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Statistical Support Document: Effluent Limitations for FGD Wastewater, Gasification Wastewater, and Combustion Residual Leachate for the Final Steam Electric Power Generating Effluent Limitations Guidelines and Standards

STATISTICAL SUPPORT DOCUMENT: EFFLUENT LIMITATIONS FOR FGD WASTEWATER, GASIFICATION WASTEWATER, AND COMBUSTION RESIDUAL LEACHATE FOR THE FINAL STEAM ELECTRIC POWER GENERATING EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS

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Acknowledgements and Disclaimer

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Executive Summary

This report presents the results of the statistical analyses performed on the Flue Gas Desulfurization (FGD) and gasification wastewater treatment data and the resulting long-term averages, variability factors, and effluent limitations. The treatment technology options for FGD wastewater presented in this report are: (i) chemical precipitation system employing both hydroxide and sulfide precipitation and iron coprecipitation (hereafter referred to as "chemical precipitation"), (ii) biological (chemical precipitation employing both hydroxide and sulfide precipitation and iron coprecipitation followed by anoxic/anaerobic biological treatment, hereafter referred to as "biological"), and (iii) chemical precipitation followed by softening and vapor-compression evaporation system (hereafter referred to as "vapor-compression evaporator." The treatment technology option for gasification wastewater is a vapor-compression evaporation system. See the *Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category* (hereafter referred to in this document as Technical Development Document) for a detailed description of the FGD and gasification systems and the wastewater associated with each system, rationale for selecting plants used in the calculation of the effluent limitations for each technology option, and pollutants for regulation for each technology option.

The following bullets summarize the plants from which data were used to calculate the limits for each technology option for FGD wastewater together with the pollutants that would be regulated:

- The effluent limitations for chemical precipitation technology option are based on data from Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie. The pollutants that would be regulated for this technology option are arsenic and mercury.

- The effluent limitations for biological technology option are based on Allen and Belews Creek. The pollutants that would be regulated for this technology option are arsenic, mercury, nitrate-nitrite as N, and selenium. While these two plants operating the biological treatment system were used as the basis for the technology option, neither of these plants include sulfide precipitation in the upstream chemical precipitation system. For this reason, EPA is transferring the arsenic and mercury limitations calculated based on the chemical precipitation treatment to the biological treatment for FGD wastewater (see Section 13 of the Technical Development Document for a detailed discussion of the transfer of limitations).

- The effluent limitations for the vapor-compression evaporation technology option are based on Brindisi. The pollutants that would be regulated for this technology option are arsenic, mercury, selenium, and total dissolved solids.

The following bullet summarizes the plants from which data were used to calculate the effluent limitations for gasification wastewater together with the pollutants that would be regulated:

- The effluent limitations for vapor-compression evaporation technology option are based on Polk and Wabash River. The pollutants that would be regulated for this technology option are arsenic, mercury, selenium, and total dissolved solids.

In addition to the technology options for FGD and gasification wastewaters discussed in the previous paragraphs, EPA is also establishing effluent limitations for combustion residuals leachate (hereafter referred to as leachate) at certain facilities based on the chemical precipitation technology option. The effluent limitations for leachate are based on transferring the effluent limitations calculated for the chemical precipitation technology option for FGD wastewater because EPA does not have available data for chemical precipitation treatment of leachate. This transfer of effluent limitations is appropriate because the pollutants in leachate are similar to those in FGD wastewater and would be removed by the chemical precipitation technology evaluated for FGD wastewater. See Section 13 of the Technical Development Document for a detailed discussion of the transfer of limitations.

Section 1 of this report provides an overview of the document. Section 2 provides a brief description of the available data used to develop the effluent limitations for each technology option. Section 3 describes the data corrections, exclusions, baseline substitutions, and aggregation made to the data before calculating the effluent limitations. Section 4 describes the data editing procedures used to select datasets for developing the effluent limitations for each pollutant at each plant. Section 5 provides the statistical methodology used to calculate the effluent limitations together with the long-term average and variability factors. Sections 6, 7, and 8 contain a detailed summary of the data together with the effluent limitations for each pollutant in each treatment technology option for FGD wastewater. Section 9 contains a detailed summary of the data together with the effluent limitations for each pollutant for the gasification wastewater treatment technology option. Section 10 presents the overall summary of the long-term average, variability factors, and effluent limitations for each pollutant in each technology option. Section 11 provides a discussion of the engineering review of the effluent limitations to verify that the limitations are reasonable based upon the design and expected operation of the control technologies.

In addition to the eleven sections described above, seven appendices are attached to the report. Appendix 1 contains a list of the data that were corrected due to entry errors. Appendix 2 identifies the data that were excluded, along with the reasons for the exclusions. Appendix 3 contains longitudinal plots (along with smoothed curves superimposed over the data) for the plant self-monitoring data that EPA used to aid in determining the start-up or initial commissioning period for the treatment systems at Allen and Belews Creek. Appendix 4 contains plots of all available data for each plant used in calculating the limits for FGD wastewater based on the chemical precipitation or biological treatment technology options, prior to any of the exclusions noted in Appendix 2. Appendix 5 contains plots used to help identify outlier observations for each plant used in calculating the limits for FGD wastewater based on the chemical precipitation or biological treatment technology options. Appendix 6 contains a summary of the results of the data editing criteria (i.e., long-term average test). Appendix 7 contains a summary of the results of the engineering review of the limitations.

Table of Contents

Chapter | **Page**

Table of Contents (continued)

Chapter **Page**

Table of Contents (continued)

Chapter **Page**

Table of Contents (continued)

Chapter **Page**

Table of Contents (continued)

Chapter **Page**

Table of Contents (continued)

Table of Contents (continued)

Tables | **Page**

Table of Contents (continued)

Tables **Page**

Table of Contents (continued)

Tables **Page**

Table of Contents (continued)

Table of Contents (continued)

Figures | **Page**

1 Introduction

This report presents the results of the statistical analyses performed on the Flue Gas Desulfurization (FGD) wastewater and gasification wastewater treatment data and the resulting long-term average, variability factors, and effluent limitations for each pollutant in each technology option.

This report is focused primarily on the summary of the data and the development of long-term averages, variability factors, and effluent limitations. See the Technical Development Document for a description of (i) FGD and gasification systems and the wastewater associated with each system, (ii) the treatment technology options for each waste stream, (iii) the rationale for selecting plants used to calculate the effluent limitations for each technology option, (iv) the rationale for transferring limitations for different technology options, or (v) a discussion of the baseline values used for adjusting the data before calculating the effluent limitations.

In this document, for simplicity, the final effluent limitations guidelines and standards are referred to as "limits." The terms option long-term averages and option variability factors refer to the technology options rather than the regulatory options described in Section 8 of the Technical Development Document. The term "detected" refers to analytical results measured and reported above the sample-specific quantitation limit (QL); and the term "non-detected" refers to values that are below the method detection limit (MDL) and those values measured by the laboratory as being between the MDL and the QL in the original data (before adjusting for baseline). The long-term averages, variability factors, and effluent limits were calculated out to five decimal points for accuracy. However, to simplify the presentation the values presented in this document have been rounded to three decimal points. All exclusions, baseline substitutions, and aggregation of data were made prior to performing the statistical analyses presented in Sections 6, 7, 8, and 9. Finally, the Excel Spreadsheet titled "Sampling Data Used as the Basis for Effluent Limitations for the Steam Electric Rulemaking" contains the listing of all the available data, the excluded data, the baseline values for each pollutant, and the final concentration values that were used in the limit calculations, among other relevant data items. This Excel Spreadsheet is in the record as DCN SE06277 (this spreadsheet will hereafter be referred to as DCN SE06277).

