0.40	25.70	0.35	79.85	0.35	0.0	3.1E-08	
19	2016	3	21	12	10.00	14940	23.0	95	95	67.60	0.00	26.15	0.45	79.40	0.45	0.0	3.0E-08	
20	2016	3	21	15	12.00	10920	23.0	95	95	67.70	0.10	26.40	0.25	79.15	0.25	0.0	2.3E-08	1
21	2016	3	21	19	36.00	15840	23.0	95	95	68.30	0.60	26.90	0.50	78.70	0.45	5.3	3.1E-08	1
22	2016	3	21	21	31.00	6900	23.0	95	95	68.10	-0.20	27.10	0.20	78.50	0.20	0.0	3.0E-08	1
23	2016	3	22	5	52.00	30060	25.0	95	95	68.90	0.80	28.05	0.95	77.65	0.85	5.6	3.1E-08	1
24	2016	3	22	10	31.00	16740	23.0	95	95	68.85	-0.05	28.45	0.40	77.20	0.45	-5.9	2.8E-08	1
25	2016	3	22	15	59.00	19680	24.0	95	95	69.40	0.55	29.00	0.55	76.70	0.50	4.8	2.9E-08	1
26	2016	3	22	22	32.00	23580	24.0	95	95	69.80	0.40	29.55	0.55	76.10	0.60	-4.3	2.7E-08	1

**A zero in this column starts a series of measurements.

*Average Kv for those rows with a 1 in the Ave. column. 2.9E-08 cm/s

(Termination determined by stable Kv and low flow differential.)

***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - BRPP BAB and DB	Cell #:	9
Project #:	231828.0003.0000	USCS Description:	N/A
Sample Name:	MW-16-05, 50-52'	USCS Classification:	N/A
Visual Descript:	Gray lean clay	Average Kv =	2.7E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.87	2.84	Permeant:	Water	
Sample Ht. (in)	3.25	3.20	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	536.11	691.40	Sample Specific Gravity:	2.70	Est.
Tare & Dry (g)	403.90	517.10	Confining Pressure (psi):	100.0	
Tare (g)	93.83	91.24	Burette Diameter (in):	0.250	
Sample Wt. (g)	610.40	600.16	Burette Zero (cm):	100.0	

Moisture (%)	42.6	40.9	Maximum Gradient:	7.3
Wet Density (pcf)	110.6	112.8	Average Gradient:	6.9
Dry Density (pcf)	77.5	80.0	Max. Effect. Stress (psi):	6.1
Saturation (%)	98.2	100.0	Min. Effect. Stress (psi):	4.6
			Ave. Effect. Stress (psi):	5.1

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	15	8	11.00		0.0	95	95	25.20		1.95		101.75				
2	2016	3	15	11	15.00		0.0	95	95	27.70		1.80		99.60				
3	2016	3	15	14	17.00	10920	23.0	95	95	29.40	1.70	2.00	0.20	98.65	0.95	-65.2	3.2E-08	
4	2016	3	15	18	16.00	14340	23.0	95	95	30.65	1.25	2.40	0.40	97.60	1.05	-44.8	3.1E-08	
5	2016	3	16	4	56.00	38400	22.0	95	95	32.20	1.55	3.85	1.45	95.40	2.20	-20.5	3.1E-08	
6	2016	3	16	8	39.00	13380	23.0	95	95	32.40	0.20	4.40	0.55	94.85	0.55	0.0	2.6E-08	
7	2016	3	16	11	57.00	11880	23.0	95	95	33.85	1.45	4.95	0.55	94.40	0.45	10.0	2.7E-08	
8	2016	3	16	15	2.00	11100	23.0	95	95	34.00	0.15	5.35	0.40	93.90	0.50	-11.1	2.7E-08	
9	2016	3	17	5	15.00	51180	22.0	95	95	35.20	1.20	7.35	2.00	91.80	2.10	-2.4	2.8E-08	
10	2016	3	17	8	17.00	10920	24.0	95	95	35.80	0.60	7.80	0.45	91.45	0.35	12.5	2.5E-08	
11	2016	3	17	12	20.00	14580	23.0	95	95	35.90	0.10	8.30	0.50	89.85	1.60	-52.4	5.1E-08	
12	2016	3	17	17	50.00	19800	23.0	95	95	36.40	0.50	9.10	0.80	89.25	0.60	14.3	2.6E-08	
13	2016	3	18	5	23.00	41580	22.0	95	95	37.00	0.60	10.65	1.55	88.60	0.65	40.9	2.0E-08	
14	2016	3	18	8	58.00	12900	24.0	95	95	37.50	0.50	11.15	0.50	88.15	0.45	5.3	2.7E-08	
15	2016	3	18	12	55.00	14220	23.0	95	95	37.70	0.20	11.65	0.50	87.60	0.55	-4.8	2.8E-08	
16	2016	3	18	16	31.00	12960	23.0	95	95	38.00	0.30	12.10	0.45	87.20	0.40	5.9	2.5E-08	
17	2016	3	21	4	59.00	217680	22.0	95	95	41.00	3.00	19.25	7.15	79.85	7.35	-1.4	3.0E-08	
18	2016	3	21	8	2.00	10980	24.0	95	95	41.40	0.40	19.55	0.30	79.60	0.25	9.1	2.4E-08	
19	2016	3	21	12	10.00	14880	23.0	95	95	41.40	0.00	19.95	0.40	79.15	0.45	-5.9	2.8E-08	
20	2016	3	21	15	13.00	10980	23.0	95	95	41.60	0.20	20.25	0.30	78.85	0.30	0.0	2.7E-08	1
21	2016	3	21	19	37.00	15840	23.0	95	95	42.00	0.40	20.80	0.55	78.55	0.30	29.4	2.7E-08	1
22	2016	3	21	21	32.00	6900	23.0	95	95	41.80	-0.20	20.90	0.10	78.30	0.25	-42.9	2.6E-08	1
23	2016	3	22	5	53.00	30060	25.0	95	95	42.75	0.95	21.75	0.85	77.55	0.75	6.3	2.6E-08	1
24	2016	3	22	10	32.00	16740	23.0	95	95	42.75	0.00	22.20	0.45	77.10	0.45	0.0	2.8E-08	1
25	2016	3	22	16	0.00	19680	24.0	95	95	43.25	0.50	22.75	0.55	76.65	0.45	10.0	2.7E-08	1
26	2016	3	22	22	33.00	23580	24.0	95	95	43.60	0.35	23.35	0.60	76.10	0.55	4.3	2.6E-08	1

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 2.7E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation		QC:	JPH
Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)		QA:	JPH

Project Name:	DTE - BRPP BAB and DB	Cell #:	9
Project #:	231828.0003.0000	USCS Description:	N/A
Sample Name:	MW-16-07, 50-52'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	2.9E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.86	2.83	Permeant:	Water	
Sample Ht. (in)	3.50	3.48	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	512.00	737.80	Sample Specific Gravity:	2.68	Est.
Tare & Dry (g)	387.40	552.10	Confining Pressure (psi):	100.0	
Tare (g)	92.18	89.22	Burette Diameter (in):	0.250	
Sample Wt. (g)	666.40	648.58	Burette Zero (cm):	100.0	

Moisture (%)	42.2	40.1		
Wet Density (pcf)	112.9	112.9		
Dry Density (pcf)	79.4	80.6	Max. Effect. Stress (psi):	6.2
Saturation (%)	102.4	100.0	Min. Effect. Stress (psi):	4.5
			Ave. Effect. Stress (psi):	5.0

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	4	21	11	16.00		0.0	95	95	16.80		2.50		102.25				
2	2016	4	21	20	32.00	33360	27.0	95	95	27.60	10.80	1.25	-1.25	96.40	5.85	-154.3	4.1E-08	
3	2016	4	22	9	22.00	46200	24.0	95	95	32.50	4.90	2.40	1.15	93.40	3.00	-44.6	3.0E-08	
4	2016	4	22	12	18.00	10560	24.0	95	95	33.50	1.00	2.85	0.45	92.90	0.50	-5.3	3.1E-08	
5	2016	4	22	18	33.00	22500	25.0	95	95	35.05	1.55	3.80	0.95	91.95	0.95	0.0	2.9E-08	
6	2016	4	25	11	30.00	233820	23.0	95	95	44.30	9.25	12.75	8.95	83.10	8.85	0.6	3.1E-08	
7	2016	4	25	17	41.00	22260	24.0	95	95	45.35	1.05	13.50	0.75	82.40	0.70	3.4	2.9E-08	
8	2016	4	25	20	39.00	10680	24.0	95	95	45.30	-0.05	13.80	0.30	82.00	0.40	-14.3	3.0E-08	
9	2016	4	25	23	15.00	9360	24.0	95	95	45.35	0.05	14.10	0.30	81.70	0.30	0.0	3.0E-08	
10	2016	4	26	4	59.00	20640	25.0	95	95	46.00	0.65	14.75	0.65	81.00	0.70	-3.7	3.0E-08	
11	2016	4	26	8	19.00	12000	24.0	95	95	45.95	-0.05	15.10	0.35	80.60	0.40	-6.7	3.0E-08	
12	2016	4	26	13	18.00	17940	24.0	95	95	46.40	0.45	15.70	0.60	80.10	0.50	9.1	3.0E-08	
13	2016	4	27	4	57.00	56340	23.0	95	95	47.60	1.20	17.40	1.70	78.60	1.50	6.2	2.9E-08	
14	2016	4	27	12	47.00	28200	23.0	95	95	47.95	0.35	18.20	0.80	77.90	0.70	6.7	2.8E-08	
15	2016	4	27	15	8.00	8460	23.0	95	95	47.90	-0.05	18.45	0.25	77.65	0.25	0.0	3.2E-08	
16	2016	4	28	5	1.00	49980	22.0	95	95	48.80	0.90	19.80	1.35	76.35	1.30	1.9	3.0E-08	
17	2016	4	28	8	5.00	11040	24.0	95	95	49.40	0.60	20.15	0.35	76.15	0.20	27.3	2.8E-08	
18	2016	4	28	14	56.00	24660	23.0	95	95	49.60	0.20	20.75	0.60	75.55	0.60	0.0	2.8E-08	
19	2016	4	28	20	48.00	21120	23.0	95	95	49.90	0.30	21.30	0.55	75.10	0.45	10.0	2.8E-08	
20	2016	4	29	5	31.00	31380	26.0	95	95	51.05	1.15	22.10	0.80	74.35	0.75	3.2	2.8E-08	
21	2016	4	29	10	27.00	17760	23.0	95	95	50.90	-0.15	22.50	0.40	73.90	0.45	-5.9	3.0E-08	
22	2016	4	29	14	41.00	15240	23.0	95	95	51.25	0.35	22.90	0.40	73.60	0.30	14.3	2.9E-08	
23	2016	4	29	18	0.00	11940	23.0	95	95	51.55	0.30	23.20	0.30	73.40	0.20	20.0	2.7E-08	
24	2016	5	1	16	23.00	166980	22.0	95	95	54.25	2.70	26.95	3.75	70.05	3.35	5.6	3.0E-08	
25	2016	5	2	4	58.00	45300	23.0	95	95	55.05	0.80	27.85	0.90	69.25	0.80	5.9	2.9E-08	
26	2016	5	2	8	4.00	11160	23.0	95	95	55.30	0.25	28.10	0.25	69.05	0.20	11.1	3.1E-08	

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column.

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation
Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - BRPP BAB and DB	Cell #:	9
Project #:	231828.0003.0000	USCS Description:	N/A
Sample Name:	MW-16-07, 50-52'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel		

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.86	2.83	Permeant:	Water	
Sample Ht. (in)	3.50	3.48	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	512.00	737.80	Sample Specific Gravity:	2.68	Est.
Tare & Dry (g)	387.40	552.10	Confining Pressure (psi):	100.0	
Tare (g)	92.18	89.22	Burette Diameter (in):	0.250	
Sample Wt. (g)	666.40	648.58	Burette Zero (cm):	100.0	

Moisture (%)	42.2	40.1	Maximum Gradient:	3.8
Wet Density (pcf)	112.9	112.9	Average Gradient:	3.6
Dry Density (pcf)	79.4	80.6	Max. Effect. Stress (psi):	5.2
Saturation (%)	102.4	100.0	Min. Effect. Stress (psi):	4.6
			Ave. Effect. Stress (psi):	4.9

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	5	2	8	4.00		0.0	95	95	55.30		28.10		69.05				
2	2016	5	2	13	15.00	18660	23.0	95	95	55.65	0.35	28.50	0.40	68.80	0.25	23.1	2.8E-08	
3	2016	5	2	20	45.00	27000	26.0	95	95	56.30	0.65	29.00	0.50	68.35	0.45	5.3	2.6E-08	
4	2016	5	3	4	50.00	29100	23.0	95	95	56.00	-0.30	29.50	0.50	67.75	0.60	-9.1	3.1E-08	
5	2016	5	3	8	0.00	11400	25.0	95	95	56.35	0.35	29.70	0.20	67.60	0.15	14.3	2.5E-08	
6	2016	5	3	11	10.00	11400	23.0	95	95	56.30	-0.05	29.90	0.20	67.35	0.25	-11.1	3.4E-08	
7	2016	5	3	14	12.00	10920	23.0	95	95	56.40	0.10	30.15	0.25	67.25	0.10	42.9	2.8E-08	
8	2016	5	3	19	36.00	19440	24.0	95	95	57.20	0.80	30.55	0.40	67.05	0.20	33.3	2.6E-08	
9	2016	5	4	5	24.00	35280	23.0	95	95	57.60	0.40	31.15	0.60	66.50	0.55	4.3	2.9E-08	
10	2016	5	4	9	48.00	15840	23.0	95	95	57.60	0.00	31.40	0.25	66.25	0.25	0.0	2.9E-08	
11	2016	5	4	14	50.00	18120	23.0	95	95	57.70	0.10	31.70	0.30	66.00	0.25	9.1	2.8E-08	
12	2016	5	4	20	0.00	18600	25.0	95	95	58.25	0.55	32.10	0.40	65.80	0.20	33.3	2.9E-08	
13	2016	5	5	5	24.00	33840	24.0	95	95	58.35	0.10	32.60	0.50	65.30	0.50	0.0	2.8E-08	1
14	2016	5	5	10	25.00	18060	24.0	95	95	58.60	0.25	32.90	0.30	65.10	0.20	20.0	2.7E-08	1
15	2016	5	5	14	42.00	15420	24.0	95	95	58.90	0.30	33.20	0.30	64.85	0.25	9.1	3.5E-08	1
16	2016	5	6	4	52.00	51000	23.0	95	95	59.50	0.60	34.00	0.80	64.25	0.60	14.3	2.8E-08	1
17	2016	5	6	9	32.00	16800	23.0	95	95	59.70	0.20	34.25	0.25	64.05	0.20	11.1	2.9E-08	1
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 2.9E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH

QA: JPH

Project Name: DTE - BRPP BAB and DB

Project #: 231828.0003.0000

Sample Name: SB-16-01, 50-52'

Visual Descript: Gray lean clay

Cell #: 10

USCS Description: N/A

USCS Classification: N/A

Average Kv = 2.1E-08 cm/s

Sample Type: Undisturbed

	Initial Values	Final Values
Sample Dia. (in)	2.87	2.82
Sample Ht. (in)	2.88	2.86
Tare & Wet (g)	534.46	607.60
Tare & Dry (g)	400.40	448.80
Tare (g)	98.45	86.36
Sample Wt. (g)	532.36	521.24

Permeant: Water

Permeant Specific Gravity: 1.00

Sample Specific Gravity: 2.70 Est.

Confining Pressure (psi): 100.0

Burette Diameter (in): 0.250

Burette Zero (cm): 100.0

Moisture (%)	44.4	43.8
Wet Density (pcf)	109.0	111.0
Dry Density (pcf)	75.5	77.2
Saturation (%)	97.4	100.0

Maximum Gradient: 8.9

Average Gradient: 8.4

Max. Effect. Stress (psi): 6.1

Min. Effect. Stress (psi): 4.5

Ave. Effect. Stress (psi): 5.1

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	15	8	11.00		0.0	95	95	24.00		1.65		102.30				
2	2016	3	15	11	16.00		0.0	95	95	27.35		1.15		99.70				
3	2016	3	15	14	17.00		0.0	95	95	29.50		1.15		98.60				
4	2016	3	15	18	17.00	14400	23.0	95	95	30.90	1.40	1.35	0.20	97.50	1.10	-69.2	2.5E-08	
5	2016	3	16	4	56.00	38340	22.0	95	95	34.75	3.85	2.00	0.65	95.00	2.50	-58.7	2.4E-08	
6	2016	3	16	8	39.00	13380	23.0	95	95	35.00	0.25	2.50	0.50	94.55	0.45	5.3	2.0E-08	
7	2016	3	16	11	58.00	11940	23.0	95	95	35.45	0.45	3.00	0.50	94.10	0.45	5.3	2.3E-08	
8	2016	3	16	15	3.00	11100	23.0	95	95	35.80	0.35	3.35	0.35	93.60	0.50	-17.6	2.2E-08	
9	2016	3	17	5	15.00	51120	22.0	95	95	38.75	2.95	4.55	1.20	91.10	2.50	-35.1	2.2E-08	
10	2016	3	17	8	18.00	10980	24.0	95	95	38.25	-0.50	5.25	0.70	90.95	0.15	64.7	2.3E-08	
11	2016	3	17	12	21.00	14580	23.0	95	95	38.60	0.35	5.65	0.40	90.35	0.60	-20.0	2.1E-08	
12	2016	3	17	17	51.00	19800	23.0	95	95	38.50	-0.10	6.45	0.80	89.85	0.50	23.1	2.1E-08	
13	2016	3	18	5	24.00	41580	22.0	95	95	40.80	2.30	7.40	0.95	87.95	1.90	-33.3	2.3E-08	
14	2016	3	18	8	59.00	12900	24.0	95	95	40.40	-0.40	8.05	0.65	87.70	0.25	44.4	2.3E-08	
15	2016	3	18	12	56.00	14220	23.0	95	95	40.70	0.30	8.40	0.35	87.25	0.45	-12.5	1.9E-08	
16	2016	3	18	16	32.00	12960	23.0	95	95	40.70	0.00	8.95	0.55	86.90	0.35	22.2	2.4E-08	
17	2016	3	21	4	59.00	217620	22.0	95	95	45.25	4.55	15.10	6.15	80.30	6.60	-3.5	2.2E-08	
18	2016	3	21	8	2.00	10980	24.0	95	95	45.25	0.00	15.50	0.40	80.10	0.20	33.3	2.2E-08	
19	2016	3	21	12	11.00	14940	23.0	95	95	45.40	0.15	15.90	0.40	79.65	0.45	-5.9	2.4E-08	1
20	2016	3	21	15	13.00	10920	23.0	95	95	45.70	0.30	16.10	0.20	79.35	0.30	-20.0	1.9E-08	1
21	2016	3	21	19	38.00	15900	23.0	95	95	45.70	0.00	16.65	0.55	79.10	0.25	37.5	2.1E-08	1
22	2016	3	21	21	33.00	6900	23.0	95	95	46.10	0.40	16.70	0.05	78.80	0.30	-71.4	2.2E-08	1
23	2016	3	22	5	53.00	30000	25.0	95	95	47.20	1.10	17.35	0.65	78.00	0.80	-10.3	2.0E-08	1
24	2016	3	22	10	32.00	16740	23.0	95	95	47.10	-0.10	17.80	0.45	77.60	0.40	5.9	2.2E-08	1
25	2016	3	22	16	0.00	19680	24.0	95	95	47.40	0.30	18.35	0.55	77.15	0.45	10.0	2.2E-08	1
26	2016	3	22	22	34.00	23640	24.0	95	95	47.10	-0.30	19.10	0.75	76.80	0.35	36.4	2.1E-08	1

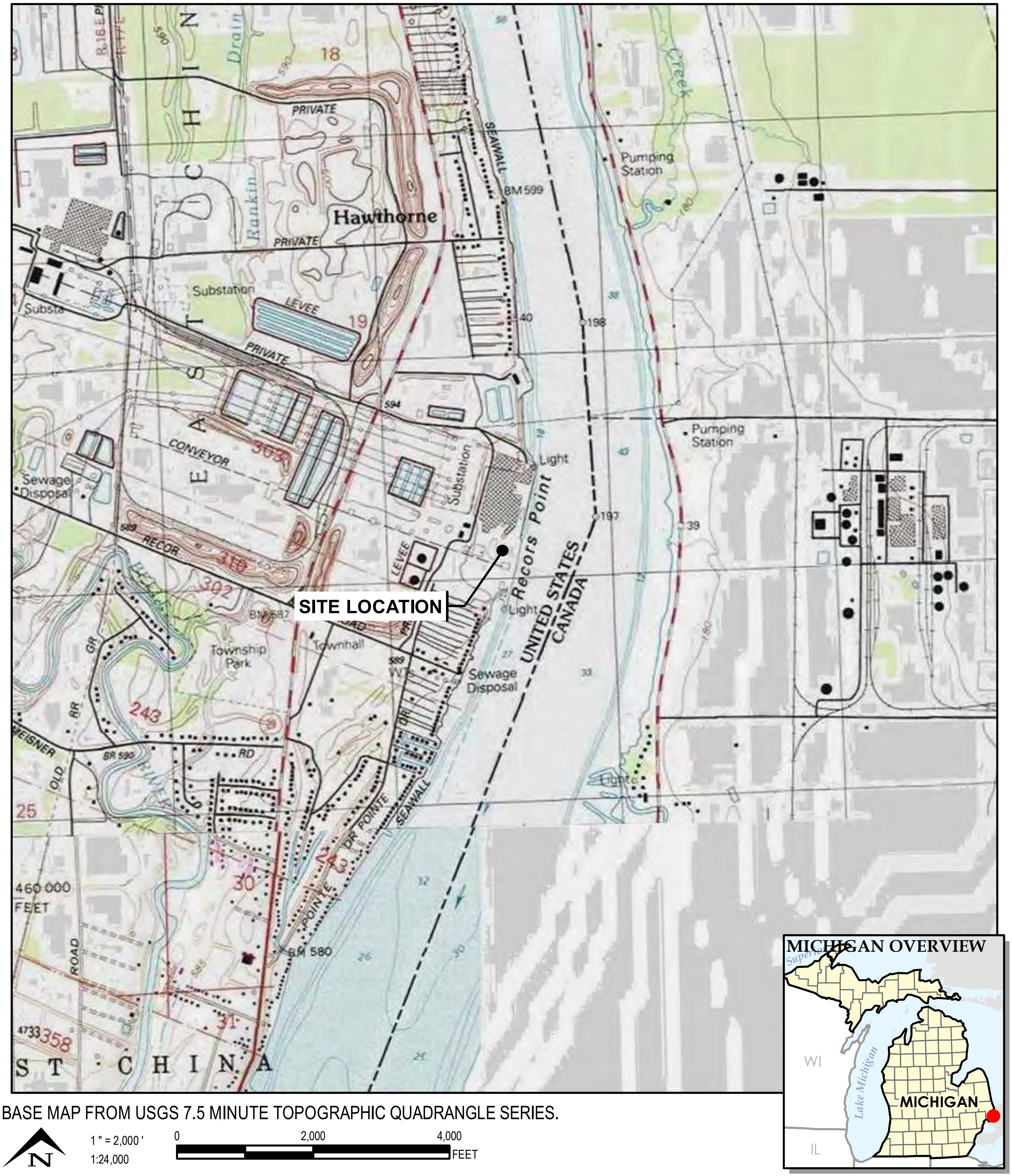
**A zero in this column starts a series of measurements.

*Average Kv for those rows with a 1 in the Ave. column. 2.1E-08 cm/s

(Termination determined by stable Kv and low flow differential.)

***Kv adjusted for temperature.

MONPP FAB CCR Unit Site



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:	**DTE ELECTRIC COMPANY ST. CLAIR POWER PLANT 4901 POINTE DRIVE EAST CHINA TOWNSHIP, MICHIGAN**
TITLE:	**SITE LOCATION MAP**

DRAWN BY:	J. PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	265996.0004
FILE:	265996-SLMMB.mxd

FIGURE 1

E:\DTE\CCR_Sites\2017_265996\265996-SLMMB.mxd -- Saved By: BDEEGAN on 10/9/2017, 14:51:49 PM

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/12/2018, 10:19:44 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-012.mxd

LEGEND

✦ MONITORING WELLS
⊟ SURFACE WATER MEASURING POINT
(579.85) GROUNDWATER ELEVATION (FT NAVD88)
~ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.
4. GROUNDWATER ELEVATION DATA FOR MW-16-02 WAS NOT USED. GROUNDWATER LEVEL WAS NOT FULLY RECOVERED AT THE TIME OF DATA COLLECTION.

N

0 100 200 Feet
1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC
SURFACE MAP
OCTOBER 2017

DRAWN BY: S. MAJOR
PROJ NO.: 265996.0004
CHECKED BY: S. SCIESZKA
APPROVED BY: V. BUENING
DATE: JANUARY 2018

FIGURE 3

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
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FILE NO.: 265996-0004-012.mxd

Table 1

Groundwater Elevation Summary
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Well ID	MP-01		MW-16-01		MW-16-02		MW-16-03		MW-16-04	
Date Installed	3/23/2016		3/31/2016		3/29/2016		3/25/2016		3/23/2016	
TOC Elevation	580.84(1)		584.74		581.43		581.39		580.95	
Geologic Unit of Screened Interval	NA		Silty Clay Shale Interface		Silty Clay Shale Interface		Silty Clay/Hardpan Shale Interface		Silty Clay/Hardpan Shale Interface	
Screened Interval Elevation	NA		458.1 to 453.1		456.2 to 451.2		455.1 to 450.1		455.0 to 450.0	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
8/1/2016	NM	NM	3.16	581.58	1.32	580.11	1.39	580.00	1.10	579.85
10/3/2016	4.25	576.58	3.63	581.09	5.25	579.49	1.70	579.69	3.22	578.98
11/11/2016	4.72	576.11	3.25	581.49	1.85	579.58	2.00	579.39	1.43	579.52
1/13/2017	4.95	575.88	3.38	581.36	1.82	579.61	1.85	579.54	1.84	579.11
2/28/2017	5.00	575.83	3.42	581.32	2.10	579.33	3.08	578.31	1.60	579.35
4/21/2017	4.21	576.62	3.44	581.30	2.42	579.01	2.06	579.33	1.24	579.71
6/9/2017	4.12	576.71	3.16	581.58	1.30	580.13	1.40	579.99	1.01	579.94
7/27/2017	4.68	576.15	2.31	582.43	1.41	580.02	1.39	580.00	1.28	579.67

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing

NA - not applicable

NM - not measured

1) Elevation represents the point of reference used to collect surface water level measurements.

LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

CROSS SECTION LOCATOR MAP

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	S. HOLMSTROM		**FIGURE 3**
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

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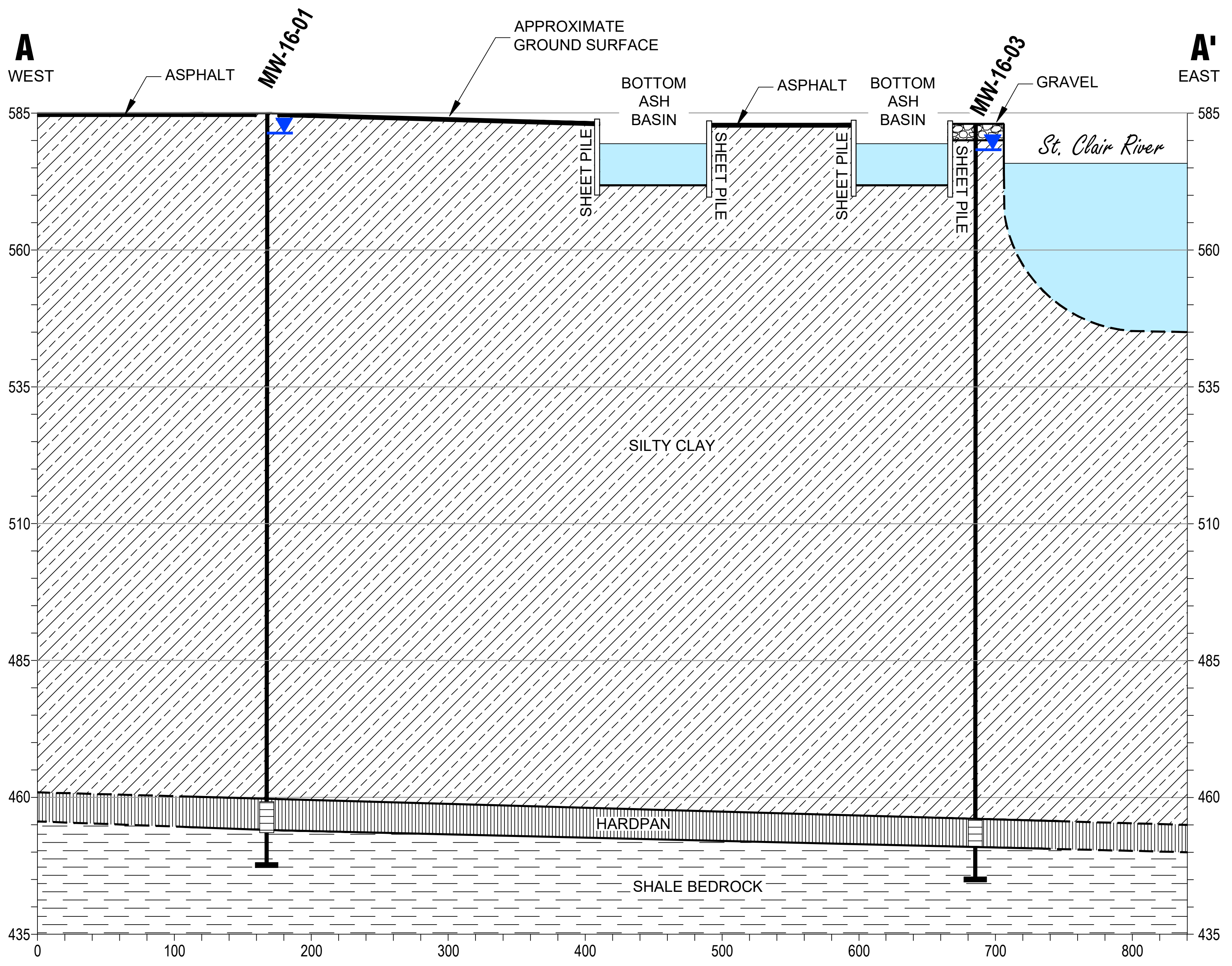
FILE NO.: 265996-0004-010.mxd

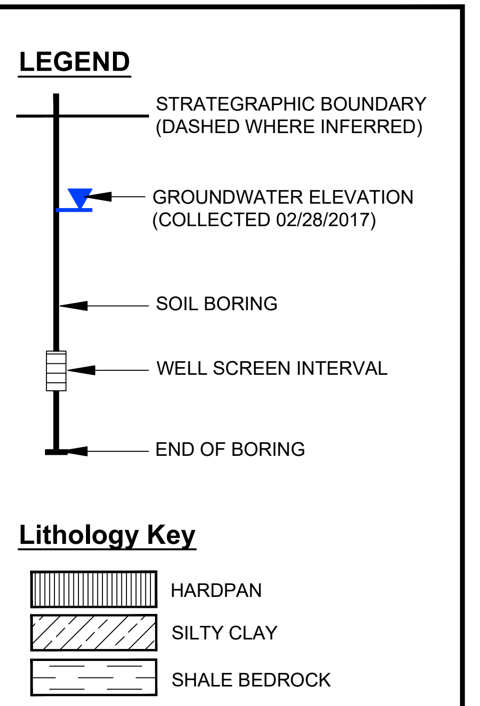
TRC - GIS

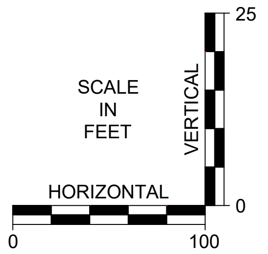
Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:36:52 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-010.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'







PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0004.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 4**	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

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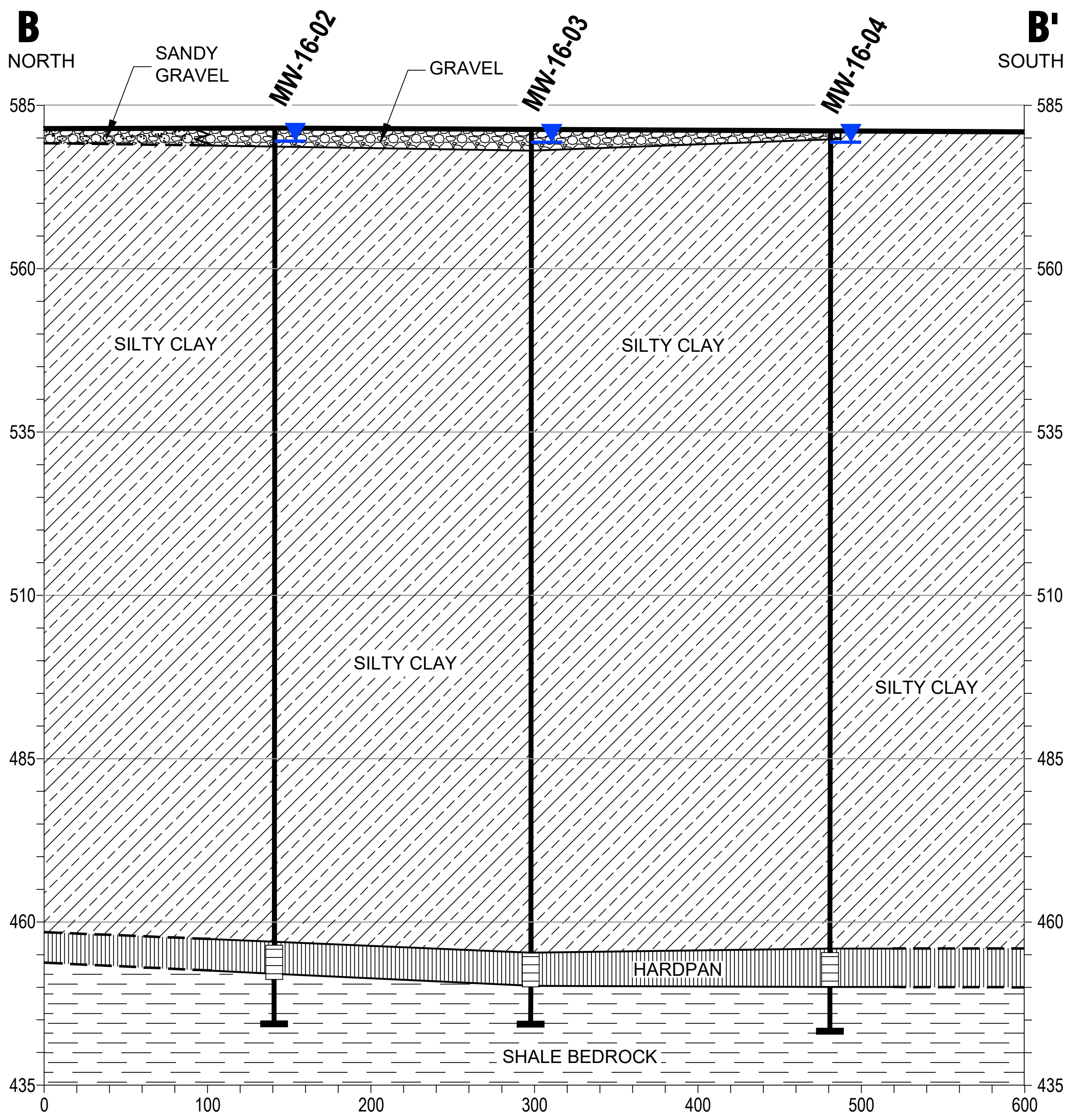
FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:02PM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

GROUNDWATER ELEVATION (COLLECTED 02/28/2017)

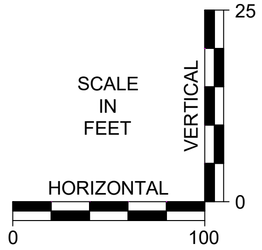
SOIL BORING

WELL SCREEN INTERVAL

END OF BORING

Lithology Key

- ▥ HARDPAN
- ▨ SILTY CLAY
- ☰ SHALE BEDROCK
- ▩ GRAVEL
- ▩ SANDY GRAVEL



PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION B-B'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0004.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 5**	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

TRC
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Ann Arbor, MI 48108
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FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:03PM --- LAYOUT: FIG05 XS BB

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - SCPP BAB	Cell #:	10
Project #:	231828.0004.0000	USCS Description:	N/A
Sample Name:	MW-16-01, 40-42'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	2.3E-08 cm/s

	Initial Values	Final Values			
Sample Type: Undisturbed					
Sample Dia. (in)	2.86	2.83	Permeant:	Water	
Sample Ht. (in)	3.62	3.47	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	470.27	763.70	Sample Specific Gravity:	2.60	Est.
Tare & Dry (g)	373.66	604.00	Confining Pressure (psi):	100.0	
Tare (g)	88.45	89.44	Burette Diameter (in):	0.250	
Sample Wt. (g)	703.30	674.26	Burette Zero (cm):	100.0	

Moisture (%)	33.9	31.0		
Wet Density (pcf)	115.2	117.7		
Dry Density (pcf)	86.1	89.8	Max. Effect. Stress (psi):	6.2
Saturation (%)	99.4	100.0	Min. Effect. Stress (psi):	4.1
			Ave. Effect. Stress (psi):	4.6

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	4	22	9	23.00		0.0	95	95	13.65		2.80		101.50				
2	2016	4	22	18	33.00	33000	25.0	95	95	31.40	17.75	1.00	-1.80	91.35	10.15	-143.1	8.2E-08	
3	2016	4	25	11	31.00	233880	23.0	95	95	54.55	23.15	2.00	1.00	79.25	12.10	-84.7	2.1E-08	
4	2016	4	25	17	43.00	22320	24.0	95	95	55.40	0.85	2.75	0.75	78.55	0.70	3.4	2.7E-08	
5	2016	4	25	20	40.00	10620	24.0	95	95	55.85	0.45	2.95	0.20	78.15	0.40	-33.3	2.3E-08	
6	2016	4	25	23	16.00	9360	24.0	95	95	56.35	0.50	3.20	0.25	77.80	0.35	-16.7	2.7E-08	
7	2016	4	26	5	0.00	20640	25.0	95	95	56.65	0.30	3.85	0.65	77.25	0.55	8.3	2.4E-08	
8	2016	4	26	8	19.00	11940	24.0	95	95	57.55	0.90	4.00	0.15	76.70	0.55	-57.1	2.5E-08	
9	2016	4	26	13	18.00	17940	24.0	95	95	58.40	0.85	4.45	0.45	76.10	0.60	-14.3	2.5E-08	
10	2016	4	27	4	58.00	56400	23.0	95	95	61.65	3.25	5.45	1.00	74.05	2.05	-34.4	2.5E-08	
11	2016	4	27	12	48.00	28200	23.0	95	95	62.00	0.35	6.10	0.65	73.35	0.70	-3.7	2.3E-08	
12	2016	4	27	15	9.00	8460	23.0	95	95	62.00	0.00	6.30	0.20	73.05	0.30	-20.0	2.8E-08	
13	2016	4	28	5	2.00	49980	22.0	95	95	65.10	3.10	6.95	0.65	71.35	1.70	-44.7	2.4E-08	
14	2016	4	28	8	6.00	11040	24.0	95	95	64.75	-0.35	7.40	0.45	71.25	0.10	63.6	2.4E-08	
15	2016	4	28	14	57.00	24660	23.0	95	95	65.30	0.55	7.85	0.45	70.60	0.65	-18.2	2.3E-08	
16	2016	4	28	20	48.00	21060	23.0	95	95	66.25	0.95	8.30	0.45	70.00	0.60	-14.3	2.6E-08	
17	2016	4	29	5	31.00	31380	26.0	95	95	68.05	1.80	8.70	0.40	69.05	0.95	-40.7	2.1E-08	
18	2016	4	29	10	27.00	17760	23.0	95	95	67.10	-0.95	9.25	0.55	68.80	0.25	37.5	2.4E-08	
19	2016	4	29	14	42.00	15300	23.0	95	95	67.70	0.60	9.55	0.30	68.50	0.30	0.0	2.1E-08	
20	2016	4	29	18	0.00	11880	23.0	95	95	67.50	-0.20	9.90	0.35	68.35	0.15	40.0	2.3E-08	
21	2016	5	1	16	24.00	167040	22.0	95	95	72.80	5.30	12.75	2.85	64.50	3.85	-14.9	2.4E-08	
22	2016	5	2	4	59.00	45300	23.0	95	95	74.50	1.70	13.35	0.60	63.50	1.00	-25.0	2.2E-08	
23	2016	5	2	8	5.00	11160	23.0	95	95	74.15	-0.35	13.65	0.30	63.35	0.15	33.3	2.6E-08	
24	2016	5	2	13	16.00	18660	23.0	95	95	74.45	0.30	14.00	0.35	63.10	0.25	16.7	2.1E-08	
25	2016	5	2	20	46.00	27000	26.0	95	95	73.50	-0.95	14.75	0.75	62.90	0.20	57.9	2.2E-08	
26	2016	5	3	4	50.00	29040	23.0	95	95	74.70	1.20	15.05	0.30	62.10	0.80	-45.5	2.5E-08	

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column.

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name: DTE - SCPP BAB
Project #: 231828.0004.0000
Sample Name: MW-16-01, 40-42'
Visual Descript: Gray sandy lean clay, with gravel

Cell #: 10
USCS Description: N/A
USCS Classification: N/A

Sample Type: Undisturbed	Initial Values	Final Values
Sample Dia. (in)	2.86	2.83
Sample Ht. (in)	3.62	3.47
Tare & Wet (g)	470.27	763.70
Tare & Dry (g)	373.66	604.00
Tare (g)	88.45	89.44
Sample Wt. (g)	703.30	674.26

Permeant:	Water	
Permeant Specific Gravity:	1.00	
Sample Specific Gravity:	2.60	Est.
Confining Pressure (psi):	100.0	
Burette Diameter (in):	0.250	
Burette Zero (cm):	100.0	

Moisture (%)	33.9	31.0
Wet Density (pcf)	115.2	117.7
Dry Density (pcf)	86.1	89.8
Saturation (%)	99.4	100.0

Maximum Gradient:	4.7
Average Gradient:	4.5
Max. Effect. Stress (psi):	4.8
Min. Effect. Stress (psi):	4.1
Ave. Effect. Stress (psi):	4.4

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	5	3	4	50.00		0.0	95	95	74.70		15.05		62.10				
2	2016	5	3	8	1.00	11460	25.0	95	95	75.05	0.35	15.25	0.20	61.90	0.20	0.0	2.3E-08	
3	2016	5	3	11	11.00	11400	23.0	95	95	75.60	0.55	15.30	0.05	61.65	0.25	-66.7	1.8E-08	
4	2016	5	3	14	13.00	10920	23.0	95	95	76.00	0.40	15.50	0.20	61.45	0.20	0.0	2.5E-08	
5	2016	5	3	19	37.00	19440	24.0	95	95	76.30	0.30	15.95	0.45	61.25	0.20	38.5	2.3E-08	
6	2016	5	4	5	24.00	35220	23.0	95	95	76.70	0.40	16.45	0.50	60.65	0.60	-9.1	2.2E-08	
7	2016	5	4	9	49.00	15900	23.0	95	95	76.85	0.15	16.75	0.30	60.35	0.30	0.0	2.8E-08	
8	2016	5	4	14	51.00	18120	23.0	95	95	77.40	0.55	16.90	0.15	60.00	0.35	-40.0	2.0E-08	
9	2016	5	4	20	1.00	18600	25.0	95	95	76.85	-0.55	17.40	0.50	59.90	0.10	66.7	2.3E-08	
10	2016	5	5	5	25.00	33840	24.0	95	95	78.30	1.45	17.75	0.35	59.15	0.75	-36.4	2.4E-08	
11	2016	5	5	10	26.00	18060	24.0	95	95	78.30	0.00	18.10	0.35	58.90	0.25	16.7	2.5E-08	1
12	2016	5	5	14	42.00	15360	24.0	95	95	78.60	0.30	18.30	0.20	58.70	0.20	0.0	2.0E-08	1
13	2016	5	6	4	53.00	51060	23.0	95	95	79.30	0.70	19.10	0.80	58.00	0.70	6.7	2.4E-08	1
14	2016	5	6	9	33.00	16800	23.0	95	95	79.90	0.60	19.25	0.15	57.70	0.30	-33.3	2.2E-08	1
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		
23																		
24																		
25																		
26																		

**A zero in this column starts a series of measurements.

*Average Kv for those rows with a 1 in the Ave. column. 2.3E-08 cm/s

(Termination determined by stable Kv and low flow differential.)

***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH

QA: JPH

Project Name:	DTE - SCPP BAB	Cell #:	11
Project #:	231828.0004.0000	USCS Description:	N/A
Sample Name:	MW-16-02, 40-42'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	2.7E-08 cm/s

Sample Type:	Undisturbed	Initial Values	Final Values			
Sample Dia. (in)		2.85	2.84	Permeant:	Water	
Sample Ht. (in)		2.69	2.68	Permeant Specific Gravity:	1.00	
Tare & Wet (g)		482.10	587.40	Sample Specific Gravity:	2.68	Est.
Tare & Dry (g)		371.38	440.90	Confining Pressure (psi):	100.0	
Tare (g)		87.03	88.43	Burette Diameter (in):	0.250	
Sample Wt. (g)		507.56	498.97	Burette Zero (cm):	100.0	

Moisture (%)	38.9	41.6	Maximum Gradient:	9.0
Wet Density (pcf)	112.8	112.0	Average Gradient:	8.3
Dry Density (pcf)	81.2	79.1	Max. Effect. Stress (psi):	5.5
Saturation (%)	98.4	100.0	Min. Effect. Stress (psi):	4.0
			Ave. Effect. Stress (psi):	4.6

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	4	29	5	36.00		0.0	95	95	65.15		2.65		103.70				
2	2016	4	29	10	28.00	17520	23.0	95	95	67.50	2.35	3.50	0.85	102.35	1.35	-22.7	3.1E-08	
3	2016	4	29	14	45.00	15420	23.0	95	95	69.50	2.00	4.40	0.90	102.40	-0.05	111.8	1.4E-08	
4	2016	4	29	17	58.00	11580	23.0	95	95	70.70	1.20	5.05	0.65	102.00	0.40	23.8	2.3E-08	
5	2016	5	1	16	20.00	166920	22.0	95	95	80.70	10.00	13.65	8.60	96.80	5.20	24.6	2.3E-08	
6	2016	5	2	5	0.00	45600	23.0	95	95	82.70	2.00	15.70	2.05	94.70	2.10	-1.2	2.8E-08	
7	2016	5	2	8	7.00	11220	23.0	95	95	83.25	0.55	16.20	0.50	94.25	0.45	5.3	2.6E-08	
8	2016	5	2	13	7.00	18000	23.0	95	95	84.00	0.75	17.05	0.85	93.55	0.70	9.7	2.7E-08	
9	2016	5	2	20	40.00	27180	26.0	95	95	85.60	1.60	18.20	1.15	92.50	1.05	4.5	2.5E-08	
10	2016	5	3	4	51.00	29460	23.0	95	95	85.85	0.25	19.35	1.15	91.10	1.40	-9.8	2.9E-08	
11	2016	5	3	8	3.00	11520	25.0	95	95	86.60	0.75	19.85	0.50	90.65	0.45	5.3	2.7E-08	
12	2016	5	3	11	8.00	11100	23.0	95	95	86.60	0.00	20.30	0.45	90.15	0.50	-5.3	3.0E-08	
13	2016	5	3	14	13.00	11100	23.0	95	95	87.30	0.70	20.75	0.45	89.70	0.45	0.0	2.9E-08	
14	2016	5	3	19	34.00	19260	24.0	95	95	88.25	0.95	21.55	0.80	89.15	0.55	18.5	2.5E-08	
15	2016	5	4	5	25.00	35460	23.0	95	95	89.35	1.10	22.85	1.30	87.75	1.40	-3.7	2.8E-08	
16	2016	5	4	9	50.00	15900	23.0	95	95	89.70	0.35	23.45	0.60	87.20	0.55	4.3	2.8E-08	
17	2016	5	4	14	52.00	18120	23.0	95	95	90.20	0.50	24.10	0.65	86.55	0.65	0.0	2.8E-08	
18	2016	5	4	19	58.00	18360	25.0	95	95	91.10	0.90	24.80	0.70	86.00	0.55	12.0	2.6E-08	
19	2016	5	5	5	26.00	34080	24.0	95	95	91.75	0.65	25.95	1.15	84.75	1.25	-4.2	2.8E-08	1
20	2016	5	5	10	27.00	18060	24.0	95	95	92.40	0.65	26.50	0.55	84.20	0.55	0.0	2.5E-08	1
21	2016	5	5	14	43.00	15360	24.0	95	95	92.80	0.40	27.05	0.55	83.70	0.50	4.8	2.9E-08	1
22	2016	5	6	4	53.00	51000	23.0	95	95	84.30	-8.50	28.70	1.65	82.15	1.55	3.1	2.8E-08	1
23	2016	5	6	9	34.00	16860	23.0	95	95	94.70	10.40	29.20	0.50	81.65	0.50	0.0	2.8E-08	1
24																		
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 2.7E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - SCPP BAB	Cell #:	2
Project #:	231828.0004.0000	USCS Description:	N/A
Sample Name:	MW-16-03, 40-42'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	2.9E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.86	2.83	Permeant:	Water	
Sample Ht. (in)	2.90	2.85	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	474.40	611.40	Sample Specific Gravity:	2.70	Est.
Tare & Dry (g)	351.87	453.40	Confining Pressure (psi):	100.0	
Tare (g)	86.27	88.02	Burette Diameter (in):	0.250	
Sample Wt. (g)	535.23	523.38	Burette Zero (cm):	100.0	

Moisture (%)	46.1	43.2	Maximum Gradient:	7.7
Wet Density (pcf)	109.4	111.2	Average Gradient:	7.3
Dry Density (pcf)	74.9	77.6	Max. Effect. Stress (psi):	5.5
Saturation (%)	99.8	100.0	Min. Effect. Stress (psi):	3.8
			Ave. Effect. Stress (psi):	4.3

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	4	29	5	39.00		0.0	95	95	71.90		3.05		103.70				
2	2016	4	29	10	29.00	17400	23.0	95	95	74.80	2.90	3.25	0.20	100.00	3.70	-89.7	6.0E-08	
3	2016	4	29	14	46.00	15420	23.0	95	95	77.30	2.50	3.70	0.45	98.60	1.40	-51.4	3.3E-08	
4	2016	4	29	17	59.00	11580	23.0	95	95	78.70	1.40	4.15	0.45	97.75	0.85	-30.8	3.1E-08	
5	2016	5	1	16	21.00	166920	22.0	95	95	90.30	11.60	11.25	7.10	89.20	8.55	-9.3	3.0E-08	
6	2016	5	2	5	1.00	45600	23.0	95	95	92.75	2.45	13.05	1.80	87.30	1.90	-2.7	2.8E-08	
7	2016	5	2	8	7.00	11160	23.0	95	95	93.70	0.95	13.40	0.35	86.80	0.50	-17.6	2.7E-08	
8	2016	5	2	13	8.00	18060	23.0	95	95	94.25	0.55	14.20	0.80	86.20	0.60	14.3	2.8E-08	
9	2016	5	2	20	42.00	27240	26.0	95	95	96.15	1.90	15.25	1.05	85.20	1.00	2.6	2.6E-08	
10	2016	5	3	4	52.00	29400	23.0	95	95	95.60	-0.55	16.20	0.95	83.85	1.35	-17.5	3.0E-08	
11	2016	5	3	8	3.00	11460	25.0	95	95	96.60	1.00	16.60	0.40	83.45	0.40	0.0	2.6E-08	
12	2016	5	3	11	9.00	11160	23.0	95	95	96.20	-0.40	17.10	0.50	82.95	0.50	0.0	3.6E-08	
13	2016	5	3	14	14.00	11100	23.0	95	95	97.05	0.85	17.35	0.25	82.55	0.40	-23.1	2.4E-08	
14	2016	5	3	19	34.00	19200	24.0	95	95	98.70	1.65	18.10	0.75	82.00	0.55	15.4	2.7E-08	
15	2016	5	4	5	26.00	35520	23.0	95	95	99.75	1.05	19.25	1.15	80.70	1.30	-6.0	2.9E-08	
16	2016	5	4	9	50.00	15840	23.0	95	95	100.30	0.55	19.80	0.55	80.20	0.50	4.5	2.9E-08	
17	2016	5	4	14	52.00	18120	23.0	95	95	100.60	0.30	20.30	0.50	79.55	0.65	-13.0	2.8E-08	
18	2016	5	4	19	59.00	18420	25.0	95	95	101.75	1.15	21.00	0.70	79.10	0.45	21.7	2.7E-08	
19	2016	5	5	5	26.00	34020	24.0	95	95	102.60	0.85	21.90	0.90	77.85	1.25	-16.3	2.8E-08	
20	2016	5	5	10	27.00	18060	24.0	95	95	103.20	0.60	22.50	0.60	77.35	0.50	9.1	2.8E-08	1
21	2016	5	5	14	43.00	15360	24.0	95	95	103.50	0.30	22.95	0.45	76.85	0.50	-5.3	2.9E-08	1
22	2016	5	6	4	54.00	51060	23.0	95	95	104.00	0.50	24.35	1.40	75.40	1.45	-1.8	2.8E-08	1
23	2016	5	6	9	35.00	16860	23.0	95	95	105.00	1.00	24.80	0.45	74.90	0.50	-5.3	2.9E-08	1
24																		
25																		
26																		

**A zero in this column starts a series of measurements.

*Average Kv for those rows with a 1 in the Ave. column. 2.9E-08 cm/s

(Termination determined by stable Kv and low flow differential.)

