GROUNDWATER STATISTICAL EVALUATION PLAN
COAL COMBUSTION RESIDUALS (CCR) RULE

INACTIVE BOTTOM ASH BASIN
DTE MONROE PLANT
MONROE, MICHIGAN

Prepared for:

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Contents

1.0 INTRODUCTION

Pursuant to the Coal Combustion Residuals Rule (CCR Rule), no later than April 17, 2019, 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.

1.1 Regulatory Framework

Regulatory guidance provided in 40 CFR §257.90 specifies that a CCR groundwater monitoring program must include selection of the statistical procedures to be used for evaluating groundwater quality data as required by 40 CFR §257.93. Groundwater quality monitoring data has been collected under the detection monitoring program for the inactive Bottom Ash Basin (a single CCR unit) including analysis of eight (8) independent groundwater samples from each background and downgradient well, as required by 40 CFR §257.94(b).

Title 40 CFR §257.93(f) outlines the statistical methods available to evaluate groundwater monitoring data. The statistical test(s) chosen will be conducted for each constituent in each monitoring well and will be appropriate for the constituent data and the data set distribution.

In accordance with 40 CFR §257.93(f)(6), a qualified professional engineer must certify that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR unit.

1.2 Site Hydrogeology

The bedrock in the site vicinity is overlain by approximately 40 to 50 feet of unconsolidated deposits of glacial origin. The deposits are comprised of two (2) distinct units: a hard glacial till immediately overlying bedrock and lacustrine (lake bed or lake shore) deposits which overlay the till unit. The till is comprised of over consolidated (highly compacted) gray silty to sandy clay with some cobbles and boulders, and ranges from approximately 20 to 50 feet in thickness. The overlying lacustrine deposits are composed of 10 to 30 feet of fine-grained sand and silt with some soft clay except where there is a thin, discontinuous coarse sand unit at the base of the lacustrine sequence. A detailed site hydrogeologic summary is presented in the Monitoring Well Installation Report, Coal Combustion Residuals Rule, Inactive Bottom Ash Basin, DTE Monroe Plant, Monroe, Michigan, dated March 2019.

Under parts of the Plant, the Inactive Bottom Ash Basin, and Process Pond areas, this sand unit ranges in thickness from 5 to 20 feet and yields groundwater. The sand unit thins progressively to the west, having a thickness of approximately 12 feet on the east side of the discharge canal and thinning to less than a few feet within 150 feet to the west of the discharge canal. Further to the west the sand unit is not evident in soil borings for monitoring wells drilled in 2016 around the Fly Ash Basin. This is consistent with the expectation that lake-deposited materials will decrease in thickness with distance away from Lake Erie. Accordingly, it appears that this sand unit is a localized lakeshore beach deposit formed by westward aggradation with rising lake level and subsequently blanketed by finer lacustrine deposits. Groundwater in the sand unit is under semi-confined conditions with groundwater elevations ranging between approximately 572.6 and 575.6 feet above mean sea level (msl).

In this scenario, the groundwater monitoring system wells do not serve as simple upgradient or downgradient monitoring points. This is because of two main factors:

- The sand unit located at the bottom of the lacustrine deposits is limited in extent. The unit is present in the inactive Bottom Ash Basin area and extends a limited distance north into the main Monroe Plant area. As noted above, the sand unit extends westward but also thins out and is not present in monitoring wells located greater than 500 feet west of the CCR unit. As a consequence, there is no representative upgradient or background monitoring position available for the unit.
- There is a strong confined hydraulic pressure in the sand unit aquifer. The overlying finer grained lacustrine deposits are relatively dry but water levels in the monitoring wells installed in the sand unit rise to within 2.5 to 12.0 feet below ground surface (bgs), likely driven by hydraulic pressure from the underlying bedrock aquifer system.

2.0 GROUNDWATER MONITORING SYSTEM

The following sections provide a summary of the monitoring well network for the inactive Bottom Ash Basin and the constituents required for the Detection and Assessment Monitoring phases under the CCR Rule.