2 Description of Data Used to Calculate Long-term Averages, Variability Factors, and Effluent Limits

This section provides an overview of the available data at each plant selected as the basis for the effluent limits for each technology option, the analytical methods used to analyze each of the pollutants, and the rationale for combining sampling data from multiple sources at each plant into a single dataset for the plant.

2.1 Overview of the Data

In developing the effluent limits for the FGD and gasification wastewater treatment technologies, EPA used data from the following nine power plants: Allen, Belews Creek, Hatfield's Ferry, Keystone, Miami Fort, Pleasant Prairie, Brindisi, Polk, and Wabash River. The following bullets provide a brief overview of the data source available for each plant (see Sections 6, 7, 8, and 9 for a more detailed description of the data at each of the plants):

- At Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie, sampling data were available for FGD wastewater from three sources: (i) plant self-monitoring (hereafter referred to as "plant self-monitoring") data; (ii) EPA sampling episodes (hereafter referred to as "EPA sampling"); and (iii) EPA directed sampling through letters issued under authority of CWA section 308 (hereafter referred to as "CWA 308 sampling"). The data used were collected at two sampling locations: FGD purge and chemical precipitation effluent. In addition, We Energies provided self-monitoring data collected at the secondary clarifier at Pleasant Prairie.

- At Allen and Belews Creek, sampling data were available for FGD wastewater from three sources: (i) plant self-monitoring data for several years of operation provided by Duke Energy, (ii) EPA sampling, and (iii) CWA 308 sampling. The data were collected at three sampling locations: FGD purge, bioreactor influent, and bioreactor effluent.

- At Brindisi, the sampling data available were from EPA sampling. The data were collected at three sampling locations: FGD purge, brine concentrator distillate, and crystallizer condensate.

- At Polk and Wabash River, the sampling data were available for gasification wastewater from CWA 308 sampling. For Polk, the data were collected at four sampling locations: neutralized weak acid waste stream, vapor compression evaporator influent, vapor compression evaporator condensate, and forced circulation evaporator condensate. For Wabash River, the sampling data were collected at four sampling locations: sour water treatment influent, steam stripper effluent, vapor compression evaporator influent, and vapor compression evaporator condensate.

2.2 Analytical Methods

Tables 1 and 2 summarize the analytical methods used to analyze each pollutant for the plant self-monitoring data, EPA sampling data, and CWA 308 sampling data.

Table 1. Summary of the analytical lab methods used for each pollutant by plant self-monitoring

Analytical method	Pollutant
200.7, 200.8, 6020A	Arsenic
1631E, 245.1[1] 245.7, SM3112B[2]	Mercury
353.2	Nitrate-nitrite as N
200.8	Selenium

1: FGD purge and bioreactor influent only. Data for this method were excluded for the chemical precipitation effluent and the bioreactor effluent, due to it being an insufficiently sensitive method.

2: FGD purge only.

Table 2 summarizes the analytical methods used to analyze each pollutant for EPA sampling and CWA 308 sampling.

Table 2. Summary of the analytical lab methods used for each pollutant by EPA sampling and CWA 308 sampling

Analytical method	Pollutant
200.8, 6020	Arsenic [1]
1631E, FGS – 069	Mercury [2]
353.2	Nitrate-nitrite as N
2540C	Total Dissolved Solids
200.8	Selenium

1: Method 200.8 was used at each of the sampling locations except for FGD. At FGD purge, due to the high solids content of the wastewater in certain samples, a combination of methods 200.8 and 6020 was used.

2: Method 1631E was used at each of the sampling locations except for FGD purge. At FGD purge, due to the high solids content of the wastewater in certain samples, a combination of methods 1631E and FGS - 069 was used.

2.3 Combining Data from Multiple Sources within a Plant

As described in Section 2.1, data for most of the model plants came from multiple sources such as EPA sampling, CWA 308, or plant self-monitoring. For five plants (Allen, Belews Creek, Hatfield's Ferry, Miami Fort, and Pleasant Prairie), the multiple sources of the data were collected during overlapping time periods, thus, EPA combined these data into a single dataset for each plant. For one plant (Keystone), the multiple sources of data were collected during non-overlapping time periods. At Keystone, EPA and CWA 308 samples were collected from September 2010 through January 2011 and arsenic self-monitoring data was available from January 2012 through April 2014. Although the data collection periods for Keystone did not overlap, EPA has no information to indicate that the data represent different operating conditions to the extent that would warrant treating the non-overlapping periods as separate datasets. Thus, EPA also combined the multiple sources of data for Keystone into a single dataset for the plant. This approach is consistent with EPA's traditional approach for other effluent guidelines rulemakings.[1] Three plants (Brindisi, Polk, and Wabash River) had data from a single source, and for these plants it was not necessary to combine data. For a listing of all the data and their sampling sources for each of the plants, see DCN SE06277.

[1] In some cases where the sampling data from a plant were collected over two or more distinct time periods, EPA may analyze the data from each time period separately. In some past effluent guidelines rulemakings, EPA analyzed data as if each time period represents a different plant when the data were considered to represent different operating conditions due to changes in management, personnel, and procedures. On the other hand, when EPA obtains the data (such as the EPA sampling and plant self-monitoring data in this rulemaking) from a plant during the same time period, EPA usually combines the data from these sources into a single dataset for the plant for the statistical analyses.

3 Data Corrections, Exclusions, Baseline Substitutions, and Aggregation

This section describe the corrections EPA made to the data it obtained, why and how EPA either excluded or substituted certain data, and how data were aggregated before developing the effluent limits for each pollutant in each technology option. It should be noted that even though EPA did not use the arsenic and mercury data from Allen and Belews Creek to calculate the limits for biological treatment system (for the reason described above and in Section 7), EPA did perform data corrections, exclusions, baseline substitutions, and aggregation for the arsenic and mercury data at these two plants.[2]

3.1 Data Corrections

For the proposed rule, several corrections were made to the plant self-monitoring data at Belews Creek due to data entry errors. In July 2011, EPA's Engineering and Analysis Division obtained the plant self-monitoring data for Allen and Belews Creek from Duke Energy. After an initial review of the data, some inconsistencies were found and EPA subsequently asked Duke Energy to address the potential errors (an email from Ronald Jordan to Nathan Craig on 07/20/2011 summarized the apparent inconsistencies). Duke Energy responded to EPA's request in an email from Nathan Craig to Ronald Jordan (dated 07/21/2011). The data issues that were clarified dealt with data entry errors in certain detection indicators (see Table 1.1 in Appendix 1). Further, after continued interaction between Ron Jordan and Nathan Craig, other data entry errors were also corrected (see Table 1.2 in Appendix 1). Subsequent to EPA publishing the proposed rule, Duke Energy provided additional plant self-monitoring data for Allen per EPA's request. After review and discussion with Duke Energy, a correction was made to the December 20th, 2011 total Nitrate/Nitrite data from the biological treatment effluent (See Table 1.2 in Appendix 1). Additional data entry errors in selenium detection indicators and sample collection date from the proposed rule data at Belews Creek were found and corrected (See Tables 1.1 and 1.3 in Appendix 1). Additional data at Keystone provided by NRG were reviewed and errors in mercury detection indicators of and arsenic concentration were corrected as shown in Table 1.1 and Table 1.2 in Appendix 1.