***Kv adjusted for temperature.

TRC Environmental Corporation Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)	QC: JPH QA: JPH

Project Name:	DTE - SCPP BAB	Cell #:	3
Project #:	231828.0004.0000	USCS Description:	N/A
Sample Name:	MW-16-04, 40-42'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	3.1E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.85	2.82	Permeant:	Water	
Sample Ht. (in)	2.88	2.84	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	561.80	656.70	Sample Specific Gravity:	2.63	Est.
Tare & Dry (g)	460.60	537.10	Confining Pressure (psi):	100.0	
Tare (g)	95.90	87.80	Burette Diameter (in):	0.250	
Sample Wt. (g)	580.00	568.90	Burette Zero (cm):	100.0	

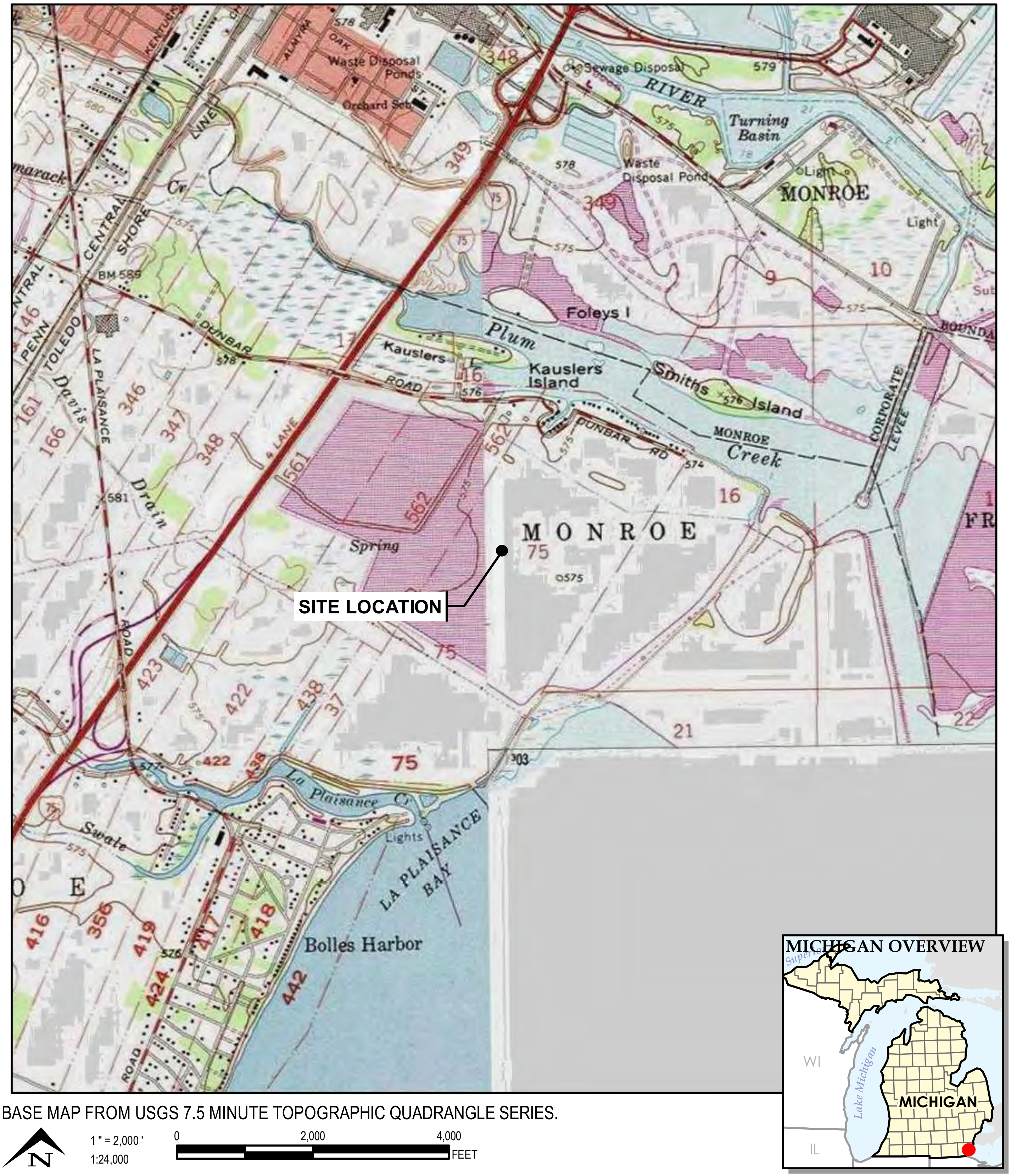
Moisture (%)	27.7	26.6	Maximum Gradient:	7.7
Wet Density (pcf)	120.5	122.2	Average Gradient:	7.3
Dry Density (pcf)	94.3	96.5	Max. Effect. Stress (psi):	5.5
Saturation (%)	98.7	100.0	Min. Effect. Stress (psi):	4.0
			Ave. Effect. Stress (psi):	4.6

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	4	29	5	41.00		0.0	95	95	66.60		1.60		104.80				
2	2016	4	29	10	30.00	17340	23.0	95	95	68.30	1.70	2.15	0.55	101.80	3.00	-69.0	5.3E-08	
3	2016	4	29	14	47.00	15420	23.0	95	95	69.60	1.30	2.90	0.75	100.80	1.00	-14.3	3.0E-08	
4	2016	4	29	17	59.00	11520	23.0	95	95	70.60	1.00	3.50	0.60	100.15	0.65	-4.0	2.9E-08	
5	2016	5	1	16	21.00	166920	22.0	95	95	77.85	7.25	11.95	8.45	91.30	8.85	-2.3	3.2E-08	
6	2016	5	2	5	2.00	45660	23.0	95	95	79.40	1.55	13.95	2.00	89.10	2.20	-4.8	3.1E-08	
7	2016	5	2	8	8.00	11160	23.0	95	95	80.15	0.75	14.40	0.45	88.65	0.45	0.0	2.8E-08	
8	2016	5	2	13	9.00	18060	23.0	95	95	80.40	0.25	15.25	0.85	88.00	0.65	13.3	3.0E-08	
9	2016	5	2	20	43.00	27240	26.0	95	95	81.60	1.20	16.40	1.15	86.95	1.05	4.5	2.8E-08	
10	2016	5	3	4	52.00	29340	23.0	95	95	80.60	-1.00	17.50	1.10	85.50	1.45	-13.7	3.3E-08	
11	2016	5	3	8	2.00	11400	25.0	95	95	81.25	0.65	18.00	0.50	85.10	0.40	11.1	2.9E-08	
12	2016	5	3	11	9.00	11220	23.0	95	95	80.75	-0.50	18.40	0.40	84.60	0.50	-11.1	3.2E-08	
13	2016	5	3	14	15.00	11160	23.0	95	95	81.55	0.80	18.85	0.45	84.15	0.45	0.0	3.2E-08	
14	2016	5	3	19	35.00	19200	24.0	95	95	82.95	1.40	19.60	0.75	83.60	0.55	15.4	2.7E-08	
15	2016	5	4	5	26.00	35460	23.0	95	95	83.40	0.45	20.90	1.30	82.20	1.40	-3.7	3.2E-08	
16	2016	5	4	9	50.00	15840	23.0	95	95	83.70	0.30	21.40	0.50	81.60	0.60	-9.1	3.0E-08	
17	2016	5	4	14	53.00	18180	23.0	95	95	83.80	0.10	22.05	0.65	80.95	0.65	0.0	3.2E-08	
18	2016	5	4	19	59.00	18360	25.0	95	95	84.80	1.00	22.80	0.75	80.50	0.45	25.0	2.8E-08	
19	2016	5	5	5	27.00	34080	24.0	95	95	85.10	0.30	23.85	1.05	79.20	1.30	-10.6	3.1E-08	
20	2016	5	5	10	28.00	18060	24.0	95	95	85.60	0.50	24.45	0.60	78.65	0.55	4.3	3.0E-08	1
21	2016	5	5	14	44.00	15360	24.0	95	95	85.80	0.20	25.00	0.55	78.25	0.40	15.8	3.0E-08	1
22	2016	5	6	4	55.00	51060	23.0	95	95	86.70	0.90	26.50	1.50	76.75	1.50	0.0	3.0E-08	1
23	2016	5	6	9	35.00	16800	23.0	95	95	87.20	0.50	27.00	0.50	76.15	0.60	-9.1	3.5E-08	1
24																		
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 3.1E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

SCPP BABs CCR Unit Site



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

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Phone: 734.971.7080

TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
MONROE POWER PLANT
7955 EAST DUNBAR ROAD
MONROE, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	J. PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	265996.0001
FILE:	265996-SLMMB.mxd

FIGURE 1

LEGEND

- MONITORING WELLS
- APPROXIMATE BOUNDARY OF FLY ASH BASIN

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN MARCH AND MAY 2016.

0 600 1,200 Feet

1 " = 600 '
1:7,200

PROJECT:
DTE ELECTRIC COMPANY
MONROE POWER PLANT FLY ASH BASIN
7955 EAST DUNBAR ROAD
MONROE, MICHIGAN

TITLE:
MONITORING NETWORK AND SITE PLAN

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0001
CHECKED BY:	S. HOLMSTROM	**FIGURE 2**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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FILE NO.: 265996-0001-000.mxd

Coordinate System: NAD 1983 UTM Zone 17N (Meter)
Map Rotation: 0

Plot Date: 1/29/2018, 09:45:57 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0001-000.mxd

TRC - GIS

LEGEND

- ✚ MONITORING WELL
- APPROXIMATE BOUNDARY OF FLY ASH BASIN
- INFERRED GROUNDWATER FLOW DIRECTION
- POTENTIOMETRIC SURFACE CONTOUR LINE (5-FT INTERVAL,DASHED WHERE INFERRED)
- (582.69) STATIC WATER ELEVATION IN FEET (NAVD, 1988)

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN MARCH AND MAY 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988

N

0 600 1,200 Feet

1 " = 600 '

1:7,200

PROJECT:

DTE ELECTRIC COMPANY
MONROE POWER PLANT FLY ASH BASIN
7955 EAST DUNBAR ROAD
MONROE, MICHIGAN

TITLE:

POTENTIOMETRIC SURFACE MAP SEPTEMBER 2017

DRAWN BY:	S MAJOR	PROJ NO.:	265996.0001
CHECKED BY:	C. SCIESZKA	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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Plot Date: 1/12/2018, 08:54:41 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0001-011a.mxd

Coordinate System: NAD 1983 UTM Zone 17N (Meter)
Map Rotation: 0

Table 1
Groundwater Elevation Summary
Range Road Landfill – RCRA CCR Monitoring Program
China Township, Michigan

Well ID	MW-16-01		MW-16-02		MW-16-03		MW-16-04		MW-16-05		MW-16-06		MW-16-07	
Date Installed	1/13/2016		1/27/2016		2/1/2016		5/24/2016		5/13/2016		5/10/2016		5/13/2016	
TOC Elevation	595.35		598.44		597.69		596.87		601.97		600.68		589.34	
Geologic Unit of Screened interval	Sand with Silt		Silty Sand with Gravel		Silty Gravel with Sand		Silty Sand		Gravel with Sand		Sand		Sand	
Screened Interval Elevation	390.7 to 385.7		393.8 to 388.8		432.1 to 427.1		414.1 to 409.1		476.6 to 471.6		508.0 to 503.0		494.4 to 489.4	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
8/11/2016	22.77	572.58	21.10	577.34	20.24	577.45	19.54	577.33	27.73	574.24	23.89	576.79	16.13	573.21
9/22/2016	21.41	573.94	21.04	577.40	20.23	577.46	20.92	575.95	27.74	574.23	23.90	576.78	16.40	572.94
11/10/2016	21.07	574.28	20.96	577.48	20.17	577.52	19.55	577.32	27.72	574.25	23.80	576.88	16.20	573.14
1/11/2017	19.63	575.72	20.87	577.57	20.10	577.59	19.38	577.49	27.53	574.44	23.71	576.97	15.80	573.54
1/3/2017	19.05	576.30	20.30	578.14	19.49	578.20	18.85	578.02	26.91	575.06	23.08	577.60	15.74	573.60
4/19/2017	19.11	576.24	20.75	577.69	19.94	577.75	19.32	577.55	27.41	574.56	23.56	577.12	16.19	573.15
6/7/2017	19.00	576.35	20.79	577.65	20.03	577.66	19.32	577.55	27.50	574.47	23.65	577.03	15.82	573.52
7/26/2017	18.90	576.45	20.45	577.99	20.05	577.64	19.45	577.42	27.60	574.37	23.75	576.93	16.30	573.04

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing.

LEGEND

- MONITORING WELLS
- APPROXIMATE BOUNDARY OF FLY ASH
- CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN MARCH AND MAY 2016.

0 600 1,200 Feet

1 " = 600 '

1:7,200

PROJECT:

DTE ELECTRIC COMPANY
MONROE POWER PLANT FLY ASH BASIN
7955 EAST DUNBAR ROAD
MONROE, MICHIGAN

TITLE:

CROSS SECTION LOCATOR MAP

DRAWN BY: J. PAPEZ
CHECKED BY: S. HOLMSTROM
APPROVED BY: V. BUENING
DATE: OCTOBER 2017
PROJ NO.: 265996.0001

FIGURE 3

TRC

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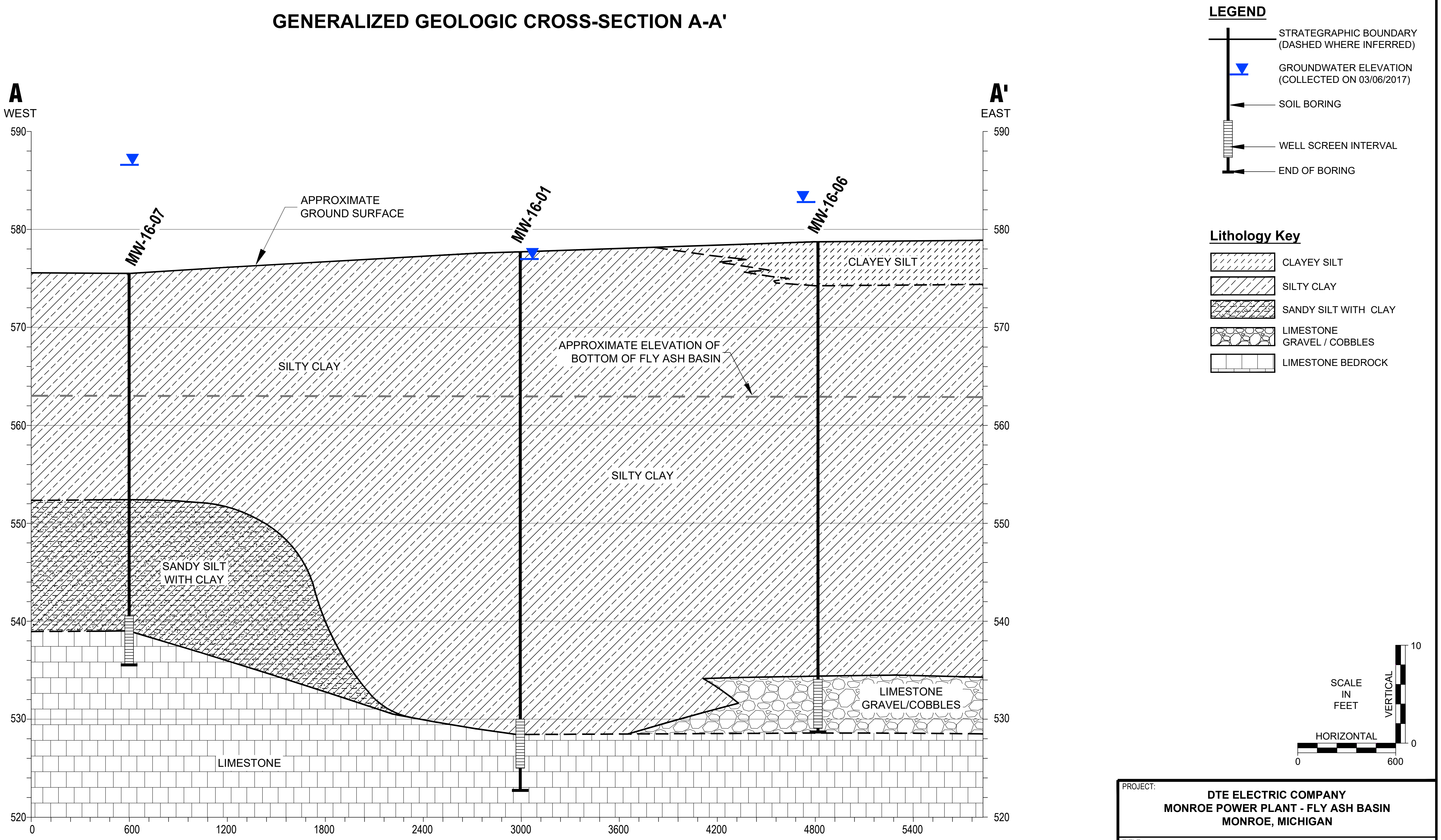
FILE NO.: 265996-0001-008.mxd

TRC - GIS

Coordinate System: NAD 1983 UTM Zone 17N (Meter)
Map Rotation: 0

Plot Date: 10/9/2017, 14:56:26 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0001-008.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'



PROJECT:
DTE ELECTRIC COMPANY
MONROE POWER PLANT - FLY ASH BASIN
MONROE, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0001.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 4**	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

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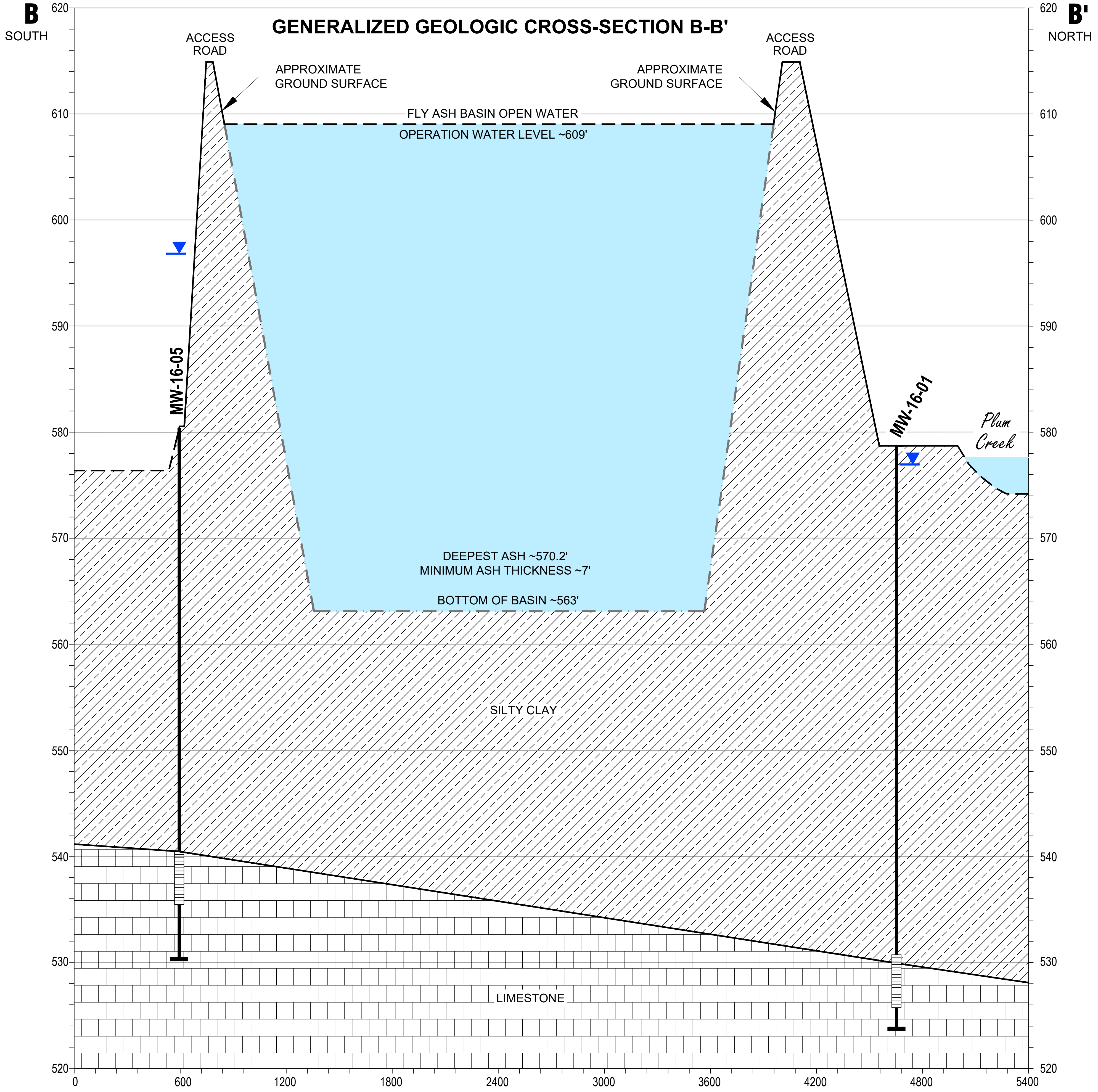
FILE NO.: 265996.0001.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\Monroe PP\265996\0001\01\ 265996.0001.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 11:17AM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

GROUNDWATER ELEVATION (COLLECTED 03/06/2017)

SOIL BORING

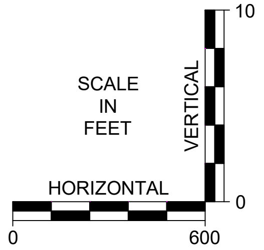
WELL SCREEN INTERVAL

END OF BORING

Lithology Key

▨ SILTY CLAY

▦ LIMESTONE BEDROCK



PROJECT:
DTE ELECTRIC COMPANY
MONROE POWER PLANT - FLY ASH BASIN
MONROE, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION B-B'

DRAWN BY:	D.Stehle	PROJ NO.:	265996.0001.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE 5**	
APPROVED BY:	V.BUENING		
DATE:	MAY 2017		

TRC
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FILE NO.: 265996.0001.01.01.04-05.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\Monroe PP\265996\0001\01\01\ 265996.0001.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 11:17AM --- LAYOUT: FIG05 XS BB

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - Monroe FAB	Cell #:	8
Project #:	231828.0001.0000	USCS Description:	N/A
Sample Name:	MW-16-01, 20-22'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	1.6E-08 cm/s

Sample Type:	Undisturbed	Initial Values	Final Values			
Sample Dia. (in)		2.87	2.87	Permeant:	Water	
Sample Ht. (in)		3.31	3.31	Permeant Specific Gravity:	1.00	
Tare & Wet (g)		542.53	912.90	Sample Specific Gravity:	2.81	Est.
Tare & Dry (g)		495.80	821.70	Confining Pressure (psi):	100.0	
Tare (g)		90.23	91.36	Burette Diameter (in):	0.250	
Sample Wt. (g)		816.00	821.54	Burette Zero (cm):	100.0	

Moisture (%)	11.5	12.5	Maximum Gradient:	6.7
Wet Density (pcf)	145.1	146.0	Average Gradient:	6.5
Dry Density (pcf)	130.1	129.8	Max. Effect. Stress (psi):	5.8
Saturation (%)	92.9	100.0	Min. Effect. Stress (psi):	4.4
			Ave. Effect. Stress (psi):	4.9

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	2	5	6.00		0.0	95	95	45.70		2.90		102.20				
2	2016	3	2	9	13.00	14820	24.0	95	95	46.50	0.80	4.15	1.25	100.65	1.55	-10.7	5.6E-08	
3	2016	3	2	12	8.00	10500	22.0	95	95	46.70	0.20	4.95	0.80	99.85	0.80	0.0	4.8E-08	
4	2016	3	2	20	42.00	30840	22.0	95	95	48.30	1.60	7.20	2.25	97.85	2.00	5.9	4.5E-08	
5	2016	3	3	14	8.00	62760	23.0	95	95	50.95	2.65	10.90	3.70	94.55	3.30	5.7	3.8E-08	
6	2016	3	3	18	52.00	17040	24.0	95	95	51.50	0.55	11.80	0.90	93.80	0.75	9.1	3.4E-08	
7	2016	3	4	13	27.00	66900	22.0	95	95	53.20	1.70	14.70	2.90	91.15	2.65	4.5	3.2E-08	
8	2016	3	4	18	53.00	19560	22.0	95	95	53.80	0.60	15.45	0.75	90.45	0.70	3.4	3.0E-08	
9	2016	3	7	5	14.00	210060	22.0	95	95	58.95	5.15	21.05	5.60	85.35	5.10	4.7	2.2E-08	
10	2016	3	7	8	14.00	10800	23.0	95	95	59.30	0.35	21.30	0.25	85.15	0.20	11.1	1.9E-08	
11	2016	3	7	13	26.00	18720	22.0	95	95	59.75	0.45	21.65	0.35	84.80	0.35	0.0	1.8E-08	
12	2016	3	7	18	47.00	19260	21.0	95	95	60.50	0.75	22.05	0.40	84.55	0.25	23.1	1.7E-08	
13	2016	3	8	5	5.00	37080	25.0	95	95	61.50	1.00	22.75	0.70	83.85	0.70	0.0	1.7E-08	
14	2016	3	8	13	23.00	29880	22.0	95	95	62.20	0.70	23.30	0.55	83.30	0.55	0.0	1.8E-08	
15	2016	3	8	19	23.00	21600	22.0	95	95	63.10	0.90	23.70	0.40	83.10	0.20	33.3	1.4E-08	
16	2016	3	9	5	30.00	36420	24.0	95	95	63.80	0.70	24.30	0.60	82.40	0.70	-7.7	1.8E-08	
17	2016	3	9	11	14.00	20640	24.0	95	95	64.30	0.50	24.65	0.35	82.15	0.25	16.7	1.5E-08	
18	2016	3	9	20	22.00	32880	22.0	95	95	64.70	0.40	25.25	0.60	81.70	0.45	14.3	1.7E-08	
19	2016	3	10	4	59.00	31020	23.0	95	95	65.20	0.50	25.70	0.45	81.20	0.50	-5.3	1.6E-08	1
20	2016	3	10	8	24.00	12300	23.0	95	95	65.40	0.20	25.90	0.20	81.00	0.20	0.0	1.7E-08	1
21	2016	3	10	11	23.00	10740	23.0	95	95	65.40	0.00	26.05	0.15	80.85	0.15	0.0	1.5E-08	1
22	2016	3	10	20	45.00	33720	23.0	95	95	66.20	0.80	26.65	0.60	80.45	0.40	20.0	1.6E-08	1
23	2016	3	11	4	53.00	29280	22.0	95	95	66.20	0.00	27.05	0.40	79.95	0.50	-11.1	1.8E-08	1
24	2016	3	11	7	57.00	11040	24.0	95	95	66.60	0.40	27.20	0.15	79.80	0.15	0.0	1.5E-08	1
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 1.6E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - Monroe FAB	Cell #:	9
Project #:	231828.0001.0000	USCS Description:	N/A
Sample Name:	MW-16-02, 30-32'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	1.3E-08 cm/s

	Initial Values	Final Values			
Sample Type: Undisturbed					
Sample Dia. (in)	2.87	2.86	Permeant:	Water	
Sample Ht. (in)	3.06	3.03	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	392.27	822.40	Sample Specific Gravity:	2.80	Est.
Tare & Dry (g)	353.20	733.00	Confining Pressure (psi):	100.0	
Tare (g)	89.98	90.41	Burette Diameter (in):	0.250	
Sample Wt. (g)	733.20	731.99	Burette Zero (cm):	100.0	

Moisture (%)	14.8	13.9	Maximum Gradient:	9.2
Wet Density (pcf)	141.0	143.2	Average Gradient:	9.0
Dry Density (pcf)	122.8	125.7	Max. Effect. Stress (psi):	5.7
Saturation (%)	98.2	100.0	Min. Effect. Stress (psi):	4.2
			Ave. Effect. Stress (psi):	4.8

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	2	5	7.00		0.0	95	95	55.10		2.10		101.90				
2	2016	3	2	9	14.00	14820	24.0	95	95	55.90	0.80	2.65	0.55	101.15	0.75	-15.4	2.4E-08	
3	2016	3	2	12	9.00	10500	22.0	95	95	56.20	0.30	2.95	0.30	100.75	0.40	-14.3	1.9E-08	
4	2016	3	2	20	43.00	30840	22.0	95	95	57.75	1.55	4.05	1.10	99.90	0.85	12.8	1.8E-08	
5	2016	3	3	14	9.00	62760	23.0	95	95	60.30	2.55	5.95	1.90	98.50	1.40	15.2	1.5E-08	
6	2016	3	3	18	53.00	17040	24.0	95	95	60.85	0.55	6.50	0.55	98.00	0.50	4.8	1.8E-08	
7	2016	3	4	13	28.00	66900	22.0	95	95	62.50	1.65	8.30	1.80	96.55	1.45	10.8	1.5E-08	
8	2016	3	4	18	54.00	19560	22.0	95	95	63.10	0.60	8.80	0.50	96.15	0.40	11.1	1.5E-08	
9	2016	3	7	5	15.00	210060	22.0	95	95	67.80	4.70	13.70	4.90	92.40	3.75	13.3	1.4E-08	
10	2016	3	7	8	14.00	10740	23.0	95	95	68.30	0.50	13.95	0.25	92.20	0.20	11.1	1.5E-08	
11	2016	3	7	13	26.00	18720	21.0	95	95	68.60	0.30	14.35	0.40	92.00	0.20	33.3	1.2E-08	
12	2016	3	7	18	48.00	19320	21.0	95	95	69.35	0.75	14.80	0.45	91.75	0.25	28.6	1.3E-08	
13	2016	3	8	5	5.00	37020	25.0	95	95	70.40	1.05	15.60	0.80	91.15	0.60	14.3	1.3E-08	
14	2016	3	8	13	48.00	31380	22.0	95	95	70.40	0.00	16.15	0.55	90.70	0.45	10.0	1.2E-08	
15	2016	3	8	19	24.00	20160	22.0	95	95	71.75	1.35	16.60	0.45	90.55	0.15	50.0	1.1E-08	
16	2016	3	9	5	31.00	36420	24.0	95	95	72.40	0.65	17.25	0.65	90.15	0.40	23.8	1.1E-08	
17	2016	3	9	11	15.00	20640	24.0	95	95	72.80	0.40	17.65	0.40	89.85	0.30	14.3	1.3E-08	
18	2016	3	9	20	23.00	32880	22.0	95	95	73.20	0.40	18.35	0.70	89.55	0.30	40.0	1.2E-08	
19	2016	3	10	4	59.00	30960	23.0	95	95	73.60	0.40	18.85	0.50	89.10	0.45	5.3	1.2E-08	1
20	2016	3	10	8	23.00	12240	23.0	95	95	73.80	0.20	19.10	0.25	88.90	0.20	11.1	1.4E-08	1
21	2016	3	10	11	23.00	10800	23.0	95	95	73.80	0.00	19.30	0.20	88.70	0.20	0.0	1.5E-08	1
22	2016	3	10	20	46.00	33780	23.0	95	95	74.50	0.70	20.00	0.70	88.45	0.25	47.4	1.1E-08	1
23	2016	3	11	4	54.00	29280	22.0	95	95	74.40	-0.10	20.45	0.45	87.85	0.60	-14.3	1.5E-08	1
24	2016	3	11	7	58.00	11040	24.0	95	95	74.80	0.40	20.70	0.25	87.75	0.10	42.9	1.3E-08	1
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 1.3E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - Monroe FAB	Cell #:	10
Project #:	231828.0001.0000	USCS Description:	N/A
Sample Name:	MW-16-03, 20-22'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	1.2E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.87	2.87	Permeant:	Water	
Sample Ht. (in)	3.00	3.01	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	563.98	834.70	Sample Specific Gravity:	2.82	Est.
Tare & Dry (g)	512.90	750.80	Confining Pressure (psi):	100.0	
Tare (g)	88.99	90.55	Burette Diameter (in):	0.250	
Sample Wt. (g)	740.10	744.15	Burette Zero (cm):	100.0	

Moisture (%)	12.0	12.7	Maximum Gradient:	9.8
Wet Density (pcf)	145.3	145.8	Average Gradient:	9.4
Dry Density (pcf)	129.7	129.4	Max. Effect. Stress (psi):	5.7
Saturation (%)	95.6	100.0	Min. Effect. Stress (psi):	4.2
			Ave. Effect. Stress (psi):	4.8

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	2	5	8.00		0.0	95	95	50.70		2.00		101.60				
2	2016	3	2	9	14.00	14760	24.0	95	95	50.40	-0.30	2.65	0.65	100.90	0.70	-3.7	2.4E-08	
3	2016	3	2	12	9.00	10500	22.0	95	95	51.00	0.60	2.95	0.30	100.50	0.40	-14.3	1.9E-08	
4	2016	3	2	20	44.00	30900	22.0	95	95	52.65	1.65	3.85	0.90	99.75	0.75	9.1	1.5E-08	
5	2016	3	3	14	10.00	62760	23.0	95	95	55.10	2.45	5.50	1.65	98.30	1.45	6.5	1.4E-08	
6	2016	3	3	18	54.00	17040	24.0	95	95	55.30	0.20	6.00	0.50	97.90	0.40	11.1	1.5E-08	
7	2016	3	4	13	29.00	66900	22.0	95	95	57.20	1.90	7.55	1.55	96.50	1.40	5.1	1.3E-08	
8	2016	3	4	18	55.00	19560	22.0	95	95	57.70	0.50	8.00	0.45	96.00	0.50	-5.3	1.5E-08	
9	2016	3	7	5	15.00	210000	22.0	95	95	63.25	5.55	12.30	4.30	92.10	3.90	4.9	1.3E-08	
10	2016	3	7	8	15.00	10800	23.0	95	95	63.40	0.15	12.60	0.30	91.90	0.20	20.0	1.6E-08	
11	2016	3	7	13	27.00	18720	21.0	95	95	63.80	0.40	12.85	0.25	91.60	0.30	-9.1	1.1E-08	
12	2016	3	7	18	49.00	19320	21.0	95	95	64.65	0.85	13.35	0.50	91.35	0.25	33.3	1.4E-08	
13	2016	3	8	5	6.00	37020	25.0	95	95	65.15	0.50	14.00	0.65	90.75	0.60	4.0	1.1E-08	
14	2016	3	8	13	48.00	31320	22.0	95	95	66.90	1.75	14.40	0.40	90.15	0.60	-20.0	1.2E-08	
15	2016	3	8	19	25.00	20220	22.0	95	95	67.60	0.70	14.80	0.40	89.95	0.20	33.3	1.1E-08	
16	2016	3	9	5	31.00	36360	24.0	95	95	67.70	0.10	15.50	0.70	89.35	0.60	7.7	1.3E-08	1
17	2016	3	9	11	15.00	20640	24.0	95	95	68.40	0.70	15.85	0.35	89.00	0.35	0.0	1.2E-08	1
18	2016	3	9	20	24.00	32940	22.0	95	95	69.10	0.70	16.40	0.55	88.60	0.40	15.8	1.1E-08	1
19	2016	3	10	5	0.00	30960	23.0	95	95	70.20	1.10	16.75	0.35	88.05	0.55	-22.2	1.1E-08	1
20	2016	3	10	8	24.00	12240	23.0	95	95	69.90	-0.30	17.00	0.25	87.80	0.25	0.0	1.6E-08	1
21	2016	3	10	11	24.00	10800	23.0	95	95	70.20	0.30	17.20	0.20	87.70	0.10	33.3	1.1E-08	1
22	2016	3	10	20	47.00	33780	23.0	95	95	70.40	0.20	17.80	0.60	87.40	0.30	33.3	1.0E-08	1
23	2016	3	11	4	54.00	29220	22.0	95	95	71.40	1.00	18.15	0.35	86.75	0.65	-30.0	1.4E-08	1
24	2016	3	11	7	58.00	11040	24.0	95	95	71.25	-0.15	18.35	0.20	86.65	0.10	33.3	1.0E-08	1
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 1.2E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

TRC Environmental Corporation

Falling Head, Rising Tailwater Permeability Test (ASTM D5084, Method C)

QC: JPH
QA: JPH

Project Name:	DTE - Monroe FAB	Cell #:	11
Project #:	231828.0001.0000	USCS Description:	N/A
Sample Name:	MW-16-04, 20-22'	USCS Classification:	N/A
Visual Descript:	Gray sandy lean clay, with gravel	Average Kv =	1.2E-08 cm/s

Sample Type: Undisturbed	Initial Values	Final Values			
Sample Dia. (in)	2.87	2.85	Permeant:	Water	
Sample Ht. (in)	3.55	3.51	Permeant Specific Gravity:	1.00	
Tare & Wet (g)	869.30	961.20	Sample Specific Gravity:	2.80	Est.
Tare & Dry (g)	785.95	875.10	Confining Pressure (psi):	100.0	
Tare (g)	0.00	89.15	Burette Diameter (in):	0.250	
Sample Wt. (g)	869.30	872.05	Burette Zero (cm):	100.0	

Moisture (%)	10.6	11.0	Maximum Gradient:	8.4
Wet Density (pcf)	144.2	148.4	Average Gradient:	8.1
Dry Density (pcf)	130.4	133.7	Max. Effect. Stress (psi):	5.7
Saturation (%)	87.3	100.0	Min. Effect. Stress (psi):	4.1
			Ave. Effect. Stress (psi):	4.7

	Date			Time		Run	Temp	Pressure (psi)		Cham	Cham.	Bot	Bot.	Top	Top	Flow	Kv ***	Ave.*
	Yr.	Mo.	Day	Hr.	Min.	Time (s)	C°**	Bot	Top	(cm)	Dif.(cm)	(cm)	Dif.(cm)	(cm)	Dif.(cm)	Dif.(%)	cm/s	0,1
1	2016	3	2	5	8.00		0.0	95	95	52.10		2.10		102.60				
2	2016	3	2	9	15.00	14820	24.0	95	95	53.45	1.35	2.75	0.65	101.85	0.75	-7.1	3.0E-08	
3	2016	3	2	12	10.00	10500	22.0	95	95	54.20	0.75	3.15	0.40	101.45	0.40	0.0	2.5E-08	
4	2016	3	2	20	40.00	30600	22.0	95	95	56.60	2.40	4.40	1.25	100.50	0.95	13.6	2.4E-08	
5	2016	3	3	14	6.00	62760	23.0	95	95	60.60	4.00	6.50	2.10	98.80	1.70	10.5	2.1E-08	
6	2016	3	3	18	50.00	17040	24.0	95	95	61.60	1.00	7.05	0.55	98.40	0.40	15.8	1.9E-08	
7	2016	3	4	13	25.00	66900	22.0	95	95	64.60	3.00	8.85	1.80	96.75	1.65	4.3	1.9E-08	
8	2016	3	4	18	51.00	19560	22.0	95	95	65.60	1.00	9.35	0.50	96.30	0.45	5.3	1.8E-08	
9	2016	3	7	5	16.00	210300	22.0	95	95	73.80	8.20	13.55	4.20	92.50	3.80	5.0	1.5E-08	
10	2016	3	7	8	15.00	10740	23.0	95	95	74.30	0.50	13.80	0.25	92.30	0.20	11.1	1.7E-08	
11	2016	3	7	13	27.00	18720	21.0	95	95	74.95	0.65	14.10	0.30	92.00	0.30	0.0	1.4E-08	
12	2016	3	7	18	46.00	19140	21.0	95	95	75.95	1.00	14.45	0.35	91.85	0.15	40.0	1.1E-08	
13	2016	3	8	5	6.00	37200	25.0	95	95	77.60	1.65	15.00	0.55	91.35	0.50	4.8	1.1E-08	
14	2016	3	8	13	50.00	31440	22.0	95	95	78.60	1.00	15.45	0.45	90.80	0.55	-10.0	1.4E-08	
15	2016	3	8	19	21.00	19860	22.0	95	95	79.60	1.00	15.80	0.35	90.70	0.10	55.6	9.9E-09	
16	2016	3	9	5	32.00	36660	24.0	95	95	80.80	1.20	16.30	0.50	90.20	0.50	0.0	1.1E-08	1
17	2016	3	9	11	16.00	20640	24.0	95	95	81.60	0.80	16.60	0.30	89.90	0.30	0.0	1.2E-08	1
18	2016	3	9	20	20.00	32640	22.0	95	95	82.25	0.65	17.10	0.50	89.60	0.30	25.0	1.1E-08	1
19	2016	3	10	5	0.00	31200	23.0	95	95	82.90	0.65	17.55	0.45	89.10	0.50	-5.3	1.4E-08	1
20	2016	3	10	8	24.00	12240	23.0	95	95	83.30	0.40	17.70	0.15	89.00	0.10	20.0	9.1E-09	1
21	2016	3	10	11	24.00	10800	23.0	95	95	83.50	0.20	17.85	0.15	88.85	0.15	0.0	1.2E-08	1
22	2016	3	10	20	43.00	33540	23.0	95	95	84.50	1.00	18.35	0.50	88.60	0.25	33.3	1.0E-08	1
23	2016	3	11	4	55.00	29520	22.0	95	95	84.70	0.20	18.65	0.30	88.05	0.55	-29.4	1.3E-08	1
24	2016	3	11	7	59.00	11040	24.0	95	95	85.30	0.60	18.85	0.20	88.00	0.05	60.0	1.0E-08	1
25																		
26																		

**A zero in this column starts a series of measurements. *Average Kv for those rows with a 1 in the Ave. column. 1.2E-08 cm/s

(Termination determined by stable Kv and low flow differential.) ***Kv adjusted for temperature.

EXHIBIT D

LABORATORY TEST RESULTS
VERIFICATION OF NATURAL SOIL BARRIER - MONROE ASH BASIN
SME PROJECT NO. PG-22087

BORING NO.	SAMPLE NO.	DEPTH (feet)	CLASSIFICATION SYMBOL	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO (calculated)	ATTERBERG LIMITS			PARTICLE SIZE DISTRIBUTION (%)						COEFFICIENT OF PERMEABILITY (cm/sec)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY	
B2	CS2	6.5	CL	21	108	2.73	0.58	42	17	25	0	0	2	5	36	57	3.3E-08
B2	CS4	11.5	CL	12	126	2.68	0.33	23	15	8	0	0	8	18	39	35	5.8E-08
B2	CS6	16.5	CL	12	126	2.72	0.35	23	14	9	0	0	8	16	40	36	1.3E-08
B2	CS8	21.5	CL	12	127	2.72	0.34	24	13	11	0	0	8	17	38	37	1.5E-08
B2	CS10	26.5	CL	10	131	2.75	0.31	20	11	9	0	0	9	24	34	33	2.0E-08
B2	CS12	31.5	CL	12	122	2.73	0.40	32	15	17	0	0	5	9	39	47	2.0E-08
B4	CS2	6.5	CL	18	111	2.73	0.53	45	19	26	0	0	2	8	37	53	6.6E-08
B4	CS4	11.5	CL	21	109	2.73	0.56	43	17	26	0	0	3	11	36	50	2.1E-08
B4	CS6	16.5	CL	12	126	2.71	0.34	24	13	11	0	0	8	17	41	34	4.7E-08
B4	CS8	21.5	CL	11	136	2.70	0.24	23	13	10	0	0	8	18	37	37	2.1E-08
B4	CS10	26.5	CL	11	130	2.73	0.31	23	14	9	0	0	8	17	38	37	3.0E-08
B4	CS12	31.5	CL	10	128	2.71	0.32	25	14	11	0	0	4	11	44	41	1.8E-08
B4	CS14	36.5	CL	8	118	2.73	0.44	24	13	11	0	0	13	23	44	20	*
B6	CS2	6.5	CL	12	123	2.70	0.37	27	15	12	0	0	8	17	39	36	7.4E-08
B6	CS4	11.5	CL	11	132	2.72	0.29	23	13	10	0	0	8	17	39	36	1.8E-08
B6	CS6	16.5	CL	8	134	2.72	0.27	21	12	9	0	0	7	22	38	33	4.0E-08
B6	CS8	21.5	CL	11	133	2.75	0.29	21	12	9	0	0	7	21	37	35	6.5E-08
B6	CS10	26.5	CL	9	125	2.71	0.35	26	14	12	0	0	5	13	39	43	*
B6	CS12	31.5	CL	10	128	2.74	0.34	26	15	11	0	0	11	17	33	39	*
B8	CS2	6.5	CL	13	118	2.73	0.44	41	15	26	0	0	3	12	35	50	1.5E-08
B8	CS4	11.5	CL	17	112	2.73	0.52	34	17	17	0	0	7	17	38	38	2.2E-08
B8	CS6	16.5	CL	13	127	2.73	0.34	26	15	11	0	0	9	19	38	34	4.8E-08
B8	CS8	21.5	CL	12	129	2.74	0.33	24	14	10	0	0	8	17	40	35	1.6E-08
B8	CS10	26.5	CL	13	130	2.76	0.32	25	14	11	0	0	7	18	36	39	1.7E-08
B8	CS12	31.5	CL	10	134	2.73	0.27	20	11	9	0	0	10	24	41	25	4.7E-08
B8	CS14	36.5	CL	11	135	2.75	0.27	23	12	11	0	0	11	24	31	34	3.8E-08
B8	CS16	41.5	CL	10	127	2.78	0.37	23	13	10	0	0	15	19	46	20	1.9E-07

EXHIBIT D

LABORATORY TEST RESULTS
VERIFICATION OF NATURAL SOIL BARRIER - MONROE ASH BASIN
SME PROJECT NO. PG-22087

BORING NO.	SAMPLE NO.	DEPTH (feet)	CLASSIFICATION SYMBOL	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO (calculated)	ATTERBERG LIMITS			PARTICLE SIZE DISTRIBUTION (%)						COEFFICIENT OF PERMEABILITY (cm/sec)
								LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY	
B10	CS2	6.5	CL	20	114	2.72	0.49	40	15	25	0	0	3	13	35	49	3.6E-08
B10	CS4	11.5	CL	18	112	2.75	0.53	35	15	20	0	0	2	9	39	50	1.2E-08
B10	CS6	16.5	CL	22	102	2.74	0.68	36	17	19	0	0	1	2	37	60	5.3E-08
B10	CS8	21.5	CL	13	127	2.71	0.33	25	14	11	0	0	8	17	37	38	3.7E-08
B10	CS10	26.5	CL	10	133	2.74	0.29	23	14	9	0	0	7	17	39	37	1.5E-08

NOTE:

* Sample too small or disturbed to run test.

JRW Ponds 1 & 2 CCR Unit and Pond 6 Inactive CCR Unit Site

BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 3,000 '
1:36,000

0 3,000 6,000 FEET

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:

CONSUMERS ENERGY COMPANY
JR WHITING POWER PLANT
ERIE, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	J. PAPEZ
CHECKED BY:	S. HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	269767-004
FILE:	269767-004-000SLM.mxd

FIGURE 1

E:\ConsumersEnergy\CCR_GW\2017_269767\269767-004-000SLM.mxd -- Saved By: JPAPEZ on 10/17/2017, 09:07:39 AM

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

JRW MW-16001
574.91' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.94' (02/01/2017)
575.55' (03/08/2017)
576.02' (04/12/2017)
576.24' (05/23/2017)
575.18' (06/27/2017)
575.50' (07/31/2017)
575.24' (09/05/2017)
NM (10/09/2017)
574.39' (11/13/2017)
575.10' (02/27/2018)
576.02' (05/01/2018)

JRW MW-16005
574.91' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.82' (02/01/2017)
575.57' (03/08/2017)
576.04' (04/12/2017)
576.24' (05/23/2017)
575.10' (06/27/2017)
575.44' (07/31/2017)
575.20' (09/05/2017)
NM (10/09/2017)
574.32' (11/13/2017)
574.99' (02/27/2018)
575.98' (05/01/2018)

JRW MW-16002
574.88' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.90' (02/01/2017)
575.54' (03/08/2017)
576.02' (04/12/2017)
576.22' (05/23/2017)
575.18' (06/27/2017)
575.45' (07/31/2017)
575.20' (09/05/2017)
NM (10/09/2017)
574.40' (11/13/2017)
575.07' (02/27/2018)
575.98' (05/01/2018)

JRW MW-16006
574.92' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.77' (02/01/2017)
575.58' (03/08/2017)
576.07' (04/12/2017)
576.25' (05/23/2017)
575.09' (06/27/2017)
575.45' (07/31/2017)
575.23' (09/05/2017)
NM (10/09/2017)
574.31' (11/13/2017)
574.98' (02/27/2018)
575.96' (05/01/2018)

JRW MW-16003
574.92' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.88' (02/01/2017)
575.58' (03/08/2017)
576.08' (04/12/2017)
576.27' (05/23/2017)
575.17' (06/27/2017)
575.47' (07/31/2017)
575.22' (09/05/2017)
NM (10/09/2017)
574.36' (11/13/2017)
575.02' (02/27/2018)
576.03' (05/01/2018)

JRW MW-16004
574.90' (11/21/2016)
NM (12/19/2016)
NM (01/24/2017)
574.78' (02/01/2017)
575.85' (03/08/2017)
576.07' (04/12/2017)
576.24' (05/23/2017)
575.10' (06/27/2017)
575.45' (07/31/2017)
575.20' (09/05/2017)
NM (10/09/2017)
574.33' (11/13/2017)
574.86' (02/27/2018)
576.03' (05/01/2018)

JRW MW-15002
NM (11/21/2016)
574.18' (12/19/2016)
575.20' (01/24/2017)
NM (02/01/2017)
575.54' (03/08/2017)
576.06' (04/12/2017)
576.31' (05/23/2017)
575.13' (06/27/2017)
575.48' (07/31/2017)
575.31' (09/05/2017)
574.51' (10/09/2017)
574.35' (11/13/2017)
575.02' (02/27/2018)
576.06' (05/01/2018)

JRW MW-16007
574.74' (11/21/2016)
574.04' (12/19/2016)
575.18' (01/24/2017)
NM (02/01/2017)
575.54' (03/08/2017)
576.14' (04/12/2017)
576.18' (05/23/2017)
574.99' (06/27/2017)
575.45' (07/31/2017)
575.18' (09/05/2017)
574.39' (10/09/2017)
574.22' (11/13/2017)
574.87' (02/27/2018)
575.87' (05/01/2018)

JRW MW-15003
NM (11/21/2016)
574.25' (12/19/2016)
575.18' (01/24/2017)
NM (02/01/2017)
575.12' (03/08/2017)
576.04' (04/12/2017)
576.34' (05/23/2017)
575.22' (06/27/2017)
575.47' (07/31/2017)
575.36' (09/05/2017)
574.56' (10/09/2017)
574.35' (11/13/2017)
575.06' (02/27/2018)
576.07' (05/01/2018)

JRW MW-15001
NM (11/21/2016)
574.16' (12/19/2016)
575.14' (01/24/2017)
NM (02/01/2017)
575.49' (03/08/2017)
576.03' (04/12/2017)
576.26' (05/23/2017)
575.06' (06/27/2017)
575.44' (07/31/2017)
575.33' (09/05/2017)
574.53' (10/09/2017)
574.33' (11/13/2017)
575.00' (02/27/2018)
576.01' (05/01/2018)

JRW MW-16008
574.91' (11/21/2016)
574.07' (12/19/2016)
575.14' (01/24/2017)
NM (02/01/2017)
575.50' (03/08/2017)
576.02' (04/12/2017)
576.18' (05/23/2017)
575.00' (06/27/2017)
575.43' (07/31/2017)
575.21' (09/05/2017)
574.43' (10/09/2017)
574.23' (11/13/2017)
574.88' (02/27/2018)
575.93' (05/01/2018)

JRW MW-15004
NM (11/21/2016)
574.28' (12/19/2016)
575.16' (01/24/2017)
NM (02/01/2017)
575.45' (03/08/2017)
576.01' (04/12/2017)
576.32' (05/23/2017)
575.19' (06/27/2017)
575.47' (07/31/2017)
575.42' (09/05/2017)
574.52' (10/09/2017)
574.32' (11/13/2017)
575.06' (02/27/2018)
576.08' (05/01/2018)

JRW MW-15006
NM (11/21/2016)
574.21' (12/19/2016)
575.10' (01/24/2017)
NM (02/01/2017)
575.45' (03/08/2017)
576.03' (04/12/2017)
576.30' (05/23/2017)
575.24' (06/27/2017)
575.46' (07/31/2017)
575.33' (09/05/2017)
574.51' (10/09/2017)
574.31' (11/13/2017)
575.01' (02/27/2018)
576.04' (05/01/2018)

JRW MW-16009
574.89' (11/21/2016)
574.06' (12/19/2016)
575.16' (01/24/2017)
NM (02/01/2017)
575.50' (03/08/2017)
576.05' (04/12/2017)
576.19' (05/23/2017)
575.00' (06/27/2017)
575.44' (07/31/2017)
575.24' (09/05/2017)
574.41' (10/09/2017)
574.24' (11/13/2017)
574.88' (02/27/2018)
575.89' (05/01/2018)

JRW MW-15005
NM (11/21/2016)
574.29' (12/19/2016)
575.13' (01/24/2017)
NM (02/01/2017)
575.46' (03/08/2017)
576.03' (04/12/2017)
576.36' (05/23/2017)
575.21' (06/27/2017)
575.46' (07/31/2017)
575.41' (09/05/2017)
574.55' (10/09/2017)
574.34' (11/13/2017)
575.08' (02/27/2018)
576.12' (05/01/2018)

LEGEND

⌖ MONITORING WELL (STATIC WATER LEVEL ONLY)
⌖ CCR UNIT MONITORING WELL

LABEL FORMAT

MONITORING WELL ID
GROUNDWATER ELEVATION FT MSL (MEASUREMENT DATE)
GROUNDWATER ELEVATION FT MSL (MEASUREMENT DATE)
etc...

NOTES

1. BASE MAP IMAGERY FROM NEARMAP, 4/12/2017.
2. WELL LOCATIONS SURVEYED BY SHERIDAN SURVEYING CO. ON 11/19/2015 AND 11/30/2016.

N

0 500 1,000
Feet

1 " = 500 '
1:6,000

PROJECT:
CONSUMERS ENERGY COMPANY
JR WHITING POWER PLANT
ERIE, MICHIGAN

TITLE:
GROUNDWATER
POTENTIOMETRIC ELEVATION SUMMARY

DRAWN BY:	J. PAPEZ	PROJ NO.:	297944-001
CHECKED BY:	J. LI	**FIGURE 3**	
APPROVED BY:			
DATE:	JULY 2018		

TRC

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

FILE NO.: 297944-001-001.mxd

Plot Date: 7/25/2018, 10:23:57 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\ConsumersEnergy\CCR_GW\2017_269767\297944-001-001.mxd

Table 1

Summary of Groundwater Elevation Data
JR Whiting – RCRA CCR Monitoring Program
Erie, Michigan

Well Location	Ground Surface Elevation (ft)	TOC Elevation (ft)	Geologic Unit of Screen Interval	Screen Interval Depth (ft BGS)			Screen Interval Elevation (ft)			Round 1				Round 2		Round 3		Round 4	
										November 21, 2016		December 19, 2016		January 24, 2017		March 8, 2017		April 12, 2017	
										Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)
Background																			
JRW-MW-16007	579.47	582.32	Limestone	68.0	to	78.0	511.5	to	501.5	7.58	574.74	8.28	574.04	7.14	575.18	6.78	575.54	6.18	576.14
JRW-MW-16008	579.95	582.84	Limestone	68.0	to	73.0	512.0	to	507.0	7.93	574.91	8.77	574.07	7.70	575.14	7.34	575.50	6.82	576.02
JRW-MW-16009	579.90	582.59	Limestone	69.0	to	79.0	510.9	to	500.9	7.70	574.89	8.53	574.06	7.43	575.16	7.09	575.50	6.54	576.05
Ponds 1 & 2																			
JRW-MW-15001	589.6	590.71	Limestone	78.0	to	88.0	511.6	to	501.6	--	--	16.55	574.16	15.57	575.14	15.22	575.49	14.68	576.03
JRW-MW-15002	590.6	592.31	Limestone	81.0	to	91.0	509.6	to	499.6	--	--	18.13	574.18	17.11	575.20	16.77	575.54	16.25	576.06
JRW-MW-15003	589.6	591.36	Limestone	81.0	to	91.0	508.6	to	498.6	--	--	17.11	574.25	16.18	575.18	16.24	575.12	15.32	576.04
JRW-MW-15004	590.8	592.52	Limestone	86.0	to	96.0	504.8	to	494.8	--	--	18.24	574.28	17.36	575.16	17.07	575.45	16.51	576.01
JRW-MW-15005	592.7	594.25	Limestone	86.0	to	96.0	506.7	to	496.7	--	--	19.96	574.29	19.12	575.13	18.79	575.46	18.22	576.03
JRW-MW-15006	590.3	592.01	Limestone	81.0	to	91.0	509.3	to	499.3	--	--	17.80	574.21	16.91	575.10	16.56	575.45	15.98	576.03

Notes:

Survey conducted by Sheridan Surveying Co., November 2015 (2015 wells), and November 2016 (2016 wells)

Elevation in feet relative to North American Vertical Datum 1988 (NAVD 88).