2.1 Groundwater Monitoring System

The monitoring well network for the inactive Bottom Ash Basin (a single CCR unit) consists of the following monitoring wells (shown on Figure 1):

MW-1S	MW-2S	MW-3S	MW-7S	MW-8S	MW-9
MW-10	MW-11	MW-12	MW-13	MW-14	MW-15

The number, spacing, and depth of monitoring wells was based on a thorough characterization of the hydrogeologic factors included in § 257.91 (b)(1)&(2). Details are presented in the *Monitoring Well Installation Report, Coal Combustion Residuals (CCR) Rule, Inactive Scrubber Basins, DTE St. Clair Plant* dated March 2019.

2.2 Constituents for Detection Monitoring

The following inorganic constituents are required to be monitored as part of the Detection Monitoring Program under the CCR Rule (Subsection 257.94):

Boron	Calcium
Chloride	Fluoride
pH	Sulfate
Total Dissolved Solids (TDS)	

These constituents comprise the Appendix III list under Subsection 257.94 of the CCR Rule. Detection Monitoring is to be performed on a semi-annual basis, unless site-specific conditions justify an alternate frequency.

2.3 Constituents for Assessment Monitoring

The following inorganic constituents are required to be monitored as part of an Assessment Monitoring Program under the CCR Rule (Subsection 257.95):

Antimony	Arsenic	Barium
Beryllium	Cadmium	Chromium
Cobalt	Fluoride	Lead
Lithium	Mercury	Molybdenum
Selenium	Thallium	Radium 226 and 228 (combined)

These constituents comprise the Appendix IV list under Subsection 257.95 of the CCR Rule. Assessment Monitoring (subsection 257.95 of the CCR Rule) is required if a statistically significant increase (SSI) over background is identified for one or more Appendix III constituents under the Detection Monitoring program.

3.0 STATISTICAL ANALYSIS

The plan for statistical analysis of the groundwater monitoring data includes a series of initial steps, and subsequent series of evaluation steps specifically applicable to Detection Monitoring, Assessment Monitoring, or Corrective Action as described in the following sections. Statistical methods specified in 40 CFR 257.93(f) must be used to evaluate groundwater monitoring data. The statistical tests must meet the performance standards outlined in 40 CFR 257.93(g). The goal of the statistical evaluation is to determine whether a CCR unit has released contaminants into underlying groundwater. This determination is made by identifying a statistically significant increase (SSI), or in the case of pH either a SSI or a statistically significant decrease (SSD), over background. The specific statistical procedure selected for a given data set depends on several factors including the distribution of the data and the percentage of not detected values within the data for each constituent. Parametric or non-parametric prediction intervals are generally considered the preferred method of evaluating detection or assessment monitoring data and will be used at this site.

3.1 Interwell vs Intrawell Statistical Approach

The first step in evaluating the data is to determine whether an interwell or an intrawell statistical approach is appropriate. Interwell testing is appropriate when there is an identifiable upgradient or background location that is not impacted by the CCR unit. Intrawell testing may be appropriate where there is no clear upgradient or background condition for comparison to the waste boundary aquifer condition. As noted in Section 1.2 above, the available hydrogeologic information indicates that the extent of the uppermost aquifer (sand unit overlying glacial till) is limited, which suggests that an intrawell approach may be applicable for evaluating groundwater data. Other support for intrawell testing includes:

- The hydraulic confinement of the uppermost aquifer and its relatively shallow potentiometric surface (2.5 to 12 feet bgs) indicates that there is relatively little hydraulic head difference to drive vertical movement of water through the overlying finer grained lacustrine deposits.

- The water quality of the uppermost aquifer (sand unit) includes the presence of naturally occurring ionic constituents, but their relative concentrations are not suggestive of CCR impact.

Accordingly, an intrawell approach has been selected for statistical testing of the inactive Bottom Ash Basin groundwater monitoring system data.

3.2 Outlier Evaluation

Outliers are inconsistently large or small data values that may be the result of sampling, analytical, or transcription errors, laboratory or field contamination, or extreme values with a population. The monitoring data will be initially evaluated graphically using box or time series plots to determine whether outliers may be present in the data for each well and constituent. Outliers for constituents with less than or equal to 50 percent non-detect data will be evaluated using Dixon's outlier test. Definitive outliers will be removed from the background data as appropriate.