[2] These arsenic and mercury data for Allen and Belews Creek were also used in the engineering review of the effluent limits to demonstrate that the biological stage of the FGD wastewater treatment system provides additional removals of these pollutants following the chemical precipitation treatment stage. See section 11.1.

3.2 Data Exclusions and Rationale for the Exclusions

Prior to calculating the effluent limits, EPA thoroughly evaluated the available data for each plant. EPA reviewed the analytical methods used for each reported observation to determine whether they were approved in 40 CFR 136 for NPDES purposes and that the methods were sufficiently sensitive to quantify pollutant concentrations. EPA also reviewed the laboratory reports and other available information to evaluate whether the laboratory analyses were performed in a manner to minimize analytical interferences and achieve detection levels low enough to quantify the pollutants present in the wastewater samples. EPA conducted additional reviews of the data to identify results that appeared to reflect quality control issues (either associated with sample collection or analysis) or associated with conditions that do not represent proper operation of BAT or NSPS treatment technology. Based on these evaluations, EPA identified certain data that warranted exclusion from the calculations of the limits because:

(i) samples were analyzed using an analytical method that is not approved in 40 CFR 136 for NPDES purposes;

(ii) samples were analyzed using a method that was not a sufficiently-sensitive analytical method (e.g., EPA Method 245.1 for mercury in effluent samples);

(iii) samples were analyzed in a manner which resulted in an unacceptable level of analytical interferences;

(iv) the samples were collected during initial commissioning period for the treatment system or plant decommissioning period and do not represent BAT/NSPS level of performance;

(v) the analytical results were identified as questionable due to quality control issues, abnormal conditions or treatment upsets, or were analytical anomalies;

(vi) the samples were collected from a location that is not representative of treated effluent (e.g., secondary clarifier sample location instead of final effluent sample location); or

(vii) the treatment system was operating in a manner that does not represent BAT/NSPS level of performance (including time periods not associated with the initial commissioning period for the treatment system or the plant decommissioning period).

Appendix 2 of this document provides a listing of each of the data points that were excluded, along with the reasons for their exclusion. Also see the memorandum "Review of Analytical Methods Used for Industry Self-Monitoring Data Considered for FGD Wastewater Effluent Limits," USEPA Office of Water, dated December 8, 2014. This memorandum is in the record as DCN SE06278 (this memo will hereafter be referred to as the "Analytical Methods Review Memo" or DCN SE06278.

3.3 Baseline Substitutions

In general, EPA used detected values or the sample-specific detection limits (i.e., sample-specific quantitation limit) for non-detected values in calculating the effluent limits. However, there were some instances in which EPA substituted a baseline value for a detected value or a sample-specific detection limit (i.e., non-detect) that were lower than the baseline value. Baseline substitution accounts for the possibility that certain detected or non-detected results in the dataset may be at a lower concentration than generally can be reliably quantified by well-operated laboratories. This approach is consistent with the way EPA has calculated effluent limits in previous effluent guidelines rulemakings and is intended to avoid establishing an effluent limit that could be biased toward a lower concentration than plants can reliably demonstrate compliance with.[3] After excluding all the necessary data as described in Section 3.2 above, EPA compared each reported result to a baseline value. Whenever a detected value or sample-specific detection limit was lower than the baseline value, EPA used the baseline value instead and classified the value as non-detected (even if the actual reported result was a detected value). For example, if the baseline value was 5 μg/L and the laboratory reported a detected value of 3 μg/L, EPA's calculations would treat the sample result as being non-detected with a sample-specific detection limit of 5 μg/L.

Table 3 presents the baseline values that were used for each pollutant for this rulemaking. It should be noted that in cases when all the concentration values are above the baseline value, then the baseline value would have no effect on the concentration values and subsequent limits. Effluent data for mercury and total dissolved solids were all above the baseline values, thus, no baseline substitution was performed when calculating limitations for these parameters. DCN SE06277

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[3] For example, if a daily maximum limit were established at a concentration lower than the baseline value, although some laboratories might be able to achieve sufficiently low quantitation levels, it is possible that typical well-operated laboratories could not reliably measure down to that level. In such cases, a plant would not be able to demonstrate compliance with the limit. A similar situation might arise with monthly average limits, particularly if the limit is at a concentration near the baseline value. EPA does not intend to suggest that the baseline value should be established at a level that every laboratory in the country can measure to, nor that limits established for the ELGs must be established sufficiently high that every laboratory in the country must be able to measure to that concentration; however, it is appropriate to use baseline values that generally can be reliably achieved by well-operated laboratories. This approach achieves a reasonable balance in establishing limits that are representative of treatment system performance and protective of the environment, while at the same time ensuring that plants have adequate access to laboratories with the analytical capabilities necessary to reliably demonstrate compliance with the limits.

provides a listing of all the data, the indicator of whether a baseline substitution was performed, and the value after the baseline substitution was performed.

See Section 13 of Technical Development Document for a detailed discussion of the baseline values for each pollutant.

Table 3. Summary of the baseline values used for each pollutant

Pollutant	Baseline Value (unit)
Arsenic	2 µg/L
Mercury	0.5 ng/L
Nitrate-nitrite as N	0.05 mg/L
Selenium	5 µg/L
Total Dissolved Solids	10 mg/L

In addition to calculating the limits for each pollutant for each technology option adjusting for the baseline values shown above, EPA also calculated the effluent limits using all valid reported results (i.e., without substituting baseline values and/or changing the classification of the result). As noted above, the reason for using baseline substitution is generally to prevent establishing an effluent that could be biased toward a lower concentration than facilities can reliably demonstrate compliance with. When incorporating baseline substitution, the effluent limit is often unchanged but sometimes results in adjusting the effluent limit upward slightly. For the steam electric ELGs, using baseline substitution results in such an increase in the limits in a few instances.[4] However, EPA found that using baseline substitution has the opposite effect in certain other instances, having the unexpected effect of suppressing the limits.[5] This downward effect on the effluent limit occurs because, although the baseline substitution increased the long-term average value slightly, it also reduces the variability of the dataset and the resulting net effect is a lower effluent limit. This means that using baseline substitution in such instances would result in a lower effluent limit than EPA would otherwise calculate directly from the unadjusted dataset. Because EPA wants to ensure that the effluent limits established by the ELGs can be achieved by facilities, EPA evaluated both the baseline-adjusted and unadjusted limits for each technology option and used the higher result for the final ELGs.

[4] This occurs for the selenium limit for gasification wastewater and for the selenium limit for FGD wastewater based on evaporation technology.

[5] This occurs for selenium and nitrate-nitrite as N in FGD wastewater (based on biological treatment technology).

3.4 Data Aggregation

EPA used daily values in developing the effluent limits. In cases with two or more samples per day, EPA mathematically aggregated these samples to obtain a single value for that day (the procedure to aggregate the samples is described in the subsections below). For the sampling data used in this rulemaking, there are instances when multiple sample results are available for a given day. This occurred with field duplicates, overlaps between plant self-monitoring and EPA sampling, or overlaps between plant self-monitoring and CWA 308 sampling.

When aggregating the data, EPA took into account whether each value was detected (D) or non-detected (ND). Measurements reported as being less than the sample-specific detection limit (or baseline values, as appropriate) are designated as non-detected (ND) for the purpose of statistical analyses to calculate the effluent limits. In the tables and data listings in this document and in the rulemaking record, EPA uses the indicators D and ND denote the censoring type for detected and non-detected values, respectively.

The subsections below describe each of the different aggregation procedures. They are presented in the order that the aggregation was performed; i.e., field duplicates were aggregated first, and then any overlaps between plant self-monitoring and EPA sampling data or CWA 308 sampling were aggregated.