TOC: Top of well casing.

ft BTOC: Feet below top of well casing.

ft BGS: Feet below ground surface.

Table 1

Summary of Groundwater Elevation Data
JR Whiting – RCRA CCR Monitoring Program
Erie, Michigan

Well Location	Ground Surface Elevation (ft)	TOC Elevation (ft)	Geologic Unit of Screen Interval	Screen Interval Depth (ft BGS)			Screen Interval Elevation (ft)			Round 5		Round 6		Round 7		Round 8		Round 9	
										May 23, 2017		June 27, 2017		July 31, 2017		September 5, 2017		October 9, 2017	
										Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)	Depth to Water (ft BTOC)	Groundwater Elevation (ft)
Background																			
JRW-MW-16007	579.47	582.32	Limestone	68.0	to	78.0	511.5	to	501.5	6.14	576.18	7.33	574.99	6.87	575.45	7.14	575.18	7.93	574.39
JRW-MW-16008	579.95	582.84	Limestone	68.0	to	73.0	512.0	to	507.0	6.66	576.18	7.84	575.00	7.41	575.43	7.63	575.21	8.41	574.43
JRW-MW-16009	579.90	582.59	Limestone	69.0	to	79.0	510.9	to	500.9	6.40	576.19	7.59	575.00	7.15	575.44	7.35	575.24	8.18	574.41
Ponds 1 & 2																			
JRW-MW-15001	589.6	590.71	Limestone	78.0	to	88.0	511.6	to	501.6	14.45	576.26	15.65	575.06	15.27	575.44	15.38	575.33	16.18	574.53
JRW-MW-15002	590.6	592.31	Limestone	81.0	to	91.0	509.6	to	499.6	16.00	576.31	17.18	575.13	16.83	575.48	17.00	575.31	17.80	574.51
JRW-MW-15003	589.6	591.36	Limestone	81.0	to	91.0	508.6	to	498.6	15.02	576.34	16.14	575.22	15.89	575.47	16.00	575.36	16.80	574.56
JRW-MW-15004	590.8	592.52	Limestone	86.0	to	96.0	504.8	to	494.8	16.20	576.32	17.33	575.19	17.05	575.47	17.10	575.42	18.00	574.52
JRW-MW-15005	592.7	594.25	Limestone	86.0	to	96.0	506.7	to	496.7	17.89	576.36	19.04	575.21	18.79	575.46	18.84	575.41	19.70	574.55
JRW-MW-15006	590.3	592.01	Limestone	81.0	to	91.0	509.3	to	499.3	15.71	576.30	16.77	575.24	16.55	575.46	16.68	575.33	17.50	574.51

Notes:

Survey conducted by Sheridan Surveying Co., November 2015 (2015 wells), and November 2016 (2016 wells)

Elevation in feet relative to North American Vertical Datum 1988 (NAVD 88).

TOC: Top of well casing.

ft BTOC: Feet below top of well casing.

ft BGS: Feet below ground surface.

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/17/2017, 09:08:10 AM by JPAPEZ -- LAYOUT: ANSI B(11"x17")
Path: E:\ConsumersEnergy\CCR_GW\2017_269767\269767-004-004.mxd

LEGEND

✛ BACKGROUND MONITORING WELL
● CCR UNIT MONITORING WELL
CROSS SECTION LOCATION

NOTES

1. BASE MAP IMAGERY FROM NEARMAP, 4/12/2017.
2. WELL LOCATIONS SURVEYED BY SHERIDAN SURVEYING CO. ON 11/19/2015 AND 11/30/2016.

N

0 500 1,000 Feet

1 " = 500 '
1:6,000

PROJECT:

CONSUMERS ENERGY COMPANY
JR WHITING POWER PLANT
ERIE, MICHIGAN

TITLE:

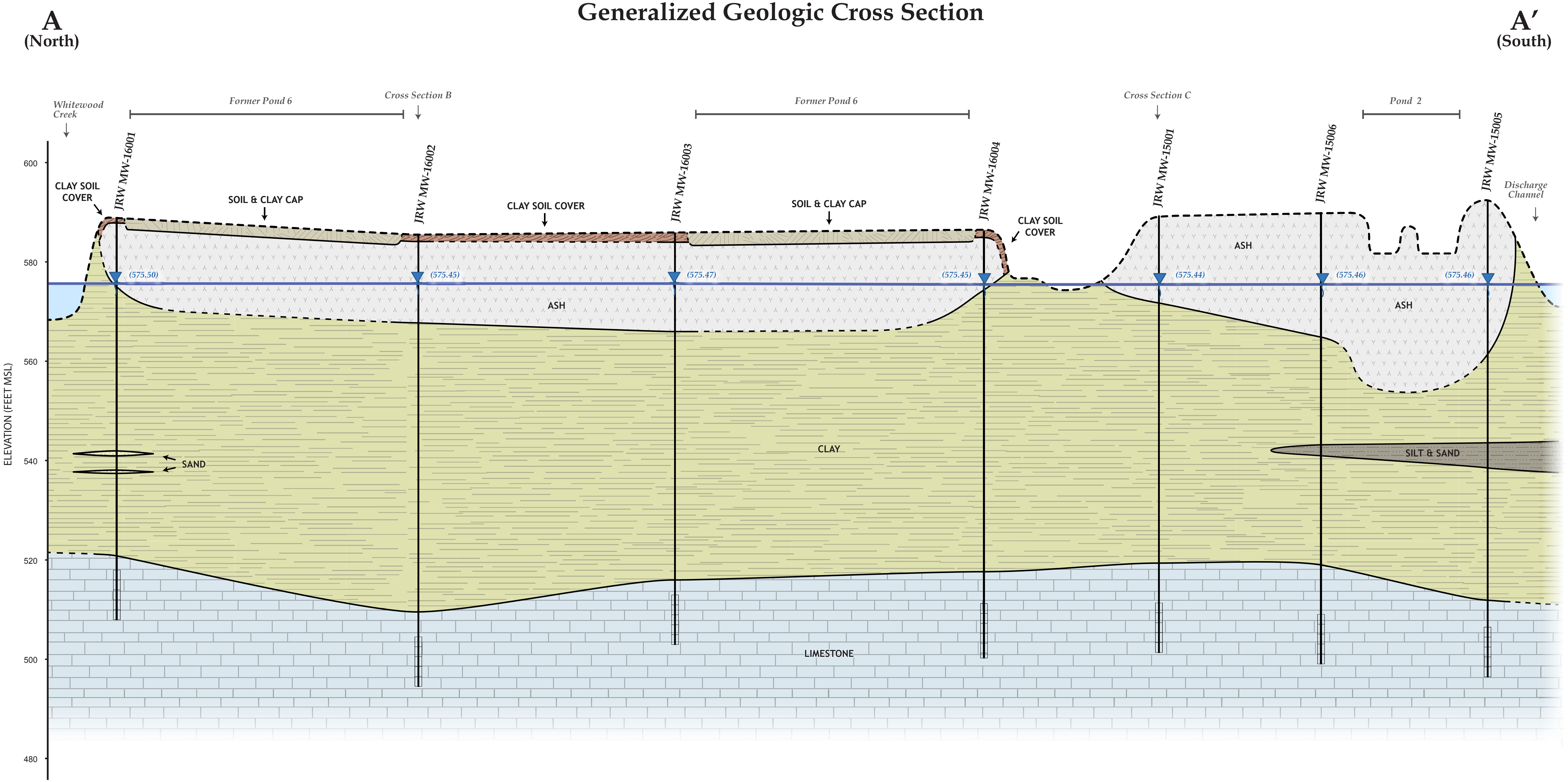
SITE PLAN
WITH MONITORING WELL LOCATIONS

DRAWN BY:	J. PAPEZ	PROJ NO.:	269767-001
CHECKED BY:	S. HOLMSTROM	**FIGURE 1**	
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

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

FILE NO.: 269767-004-004.mxd

Generalized Geologic Cross Section



LEGEND

GROUND SURFACE PROFILE, DASHED WHERE INFERRED

STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED

APPROXIMATE CONFINED GROUNDWATER POTENTIOMETRIC ELEVATION (JULY 31, 2017)

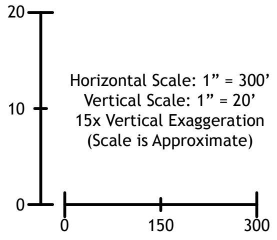
SOIL UNIT LITHOLOGY

SOIL & CLAY CAP
CLAY SOIL COVER
ASH
CLAY
LIMESTONE
SILT & SAND
SAND

WELL BOREHOLE
WELL SCREEN

NOTES

1. FEATURE LOCATIONS AND SCALE ARE APPROXIMATE.
2. CROSS SECTION BASED UPON INFORMATION FROM ASH POND MATERIAL CHARACTERIZATION (GOLDER, 2016), SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT (ARCADIS, 2016), AND 2016 MONITORING WELL DESIGN, INSTALLATION, DEVELOPMENT, AND DECOMISSIONING (TRC, 2016).



Horizontal Scale: 1” = 300’
Vertical Scale: 1” = 20’
15x Vertical Exaggeration
(Scale is Approximate)

PROJECT:
CONSUMERS ENERGY COMPANY
JR WHITING POWER PLANT
ERIE, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS SECTION A-A’

DRAWN BY: L. AUNER
CHECKED BY: S. HOLMSTROM
APPROVED BY: V. BUENING
DATE: OCTOBER 2017
PROJ NO.: 269767

FIGURE 2

TRC
1540 Eisenhower Place
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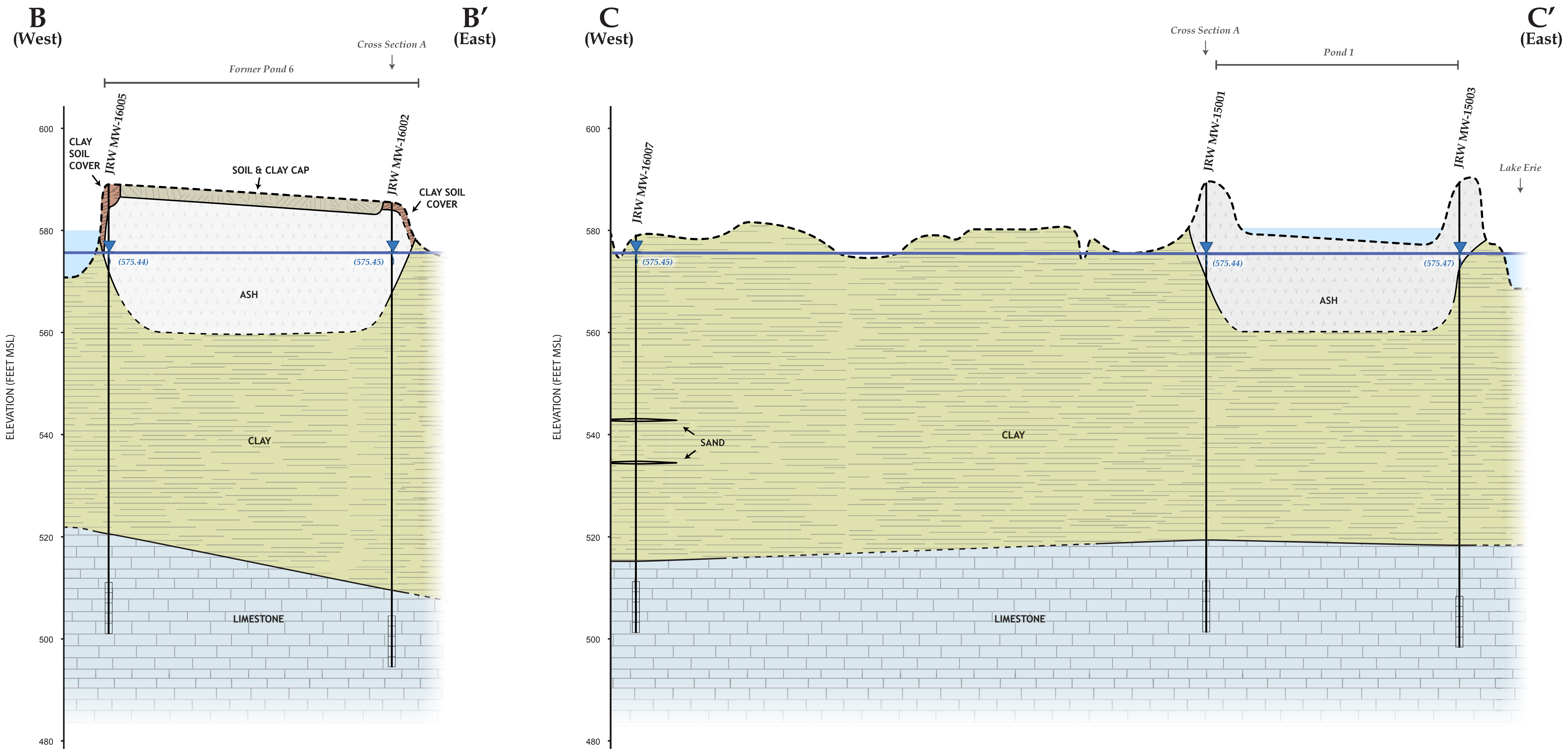
Phone: 734.971.7080

FILE NO.: 269767-004-ai01.ai

File Path: E:\WI_DOT\2015_229576\AI\269767-004-ai01.ai

Generalized Geologic Cross Sections



LEGEND

- GROUND SURFACE PROFILE, DASHED WHERE INFERRED
- STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED
- APPROXIMATE CONFINED GROUNDWATER POTENTIOMETRIC ELEVATION (JULY 31, 2017)

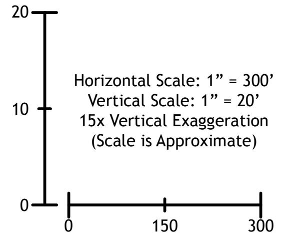
SOIL UNIT LITHOLOGY

▨ SOIL & CLAY CAP
▨ CLAY SOIL COVER
▨ ASH
▨ CLAY
▨ LIMESTONE
▨ SAND

WELL BOREHOLE
WELL SCREEN

NOTES

1. FEATURE LOCATIONS AND SCALE ARE APPROXIMATE.
2. CROSS SECTION BASED UPON INFORMATION FROM ASH POND MATERIAL CHARACTERIZATION (GOLDER, 2016), SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT (ARCADIS, 2016), AND 2016 MONITORING WELL DESIGN, INSTALLATION, DEVELOPMENT, AND DECOMISSIONING (TRC, 2016).



Horizontal Scale: 1” = 300’
Vertical Scale: 1” = 20’
15x Vertical Exaggeration
(Scale is Approximate)

PROJECT:
CONSUMERS ENERGY COMPANY
JR WHITING POWER PLANT
ERIE, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC
CROSS SECTIONS B-B’ AND C-C’

DRAWN BY: L. AUNER
CHECKED BY: S. HOLMSTROM
APPROVED BY: V. BUENING
DATE: OCTOBER 2017
PROJ NO.: 269767

FIGURE 3

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080

FILE NO.: 269767-004-ai02.ai

File Path: E:\WI_DOT\2015_229576\AI\269767-004-ai02.ai

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

Mr. Zachary Carr, P.E.
FK Engineering Associates
30425 Stephenson Hwy.
Madison Heights, MI 48071

Enclosed are the laboratory test results for the project shown above.

NUMBER	TEST
8	Permeability

We appreciate the opportunity to be of service to you on this project. If you have any questions, please feel free to contact our office.

Respectfully Submitted,

Malek Smadi, Ph.D., PE
Principal Engineer
GEOTILL, Inc.
Ph: (317) 449-0033 - Ext 101
e-mail: msmadi@geotill.com

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
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TOTAL PAGES: 9

Mr. Zachary Carr, P.E.
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30425 Stephenson Hwy.
Madison Heights, MI 48071

LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16007	Confining Pressure (psi):	75
Sample No.:	BS-5	Target Back Pressure Differential (psi):	NA
Depth (ft):	34.0'-35.0'	Target Bottom Burette Pressure (psi):	70
		Target Top Burette Pressure (psi):	70

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.14	4.22
Diameter (in)	4.21	4.14
Dry Unit Weight (pcf)	**130.1**	131.0
Moisture Content (%)	**10.5**	10.1
B Value	96	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	947	1027	1124	1740
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$1.21x10^{-8}$	$1.07x10^{-8}$	$9.14x10^{-9}$	$8.03x10^{-9}$

Average Hydraulic Conductivity (cm/sec) **$1.00x10^{-8}$** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
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SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16006	Confining Pressure (psi):	75
Sample No.:	BS-5	Target Back Pressure Differential (psi):	NA
Depth (ft):	34.5'-35.5	Target Bottom Burette Pressure (psi):	70
		Target Top Burette Pressure (psi):	70

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.13	4.20
Diameter (in)	3.99	3.91
Dry Unit Weight (pcf)	**120.2**	123.0
Moisture Content (%)	**15.1**	12.8
B Value	98	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	1015	1040	1106	1136
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$2.13x10^{-8}$	$1.90x10^{-8}$	$1.85x10^{-8}$	$1.62x10^{-8}$

Average Hydraulic Conductivity (cm/sec) **$1.88x10^{-8}$** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16005	Confining Pressure (psi):	75
Sample No.:	BS-7	Target Back Pressure Differential (psi):	NA
Depth (ft):	38.0'-39.0'	Target Bottom Burette Pressure (psi):	70
		Target Top Burette Pressure (psi):	70

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.18	4.20
Diameter (in)	4.11	4.08
Dry Unit Weight (pcf)	**128.2**	130.4
Moisture Content (%)	**11.9**	9.9
B Value	100	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	1027	1105	1151	1242
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	1.55x10^{-8}	1.25x10^{-8}	1.13x10^{-8}	1.15x10^{-8}

Average Hydraulic Conductivity (cm/sec) **1.27x10^{-8}** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16001	Confining Pressure (psi):	80
Sample No.:	BS-7	Target Back Pressure Differential (psi):	NA
Depth (ft):	44.0'-45.0'	Target Bottom Burette Pressure (psi):	75
		Target Top Burette Pressure (psi):	75

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.10	4.10
Diameter (in)	3.67	3.65
Dry Unit Weight (pcf)	**136.4**	137.0
Moisture Content (%)	**9.0**	8.5
B Value	96	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	1357	1418	1442	1511
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$1.64x10^{-8}$	$1.28x10^{-8}$	$1.20x10^{-8}$	$1.17x10^{-8}$

Average Hydraulic Conductivity (cm/sec) **$1.32x10^{-8}$** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16002	Confining Pressure (psi):	80
Sample No.:	BS-5	Target Back Pressure Differential (psi):	NA
Depth (ft):	33.0'-34.0'	Target Bottom Burette Pressure (psi):	75
		Target Top Burette Pressure (psi):	75

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	3.88	3.89
Diameter (in)	3.37	3.35
Dry Unit Weight (pcf)	**123.4**	123.7
Moisture Content (%)	**13.7**	13.1
B Value	96	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	1346	1417	1445	1521
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$1.79x10^{-8}$	$1.38x10^{-8}$	$1.46x10^{-8}$	$1.31x10^{-8}$
Average Hydraulic Conductivity (cm/sec)	**$1.50x10^{-8}$**	**(Temperature Corrected)**		

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16003	Confining Pressure (psi):	80
Sample No.:	BS-4C	Target Back Pressure Differential (psi):	NA
Depth (ft):	33.0'-34.0'	Target Bottom Burette Pressure (psi):	75
		Target Top Burette Pressure (psi):	75

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.11	4.11
Diameter (in)	3.88	3.90
Dry Unit Weight (pcf)	**124.3**	123.3
Moisture Content (%)	**10.5**	10.8
B Value	96	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	1430	1534	1643	1614
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$6.65x10^{-9}$	$6.05x10^{-9}$	$5.07x10^{-9}$	$4.24x10^{-9}$

Average Hydraulic Conductivity (cm/sec) **$5.50x10^{-9}$** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16007	Confining Pressure (psi):	75
Sample No.:	BS-10	Target Back Pressure Differential (psi):	NA
Depth (ft):	52.0'-53.0'	Target Bottom Burette Pressure (psi):	70
		Target Top Burette Pressure (psi):	70

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	4.17	4.17
Diameter (in)	4.14	4.11
Dry Unit Weight (pcf)	**115.3**	116.1
Moisture Content (%)	**15.6**	15.3
B Value	96	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	933	947	1009	1032
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	3.69x10^{-8}	3.15x10^{-8}	2.87x10^{-8}	2.14x10^{-8}

Average Hydraulic Conductivity (cm/sec) **2.23x10^{-8}** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

GEOTILL
ENGINEERING, INC.

December 23, 2016

PROJECT: Laboratory Services
Geotill PROJECT NO.: 111610601
Geotill WORK ORDER NO.: 8601
SAMPLE RECEIVED: December 15, 2016
TOTAL PAGES: 9

Mr. Zachary Carr, P.E.
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LABORATORY HYDRAULIC CONDUCTIVITY TEST SUMMARY
TRIAXIAL CELL WITH BACK PRESSURE /ASTM D-5084

TEST CHARACTERISTICS

Boring No.:	MW-16004	Confining Pressure (psi):	75
Sample No.:	BS-4	Target Back Pressure Differential (psi):	NA
Depth (ft):	31.5'-32.3'	Target Bottom Burette Pressure (psi):	70
		Target Top Burette Pressure (psi):	70

SAMPLE CHARACTERISTICS

CHARACTERISTICS	INITIAL	FINAL
Length (in)	3.92	3.92
Diameter (in)	3.91	3.84
Dry Unit Weight (pcf)	**121.0**	123.5
Moisture Content (%)	**14.4**	13.3
B Value	104	

SUMMARY OF FINAL FOUR MEASUREMENTS

MEASUREMENT	1	2	3	4
Elapsed Time (sec)	951	1010	1030	1058
True Back Pressure Differential (psi)	NA*	NA*	NA*	NA*
Flow Into Sample (cm^3)	NA*	NA*	NA*	NA*
Flow Out of Sample (cm^3)	NA*	NA*	NA*	NA*
Hydraulic Conductivity (cm/sec)	$2.222.8x10^{-8}$	$1.78x10^{-8}$	$1.72x10^{-8}$	$1.58x10^{-8}$

Average Hydraulic Conductivity (cm/sec) **$1.83x10^{-8}$** **(Temperature Corrected)**

COMMENTS: * Constant volume panel was used for the flow measurement Permeant: tap water

Deviations from the test method: None

Appendix B
Calculation Documentation

SHEET NO. 1 OF 2
PROJECT NO. 319742
DATE 11-27-2018
BY S. Sellwood
CHK'D A. Sellwood

TRC
Results you can rely on

SUBJECT Composite Liner Leakage

Per Giroud et al. 1998, rate of leakage through a composite liner can be calculated by:

$$Q = 0.976\, C_{q_0} \left[1 + 0.1 \left(h/T \right)^{0.95} \right] d^{0.2}\, h^{0.9}\, K^{0.74}$$

where Q = leakage rate, m^3/s
C_{q_0} = coefficient characterizing contact between geomembrane and underlying clay, dimensionless
$C_{q_0}\text{-good} = 0.21$
$C_{q_0}\text{-poor} = 1.15$
h = leachate head on top of liner, m
T = thickness of clay liner below geomembrane, m
d = defect diameter, m
K = hydraulic conductivity of clay liner, m/s

Assume:
$h = 0.3\ m$ $T = 0.61\ m$ $K = 1 \times 10^{-9}\ m/s$

1. Assume:
$d = 0.001\ m$ $C_{q_0} = 0.21$

$$Q = 0.976(0.21)\left[1 + 0.1\left(\frac{0.3}{0.61}\right)^{0.95}\right](0.001)^{0.2}(0.3)^{0.9}(1\times10^{-9})^{0.74}$$

$$Q = 0.976(0.21)(1.05)(0.251)(0.338)(2.19\times10^{-7}) = 4\times10^{-9}\ m^3/s$$

$$4\times10^{-9}\,m^3/s \cdot 86400\,\frac{s}{day} \cdot \frac{1000\,L}{m^3} = 0.35\,\frac{L}{day} \text{ per defect}$$

$$0.35\,\frac{L}{day}/\text{defect} \cdot 2.5\,\frac{\text{defects}}{hc} = \boxed{0.9\ lphd}$$

lphd = liters per hectare per day

$$0.35\,\frac{L}{day}/\text{defect} \cdot 5\,\frac{\text{defects}}{hc} = \boxed{1.8\ lphd}$$

hc = hectare

2. Assume:
$d = 0.00564\,m$ $C_{q_0} = 0.21$

$$Q = 0.976(0.21)\left[1 + 0.1\left(\frac{0.3}{0.61}\right)^{0.95}(0.00564)^{0.2}(0.3)^{0.9}(1\times10^{-9})^{0.74}\right.$$

$$Q = 0.976(0.21)(1.05)(0.355)(0.338)(2.19\times10^{-7}) = 5.7\times10^{-9}\ m^3/s$$

$$5.7\times10^{-9}\,m^3/s \cdot 86400\,\frac{s}{d} \cdot \frac{1000\,L}{m^3} = 0.5\,L/day \text{ per defect}$$

$$0.5\,L/day\cdot\text{defect}\left(2.5\,\frac{\text{defects}}{hc}\right) = \boxed{1.2\ lphd}$$

$$0.5\,L/day\cdot\text{defect}\left(5\,\frac{\text{defects}}{hc}\right) = \boxed{2.5\ lphd}$$

A

3. Assume

$d = 0.001\ m \qquad C_{q0} = 1.15$

$$Q = 0.976(1.15)[1.05](0.001)^{0.2}(0.338)(2.19 \times 10^{-7}) = 2.2 \times 10^{-8}\ m^3/s$$

$$2.2 \times 10^{-8}\ m^3/s \cdot 86400 \frac{s}{day} \cdot \frac{1000L}{m^3} = 1.9 \frac{L}{day} \text{ per defect}$$

$$1.9 \frac{L}{day\text{-}defect} \cdot \frac{2.5\ defects}{hc} = \boxed{4.8\ lphd}$$

$$1.9 \frac{L}{day \cdot defect} \cdot 5 \frac{defects}{hc} = \boxed{9.6\ lphd}$$

4. Assume

$d = 0.00564\ m \qquad C_{q0} = 1.15$

$$Q = 0.976(1.15)[1.05](0.00564)^{0.2}(0.338)(2.19 \times 10^{-7}) = 3.1 \times 10^{-8}\ m^3/s$$

$$3.1 \times 10^{-8}\ m^3/s \cdot 86400 \frac{s}{day} \cdot \frac{1000L}{m^3} = 2.7 \frac{L}{day} \text{ per defect}$$

$$2.7 \frac{L}{day} \cdot \frac{2.5\ defects}{hc} = \boxed{6.7\ lphd}$$

$$2.7 \frac{L}{day} \cdot \frac{5\ defects}{hc} = \boxed{14\ lphd}$$

TRC
Results you can rely on

SHEET NO. 2 OF 2
PROJECT NO. 319742
DATE 11-27-2018
BY S. Sellwood
CHK'D A. Sellwood

SUBJECT Natural Clay Leakage

Leakage through a clay-only liner can be calculated using Darcy's Law assuming one-dimensional vertical flow:

$$Q = -KA\frac{dh}{dl}$$

where Q = leakage rate (units depend on inputs)
K = hydraulic conductivity of the clay
A = cross-sectional area of flow
dh = difference in head between the head above the clay and the head in the aquifer underlying the clay
dl = thickness of clay separating hydrogeologic units

CCR Unit	K	dh	dl	A
a. BRPP BABs	2.9×10^{-8} cm/s	16 ft	80 ft	assume 1 hectare (hc)
b. BRPP DB	2.9×10^{-8} cm/s	5 ft	117 ft	"
c. SCPP BABs	3.1×10^{-8} cm/s	1 ft	110 ft	"
d. Monroe PP FAB	6.5×10^{-8} cm/s	12 ft	23 ft	"
e. Whiting Ponds 1+2	2.23×10^{-8} cm/s	11 ft	35 ft	"
f. Whiting Pond 6	2.23×10^{-8} cm/s	22 ft	40 ft	"

a. $Q = -2.9\times10^{-8}\text{ cm/s}\left(-\frac{16\text{ ft}}{80\text{ ft}}\right)(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 50$ lph

b. $Q = -2.9\times10^{-8}\text{ cm/s}\left(\frac{-5\text{ ft}}{117\text{ ft}}\right)(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 11$ lphd

c. $Q = -3.1\times10^{-8}\text{ cm/s}(-1\text{ ft}/110\text{ ft})(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 2$ lphd

d. $Q = -6.5\times10^{-8}\text{ cm/s}(-12\text{ ft}/23\text{ ft})(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 293$ lp

e. $Q = -2.23\times10^{-8}\text{ cm/s}(-11\text{ ft}/35\text{ ft})(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 61$ lphd

f. $Q = -2.23\times10^{-8}\text{ cm/s}(-22\text{ ft}/40\text{ ft})(1\text{ hc})(107{,}639\text{ ft}^2/\text{hc})(28.317\text{ L/ft}^3)(2834.6\text{ ft/d/cm/s}) = 106$ lphd

Velocity: $V = \frac{-K}{n_e}\frac{dh}{dl}$ where n_e = effective clay porosity, assume 0.40 (dimensionless

a. $V = -2.9\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-16\text{ ft}/80\text{ ft})(2834.6\text{ ft/d/cm/s}) = 4.1\times10^{-5}$ ft/d

b. $V = -2.9\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-5\text{ ft}/117\text{ ft})(2834.6\text{ ft/d/cm/s}) = 8.8\times10^{-6}$ ft/d

c. $V = -3.1\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-10\text{ ft}/110\text{ ft})(2834.6\text{ ft/d/cm/s}) = 2\times10^{-6}$ ft/d

d. $V = -6.5\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-12\text{ ft}/23\text{ ft})(2834.6\text{ ft/d/cm/s}) = 2.4\times10^{-4}$ ft/d

e. $V = -2.23\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-11\text{ ft}/35\text{ ft})(2834.6\text{ ft/d/cm/s}) = 5\times10^{-5}$ ft/d

f. $V = -2.23\times10^{-8}\text{ cm/s}\left(\frac{1}{0.4}\right)(-22\text{ ft}/40\text{ ft})(2834.6\text{ ft/d/cm/s}) = 8.7\times10^{-5}$ ft/d

* lphd = liters per hectare per day

A

travel time: $t = \frac{dl}{v}$

a. $t = \frac{80 \text{ ft}}{4.1 \times 10^{-5} \text{ ft/d}} = 1.95 \times 10^{6}$ days

$\frac{1.95 \times 10^{6} \text{ days}}{365.25 \text{ days/yr}} = 5{,}300$ yrs

b. $t = \frac{117 \text{ ft}}{8.8 \times 10^{-6} \text{ ft/d}} = 1.33 \times 10^{7}$ days

$\frac{1.33 \times 10^{7} \text{ days}}{365.25 \text{ days/yr}} = 36{,}400$ yrs

c. $t = \frac{110 \text{ ft}}{2 \times 10^{-6} \text{ ft/d} \, (365.25 \text{ d/yr})} = 151{,}000$ yrs

d. $t = \frac{23 \text{ ft}}{2.4 \times 10^{-4} \text{ ft/d} \, (365.25 \text{ d/yr})} = 260$ yrs

e. $t = \frac{35 \text{ ft}}{5 \times 10^{-5} \text{ ft/d} \, (365.25 \text{ d/yr})} = 1{,}900$ yrs

f. $t = \frac{40 \text{ ft}}{8.7 \times 10^{-5} \text{ ft/d} \, (365.25 \text{ d/yr})} = 1{,}260$ yrs

Monroe PP FAB assuming average K, steeper gradient, and clay thickness associated with the steeper gradient.

$K = 2.7 \times 10^{-8}$ cm/s $\quad dh = 29$ ft $\quad dl = 30$ ft

$Q = -2.7 \times 10^{-8} \text{ cm/s} \left(\frac{-29 \text{ ft}}{30 \text{ ft}}\right)(1 \text{ ha})(107{,}639 \text{ ft}^2/\text{ha})(28.317 \text{ L/ft}^3)(2834.6 \text{ ft/d/cm/s}) = 226$ lphd

$V = -2.7 \times 10^{-8} \text{ cm/s} \left(\frac{1}{0.4}\right)\left(\frac{-29 \text{ ft}}{30 \text{ ft}}\right)(2834.6 \text{ ft/d/cm/s}) = 1.85 \times 10^{-4}$ ft/d

$t = \frac{30 \text{ ft}}{1.85 \times 10^{-4} \text{ ft/d} \, (365.25 \text{ d/yr})} = 440$ yrs

Appendix C
Well Construction Diagrams and Soil Boring Logs

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant
Date Drilling Started: 3/31/16
Date Drilling Completed: 3/31/16
Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling
Drilling Method: Sonic
Surface Elev. (ft): 585.12
TOC Elevation (ft): 584.74
Total Depth (ft bgs): 138.0
Borehole Dia. (in): 6

Boring Location: S side of median, in parking lot W of ash basin.
N: 465440.66 E: 13631612.80

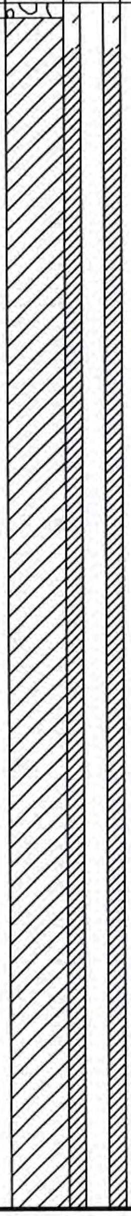
Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:45 ▼ Depth (ft bgs) 14.08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, little sand, brown (10YR 5/3), no odor, moist.				
				CLAY mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, dense.				
			5					
1 CS	90		10	Change to medium dense at 10.0 feet.				
				Change to soft to medium dense at 12.5 feet.				
			▼					
			15					
			20		CL			
			25					
2 CS	95		30					
			35					

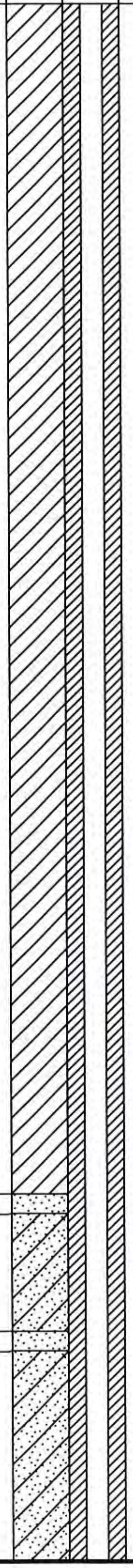


Signature: for J. Reed

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

Checked By: C. Scieszka

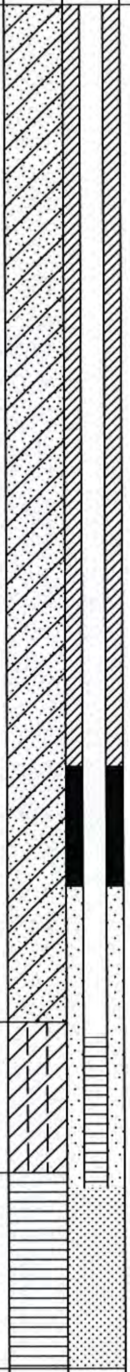
SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
3 ST				**CLAY** mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, soft to medium dense.				
				Change to few fine to coarse sand at 43.0 feet.				
			45					
4 CS	100		50	Change to gray (10YR 5/1) at 50.0 feet.				
			55					
			60		CL			
			65					
5 CS	100		70					
			75					
			80					
				Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 80.25 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
			85					
				Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 85.0 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
6 CS	100		90	Change to few to little fine to coarse sand at 90.0 feet.				



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
				CLAY WITH SAND mostly clay, few to little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.				
			95					
			100					
			105					
7 CS	100		110		CL			
			115					
			120	Change to soft at 120.0 feet.				
8 CS	100		125					
				SILTY CLAY mostly clay, some silt, very dark gray, (10YR 3/1), no odor, dry to moist, hard.	CL-ML			
			130					
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
9 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					



WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant	Date Drilling Started: 3/28/16	Date Drilling Completed: 3/28/16	Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 582.18	TOC Elevation (ft) 581.43	Total Depth (ft bgs) 138.0	Borehole Dia. (in) 6

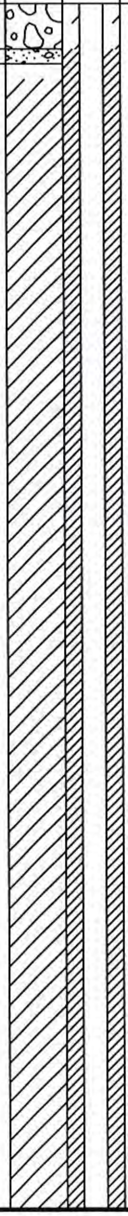
Boring Location: NE side of ash basin.
N: 465503.41 E: 13632151.32

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

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:38 ▼ Depth (ft bgs) 1.76



SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	95		5	▼ **GRAVEL** mostly coarse gravel, few coarse sand, black (10YR 2/1), no odor, moist, loose. **SAND WITH GRAVEL** mostly fine to coarse sand, some fine to coarse gravel, brown (10YR 5/3), no odor, moist, loose. **CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, stiff.				
2 CS	100		10 15	Change to soft at 8.0 feet.				
3 CS	100		20 25		CL			
4 CS	100		30 35					

Signature: for A. Knutson

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

Checked By: C. Scieszka

TRC

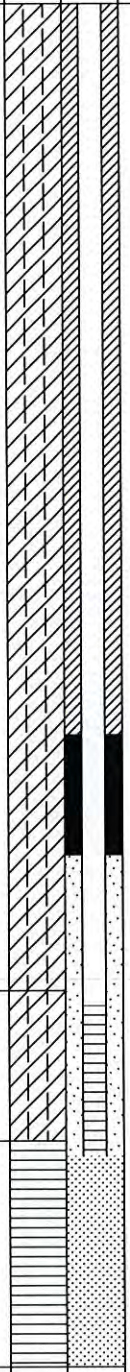
WELL CONSTRUCTION LOG

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			**CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, soft.				
			45	Change to few silt at 45.0 feet. Change to no silt at 46.0 feet.	CL			
6 CS	100		50					
			55					
7 CS	100			**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.				
			60					
			65					
8 CS	100		70					
				Change to few fine to coarse sand at 73.5 feet.	CL-ML			
			75	Change to no sand at 76.5 feet.				
9 CS	100		80					
			85					
			90					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
10 CS	100		95	**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.		
11 CS	100		100 105			
12 CS	100		110 115		CL-ML	
13 CS	80		120 125			
				SILTY CLAY mostly clay, some silt, very dark gray (10YR 3/1), no odor, dry, hard.	CL-ML	
14 CS	100		130 135	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.		
			140 145	End of boring at 138.0 feet below ground surface.		

GRAPHIC LOG / WELL DIAGRAM



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant		Date Drilling Started: 3/24/16	Date Drilling Completed: 3/24/16	Project Number: 231828.0004.0000
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 582.08	TOC Elevation (ft) 581.39	Total Depth (ft bgs) 138.0
				Borehole Dia. (in) 6
Boring Location: E side of ash basin. N: 465353.06 E: 13632114.23		Personnel Logged By - J. Reed Driller - A. Goldsmith		Drilling Equipment: Terrasonic
Civil Town/City/or Village: Saint Clair	County: Saint Clair	State: MI	Water Level Observations: While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/8/16 08:35 ▼ Depth (ft bgs) 2.16	

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, some sand, black (10YR 2/1), no odor, moist, loose.				
			▼	**SAND AND GRAVEL** brown (10YR 5/3), no odor, moist, loose.				
1 CS	95		5	**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, stiff.				
			10	Change to medium stiff at 10.0 feet.				
2 CS	100		15					
			20		CL			
3 CS	100		25					
			30	Change to trace to few sand at 30.0 feet.				
				Change to no sand at 32.5 feet.				
4 CS	100		35					

Signature: For J. Reed

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

Checked By: C. Scieszka

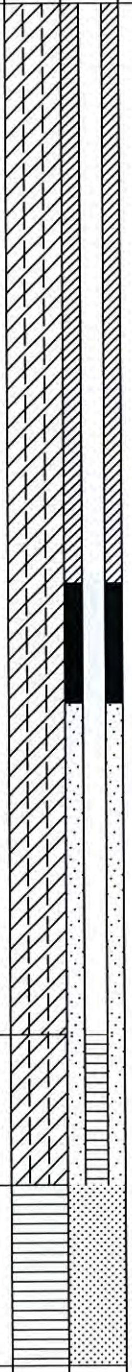
SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 ST				**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
6 CS	100		45					
			50		CL			
7 CS	100		55					
			60	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
8 CS	100		65					
			70					
9 CS	100		75		CL-ML			
			80					
10 CS	100		85					
			90					

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 3 of 3

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				SILTY CLAY mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
11 CS	100		95					
			100					
12 CS	100		105					
			110		CL- ML			
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN AND SHALE very dark gray (10YR 3/1), no odor, dry to slightly moist, hard.	CL- ML			
			130					
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
15 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					

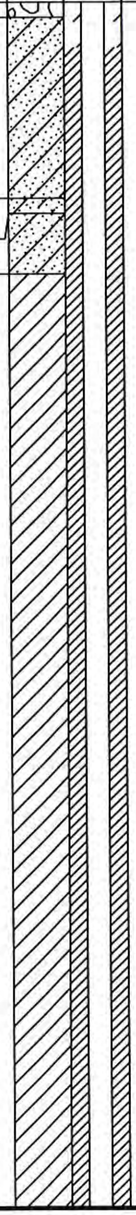


WELL CONSTRUCTION LOG

WELL NO. MW-16-04

Facility/Project Name: DTE: Saint Clair Power Plant
Date Drilling Started: 3/22/16
Date Drilling Completed: 3/23/16
Project Number: 231828.0004.0000
Drilling Firm: Stock Drilling
Drilling Method: Sonic
Surface Elev. (ft): 581.99
TOC Elevation (ft): 580.95
Total Depth (ft bgs): 138.0
Borehole Dia. (in): 6
Boring Location: SE side of ash basin.
N: 465173.94 E: 13632077.11
Personnel
Logged By - J. Reed
Driller - A. Goldsmith
Drilling Equipment: Terrasonic
Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI
Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:28 ▼ Depth (ft bgs) 2.19

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
				GRAVEL mostly gravel, few to little fine to coarse sand, very dark gray (10YR 3/1), no odor, moist.		
			▼	**CLAY WITH SAND** mostly clay, little to some fine to coarse sand, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
1 CS	80		5			
				SAND WITH CLAY mostly sand, little to some clay, dark grayish brown (10YR 4/2), no odor, moist.	SW-SC	
				CLAY WITH SAND mostly clay, little to some fine to coarse sand, medium plasticity, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
			10			
				CLAY mostly clay, trace fine to medium sand, medium plasticity, grayish brown (10YR 5/2), no odor, moist, stiff.		
2 CS	95		15			
			20			
3 CS	100		25	Change to medium stiff at 25.0 feet.	CL	
			30			
4 CS	100		35			



Signature: for J. Reed.

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

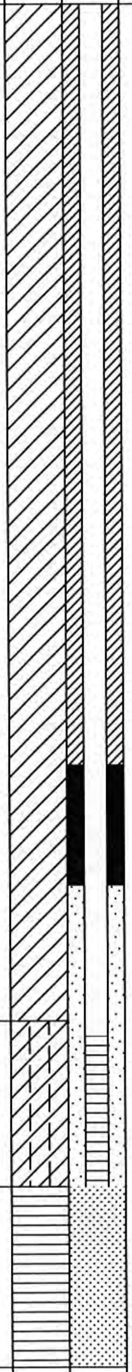
Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 ST					CL			
				SILTY CLAY mostly clay, little to some silt, few fine to coarse sand, dark grayish brown (10YR 5/2), no odor, moist, medium stiff.				
6 CS	100		45					
			50		CL- ML			
7 CS	100		55					
			60	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
8 CS	100		65					
			70					
9 CS	100		75		CL			
			80	Change to wet at 79.5 feet.				
				Change to moist at 83.0 feet.				
10 CS	100		85					
			90					

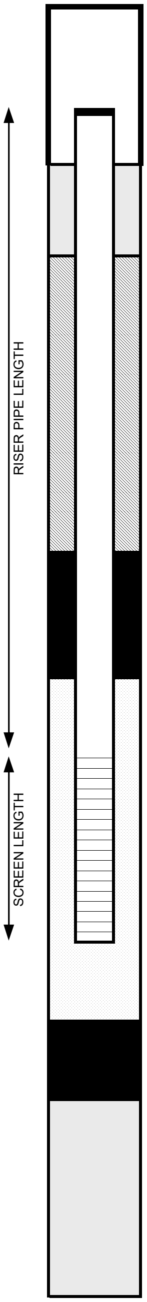
SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
			100					
12 CS	100		105					
			110		CL			
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN/SHALE mostly clay and silt, very dark gray (10YR 3/1), no odor, dry to moist, hard.	CL-ML			
			130					
				SHALE light gray (10YR 7/1) to very dark gray (10YR 3/1), no odor, dry.				
15 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					



WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-01**
PROJ. NO:	2381828.0004	DATE INSTALLED: 3/31/2016 INSTALLED BY: J. REED	CHECKED BY: C. SCIESZKA

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
585.12	0.0	GROUND SURFACE
584.74	0.4	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
126.6		
	118.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	122.0	BENTONITE SEAL
458.1	127.0	TOP OF SCREEN
		FILTER PACK MATERIAL MEDIUM, WASHED SAND
5.0		
453.1	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
447.1	138.0	HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 2.5 HOURS
WATER REMOVED: 50 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: CLEAR TO VERY LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

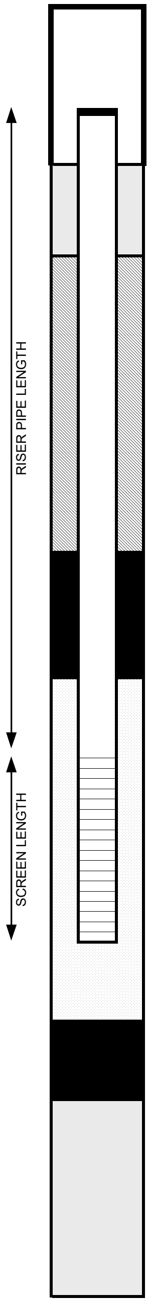
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	132.00	T/PVC	4/5/16	940
DTB AFTER DEVELOPING:	132.00	T/PVC	4/5/16	1420
SWL BEFORE DEVELOPING:	--	T/PVC	--	--
SWL AFTER DEVELOPING:	13.70	T/PVC	4/8/16	828
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-02**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/29/2016 INSTALLED BY: A. Knutson		CHECKED BY: C. SCIESZKA



ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
582.18	0.0	GROUND SURFACE
581.43	0.8	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
125.3		
	117.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	121.0	BENTONITE SEAL
456.2	126.0	TOP OF SCREEN
5.0		FILTER PACK MATERIAL MEDIUM, WASHED SAND
451.2	131.0	BOTTOM OF SCREEN
	131.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
444.2	138.0	HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 2.5 HOURS
WATER REMOVED: 55 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: CLEAR TO VERY LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

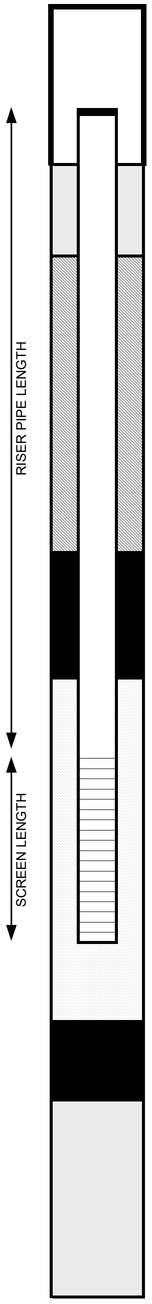
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	131.90	T/PVC	4/4/16	--
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	--
SWL BEFORE DEVELOPING:	1.40	T/PVC	4/4/16	--
SWL AFTER DEVELOPING:	1.10	T/PVC	4/8/16	838
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-03**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/25/2016	INSTALLED BY: J. Reed	CHECKED BY: C. SCIESZKA



ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
582.08	0.0	GROUND SURFACE
581.39	0.7	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
126.3		
	112.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	116.0	BENTONITE SEAL
455.1	127.0	TOP OF SCREEN
		FILTER PACK MATERIAL MEDIUM, WASHED SAND
5.0		
450.1	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
444.1	138.0	HOLE BOTTOM

NOTES:

APPROXIMATELY 8.6 FEET OF MEDIUM, WASHED SAND WAS UNINTENTIONALLY PLACED IN WELL DURING INSTALLATION. THE SAND WAS REMOVED DURING WELL DEVELOPMENT.

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 4 HOURS
WATER REMOVED: 74 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY/SUSPENDED SAND
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: VERY LIGHT GRAY TO CLEAR

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	123.40	T/PVC	4/4/16	950
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	1420
SWL BEFORE DEVELOPING:	1.00	T/PVC	4/4/16	950
SWL AFTER DEVELOPING:	1.47	T/PVC	4/8/16	835
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

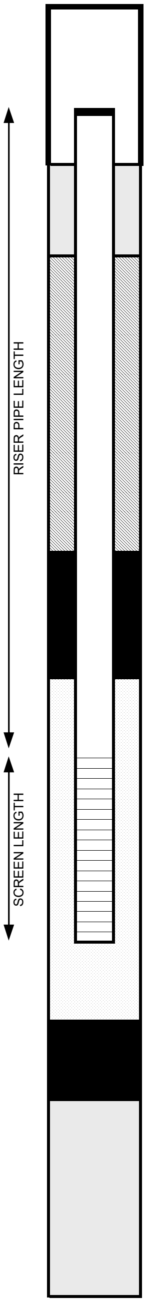
PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE EC: SCPP CCR MW Installation		WELL ID:	**MW-16-04**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/23/2016 INSTALLED BY: J. Reed		CHECKED BY: C. SCIESZKA

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
581.99	0.0	GROUND SURFACE
580.95	1.0	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
126.0		
	118.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	122.0	BENTONITE SEAL
455.0	127.0	TOP OF SCREEN
		FILTER PACK MATERIAL MEDIUM, WASHED SAND
5.0		
450.0	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
444.0	138.0	HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 2 HOURS
WATER REMOVED: 40 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY/GRAY
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	133.10	T/PVC	4/4/16	945
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	1700
SWL BEFORE DEVELOPING:	1.01	T/PVC	4/4/16	945
SWL AFTER DEVELOPING:	1.15	T/PVC	4/8/16	828
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

REVISED 11/2013

Appendix D
Groundwater Monitoring System Summary Report - October 2017

Groundwater Monitoring System Summary Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2017

Groundwater Monitoring System Summary Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2017

Prepared For
DTE Electric Company

Graham Crockford, C.P.G.
Senior Project Geologist

David B. McKenzie, P.E.
Senior Project Engineer

TRC Engineers Michigan, Inc. | DTE Electric Company
Final
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Section 1
Introduction

1.1 Background and Objective

The United States Environmental Protection Agency (U.S. EPA) established a comprehensive set of requirements for management and disposal of coal combustion residuals (CCR) in landfills and surface impoundments in the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule) on April 17, 2015. The DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) CCR bottom ash basins (BABs) unit is subject to the CCR Rule.

The objective of this report is to document and certify that the CCR Groundwater Monitoring System for the SCPP BABs CCR unit has been designed and constructed to meet the requirements of Title 40 Code of Federal Regulations (CFR) §257.91 (a)(1) and (2) of the CCR Rule. TRC Engineers Michigan, Inc. (TRC) was retained by DTE Electric to provide this report documenting the construction of the CCR groundwater monitoring system for the SCPP BABs.

1.2 Site Location

The SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan (**Figure 1**). The SCPP including the BABs CCR unit was constructed in the early 1950s, just south of the DTE Electric SCPP. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River.

1.3 Description of SCPP CCR Unit

The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953 and is constructed over a natural continuous clay-rich soil base as shown in historical soil borings performed at the SCPP property. The BABs have been in operation at the SCPP since the plant began operation and have collected CCR bottom ash that is routinely cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments (**Figure 2**). The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (feet-bgs) into the native clay-rich soil. The BABs are located south of the SCPP and adjacent to the St. Clair River and are used for receiving bottom ash and other process flow water from the power plant, which is first sent to the East BAB then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with an National Pollution Discharge Elimination System (NPDES) permit.

The West and East BABs are located south of the SCPP main building and run roughly north to south with the following approximate dimensions:

- The West BAB is approximately 300 feet long by 90 feet wide with a bottom elevation of approximately 572 feet (when fully cleaned out) relative to the North American Vertical Datum (NAVD) 1988 with an outflow weir elevation of approximately 579.3 feet relative to the NAVD 1988; and
- The East BAB is approximately 400 feet long by 70 feet wide with a bottom elevation of approximately 572 feet (when fully cleaned out) relative to the NAVD 1988 with an outflow weir elevation of approximately 579.4 feet relative to the NAVD 1988.

Section 2
Hydrogeology

2.1 Regional Hydrogeologic Setting

The geology of St. Clair County consists of approximately 101 to 400 feet of glacial deposits, primarily lacustrine deposits, till, and, to a lesser extent, sand and gravel outwash, overlying a variety of bedrock surfaces[1]. The thicker glacial deposits are present toward the central portion of the county. Bedrock in the county includes the Michigan Formation, Marshall Sandstone, Coldwater Shale, Sunbury Shale, Berea Sandstone, Bedford Shale, and Antrim Shale.