3.3 Normality Tests

Tests to determine whether the data exhibit a normal distribution will be performed using the Shapiro-Wilk test for data sets comprised of less than or equal to 50 observations or the Shapiro-Francia test of normality will be used for datasets comprised of greater than 50 observations. Distributions will be determined using the ladder-of-powers for untransformed (raw data), In (x), x1/3, x1/2, x2, x3. The first distribution in the ladder-of-powers having a Shapiro-Wilk W statistic greater than the critical value will be used to calculate the background summary statistics and determine whether the data exhibit a normal or non-normal distribution. Normally distributed data will be evaluated using parametric tests. Nonparametric tests will be used when data cannot be normalized.

3.4 Evaluation of Non-Detects

Constituent concentrations that are reported below the practical quantitation limit (PQL), typically referred to as non-detects, will be evaluated differently depending on the percentage of non-detect values for a particular constituent in a given well. Data that are normally distributed and have less than 15 percent non-detects will be evaluated by substituting one-half of the detection limit to calculate the prediction limit. If more than 15 percent but less than 50 percent of the data are non-detects and the data are normally distributed, the prediction limit will be calculated using Aitchison’s, Cohen’s, or the Kaplan-Meijer adjustment. For data that contain 50 percent or more, a non-parametric prediction limit will be used.

3.5 Parametric or Nonparametric Prediction Limits

Intrawell parametric prediction limits will be used to statistically analyze constituents that are normally distributed and have less than 50 percent non-detects. Nonparametric prediction limits will be used to statistically analyze constituents do not fit a normal distribution, or that may be normally distributed but have 50 percent or more non-detect values. Parametric prediction limits are calculated as outlined in the U.S. Environmental Protection Agency’s (EPA’s) Unified Statistical Guidance (USEPA 2009). A nonparametric prediction limit is determined as the largest constituent concentration (excluding outliers) measured during the background period. For parameters comprised of 100 percent non-detect data, the most recent practical quantitation limit (PQL) will be set as the nonparametric prediction limit. It is noted that if there is a new lower PQL utilized by the laboratory in the future, the statistical limit will be maintained at the previous higher PQL until there are a minimum of eight observations reported using the new lower PQL. The statistical limit will be re-evaluated once eight (8) results at the lower PQL are available.

Semiannual sampling results will be compared to the parametric or nonparametric prediction limits to determine if results exhibit any SSIs above background. For parameters where background is comprised of 100 percent non-detect data, the double quantification rule will be applied, wherein an exceedance of the PQL by a quantified constituent concentration will be considered a SSI, and may be verified by resampling. Two or more consecutive SSIs are required to confirm a constituent as exhibiting a SSI over background.

3.6 False Positive and Negative (Statistical Power)

To achieve the site-wide false positive rates (SWFPR) recommended in the EPA's Unified Statistical Guidance (USEPA 2009), the verification resampling program outlined in Section 4.2 is required. Without verification resampling, the SWFPR cannot be reasonably met, and much larger statistical limits would be required to achieve a SWFPR of 5 percent or less for a semi-annual sampling event. Furthermore, the false negative rate would also be greatly increased. Power curves will be calculated to verify that the SWFPR is achieved for each sampling event.

3.7 Updating Background

Due to the complex behavior of groundwater and the need for sufficiently large sample sizes, background data should not be regarded as a single fixed quantity. Background should be sampled regularly throughout the life of the facility, and periodically reviewed and revised as necessary to account for changes in background water quality that are not attributable to a CCR unit. There are no firm rules on how often to update background data. The EPA's Unified Statistical Guidance (USEPA, 2009) adopts the general principle that updating should occur when enough new measurements have been collected to allow a two-sample statistical comparison between the existing background data and a potential set of newer data. At least 4 to 8 new measurements should be gathered to enable such a test; this implies that updating would take place every 2 to 4 years with semi-annual sampling.

4.0 ASSESSMENT MONITORING

If through the statistical analyses discussed in Section 3, it becomes evident that an SSI over background has occurred for one or more of the Detection Monitoring constituents, then the Site must place documentation in the facility operating record indicating which constituents have shown a SSI over background. The site then has three options to continue groundwater monitoring at the CCR unit.

- **Verification Sampling:** The first option would be to evaluate whether the increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality;
- **Alternate Source Demonstration:** The second option would be to evaluate whether a source other than the waste unit caused the statistically significant increase; or
- **Assessment Monitoring:** The third option would be to establish an assessment monitoring program for the CCR unit. The purpose of assessment monitoring would be to evaluate if constituent releases have occurred from the CCR unit to the underlying groundwater.