3.4.1 Aggregation of Field Duplicates

During the EPA sampling episodes, EPA collected field duplicate samples as part of the quality assurance/quality control activities. Field duplicates are two samples collected for the same sampling point at approximately the same time. The duplicates are assigned different sample numbers, and they are flagged as duplicates for a single sampling point at a plant. Because the analytical data from a duplicate pair are intended to characterize the same conditions at a given time at a single sampling point, EPA averaged the data to obtain one value for each duplicate pair.

In most cases, both duplicates in a pair had the same censoring type, so the censoring type of the aggregated value was the same as that of the duplicates. In some instances, one duplicate was a detected (D) value but the other duplicate was a non-detected (ND) value. When this occurred, EPA determined that the aggregated value should be treated as detected (D) because the pollutant is confirmed to be present at a level above the sample-specified detection limit in one of the duplicates. DCN SE06277 lists the data before the aggregation as well as after the aggregation.

Table 4 below summarizes the procedure for aggregating the sample measurements from the field duplicates.

Table 4. Aggregation of field duplicates

If the field duplicates are:	Censoring type of average is:	Value of the aggregate is:	Formulas for aggregate values of duplicates
Both detected	D	Arithmetic average of measured values	$(D_1 + D_2)/2$
Both non-detected	ND	Arithmetic average of sample-specific detected limits (or baseline)	$(DL_1 + DL_2)/2$
One detected and one non-detected	D	Arithmetic average of measured value and sample-specific detection limit (or baseline)	(D + DL)/2

D: detected.
ND: non-detected.
DL: sample-specific detection limit.

3.4.2 Aggregation of Overlapping Samples

At the Allen, Belews Creek, Hatfield's Ferry, Miami Fort, and Pleasant Prairie plants, sampling data were available from EPA sampling, CWA 308 sampling, and plant self-monitoring. As explained in Section 2.3 above, there was some overlap between the data from these sources. On some days at a given plant, samples were available from two sources, such as plant self-monitoring and either EPA sampling or CWA 308 sampling. When these overlaps occurred, EPA aggregated the measurements from the available samples to obtain one value for that day. DCN SE06277 lists the data before the aggregation as well as after the aggregations.

The procedure averaged the measurements to obtain a single value for that day. When both measurements had the same censoring type, then the censoring type of the aggregate was the same as that of the overlapping values. When one or more measurements were detected (D), EPA determined that the appropriate censoring type of the aggregate was detected because the pollutant is confirmed to be present at a level above the sample-specific detection limit in one of the samples. The procedure for obtaining the aggregated value and censoring type is similar to the procedure shown in Table 4 above.

4 Data Editing Criteria

After excluding and aggregating the data, EPA applied data editing criteria on a pollutant-by-pollutant basis to select the datasets to be used for developing the effluent limits for each technology option. These criteria are referred to as the long-term average test (or LTA test). EPA often uses the LTA test to ensure that the pollutants for which limits are being set were present in the influent at sufficient concentrations to evaluate treatment effectiveness at the plant. For each pollutant for which EPA calculated a limit, the influent first had to pass a basic requirement that 50% of the influent measurements for the pollutants had to be detected at any concentration. If the dataset at a plant passed the basic requirement, then the data had to pass one of the following two criteria to pass the LTA test:

> Criterion 1. At least 50% of the influent measurements in a dataset at a plant were detected at levels equal to or greater than 10 times the baseline value (shown in Section 3.3).
>
> Criterion 2. At least 50% of the influent measurements in a dataset at a plant were detected at any concentration and the influent arithmetic average was equal to or greater than 10 times the baseline value (shown in Section 3.3).

If the dataset at a plant failed the basic requirement, then EPA automatically set both Criteria 1 and 2 to "fail." If the dataset for a plant failed the basic requirement, or passed the basic requirement but failed both criteria, EPA would exclude the plant's effluent data for that pollutant when calculating limits. Through the application of the LTA test, EPA ensures that the limits result from treatment of the wastewater and not simply the absence or substantial dilution of that pollutant in the waste stream.

After performing the LTA test for the pollutants at each plant that were selected as the basis for the limits for this rulemaking, all the datasets passed the LTA test except for arsenic and mercury data at Wabash River. Thus, data for arsenic and mercury at Wabash River were excluded from the calculation of the limits. See Appendix 3 for the results of the LTA test for each pollutant at each plant.

5 Statistical Methodology

The sections below provide the following: (i) general definitions and background, (ii) statistical model selected for the data, (iii) analysis of autocorrelation, (iv) dataset requirement, (v) the calculation of the effluent limits, and (vi) description of how the limit was set in a special case where most of the observations were non-detects.

5.1 Definitions and Background

In developing the effluent limits, a statistical procedure is used that involves fitting effluent data to a distribution and estimating specified upper percentiles of the fitted distribution. The bullets below describe in detail the important quantities that are typically estimated based on the effluent data.

- The long-term average (LTA) is the average concentration that is achieved over a period of time. The long-term average is the mean of the underlying statistical distribution of the daily effluent values.
- The daily maximum limitation is the highest allowable discharge in any one day. The daily maximum limitation is the estimate of the 99^{th} percentile (denoted as P_{99}) of the distribution of the historical daily effluent values.
- The daily variability factor is the ratio of the daily maximum limitation to the LTA. This ratio represents the relationship between the large values and the average treatment performance level that a well-designed and well-operated treatment system should be capable of achieving at all times.
- The monthly average limitation is the highest allowable average of discharges calculated from the effluent data collected over a calendar month (or period of time specified in the permit). The monthly average limitation is the estimate of the 95^{th} percentile (denoted as P_{95}) of the distribution of the monthly averages of the historical daily effluent values.
- The monthly variability factor is the ratio of the monthly average limitation to the LTA.

5.2 Statistical Model Selected for the Data

In calculating the long-term average, variability factors, and effluent limits, a statistical model is assumed for the distribution of the effluent data. For this rulemaking, EPA selected the modified delta-lognormal distribution to model pollutant effluent concentration to develop the long-term average, variability factors, and limits. A typical effluent dataset from EPA sampling, CWA 308 sampling, or from a plant's self-monitoring consists of a mixture of detected and non-detected values. The modified delta-lognormal distribution is appropriate for such datasets because it models the data as a mixture of detected measurements that follow a lognormal distribution and non-detect measurements that occur with a certain probability. The model also allows for the possibility that non-detected measurements occur at multiple sample-specific detection limits. Because the data appeared to fit the modified delta-lognormal model reasonably well, EPA has determined that this model is appropriate for these data. See Appendix B of the Technical Development Document for an overview of the statistical model and a description of the procedures EPA used to estimate these parameters.

5.3 Autocorrelation Analysis

Effluent concentrations that are collected over time may be autocorrelated. The data are positively autocorrelated when measurements taken at specific time intervals, such as one or two days apart, are similar. For example, positive autocorrelation would occur if the effluent concentration was relatively high one day and was likely to remain high on the next and possibly succeeding days. Because the autocorrelated data affect the true variability of treatment performance, EPA typically adjusts the variance estimates for the autocorrelated data, when appropriate.