In the vicinity of the site, the Devonian Bedford and/or Antrim Shale bedrock dips to the northwest and is generally covered by more than 100 feet of unconsolidated clay, silt, sand, and gravel. In this area, generally on the eastern side of the county, the glacial deposits are predominantly silty-clay till and lacustrine deposits with lenses of sand and gravel. Where present, unconsolidated sand and gravel deposits within the till and lacustrine deposits are generally used for water supply throughout the county. Approximately 85 percent of the water supply wells in St. Clair County are completed in the glacial deposits compared to approximately 13 percent installed in bedrock [1].

The current topography of the St. Clair area gently undulates reflecting floodplain, stream terrace, and lakeshore deposits. The St. Clair River is the major surface water body in the county and runs along the eastern boundary of the county. Regional groundwater and surface water flow would be expected to be to the east towards the St. Clair River.

2.2 SCPP Hydrogeology

The subsurface geology presented within this report is based on information from historical borings advanced during initial design and later expansion of the SCPP, in addition to the soil boring data collected from around the BABs during the groundwater monitoring system installation detailed in Section 3. Soil borings from the groundwater monitoring system are included in Appendix A and generalized geologic cross sections are provided in **Figures 3 through 5**.

This information documents that the SCPP CCR unit is underlain by glacial silty-clay till, with few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock is generally encountered below

---

[1] Beth A. Apple and Howard W. Reeves, 2007, Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p.

130 feet-bgs (see cross-sections in **Figures 3 through 5**). No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer). Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone.

No water supply wells are present within the unconsolidated sediment or bedrock within one mile of the SCPP. Surface water bodies present in the area of the SCPP include the Belle River (as close as 3,000 feet southwest of SCPP) and the St. Clair River (located immediately adjacent to the east of the SCPP BABs CCR unit).

2.2.1 Uppermost Aquifer

Definition

The 40 CFR §257.53 definitions of an aquifer and uppermost aquifer are as follows:

- *Aquifer* means a geologic formation, group of formations, or portion of a formation capable of yielding useable quantities of groundwater to wells or springs.
- *Uppermost aquifer* means the geologic formation nearest the natural ground surface that is an aquifer, as well as the lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

Site Uppermost Aquifer

As described above, the potential uppermost aquifer as defined in 40 CFR §257.53 was present beneath at least a 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer (**Figures 3 through 5**). The overlying silty clay-rich low permeability clay-rich soil consistently has a hydraulic conductivity on the order of 2 to 3 x 10^{-8} centimeters per second (cm/s) as found in soil testing performed during the CCR monitoring well installation in the area of the BABs. The first underlying saturated zone that would presumably become affected with CCR constituent's is located at the silty clay hardpan/shale bedrock interface (130.5 to 132 feet-bgs) and is limited to no more than five feet thick (**Figures 3 through 5** and Appendix A).

2.2.2 Groundwater Flow

Groundwater Flow Direction

Groundwater flow is generally to the east-southeast based potentiometric surface data measured during the collection of the first seven independent samples from the groundwater monitoring system in accordance with the CCR Rule since August 2016. The representative February 2017 potentiometric static water level elevations are displayed on **Figure 6**. As can be seen on **Figure 6**, CCR monitoring well MW-16-04 (up gradient) to the west of the BABs CCR unit has a slightly higher potentiometric elevation than the CCR monitoring wells MW-16-01, MW-16-02 and MW-16-03 (down gradient) to the east of the BABs CCR unit. These potentiometric groundwater elevations suggest that overall, beneath the more than 120 feet of clay-rich confining till, there is a potential horizontal groundwater flow direction to east-southeast with a mean hydraulic gradient of 0.0036 foot/foot in the area of the BABs CCR unit.

The elevation of CCR-affected water maintained within the BABs is similar to slightly higher than to the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit. Flow potential from the CCR unit to the surrounding area would likely be radially outward from all sides. However, with the very thick continuous silty clay-rich confining unit beneath the SCPP it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s (see vertical time of travel discussion below).

Uppermost Aquifer Hydraulic Conductivity

Hydraulic conductivities measured within the CCR monitoring wells using single well hydraulic conductivity tests (e.g., slug tests) range from approximately 0.009 to 0.017 feet/day with a mean of approximately 0.013 feet/day. These low hydraulic conductivities further demonstrate the low groundwater yield potential across the conservatively interpreted, potential uppermost aquifer encountered at the site.

Horizontal Time of Travel

Assuming an average porosity of 0.4 for the silt/clay-rich soil within the uppermost aquifer, the mean hydraulic conductivity of 0.013 feet/day and a hydraulic gradient of 0.0036 foot/foot for the potential upper aquifer, the potential horizontal groundwater flow rate is approximately 0.00012 feet/day or 0.044 feet/year. Given the low flow velocity of this zone, inter-well (upgradient to downgradient) statistical tests are inappropriate for detection monitoring of this basin.

Vertical Time of Travel

The SCPP is a natural silty-clay site, and the natural hydraulic barrier has been verified by numerous historical soil borings and further confirmed by the four soil borings installed as part of the CCR monitoring well installation program. Therefore, the geology and hydrogeology of the site provides a very high level of environmental protection of the potential uppermost aquifer. Based on the site geology and hydrogeology, there is extremely low potential for the impoundments to affect the off-site uppermost aquifer groundwater in the future. Groundwater present within the deep confined potential uppermost aquifer is protected from CCR constituents by the over 120 feet thick clay-rich aquitard with low hydraulic conductivity. Using the hydrogeologic information for the site, the time of travel for water from the base-grade elevation of the SCPP CCR unit down to the uppermost aquifer can be calculated using the following formula:

$$V = Ki/N_e$$

Where:

V = Velocity (feet/day)

K = Hydraulic Conductivity (3×10^{-8} cm/s based on high end silty clay-rich soil geotechnical measurements)

i = Downward Vertical Gradient (conservatively assumed to be one foot/foot)

N_e = Effective Porosity (0.5 for clay-rich soil)

From the above formula, the maximum downward flow velocity through the silty-clay confining till unit to the uppermost aquifer is 6×10^{-8} cm/sec, or 0.063 feet/year (lower than typical hydraulic conductivity requirement of 1×10^{-7} cm/sec for landfill liners). Therefore, the time of travel for liquid from the base of the SCPP through at least 120 feet of silty-clay (thinnest section of silty-clay confining unit found on SCPP above the potential uppermost aquifer) to the potential uppermost aquifer is approximately 1,900 years. Given that SCPP operations began in 1953, approximately 64 years ago, there is no potential for the uppermost aquifer CCR groundwater monitoring system wells to be affected from the SCPP CCR unit.

Section 3
Groundwater Monitoring System

3.1 Groundwater Monitoring System Installation

During 2016, TRC, on behalf of DTE Electric oversaw the installation and development of the groundwater monitoring system in accordance with the 40 CFR §257.91. Four monitoring wells (MW-16-01 through MW-16-04) were installed at the SCPP CCR unit by a Michigan-licensed well driller at the SCPP in order to establish the groundwater monitoring system as described below:

3.1.1 Soil Boring Advancement

In March and April 2016, four soil borings were advanced to evaluate the subsurface geology and to allow monitoring well installation using sonic drilling techniques with 4-inch and 6-inch tooling along to the west and east of the SCPP BABs. Soil samples were collected continuously in 10-foot sections from the ground surface to the termination of the soil boring. A TRC geologist was present to log each boring and describe the soil samples in accordance with the Unified Soil Classification System (USCS).

The soil borings were advanced to depths of approximately 138 feet-bgs through the unconsolidated clay-rich and hard pan deposits, and into the underlying shale bedrock encountered at depths ranging from 130.5 to 132 feet-bgs. The clay-rich deposits changed to a hard pan over the final interval of 5 to 5.5 feet above the shale bedrock. No significant sand-rich units were encountered within any of these soil borings. However, some saturation was noted at the clay-rich till or hard pan interface with the shale bedrock. As discussed above, this was the only interval where any significant saturation was encountered; therefore, the clay-rich till/shale bedrock interface is considered to be a potential uppermost aquifer for the SCPP CCR unit.

3.1.2 Monitoring Well Installation

Based on the saturation noted to be present, CCR monitoring wells MW-16-01 through MW-16-04 were screened at the clay till/shale bedrock interface. Screened intervals in these monitoring wells range from 125 to 131 feet-bgs to 127 to 132 feet-bgs, with three locations on the eastern side of the BABs (presumed down hydraulic gradient adjacent to the St. Clair River) and one to the west of the BABs (presumed up hydraulic gradient) (**Figure 2**). Given the presence of the natural clay-rich till hydraulic barrier and the relatively small footprint of the BABs, the horizontal spacing of the wells is adequate to detect constituents from the CCR unit.

Monitoring wells were constructed within each borehole using 2-inch-diameter, Schedule 40 PVC casing and 5-foot long screens with 0.010-inch factory cut slots. Monitoring well construction diagrams from the installed monitoring wells accompany the soil boring logs in Appendix A. Following well installation, the grout and bentonite seal materials were allowed to stabilize for more than 24-hours before monitoring well development began.

3.1.3 Monitoring Well Development and Surveying

Following installation, each CCR monitoring well was developed by air lifting methods. In addition, a Michigan-licensed surveyor located each monitoring well utilizing the Michigan State Plan South Zone-2113, North American Datum 1983, International feet. Vertical elevations of the ground surface at each soil boring and monitoring well location and the top of casing for each monitoring well were also surveyed in feet relative to the North American Vertical Datum of 1988 (NAVD 88). Monitoring well coordinates, elevations, screened intervals, and other monitoring well details are included in Table 1.

3.1.4 Detection Monitoring

The SCPP CCR unit groundwater monitoring system, as shown on **Figure 2**, will serve as the detection monitoring locations pursuant to Title 40 CFR §257.93 and §257.94 of the CCR Rule. Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the SCPP CCR unit using intra well statistical methods is appropriate. As such, intra-well statistical approaches will be evaluated for use during detection monitoring. Using the data collected from the monitoring well system, a statistical evaluation plan is being developed to evaluate compliance with the CCR Rule.

Section 4
Groundwater Monitoring System Certification

Groundwater Monitoring System Certification per 40 CFR §257.91(f)
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.91 requires that the owner or operator of an existing CCR unit install a groundwater monitoring system. The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of Title 40 CFR §257.91.

CERTIFICATION

I hereby certify that the groundwater monitoring system presented within this document for the SCPP BABs CCR unit has been designed and constructed to meet the requirements of Title 40 CFR §257.91 of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.91.

Name David B. McKenzie, P.E.	Expiration Date October 31, 2017	STATE OF MICHIGAN DAVID B. McKENZIE ENGINEER No. 42332 LICENSED PROFESSIONAL ENGINEER
Company TRC Engineers Michigan, Inc.	Date October 13, 2017	Stamp

Tables

Table 1

Monitoring Well Information Summary
DTE Electric Company – St. Clair Power Plant
China Township, Michigan

Well Location	Date Installed	Northing	Easting	Ground Surface Elevation (ft AMSL)	TOC Elevation (ft AMSL)	Geologic Unit of Screen Interval	Well Construction	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft AMSL)	Borehole Terminus Depth (ft BGS)	Borehole Terminus Elevation (ft AMSL)
St. Clair Power Plant											
MW-16-01	3/31/2016	465440.66	13631612.80	585.12	584.74	Silty Clay at 127-131.5 ft BGS, and Shale bedrock at 131.5-132 ft BGS	2" PVC	127.0 to 132.0	458.1 to 453.1	138.0	447.1
MW-16-02	3/29/2016	465503.41	13632151.32	582.18	581.43	Silty Clay at 126-130.5 ft BGS, and Shale bedrock at 130.5-131 ft BGS	2" PVC	126.0 to 131.0	456.2 to 451.2	138.0	444.2
MW-16-03	3/25/2016	465353.06	13632114.23	582.08	581.39	Silty Clay Hardpan and Shale	2" PVC	127.0 to 132.0	455.1 to 450.1	138.0	444.1
MW-16-04	3/23/2016	465173.94	13632077.11	581.99	580.95	Silty Clay Hardpan and Shale	2" PVC	127.0 to 132.0	455.0 to 450.0	138.0	444.0

Notes:

Coordinates are Michigan State Plane South Zone-2113, International Feet

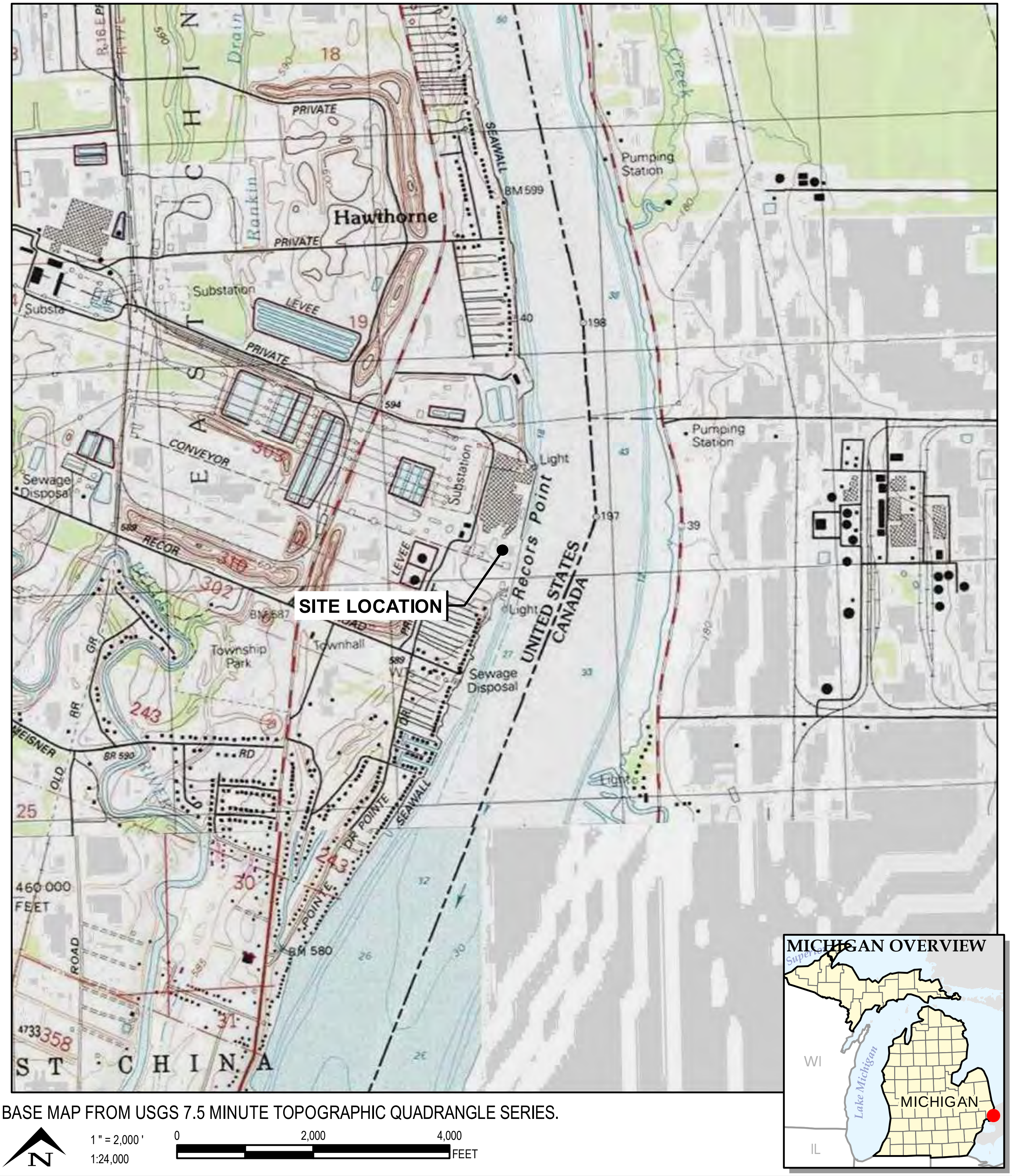
Elevation in feet above NAVD88.

TOC: Top of well casing.

ft AMSL: Feet above mean sea level.

ft BGS: Feet below ground surface.

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	J. PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	265996.0004
FILE:	265996-SLMMB.mxd

FIGURE 1

E:\DTE\CCR_Sites\2017_265996\265996-SLMMB.mxd -- Saved By: BDEEGAN on 10/9/2017, 14:51:49 PM

TRC - GIS
Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0
Plot Date: 10/9/2017, 15:35:34 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-002.mxd

LEGEND

✦	MONITORING WELLS
▤	SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	J PAPEZ	PROJ NO.:	254222.0004
CHECKED BY:	S HOLMSTROM	**FIGURE 2**	
APPROVED BY:	V BUENING		
DATE:	OCTOBER 2017		

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

FILE NO.: 265996-0004-002.mxd

LEGEND

⯁	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
CROSS SECTION LOCATOR MAP

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	S. HOLMSTROM	FIGURE 3	
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

TRC
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Phone: 734.971.7080
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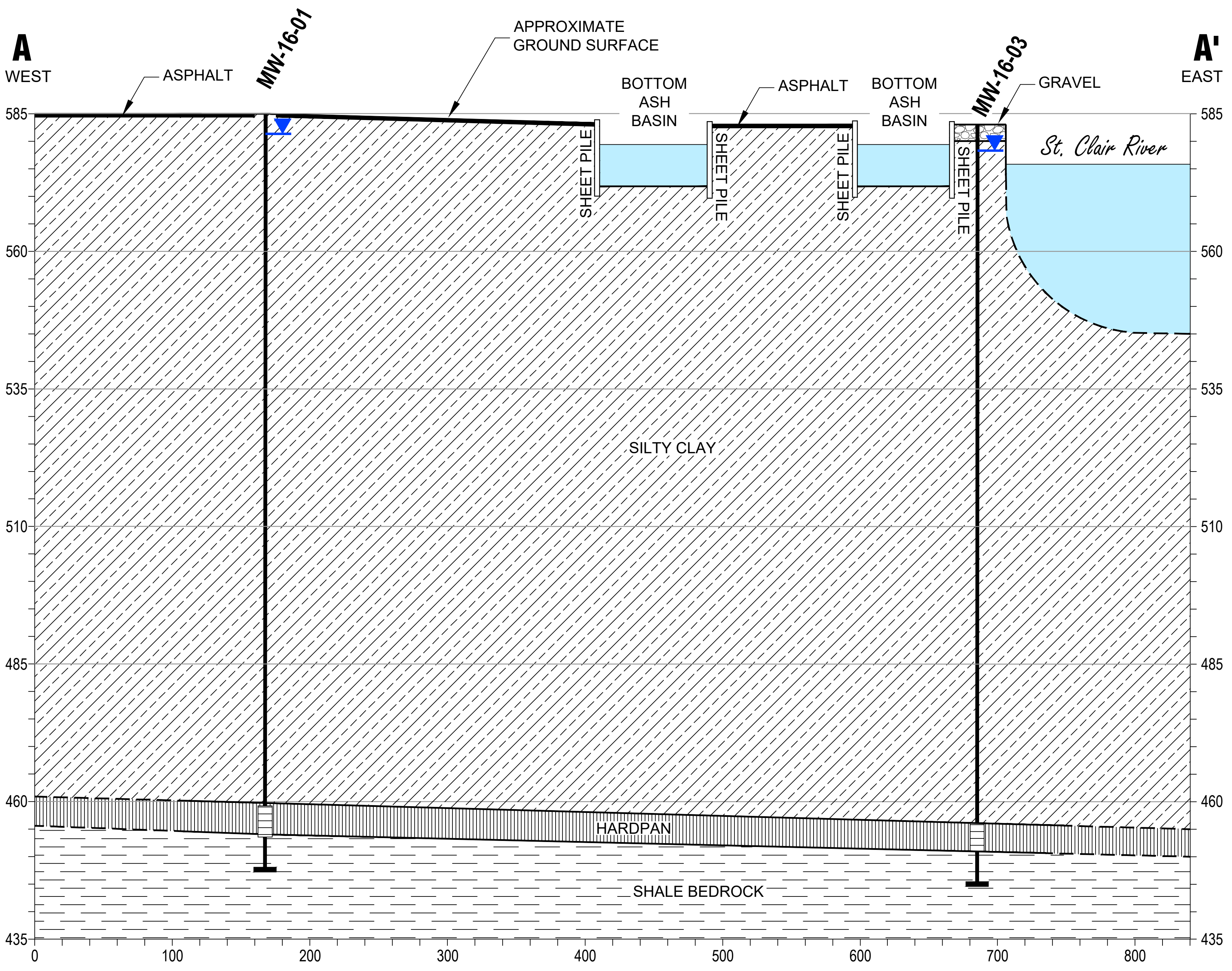
FILE NO.: 265996-0004-010.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:36:52 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-010.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

GROUNDWATER ELEVATION (COLLECTED 02/28/2017)

SOIL BORING

WELL SCREEN INTERVAL

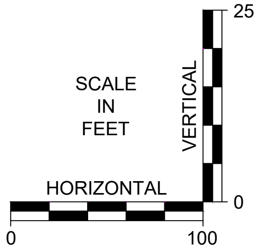
END OF BORING

Lithology Key

▥ HARDPAN

▨ SILTY CLAY

▤ SHALE BEDROCK



PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE
CHECKED BY:	S.HOLMSTROM
APPROVED BY:	V.BUENING
DATE:	SEPTEMBER 2017

PROJ NO.: 265996.0004.01.01

FIGURE 4

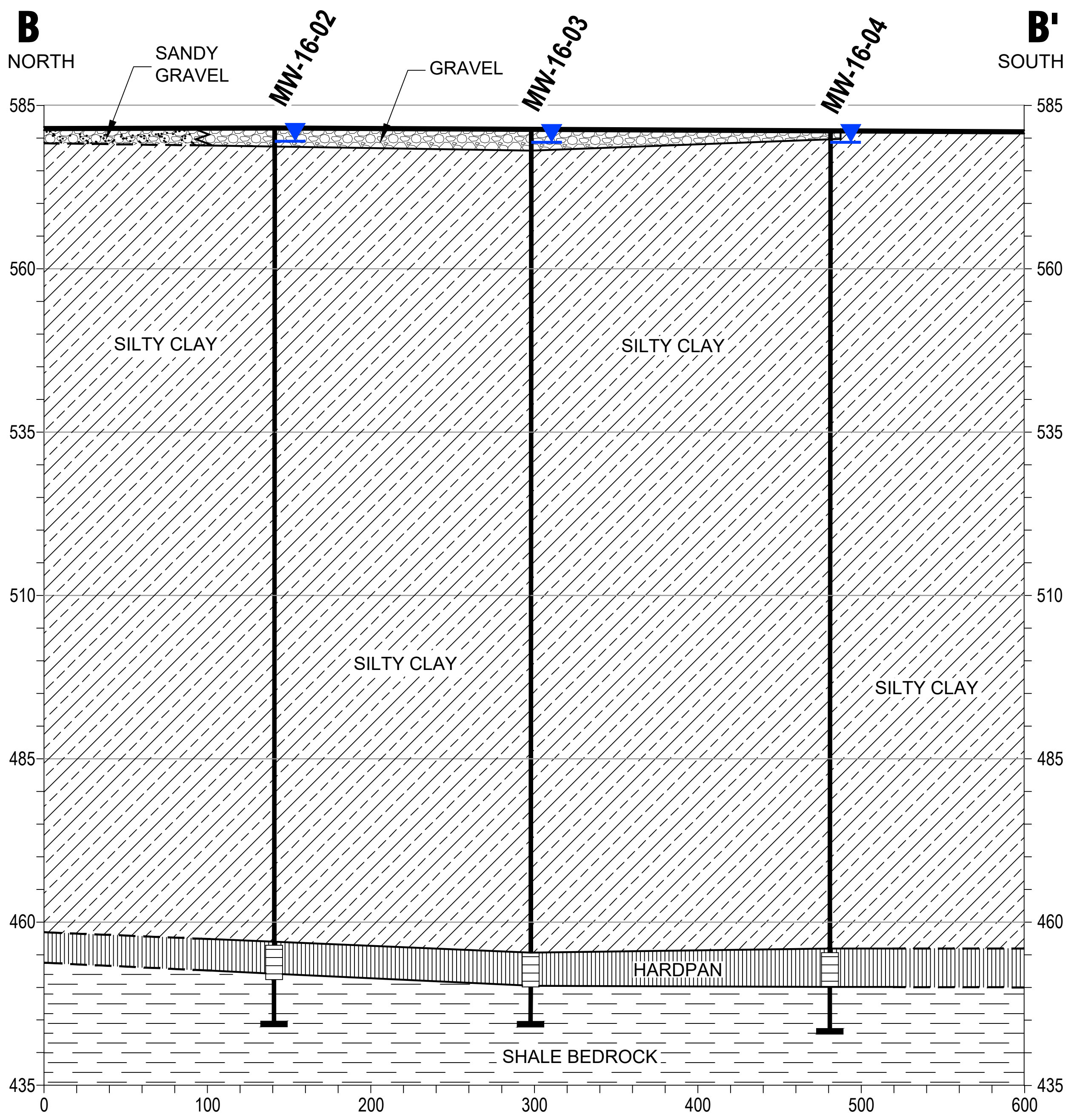
TRC

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

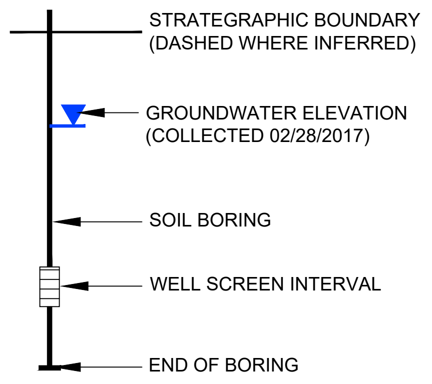
FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:02PM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'

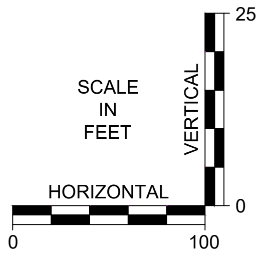


LEGEND



Lithology Key

- ▥ HARDPAN
- ▨ SILTY CLAY
- ▤ SHALE BEDROCK
- ▩ GRAVEL
- ▩ SANDY GRAVEL



PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

GENERALIZED
GEOLOGIC CROSS-SECTION B-B'

DRAWN BY: D.STEHLE
CHECKED BY: S.HOLMSTROM
APPROVED BY: V.BUENING
DATE: SEPTEMBER 2017
PROJ NO.: 265996.0004.01.01

FIGURE 5

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
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FILE NO.: 265996.0004.01.01.04-05.dwg

LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT MSL)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET ABOVE MEAN SEA LEVEL.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

GROUNDWATER POTENTIOMETRIC SURFACE MAP FEBRUARY 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	S. HOLMSTROM		**FIGURE 6**
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

TRC

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

FILE NO.: 265996-0004-007.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:38:35 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-007.mxd

Appendix A
Soil Boring and Monitoring Well Installation Logs

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant
Date Drilling Started: 3/31/16
Date Drilling Completed: 3/31/16
Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling
Drilling Method: Sonic
Surface Elev. (ft): 585.12
TOC Elevation (ft): 584.74
Total Depth (ft bgs): 138.0
Borehole Dia. (in): 6

Boring Location: S side of median, in parking lot W of ash basin.
N: 465440.66 E: 13631612.80

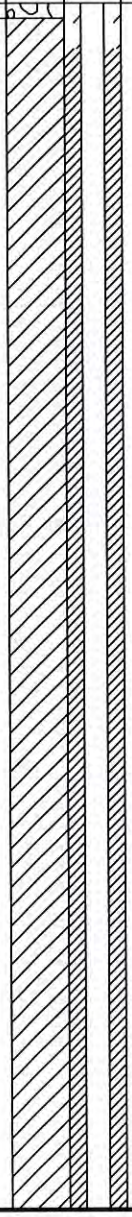
Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:45 ▼ Depth (ft bgs) 14.08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, little sand, brown (10YR 5/3), no odor, moist.				
				CLAY mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, dense.				
			5					
1 CS	90		10	Change to medium dense at 10.0 feet.				
				Change to soft to medium dense at 12.5 feet.				
			▼					
			15					
			20		CL			
			25					
2 CS	95		30					
			35					



Signature: for J. Reed

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

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

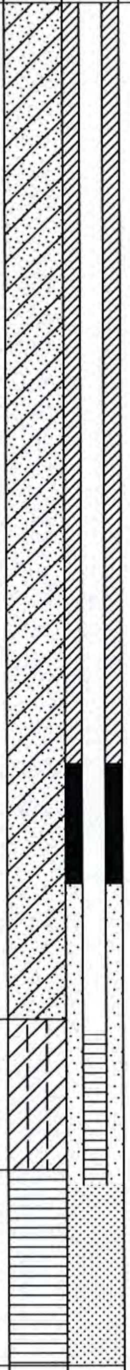
WELL NO. MW-16-01

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
3 ST				**CLAY** mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, soft to medium dense.				
				Change to few fine to coarse sand at 43.0 feet.				
			45					
4 CS	100		50	Change to gray (10YR 5/1) at 50.0 feet.				
			55					
			60		CL			
			65					
5 CS	100		70					
			75					
			80	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 80.25 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
			85	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 85.0 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
6 CS	100		90	Change to few to little fine to coarse sand at 90.0 feet.				

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			95	**CLAY WITH SAND** mostly clay, few to little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.				
			100					
			105					
7 CS	100		110		CL			
			115					
			120	Change to soft at 120.0 feet.				
8 CS	100		125					
				SILTY CLAY mostly clay, some silt, very dark gray, (10YR 3/1), no odor, dry to moist, hard.	CL- ML			
			130					
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
9 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					



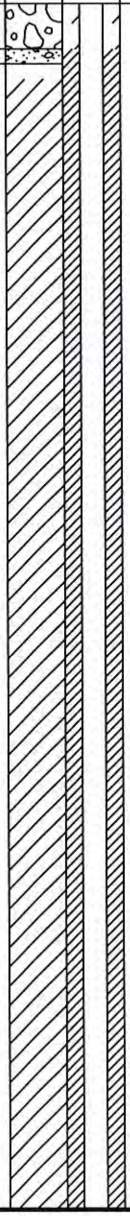
WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant
Date Drilling Started: 3/28/16
Date Drilling Completed: 3/28/16
Project Number: 231828.0004.0000
Drilling Firm: Stock Drilling
Drilling Method: Sonic
Surface Elev. (ft): 582.18
TOC Elevation (ft): 581.43
Total Depth (ft bgs): 138.0
Borehole Dia. (in): 6
Boring Location: NE side of ash basin.
N: 465503.41 E: 13632151.32
Personnel
Logged By - A. Knutson
Driller - A. Goldsmith
Drilling Equipment: Terrasonic
Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI
Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:38 ▼ Depth (ft bgs) 1.76

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
1 CS	95		5	**GRAVEL** mostly coarse gravel, few coarse sand, black (10YR 2/1), no odor, moist, loose. ▼ **SAND WITH GRAVEL** mostly fine to coarse sand, some fine to coarse gravel, brown (10YR 5/3), no odor, moist, loose. **CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, stiff. Change to soft at 8.0 feet.		
2 CS	100		10 15			
3 CS	100		20 25		CL	
4 CS	100		30 35			



Signature: for A. Knutson
Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

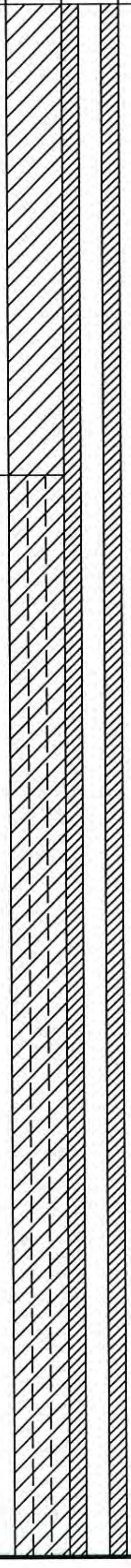
Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-02

SAMPLE						
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
5 CS	100		45	**CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, soft. Change to few silt at 45.0 feet. Change to no silt at 46.0 feet.	CL	
6 CS	100		50 55	**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.		
7 CS	100		60 65			
8 CS	100		70 75	Change to few fine to coarse sand at 73.5 feet. Change to no sand at 76.5 feet.	CL-ML	
9 CS	100		80 85			
			90			

GRAPHIC LOG / WELL DIAGRAM

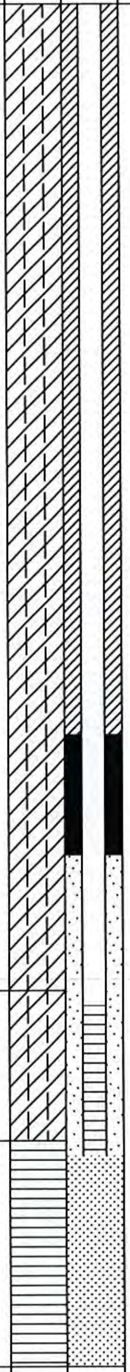


WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 3 of 3

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
10 CS	100		95	**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.	CL-ML	
11 CS	100		100 105			
12 CS	100		110 115			
13 CS	80		120 125	**SILTY CLAY** mostly clay, some silt, very dark gray (10YR 3/1), no odor, dry, hard.	CL-ML	
14 CS	100		130 135	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.		
			140 145	End of boring at 138.0 feet below ground surface.		



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant	Date Drilling Started: 3/24/16	Date Drilling Completed: 3/24/16	Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 582.08	TOC Elevation (ft) 581.39	Total Depth (ft bgs) 138.0	Borehole Dia. (in) 6

Boring Location: E side of ash basin.
N: 465353.06 E: 13632114.23

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

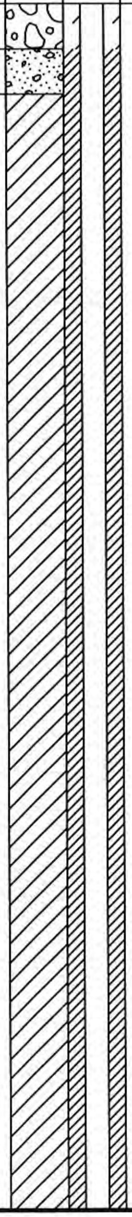
Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair	County: Saint Clair	State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:35 ▼ Depth (ft bgs) 2.16

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
1 CS	95		5	**GRAVEL WITH SAND** mostly gravel, some sand, black (10YR 2/1), no odor, moist, loose. ▼ **SAND AND GRAVEL** brown (10YR 5/3), no odor, moist, loose. **CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, stiff.		
2 CS	100		10 15	Change to medium stiff at 10.0 feet.		
3 CS	100		20 25		CL	
4 CS	100		30 35	Change to trace to few sand at 30.0 feet. Change to no sand at 32.5 feet.		

GRAPHIC LOG WELL DIAGRAM



Signature: For J. Reed

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

Checked By: C. Scieszka

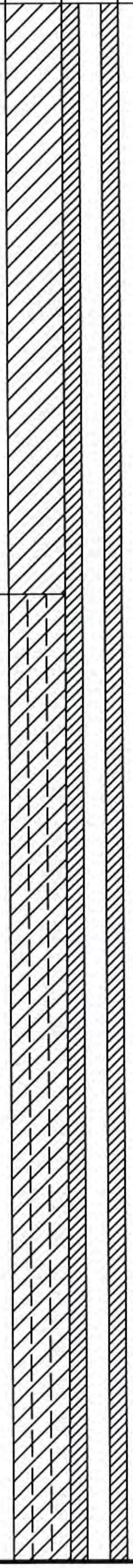
TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 2 of 3

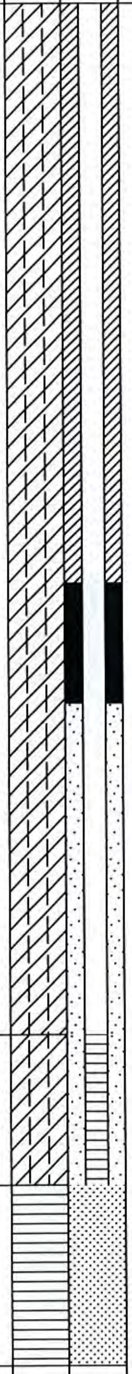
SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 ST				**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
6 CS	100		45					
			50		CL			
7 CS	100		55					
			60	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
8 CS	100		65					
			70					
9 CS	100		75		CL-ML			
			80					
10 CS	100		85					
			90					



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
			100					
12 CS	100		105					
			110		CL-ML			
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN AND SHALE very dark gray (10YR 3/1), no odor, dry to slightly moist, hard.	CL-ML			
			130					
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
15 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					



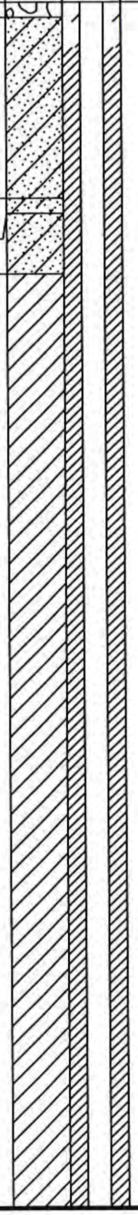
WELL CONSTRUCTION LOG

WELL NO. MW-16-04

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant
Date Drilling Started: 3/22/16
Date Drilling Completed: 3/23/16
Project Number: 231828.0004.0000
Drilling Firm: Stock Drilling
Drilling Method: Sonic
Surface Elev. (ft): 581.99
TOC Elevation (ft): 580.95
Total Depth (ft bgs): 138.0
Borehole Dia. (in): 6
Boring Location: SE side of ash basin.
N: 465173.94 E: 13632077.11
Personnel
Logged By - J. Reed
Driller - A. Goldsmith
Drilling Equipment: Terrasonic
Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI
Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:28 ▼ Depth (ft bgs) 2.19

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
				GRAVEL mostly gravel, few to little fine to coarse sand, very dark gray (10YR 3/1), no odor, moist.		
1 CS	80		5	▼ **CLAY WITH SAND** mostly clay, little to some fine to coarse sand, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
				SAND WITH CLAY mostly sand, little to some clay, dark grayish brown (10YR 4/2), no odor, moist.	SW-SC	
			10	**CLAY WITH SAND** mostly clay, little to some fine to coarse sand, medium plasticity, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
2 CS	95		15	**CLAY** mostly clay, trace fine to medium sand, medium plasticity, grayish brown (10YR 5/2), no odor, moist, stiff.		
			20			
3 CS	100		25	Change to medium stiff at 25.0 feet.	CL	
			30			
4 CS	100		35			



Signature: for J. Reed.

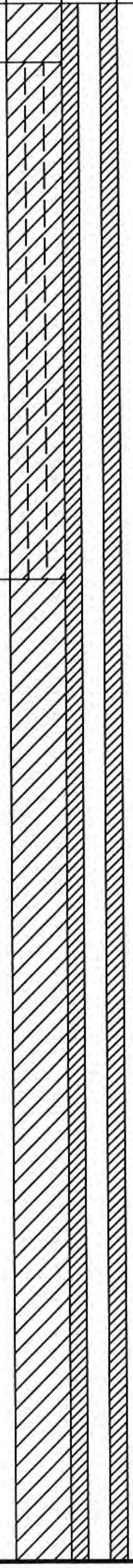
Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

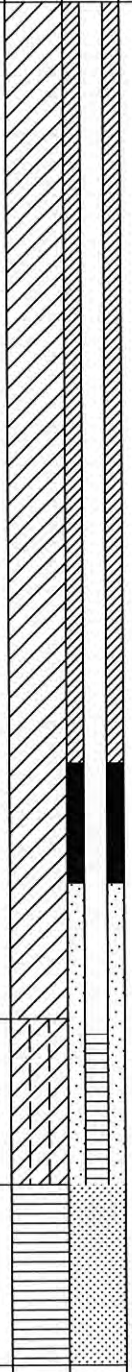
SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
5 ST					CL	
6 CS	100		45	**SILTY CLAY** mostly clay, little to some silt, few fine to coarse sand, dark grayish brown (10YR 5/2), no odor, moist, medium stiff.		
			50		CL-ML	
7 CS	100		55			
			60	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.		
8 CS	100		65			
			70			
9 CS	100		75		CL	
			80	Change to wet at 79.5 feet.		
				Change to moist at 83.0 feet.		
10 CS	100		85			
			90			



TRC

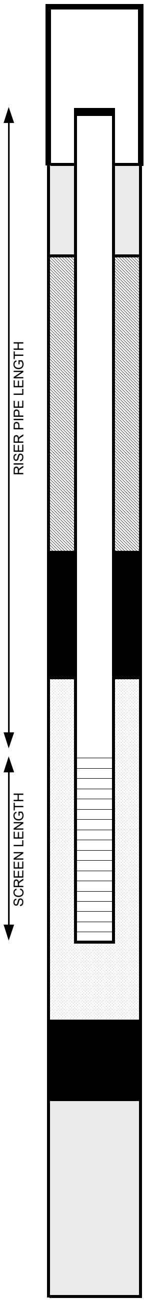
WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
			100					
12 CS	100		105					
			110		CL			
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN/SHALE mostly clay and silt, very dark gray (10YR 3/1), no odor, dry to moist, hard.	CL- ML			
			130					
				SHALE light gray (10YR 7/1) to very dark gray (10YR 3/1), no odor, dry.				
15 CS	100							
			135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-01**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/31/2016	INSTALLED BY: J. REED	CHECKED BY: C. SCIESZKA



ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
585.12	0.0	GROUND SURFACE
584.74	0.4	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
126.6		GROUT/BACKFILL METHOD TREMIE
	118.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	122.0	BENTONITE SEAL
458.1	127.0	TOP OF SCREEN
5.0		FILTER PACK MATERIAL MEDIUM, WASHED SAND
453.1	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
447.1	138.0	HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 2.5 HOURS
WATER REMOVED: 50 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: CLEAR TO VERY LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

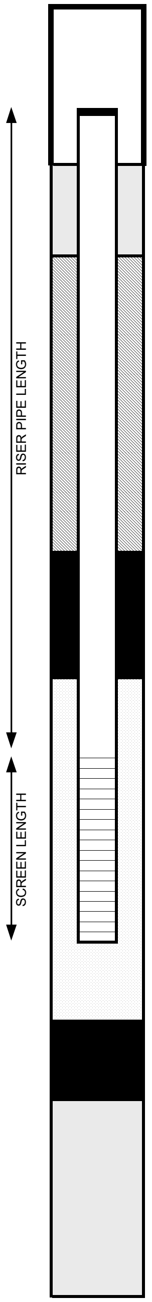
	MEASUREMENT (FEET)		DATE	TIME
DTB BEFORE DEVELOPING:	132.00	T/PVC	4/5/16	940
DTB AFTER DEVELOPING:	132.00	T/PVC	4/5/16	1420
SWL BEFORE DEVELOPING:	--	T/PVC	--	--
SWL AFTER DEVELOPING:	13.70	T/PVC	4/8/16	828
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-02**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/29/2016 INSTALLED BY: A. Knutson		CHECKED BY: C. SCIESZKA



ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
582.18	0.0	GROUND SURFACE
581.43	0.8	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL: BENTONITE SLURRY
		GROUT/BACKFILL METHOD: TREMIE
125.3		
	117.0	GROUT
		BENTONITE SEAL MATERIAL: TIME RELEASE PELLETS
	121.0	BENTONITE SEAL
456.2	126.0	TOP OF SCREEN
5.0		
		FILTER PACK MATERIAL: MEDIUM, WASHED SAND
451.2	131.0	BOTTOM OF SCREEN
	131.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL: WASHED SAND
444.2	138.0	HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
__ IN. FROM __ TO __ FT.

SURF. CASING DIAMETER: __ IN. FROM __ TO __ FT.
__ IN. FROM __ TO __ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 2.5 HOURS

WATER REMOVED: 55 GALLONS

WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY

COLOR BEFORE: GRAY

CLARITY AFTER: SLIGHTLY CLOUDY

COLOR AFTER: CLEAR TO VERY LIGHT GRAY

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	131.90	T/PVC	4/4/16	--
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	--
SWL BEFORE DEVELOPING:	1.40	T/PVC	4/4/16	--
SWL AFTER DEVELOPING:	1.10	T/PVC	4/8/16	838
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

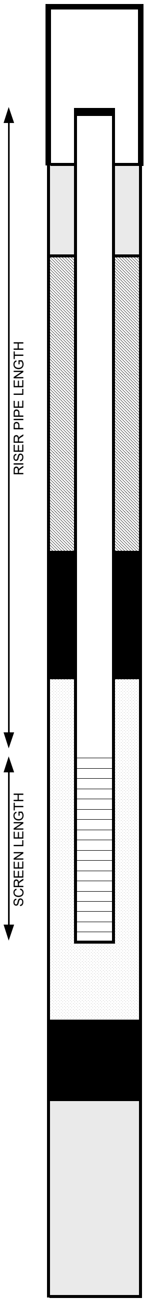
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE EC: SCPP CCR MW Installation	WELL ID:	**MW-16-03**
PROJ. NO: 2381828.0004	DATE INSTALLED: 3/25/2016 INSTALLED BY: J. Reed		CHECKED BY: C. SCIESZKA

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
582.08	0.0	GROUND SURFACE
581.39	0.7	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
126.3		
	112.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	116.0	BENTONITE SEAL
455.1	127.0	TOP OF SCREEN
		FILTER PACK MATERIAL MEDIUM, WASHED SAND
5.0		
450.1	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
444.1	138.0	HOLE BOTTOM



CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
___ IN. FROM ___ TO ___ FT.

SURF. CASING DIAMETER: ___ IN. FROM ___ TO ___ FT.
___ IN. FROM ___ TO ___ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 74 GALLONS

WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY/SUSPENDED SAND

COLOR BEFORE: GRAY

CLARITY AFTER: SLIGHTLY CLOUDY

COLOR AFTER: VERY LIGHT GRAY TO CLEAR

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	123.40	T/PVC	4/4/16	950
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	1420
SWL BEFORE DEVELOPING:	1.00	T/PVC	4/4/16	950
SWL AFTER DEVELOPING:	1.47	T/PVC	4/8/16	835
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO

LOCK KEY NUMBER: 3120

NOTES:

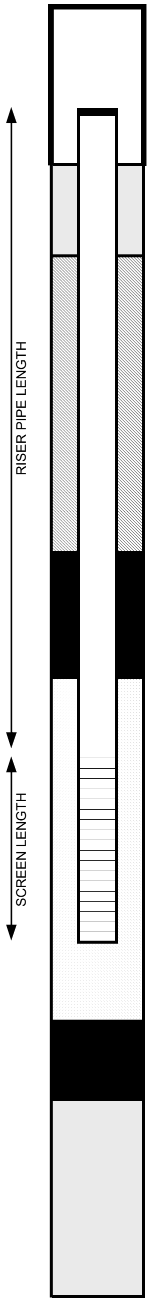
APPROXIMATELY 8.6 FEET OF MEDIUM, WASHED SAND WAS UNINTENTIONALLY PLACED IN WELL DURING INSTALLATION. THE SAND WAS REMOVED DURING WELL DEVELOPMENT.

REVISED 11/2013

WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE EC: SCPP CCR MW Installation
WELL ID: **MW-16-04**
PROJ. NO: 2381828.0004
DATE INSTALLED: 3/23/2016
INSTALLED BY: J. Reed
CHECKED BY: C. SCIESZKA

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)	
581.99	0.0	GROUND SURFACE
580.95	1.0	TOP OF CASING
	1.5	CEMENT SURFACE PLUG
		GROUT/BACKFILL MATERIAL BENTONITE SLURRY
		GROUT/BACKFILL METHOD TREMIE
126.0		
	118.0	GROUT
		BENTONITE SEAL MATERIAL TIME RELEASE PELLETS
	122.0	BENTONITE SEAL
455.0	127.0	TOP OF SCREEN
5.0		FILTER PACK MATERIAL MEDIUM, WASHED SAND
450.0	132.0	BOTTOM OF SCREEN
	132.0	BOTTOM OF FILTER PACK
	NA	BENTONITE PLUG
		BACKFILL MATERIAL WASHED SAND
444.0	138.0	HOLE BOTTOM



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC
PIPE SCHEDULE: 40
PIPE JOINTS: THREADED O-RINGS
SCREEN TYPE: 2-INCH PVC
SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 138 FT.
IN. FROM TO FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: SURGE AND PUMP
TIME DEVELOPING: 2 HOURS
WATER REMOVED: 40 GALLONS
WATER ADDED: NA GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: CLOUDY/GRAY
COLOR BEFORE: GRAY
CLARITY AFTER: SLIGHTLY CLOUDY
COLOR AFTER: LIGHT GRAY
ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	133.10	T/PVC	4/4/16	945
DTB AFTER DEVELOPING:	132.00	T/PVC	4/4/16	1700
SWL BEFORE DEVELOPING:	1.01	T/PVC	4/4/16	945
SWL AFTER DEVELOPING:	1.15	T/PVC	4/8/16	828
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☑ YES ☐ NO
PROTECTIVE COVER AND LOCK INSTALLED? ☑ YES ☐ NO
LOCK KEY NUMBER: 3120

Appendix E
2017 through 2019 Annual Groundwater Monitoring Reports

Annual Groundwater Monitoring Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
4901 Pointe Drive
East China Township, Michigan

January 2018

Annual Groundwater Monitoring Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins

4901 Pointe Drive
East China Township, Michigan

January 2018

Prepared For
DTE Electric Company

Graham Crockford, C.P.G
Senior Project Geologist

David B. McKenzie, P.E.
Senior Project Engineer

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www.TRCsolutions.com

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Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule). The CCR Rule, which became effective on October 19, 2015, applies to the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) CCR unit. Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e).

TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), prepared this Annual Groundwater Monitoring Report (Annual Report) for the SCPP BABs CCR unit on behalf of DTE Electric. This Annual Report was prepared in accordance with the requirements of §257.90(e) and presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the October 2017 semiannual groundwater monitoring event for the SCPP BABs CCR unit. This event is the initial detection monitoring event performed to comply with §257.94. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed background levels.

There were no potential SSIs over background limits were for any of the Appendix III parameters during the October 2017 monitoring event. Therefore, DTE Electric is taking no further action at this time. The next semiannual monitoring event at the SCPP BABs CCR unit is scheduled for the second calendar quarter of 2018.

Section 1
Introduction

1.1 Program Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule). The CCR Rule, which became effective on October 19, 2015, applies to the DTE Electric Company (DTE Electric) St.Clair Power Plant (SCPP) Bottom Ash Basins (BABs). Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e).

TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), prepared this Annual Groundwater Monitoring Report (Annual Report) for the SCPP BABs CCR unit on behalf of DTE Electric. This Annual Report was prepared in accordance with the requirements of §257.90(e) and presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the October 2017 semiannual groundwater monitoring event for the SCPP BABs CCR unit. This event is the initial detection monitoring event performed to comply with §257.94. The monitoring was performed in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins* (QAPP) (TRC, July 2016; revised August 2017) and statistically evaluated per the *Groundwater Statistical Evaluation Plan – St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins* (Stats Plan) (TRC, October 2017). As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) of detection monitoring parameters compared to background levels.

1.2 Site Overview

The SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan. The SCPP including the BABs CCR unit was constructed in the early 1950s, just south of the DTE Electric SCPP main building. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River.

The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953 and is constructed over a natural continuous clay-rich soil base as shown in historical soil borings performed at the SCPP property. The BABs have been in operation at the SCPP since the plant began operation and have collected CCR bottom ash that is routinely cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments. The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (ft bgs) into the native clay-rich soil. The BABs are located south of the SCPP and adjacent to the St. Clair River and are used for receiving bottom ash and other process flow water from the power plant, which is first sent to the East BAB then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.3 Geology/Hydrogeology

The SCPP BABs CCR unit is located immediately adjacent to the west of the St. Clair River. The SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock lower confining unit is generally encountered at depths greater than 130 ft bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above was present beneath at least a 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer. The first underlying saturated zone (the potential uppermost aquifer) that would presumably become affected with CCR constituent's is located at the silty clay hardpan/shale bedrock interface (130.5 to 132 ft bgs) and is limited to no more than four feet thick.

A definitive groundwater flow direction with a mean gradient in 2016 and 2017 of 0.0036 foot/foot to the east-southeast within the uppermost aquifer is evident around the SCPP CCR BABs CCR unit, however potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

In addition, the elevation of CCR-affected water maintained within the SCPP BABs is very similar to the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR affected surface water in the BABs were able to penetrate the silty clay-rich underlying confining unit, the head on that release likely would travel radially away from the BABs within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the SCPP, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s.

Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, the radial flow potential outward from the CCR unit, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the SCPP BABs CCR unit using intrawell statistical methods is appropriate. As such, intrawell statistical approaches is being used during detection monitoring as discussed in the Stats Plan.

Section 2
Groundwater Monitoring

2.1 Monitoring Well Network

A groundwater monitoring system has been established for the SCPP BABs CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2.

As discussed in the Stats Plan, intrawell statistical methods for the BABs CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the variability in the presence of the uppermost aquifer across the site, and presence of no flow boundary on the southeast side of the aquifer), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). An intrawell statistical approach requires that each of the downgradient wells doubles as the background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background dataset from that same well. Monitoring wells MW-16-01 through MW-16-04 are located around the east and west perimeter of the BABs and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of four background/downgradient monitoring wells).

2.2 Background Sampling

Background groundwater monitoring was conducted at the SCPP BABs CCR unit from August 2016 through September 2017 in accordance with the QAPP. Data collection included eight background data collection events of static water elevation measurements, analysis for parameters required in the CCR Rule's Appendix III and Appendix IV to Part 257, and field parameters (dissolved oxygen, oxidation reduction potential, pH, specific conductivity, temperature, and turbidity) from all four monitoring wells installed for the BABs CCR unit, in addition to one supplemental sampling event. The supplemental background sampling event was conducted in September 2017 to expand the background data set and confirm analytical results. The groundwater samples were analyzed by TestAmerica Laboratories, Inc. (TestAmerica).

Background data are included in Appendix A Tables 1 through 3, where: Table 1 is a summary of static water elevation data; Table 2 is a summary of groundwater analytical data compared to potentially relevant criteria; and Table 3 is a summary of field data. In addition to the data tables, groundwater potentiometric elevation data are summarized for each background monitoring event in Appendix A Figures 1 through 8.

2.3 Semiannual Groundwater Monitoring

The semiannual monitoring parameters for the detection groundwater monitoring program were selected per the CCR Rule's Appendix III to Part 257 – Constituents for Detection Monitoring. The Appendix III indicator parameters consist of boron, calcium, chloride, fluoride, pH (field reading), sulfate, and total dissolved solids (TDS) and were analyzed in accordance with the sampling and analysis plan included within the QAPP. In addition to pH, the collected field parameters included dissolved oxygen, oxidation reduction potential, specific conductivity, temperature, and turbidity.

2.3.1 Data Summary

The initial semiannual groundwater detection monitoring event for 2017 was performed during October 2 and 3, 2017, by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all four monitoring well locations. Groundwater samples were collected from the four detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the October 2017 event is provided in Table 1 (static groundwater elevation data), Table 2 (analytical results), and Table 3 (field data).