4.1 Verification Sampling

Verification resampling is an integral component of the statistical methods outlined above. Verification resampling provides a way to evaluate unexpected or errant sample results and can help avoid unnecessary entry into assessment monitoring. A verification resample would only be collected from the well(s) where an outlier or statistically significant concentration increase was observed, and only for the relevant analyte(s). The same sampling procedures used for Detection Monitoring would also be used for verification resampling. The facility will take reasonable efforts to complete verification resampling within 30 days of identifying the need to resample. A "1 of m" sampling protocol will be used to verify initial statistical exceedances. A "1 of 2" sampling method is defined as the collection of an initial sample and one confirmatory resample. A SSI is only flagged when a verification sample confirms the initial result.

4.2 Alternate Source Demonstration

In addition to verification resampling, the facility may also choose to evaluate whether the statistically significant concentration increase was derived from another source besides the CCR unit. Such an evaluation, if warranted, may require specialized sample analyses to identify concentration inputs from other potential sources. Any report prepared as a result of this evaluation or as a result of verification resampling will be placed into the facility operating record within 90 days of identifying the statistically significant concentration increase. The report must also be certified by a qualified Professional Engineer.

4.3 Assessment Monitoring Program

Assessment Monitoring is required whenever a SSI over background levels has been detected for one or more of the constituents listed in 40 CFR 257 Appendix III. A routine sample result will only be considered valid if the verification sample result confirms a SSI over background. If this situation occurs, the facility will implement an Assessment Monitoring program within 90 days of obtaining the verification resample result in accordance with 40 CFR 257.95. In Assessment Monitoring, the owner or operator of the CCR unit must sample and analyze the groundwater for all constituents listed in 40 CFR 257 Appendix IV within 90 days of a confirmed SSI over background, and annually thereafter. Within 90 days of obtaining the initial Assessment Monitoring results, and on at least a semiannual basis thereafter, resample all monitoring wells and conduct analyses for all parameters in 40 CFR 257 Appendix III and for those constituents in 40 CFR 257 Appendix IV that are detected above background in the initial assessment monitoring. All assessment monitoring results will be entered into the facility operating record as required by 40 CFR 257.95. The facility can return to detection monitoring once assessment monitoring results are at or below background values for two consecutive Assessment Monitoring events.

5.0 CERTIFICATION STATEMENT PER 40 CFR § 257.93(F)(6)

CCR Unit: DTE Electric Company, Monroe Power Plant – Inactive Bottom Ash Basin

I, Scott Hutsell, 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 is prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced coal combustion residuals (CCR) Unit, that the statistical approach selected for the groundwater monitoring system, as described in this document, is appropriate for evaluating the groundwater monitoring data for the CCR management area.

Scott Hutsell

Printed Name

04/15/19

Date

6.0 REFERENCES

AECOM, 2019. *Monitoring Well Installation Report, Coal Combustion Residuals Rule, Inactive Bottom Ash Basin, DTE Monroe Plant, Monroe, Michigan, March 2019*

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 1

Monitoring Well Location Map

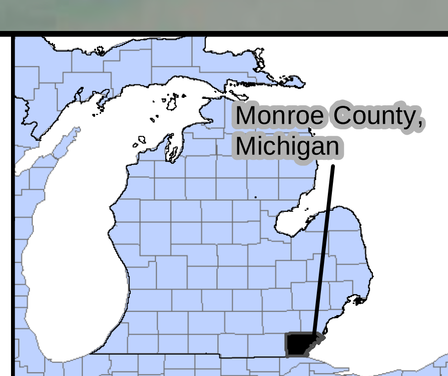
Document Path: G:\Cincinnati\DCS\GIS\ArcMap_GeoDB_Projects\D\DTE\DTE-Monroe Plant\Data-Tech\GIS\DTE_Monroe_Fig2_WellLocationMap_WithDeepWells_2018_20190114.mxd

LEGEND:

- CCR Program Monitoring Well
- Investigation Monitoring Well (Potentiometry Only)
- Unit Separation Berm
- Approximate Plant Boundary
- Approximate Boundary of Inactive Bottom Ash Basin

N

0 700 1,400 Feet



DTE Energy

Monroe Power Plant

FIGURE 1
INACTIVE BOTTOM ASH BASIN
WELL LOCATION MAP
2018

DATE: 3/20/2019	SCALE 1 inch = 720 feet
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