For this rulemaking, whenever there was sufficient data for a pollutant at a plant to evaluate the autocorrelation reliably, EPA estimated the autocorrelation and incorporated it into the calculation of the limits. For a plant without enough data to reliably evaluate and obtain a reliable estimate of the autocorrelation, when there was a correlation of a pollutant available from a similar technology and waste stream, EPA transferred the autocorrelation estimates from that treatment technology. Otherwise, EPA set the autocorrelation to zero in the calculation of the effluent limits. EPA did so because it is reasonable to set the autocorrelation to zero whenever there is not a sufficient amount of data to reliably evaluate the autocorrelation and when there is no correlation available that can be transferred from a similar technology and waste stream. See the memorandum titled "Serial correlations for Steam Electric with and without adjustment for baseline values" from John Rogers to Ron Jordan for details of the statistical methods and procedures used to determine the autocorrelation values, as well as a detailed discussion of the minimum number of observations needed to obtain a reliable estimate of the autocorrelation. This memo is in the record as DCN

SE06279 (this memo will hereafter be referred to as DCN SE06279). The following paragraphs describe the instances where EPA was able to obtain an estimated autocorrelation and the assumptions made about the autocorrelation when there were too few observations to estimate the autocorrelation.

For the biological treatment technology for FGD wastewater (represented by Allen and Belews Creek plants), EPA was able to perform a statistical evaluation and obtain a reliable estimate of the autocorrelation for selenium because several years of data were available for these plants. Because of the similarities between the removal processes for pollutants, EPA determined that it would be appropriate to also use the value estimated for selenium as the autocorrelation estimate for nitrate-nitrite as N. The arsenic and mercury limits for the biological technology option are based on (i.e., transferred from) the chemical precipitation technology option, thus, the data from the chemical precipitation plants were used to estimate autocorrelation for arsenic and mercury. (See Section 13 of the Technical Development Document for a detailed discussion of the transfer of the limits.) Table 5 below lists the autocorrelation values used in the limits calculation for nitrate-nitrite as N and selenium for the biological treatment option.

For the chemical precipitation treatment option for FGD wastewater (represented by Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie), EPA was able to perform a statistical evaluation of the autocorrelation and obtain a reliable estimate of the autocorrelation because several years of data were available for these plants. Table 5 below lists the autocorrelation values used in the limits calculation for arsenic and mercury for the chemical precipitation option.

Table 5. Summary of estimated autocorrelation values by plant and pollutant

Treatment technology	Plants representing the treatment technology	Pollutant	Baseline[4]	Correlation value used for limit calculation
FGD Biological treatment	Allen, Belews Creek	Selenium	0	0.69
			5	0.67
		Nitrate-nitrite as N[1]	0	0.69
			0.05	0.67
FGD Chemical precipitation treatment	Hatfield's Ferry, Keystone, Miami Fort, Pleasant Prairie	Arsenic[2]	0	0.86
			2	
		Mercury[3]	0	0.89
			0.5	

[1]: Although there were too few detected values for nitrate-nitrite as N for EPA to obtain a reliable estimate of autocorrelation (12 detected values at Allen; 3 baseline adjusted detected values and 4 non baseline adjusted values at Belews Creek), EPA transferred the autocorrelation from selenium since these two chemicals behave similarly in the biological treatment system.

[2]: The correlation was estimated using data from Hatfield's Ferry.

[3]: The correlation was estimated using data from Hatfield's Ferry, Miami Fort, and Pleasant Prairie.

[4]: Baseline value of 0 indicates no adjustment for baseline.

For the vapor-compression evaporation treatment technology option for FGD wastewater (represented by Brindisi), and for the vapor-compression treatment technology option for gasification wastewater (represented by Polk and Wabash River), EPA was unable to perform an evaluation and obtain a reliable estimate of the autocorrelation because there were too few observations available at the plants. Thus, for these plants, EPA set the autocorrelation to zero in the calculation of the limits. EPA did so because there were not sufficient data to reliably evaluate the autocorrelation, nor did EPA have a valid correlation estimate available that could be transferred from a similar technology and waste stream.

5.4 Dataset Requirement

The statistical model requires at least two distinct detected values in order to estimate the variance of the distribution (i.e., to allow the variability factor to be calculated). Generally, EPA has been reluctant to estimate a variability factor from plants with a small number of detected observations. The minimum number of observations required to calculate the variability factor has been evaluated on a case-by-case basis. For example, for the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) rulemaking, a variability factor was estimated for a plant if it had at least 7 daily observations with at least 3 observations above the detection limit. In the Iron and Steel rulemaking, a variability factor was estimated for a plant if it had at least three observations, at least two of which were above the detection limit. For the steam electric rulemaking, a variability factor was estimated for a plant if it had at least three observations, at least two of which were above the detection limit.

5.5 Calculating Effluent Limits for Each Pollutant in Each Technology Option

EPA calculated the percentiles that are used as a basis for the limits by multiplying the long-term average (the option long-term average discussed below) by the appropriate variability factors (the option variability factor discussed below). The paragraphs below describe the calculation of the option long-term average, option variability factors, and effluent limits. As mentioned in Section 1, the option long-term averages and variability factors in this document refer to the long-term average and variability factors for that particular technology option, not the regulatory option described in Section 8 of the Technical Development Document.

The option long-term average is calculated for a pollutant using two steps. First, EPA calculated the plant-specific long-term average for each pollutant that had enough distinct detected values by fitting a statistical model to the daily concentration values. In cases when a dataset for a specific pollutant did not have enough distinct detected values, the plant-specific long-term average was calculated as the arithmetic mean of the available daily concentration values. Second, the option long-term average for each pollutant is calculated as the median of the plant-specific long-term averages for that pollutant.

The following describes the calculations performed to obtain the option variability factors. First, EPA calculated the plant-specific variability factors for each pollutant that had enough distinct detected values by fitting a statistical model to the daily concentration values. The plant-specific daily variability factor for each pollutant is the estimated 99th percentile of the distribution of the daily concentration values divided by the plant-specific long-term average. The plant-specific monthly variability factor for each pollutant is the estimated 95th percentile of the distribution of the 4-day average concentration divided by the plant-specific long-term average. The calculation of the plant-specific monthly variability factor assumes that the monthly averages are based on the pollutant being monitored weekly (approximately four times each month). The option variability factor for each pollutant is calculated as the mean of the plant-specific long-term averages for that pollutant. In cases when there were not enough distinct detected values for a specific pollutant at a plant, the data for the pollutant at the plant was excluded from the calculation of the option variability factors.

Finally, the daily maximum limit for each pollutant for each technology option is the product of the option long-term average and option daily variability factors. The monthly average limit for each pollutant for each technology option is the product of the option long-term average and option monthly variability factors.

5.6 Special Case – Effluent Limits Based on Detection Limits

Although the percentile estimates described in the section above play an important role in determining daily maximum and monthly average effluent limits, they are not a requirement under the Clean Water Act and are not always used as the basis for effluent limits. In situations where there are too few detected results, the statistical models are not appropriate for use in obtaining the effluent limits since reliable estimates could not be calculated from the model. In such instances, EPA has instead established the daily effluent limits based on a detection limit. Also, the monthly average limit is not established when the daily limit is based on the detection limit. The purpose of a monthly average limit is to require dischargers to provide better control, on a monthly basis, than required by the daily maximum limit. However, for these pollutants, current analytical methods cannot measure below the detection limit specified for the daily maximum limit. Thus, even if a permitting or pretreatment authority requires more frequent monitoring for these pollutants than once a month, monthly average limits would still be expressed as less than detection limits.

6 Treatment Technology Option for FGD Wastewater: Chemical Precipitation

EPA used data from four coal-fired power plants (Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie) to develop the long-term averages, variability factors, and effluent limits for the chemical precipitation treatment technology option for FGD wastewater. The pollutants for which the limits are calculated are arsenic and mercury.