2.3.2 Data Quality Review

Data from each round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The data were found to be complete and usable for the purposes of the CCR monitoring program. Particular data non-conformances are summarized in Appendix B.

2.3.3 Groundwater Flow Rate and Direction

Groundwater elevation data collected during the most recent background sampling events showed that groundwater within the uppermost aquifer generally flows to the east-southeast across the SCPP BABs CCR unit. Groundwater potentiometric surface elevations measured across the SCPP BABs during the October 2017 sampling event are provided in Table 1 and were used to construct a groundwater potentiometric surface map (Figure 3).

The map indicates that current groundwater flow is consistent with previous monitoring events. The average hydraulic gradient throughout the SCPP BABs during this event is estimated at 0.0035 ft/ft. Resulting in an estimated average seepage velocity of approximately 0.0001 ft/day or 0.04 ft/year (approximately 0.5 inches/year) for this event, using the average hydraulic conductivity of 0.2 ft/day (TRC, 2017) and an assumed effective porosity of 0.4.

As presented in the GWMS Report, and mentioned above, there is a horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the SCPP BABs CCR unit. The general flow rate and direction in the uppermost aquifer is similar to that identified in previous monitoring rounds and continues to demonstrate that groundwater flows at a low rate and the compliance wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the SCPP BABs CCR unit.

Section 3
Statistical Evaluation

3.1 Establishing Background Limits

Per the Stats Plan, background limits were established for the Appendix III indicator parameters following the collection of at least eight background monitoring events using data collected from each of the four established detection monitoring wells (MW-16-01 through MW-16-04). The statistical evaluation of the background data is presented in detail in Appendix C. The Appendix III background limits for each monitoring well will be used throughout the detection monitoring period to determine whether groundwater has been impacted from the SCPP BABs CCR unit by comparing concentrations in the detection monitoring wells to their respective background limits for each Appendix III indicator parameter.

3.2 Data Comparison to Background Limits

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth). The comparisons are presented in Table 4.

The statistical evaluation of the October 2017 Appendix III indicator parameters shows that there were no potential SSIs compared to background for boron, calcium, chloride, fluoride, pH, sulfate or TDS.

Section 4
Conclusions and Recommendations

There were no potential SSIs over background limits were for any of the Appendix III parameters during the October 2017 monitoring event. Therefore, DTE Electric is taking no further action at this time.

The next semiannual monitoring event at the SCPP BABs CCR unit is scheduled for the second calendar quarter of 2018.

Section 5
Groundwater Monitoring Report Certification

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.90(e) requires that the owner or operator of an existing CCR unit prepare an annual groundwater monitoring and corrective action report.

Annual Groundwater Monitoring Report Certification
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

CERTIFICATION

I hereby certify that the annual groundwater and corrective action report presented within this document for the SCPP BABs CCR unit has been prepared to meet the requirements of Title 40 CFR §257.90(e) of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.90(e).

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2019	David B. McKenzie Engineer No. 42332
Company: TRC Engineers Michigan, Inc.	Date: January 30, 2018 1/30/18	Stamp

Section 6
References

TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

Tables

Table 1

Summary of Groundwater Elevation Data – October 2017
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Well ID	MP-01		MW-16-01		MW-16-02		MW-16-03		MW-16-04	
Date Installed	3/23/2016		3/31/2016		3/29/2016		3/25/2016		3/23/2016	
TOC Elevation	580.84(1)		584.74		581.43		581.39		580.95	
Geologic Unit of Screened Interval	NA		Silty Clay Shale Interface		Silty Clay Shale Interface		Silty Clay/Hardpan Shale Interface		Silty Clay/Hardpan Shale Interface	
Screened Interval Elevation	NA		458.1 to 453.1		456.2 to 451.2		455.1 to 450.1		455.0 to 450.0	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
10/5/2017	3.98	576.85	3.66	581.08	2.81	578.62	1.82	579.57	1.24	579.71

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing

NA - not applicable

1) Elevation represents the point of reference used to collect surface water level measurements.

Table 2

Summary of Groundwater Analytical Data – October 2017
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

	Sample Location:	**MW-16-01**	**MW-16-02**	**MW-16-03**	**MW-16-04**
	Sample Date:	10/6/2017	10/6/2017	10/6/2017	10/6/2017
Constituent	Unit				
Appendix III					
Boron	ug/L	2,000	2,000	1,900	2,100
Calcium	ug/L	19,000	40,000	56,000	38,000
Chloride	mg/L	1,200	1,900	2,100	2,500
Fluoride	mg/L	2.0	1.6	1.5	1.7
pH, Field	SU	8.2	8.1	7.9	8.0
Sulfate	mg/L	7.1	<2.0	<2.0	<5.0
Total Dissolved Solids	mg/L	2,000	2,700	3,200	3,600

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total
unless otherwise specified.

Table 3

Summary of Field Data – October 2017
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-01	10/6/2017	0.17	-165.5	8.2	4,287	13.30	16.5
MW-16-02	10/6/2017	0.14	-191.3	8.1	6,140	15.28	29.7
MW-16-03	10/6/2017	0.16	-172.0	7.9	6,569	14.66	67.0
MW-16-04	10/6/2017	0.07	-183.9	8.0	7,947	13.94	88.0

Notes:

mg/L - milligrams per liter.

mV - milliVolt.

SU - standard unit.

umhos/cm - micro-mhos per centimeter.

deg C - degrees celcius.

NTU - nephelometric turbidity units.

Table 4

Comparison of Appendix III Parameter Results to Background Limits – October 2017
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
Sample Date:		10/6/2017		10/6/2017		10/6/2017		10/6/2017	
Constituent	Unit	Data	PL	Data	PL	Data	PL	Data	PL
Appendix III									
Boron	ug/L	2,000	2,600	2,000	2,400	1,900	2,300	2,100	2,600
Calcium	ug/L	19,000	24,000	40,000	69,000	56,000	61,000	38,000	57,000
Chloride	mg/L	1,200	1,400	1,900	2,100	2,100	2,200	2,500	2,800
Fluoride	mg/L	2.0	2.1	1.6	1.6	1.5	1.6	1.7	1.7
pH, Field	SU	8.2	7.2 - 8.6	8.1	7.5 - 8.3	7.9	7.3 - 8.5	8.0	7.3 - 8.4
Sulfate	mg/L	7.1	62	<2.0	25	<2.0	25	<5.0	25
Total Dissolved Solids	mg/L	2,000	2,500	2,700	3,600	3,200	4,000	3,600	4,400

Notes:

ug/L - micrograms per liter.

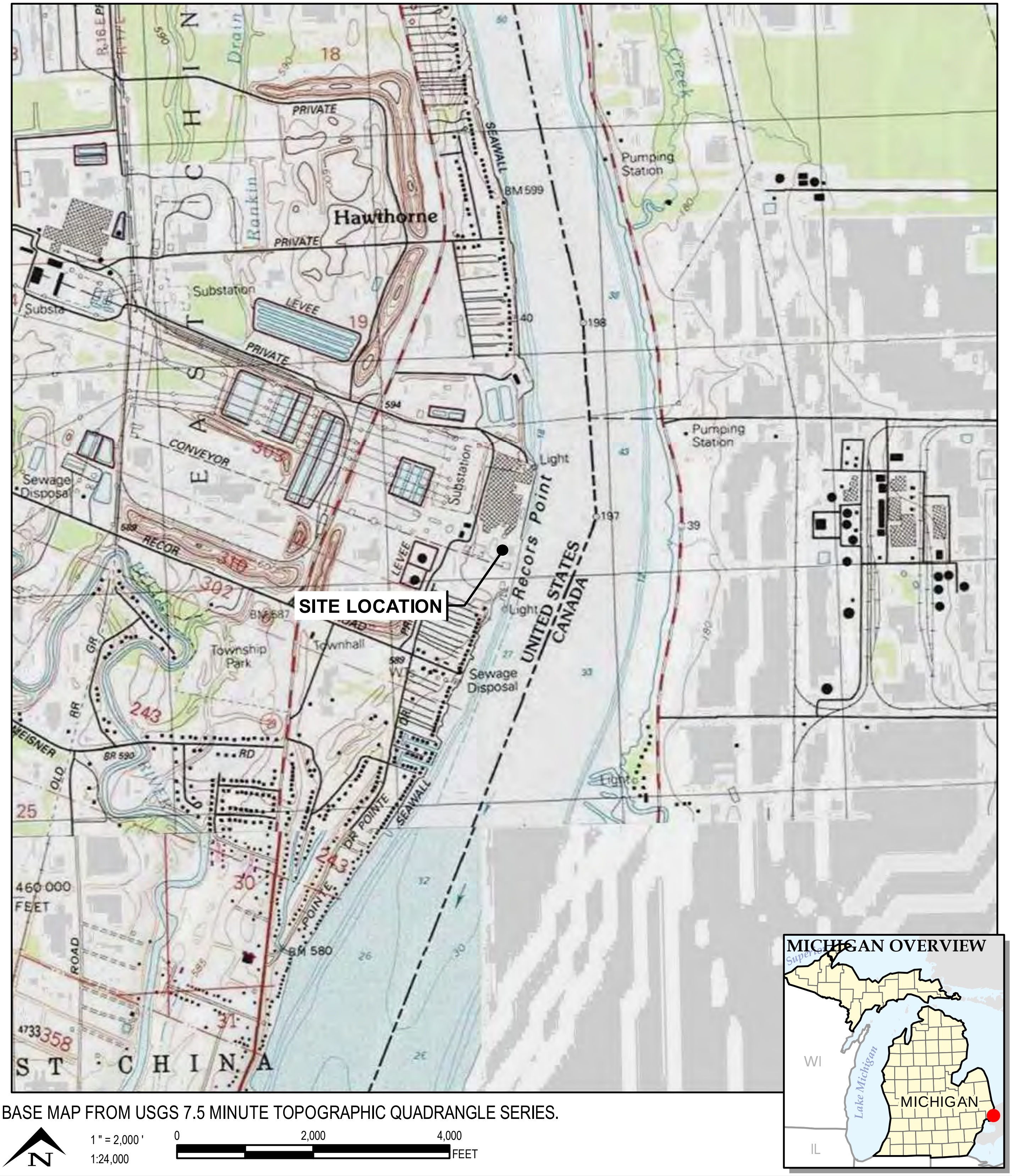
mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

RESULT	Shading and bold font indicates an exceedance of the Prediction Limits (PL).

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:	**DTE ELECTRIC COMPANY ST. CLAIR POWER PLANT 4901 POINTE DRIVE EAST CHINA TOWNSHIP, MICHIGAN**	DRAWN BY:	J. PAPEZ
		CHECKED BY:	S HOLMSTROM
		APPROVED BY:	V. BUENING
TITLE:	**SITE LOCATION MAP**	DATE:	OCTOBER 2017
		PROJ. NO.:	265996.0004
		FILE:	265996-SLMMB.mxd
		FIGURE 1	

E:\DTE\CCR_Sites\2017_265996\265996-SLMMB.mxd -- Saved By: BDEEGAN on 10/9/2017, 14:51:49 PM

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/9/2017, 15:35:34 PM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-002.mxd

LEGEND

✦ MONITORING WELLS

⊟ SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	J PAPEZ	PROJ NO.:	254222.0004
CHECKED BY:	S HOLMSTROM	**FIGURE 2**	
APPROVED BY:	V BUENING		
DATE:	OCTOBER 2017		

TRC

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

FILE NO.: 265996-0004-002.mxd

LEGEND

✛	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.
4. GROUNDWATER ELEVATION DATA FOR MW-16-02 WAS NOT USED. GROUNDWATER LEVEL WAS NOT FULLY RECOVERED AT THE TIME OF DATA COLLECTION.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP OCTOBER 2017

DRAWN BY:	S. MAJOR	PROJ NO.:	265996.0004
CHECKED BY:	S. SCIESZKA	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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

FILE NO.: 265996-0004-012.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/12/2018, 10:19:44 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-012.mxd

Appendix A
Background Data

Table 1
Groundwater Elevation Summary
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Well ID	**MP-01**		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
Date Installed	3/23/2016		3/31/2016		3/29/2016		3/25/2016		3/23/2016	
TOC Elevation	580.84(1)		584.74		581.43		581.39		580.95	
Geologic Unit of Screened Interval	NA		Silty Clay Shale Interface		Silty Clay Shale Interface		Silty Clay/Hardpan Shale Interface		Silty Clay/Hardpan Shale Interface	
Screened Interval Elevation	NA		458.1 to 453.1		456.2 to 451.2		455.1 to 450.1		455.0 to 450.0	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
8/1/2016	NM	NM	3.16	581.58	1.32	580.11	1.39	580.00	1.10	579.85
10/3/2016	4.25	576.58	3.63	581.09	5.25	579.49	1.70	579.69	3.22	578.98
11/11/2016	4.72	576.11	3.25	581.49	1.85	579.58	2.00	579.39	1.43	579.52
1/13/2017	4.95	575.88	3.38	581.36	1.82	579.61	1.85	579.54	1.84	579.11
2/28/2017	5.00	575.83	3.42	581.32	2.10	579.33	3.08	578.31	1.60	579.35
4/21/2017	4.21	576.62	3.44	581.30	2.42	579.01	2.06	579.33	1.24	579.71
6/9/2017	4.12	576.71	3.16	581.58	1.30	580.13	1.40	579.99	1.01	579.94
7/27/2017	4.68	576.15	2.31	582.43	1.41	580.02	1.39	580.00	1.28	579.67

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing

NA - not applicable

NM - not measured

1) Elevation represents the point of reference used to collect surface water level measurements.

Table 2

Summary of Groundwater Analytical Data
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-01													
Sample Date:		8/3/2016	9/21/2016	11/11/2016	11/11/2016	1/13/2017	1/13/2017	2/28/2017	4/21/2017	4/21/2017	6/9/2017	6/9/2017	7/27/2017	7/27/2017	9/14/2017
Constituent	Unit				Field Dup		Field Dup			Field Dup		Field Dup		Field Dup	
Appendix III															
Boron	ug/L	2,200	2,100	2,500	2,400	2,400	2,400	2,300	2,500	2,400	2,400	2,400	2,300	2,200	2,400
Calcium	ug/L	23,000	23,000	20,000	21,000	21,000	21,000	21,000	21,000	21,000	23,000	23,000	20,000	19,000	21,000
Chloride	mg/L	1,200	1,300	1,300	1,300	1,300	1,300	1,200	1,200	1,200	1,300	1,300	1,200	1,200	1,300
Fluoride	mg/L	1.6	1.6	1.7	1.7	1.4	1.5	1.9	1.7	1.7	1.7	1.8	1.8	1.6	2.0
pH	SU	7.93	8.1	8.0	8.0	7.9	8.0	8.2	7.9	7.9	7.8	7.8	8.1	8.2	8.3
Sulfate	mg/L	44	31	28	27	26	26	26	<20	20	58	<25	<20	<20	7.9
Total Dissolved Solids	mg/L	2,200	2,200	2,200	2,200	2,400	2,500	2,200	2,300	2,200	2,500	2,300	2,300	1,800	2,100
Appendix IV															
Antimony	ug/L	<2.0	<2.0	<2.0	<2.0	2.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Barium	ug/L	130	190	160	160	150	150	150	160	150	150	160	190	180	210
Beryllium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0
Chromium	ug/L	4.0	11	5.8	3.7	2.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.6	2.4	3.5
Cobalt	ug/L	<1.0	3.4	2.0	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	<1.0	<1.0
Fluoride	mg/L	1.6	1.6	1.7	1.7	1.4	1.5	1.9	1.7	1.7	1.7	1.8	1.8	1.6	2.0
Lead	ug/L	<1.0	2.4	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.5	<1.0	<1.0
Lithium	ug/L	34	56	48	45	41	39	41	46	44	41	41	53	50	46
Mercury	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum	ug/L	49	39	31	30	34	30	30	35	31	29	30	27	25	24
Radium-226	pCi/L	0.334	0.346	<0.342	0.652	0.428	0.278	0.407	0.246	0.231	0.258	0.279	0.416	0.408	0.337
Radium-226/228	pCi/L	1.16	<0.790	0.736	0.785	0.693	0.455	0.443	0.457	0.480	0.410	0.493	1.43	0.860	0.993
Radium-228	pCi/L	<0.861	<0.790	0.506	<0.415	<0.414	<0.392	<0.407	<0.355	<0.340	<0.316	<0.377	1.01	0.452	0.656
Selenium	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Thallium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units.

pCi/L - picocuries per liter.

All metals were analyzed as total
unless otherwise specified.

Table 2

Summary of Groundwater Analytical Data
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-02										
Sample Date:		8/3/2016	9/21/2016	9/21/2016	11/11/2016	1/13/2017	2/28/2017	4/21/2017	6/9/2017	7/27/2017	9/14/2017	9/14/2017
Constituent	Unit			Field Dup								Field Dup
Appendix III												
Boron	ug/L	1,900	2,000	2,000	2,300	2,100	2,200	2,200	2,200	2,200	2,200	2,300
Calcium	ug/L	69,000	51,000	45,000	40,000	36,000	38,000	36,000	38,000	38,000	43,000	42,000
Chloride	mg/L	1,800	2,000	2,000	2,000	2,000	1,800	1,800	1,900	1,900	1,900	1,900
Fluoride	mg/L	1.2	1.2	1.1	1.5	1.2	1.4	1.3	1.4	1.4	1.6	1.6
pH	SU	7.86	8.0	8.0	7.9	7.8	8.1	7.9	7.8	8.0	8.2	8.2
Sulfate	mg/L	9.6	<10	<10	<20	<20	<20	<20	<25	<20	<5.0	<5.0
Total Dissolved Solids	mg/L	3,100	3,000	3,000	3,000	3,600	3,300	3,500	3,100	3,300	3,200	3,000
Appendix IV												
Antimony	ug/L	2.1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic	ug/L	12	5.6	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Barium	ug/L	530	470	420	390	360	360	390	380	400	420	420
Beryllium	ug/L	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.9	<1.0	<1.0
Chromium	ug/L	48	14	11	6.9	3.9	<2.0	<2.0	<2.0	5.5	4.1	3.7
Cobalt	ug/L	13	4.3	3.2	2.1	1.1	<1.0	<1.0	<1.0	2.7	<1.0	<1.0
Fluoride	mg/L	1.2	1.2	1.1	1.5	1.2	1.4	1.3	1.4	1.4	1.6	1.6
Lead	ug/L	10	4.5	3.5	2.2	1.3	<1.0	<1.0	<1.0	3.0	1.2	1.1
Lithium	ug/L	76	81	74	62	53	60	63	62	66	56	62
Mercury	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum	ug/L	47	39	34	69	34	33	37	33	32	26	26
Radium-226	pCi/L	2.03	1.28	1.21	1.35	1.29	1.11	0.977	1.04	1.24	1.13	3.25
Radium-226/228	pCi/L	2.90	2.63	2.24	2.13	1.92	1.89	1.22	1.57	2.56	2.13	4.99
Radium-228	pCi/L	<1.58	1.34	1.03	0.783	0.631	0.781	<0.320	0.531	1.32	1.00	1.74
Selenium	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Thallium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units.

pCi/L - picocuries per liter.

All metals were analyzed as total
unless otherwise specified.

Table 2

Summary of Groundwater Analytical Data
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-03										
Sample Date:		8/3/2016	8/3/2016	9/21/2016	11/11/2016	1/13/2017	2/28/2017	2/28/2017	4/21/2017	6/9/2017	7/28/2017	9/14/2017
Constituent	Unit		Field Dup					Field Dup				
Appendix III												
Boron	ug/L	1,900	1,800	1,800	2,100	2,100	2,100	2,000	2,000	2,200	2,100	2,200
Calcium	ug/L	49,000	47,000	55,000	49,000	49,000	51,000	51,000	47,000	52,000	51,000	62,000
Chloride	mg/L	1,900	2,000	2,000	2,000	2,100	1,900	1,900	1,800	2,000	2,000	2,100
Fluoride	mg/L	1.2	1.1	1.0	1.2	1.1	1.4	1.4	1.2	<1.3	1.1	1.5
pH	SU	7.92	7.96	8.0	7.9	7.9	8.1	8.1	8.0	8.0	7.9	8.0
Sulfate	mg/L	6.0	5.7	<10	<20	<20	<20	<20	<20	<25	<20	<5.0
Total Dissolved Solids	mg/L	3,000	3,100	3,100	4,100	3,600	3,300	3,100	3,500	3,400	3,500	3,300
Appendix IV												
Antimony	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Barium	ug/L	410	400	440	430	420	420	380	440	460	500	590
Beryllium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	ug/L	<2.0	<2.0	3.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.4	14
Cobalt	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	3.3
Fluoride	mg/L	1.2	1.1	1.0	1.2	1.1	1.4	1.4	1.2	<1.3	1.1	1.5
Lead	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	4.6
Lithium	ug/L	36	36	40	36	33	39	39	46	46	62	62
Mercury	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum	ug/L	26	25	34	32	31	31	30	31	31	26	24
Radium-226	pCi/L	1.15	1.08	1.13	0.815	0.812	0.985	1.03	0.775	0.787	1.09	1.53
Radium-226/228	pCi/L	1.79	1.84	1.79	1.58	1.31	1.35	1.65	1.15	1.67	2.31	2.28
Radium-228	pCi/L	0.639	0.768	0.663	0.763	0.499	0.363	0.629	0.373	0.882	1.22	0.745
Selenium	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Thallium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units.

pCi/L - picocuries per liter.

All metals were analyzed as total
unless otherwise specified.

Table 2
Summary of Groundwater Analytical Data
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-04								
Sample Date:		8/3/2016	9/21/2016	11/11/2016	1/13/2017	2/28/2017	4/21/2017	6/9/2017	7/27/2017	9/14/2017
Constituent	Unit									
Appendix III										
Boron	ug/L	2,300	2,200	2,500	2,600	2,500	2,600	2,600	2,500	2,600
Calcium	ug/L	48,000	58,000	42,000	46,000	45,000	44,000	46,000	39,000	49,000
Chloride	mg/L	2,600	2,600	2,700	2,700	2,500	2,400	2,600	2,500	2,500
Fluoride	mg/L	1.3	1.2	1.4	1.2	1.5	1.3	1.4	1.4	1.7
pH	SU	7.78	8.0	7.9	7.8	8.0	7.8	7.2	8.0	8.1
Sulfate	mg/L	<5.0	<10	<20	<20	<20	<20	<25	<25	<5.0
Total Dissolved Solids	mg/L	4,100	4,100	4,100	4,400	4,000	4,000	4,000	4,100	4,000
Appendix IV										
Antimony	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Arsenic	ug/L	<5.0	10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.1
Barium	ug/L	680	890	680	710	660	730	730	690	860
Beryllium	ug/L	<1.0	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	ug/L	2.1	31	7.7	7.4	2.2	2.4	<2.0	8.9	15
Cobalt	ug/L	<1.0	11	2.7	2.5	<1.0	<1.0	<1.0	2.9	5.8
Fluoride	mg/L	1.3	1.2	1.4	1.2	1.5	1.3	1.4	1.4	1.7
Lead	ug/L	<1.0	8.8	2.1	2.3	<1.0	1.0	<1.0	2.8	5.4
Lithium	ug/L	57	130	91	81	81	85	77	100	110
Mercury	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Molybdenum	ug/L	28	32	22	24	23	25	24	19	21
Radium-226	pCi/L	2.89	3.63	2.87	2.16	2.43	2.07	1.85	2.75	3.09
Radium-226/228	pCi/L	4.11	6.00	3.81	3.18	3.31	2.59	3.52	4.14	4.78
Radium-228	pCi/L	1.22	2.37	<1.24	1.02	0.887	0.519	1.67	1.39	1.70
Selenium	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Thallium	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units.

pCi/L - picocuries per liter.

All metals were analyzed as total unless otherwise specified.

Table 3

Summary of Field Parameters

St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program

East China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-01	8/3/2016	1.19	-81.2	8.15	3,926	19.66	37.1
	9/21/2016	1.45	46.1	7.46	4,255	18.68	64.2
	11/11/2016	1.77	2.2	7.63	3,438	14.29	13.1
	1/13/2017	4.09	46.0	7.80	2,674	4.20	3.95
	2/28/2017	1.10	61.4	7.91	2,976	11.57	4.64
	4/21/2017	0.73	-76.9	7.92	4,148	12.74	2.28
	6/9/2017	0.98	-86.2	7.67	3,905	14.47	6.86
	7/27/2017	0.41	-146.6	8.24	3,496	16.92	19.1
	9/14/2017	0.24	-188.9	8.19	4,267	16.77	27.1
MW-16-02	8/3/2016	0.35	-25.2	7.96	5,325	18.88	986
	9/21/2016	1.26	123.1	7.69	6,622	22.06	50.1
	11/11/2016	1.87	57.7	7.95	4,995	15.50	26.0
	1/13/2017	1.33	-10.2	7.64	4,202	7.50	6.97
	2/28/2017	0.50	6.3	8.11	4,253	11.64	6.19
	4/21/2017	0.89	-111.3	7.86	5,758	13.12	11.6
	6/9/2017	0.96	-128.8	7.92	5,466	13.84	4.76
	7/27/2017	0.17	-199.3	8.14	5,867	19.76	24.4
	9/14/2017	0.20	-198.4	8.04	6,132	19.36	26.8
MW-16-03	8/3/2016	0.36	-224.0	8.10	5,565	17.89	4.37
	9/21/2016	0.92	79.9	7.64	6,573	21.80	46.8
	11/11/2016	1.27	-1.1	7.98	4,836	14.13	15.6
	1/13/2017	0.54	-11.7	7.45	4,887	12.19	2.86
	2/28/2017	0.74	-25.5	8.19	4,351	12.13	2.84
	4/21/2017	0.40	-149.4	8.01	6,013	12.85	4.78
	6/9/2017	0.61	-128.3	7.63	5,776	13.36	3.74
	7/28/2017	0.38	-176.1	7.93	5,220	16.61	28.4
	9/14/2017	0.20	-193.8	7.80	6,547	17.04	70.0
MW-16-04	8/3/2016	0.60	52.4	7.79	7,208	17.94	20.6
	9/21/2016	1.14	124.1	7.58	8,321	21.13	203
	11/11/2016	1.57	60.2	7.93	5,979	12.47	44.5
	1/13/2017	1.68	10.6	7.56	5,873	10.02	16.8
	2/28/2017	0.53	9.4	8.18	5,378	10.68	8.50
	4/21/2017	0.40	-87.6	7.84	7,593	11.86	6.77
	6/9/2017	0.67	-108.7	7.82	7,240	12.87	9.23
	7/27/2017	0.23	-190.3	8.11	6,705	18.42	54.0
	9/14/2017	0.07	-207.8	8.07	7,981	13.88	704

Notes:

mg/L - milligrams per liter.

mV - milliVolt.

SU - standard unit.

umhos/cm - micro-mhos per centimeter.

deg C - degrees celcius.

NTU - nephelometric turbidity units.

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

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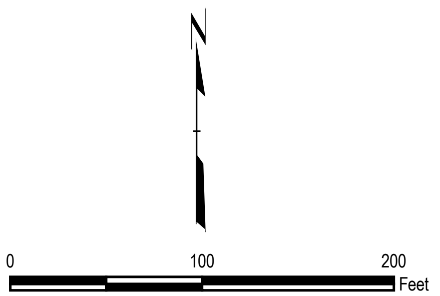
LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
(NM)	WATER ELEVATION NOT MEASURED
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC
SURFACE MAP
AUGUST 2016

DRAWN BY:	B DEEGAN	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA		
APPROVED BY:	V. BUENING	**FIGURE 1**	
DATE:	JANUARY 2018		

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FILE NO.: 265996-0004-003.mxd

LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
(NM)	WATER ELEVATION NOT MEASURED
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.
4. GROUNDWATER ELEVATION DATA FOR MW-16-04 WAS NOT USED. THE GROUNDWATER LEVEL WAS NOT FULLY RECOVERED AT THE TIME OF DATA COLLECTION.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

GROUNDWATER POTENTIOMETRIC SURFACE MAP SEPTEMBER 2016

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA		FIGURE 2
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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FILE NO.: 265996-0004-004.mxd

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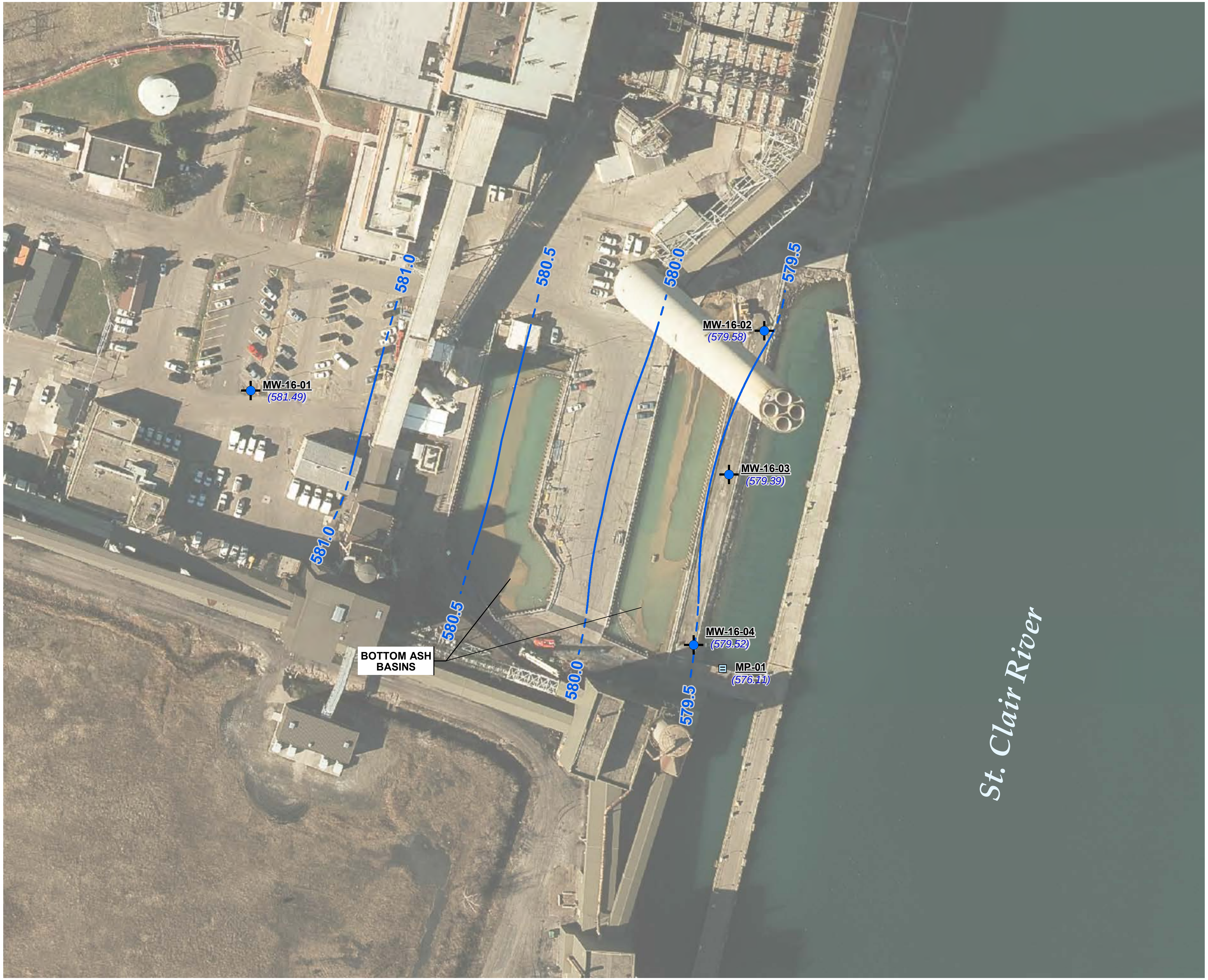

LEGEND

✛	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∿	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200
Feet

1 " = 100 '
1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

GROUNDWATER POTENTIOMETRIC
SURFACE MAP
NOVEMBER 2016

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA		
APPROVED BY:	V. BUENING		**FIGURE 3**
DATE:	JANUARY 2018		

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Map Rotation: 0

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TRC - GIS

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Map Rotation: 0

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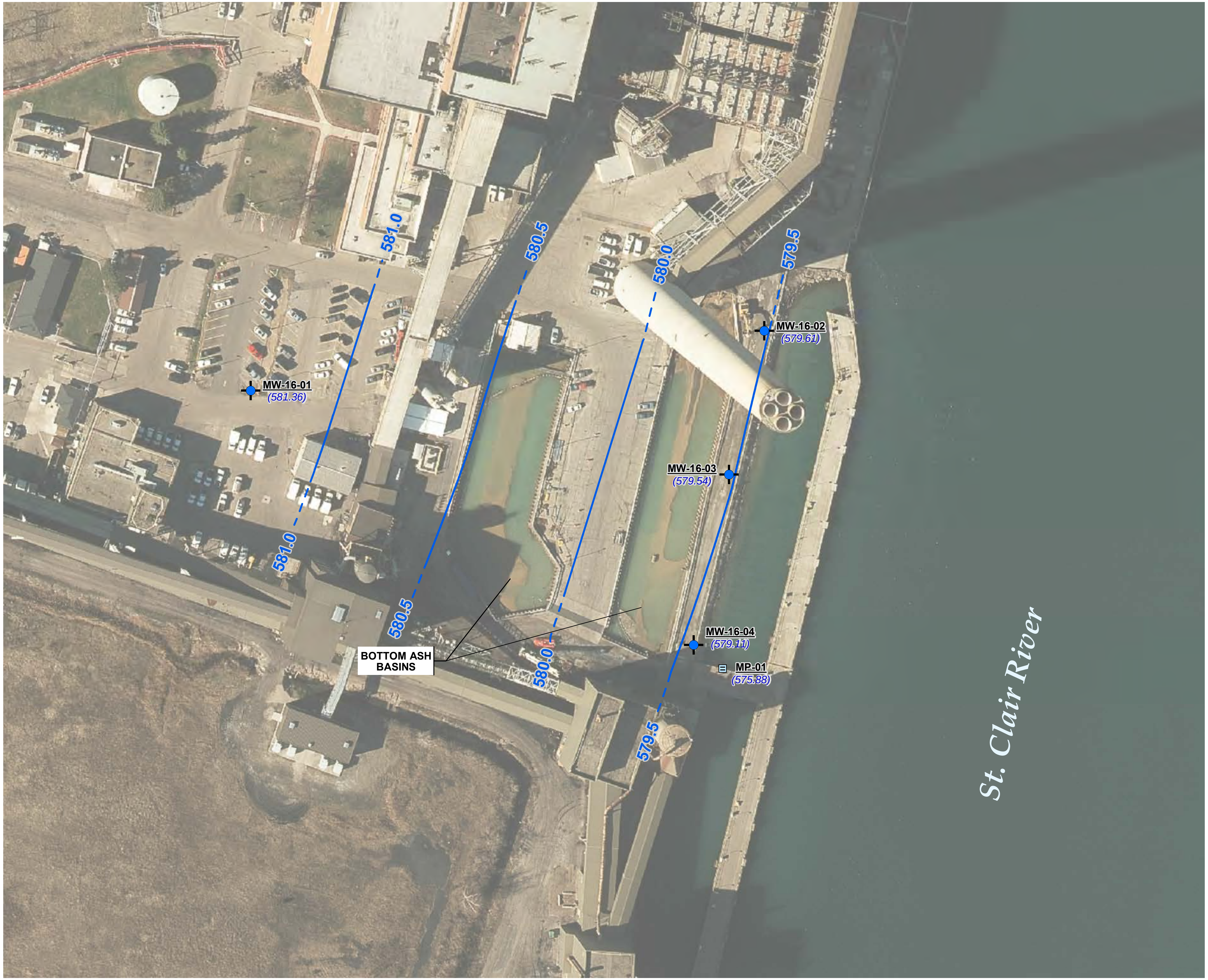

LEGEND

✥ MONITORING WELLS

⊟ SURFACE WATER MEASURING POINT

(579.85) GROUNDWATER ELEVATION (FT NAVD88)

〜 GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP JANUARY 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 4**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

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LEGEND

- ⌖ MONITORING WELLS
- ⊟ SURFACE WATER MEASURING POINT
- *(579.85)* GROUNDWATER ELEVATION (FT NAVD88)
- ∼ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP FEBRUARY 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 5**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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LEGEND

✚ MONITORING WELLS

⊟ SURFACE WATER MEASURING POINT

(579.85) GROUNDWATER ELEVATION (FT NAVD88)

∼ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP
APRIL 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 6**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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FILE NO.: 265996-0004-008.mxd

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Map Rotation: 0

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LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∼	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

GROUNDWATER POTENTIOMETRIC SURFACE MAP
JUNE 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA		**FIGURE 7**
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

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LEGEND

✛ MONITORING WELLS

⊟ SURFACE WATER MEASURING POINT

(579.85) GROUNDWATER ELEVATION (FT NAVD88)

∼ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP
JULY 2017

DRAWN BY:	J. PAPEZ	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 8**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2018		

TRC
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FILE NO.: 265996-0004-011.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

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Appendix B

Data Quality Review

Laboratory Data Quality Review
Groundwater Monitoring Event October 2017
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the October 2017 sampling event. Samples were analyzed for anions, pH, total metals, and total dissolved solids by Test America Laboratories, Inc. (Test America), located in Canton, Ohio. The laboratory analytical results are reported in laboratory report J86193-1.

During the October 2017 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	EPA 9056A
pH	EPA 9040C
Total Metals	EPA 6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Percent recoveries for matrix spike (MS) and matrix spike duplicates (MSD). Percent recoveries are calculated for each analyte spiked and used to assess bias due to sample matrix effects;
- Reporting limits (RLs) compared to project-required RLs;

- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for laboratory duplicates. The laboratory duplicates are replicate analyses of one sample and are used to assess the precision of the analytical method; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.
- When the data are evaluated through a detection monitoring statistical program, findings below may be used to support the removal of outliers.

QA/QC Sample Summary:

- Sample times were not provided on the chain-of-custody. The laboratory reported the sample times that were provided on the sample container labels. Data usability is not affected.
- Target analytes were not detected in the method blank and the equipment blank.
- Dup-01 corresponds with MW-16-02; relative percent differences (RPDs) between the parent and duplicate sample were within the QC limits, with the exception of calcium. The RPD for calcium was >20%; therefore, potential uncertainty exists for calcium results for the field duplicate sample pair.
- Laboratory duplicates were performed on sample MW-16-01 for pH and total dissolved solids; RPDs between the parent and duplicate sample were within the QC limits.
- MS/MSD analyses were performed on sample MW-16-01 for calcium and boron. The boron recoveries in the MS/MSD were above the upper laboratory control limits. The boron concentration in the parent sample was >4x the spike concentration; therefore, the laboratory control limits are not applicable. Data usability is not affected.

Appendix C
Statistical Background Limits

TRC
Results you can rely on

Technical Memorandum

Date: January 15, 2018

To: DTE Electric Company

From: Darby Litz, TRC
Sarah Holmstrom, TRC
Jane Li, TRC

Project No.: 265996.0004.0000 Phase 001, Task 001

Subject: Background Statistical Evaluation – DTE Electric Company, St. Clair Power Plant Bottom Ash Basins, China Township, Michigan

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Pursuant to the United States Environmental Protection Agency's (U.S. EPA's) Resource Conservation and Recovery Act (RCRA) Federal Final Rule for Hazardous and Solid Waste Management System Disposal of Coal Combustion Residuals from Electric Utilities (herein after "the CCR Rule") promulgated on April 17, 2015, the owner or operator of a CCR Unit must collect a minimum of eight rounds of background groundwater data to initiate a detection monitoring program and evaluate statistically significant increases above background (40 CFR §257.94). This memorandum presents the background statistical limits derived for the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) CCR unit.

The SCPP including the BABs CCR unit was constructed in the early 1950s, just south of the DTE Electric SCPP main building. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River.

The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953 and is constructed over a natural continuous clay-rich soil base as shown in historical soil borings performed at the SCPP property. The BABs have been in operation at the SCPP since the plant began operation and have collected CCR bottom ash that is routinely cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

A groundwater monitoring system has been established for SCPP BABs CCR unit (TRC, October 2017), which established the following locations for detection monitoring.

MW-16-01	MW-16-02	MW-16-03	MW-16-04

Following the baseline data collection period (August 2016 through September 2017), the background data for the SCPP BABs CCR unit were evaluated in accordance with the *Groundwater Statistical Evaluation Plan* (Stats Plan) (TRC, October 2017). Background data were evaluated utilizing ChemStat™ statistical software. ChemStat™ is a software tool that is commercially available for performing statistical evaluation consistent with procedures outlined in U.S. EPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (Unified Guidance; UG). Within the ChemStat™ statistical program (and the UG), prediction limits (PLs) were selected to perform the statistical calculation for background limits. Use of PLs is recommended by the UG to provide high statistical power and is an acceptable approach for intrawell detection monitoring under the CCR rule. PLs were calculated for each of the CCR Appendix III parameters. The following narrative describes the methods employed and the results obtained and the ChemStat™ output files are included as an attachment.

The set of four background wells utilized for the SCPP BABs CCR unit includes MW-16-01 through MW-16-04. An intrawell statistical approach requires that each of the monitoring system wells doubles as the background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background/baseline dataset from that same well. The background evaluation included the following steps:

- Review of data quality checklists for the baseline/background data sets for CCR Appendix III constituents;
- Graphical representation of the baseline data as time versus concentration (T v. C) by well/constituent pair;
- Outlier testing of individual data points that appear from the graphical representations as potential outliers;
- Evaluation of percentage of nondetects for each baseline/background well-constituent (w/c) pair;
- Distribution of the data; and
- Calculation of the upper PLs for each cumulative baseline/background data set (upper and lower PLs were calculated for field pH).

The results of these evaluations are presented and discussed below.

Data Quality

Data from each sampling round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The review was completed using the following quality control (QC) information which at a minimum included chain-of-custody forms, investigative sample results including blind field duplicates, and, as provided by the laboratory, method blanks, laboratory control spikes, laboratory duplicates. The data were found to be complete and usable for the purposes of the CCR monitoring program.

Time versus Concentration Graphs

The time versus concentration (T v. C) graphs (Attachment A) do not show potential or suspect outliers for any of the Appendix III parameters.

While variations in results are present, the graphs show consistent baseline data and do not suggest that data sets, as a whole, likely have overall trending or seasonality. However, due to limitations on CCR Rule implementation timelines, the data sets are of relatively short duration for making such observations regarding overall trending or seasonality.

Outlier Testing

No outliers were identified in the T v. C graphs. Therefore, outlier testing was not applicable.

Distribution of the Data Sets

ChemStat™ was utilized to evaluate each data set for normality. If the skewness coefficient was calculated to be between negative one and one, then the data were assumed to be approximately normally distributed. If the skewness coefficient was calculated as greater than one (or less than negative one) then the calculation was performed on the natural log (Ln) of the data. If the Ln of the data still determined that the data appeared to be skewed, then the Shapiro-Wilk test of normality (Shapiro-Wilk) was performed. The Shapiro-Wilk statistic was calculated on both non-transformed data, and the Ln-transformed data. If the Shapiro-Wilk statistic indicated that normal distributional assumptions were not valid, then the parameter was considered a candidate for non-parametric statistical evaluation. The data distributions are summarized in Table 1.

Prediction Limits

Table 1 presents the calculated PLs for the background/baseline data sets. For normal and lognormal distributions, PLs are calculated for 95 percent confidence using parametric methods. For nonnormal background datasets, a nonparametric PL is utilized, resulting in the highest value from the background dataset as the PL. The achieved confidence levels for nonparametric prediction limits depend entirely on the number of background data points, which are shown in the ChemStat™ outputs. Verification resampling (1 of 2) is recommended per the Stats Plan and UG to achieve performance standards specified in the CCR rules.

Attachments

Table 1 – Summary of Descriptive Statistics and Prediction Limit Calculations
Attachment A – Background Concentration Time-Series Charts
Attachment B – ChemStat™ Prediction Limit Outputs

Table 1

Summary of Descriptive Statistics and Prediction Limit Calculations

Table 1

Summary of Descriptive Statistics and Prediction Limit Calculations
Background Statistical Evaluation
DTE Electric Company – St. Clair Power Plant

Monitoring Well	Skewness Test		Shapiro-Wilks Test (5% Critical Value)		Outliers Removed	Prediction Limit Test	Prediction Limit
	Un-Transformed Data	Natural Log Transformed Data	Un-Transformed Data	Natural Log Transformed Data			
Appendix III							
Boron (ug/L)							
MW-16-01	-1 < -0.545522 < 1	--	--	--	N	Parametric	2,600
MW-16-02	-1 < -0.918791 < 1	--	--	--	N	Parametric	2,400
MW-16-03	-1 < -0.796876 < 1	--	--	--	N	Parametric	2,300
MW-16-04	-1.09606 < -1	-1.14593 < -1	0.829 > 0.776219	0.829 > 0.768556	N	Non-Parametric	2,600
Calcium (ug/L)							
MW-16-01	-1 < 0.34498 < 1	--	--	--	N	Parametric	24,000
MW-16-02	1.75711 > 1	1.53264 > 1	0.829 > 0.704151	0.829 > 0.757575	N	Non-Parametric	69,000
MW-16-03	1.42779 > 1	1.291 > 1	0.829 > 0.824984	0.829 < 0.851722	N	Parametric	61,000
MW-16-04	-1 < 0.989544 < 1	--	--	--	N	Parametric	57,000
Chloride (mg/L)							
MW-16-01	-1 < -0.223607 < 1	--	--	--	N	Parametric	1,400
MW-16-02	-1 < 0 < 1	--	--	--	N	Parametric	2,100
MW-16-03	-1 < -0.413737 < 1	--	--	--	N	Parametric	2,200
MW-16-04	-1 < -0.0883883 < 1	--	--	--	N	Parametric	2,800
Fluoride (mg/L)							
MW-16-01	-1 < -0.031618 < 1	--	--	--	N	Parametric	2.1
MW-16-02	-1 < 0.294764 < 1	--	--	--	N	Parametric	1.6
MW-16-03	-1 < -0.64941 < 1	--	--	--	N	Parametric	1.6
MW-16-04	-1 < 0.802603 < 1	--	--	--	N	Parametric	1.7

Notes:

2.14275 > 1 -1 < 0.537721 < 1 0.818 > 0.781314

Skewness Coefficient

Shapiro-Wilks 5%
Critical Value

Shapiro-Wilks 'W' Statistic

PQL = Practical Quantitation Limit
ug/L = micrograms per liter
mg/L = milligrams per liter
SU = standard units

Table 1

Summary of Descriptive Statistics and Prediction Limit Calculations
Background Statistical Evaluation
DTE Electric Company – St. Clair Power Plant

Monitoring Well	Skewness Test		Shapiro-Wilks Test (5% Critical Value)		Outliers Removed	Prediction Limit Test	Prediction Limit
	Un-Transformed Data	Natural Log Transformed Data	Un-Transformed Data	Natural Log Transformed Data			
pH, Field (SU)							
MW-16-01	-1 < -0.0866938 < 1	--	--	--	N	Parametric	7.2 - 8.6
MW-16-02	-1 < -0.453978 < 1	--	--	--	N	Parametric	7.5 - 8.3
MW-16-03	-1 < -0.315735 < 1	--	--	--	N	Parametric	7.3 - 8.5
MW-16-04	-1 < -0.117933 < 1	--	--	--	N	Parametric	7.3 - 8.4
Sulfate (mg/L)							
MW-16-01	-1 < 0.12556 < 1	--	--	--	N	Parametric	62
MW-16-02	>50% Non-Detect	--	--	--	N	Non-Parametric	25
MW-16-03	>50% Non-Detect	--	--	--	N	Non-Parametric	25
MW-16-04	100% Non-Detect	--	--	--	N	PQL	25
Total Dissolved Solids (mg/L)							
MW-16-01	-1 < 0.673575 < 1	--	--	--	N	Parametric	2,500
MW-16-02	-1 < 0.537037 < 1	--	--	--	N	Parametric	3,600
MW-16-03	-1 < 0.837178 < 1	--	--	--	N	Parametric	4,000
MW-16-04	1.77051 > 1	1.72336 > 1	0.829 > 0.685256	0.829 > 0.693725	N	Non-Parametric	4,400

Notes:

2.14275 > 1   -1 < 0.537721 < 1   0.818 > 0.781314

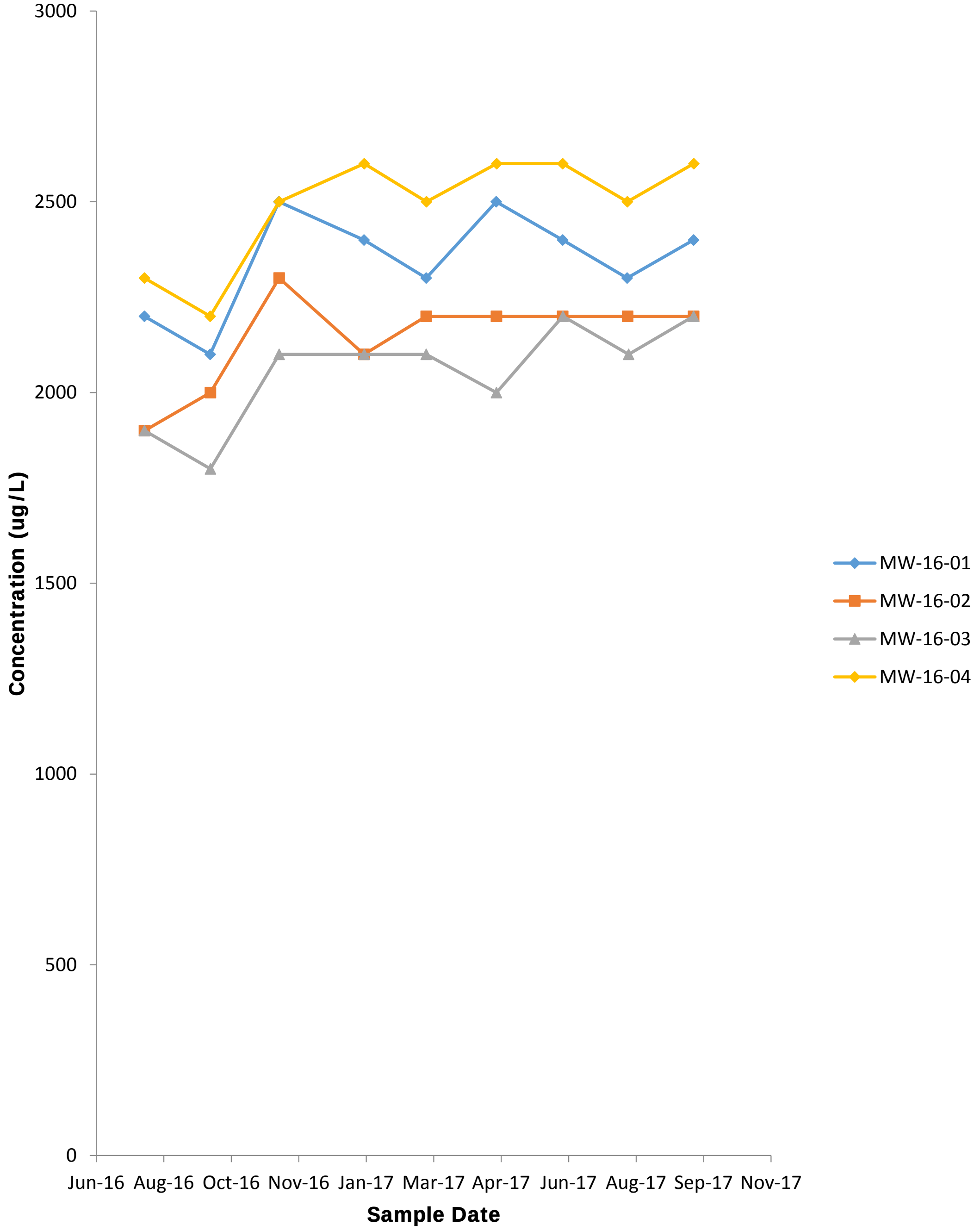
Skewness Coefficient   Shapiro-Wilks 5% Critical Value   Shapiro-Wilks 'W' Statistic

PQL = Practical Quantitation Limit
ug/L = micrograms per liter
mg/L = milligrams per liter
SU = standard units

Attachment A

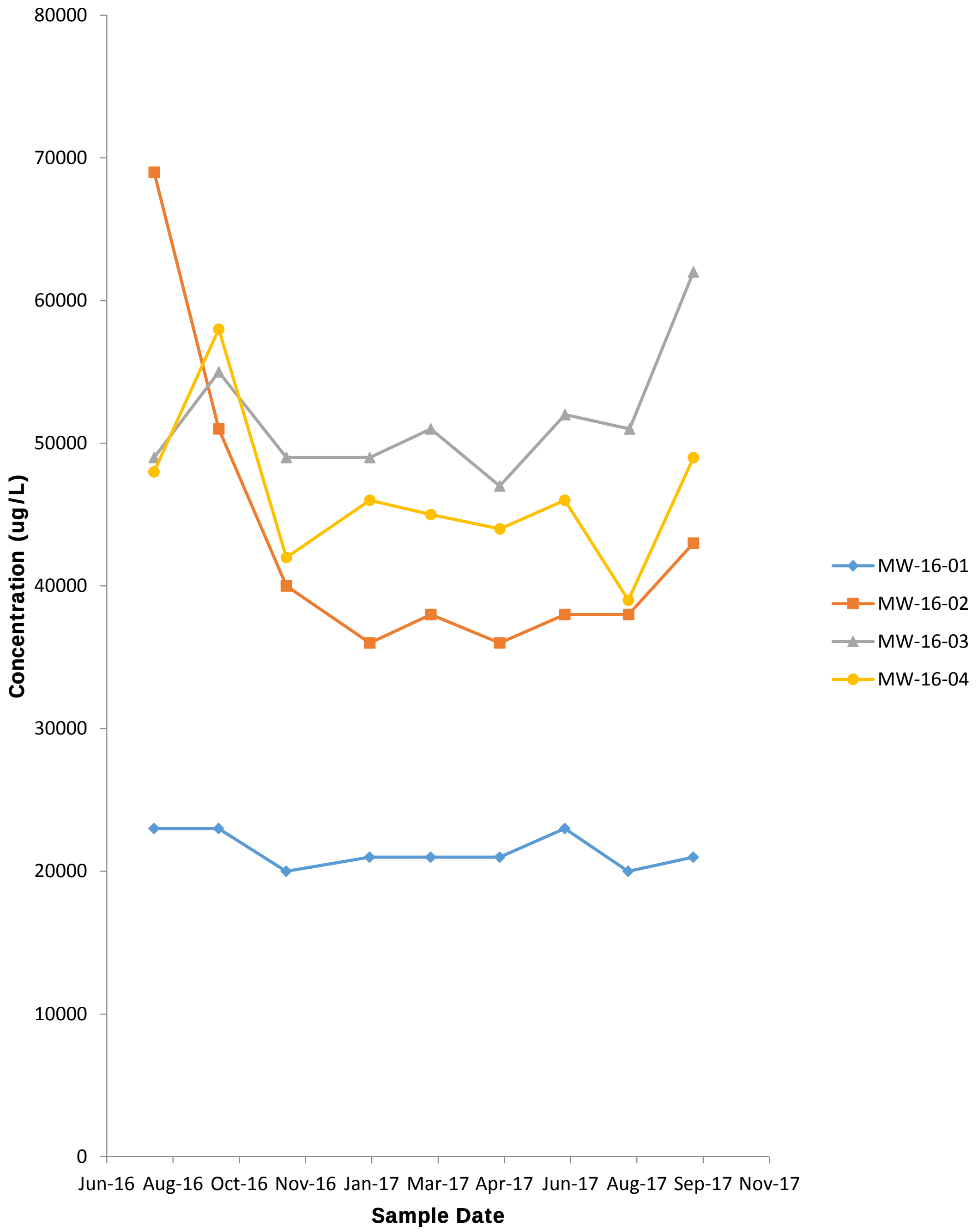
Background Concentration Time-Series Charts

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Boron



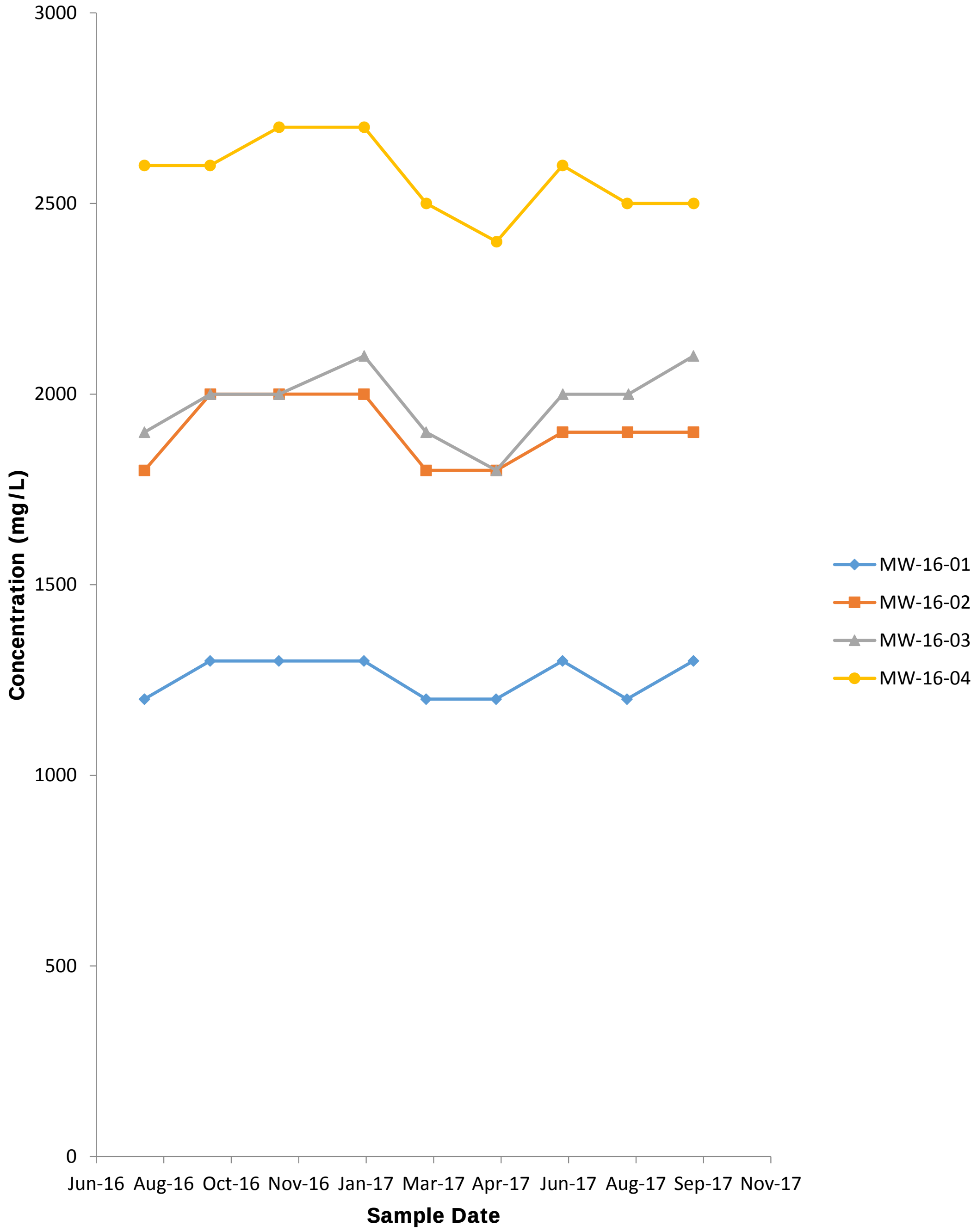
Open symbols denote non-detect concentrations.

