

December 15, 2022

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

**Groundwater Monitoring Statistical Methods, Revision 1
Update from 2017 Certification
Ash Pond Complex
TVA Gallatin Fossil Plant
Gallatin, Tennessee**

1. Introduction

This letter documents AECOM's updated certification of the statistical methods for use in the Tennessee Valley Authority (TVA) Coal Combustion Residuals (CCR) Rule Groundwater Quality Monitoring Program at the Gallatin Fossil Plant Ash Pond Complex (APC), which includes Ash Pond A, Ash Pond E, Middle Pond A, and the Bottom Ash Pond. The statistical methods described below are appropriate for evaluating the groundwater monitoring data for the Ash Pond Complex, as required by the CCR Rule at 40 CFR § 257.93, 257.94, and 257.95. This is an update from the previous certification dated November 2017.

Revision Log

Revision	Date	Details
0	11/14/2017	Initial certification in accordance with 40 CFR 257.93(f)(6)
1	12/15/2022	Update for consistency with the statistical methods used at other TVA fossil plants

2. Description of Statistical Methods

The statistical methods presented here are subject to change based on data that may be collected in the future and/or for different phases of monitoring. Changes to the statistical methods will need re-certification.

2.1 Detection Monitoring (257.93, 257.94)

The statistical evaluations of background at the APC are based on an inter-well approach, where background concentrations are derived from sampling of background/upgradient wells. The statistical methods described below are used during Detection Monitoring at the APC to identify statistically significant increases (SSIs) over background at downgradient wells in accordance with 257.93(h).

- Background concentrations of Appendix III constituents are calculated using an Upper Prediction Limit (UPL) statistic. The UPL is one of the statistical methods specifically identified in the CCR Rule at 257.93(f)(3) and 257.93(g)(4).
- The UPLs are calculated with a 99% confidence, consistent with the US Environmental Protection Agency's (USEPA) Unified Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (EPA 530/R-09-007; March 2009).
- Separate background UPLs are calculated for the Carters Limestone and Lebanon Limestone formations. Specific wells representing background for these formations are provided on Table 1 of the Groundwater Monitoring System Certification dated September 10, 2020 (Revision 2). The initial background dataset is based on the data collected from these wells between November 2016 and August 2017, which represents a minimum of eight sampling events. The UPLs may be recalculated and updated, as additional data is obtained from these wells in subsequent sampling events.
- Background UPLs are calculated using ProUCL, a software tool developed by the USEPA. ProUCL also evaluates the distribution of the data, so that a distribution-appropriate UPL is calculated for each constituent, as required by 257.93(g)(1). ProUCL may identify a distribution as normal, log-normal, gamma, or distribution-free (i.e., non-parametric).
- ProUCL is also designed to handle results below the limit of detection, as required by 257.93(g)(5).
- For pH, a Lower Prediction Limit (LPL) with 99% confidence is also calculated.
- During Detection Monitoring (257.94), to identify potential SSIs over background, the results from each of the downgradient wells are compared to the formation-specific (i.e., Carters or Lebanon Limestone) background UPL for each Appendix III constituent (257.93(f)(3) and 257.93(h)). For pH, the detection monitoring results from the downgradient wells are compared to both the UPL and LPL to identify both statistically significant increases and decreases in pH compared to background levels.
- Where an SSI over background may be found, verification re-sampling may be used to confirm the sampling results.

2.2 Assessment Monitoring (257.95)

There are two aspects of Assessment Monitoring that may involve statistics. Where background concentrations of an Appendix IV constituent are above the published Groundwater Protection Standard (GWPS), statistics may be used to calculate a site-specific GWPS based on background (257.94(h)). Statistics are also used to identify Statistically Significant Levels (SSLs) above GWPSs. The statistical methods used in Assessment Monitoring are described below.

2.2.1 Site-Specific GWPSs

Where background concentrations are above published GWPSs for Appendix IV constituents, a site-specific GWPS based on background (257.95(h)(3)) is developed based on an upper tolerance limit (UTL). The UTL is one of the statistical methods specifically identified in the CCR Rule at 257.93(f)(3) and 257.93(g)(4).

- The UTL is calculated with 95% confidence ($\alpha=0.05$) and 95% coverage, consistent with recommendations in the USEPA's Unified Guidance.

- UTLs are calculated at each of the seven background wells, using the current full dataset (November 2016 to September 2022). The UTLs may be recalculated and updated, as additional data is obtained from these wells in subsequent sampling events.
- Background UTLs are calculated using ProUCL. ProUCL also evaluates the distribution of the data, so that a distribution-appropriate UTL is calculated for each constituent, as required by 257.93(g)(1). ProUCL may identify a distribution as normal, log-normal, gamma, or distribution-free (i.e., non-parametric).
- ProUCL is designed to handle results below the limit of detection, as required by 257.93(g)(5). Non-detect results with a detection limit greater than the maximum detected concentration were omitted from the datasets. Other non-detect results were retained.
- UTLs are calculated for each well of the background wells in the monitoring network. The maximum UTL is then used as the GWPS applicable to the CCR unit.

2.2.2 GWPS Exceedances

During assessment monitoring, 40 CFR 257.95(g) requires SSLs of Appendix IV constituents above GWPSs to be identified. The identification of SSLs is performed in a step-wise process:

- At each downgradient well, the sampling result for each Appendix IV constituent is compared directly to the GWPS. When the concentration is below the GWPS, no SSL is identified.
- Where sampling results may exceed the GWPS, verification re-sampling may be used to confirm the sampling results. If the verification sampling concentration is below the GWPS (i.e., the exceedance is not confirmed), no SSL is identified.
- Where the direct comparison indicates a concentration above the GWPS, further statistical analysis is performed to identify levels statistically greater than the GWPS, using procedures recommended in the USEPA's Unified Guidance, and described below.
- The additional statistical evaluations use all available data for the constituent at the relevant well since monitoring started (November 2016 for most wells). At some point in time, it may be appropriate to focus only on more recent data to conduct these evaluations.
- Non-detect results with elevated detection limits may be omitted from these calculations where the result could bias the outcome.
- A linear regression analysis is used to identify whether there is a statistically significant concentration trend over time for the Appendix IV constituent in the well that exceeds the GWPS. A trend is considered statistically significant when the slope of the regression line is greater than zero with 95% confidence ($\alpha=0.05$).
- If there is not a statistically significant trend, the 99% upper and lower confidence levels (UCL, LCL, respectively) on the mean concentration in that monitoring well are calculated. As recommended in the Unified Guidance, when both the UCL and LCL exceed the GWPS, an SSL is identified. If the LCL and/or UCL is below the GWPS, no SSL is identified.
- Where there is a statistically significant trend, a confidence band approach is used instead. A 98% confidence band is constructed around the regression line, resulting in a 99% upper and a 99% lower confidence band around the mean. If, for the most recent sample, both the upper and lower confidence bands are above the GWPS, an SSL is identified.
- If either the lower and/or the upper confidence band around the most recent sample is below the GWPS, no SSL is identified.

3. Qualified Professional Engineer Certification

I, David E. Skeggs, PE, being a Registered Professional Engineer in good standing in the State of Tennessee, 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; that the information contained herein is accurate as of the date of my signature below; and that the statistical methods described above are appropriate for evaluating the groundwater monitoring data at the Gallatin Fossil Plant Ash Pond Complex in accordance with 40 CFR § 257.93. Opinions relating to environmental, geologic, and hydrogeologic conditions or other estimates are based on available data; actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

SIGNATURE: 

DATE: 12/15/2022

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