The following provides a detailed summary of all the available data for each plant. The available data from each of the plants came from the following three sources: plant self-monitoring, EPA sampling, and CWA 308 sampling. As explained in Section 2.3, EPA combined these three sources of data at each plant into a single dataset for the plant. The data described below include all the available data prior to any of the exclusions.

Hatfield's Ferry Sampling Data

The sampling data were collected at two sampling locations: FGD Purge and chemical precipitation effluent. The bullets below provide a brief summary of the data:

- Plant self-monitoring data collected by the plant between: 06/30/2009 and 12/10/2013.
- EPA sampling data collected by EPA between 12/06/2010 and 12/10/2010.
- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 10/5/2010, 11/10/2010, 1/12/2011, and 02/09/2011.

Keystone Sampling Data

The sampling data were collected at two sampling locations: FGD Purge and chemical precipitation effluent. The bullets below provide a brief summary of the data:

- Plant self-monitoring data collected by the plant between: 01/03/2012 and 04/28/2014.
- EPA sampling data collected by EPA between 09/13/2010 and 09/17/2010.

- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 10/7/2010, 11/4/2010, 12/9/2010, and 01/13/2011.

Miami Fort Sampling Data

The sampling data were collected at two sampling locations: FGD Purge and chemical precipitation effluent. The bullets below provide a brief summary of the data for each of the data sources:

- Plant self-monitoring data collected by the plant between: 07/01/2009 and 12/03/2013.
- EPA sampling data collected by EPA between 07/12/2010 and 07/16/2010.
- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 09/28/2010, 11/2/2010, 12/7/2010, and 01/14/2011.

Pleasant Prairie Data

The sampling data were collected at three sampling locations: FGD Purge, chemical precipitation effluent, and secondary clarifier effluent. The bullets below provide a brief summary of the data for each of the data sources:

- Plant self-monitoring data collected by the plant between: 10/04/2007 and 12/18/2013.
- EPA sampling data collected by EPA between 06/21/2010 and 06/25/2010.
- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 09/30/2010, 11/3/2010, 12/8/2010, and 01/26/2011.

EPA was able to estimate the autocorrelations for use in the calculation of the limits at Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie (at the chemical precipitation effluent sampling location) because several years of data were available for these plants. See DCN SE06279 for the statistical method and results of the autocorrelation values for each pollutant. Thus, the estimated autocorrelation values were used in developing limits for each pollutant for this technology option. In addition, an autocorrelation value of zero (0) was also used to assess the sensitivity of the limits to the correlation values used. The effluent limits calculated using both approaches are presented below. The limits for this technology option are based on the calculations that incorporated the estimated autocorrelations.

The sections below provide the following for each of the pollutants at each of the plants: longitudinal plots of the data (baseline adjusted data only), summary statistics, plant-specific long-term average and plant-specific variability factors (see Appendix B of the Technical Development Document for an overview of the statistical model and the procedures used to estimate the plant-specific long term average and variability factors). Also provided in the sections below are the option long-term average, option variability factors, and effluent limits for each pollutant. All exclusions, baseline substitutions, and aggregation of data were made prior to conducting the analyses presented below.

6.1 Chemical Precipitation Treatment for FGD Wastewater: Arsenic

6.1.1 Longitudinal Plots of the Data for Arsenic (µg/L)

Below are the longitudinal plots of the arsenic concentrations (on a logarithmic scale) for Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie.

6.1.2 Summary Statistics for Arsenic (µg/L)

Table 6 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant. For example, for Hatfield's Ferry at the FGD Purge sampling location, all 8 observations were detected; at the chemical precipitation effluent sampling location, of the 130 observations, 129 observations were detected and 1 was non-detected. The one non-detect had a detection limit of 4 µg/L (shown at the top of the column).

Figure 1. Plot of arsenic (µg/L) data on a logarithmic scale for Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie

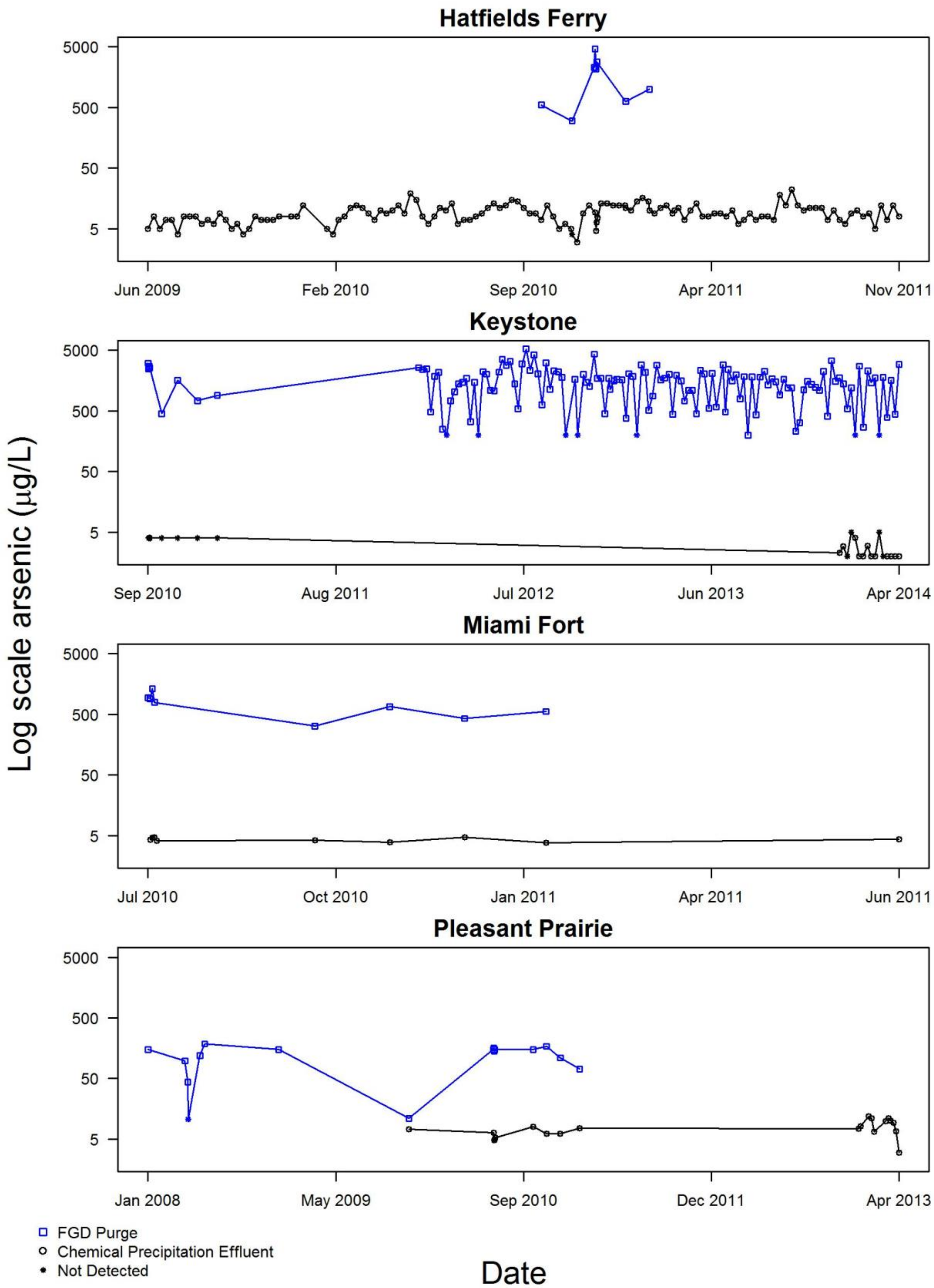


Table 6. Numbers of detected and non-detected observations and sample-specific detection limits for arsenic (µg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n) [4]	Sample Specific Detection Limits for Arsenic (µg/L)				
				2	4	5	10.656	200
Hatfield's Ferry[1]	FGD Purge (N = 8)	0 or 2	D (n=8)					
	Chemical Precip. Effluent (N = 130)	0 or 2	D (n=129)					
			ND (n=1)		1			
Keystone[1]	FGD Purge (N = 130)	0 or 2	D (n=123)					
			ND (n=7)					7
	Chemical Precip. Effluent (N = 24)	0	D (n=14)					
			ND (n=10)	1	7	2		
		2	D (n=13)					
			ND (n=11)	2	7	2		
Miami Fort[1]	FGD Purge (N = 8)	0 or 2	D (n=8)					
	Chemical Precip. Effluent (N = 9)	0 or 2	D (n=9)					
Pleasant Prairie[1]	FGD Purge (N = 16)	0 or 2	D (n=15)					
			ND (n=1)				1	
	Chemical Precip. Effluent (N = 20)	0 or 2	D (n=20)					

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 7 provides the summary statistics for all observations (detected and non-detected combined) for FGD Purge and chemical precipitation effluent at each of the plants.

Table 7. Summary statistics of arsenic concentration (µg/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Arsenic (µg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Hatfield's Ferry[1]	FGD Purge	0 or 2	8	300.0	1,796.3	1,575.0	4,610.0	1,471.2
	Chemical Precip. Effluent	0 or 2	130	3.0	9.1	9.0	22.0	3.1
Keystone[1]	FGD Purge	0 or 2	130	200.0	1,569.9	1,580.0	5,250.0	962.1
	Chemical Precip. Effluent	0	24	1.0	3.1	3.0	5.0	1.2
		2	24	2.0	3.1	3.0	5.0	1.1
Miami Fort[1]	FGD Purge	0 or 2	8	320.0	744.8	729.8	1,330.0	323.5
	Chemical Precip. Effluent	0 or 2	9	3.8	4.3	4.3	4.7	0.3
Pleasant Prairie[1]	FGD Purge	0 or 2	16	10.7	117.0	145.0	187.0	55.3
	Chemical Precip. Effluent	0 or 2	20	3.0	7.6	7.4	12.0	2.4

[1]: Combination of EPA sampling (4 daily samples), CWA 308 sampling (4 monthly samples), and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

6.1.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for Arsenic (µg/L)

Table 8 provides the plant-specific LTA, plant-specific variability factors, option LTA, option variability factors, and effluent limits for arsenic in the chemical precipitation effluent.

Table 8. Plant-specific long-term averages and variability factors, option long-term average and variability factors, and limits for arsenic (µg/L) in chemical precipitation effluent

Baseline Adjusted[1]	Autocorrelation Value[2]	TYPE	N[3]	Plant Name	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0	0	Plant-Specific	130 (D=129, ND=1)	Hatfield's Ferry[4]	9.130	2.091	1.315		
			24 (D=14, ND=10)	Keystone[4]	3.059	1.634	1.342		
			9 (D=9, ND=0)	Miami Fort[4]	4.296	1.196	1.066		
			20 (D=20, ND=0)	Pleasant Prairie[4]	7.634	2.068	1.307		
		Option			5.965	1.747	1.258	10.424	7.501
0	0.86	Plant-Specific	130 (D=129, ND=1)	Hatfield's Ferry[4]	9.135	2.098	1.412		
			24 (D=14, ND=10)	Keystone[4]	3.064	1.632	1.431		
			9 (D=9, ND=0)	Miami Fort[4]	4.298	1.211	1.092		
			20 (D=20, ND=0)	Pleasant Prairie[4]	7.655	2.101	1.410		
		Option			5.976	1.760	1.336	10.521	7.985
2	0	Plant-Specific	130 (D=129, ND=1)	Hatfield's Ferry[4]	9.130	2.091	1.315		
			24 (D=13, ND=11)	Keystone[4]	3.093	1.616	1.301		
			9 (D=9, ND=0)	Miami Fort[4]	4.296	1.196	1.066		
			20 (D=20, ND=0)	Pleasant Prairie[4]	7.634	2.068	1.307		
		Option			5.965	1.743	1.247	10.397	7.441

Table 8. Plant-specific long-term averages and variability factors, option long-term average and variability factors, and limits for arsenic (µg/L) in chemical precipitation effluent (continued)

Baseline Adjusted[1]	Autocorrelation Value[2]	TYPE	N[3]	Plant Name	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
2	0.86	Plant-Specific	130 (D=129, ND=1)	Hatfield's Ferry[4]	9.135	2.098	1.412		
			24 (D=13, ND=11)	Keystone[4]	3.096	1.615	1.383		
			9 (D=9, ND=0)	Miami Fort[4]	4.298	1.211	1.092		
			20 (D=20, ND=0)	Pleasant Prairie[4]	7.655	2.101	1.410		
		Option			5.976	1.756	1.324	10.496	7.914

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: D = detected and ND = non-detected.

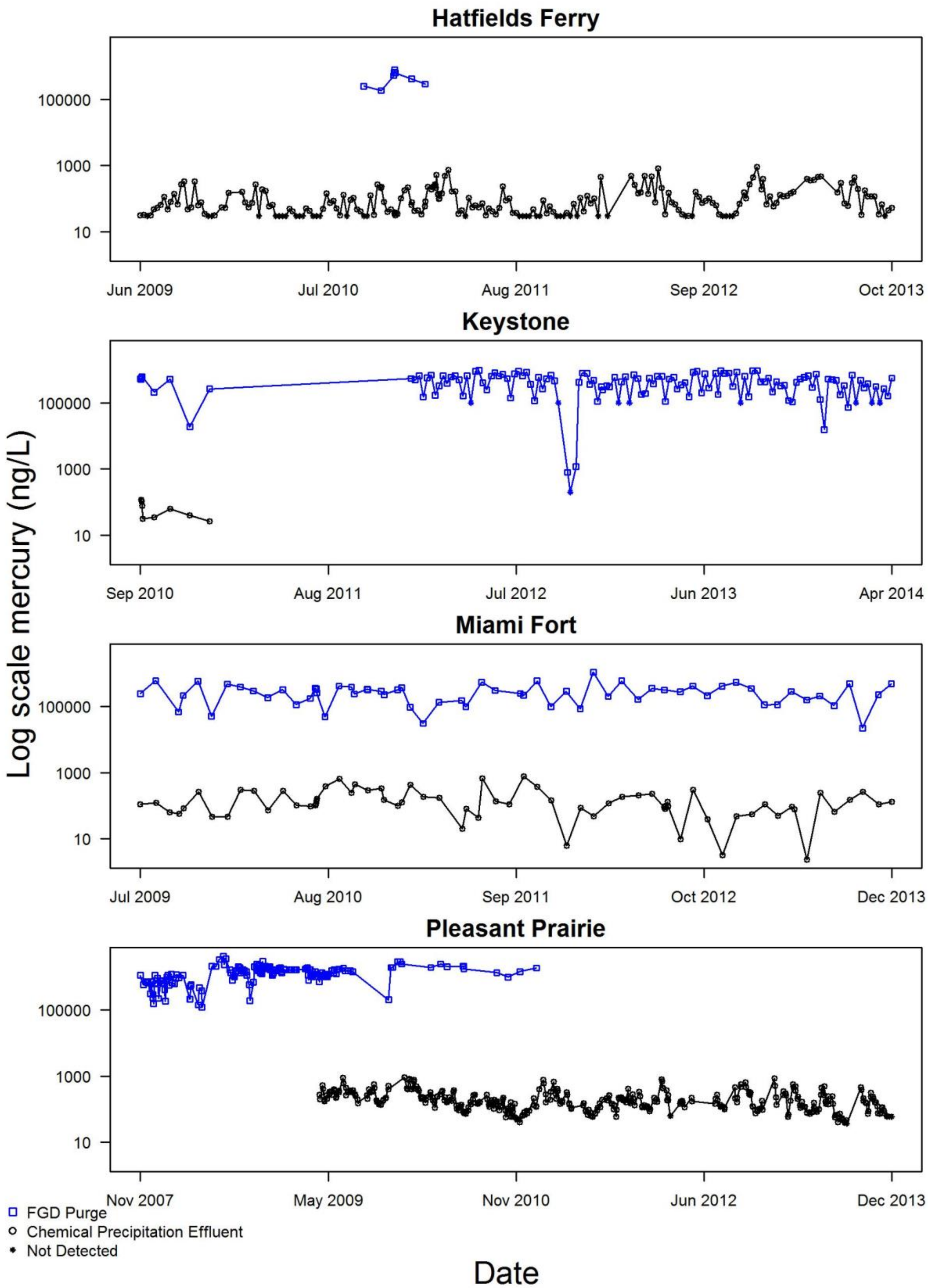
[4]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