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Calcium



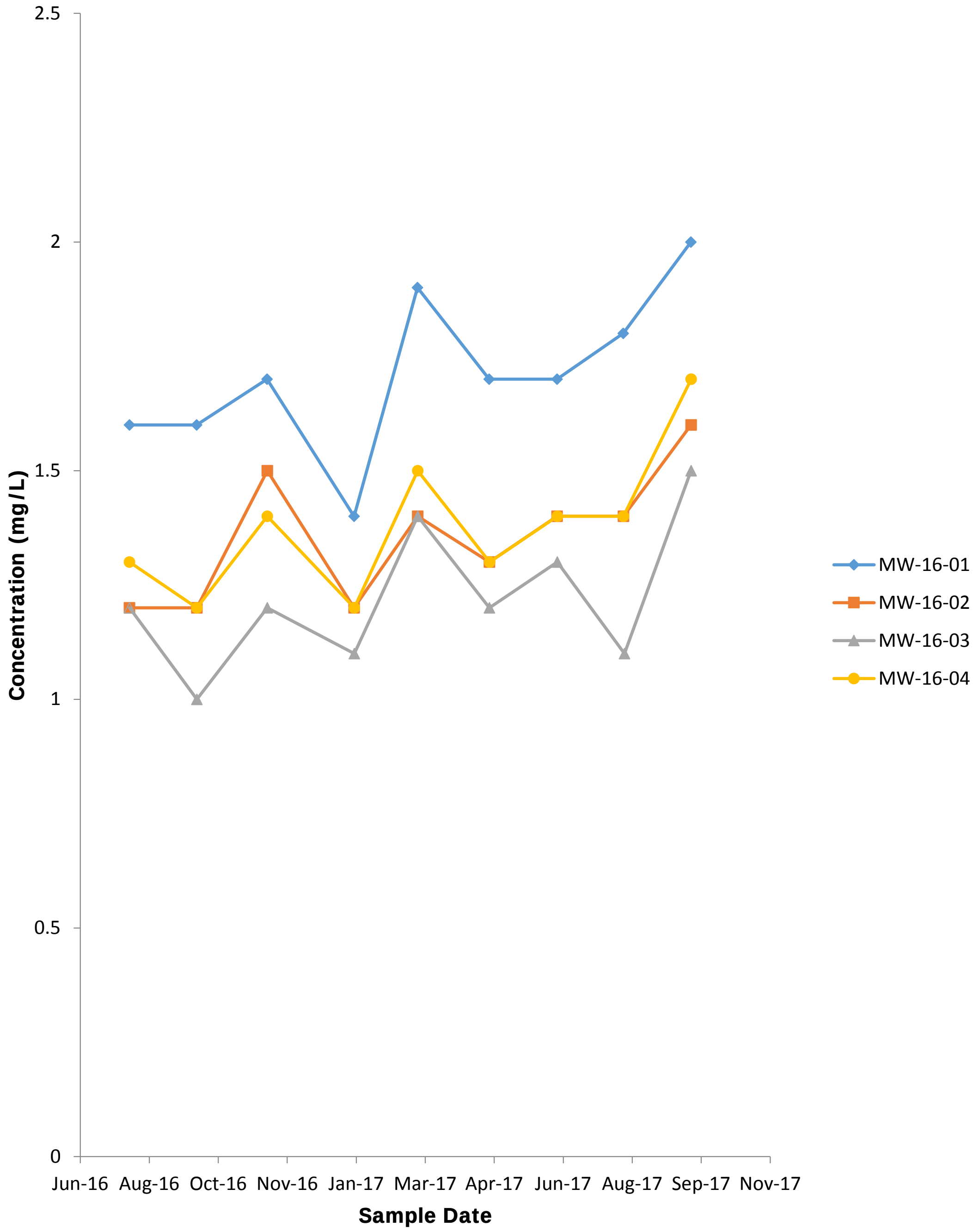
Open symbols denote non-detect concentrations.

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Chloride



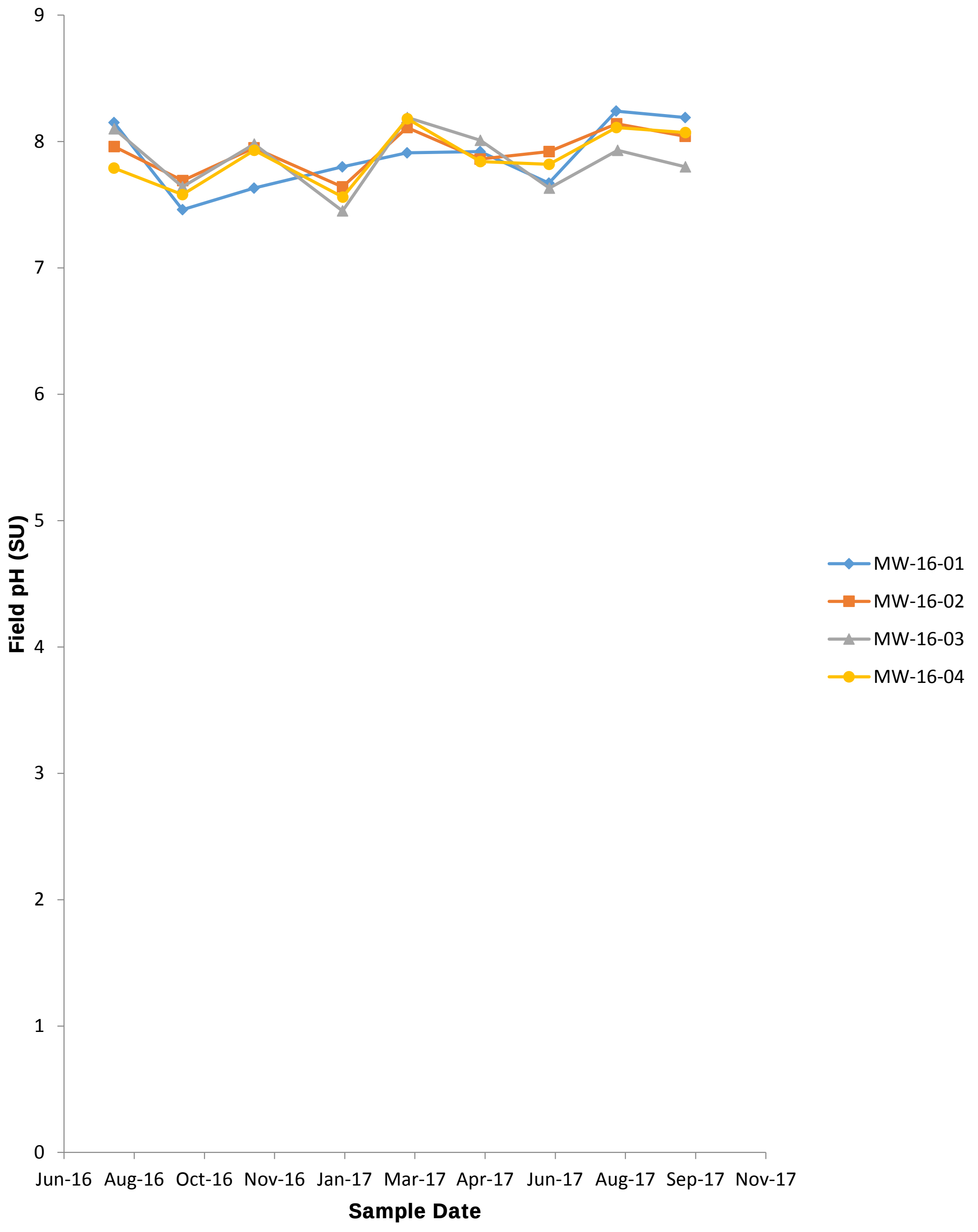
Open symbols denote non-detect concentrations.

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Fluoride

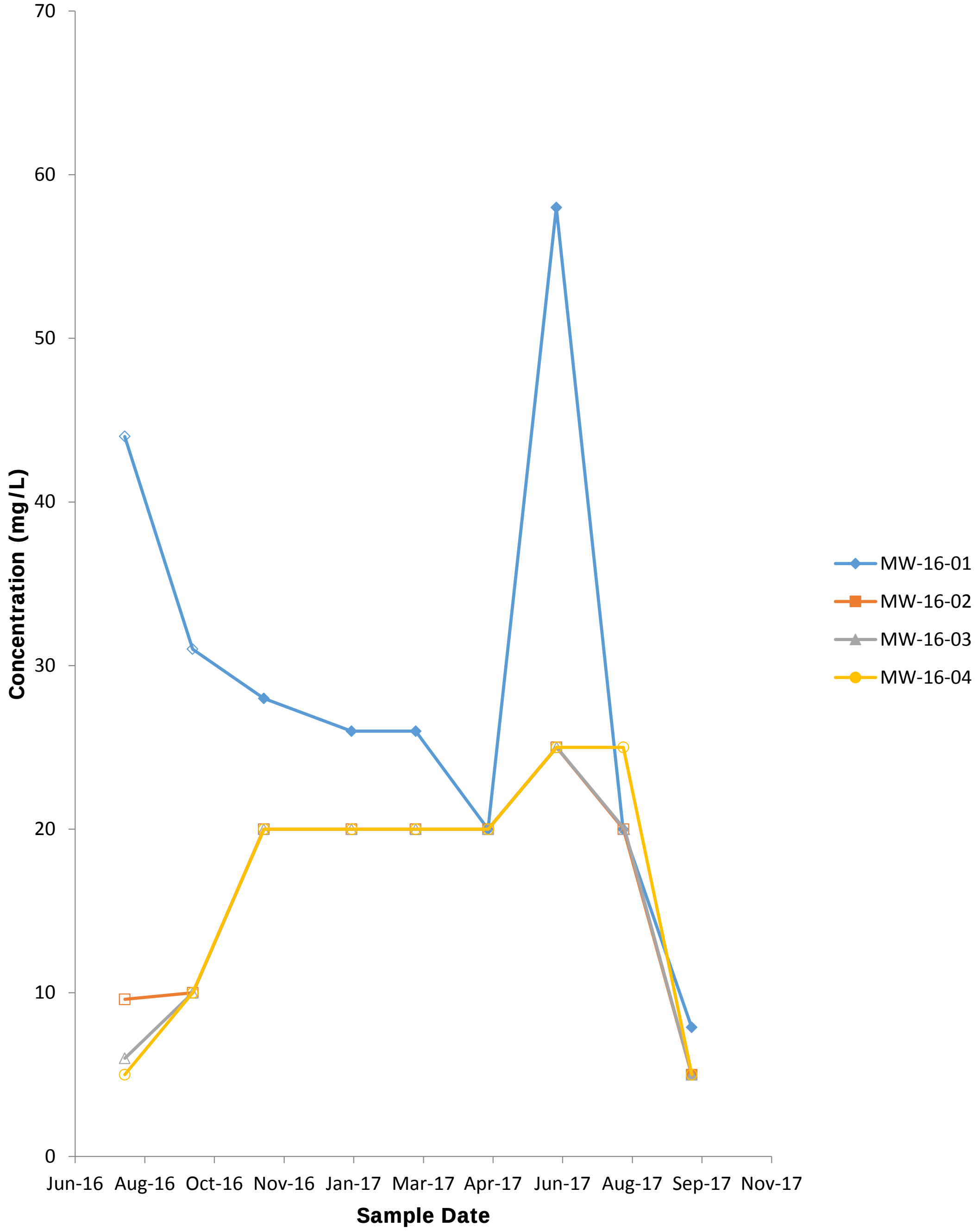


Open symbols denote non-detect concentrations.

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
pH, Field

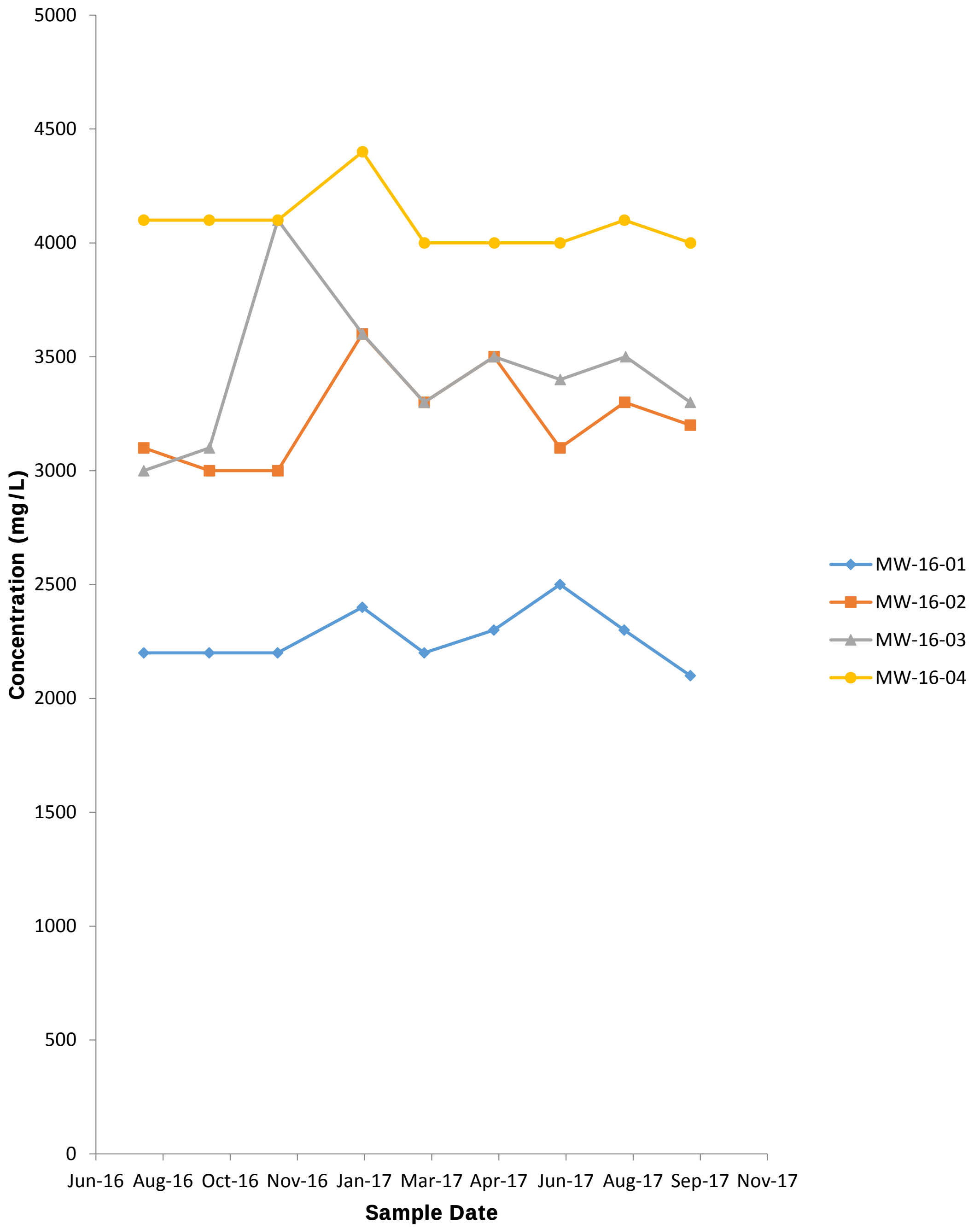


Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Sulfate



Open symbols denote non-detect concentrations.

Time-Series Plots
DTE Electric Company - St. Clair Power Plant
East China Township, Michigan
Total Dissolved Solids



Open symbols denote non-detect concentrations.

Attachment B

Probability Plots for MW-101 and MW-106 Outlier Evaluation

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: Boron
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	2200
	9/21/2016	2100
	11/11/2016	2500 B
	1/13/2017	2400
	2/28/2017	2300
	4/21/2017	2500
	6/9/2017	2400
	7/27/2017	2300
	9/14/2017	2400

From 9 baseline samples
Baseline mean = 2344.44
Baseline std Dev = 133.333

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2000	[0, 2605.8]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-02
Parameter: Boron
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1900
	9/21/2016	2000
	11/11/2016	2300 B
	1/13/2017	2100
	2/28/2017	2200
	4/21/2017	2200
	6/9/2017	2200
	7/27/2017	2200
	9/14/2017	2200

From 9 baseline samples
Baseline mean = 2144.44
Baseline std Dev = 123.603

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2000	[0, 2386.72]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03

Parameter: Boron

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1900
	9/21/2016	1800
	11/11/2016	2100 B
	1/13/2017	2100
	2/28/2017	2100
	4/21/2017	2000
	6/9/2017	2200
	7/28/2017	2100
	9/14/2017	2200

From 9 baseline samples
Baseline mean = 2055.56
Baseline std Dev = 133.333

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	1900	[0, 2316.91]	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-04

Parameter: Boron

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 0%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 2600
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	2300
	9/21/2016	2200
	11/11/2016	2500 B
	1/13/2017	2600
	2/28/2017	2500
	4/21/2017	2600
	6/9/2017	2600
	7/27/2017	2500
	9/14/2017	2600

Date	Count	Mean	Significant
10/6/2017	1	2100	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: Calcium
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	23000
	9/21/2016	23000
	11/11/2016	20000
	1/13/2017	21000
	2/28/2017	21000
	4/21/2017	21000
	6/9/2017	23000
	7/27/2017	20000
	9/14/2017	21000

From 9 baseline samples
Baseline mean = 21444.4
Baseline std Dev = 1236.03

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	19000	[0, 23867.2]	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-02

Parameter: Calcium

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 0%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 69000
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	69000
	9/21/2016	51000
	11/11/2016	40000
	1/13/2017	36000
	2/28/2017	38000
	4/21/2017	36000
	6/9/2017	38000
	7/27/2017	38000
	9/14/2017	43000

Date	Count	Mean	Significant
10/6/2017	1	40000	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03
Parameter: Calcium
Natural Logarithm Transformation
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	10.7996
	9/21/2016	10.9151
	11/11/2016	10.7996
	1/13/2017	10.7996
	2/28/2017	10.8396
	4/21/2017	10.7579
	6/9/2017	10.859
	7/28/2017	10.8396
	9/14/2017	11.0349

From 9 baseline samples
Baseline mean = 10.8494
Baseline std Dev = 0.082784

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	10.9331	[0, 11.0117]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-04

Parameter: Calcium

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	48000
	9/21/2016	58000
	11/11/2016	42000
	1/13/2017	46000
	2/28/2017	45000
	4/21/2017	44000
	6/9/2017	46000
	7/27/2017	39000
	9/14/2017	49000

From 9 baseline samples
Baseline mean = 46333.3
Baseline std Dev = 5315.07

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	38000	[0, 56751.6]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: Chloride
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1200
	9/21/2016	1300
	11/11/2016	1300
	1/13/2017	1300
	2/28/2017	1200
	4/21/2017	1200
	6/9/2017	1300
	7/27/2017	1200
	9/14/2017	1300

From 9 baseline samples
Baseline mean = 1255.56
Baseline std Dev = 52.7046

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	1200	[0, 1358.86]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-02
Parameter: Chloride
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1800
	9/21/2016	2000
	11/11/2016	2000
	1/13/2017	2000
	2/28/2017	1800
	4/21/2017	1800
	6/9/2017	1900
	7/27/2017	1900
	9/14/2017	1900

From 9 baseline samples
Baseline mean = 1900
Baseline std Dev = 86.6025

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	1900	[0, 2069.75]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03

Parameter: Chloride

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1900
	9/21/2016	2000
	11/11/2016	2000
	1/13/2017	2100
	2/28/2017	1900
	4/21/2017	1800
	6/9/2017	2000
	7/28/2017	2000
	9/14/2017	2100

From 9 baseline samples
Baseline mean = 1977.78
Baseline std Dev = 97.1825

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2100	[0, 2168.27]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-04

Parameter: Chloride

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	2600
	9/21/2016	2600
	11/11/2016	2700
	1/13/2017	2700
	2/28/2017	2500
	4/21/2017	2400
	6/9/2017	2600
	7/27/2017	2500
	9/14/2017	2500

From 9 baseline samples
Baseline mean = 2566.67
Baseline std Dev = 100

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2500	[0, 2762.68]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: Fluoride
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1.6
	9/21/2016	1.6
	11/11/2016	1.7
	1/13/2017	1.4
	2/28/2017	1.9
	4/21/2017	1.7
	6/9/2017	1.7
	7/27/2017	1.8
	9/14/2017	2

From 9 baseline samples
Baseline mean = 1.71111
Baseline std Dev = 0.176383

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2	[0, 2.05685]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-02

Parameter: Fluoride

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1.2
	9/21/2016	1.2
	11/11/2016	1.5
	1/13/2017	1.2
	2/28/2017	1.4
	4/21/2017	1.3
	6/9/2017	1.4
	7/27/2017	1.4
	9/14/2017	1.6

From 9 baseline samples
Baseline mean = 1.35556
Baseline std Dev = 0.1424

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	1.6	[0, 1.63468]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03

Parameter: Fluoride

Original Data (Not Transformed)

Non-Detects Replaced with 1/2 DL

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1.2
	9/21/2016	1
	11/11/2016	1.2
	1/13/2017	1.1
	2/28/2017	1.4
	4/21/2017	1.2
	6/9/2017	ND<0.65 U
	7/28/2017	1.1
	9/14/2017	1.5

From 9 baseline samples
Baseline mean = 1.15
Baseline std Dev = 0.242384

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	1.5	[0, 1.62511]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-04
Parameter: Fluoride
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	1.3
	9/21/2016	1.2
	11/11/2016	1.4
	1/13/2017	1.2
	2/28/2017	1.5
	4/21/2017	1.3
	6/9/2017	1.4
	7/27/2017	1.4
	9/14/2017	1.7

From 9 baseline samples
Baseline mean = 1.37778
Baseline std Dev = 0.156347

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	**1**	**1.7**	**[0, 1.68424]**	**TRUE**

Prediction limit (PL) is 1.7 mg/L with appropriate significant figures. Result from 10/6/17 is equal to, but does not exceed the final PL.

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: pH, Field
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% Two-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	8.15
	9/21/2016	7.46
	11/11/2016	7.63
	1/13/2017	7.8
	2/28/2017	7.91
	4/21/2017	7.92
	6/9/2017	7.67
	7/27/2017	8.24
	9/14/2017	8.19

From 9 baseline samples
Baseline mean = 7.88556
Baseline std Dev = 0.271621

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1)/2 = 97.5 %
t is Percentile of Student's T-Test (0.95/1/2) = 0.975
Degrees of Freedom = 9 (background observations) - 1
t(0.975, 9) = 2.30601

Date	Samples	Mean	Interval	Significant
10/6/2017	1	8.18	[7.23, 8.55]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-02
Parameter: pH, Field
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% Two-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	7.96
	9/21/2016	7.69
	11/11/2016	7.95
	1/13/2017	7.64
	2/28/2017	8.11
	4/21/2017	7.86
	6/9/2017	7.92
	7/27/2017	8.14
	9/14/2017	8.04

From 9 baseline samples
Baseline mean = 7.92333
Baseline std Dev = 0.171828

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1)/2 = 97.5 %
t is Percentile of Student's T-Test (0.95/1/2) = 0.975
Degrees of Freedom = 9 (background observations) - 1
t(0.975, 9) = 2.30601

Date	Samples	Mean	Interval	Significant
10/6/2017	1	8.05	[7.51, 8.34]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03

Parameter: pH, Field

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% Two-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	8.1
	9/21/2016	7.64
	11/11/2016	7.98
	1/13/2017	7.45
	2/28/2017	8.19
	4/21/2017	8.01
	6/9/2017	7.63
	7/28/2017	7.93
	9/14/2017	7.8

From 9 baseline samples
Baseline mean = 7.85889
Baseline std Dev = 0.245278

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1)/2 = 97.5 %
t is Percentile of Student's T-Test (0.95/1/2) = 0.975
Degrees of Freedom = 9 (background observations) - 1
t(0.975, 9) = 2.30601

Date	Samples	Mean	Interval	Significant
10/6/2017	1	7.85	[7.26, 8.46]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-04
Parameter: pH, Field
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% Two-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	7.79
	9/21/2016	7.58
	11/11/2016	7.93
	1/13/2017	7.56
	2/28/2017	8.18
	4/21/2017	7.84
	6/9/2017	7.82
	7/27/2017	8.11
	9/14/2017	8.07

From 9 baseline samples
Baseline mean = 7.87556
Baseline std Dev = 0.219949

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1)/2 = 97.5 %
t is Percentile of Student's T-Test (0.95/1/2) = 0.975
Degrees of Freedom = 9 (background observations) - 1
t(0.975, 9) = 2.30601

Date	Samples	Mean	Interval	Significant
10/6/2017	1	8.01	[7.34, 8.41]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01

Parameter: Sulfate

Original Data (Not Transformed)

Cohen's Adjustment

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	44
	9/21/2016	31
	11/11/2016	28
	1/13/2017	26
	2/28/2017	26
	4/21/2017	ND<20 U
	6/9/2017	58
	7/27/2017	ND<20 U
	9/14/2017	7.9

From 9 baseline samples
Baseline mean = 31.5571
Baseline std Dev = 15.7503

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	7.1	[0, 62.4299]	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-02
Parameter: Sulfate
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 88.8889%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 25
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	9.6
	9/21/2016	ND<10 U
	11/11/2016	ND<20 U
	1/13/2017	ND<20 U
	2/28/2017	ND<20 U
	4/21/2017	ND<20 U
	6/9/2017	ND<25 U
	7/27/2017	ND<20 U
	9/14/2017	ND<5 U

Date	Count	Mean	Significant
10/6/2017	1	2	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-03

Parameter: Sulfate

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 88.8889%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 25
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	6
	9/21/2016	ND<10 U
	11/11/2016	ND<20 U
	1/13/2017	ND<20 U
	2/28/2017	ND<20 U
	4/21/2017	ND<20 U
	6/9/2017	ND<25 U
	7/28/2017	ND<20 U
	9/14/2017	ND<5 U

Date	Count	Mean	Significant
10/6/2017	1	2	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-04

Parameter: Sulfate

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 100%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 25
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	ND<5 U
	9/21/2016	ND<10 U
	11/11/2016	ND<20 U
	1/13/2017	ND<20 U
	2/28/2017	ND<20 U
	4/21/2017	ND<20 U
	6/9/2017	ND<25 U
	7/27/2017	ND<25 U
	9/14/2017	ND<5 U

Date	Count	Mean	Significant
10/6/2017	1	5	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-01
Parameter: Total Dissolved Solids
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	2200
	9/21/2016	2200
	11/11/2016	2200
	1/13/2017	2400
	2/28/2017	2200
	4/21/2017	2300
	6/9/2017	2500
	7/27/2017	2300
	9/14/2017	2100

From 9 baseline samples
Baseline mean = 2266.67
Baseline std Dev = 122.474

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2000	[0, 2506.73]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-02
Parameter: Total Dissolved Solids
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	3100
	9/21/2016	3000
	11/11/2016	3000
	1/13/2017	3600
	2/28/2017	3300
	4/21/2017	3500
	6/9/2017	3100
	7/27/2017	3300
	9/14/2017	3200

From 9 baseline samples
Baseline mean = 3233.33
Baseline std Dev = 212.132

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	2700	[0, 3649.14]	FALSE

Parametric Prediction Interval Analysis

Intra-Well Comparison for MW-16-03
Parameter: Total Dissolved Solids
Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Intra-Well Unified Guid. Formula 95% One-Sided Comparison

Baseline Samples	Date	Result
	8/3/2016	3000
	9/21/2016	3100
	11/11/2016	4100
	1/13/2017	3600
	2/28/2017	3300
	4/21/2017	3500
	6/9/2017	3400
	7/28/2017	3500
	9/14/2017	3300

From 9 baseline samples
Baseline mean = 3422.22
Baseline std Dev = 319.287

For 1 recent sampling event(s)
Actual confidence level is 1.0 - (0.05/1) = 95 %
t is Percentile of Student's T-Test (0.95/1) = 0.95
Degrees of Freedom = 9 (background observations) - 1
t(0.95, 9) = 1.85955

Date	Samples	Mean	Interval	Significant
10/6/2017	1	3200	[0, 4048.07]	FALSE

Non-Parametric Prediction Interval

Intra-Well Comparison for MW-16-04

Parameter: Total Dissolved Solids

Original Data (Not Transformed)

Non-Detects Replaced with Detection Limit

Total Percent Non-Detects = 0%
Future Samples (k) = 1
Recent Dates = 1
Baseline Measurements (n) = 9
Maximum Baseline Concentration = 4400
Confidence Level = 90%
False Positive Rate = 10%

Baseline Measurements	Date	Value
	8/3/2016	4100
	9/21/2016	4100
	11/11/2016	4100
	1/13/2017	4400
	2/28/2017	4000
	4/21/2017	4000
	6/9/2017	4000
	7/27/2017	4100
	9/14/2017	4000

Date	Count	Mean	Significant
10/6/2017	1	3600	FALSE

2018 Annual Groundwater Monitoring Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
4901 Pointe Drive
East China Township, Michigan

January 2019

2018 Annual Groundwater Monitoring Report

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4901 Pointe Drive
East China Township, Michigan

January 2019

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Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) CCR unit. Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for the calendar year 2018 activities at the SCPP BABs CCR Unit.

In the January 31, 2018 *Annual Groundwater Monitoring Report for the St. Clair Power Plant Bottom Ash Basins CCR Unit,* covering calendar year 2017 activities, DTE Electric reported no concentrations over the background limits for any of the Appendix III indicator parameters. Therefore, DTE Electric continued detection monitoring at the SCPP BABs CCR unit. The semiannual detection monitoring events for 2018 were completed in April and October 2018 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed background levels. Detection monitoring data that has been collected and evaluated in 2018 are presented in this report.

No SSIs were recorded for the 2018 monitoring period and detection monitoring will be continued at the SCPP BABs CCR unit in accordance with §257.94. In addition, based on the hydrogeology at the Site, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the SCPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from operations. Due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer.

Section 1
Introduction

1.1 Program Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs). Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2018 activities at the SCPP BABs CCR unit (2018 Annual Report).

In the January 31, 2018 *Annual Groundwater Monitoring Report for the St. Clair Power Plant Bottom Ash Basins CCR Unit,* covering calendar year 2017 (2017 Annual Report), DTE Electric reported no concentrations over the background limits for any of the Appendix III indicator parameters. Therefore, DTE Electric continued detection monitoring at the SCPP BABs CCR unit. The semiannual detection monitoring events for 2018 were completed in April and October 2018 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule.

This 2018 Annual Report presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the April and October 2018 semiannual groundwater monitoring events for the SCPP BABs CCR unit. Detection monitoring for these events continued to be performed in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins* (QAPP) (TRC, July 2016; revised August 2017) and statistically evaluated per the *Groundwater Statistical Evaluation Plan – St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins* (Stats Plan) (TRC, October 2017). As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) of detection monitoring parameters compared to background levels.

1.2 Site Overview

The SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan. The SCPP including the BABs CCR unit was constructed in the early 1950s, just south of the DTE Electric SCPP main building. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River.

The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953 and is constructed over a natural continuous clay-rich soil base as shown in historical soil borings performed at the SCPP property. The BABs have been in operation at the SCPP since the plant began operation and have collected CCR bottom ash that is routinely cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments. The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (ft bgs) into the native clay-rich soil. The BABs are located south of the SCPP and adjacent to the St. Clair River and are used for receiving bottom ash and other process flow water from the power plant, which is first sent to the East BAB then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.3 Geology/Hydrogeology

The SCPP BABs CCR unit is located immediately adjacent to the west edge of the St. Clair River. The SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock lower confining unit is generally encountered at depths greater than 130 ft bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above was present beneath at least 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer. The first underlying saturated zone (the potential uppermost aquifer) that would presumably become affected with CCR constituents is located at the silty clay hardpan/shale bedrock interface (130.5 to 132 ft bgs) and is limited to no more than 4 feet thick.

A definitive groundwater flow direction to the east-southeast with a mean gradient of 0.0034 foot/foot (2016 to 2018) within the uppermost aquifer is evident around the SCPP CCR BABs CCR unit, however potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

In addition, the elevation of CCR-affected water maintained within the SCPP BABs is very similar to the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR affected surface water in the BABs were able to penetrate the silty clay-rich underlying confining unit, the head on that release likely would travel radially away from the BABs within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the SCPP, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s.

Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, the radial flow potential outward from the CCR unit, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the SCPP BABs CCR unit using intrawell statistical methods is appropriate. As such, an intrawell statistical approach is being used during detection monitoring as discussed in the Stats Plan.

Section 2
Groundwater Monitoring

2.1 Monitoring Well Network

A groundwater monitoring system has been established for the SCPP BABs CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2.

As discussed in the Stats Plan, intrawell statistical methods for the BABs CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the relatively small footprint of the BABs, and the low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). An intrawell statistical approach requires that each of the downgradient wells doubles as a background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background dataset from that same well. Monitoring wells MW-16-01 through MW-16-04 are located around the east and west perimeter of the BABs and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of four background/downgradient monitoring wells).

2.2 Semiannual Groundwater Monitoring

The semiannual monitoring parameters for the detection groundwater monitoring program were selected per the CCR Rule's Appendix III to Part 257 – Constituents for Detection Monitoring. The Appendix III indicator parameters consist of boron, calcium, chloride, fluoride, pH (field reading), sulfate, and total dissolved solids (TDS) and were analyzed in accordance with the sampling and analysis plan included within the QAPP. In addition to pH, the collected field parameters included dissolved oxygen, oxidation reduction potential, specific conductivity, temperature, and turbidity.

2.2.1 Data Summary

The first semiannual groundwater monitoring event for 2018 was performed during April 12 to April 14, 2018 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all four monitoring well locations. Groundwater samples were collected from the four detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the April 2018 event is provided in Table 1 (static groundwater elevation data), Table 2 (field data), and Table 3 (analytical results).

The second semiannual groundwater monitoring event for 2018 was performed during October 4 and October 5, 2018 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all four monitoring well locations. Groundwater samples were collected from the four detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the October 2018 event is provided in Table 1 (static groundwater elevation data), Table 2 (field data), and Table 4 (analytical results).

2.2.2 Data Quality Review

Data from each round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The data were found to be complete and usable for the purposes of the CCR monitoring program. Data quality reviews are summarized in Appendix A.

2.2.3 Groundwater Flow Rate and Direction

Groundwater elevation data collected during the April and October 2018 sampling events show that groundwater within the uppermost aquifer generally flows to the east-southeast across the SCPP BABs CCR unit. Groundwater potentiometric surface elevations measured across the SCPP BABs during the April and October 2018 sampling events are provided in Table 1 and were used to construct the groundwater potentiometric surface maps shown on Figure 3 and Figure 4, respectively. The groundwater flow rate and direction is consistent with previous monitoring events. The average hydraulic gradient throughout the SCPP BABs during both 2018 monitoring events is estimated at 0.003 ft/ft with an estimated average seepage velocity of approximately 0.0009 ft/day or 0.033 ft/year (approximately 0.4 inches/year), using the average hydraulic conductivity of 0.2 ft/day (TRC, 2017) and an assumed effective porosity of 0.4.

As presented in the GWMS Report, there is a horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the SCPP BABs CCR unit. The general flow rate and direction in the uppermost aquifer from both events are similar to that identified in previous monitoring rounds and continues to demonstrate that groundwater flows at a low rate and the compliance wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the SCPP BABs CCR unit.

Section 3
Statistical Evaluation

3.1 Establishing Background Limits

Per the Stats Plan, background limits were established for the Appendix III indicator parameters following the collection of at least eight background monitoring events using data collected from each of the four established detection monitoring wells (MW-16-01 through MW-16-04). The statistical evaluation of the background data is presented in the 2017 Annual Report. The Appendix III background limits for each monitoring well will be used throughout the detection monitoring period to determine whether groundwater has been impacted from the SCPP BABs CCR unit by comparing concentrations in the detection monitoring wells to their respective background limits for each Appendix III indicator parameter.

3.2 Data Comparison to Background Limits – First Semiannual Event (April 2018)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth).

The statistical evaluation of the April 2018 Appendix III indicator parameters shows that there were no concentrations above background limits for any Appendix III indicator parameter. The comparisons of the April 2018 data to background limits are presented on Table 3.

3.3 Data Comparison to Background Limits – Second Semiannual Event (October 2018)

The data comparisons of the October 2018 data to background limits are presented on Table 4. Based on the statistical evaluation of the October 2018 Appendix III indicator parameters the following resample was collected in accordance with the Stats Plan:

- Boron at MW-16-04

Verification resampling is recommended per the Stats Plan and the *USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009) (Unified Guidance), to achieve performance standards as specified by §257.93(g) in the CCR Rule. Per the Stats Plan, if there is an exceedance of a prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Constituents that are addressed by an alternate source demonstration (ASD) will not be analyzed for verification purposes.

3.4 Verification Resampling for the Second Semiannual Event

Verification resampling for the October 2018 event was conducted on January 8, 2019 by TRC personnel in accordance with the QAPP. A summary of the analytical results collected during the January 2019 resampling event is provided in Table 4. The associated data quality review is included in Appendix B.

The verification results for boron are below the prediction limit and no SSI exists for the October 2018 event in accordance with the Stats Plan and the Unified Guidance.

Section 4
Conclusions and Recommendations

No SSIs were recorded for the 2018 monitoring period and detection monitoring will be continued at the MONPP FAB CCR unit in accordance with §257.94. As discussed above, and in the GWMS Report, with the very thick continuous silty clay-rich confining unit beneath the SCPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations. Due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer.

No corrective actions were performed in 2018. The next semiannual monitoring event is scheduled for the second calendar quarter of 2019.

Section 5
Groundwater Monitoring Report Certification

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.90(e) requires that the owner or operator of an existing CCR unit prepare an annual groundwater monitoring and corrective action report.

Annual Groundwater Monitoring Report Certification
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

CERTIFICATION

I hereby certify that the annual groundwater and corrective action report presented within this document for the SCPP BABs CCR unit has been prepared to meet the requirements of Title 40 CFR §257.90(e) of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.90(e).

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2019	David B. McKenzie Engineer No. 42332 Stamp
Company: TRC Engineers Michigan, Inc.	Date: January 31, 2019	

Section 6
References

TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. January 2018. Annual Groundwater Monitoring Report – DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA facilities, Unified Guidance. Office of Conservation and Recovery. EPA 530/R-09-007.

USEPA. April 2015. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 80 Federal Register 74 (April 17, 2015), pp. 21301-21501 (80 FR 21301).

USEPA. July 2018. 40 CFR Part 257. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One); Final Rule. 83 Federal Register 146 (July 30, 2018), pp. 36435-36456 (83 FR 36435).

USEPA. April 2018. Barnes Johnson (Office of Resource Conservation and Recovery) to James Roewer (c/o Edison Electric Institute) and Douglas Green, Margaret Fawal (Venable LLP). Re: Coal Combustion Residuals Rule Groundwater Monitoring Requirements. April 30, 2018. United States Environmental Protection Agency, Washington, D.C. 20460. Office of Solid Waste and Emergency Response, now the Office of Land and Emergency Management.

Tables

Table 1
Summary of Groundwater Elevation Data – April & October 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Well ID	MP-01		MW-16-01		MW-16-02		MW-16-03		MW-16-04	
Date Installed	3/23/2016		3/31/2016		3/29/2016		3/25/2016		3/23/2016	
TOC Elevation	580.84$^{(1)}$		584.74		581.43		581.39		580.95	
Geologic Unit of Screened Interval	NA		Silty Clay Shale Interface		Silty Clay Shale Interface		Silty Clay/Hardpan Shale Interface		Silty Clay/Hardpan Shale Interface	
Screened Interval Elevation	NA		458.1 to 453.1		456.2 to 451.2		455.1 to 450.1		455.0 to 450.0	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
4/12/2018	4.10	576.74	3.20	581.54	1.20	580.23	2.03	579.36	1.02	579.93
10/04/2018	3.72	577.11	3.39	581.35	1.72	579.71	1.41	579.98	1.39	579.56

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing

NA - not applicable

1) Elevation represents the point of reference used to collect surface water level measurements.

Table 2

Summary of Field Data – April & October 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-01	4/13/2018	2.58	111.2	7.9	3,197	11.50	22.6
	10/5/2018	0.21	-182.0	8.3	3,825	13.35	7.57
MW-16-02	4/13/2018	2.03	100.4	8.0	4,612	11.91	37.4
	10/5/2018	0.10	-194.6	8.1	5,468	15.07	9.85
MW-16-03	4/13/2018	2.88	75.1	7.7	5,031	12.55	123
	10/5/2018	0.15	-185.3	8.0	5,902	14.23	41.1
MW-16-04	4/13/2018	2.46	82.6	7.7	5,631	9.69	994
	10/5/2018	0.06	-196.0	8.1	7,069	14.52	85.0

Notes:

mg/L - milligrams per liter.

mV - milliVolt.

SU - standard unit.

umhos/cm - micro-mhos per centimeter.

deg C - degrees celcius.

NTU - nephelometric turbidity units.

Table 3

Comparison of Appendix III Parameter Results to Background Limits – April 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		MW-16-01		MW-16-02		MW-16-03		MW-16-04	
Sample Date:		4/13/2018	PL	4/13/2018	PL	4/13/2018	PL	4/13/2018	PL
Constituent	Unit	Data		Data		Data		Data	
Appendix III									
Boron	ug/L	2,100	2,600	2,000	2,400	2,100	2,300	2,400	2,600
Calcium	ug/L	19,000	24,000	39,000	69,000	61,000	61,000	56,000	57,000
Chloride	mg/L	1,300	1,400	2,000	2,100	2,100	2,200	2,500	2,800
Fluoride	mg/L	2.1	2.1	1.6	1.6	1.5	1.6	1.7	1.7
pH, Field	SU	7.9	7.2 - 8.6	8.0	7.5 - 8.3	7.7	7.3 - 8.5	7.7	7.3 - 8.4
Sulfate	mg/L	3.4	62	<2.0	25	<2.0	25	<2.0	25
Total Dissolved Solids	mg/L	2,200	2,500	3,200	3,600	3,400	4,000	4,000	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

🟩 **RESULT**	Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

Table 4

Comparison of Appendix III Parameter Results to Background Limits – October 2018
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**		
Sample Date:		10/5/2018	PL	10/5/2018	PL	10/5/2018	PL	10/5/2018	1/8/2019$^{(1)}$	PL
Constituent	Unit	Data		Data		Data		Data	Data	
Appendix III										
Boron	ug/L	2,400	2,600	2,200	2,400	2,200	2,300	**2,700**	2,400	2,600
Calcium	ug/L	20,000	24,000	38,000	69,000	54,000	61,000	46,000	--	57,000
Chloride	mg/L	1,300	1,400	2,000	2,100	2,100	2,200	2,600	--	2,800
Fluoride	mg/L	1.9	2.1	1.5	1.6	1.4	1.6	1.6	--	1.7
pH, Field	SU	8.3	7.2 - 8.6	8.1	7.5 - 8.3	8.0	7.3 - 8.5	8.1	--	7.3 - 8.4
Sulfate	mg/L	2.9	62	< 1.0	25	< 2.0	25	< 2.0	--	25
Total Dissolved Solids	mg/L	2,000	2,500	2,300	3,600	3,200	4,000	3,700	--	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

-- = not analyzed

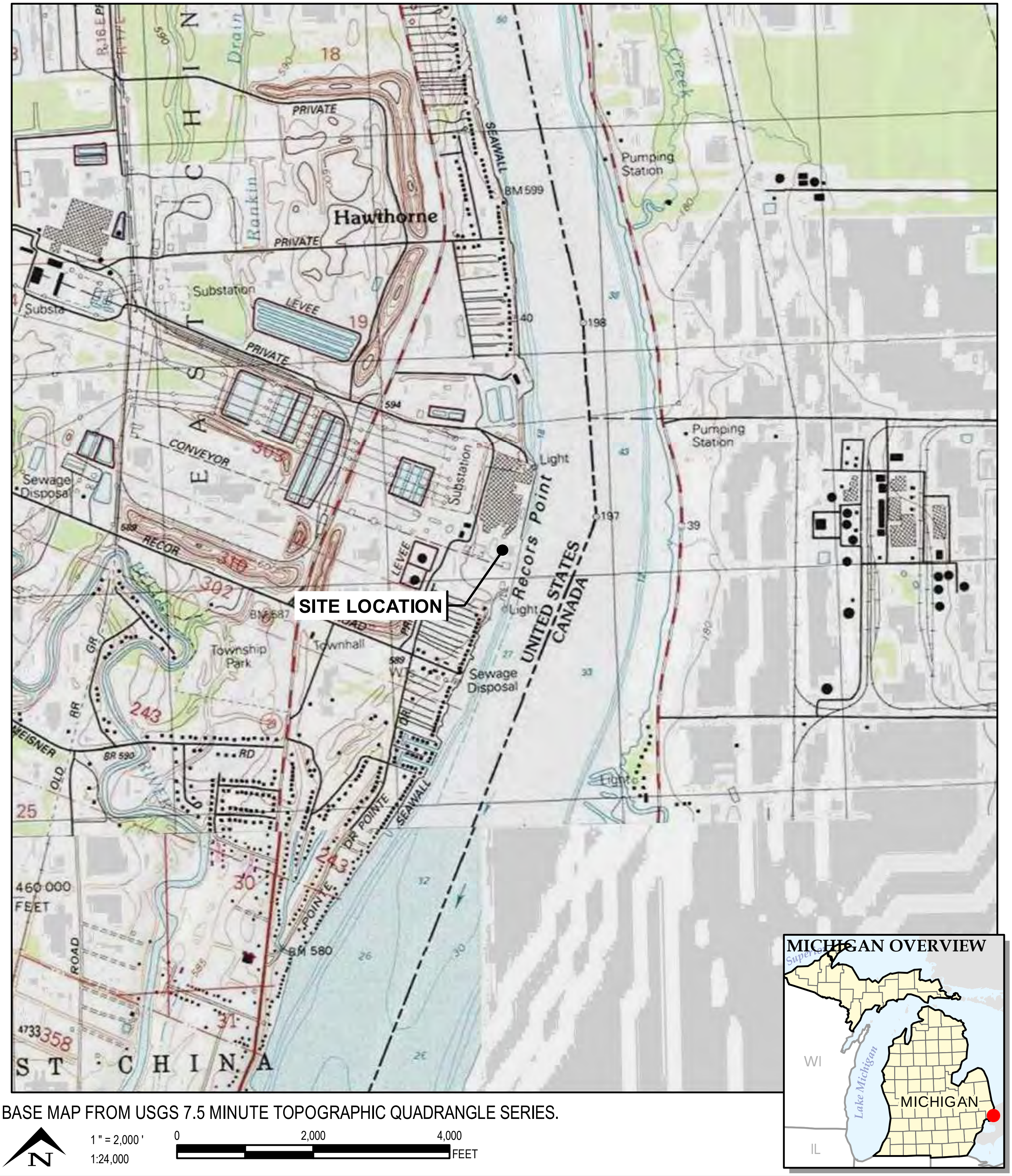
All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

(1) Results shown for verification sampling performed on 1/8/2019.

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080

TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	J. PAPEZ
CHECKED BY:	S HOLMSTROM
APPROVED BY:	V. BUENING
DATE:	OCTOBER 2017
PROJ. NO.:	265996.0004
FILE:	265996-SLMMB.mxd

FIGURE 1

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LEGEND

✦	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	S. MAJOR	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	FIGURE 2	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2019		

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

FILE NO.: 265996-0004-013.mxd

Plot Date: 1/2/2019, 09:27:35 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-013.mxd

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

LEGEND

✛ MONITORING WELLS

⊟ SURFACE WATER MEASURING POINT

(579.85) GROUNDWATER ELEVATION (FT NAVD88)

∼ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

0 100 200
Feet
1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP
APRIL 2018

DRAWN BY:	S. MAJOR	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 3**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2019		

TRC

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Ann Arbor, MI 48108-3284
Phone: 734.971.7080
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FILE NO.: 265996-0004-014.mxd

Plot Date: 1/2/2019, 09:25:39 AM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-014.mxd

LEGEND

⌖	MONITORING WELLS
⊟	SURFACE WATER MEASURING POINT
(579.85)	GROUNDWATER ELEVATION (FT NAVD88)
∿	GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC
SURFACE MAP
OCTOBER 2018

DRAWN BY:	S. MAJOR	PROJ NO.:	265996.0004
CHECKED BY:	C. SCIESZKA	**FIGURE 4**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2019		

TRC

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Phone: 734.971.7080
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FILE NO.: 265996-0004-015.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/28/2019, 15:08:14 PM by SMAJOR -- LAYOUT: ANSI B(11"x17")
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Appendix A
Data Quality Reviews

Laboratory Data Quality Review
Groundwater Monitoring Event April 2018
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the April 2018 sampling event. Samples were analyzed for anions, total metals, and total dissolved solids by Test America Laboratories, Inc. (Test America), located in Canton, Ohio. The laboratory analytical results are reported in laboratory report J94114-1.

During the April 2018 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	EPA 9056A
Total Metals	EPA 6010B, 6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and

- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Sample EB-01_20180413 was not reported on the chain of custody. The laboratory reported the sample ID and sample collection time that were provided on the sample container labels. Data usability is not affected.
- Target analytes were not detected in the method blank. Boron and total dissolved solids were detected in the equipment blank (EB-01_20180413). Boron and total dissolved solids concentrations for project samples were >10x the boron and total dissolved solids concentrations in the equipment blank sample. Data usability is not affected by the equipment blank detections.
- LCS recoveries for all target analytes were within laboratory control limits.
- Dup-01 corresponds with MW-16-03; relative percent differences (RPDs) between the parent and duplicate sample were within the QC limits.

Laboratory Data Quality Review
Groundwater Monitoring Event October 2018
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the October 2018 sampling event. Samples were analyzed for anions, total metals, and total dissolved solids by Test America Laboratories, Inc. (Test America), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-102513-1.

During the October 2018 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;

- Data for matrix spike and matrix spike duplicate samples (MS.MSDs). The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Target analytes were not detected in the equipment blank (EB-01_20181004).

- Target analytes were not detected in the method blank.

- LCS recoveries for all target analytes were within laboratory control limits.

- MS/MSD were performed on sample MW-16-01 for boron and on sample MW-16-02 for calcium.

- Dup-01 corresponds with MW-16-01; relative percent differences (RPDs) between the parent and duplicate sample were within the QC limits.

- The reporting limit (2.0 mg/L) for the nondetect results, which were only sulfate in samples MW-16-03 and MW-16-04, was above the QAPP-specified RL (1.0 mg/L) due to 2-fold dilution as a result of a difficult matrix

Laboratory Data Quality Review
Groundwater Monitoring Event January 2019 (Verification Resampling)
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the January 2019 verification resampling event. Samples were analyzed for boron by Test America Laboratories, Inc. (Test America), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-106658-1.

During the January 2019 sampling event, a groundwater sample was collected from well MW-16-04.

The sample was analyzed for the following constituent:

Analyte Group	Method
Total Boron	SW846 3005A/6010B

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS.MSDs). The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- The reviewed Appendix III constituent will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Boron was not detected in the equipment blank (EB-01_20190107).

- Boron was not detected in the method blank.

- The LCS recovery for boron was within laboratory control limits.

- MS/MSDs and laboratory duplicates were not performed on any samples in this data set.

- Dup-01 corresponds with MW-16-04; the relative percent difference (RPD) between the parent and duplicate sample were within the QC limits.

2019 Annual Groundwater Monitoring Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins

4901 Pointe Drive
East China Township, Michigan

January 2020

2019 Annual Groundwater Monitoring Report

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins

4901 Pointe Drive
East China Township, Michigan

January 2020

Prepared For
DTE Electric Company

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TRC | DTE Electric Company
Final
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Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs) CCR unit. Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for the calendar year 2019 activities at the SCPP BABs CCR Unit.

In the January 31, 2019 *Annual Groundwater Monitoring Report for the St. Clair Power Plant Bottom Ash Basins CCR Unit,* covering calendar year 2018 activities, DTE Electric reported no concentrations over the background limits for any of the Appendix III indicator parameters. Therefore, DTE Electric continued detection monitoring at the SCPP BABs CCR unit in 2019 in accordance with §257.94. The semiannual detection monitoring events for 2019 were completed in March and September 2019 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed background levels. Detection monitoring data that has been collected and evaluated in 2019 are presented in this report.

No SSIs were recorded for the 2019 monitoring period and detection monitoring will be continued at the SCPP BABs CCR unit in accordance with §257.94. In addition, based on the hydrogeology at the Site, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the SCPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from operations. Due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer.

Section 1
Introduction

1.1 Program Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) St. Clair Power Plant (SCPP) Bottom Ash Basins (BABs). Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2019 activities at the SCPP BABs CCR unit (2019 Annual Report).

In the January 31, 2019 *Annual Groundwater Monitoring Report for the St. Clair Power Plant Bottom Ash Basins CCR Unit,* covering calendar year 2018 (2018 Annual Report), DTE Electric reported no concentrations over the background limits for any of the Appendix III indicator parameters. Therefore, DTE Electric continued detection monitoring at the SCPP BABs CCR unit. The semiannual detection monitoring events for 2019 were completed in March and September 2019 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule.

This 2019 Annual Report presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the March and September 2019 semiannual groundwater monitoring events for the SCPP BABs CCR unit. Detection monitoring for these events continued to be performed in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins* (QAPP) (TRC, July 2016; revised August 2017) and statistically evaluated per the *Groundwater Statistical Evaluation Plan – St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins* (Stats Plan) (TRC, October 2017). As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify statistically significant increases (SSIs) of detection monitoring parameters compared to background levels.

1.2 Site Overview

The SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan. The SCPP including the BABs CCR unit was constructed in the early 1950s, just south of the DTE Electric SCPP main building. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River.

The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953 and is constructed over a natural continuous clay-rich soil base as shown in historical soil borings performed at the SCPP property. The BABs have been in operation at the SCPP since the plant began operation and have collected CCR bottom ash that is routinely cleaned out and either sold for beneficial reuse or disposed of at the Range Road Landfill (RRLF).

The SCPP BABs are two adjacent sedimentation basins that are incised CCR surface impoundments. The impoundments are sheet piled around the perimeters to approximately 13 feet below ground surface (ft bgs) into the native clay-rich soil. The BABs are located south of the SCPP and adjacent to the St. Clair River and are used for receiving bottom ash and other process flow water from the power plant, which is first sent to the East BAB then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.3 Geology/Hydrogeology

The SCPP BABs CCR unit is located immediately adjacent to the west edge of the St. Clair River. The SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock lower confining unit is generally encountered at depths greater than 130 ft bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above was present beneath at least 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer. The first underlying saturated zone (the potential uppermost aquifer) that would presumably become affected with CCR constituents is located at the silty clay hardpan/shale bedrock interface (130.5 to 132 ft bgs) and is limited to no more than 4 feet thick.

A definitive groundwater flow direction to the east-southeast with a mean gradient of 0.0034 foot/foot (2016 to 2018) within the uppermost aquifer is evident around the SCPP CCR BABs CCR unit, however potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

In addition, the elevation of CCR-affected water maintained within the SCPP BABs is very similar to the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR affected surface water in the BABs were able to penetrate the silty clay-rich underlying confining unit, the head on that release likely would travel radially away from the BABs within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the SCPP, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s.

Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, the radial flow potential outward from the CCR unit, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the SCPP BABs CCR unit using intrawell statistical methods is appropriate. As such, an intrawell statistical approach is being used during detection monitoring as discussed in the Stats Plan.

Section 2
Groundwater Monitoring

2.1 Monitoring Well Network

A groundwater monitoring system has been established for the SCPP BABs CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2.

As discussed in the Stats Plan, intrawell statistical methods for the BABs CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the relatively small footprint of the BABs, and the low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). An intrawell statistical approach requires that each of the downgradient wells doubles as a background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background dataset from that same well. Monitoring wells MW-16-01 through MW-16-04 are located around the east and west perimeter of the BABs and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of four background/downgradient monitoring wells).

2.2 Semiannual Groundwater Monitoring

The semiannual monitoring parameters for the detection groundwater monitoring program were selected per the CCR Rule's Appendix III to Part 257 – Constituents for Detection Monitoring. The Appendix III indicator parameters consist of boron, calcium, chloride, fluoride, pH (field reading), sulfate, and total dissolved solids (TDS) and were analyzed in accordance with the sampling and analysis plan included within the QAPP. In addition to pH, the collected field parameters included dissolved oxygen, oxidation reduction potential, specific conductivity, temperature, and turbidity.

2.2.1 Data Summary

The first semiannual groundwater monitoring event for 2019 was performed during March 20 and March 21, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all four monitoring well locations. Groundwater samples were collected from the four detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the March 2019 event is provided in Table 1 (static groundwater elevation data), Table 2 (field data), and Table 3 (analytical results).

The second semiannual groundwater monitoring event for 2019 was performed during September 18 and September 19, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all four monitoring well locations. Groundwater samples were collected from the four detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the September 2019 event is provided in Table 1 (static groundwater elevation data), Table 2 (field data), and Table 4 (analytical results).

2.2.2 Data Quality Review

Data from each round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The data were found to be complete and usable for the purposes of the CCR monitoring program. Data quality reviews are summarized in Appendix A.

2.2.3 Groundwater Flow Rate and Direction

Groundwater elevation data collected during the March and September 2019 sampling events show that groundwater within the uppermost aquifer generally flows to the east-southeast across the SCPP BABs CCR unit. Groundwater potentiometric surface elevations measured across the SCPP BABs during the March and September 2019 sampling events are provided in Table 1 and were used to construct the groundwater potentiometric surface maps shown on Figure 3 and Figure 4, respectively. The groundwater flow rate and direction is consistent with previous monitoring events. The average hydraulic gradient throughout the SCPP BABs during both 2019 monitoring events is estimated at 0.004 ft/ft with an estimated average seepage velocity of approximately 0.00013 ft/day or 0.047 ft/year (approximately 0.57 inches/year), using the average hydraulic conductivity of 0.013 ft/day (TRC, 2017) and an assumed effective porosity of 0.4.

As presented in the GWMS Report, there is a horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the SCPP BABs CCR unit. The general flow rate and direction in the uppermost aquifer from both events are similar to that identified in previous monitoring rounds and continues to demonstrate that groundwater flows at a low rate and the compliance wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the SCPP BABs CCR unit.

Section 3
Statistical Evaluation

3.1 Establishing Background Limits

Per the Stats Plan, background limits were established for the Appendix III indicator parameters following the collection of at least eight background monitoring events using data collected from each of the four established detection monitoring wells (MW-16-01 through MW-16-04). The statistical evaluation of the background data is presented in the 2017 Annual Report. The Appendix III background limits for each monitoring well will be used throughout the detection monitoring period to determine whether groundwater has been impacted from the SCPP BABs CCR unit by comparing concentrations in the detection monitoring wells to their respective background limits for each Appendix III indicator parameter.

3.2 Data Comparison to Background Limits – First Semiannual Event (March 2019)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth). The data comparisons of the March 2019 data to background limits are presented in Table 3. Based on the statistical evaluation of the March 2019 Appendix III indicator parameters the following resample was collected in accordance with the Stats Plan:

- Chloride at MW-16-03

Verification resampling is recommended per the Stats Plan and the *USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009) (Unified Guidance), to achieve performance standards as specified by §257.93(g) in the CCR Rule. Per the Stats Plan, if there is an exceedance of a prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Constituents that are addressed by an alternate source demonstration (ASD) will not be analyzed for verification purposes.

3.3 Verification Resampling for the First Semiannual Event

Verification resampling for the March 2019 event was conducted on May 7 and 8, 2019 by TRC personnel in accordance with the QAPP. A summary of the analytical results collected during the May 2019 resampling event is provided in Table 3. The associated data quality review is included in Appendix A.

The verification results for chloride at MW-16-03 are below the prediction limit and no SSI exists for the March 2019 event in accordance with the Stats Plan and the Unified Guidance.

3.4 Data Comparison to Background Limits – Second Semiannual Event (September 2019)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-01 through MW-16-04) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-01 is compared to the background limit developed using the background dataset from MW-16-01, and so forth).

The statistical evaluation of the September 2019 Appendix III indicator parameters shows that there were no concentrations above background limits for any Appendix III indicator parameter. The comparisons of the September 2019 data to background limits are presented on Table 4.

Section 4
Conclusions and Recommendations

No SSIs were recorded for the 2019 monitoring period and detection monitoring will be continued at the SCPP BABs CCR unit in accordance with §257.94. As discussed above, and in the GWMS Report, with the very thick continuous silty clay-rich confining unit beneath the SCPP BABs CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations. Due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer.

No corrective actions were performed in 2019. The next semiannual monitoring event is scheduled for the second calendar quarter of 2020.

Section 5
Groundwater Monitoring Report Certification

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.90(e) requires that the owner or operator of an existing CCR unit prepare an annual groundwater monitoring and corrective action report.

Annual Groundwater Monitoring Report Certification
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

CERTIFICATION

I hereby certify that the annual groundwater and corrective action report presented within this document for the SCPP BABs CCR unit has been prepared to meet the requirements of Title 40 CFR §257.90(e) of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.90(e).

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2021	David B. McKenzie Engineer No. 42332 Stamp
Company: TRC Engineers Michigan, Inc.	Date: January 30, 2020	

Section 6
References

TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company St. Clair Power Plant Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

TRC Environmental Corporation. January 2018. Annual Groundwater Monitoring Report – DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins, 4901 Pointe Drive, East China Township, Michigan. Prepared for DTE Electric Company.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA facilities, Unified Guidance. Office of Conservation and Recovery. EPA 530/R-09-007.

USEPA. April 2015. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 80 Federal Register 74 (April 17, 2015), pp. 21301-21501 (80 FR 21301).

USEPA. July 2018. 40 CFR Part 257. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One); Final Rule. 83 Federal Register 146 (July 30, 2018), pp. 36435-36456 (83 FR 36435).

USEPA. April 2018. Barnes Johnson (Office of Resource Conservation and Recovery) to James Roewer (c/o Edison Electric Institute) and Douglas Green, Margaret Fawal (Venable LLP). Re: Coal Combustion Residuals Rule Groundwater Monitoring Requirements. April 30, 2018. United States Environmental Protection Agency, Washington, D.C. 20460. Office of Solid Waste and Emergency Response, now the Office of Land and Emergency Management.

Tables

Table 1

Summary of Groundwater Elevation Data – March and September 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Well ID	MP-01		MW-16-01		MW-16-02		MW-16-03		MW-16-04	
Date Installed	3/23/2016		3/31/2016		3/29/2016		3/25/2016		3/23/2016	
TOC Elevation	580.84(1)		584.74		581.43		581.39		580.95	
Geologic Unit of Screened Interval	NA		Silty Clay Shale Interface		Silty Clay Shale Interface		Silty Clay/Hardpan Shale Interface		Silty Clay/Hardpan Shale Interface	
Screened Interval Elevation	NA		458.1 to 453.1		456.2 to 451.2		455.1 to 450.1		455.0 to 450.0	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
3/20/2019	3.90	576.93	3.23	581.51	1.65	579.78	1.70	579.69	1.20	579.75
9/18/2019	3.85	576.98	2.70	582.04	1.65	579.78	1.60	579.79	1.00	579.95

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet below top of casing

NA - not applicable

1) Elevation represents the point of reference used to collect surface water level measurements.

Table 2

Summary of Field Data – March and September 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-01	3/21/2019	1.18	43.8	8.0	3,724	11.80	26.4
	9/19/2019	0.48	-181.3	8.2	4,343	14.60	17.7
MW-16-02	3/21/2019	1.01	-142.4	7.9	5,342	10.00	25.8
	9/19/2019	0.18	-211.4	8.2	6,310	16.50	40.0
MW-16-03	3/21/2019	0.94	-178.3	7.9	5,727	12.50	53.7
	9/19/2019	0.18	-201.0	8.1	6,395	15.50	55.0
MW-16-04	3/21/2019	0.89	-195.2	8.1	6,939	10.90	138
	9/19/2019	0.19	-212.0	8.2	8,080	16.30	109

Notes:

mg/L - milligrams per liter.

mV - milliVolt.

SU - standard unit.

umhos/cm - micro-mhos per centimeter.

deg C - degrees celcius.

NTU - nephelometric turbidity units.

Table 3

Comparison of Appendix III Parameter Results to Background Limits – March and May 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

	Sample Location:	MW-16-01		MW-16-02		MW-16-03			MW-16-04	
	Sample Date:	3/21/2019	PL	3/21/2019	PL	3/21/2019	5/8/2019(1)	PL	3/21/2019	PL
Constituent	Unit	Data		Data		Data			Data	
Appendix III										
Boron	ug/L	2,200	2,600	2,200	2,400	2,200	--	2,300	2,500	2,600
Calcium	ug/L	19,000	24,000	37,000	69,000	51,000	--	61,000	40,000	57,000
Chloride	mg/L	1,400	1,400	2,100	2,100	**2,300**	2,100	2,200	2,800	2,800
Fluoride	mg/L	1.9	2.1	1.3	1.6	1.2	--	1.6	1.4	1.7
pH, Field	SU	8.0	7.2 - 8.6	7.9	7.5 - 8.3	7.9	7.8	7.3 - 8.5	8.1	7.3 - 8.4
Sulfate	mg/L	<5.0	62	<5.0	25	<5.0	--	25	<5.0	25
Total Dissolved Solids	mg/L	2,000	2,500	2,800	3,600	3,100	--	4,000	3,900	4,400

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

RESULT Shading and bold font indicates a comfirmed exceedance of the Prediction Limit (PL).

(1) - Results shown for verification sampling performed on 5/8/2019.

Table 4
Comparison of Appendix III Parameter Results to Background Limits – September 2019
St. Clair Power Plant Bottom Ash Basins – RCRA CCR Monitoring Program
East China Township, Michigan

Sample Location:		**MW-16-01**		**MW-16-02**		**MW-16-03**		**MW-16-04**	
Sample Date:		9/19/2019	PL	9/19/2019	PL	9/19/2019	PL	9/19/2019	PL
Constituent	Unit	Data		Data		Data		Data	
Appendix III									
Boron	ug/L	2,200	2,600	2,100	2,400	2,000	2,300	2,400	2,600
Calcium	ug/L	21,000	24,000	41,000	69,000	51,000	61,000	43,000	57,000
Chloride	mg/L	1,200	1,400	1,800	2,100	2,000	2,200	2,400	2,800
Fluoride	mg/L	1.8	2.1	1.4	1.6	1.2	1.6	1.4	1.7
pH, Field	SU	8.2	7.2 - 8.6	8.2	7.5 - 8.3	8.1	7.3 - 8.5	8.2	7.3 - 8.4
Sulfate	mg/L	< 5.0	62	< 5.0	25	< 5.0	25	< 5.0	25
Total Dissolved Solids	mg/L	2,100	2,500	2,900	3,600	3,800	4,000	3,900	4,400

Notes:

ug/L - micrograms per liter.

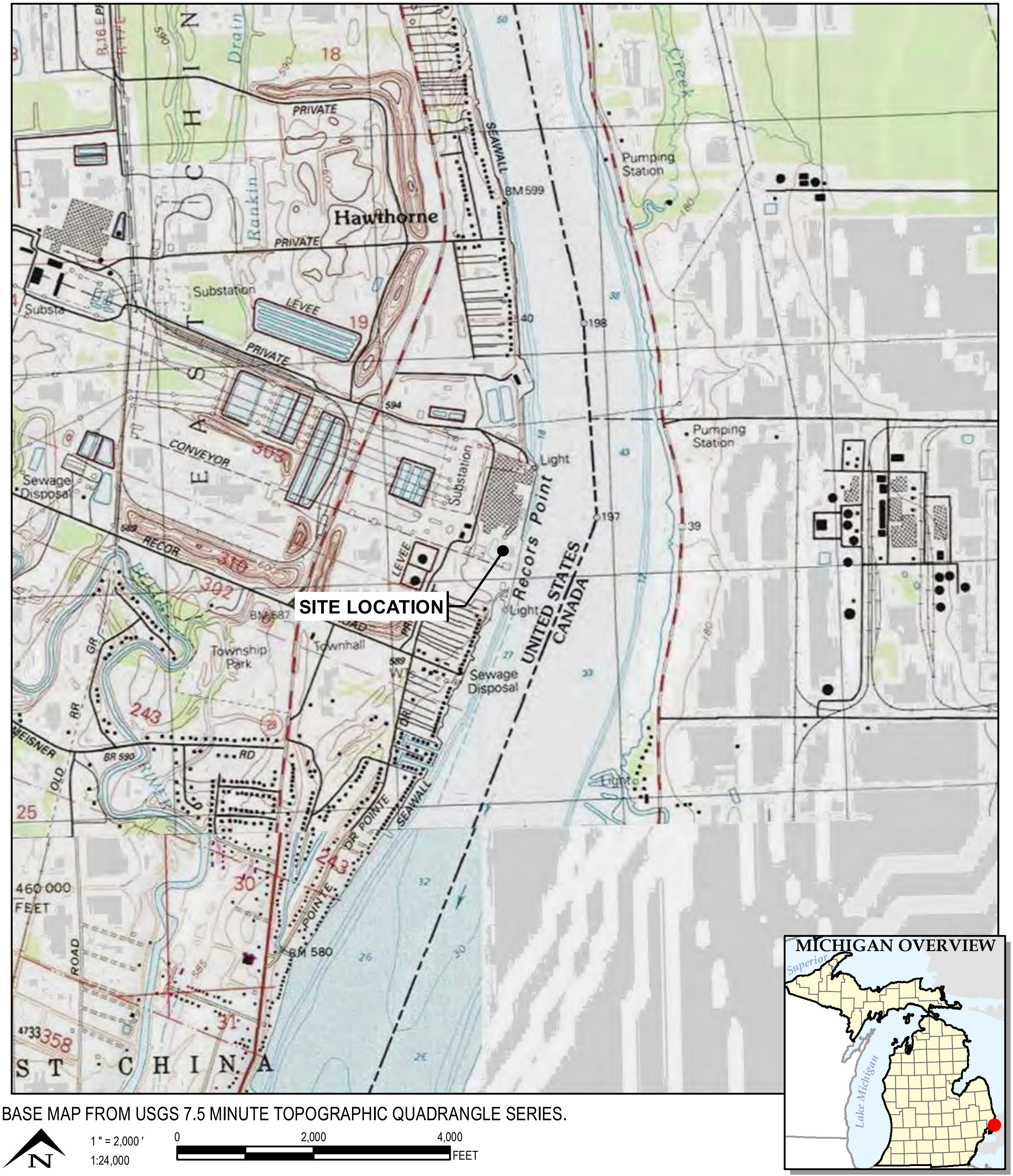
mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

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TRC - GIS

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

SITE LOCATION MAP

DRAWN BY:	S. MAJOR
CHECKED BY:	J. KRENZ
APPROVED BY:	V. BUENING
DATE:	JANUARY 2020
PROJ. NO.:	320511.0004
FILE:	320511-0003-002slmMB.mxd

FIGURE 1

LEGEND

- MONITORING WELLS
- ⊟ SURFACE WATER MEASURING POINT

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT BOTTOM ASH BASINS
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
SITE PLAN

DRAWN BY:	S. MAJOR	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ		
APPROVED BY:	V. BUENING		**FIGURE 2**
DATE:	JANUARY 2020		

TRC
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Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.: 320511-0004-006.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/27/2020, 11:01:42 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0004-006.mxd

LEGEND

⊕ MONITORING WELLS

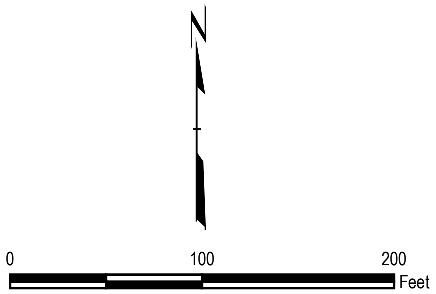
⊟ SURFACE WATER MEASURING POINT

(579.85) GROUNDWATER ELEVATION (FT NAVD88)

∼ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP MARCH 2019

DRAWN BY:	S. MAJOR	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ		
APPROVED BY:	V. BUENING	**FIGURE 3**	
DATE:	JANUARY 2020		

TRC

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

FILE NO.: 320511-0004-007.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/27/2020, 11:06:39 AM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0004-007.mxd

LEGEND

- ⌖ MONITORING WELLS
- ⊟ SURFACE WATER MEASURING POINT
- *(579.85)* GROUNDWATER ELEVATION (FT NAVD88)
- ~ GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, MARCH 2019.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.

N

0 100 200
Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT BOTTOM ASH BASINS
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
GROUNDWATER POTENTIOMETRIC SURFACE MAP SEPTEMBER 2019

DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0004
CHECKED BY:	J. KRENZ	**FIGURE 4**	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		

TRC

1540 Eisenhower Place
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FILE NO.: 320511-0004-008.mxd

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 1/28/2020, 16:00:27 PM by MVAPHIADIS -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\320511-0004-008.mxd

Appendix A
Data Quality Reviews

Laboratory Data Quality Review
Groundwater Monitoring Event March 2019
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the March 2019 sampling event. Samples were analyzed for anions, boron, calcium, and total dissolved solids by Test America Laboratories, Inc. (Test America), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-109882-1 (rev. 1).

During the March 2019 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;

- Data for matrix spike and matrix spike duplicate samples (MS.MSDs), if applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, if applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Target analytes were not detected in the equipment blank (EB-01_20190320).
- Target analytes were not detected in the method blanks.
- LCS recoveries for all target analytes were within laboratory control limits.
- The field duplicate pair samples were DUP-01 and MW-16-01. The relative percent differences (RPDs) between the parent and duplicate sample were within the acceptance limits.
- MS/MSD analyses were performed on sample MW-16-01 for boron; the percent recoveries (%Rs) and RPDs were within the acceptance limits.
- MS/MSD analyses were not performed for calcium and anions in this SDG. Per the project QAPP, MS/MSD analyses are required for boron, calcium, and anions at a frequency of 1 per 20 samples.
- Laboratory duplicate analyses were not performed for TDS. Per the project QAPP, laboratory duplicate analyses are required for TDS at a frequency of 1 per 20 samples.

- The reporting limit (5.0 mg/L) for the nondetect sulfate results in samples MW-16-01, MW-16-02, MW-16-03, MW-16-04, and DUP-01 were above the project QAPP-specified RL (1.0 mg/L) due to a 5-fold dilution because of a difficult matrix.

Laboratory Data Quality Review
Groundwater Monitoring Event
May 2019 Verification (Detection Monitoring)
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the May 2019 verification sampling event. Samples were analyzed for anions by Test America Laboratories, Inc. (Test America), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-112499-1.

During the May 2019 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-03

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS.MSDs), if applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;

- Data for laboratory duplicates, if applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- Target analytes were not detected in the equipment blank (EB-01).
- Target analytes were not detected in the method blanks.
- LCS recoveries for all target analytes were within laboratory control limits.
- The field duplicate pair samples were DUP-01 and MW-16-03. The relative percent differences (RPDs) between the parent and duplicate sample were within the acceptance limits.
- The reporting limit (25 mg/L) for the nondetect sulfate results in samples MW-16-03, and DUP-01 were above the project QAPP-specified RL (1.0 mg/L) due to a 25-fold dilution because of a difficult matrix.

Laboratory Data Quality Review
Groundwater Monitoring Event September 2019
DTE Electric Company St. Clair Power Plant (DTE SCPP)

Groundwater samples were collected by TRC for the September 2019 sampling event. Samples were analyzed for anions, total metals, and total dissolved solids by Eurofins-Test America Laboratories, Inc. (Eurofins-TA), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-119343-1.

During the September 2019 sampling event, a groundwater sample was collected from each of the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;

- Data for matrix spike and matrix spike duplicate samples (MS/MSDs), where applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, where applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

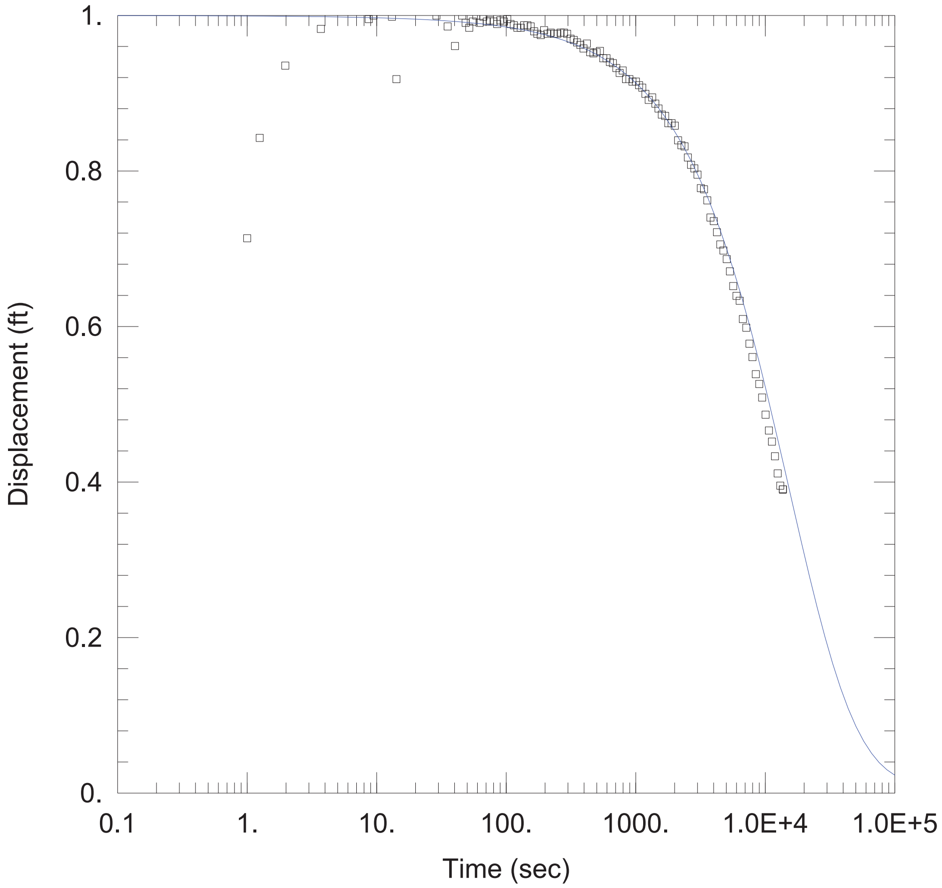
QA/QC Sample Summary:

- There was one equipment blank submitted with this dataset (EB-01). Fluoride at 0.11 mg/L and TDS at 33 mg/L were detected in this equipment blank. However, the sample results for TDS were detected at concentrations greater than five times the blank concentration; thus, there was no impact on data usability. The positive results for fluoride in several samples were less than five times the blank concentration and are potentially biased high, as summarized in the attached table.
- Target analytes were not detected in the method blank.
- LCS recoveries for all target analytes were within laboratory control limits.

- MS/MSD analyses were not performed for boron, calcium, and anions in this SDG. Per the project QAPP, MS/MSD analyses are required for boron, calcium, and anions at a frequency of 1 per 20 samples.
- Laboratory duplicate analyses were not performed for TDS. Per the project QAPP, laboratory duplicate analyses are required for TDS at a frequency of 1 per 20 samples.

- Dup-01 corresponds with MW-16-01; relative percent differences (RPDs) between the parent and duplicate sample were within the QC limits.
- The nondetect reporting limits (5.0 mg/L) for sulfate in samples MW-16-01, MW-16-02, MW-16-03, and MW-16-04 were above the QAPP-specified RL (1.0 mg/L) due to 5-fold dilutions likely performed due to elevated concentrations of chloride.

Appendix F
Single Well Hydraulic Conductivity Testing Results



FALLING HEAD SLUG TEST

Data Set: P:\...\MW-16-01_IN.aqt
Date: 11/29/17 Time: 12:23:54

PROJECT INFORMATION

Company: TRC Environmental Corporation
Client: DTE EC SCPP CCR
Project: 231828.0004.0000
Location: East ChinaTownship, MI
Test Well: MW-16-01
Test Date: 4/15/16

AQUIFER DATA

Saturated Thickness: 5. ft

WELL DATA (MW-16-01)

Initial Displacement: 0.635 ft
Total Well Penetration Depth: 126.9 ft
Casing Radius: 0.08333 ft

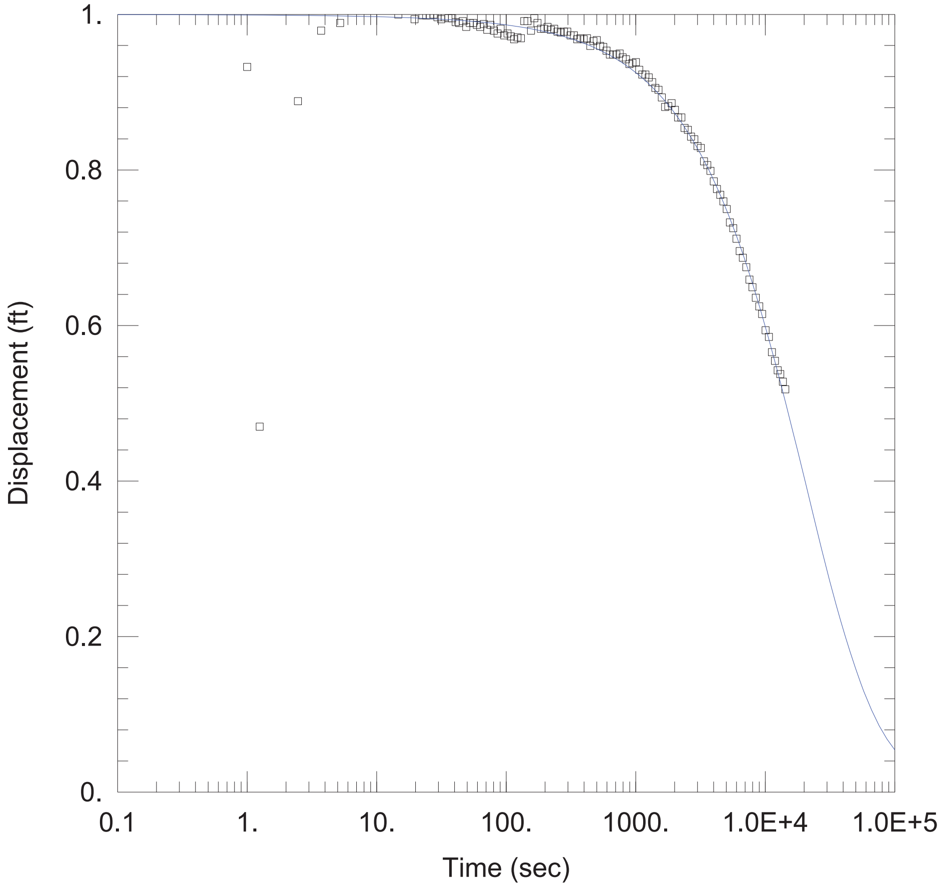
Static Water Column Height: 126.9 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 6.131E-6 cm/sec
Kz/Kr = 1.

Ss = 0.0002 ft^{-1}



MW-16-02 RISING HEAD SLUG TEST

Data Set: P:\...\MW-16-02_OUT.aqt
Date: 11/29/17 Time: 12:24:45

PROJECT INFORMATION

Company: TRC Environmental Corporation
Client: DTE EC SCPP CCR
Project: 231828.0004.0000
Location: East ChinaTownship, MI
Test Well: MW-16-02
Test Date: 4/15/16

AQUIFER DATA

Saturated Thickness: 5. ft

WELL DATA (MW-16-02)

Initial Displacement: 0.815 ft
Total Well Penetration Depth: 129.6 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 129.6 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 3.053E-6 cm/sec
Kz/Kr = 1.
Ss = 0.0002 ft^{-1}

Appendix G
Owner Certification of Compliance

Owner Certification of Site Compliance per 40 CFR 257 Subpart D
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

The United States Environmental Protection Agency (EPA) Criteria for Classification of Solid Waste Disposal and Practices; Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments; Alternative Closure Requirements (40 CFR §257.103) requires that the owner of an existing CCR unit certify the facility is in compliance with the requirements of the CCR Rules (40 CFR 257 Subpart D).

CERTIFICATION

Based on our review of the CCR Rules, I hereby certify that the subject facility is in compliance with the requirements of 40 CFR 257 Subpart D.

Leann Warner
SIGNATURE

11/24/2020
DATE

Leann Warner
PRINT NAME

Plant Manager
TITLE

DTE Electric Company
COMPANY NAME

Appendix H
Groundwater Statistical Evaluation Plan – October 2017

Groundwater Statistical Evaluation Plan

DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins

4901 Pointe Drive
East China Township, Michigan

October 2017

Groundwater Statistical Evaluation Plan

DTE Electric Company St. Clair Power Plant Coal Combustion Residual Bottom Ash Basins

4901 Pointe Drive
East China Township, Michigan

October 2017

Prepared For
DTE Electric Company

Graham Crockford, C.P.G.
Senior Project Geologist

David B. McKenzie, P.E.
Senior Project Engineer

TRC Engineers Michigan, Inc. | DTE Electric Company
Final
X:\WPAAM\PJT2\265996\STATS CERTS\04 SCPP\R265996-SCPP.DOCX

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Table of Contents

List of Figures

Section 1
Introduction

1.1 Regulatory Framework

The United States Environmental Protection Agency (U.S. EPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule) on April 17, 2015. The CCR Rule, which became effective on October 19, 2015, applies to the St. Clair Power Plant (SCPP) CCR Bottom Ash Basins (BABs). Pursuant to the CCR Rule, no later than October 17, 2017, the owner or operator of a CCR unit must develop the groundwater sampling and analysis program to include selection and certification of the statistical procedures to be used for evaluating groundwater in accordance with Title 40 Code of Federal Regulations (CFR) §257.93. This certification must include a narrative description of the statistical method that will be used for evaluating groundwater monitoring data.

TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), prepared this Groundwater Statistical Evaluation Plan (Statistical Plan) for the SCPP BABs CCR unit on behalf of DTE Electric Company (DTE Electric). This Statistical Plan was prepared in accordance with the requirements of §257.93 and describes how data collected from the groundwater monitoring system will be evaluated. As part of the evaluation, the data collected during detection monitoring events (post October 17, 2017), are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters (Appendix III of the CCR Rule) to determine if concentrations in detection monitoring well samples exceed background levels.

The CCR Rule is not prescriptive with regards to the actual means and methods to be used for statistically evaluating groundwater data, and there is flexibility in the method selection, as long as specific performance metrics are met. A description of statistical methods that meet the performance objectives of the CCR Rule are described in U.S. EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* USEPA, 2009).

1.2 Site Hydrogeology

The SCPP BABs CCR unit is located immediately adjacent to the west of the St. Clair River. The SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying the shale bedrock (likely the Bedford Shale). The shale bedrock lower confining unit is generally encountered at depths greater than130 feet below ground surface (feet-bgs). No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well locations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock. The underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Although the encountered zone of saturation along the interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents, since it was saturated, and although the hydraulic conductivity was low, exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above was present beneath at least a 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer. The first underlying saturated zone (the potential uppermost aquifer) that would presumably become affected with CCR constituent's is located at the silty clay hardpan/shale bedrock interface (130.5 to 132 feet-bgs) and is limited to no more than five feet thick.

A definitive groundwater flow direction with a mean gradient in 2016 and 2017 of 0.0036 foot/foot to the east-southeast within the uppermost aquifer is evident around the SCPP CCR BABs CCR unit, however potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

In addition, the elevation of CCR-affected water maintained within the SCPP BABs is very similar to the potentiometric surface elevations in the uppermost aquifer at the BABs CCR unit area. This suggests that if the CCR affected surface water in the BABs were able to penetrate the silty clay-rich underlying confining unit, the head on that release likely would travel radially away from the BABs within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the SCPP, it is not possible for the uppermost aquifer to have been affected by CCR from SCPP operations that began in the 1950s.

Due to the relatively small footprint of the BABs, the low vertical and horizontal groundwater flow velocity, the radial flow potential outward from the CCR unit, and the fact that the saturated unit being monitored is isolated by a laterally contiguous silty-clay unit, which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone from potentially being affected by CCR, monitoring of the SCPP BABs CCR unit using intra well statistical methods is appropriate. As such, intra-well statistical approaches will be used during detection monitoring.

Section 2
Groundwater Monitoring System

2.1 Groundwater Monitoring System

A groundwater monitoring system has been established for SCPP BABs CCR unit (TRC, October 2017), which established the following locations for detection monitoring. The locations are shown on Figure 1.

MW-16-01
MW-16-02
MW-16-03
MW-16-04

2.2 Constituents for Detection Monitoring

Subsection 257.94 describes the requirement for detection monitoring for Appendix III parameters. Detection monitoring will be performed semiannually unless an alternative frequency is made on a site-specific basis. The detection monitoring parameters are identified in Appendix III of §257.94 and consist of the following:

Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

2.3 Constituents for Assessment Monitoring

Assessment monitoring per §257.95 is required when a SSI over background has been detected for one or more of the constituents identified in Appendix III to Part 257 – Constituents for Detection Monitoring. In the event that assessment monitoring is triggered through the statistical evaluation of detection monitoring parameters, the following assessment monitoring parameters will be sampled:

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 (combined)

Section 3
Statistical Analysis

Groundwater sampling and analytical requirements are described in §257.93. The owner or operator of the CCR unit must select a statistical method specified in §257.93(f) to be used in evaluating groundwater monitoring data. The test shall meet the performance standards outlined in §257.93(g). The goal of the statistical evaluation plan is to provide a means to formulate an opinion or judgement as to whether the CCR unit has released contaminants into groundwater. This plan describes the statistical procedures to be used to determine if a statistical significant increase (SSI) or in the case of pH, a statistically significant difference (SSD), indicating that data is from a different population than background. This plan was developed using applicable guidance, including the *Unified Guidance*. In addition to using applicable guidance documents, commercially available statistical evaluation tools will be utilized by SCPP BABs CCR unit to develop statistically derived limits so that detection monitoring results can be compared to background.

The CCR Rule allows a variety of methods for conducting statistical evaluations. The specific procedure for a given data set depends on several factors including the proportion of the data set with detected values and the distribution of the data. These will not be known until the data are collected. It is generally anticipated, however, that the tolerance or prediction interval procedure will be the preferred method of conducting detection monitoring data evaluation to the extent that the data support the use of that method. This statistical procedure is described below in this section of the plan and in detail in the *Unified Guidance*.

3.1 Establishing Background

Background groundwater quality shall be established prior to October 17, 2017. Per §257.93(d), the owner or operator of the CCR unit must establish background groundwater quality in hydraulically upgradient or background well(s). The development of a groundwater statistical evaluation program for detection monitoring involves the proper collection of background samples, regardless of whether an inter-well or intra-well monitoring strategy is implemented. Background may be established at wells that are not located hydraulically upgradient from the unit if it meets the requirement of §257.91(a)(1). A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

1. Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or
2. Sampling at other wells will provide an indication of background groundwater quality that is as representative as or more representative than that provided by the upgradient wells.

The purpose of obtaining adequate background groundwater data is to approximate, as accurately as possible, the true range of ambient concentrations of targeted constituents. Background groundwater data should eliminate, to the extent possible, statistically significant concentration increases not attributable to the CCR unit. Specifically, the owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. The sampling frequency should be selected so that the samples are physically independent. These background groundwater parameters can be adequately qualified by doing the following:

- Collecting the minimum number of samples that satisfy the requirements of the statistical methods that are used (i.e., that result in adequate statistical power);
- Incorporating seasonal and/or temporal variability into the background data set; and

Incorporating the spatial component of variability into the background data set (i.e., the variability that comes with obtaining samples from different locations within the same groundwater zone).

The initial background/baseline sampling period is a minimum of eight events for Existing CCR units that were in operation on October 19, 2015. This provides a minimal background data set to initiate statistical comparisons. Over time, the short baseline period may result in a high risk of false positive statistical results. The facility may periodically update background data to account for variability in background conditions. The *Unified Guidance* recommends that background data be updated every 4 to 8 measurements (i.e., every two to four years if samples are collected semi-annually, or one to two years if samples are collected quarterly). The background data will be reviewed for trends or changes that may necessitate discontinuation of earlier portions of the background data set.

3.2 Data Evaluation and Data Distributions

DTE Electric will evaluate the groundwater data for each constituent included in the groundwater monitoring program using intra-well tolerance or prediction limits. The tolerance or prediction interval statistical procedure establishes an interval that bounds the ranges of expected concentrations representative of unaffected groundwater using the distribution of background data. The upper tolerance or prediction limit of that interval is then used for comparison to the concentration level of each constituent in each compliance well. Development of the tolerance or prediction limits used for comparison during detection monitoring will be conducted in accordance with the *Unified Guidance.* The following is a summary of descriptive statistics and tolerance or prediction limit choices.

3.2.1 Background Determination

Statistical limits will be calculated after the collection of a minimum of eight independent samples. The analytical results from the eight "background" samples will be used to determine the statistical limits for each individual parameter. For inter-well comparisons, background data should be "pooled" creating a single, combined background dataset from the background monitoring wells. For intra-well, the background data set is comprised of the historical data set established at each individual monitoring well.

The background dataset (and hence the prediction limits) will be updated as appropriate (as discussed above in Section 3.1) to maintain necessary statistical sensitivity. New data will be compared to the existing background data set to determine if there are outlier values, and whether the data are statistically similar. If there are no outliers and the data are statistically similar, the new data will be added to the existing background data set.

3.2.2 Outlier Evaluation

Outliers and anomalies are inconsistently large or small values that can occur as a result of sampling, analytical, or transcription errors; laboratory or field contamination; or shelf-life exceedance; or extreme, but accurately detected environmental conditions (e.g., spills). Data will be reviewed graphically using tools such as time concentration trend plots, box and whisker plots and/or probability plots to illustrate and identify outliers, trends, or otherwise unusual observations at each monitoring location. This will be accomplished prior to further in-depth review of the data sets to identify any obvious field or laboratory anomalies. Data points that are determined to be non-representative will be 'flagged' for further detailed evaluation prior to removing from the background data or designating as an outlier.

3.2.3 Testing for Normality

Statistical tests often assume that data are normally distributed or that data can be normalized by various standard methods. The assumption of normality can be tested in various ways. Formal normality testing such as utilizing the Shapiro-Wilk test (for $n<50$) or the Shapiro-Francia Test (for $n>50$) or calculation of a coefficient of skewness may be utilized in accordance with the *Unified Guidance*. Alternatively, graphing data on a probability plot can also be used to test for normality. If the data appear to be non-normal, mathematical transformations of the data may be utilized such that the transformed data follow a normal distribution (e.g., lognormal distributions). Alternatively, non-parametric tests may be utilized when data cannot be normalized.

The following are guidelines for decision making during normality testing:

1. If the original data show that the data are not normally distributed, then apply a natural log-transformation to the data and test for normality using the above methods.
2. If the original or the natural log-transformed data confirm that the data are normally distributed, then apply a normal distribution test.
3. If neither the original nor the natural log-transformed data fit a normal distribution, then apply a distribution-free test.

3.2.4 Evaluation of Non-Detects

Background concentrations that are reported as less than the practical quantitation limit (PQL) (herein referred to as non-detects) will be evaluated differently, depending upon the percentage of non-detects to the reported concentrations for a given parameter at a given monitoring well. The evaluation of non-detects was as follows:

Less Than 15% Non-detects

For data that was normally or lognormally distributed and less than 15% non-detects, one-half the value of the method detection limit will be used to calculate the prediction limit. If normally or lognormally cannot be met using one-half of the method detection limit, and if the method detection limits were equal, alternating zero with the value of the method detection limit will be considered in order to determine the normality of the data set.

15% to 50% Non-detects

If more than 15% but less than 50% of the overall data are less than the detection limit, either Aitchison's adjustment, or Cohen's adjustment, or the Kaplan Meijer adjustment will be used to determine the statistical limits in accordance with the *Unified Guidance*.

51% to 100% Non-detects

For data sets that contain greater than 50% non-detects, the non-parametric statistical limits will be utilized as described below.

3.3 Parametric Tolerance or Prediction Limits

Tolerance and prediction intervals are similar approaches to establish statistical ranges constructed from background or baseline data. However, tolerance limits define the range of data that fall within a specified percentage with a specified level of confidence (where a proportion of the population is expected to lie), whereas prediction limits involve predicting the upper limit of possible future values based on a background or baseline data set and comparing that predicted limit to compliance well data.

Intra-well tolerance or prediction limits are calculated using baseline period or background data from each well. The tolerance or prediction limit will be calculated in accordance with the *Unified Guidance*. If the data set is log-normally distributed the tolerance or prediction limits will be calculated using the log-normally transformed data, and subsequently un-transformed to normal units.

In §257.93(g)(2) it states that for multiple comparisons, each testing period should have a Type I error rate no less than 0.05 while maintaining an individual well Type I error rate of no less than 0.01. Per §257.93(g)(4), these Type I limits do not apply directly to tolerance intervals or prediction intervals; however, the levels of confidence for the tolerance or prediction limit approach must be at least as effective as any other approach based on consideration of the number of samples, distribution, and range of concentration values in the background data set for each constituent.

3.4 Non-Parametric Tolerance or Prediction Limits

Parameters that consist of mainly non-detect data usually violate the assumptions needed for normal based tolerance or parametric prediction intervals. Therefore, as recommended in the *Unified Guidance*, the non-parametric tolerance or prediction limit method will be chosen.

A non-parametric upper tolerance or prediction limit is constructed by setting the limit as a large order statistic selected from background (e.g., the maximum background value). This method has lower statistical power than parametric methods; therefore, it is important to control outliers within the dataset to maintain adequate statistical power that this method can provide. Due to the lack of statistical power of this method, it will only be used when other methods are not available.

3.5 Double Quantification Rule

The double quantification rule is discussed in Section 6.2.2 of the *Unified Guidance*. In the cases where the background dataset for a given well is 100% non-detect, a confirmed exceedance is registered if any well-constituent pair exhibits quantified measurements (i.e., at or above the reporting limit) in two consecutive sample and resample events. This method will be used for non-detect data sets.

3.6 Verification Resampling

In order to achieve the site wide false positive rates (SWFPR) recommended in the *Unified Guidance*, a verification resampling program is necessary. Without verification resampling, the

SWFPR cannot be reasonably met, and much larger statistical limits would be required to achieve a SWFPR of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. Under these circumstances, if there is an exceedance of a tolerance limit or prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Only constituents that initially exceed their statistical limit (i.e., have no previously recorded SSIs) will be analyzed for verification purposes. This verification sampling must be performed within the same compliance period as the event being verified. If the verification sample remains statistically significant, then statistical significance will be considered. If the verification sample is not statistically significant, then no SSI will be recorded for the monitoring event.

Section 4
Evaluation of Detection Monitoring Data

4.1 Statistical Evaluation during Detection Monitoring

According to §257.94(e), if the facility determines, pursuant to §257.93(h), that there is a SSI over background levels for one or more of the Appendix III constituents, the facility will, within 90 days of detecting a SSI, establish an assessment monitoring program **<or>** demonstrate that:

- A source other than the CCR unit caused the SSI, or
- The SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

The owner or operator must complete a written demonstration (i.e., Alternative Source Demonstration, ASD), of the above within 90 days of confirming the SSI. If a successful ASD is completed, a certification from a qualified professional engineer is required, and the CCR unit may continue with detection monitoring.

If a successful ASD is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under §257.95, described further in Section 5. The facility must also include the ASD in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

Section 5
Assessment Monitoring

As discussed in Section 4, the facility must begin assessment monitoring for the CCR unit if a SSI is identified, and the SSI cannot be attributed to an ASD. Per the CCR Rule, assessment monitoring must begin within 90 days of identification of a SSI that is not attributed to an alternative source. During the 90-day period, wells included in the groundwater monitoring system will be sampled for Appendix IV constituents pursuant to §257.95(b). Within 90 days of obtaining the results from the first assessment monitoring event, all of the wells will be sampled for Appendix III and the detected Appendix IV parameters in the initial assessment monitoring event.

If assessment monitoring is triggered pursuant to §257.94(e)(1), data are compared to Groundwater Protection Standards (GPSs) or background groundwater quality. The CCR Rule [§257.95(h)] requires GPSs to be established for Appendix IV constituents that have been detected during baseline sampling. The GPS is set at the EPA maximum contaminant level (MCL) or a value based on background data. The MCLs will be the GPSs for those constituents that have MCLs unless the background concentration is greater than the MCL, which in that case, the statistically-determined background values becomes the GPS. For all other parameters that do not have MCLs, the GPS defaults to a statistically-based limit developed using background data. For GPSs that are established using background, tolerance limits are anticipated to be used to calculate the GPS. The background will be updated every two years, along with the resulting GPS, consistent with the *Unified Guidance*. If additional assessment monitoring parameters become detected during the assessment monitoring, GPSs will be developed for those parameters in the same manner as the initial parameters.

Consistent with the *Unified Guidance*, the preferred method for comparisons to a fixed standard will be confidence limits. An exceedance of the standard occurs when the 95 percent lower confidence level of the downgradient data exceeds the GPS. Confidence intervals will be established in a manner appropriate to the data set being evaluated (proportion of non-detect data, distribution, etc.). If the statistical tests conclude that an exceedance of the GPS or background has occurred, verification resampling may be conducted by the facility. Once the resampling data are available, the comparison to the GPS or background will be evaluated.

Section 6
Certification

Statistical Methods Certification per 40 CFR §257.93(f)
St. Clair Power Plant Bottom Ash Basins
East China Township, Michigan

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.93 requires that the owner or operator of an existing CCR unit develop the groundwater sampling and analysis program to include the selection of the statistical procedures to be used for evaluating groundwater monitoring data. The owner or operator must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data to meet the requirements of Title 40 CFR §257.93.

CERTIFICATION

By means of this certification, I certify that I am a qualified professional engineer as defined by Title 40 CFR §257.53, that I have reviewed this Statistical Evaluation Plan, and that the statistical methods described herein are appropriate and meet the requirements of Title 40 CFR §257.93. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.93.

Name: David B. McKenzie, P.E.	Date: October 31, 2017	STATE OF MICHIGAN DAVID B. McKENZIE ENGINEER No. 42332 LICENSED PROFESSIONAL ENGINEER
Company: TRC Engineers Michigan, Inc.	Expiration Date: October 13, 2017	Stamp

Section 7
References

ASTM. 2012. *Standard Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs*. D6312-98(2012)e1. West Conshohocken, PA: ASTM International.

ITRC (Interstate Technology & Regulatory Council). 2013. Groundwater Statistics and Monitoring Compliance, Statistical Tools for the Project Life Cycle. GSMC-1. Washington, D.C.: Interstate Technology & Regulatory Council, Groundwater Statistics and Monitoring Compliance Team. http://www.itrcweb.org/gsmc-1/.

TRC. 2017. Groundwater Monitoring System Summary Report, DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit, East China Township, Michigan.

United States Environmental Protection Agency (USEPA). 2010. *ProUCL Version 5.0.00 (5.0) Technical Guide*. EPA/600/R-07/041. Washington, DC: United States Environmental Protection Agency. https://www.epa.gov/land-research/proucl-software.

USEPA. 2015. *ProUCL Version 5.1.00 (5.1) Technical Guide.* EPA/600/R-07/041. Washington, DC: United States Environmental Protection Agency. https://www.epa.gov/land-research/proucl-software.

USEPA. 1989. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance.* Office of Solid Waste.

USEPA. 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*. Office of Conservation and Recovery. EPA 530/R-09-007.

Figure

LEGEND

⯌ MONITORING

⊟ SURFACE WATER MEASURING

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:

MONITORING NETWORK AND SITE PLAN

DRAWN BY:	J. PAPEZ	PROJ NO.:	254222.0004
CHECKED BY:	C. SCIESZKA	FIGURE 1	
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2017		

TRC

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FILE NO.: 265996-0004-002_Stat.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 10/4/2017, 13:49:41 PM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2017_265996\265996-0004-002_Stat.mxd

Appendix I
Location Restrictions Demonstrations

Location Restrictions Demonstrations

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2018

Location Restrictions Demonstrations

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2018

Prepared For
DTE Electric Company

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Senior Project Geologist

McKenzie
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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.

David B. McKenzie
Engineer
No. 42332

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 St. Clair Power Plant (SCPP) are in compliance with the location restrictions outlined in the Environmental Protection Agency's (EPA) final CCR rule [Title 40 Code of Federal Regulations (CFR) 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 and also includes engineering calculations to demonstrate that the BABs comply with placement above the uppermost aquifer criteria (§257.60), and with 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 as appendices to this demonstration.

1.1 Facility and CCR Unit Information

The two SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan. The SCPP including the BABs CCR unit was constructed in the early 1950s. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River. The SCPP BABs are located just south of the main SCPP building.

The property has been used continuously as a coal-fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953. The power plant is constructed over a natural continuous clay-rich soil base as shown in soil borings performed at the SCPP property (Appendix A). The adjacent incised BABs have been used to collect bottom ash from coal combustion processes since the plant began operations. This collected CCR is routinely cleaned out of the BABs and either sold for beneficial reuse or disposed at the Range Road Landfill (RRLF).

In 1995, the impoundments were reconstructed by driving steel sheet-pile around each basin's perimeter to a depth of approximately 13 feet below ground surface (ft bgs) into the native clay-rich soil. The BAB perimeter sheet pile wall is tied-back to 10-ft long steel sheets located 15 ft behind the perimeter wall and connected with rods at 8 to 20-ft centers. The BABs receive bottom ash and other process water from the power plant; the ash and process water first flow to the East BAB and then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.2 Site Setting

A groundwater monitoring system has been established for the SCPP BABs CCR unit as detailed in the Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well boring logs are included in Appendix A.

The SCPP BABs CCR unit is located immediately adjacent to and west of the St. Clair River. The geologic setting of the SCPP BABs is detailed in the *Annual Groundwater Monitoring Report* (TRC, January 2018). In summary, the SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying shale bedrock (likely the Bedford Shale) which is generally encountered at depths greater than 130 ft bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well installations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock[1]. The underlying shale bedrock does not yield groundwater; rather, it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Hydraulic conductivities measured within the CCR monitoring wells using single well hydraulic conductivity tests (e.g., slug tests) range from approximately 0.009 to 0.017 feet/day with a mean of approximately 0.013 feet/day. Although the encountered zone of saturation along the till/hardpan and shale bedrock interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents. Since it was saturated, and although the hydraulic conductivity was low, it exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above, was present beneath at least 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer from the BABs.

---

[1] The interface is located at a depth of approximately 130.5 ft to 132 ft below ground surface (bgs).

A definitive groundwater flow direction toward the east-southeast with a mean hydraulic gradient of 0.0036 foot/foot in calendar years 2016 and 2017 is evident in this identified uppermost aquifer around the SCPP CCR BABs CCR unit. However, based on the measured hydraulic conductivity and gradient, the potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

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 SCPP BABs must be constructed with a base that is located no less than 1.52 meters (5 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 1.1 (above), the perimeter of each BAB is constructed of steel sheet piling installed to a depth of approximately 13 ft bgs (approximately 570.5 ft. MSL based on site-specific datum). Pond bottom is maintained, by periodic dredging, at an elevation of approximately 572 ft MSL. The BABs are underlain by approximately 130 ft of silty clay with no significant zones of saturation. The uppermost aquifer is the silty clay hardpan/shale bedrock interface, located approximately 130.5 to 132 ft bgs. The base of the BABs and the uppermost aquifer are separated by approximately 120 ft of silty clay. Cross-sections showing the installation top and bottom elevation of the perimeter sheet pile and approximate pond bottom elevation for each BAB, the presence of low hydraulic conductivity clay, 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 5 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 fluctuations in groundwater level. Therefore, each of the SCPP BABs 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 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 SCPP 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 350 ft south-southwest of the BABs as a wetland. This area is not immediately adjacent to the BABs and is hydraulically separated by the silty clay confining layer surrounding and underlying the BABs, and therefore, there is no risk of impact to this area from the BAB operations.

Based on TRC's review of wetland inventory resources and current site conditions, TRC is of the opinion that the SCPP 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 SCPP BABs.

Evidence of active faulting during the Holocene in the SCPP BABs area 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 existing SCPP BABs are located in a seismic impact zone, the USGS Earthquake Hazards Program was consulted to determine the earthquake hazard for the SCPP. 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 SCPP 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 SCPP 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, topography, and evaluating human-made features in the area of the SCPP BABs.

Geotechnical explorations performed at the SCPP BAB area identified silty clay with traces of sand and gravel overlying an approximately 5-ft thick saturated hardpan which overlies a low permeability shale bedrock at a depth of approximately 130 ft bgs. These observations suggest that there are no unstable soil or underlying bedrock conditions proximal to the BABs. Additionally, the perimeter walls of the BABs are constructed of steel sheet pile driven into the stable clay-rich soils, and these perimeter walls are tied back to driven steel sheets located 15 feet behind the perimeter walls. These tie-backs further serve to stabilize the BAB walls and minimize potential for sidewall collapse.

Human-made features surrounding the BAB area include concrete pavement and a steel seawall along the St. Clair River shoreline. Both of these features significantly reduce any erosional forces on surficial and near-surficial soils caused by surface water drainage and river flow adjacent to the BABs. Geological and geomorphological changes near the SCPP were primarily caused by hydrologic forces imparted by the St. Clair River flow. These ongoing forces and any impact they might have on the BABs are negated by the facility's shoreline sea wall and are not contributing to any 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 SCPP BABs are not located in unstable areas. The BABs are in compliance with the requirements of §257.64.

Section 3
Conclusions

Based on the evaluation provided in this demonstration, the SCPP BABs CCR unit is 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

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

TRC. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair 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].

United States Geological Survey (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 [8/16/2018].

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].

Appendix A
Monitoring Well Boring Logs

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

Facility/Project Name: DTE: Saint Clair Power Plant	Date Drilling Started: 3/31/16	Date Drilling Completed: 3/31/16	Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 585.12	TOC Elevation (ft) 584.74	Total Depth (ft bgs) 138.0	Borehole Dia. (in) 6

Boring Location: S side of median, in parking lot W of ash basin.
N: 465440.66 E: 13631612.80

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

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair	County: Saint Clair	State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:45 ▼ Depth (ft bgs) 14.08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, little sand, brown (10YR 5/3), no odor, moist.				
				CLAY mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, dense.				
			5					
1 CS	90		10	Change to medium dense at 10.0 feet.				
				Change to soft to medium dense at 12.5 feet.				
			▼					
			15					
			20		CL			
			25					
2 CS	95		30					
			35					

Signature: for J. Reed

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

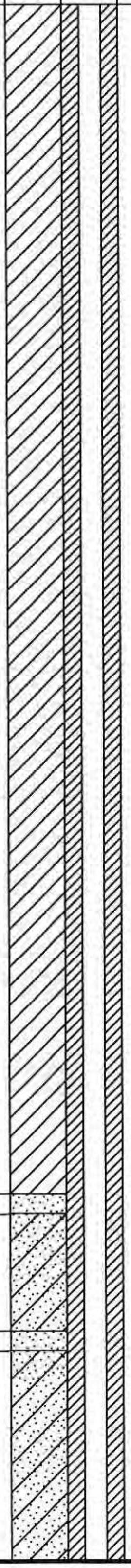
Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
3 ST				**CLAY** mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, soft to medium dense.		
				Change to few fine to coarse sand at 43.0 feet.		
			45			
4 CS	100		50	Change to gray (10YR 5/1) at 50.0 feet.		
			55			
			60		CL	
			65			
5 CS	100		70			
			75			
			80	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 80.25 feet.	SP	
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL	
			85	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 85.0 feet.	SP	
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL	
6 CS	100		90	Change to few to little fine to coarse sand at 90.0 feet.		

GRAPHIC LOG / WELL DIAGRAM

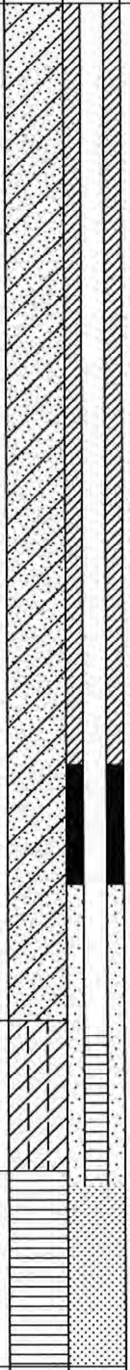


WELL CONSTRUCTION LOG

WELL NO. MW-16-01

Page 3 of 3

SAMPLE						
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
				CLAY WITH SAND mostly clay, few to little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.		
			95			
			100			
			105			
7 CS	100		110		CL	
			115			
			120	Change to soft at 120.0 feet.		
8 CS	100		125			
				SILTY CLAY mostly clay, some silt, very dark gray, (10YR 3/1), no odor, dry to moist, hard.	CL-ML	
			130			
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.		
9 CS	100		135			
				End of boring at 138.0 feet below ground surface.		
			140			
			145			



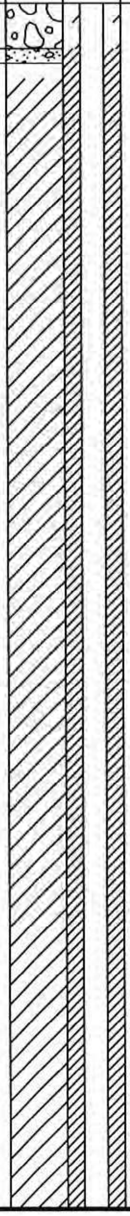
WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant		Date Drilling Started: 3/28/16	Date Drilling Completed: 3/28/16	Project Number: 231828.0004.0000
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 582.18	TOC Elevation (ft) 581.43	Total Depth (ft bgs) 138.0 Borehole Dia. (in) 6
Boring Location: NE side of ash basin. N: 465503.41 E: 13632151.32		Personnel Logged By - A. Knutson Driller - A. Goldsmith		Drilling Equipment: Terrasonic
Civil Town/City/or Village: Saint Clair	County: Saint Clair State: MI	Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/8/16 08:38		Depth (ft bgs) ▼ Depth (ft bgs) 1.76

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	95		5	**GRAVEL** mostly coarse gravel, few coarse sand, black (10YR ▼ 2/1), no odor, moist, loose. **SAND WITH GRAVEL** mostly fine to coarse sand, some fine to coarse gravel, brown (10YR 5/3), no odor, moist, loose. **CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, stiff.				
				Change to soft at 8.0 feet.				
2 CS	100		10 15					
3 CS	100		20 25		CL			
4 CS	100		30 35					



Signature: for A. Knutson

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

Checked By: C. Scieszka

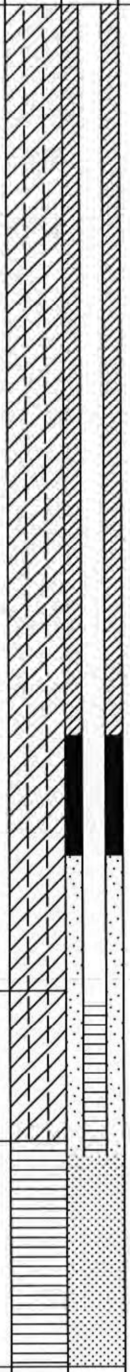
WELL CONSTRUCTION LOG

WELL NO. MW-16-02

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 CS	100			**CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, soft.				
			45	Change to few silt at 45.0 feet. Change to no silt at 46.0 feet.	CL			
6 CS	100		50					
			55					
				SILTY CLAY mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.				
			60					
7 CS	100		65					
			70					
8 CS	100			Change to few fine to coarse sand at 73.5 feet.	CL-ML			
			75	Change to no sand at 76.5 feet.				
			80					
9 CS	100		85					
			90					

WELL CONSTRUCTION LOG

WELL NO. MW-16-02



SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
10 CS	100		95	**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.	CL-ML			
11 CS	100		100 105					
12 CS	100		110 115					
13 CS	80		120 125	**SILTY CLAY** mostly clay, some silt, very dark gray (10YR 3/1), no odor, dry, hard.	CL-ML			
14 CS	100		130 135	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
			140 145	End of boring at 138.0 feet below ground surface.				

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant	Date Drilling Started: 3/24/16	Date Drilling Completed: 3/24/16	Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 582.08	TOC Elevation (ft) 581.39	Total Depth (ft bgs) 138.0	Borehole Dia. (in) 6

Boring Location: E side of ash basin.
N: 465353.06 E: 13632114.23

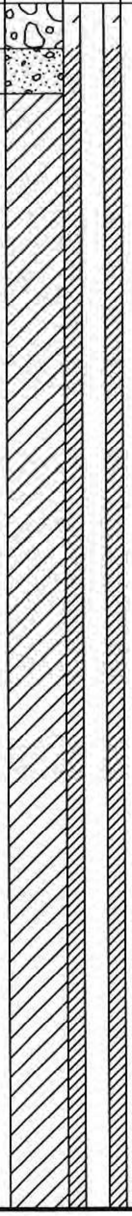
Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:35 ▼ Depth (ft bgs) 2.16

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, some sand, black (10YR 2/1), no odor, moist, loose.				
			▼	**SAND AND GRAVEL** brown (10YR 5/3), no odor, moist, loose.				
				CLAY mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, stiff.				
1 CS	95		5					
			10	Change to medium stiff at 10.0 feet.				
2 CS	100		15					
			20					
					CL			
3 CS	100		25					
			30	Change to trace to few sand at 30.0 feet.				
				Change to no sand at 32.5 feet.				
4 CS	100		35					



Signature: For J. Reed

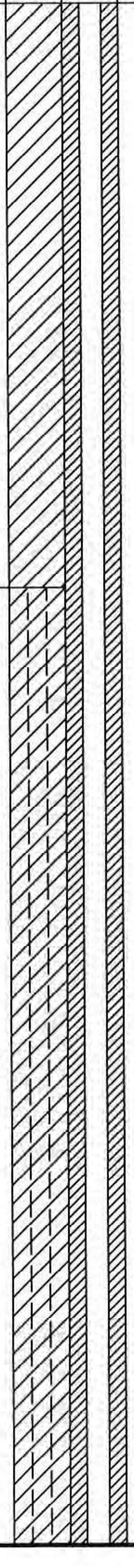
Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

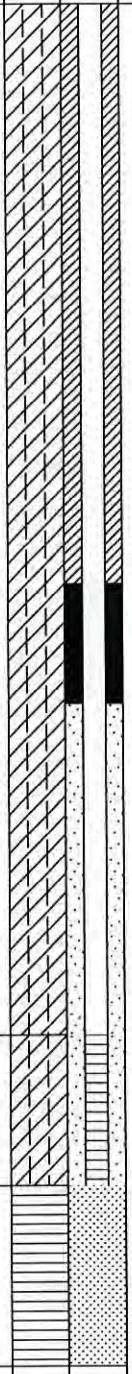
SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
5 ST				**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, medium stiff.	CL	
6 CS	100		45			
			50			
7 CS	100		55			
			60	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.	CL-ML	
8 CS	100		65			
			70			
9 CS	100		75			
			80			
10 CS	100		85			
			90			



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

Page 3 of 3



SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
11 CS	100		95	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.		
			100			
12 CS	100		105			
			110		CL-ML	
13 CS	100		115			
			120			
14 CS	100		125			
				SILTY CLAY HARDPAN AND SHALE very dark gray (10YR 3/1), no odor, dry to slightly moist, hard.		
			130		CL-ML	
				SHALE very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.		
15 CS	100		135			
				End of boring at 138.0 feet below ground surface.		
			140			
			145			

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

Page 1 of 3

Facility/Project Name: DTE: Saint Clair Power Plant	Date Drilling Started: 3/22/16	Date Drilling Completed: 3/23/16	Project Number: 231828.0004.0000

Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 581.99	TOC Elevation (ft) 580.95	Total Depth (ft bgs) 138.0	Borehole Dia. (in) 6

Boring Location: SE side of ash basin.
N: 465173.94 E: 13632077.11

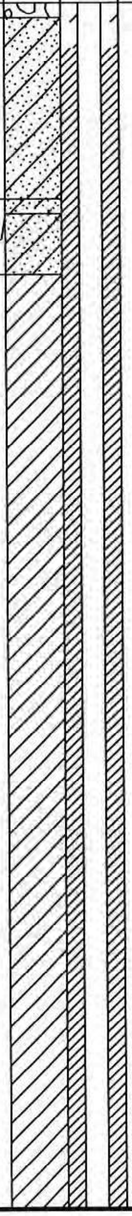
Personnel
Logged By - J. Reed
Driller - A. Goldsmith

Drilling Equipment: Terrasonic

Civil Town/City/or Village: Saint Clair
County: Saint Clair
State: MI

Water Level Observations:
While Drilling: Date/Time Depth (ft bgs)
After Drilling: Date/Time 4/8/16 08:28 ▼ Depth (ft bgs) 2.19

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
				GRAVEL mostly gravel, few to little fine to coarse sand, very dark gray (10YR 3/1), no odor, moist.		
				CLAY WITH SAND mostly clay, little to some fine to coarse sand, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
1 CS	80		5			
				SAND WITH CLAY mostly sand, little to some clay, dark grayish brown (10YR 4/2), no odor, moist.	SW-SC	
				CLAY WITH SAND mostly clay, little to some fine to coarse sand, medium plasticity, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL	
			10			
				CLAY mostly clay, trace fine to medium sand, medium plasticity, grayish brown (10YR 5/2), no odor, moist, stiff.		
2 CS	95		15			
			20			
3 CS	100		25	Change to medium stiff at 25.0 feet.	CL	
			30			
4 CS	100		35			

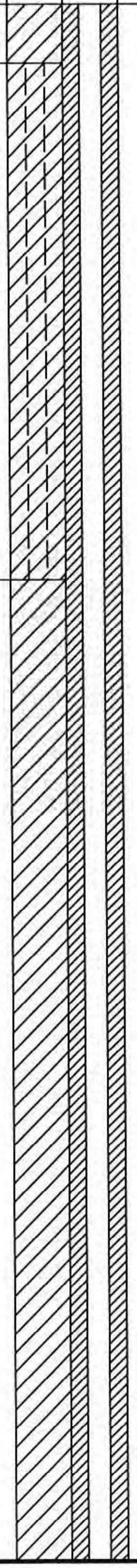


Signature: for J. Reed.

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

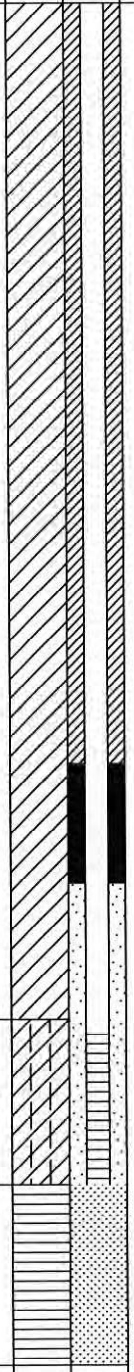
Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
5 ST					CL	
6 CS	100		45	**SILTY CLAY** mostly clay, little to some silt, few fine to coarse sand, dark grayish brown (10YR 5/2), no odor, moist, medium stiff.		
			50		CL-ML	
7 CS	100		55			
			60	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.		
8 CS	100		65			
			70			
9 CS	100		75		CL	
			80	Change to wet at 79.5 feet.		
				Change to moist at 83.0 feet.		
10 CS	100		85			
			90			



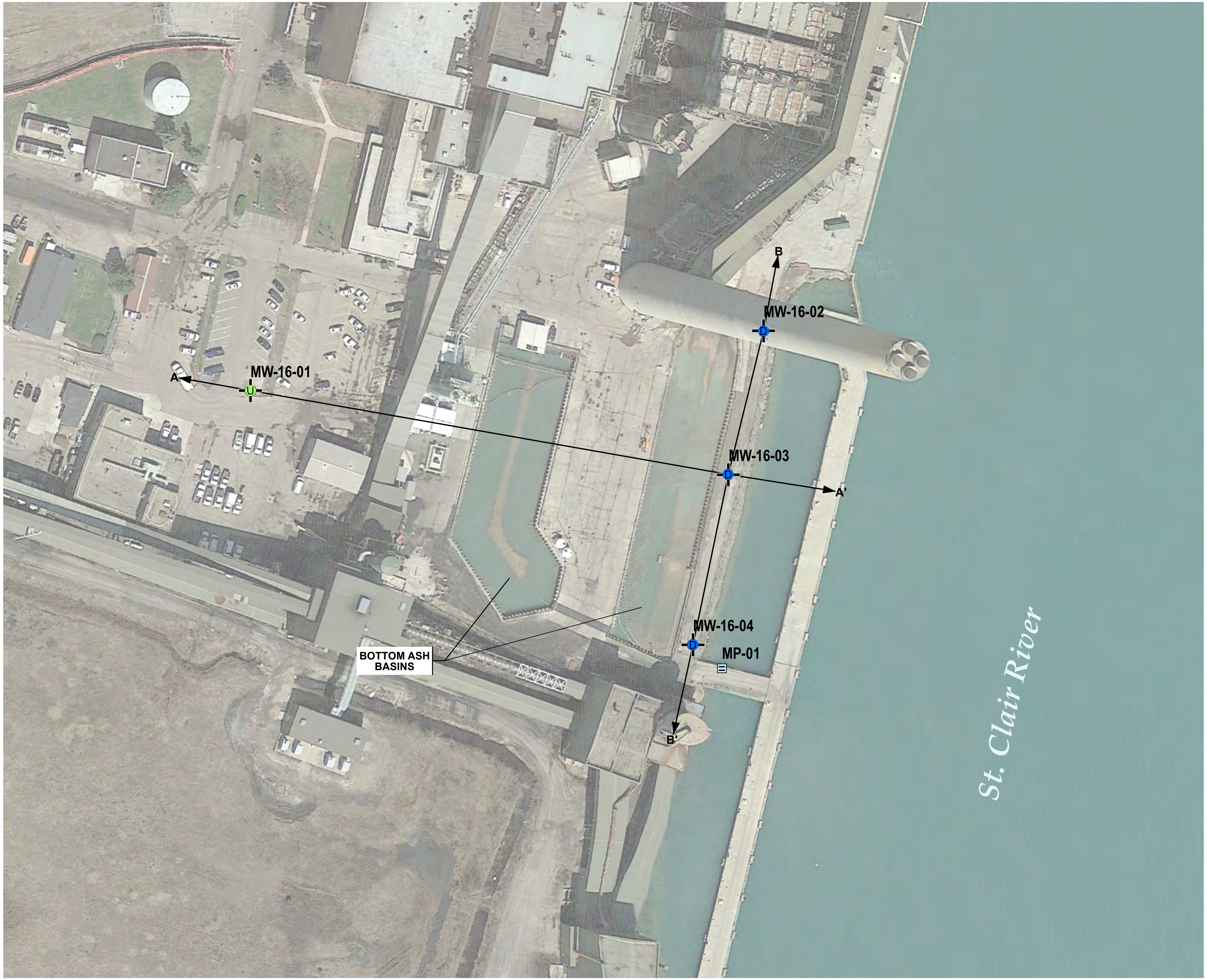
WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE								
NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
			100					
12 CS	100		105					
			110		CL			
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN/SHALE mostly clay and silt, very dark gray (10YR 3/1), no odor, dry to moist, hard.	CL-ML			
			130					
				SHALE light gray (10YR 7/1) to very dark gray (10YR 3/1), no odor, dry.				
15 CS	100		135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					

Appendix B
Hydrogeologic Cross Sections

TRC - GIS



LEGEND

D	DOWN-GRADIENT WELL
U	UP-GRADIENT WELL
⊟	RIVER LEVEL MONITORING POINT
⟷	CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '
1:1,200

PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
4901 POINTE DRIVE
CHINA TOWNSHIP, MICHIGAN

TITLE:
CROSS-SECTION LOCATOR MAP

DRAWN BY:	B DEEGAN	PROJ NO.:	254222.0004
CHECKED BY:	S.HOLMSTROM		
APPROVED BY:	V.BUENING	**FIGURE B-1**	
DATE:	FEBRUARY 2017		

TRC

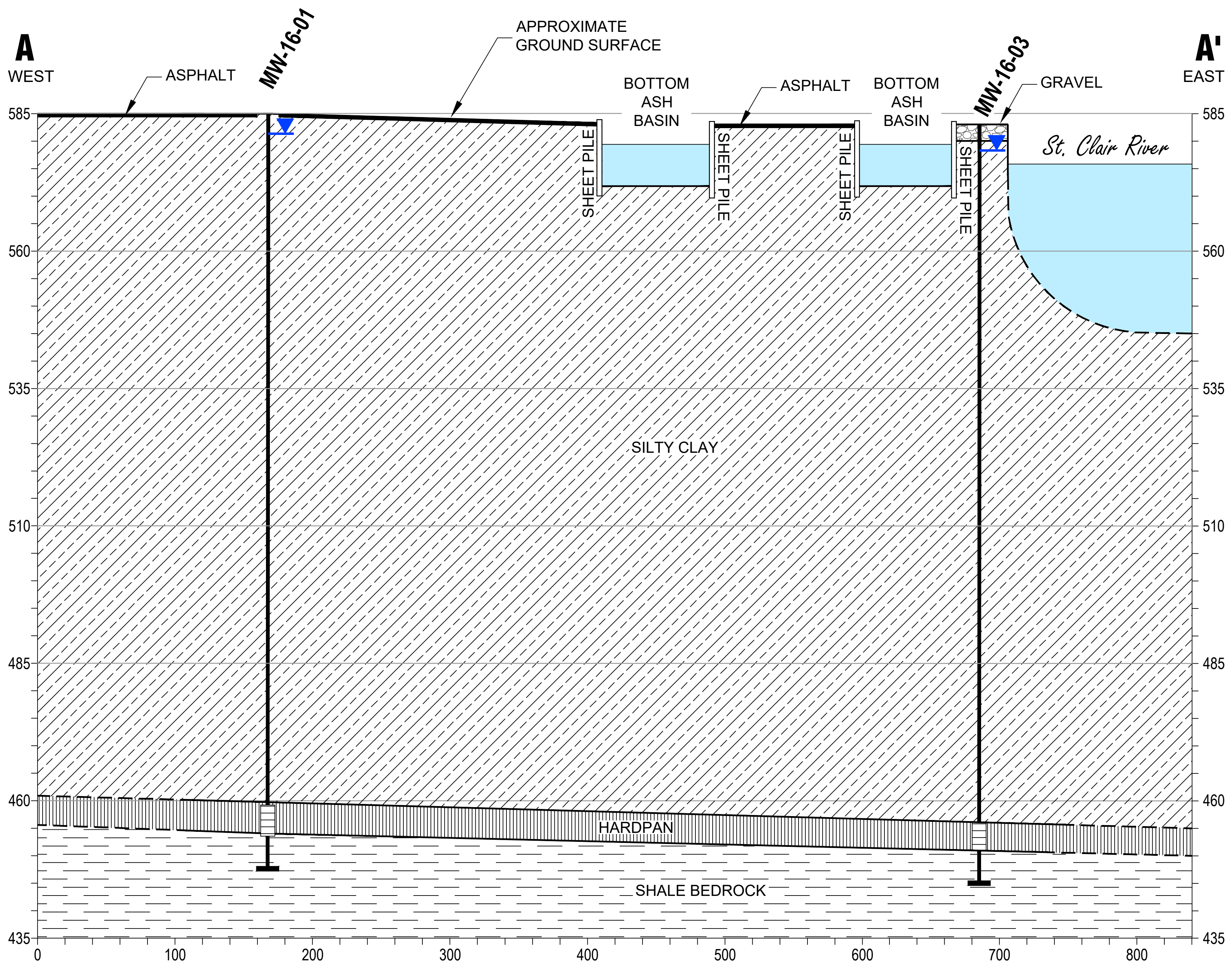
1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 254222-0004-002.mxd

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 2/23/2017, 11:57:48 AM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2016_231828\254222-0004-002.mxd

GENERALIZED GEOLOGIC CROSS-SECTION A-A'



LEGEND

STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)

GROUNDWATER ELEVATION (COLLECTED 02/28/2017)

SOIL BORING

WELL SCREEN INTERVAL

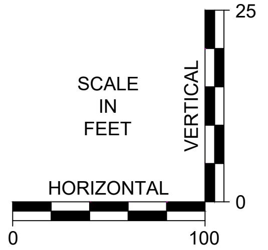
END OF BORING

Lithology Key

▥ HARDPAN

▨ SILTY CLAY

☰ SHALE BEDROCK



PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

GENERALIZED
GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.: 265996.0004.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE B-2**
APPROVED BY:	V.BUENING	
DATE:	SEPTEMBER 2017	

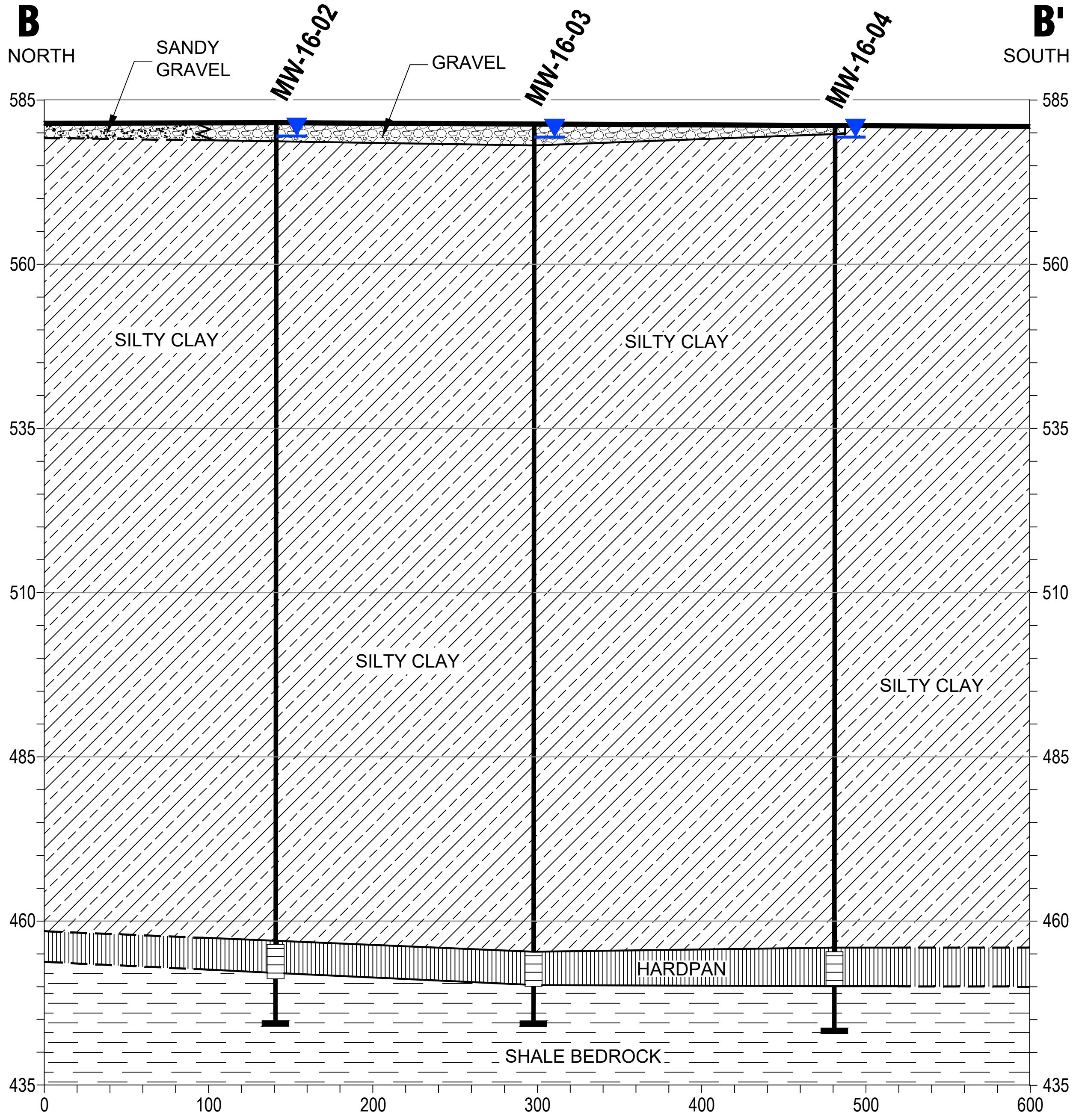
TRC

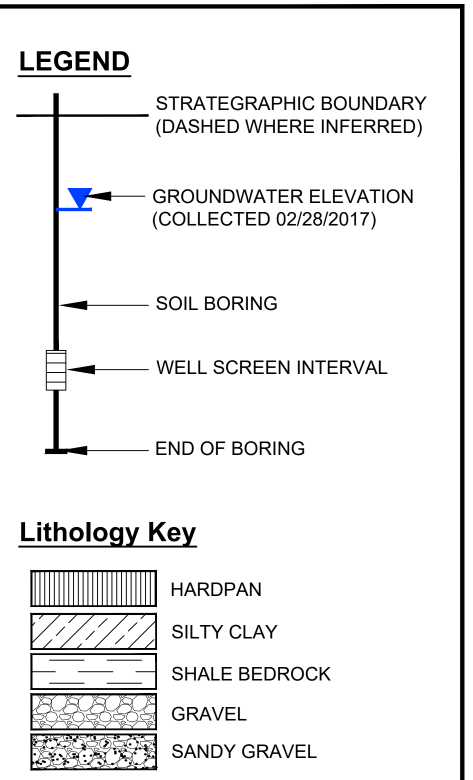
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

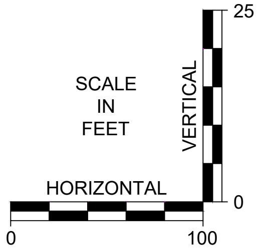
FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:02PM --- LAYOUT: FIG04 XS AA

GENERALIZED GEOLOGIC CROSS-SECTION B-B'







PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED
GEOLOGIC CROSS-SECTION B-B'

DRAWN BY: D.STEHLE
CHECKED BY: S.HOLMSTROM
APPROVED BY: V.BUENING
DATE: SEPTEMBER 2017
PROJ NO.: 265996.0004.01.01

FIGURE B-3

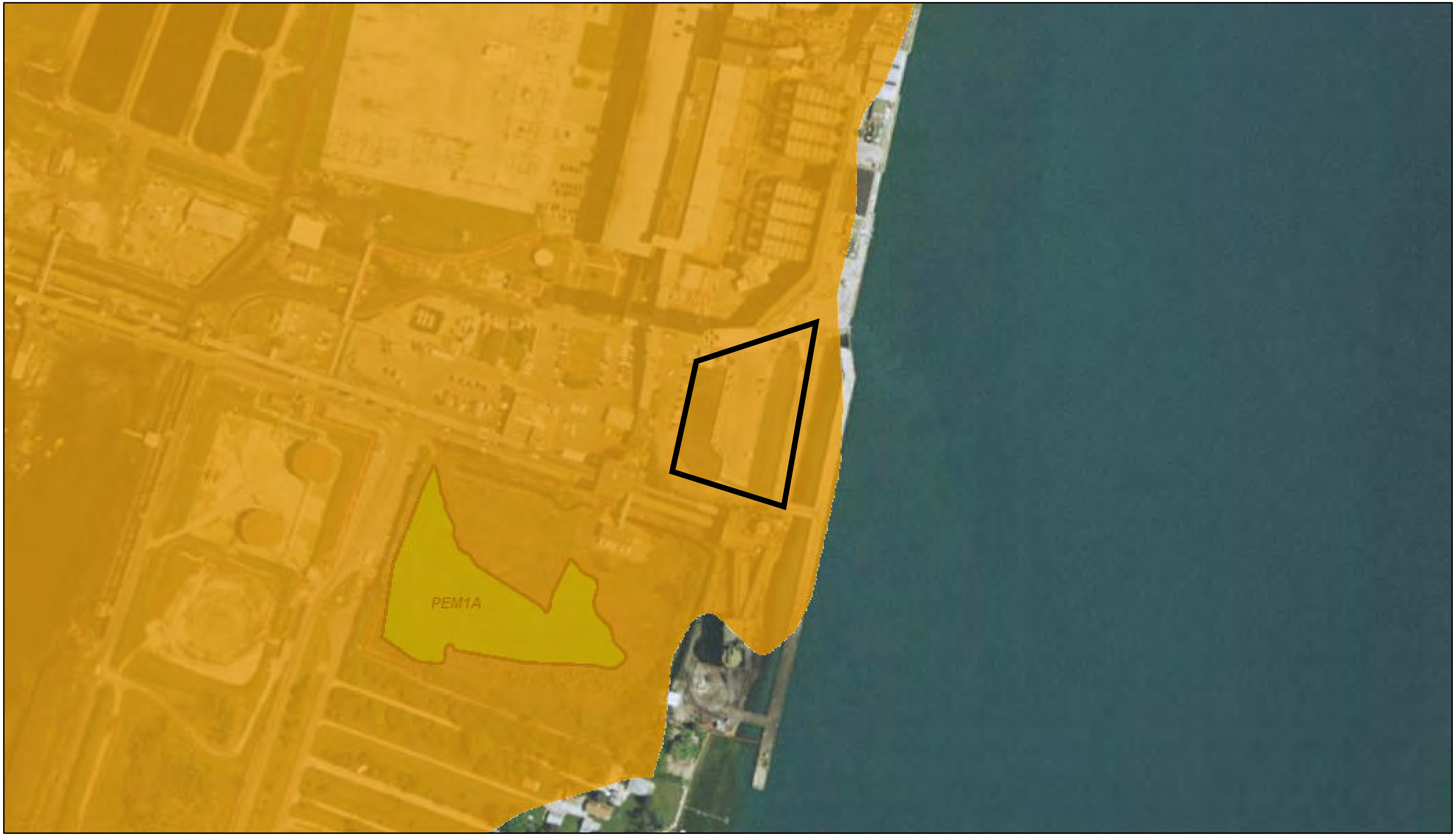
TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:03PM --- LAYOUT: FIG05 XS BB

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

1:3,809

0 0.0325 0.065 0.13 mi

0 0.05 0.1 0.2 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

Disclamer: This map is not intended to be used to determine the specific locations and jurisdictional boundaries of wetland areas subject to regulation. More information regarding this map, including how to obtain a copy can be accessed at www.michigan.gov/wetlands.

Map by: State of Michigan - CSS

Appendix D
U.S. Quaternary Faults and Folds Map

Appendix E
U.S. Seismic Design Maps and Calculations

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.

SCPP BABs - Seismic Impact Zone

Latitude = 42.761°N, Longitude = 82.472°W

Location

Reference Document

2015 NEHRP Provisions

Site Class

D (default): Stiff Soil

Risk Category

I or II or III

S_S = 0.088 g

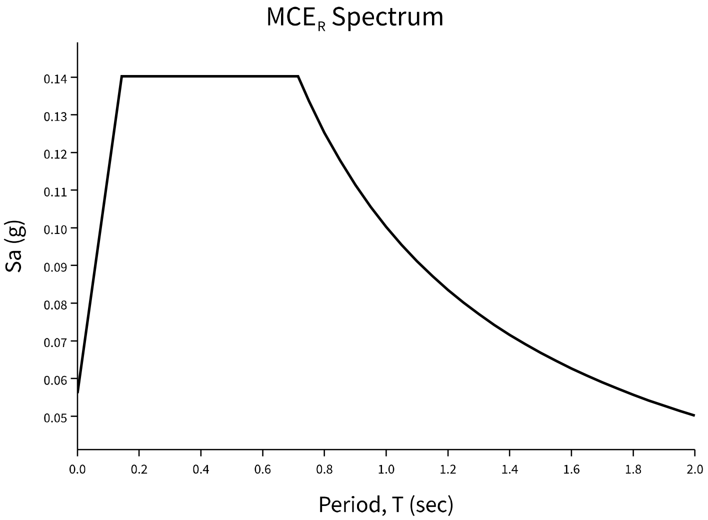
S_{MS} = 0.140 g

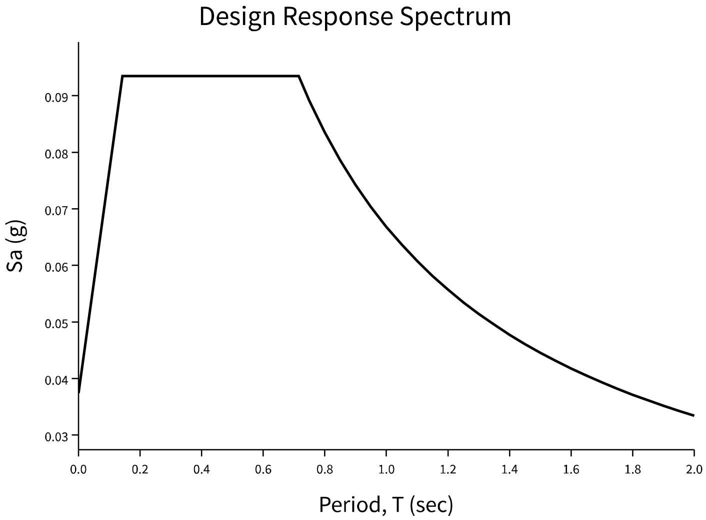
S_{DS} = 0.093 g

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)

$C_{RS}S_{SUH} = 0.935 \times 0.094 = 0.088$ g

Deterministic Ground Motion (0.2 s)

$S_{SD} = 1.500$ g

$S_S \equiv$ “Lesser of $C_{RS}S_{SUH}$ and S_{SD}” = 0.088 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

	Spectral Reponse Acceleration Parameter at Short Period					
Site Class	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S = 1.25$	$S_S \ge 1.50$
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)	$\boxed{1.6}$	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 $S_S \ge 1.0$ 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 = 0.088 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)

$S_{MS} = F_a S_S = 1.600 \times 0.088 = 0.140$ g

Site-adjusted MCE_R (1.0 s)

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

Design Spectral Acceleration Parameters

Design Ground Motion (0.2 s)

$S_{DS} = ⅔ S_{MS} = ⅔ \times 0.140 = 0.093$ g

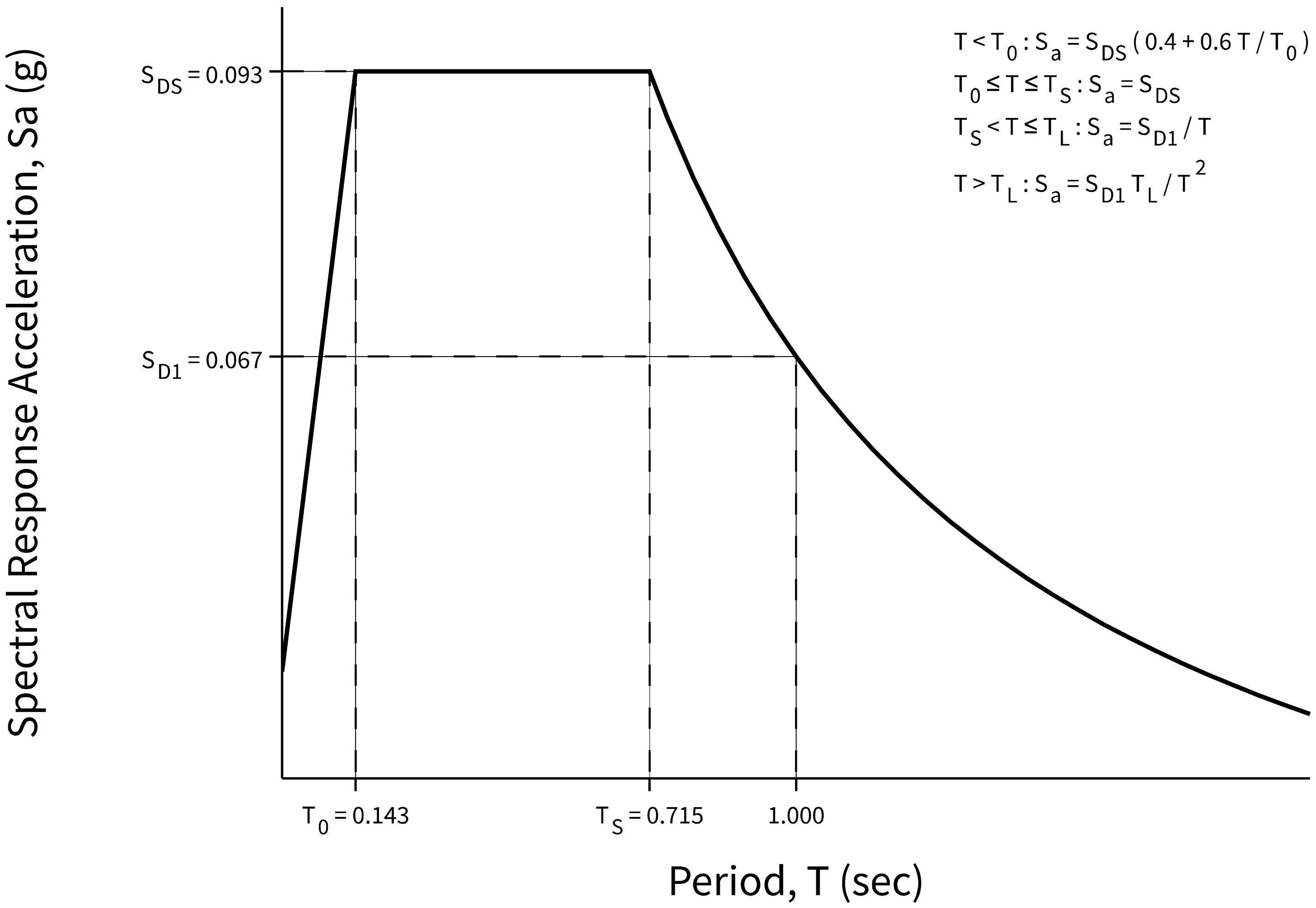
Design Ground Motion (1.0 s)

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

Design Response Spectrum

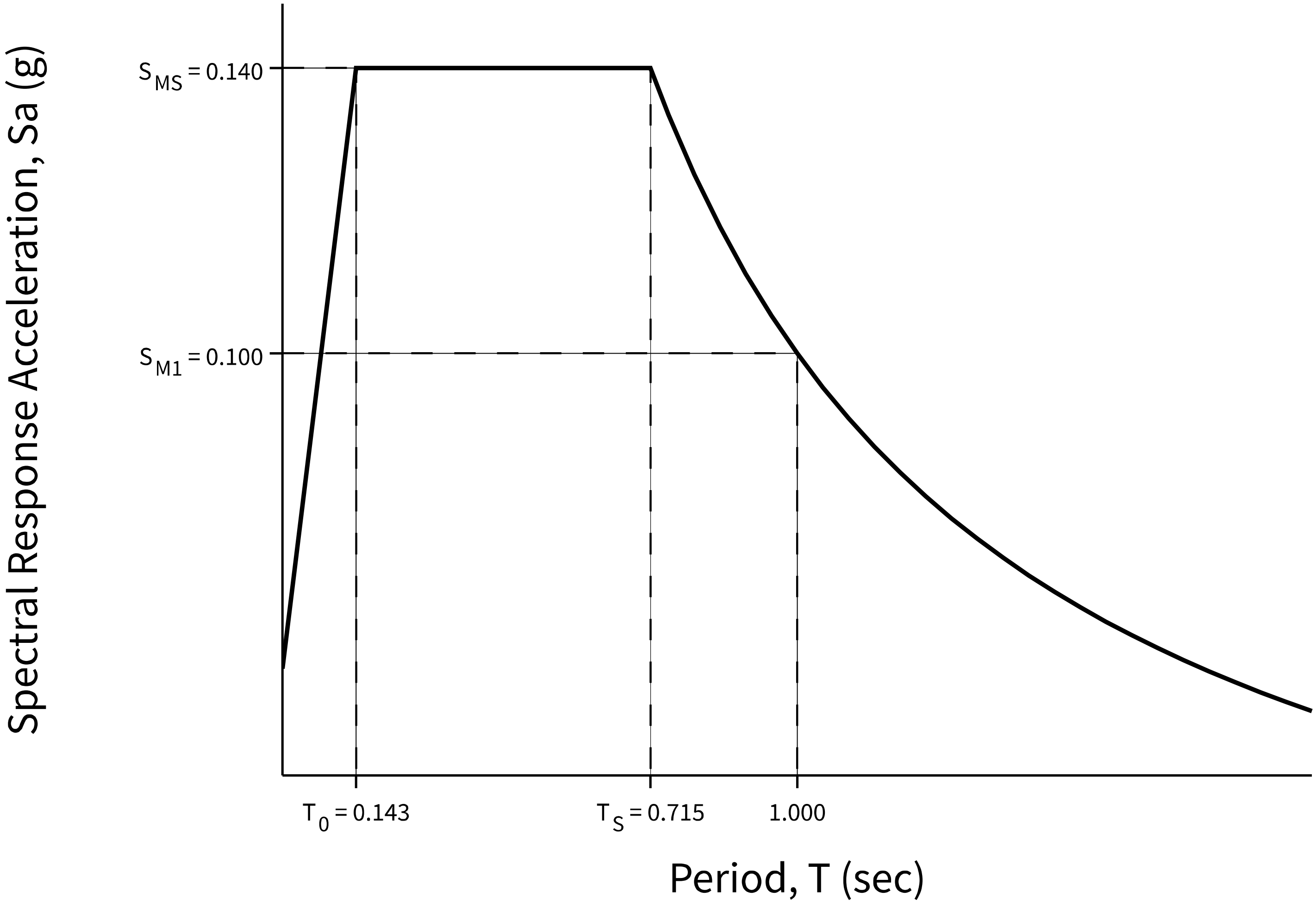
Long-Period Transition Period = T_L = 12 s

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

Appendix J
Closure Plans

Closure Plan East Bottom Ash Basin

CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT PER 40 CFR 257.102 (b)

SITE INFORMATION

Site Name / Address	DTE Energy St. Clair Power Plant Bottom Ash Basin #2 (east) / 4877 M-29, East China, MI 48054		
Owner Name / Address	DTE Electric Company / One Energy Plaza, Detroit, MI 48226		
CCR Unit	Ash Pond	Final Cover Type	N/A
Reason for Initiating Closure	Known final receipt of waste	Closure Method	Closure by Removal

CLOSURE PLAN DESCRIPTION

(b)(1)(i) – Narrative description of how the CCR unit will be closed in accordance with this section.	The Ash Pond will be dewatered to facilitate CCR removal and decontamination of the unit. Closure operations will involve: (i) CCR removal by excavation of the ash pond, (ii) removal or decontamination of any areas affected by releases of CCR, (iii) demolition/abandonment of associated non-earthen features, and (iv) regrading to final desired grades using borrow soil for fill, as needed. In accordance with 257.102(b)(3), this written closure plan will be amended to provide additional details after the final engineering design for the closure by removal is completed. This closure plan reflects the best information available to date.
(b)(1)(ii) If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.	CCR will be removed primarily by excavation of the ash pond. The underlying and surrounding soils will be removed or decontaminated. If necessary and as confirmed by groundwater monitoring results, the upper-most usable aquifer will be flushed, pumped, and/or treated. Wastes generated will be disposed in compliance with applicable regulations.

INVENTORY AND AREA ESTIMATES

(b)(1)(iv) – Estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit	2,080 cubic yards
(b)(1)(v) – Estimate of the largest area of the CCR unit ever requiring a final cover	No final cover will be placed as the CCR is being removed.

CLOSURE SCHEDULE

(b)(1)(vi) – Schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including major milestones …and the estimated timeframes to complete each step or phase of CCR unit closure.

The milestone and the associated timeframes are estimates. Some of the activities associated with the milestones will overlap. Amendments to the milestones and timeframes will be made as more information becomes available.

Written Closure Plan Placed in Operating Record	November 25, 2020
Notification of Intent to Close Placed in Operating Record	January 2022
Agency coordination and permit acquisition • Coordinating with state agencies for compliance • Acquiring state permits	 Fall 2021 through Spring 2022 (estimated) Spring/Summer 2022 (estimated)
Mobilization	Summer 2022 (estimated)
Dewater ash pond	Summer 2022 (estimated)
CCR removal and decontamination	Summer/Fall 2022 (estimated)
Estimate of Year in which all closure activities will be completed	2023

Certification by qualified professional engineer appended to this plan.

Certification Statement 40 CFR § 257.102(b)(4) – Written Closure Plan for a CCR Surface Impoundment

CCR Unit: DTE Energy St. Clair Power Plant Bottom Ash Basin #2 (east)

I, David McKenzie, P.E., being a Registered Professional Engineer in good standing in the State of Michigan, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in this written closure plan dated November 25, 2020 meets the requirements of 40 CFR § 257.102.

David McKenzie, P.E
Printed Name

November 25, 2020
Date

David B. McKenzie
No. 42332

Closure Plan West Bottom Ash Basin

CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT PER 40 CFR 257.102 (b)

SITE INFORMATION

Site Name / Address	DTE Energy St. Clair Power Plant Bottom Ash Basin #1 (west) / 4877 M-29, East China, MI 48054		
Owner Name / Address	DTE Electric Company / One Energy Plaza, Detroit, MI 48226		
CCR Unit	Ash Pond	Final Cover Type	N/A
Reason for Initiating Closure	Known final receipt of waste	Closure Method	Closure by Removal

CLOSURE PLAN DESCRIPTION

(b)(1)(i) – Narrative description of how the CCR unit will be closed in accordance with this section.	The Ash Pond will be dewatered to facilitate CCR removal and decontamination of the unit. Closure operations will involve: (i) CCR removal by excavation of the ash pond, (ii) removal or decontamination of any areas affected by releases of CCR, (iii) demolition/abandonment of associated non-earthen features, and (iv) regrading to final desired grades using borrow soil for fill, as needed. In accordance with 257.102(b)(3), this written closure plan will be amended to provide additional details after the final engineering design for the closure by removal is completed. This closure plan reflects the best information available to date.
(b)(1)(ii) If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.	CCR will be removed primarily by excavation of the ash pond. The underlying and surrounding soils will be removed or decontaminated. If necessary and as confirmed by groundwater monitoring results, the upper-most usable aquifer will be flushed, pumped, and/or treated. Wastes generated will be disposed in compliance with applicable regulations.

INVENTORY AND AREA ESTIMATES

(b)(1)(iv) – Estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit	4,450 cubic yards
(b)(1)(v) – Estimate of the largest area of the CCR unit ever requiring a final cover	No final cover will be placed as the CCR is being removed.

CLOSURE SCHEDULE

(b)(1)(vi) – Schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including major milestones …and the estimated timeframes to complete each step or phase of CCR unit closure.

The milestone and the associated timeframes are estimates. Some of the activities associated with the milestones will overlap. Amendments to the milestones and timeframes will be made as more information becomes available.

Written Closure Plan Placed in Operating Record	November 25, 2020
Notification of Intent to Close Placed in Operating Record	January 2022
Agency coordination and permit acquisition • Coordinating with state agencies for compliance • Acquiring state permits	Fall 2021 through Spring 2022 (estimated) Spring/Summer 2022 (estimated)
Mobilization	Summer 2022 (estimated)
Dewater ash pond	Summer 2022 (estimated)
CCR removal and decontamination	Summer/Fall 2022 (estimated)
Estimate of Year in which all closure activities will be completed	2023

Certification by qualified professional engineer appended to this plan.

TRC

Certification Statement 40 CFR § 257.102(b)(4) - Written Closure Plan for a CCR Surface Impoundment

CCR Unit: DTE Energy St. Clair Power Plant Bottom Ash Basin #1 (west)

I, David McKenzie, being a Registered Professional Engineer in good standing in the State of Michigan, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the written closure plan dated November 25, 2020 meets the requirements of 40 CFR § 257.102.

David McKenzie, P.E
Printed Name

November 25, 2020
Date

David B. McKenzie
Engineer
No. 42332