6.2 Chemical Precipitation Treatment for FGD Wastewater: Mercury

6.2.1 Longitudinal Plots of the Data for Mercury (ng/L)

Below are the longitudinal plots of the mercury concentrations (on a logarithmic scale) for Hatfield's Ferry, Keystone, and Miami Fort, and Pleasant Prairie.

Figure 2. Plot of mercury (ng/L) data on a logarithmic scale for Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie



6.2.2 Summary Statistics for Mercury (ng/L)

Table 9 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant. For example, for Hatfield's Ferry at the FGD Purge sampling location, all 7 observations were detected; at the chemical precipitation effluent sampling location, of the 219 observations, 181 observations were detected and 38 were non-detected. Of the 38 non-detects, all had a detection limit of 30 ng/L (shown at the top of the column).

Table 9. Numbers of detected and non-detected observations and sample-specific detection limits for mercury (ng/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limits for Mercury (ng/L)						
				30	37	47	60	63	200	100,000
Hatfield's Ferry[1]	FGD Purge (N = 7)	0 or 0.5	D (n=8)							
	Chemical Precip. Effluent (N = 219)	0 or 0.5	D (n=181)							
			ND (n=38)	38						
Keystone[1]	FGD Purge (N = 130)	0 or 0.5	D (n=121)							
			ND (n=9)						1	8
	Chemical Precip. Effluent (N = 8)	0 or 0.5	D (n=8)							
Miami Fort[1]	FGD Purge (N = 62)	0 or 0.5	D (n=62)							
	Chemical Precip. Effluent (N = 68)	0 or 0.5	D (n=68)							
Pleasant Prairie[1]	FGD Purge (N = 166)	0 or 0.5	D (n=166)							
	Chemical Precip. Effluent (N = 375)	0 or 0.5	D (n=365)							
			ND (n=10)		1	2	5	2		

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 10 provides summary statistics for all observations for FGD Purge and chemical precipitation effluent at each of the plants.

Table 10. Summary statistics of mercury concentration (ng/L) for all detected and non-detected samples by plant and sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Mercury (ng/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Hatfield's Ferry[1]	FGD Purge	0 or 0.5	8	184,000.0	465,125.0	467,000.0	789,000.0	216,886.7
	Chemical Precip. Effluent	0 or 0.5	219	30.0	122.2	67.3	909.0	140.0
Keystone[1]	FGD Purge	0 or 0.5	130	200.0	438,659.2	434,000.0	950,000.0	253,603.8
	Chemical Precip. Effluent	0 or 0.5	8	26.4	62.8	52.6	119.0	35.9
Miami Fort[1]	FGD Purge	0 or 0.5	62	22,000.00	286,137.90	277,500.00	1,065,000.00	181,137.86
	Chemical Precip. Effluent	0 or 0.5	68	2.4	168.4	111.4	770.0	155.2
Pleasant Prairie [1]	FGD Purge	0 or 0.5	166	120,000.0	1,382,747.0	1,400,000.0	4,200,000.0	666,941.0
	Chemical Precip. Effluent	0 or 0.5	375	37.0	214.8	170.0	905.0	157.7

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

6.2.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for Mercury (ng/L)

Table 11 provides the plant-specific LTA, plant-specific variability factors, option LTA, option variability factors, and effluent limits for mercury in chemical precipitation effluent.

Table 11. Plant-specific long-term average and variability factors, option long-term average and variability factors, and limits for mercury (ng/L) in chemical precipitation effluent

Baseline Adjusted[1]	Autocorrelation Value[2]	TYPE	N[3]	Plant Name	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 0.5	0	Plant-Specific	219 (D = 181, ND = 38)	Hatfield's Ferry[4]	118.294	5.289	2.035		
			8 (D = 8)	Keystone[4]	64.260	3.257	1.584		
			68 (D = 68)	Miami Fort[4]	199.080	7.007	2.418		
			375 (D = 365, ND = 10)	Pleasant Prairie[4]	214.161	3.732	1.693		
		Option			158.687	4.821	1.932	765.069	306.652
0 or 0.5	0.89	Plant-Specific	219 (D = 181, ND = 38)	Hatfield's Ferry[4]	118.683	5.321	2.352		
			8 (D = 8)	Keystone[4]	66.878	3.642	1.907		
			68 (D = 68)	Miami Fort[4]	200.007	7.044	2.732		
			375 (D = 365, ND = 10)	Pleasant Prairie [4]	214.609	3.752	1.943		
		Option			159.345	4.940	2.233	787.119	355.873

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: D = detected and ND = non-detected.

[4]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

6.3 Chemical Precipitation Treatment for FGD Wastewater: Summary of the Option Long-term Averages, Option Variability Factors, and Effluent Limits

Table 12 provides a summary of the option long-term averages, option variability factors, and effluent limits for arsenic and mercury.

Table 12. Summary of option long-term averages, option variability factors, and effluent limits for chemical precipitation FGD wastewater treatment technology

Pollutant	Baseline[1]	Autocorrelation Value[2]	Option LTA	Option Daily Variability Factor	Option Monthly Variability Factor	Daily Limit[3]	Monthly Average Limit[3]
Arsenic (µg/L)	0	0.86	5.976	1.760	1.336	11	8
	2		5.976	1.756	1.324	11	8
Mercury (ng/L)	0 or 0.5	0.89	159.345	4.940	2.233	788	356

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: Effluent limitations have been rounded upward to the next highest integer.

7 Treatment Technology Option for FGD Wastewater: Biological Treatment

EPA used data from two coal-fired power plants (Allen and Belews Creek) to develop the long-term averages, variability factors, and effluent limits based on the chemical precipitation followed by biological treatment technology option for FGD wastewater. Summary statistics for arsenic, mercury, nitrate-nitrite as N, and selenium are presented for these two plants. The data from these two plants were used to calculate the limits for nitrate-nitrite as N and selenium. As noted above, while these two plants operate the biological treatment system used as the basis for the technology option, neither of these plants includes sulfide precipitation in the upstream chemical precipitation system. For this reason, EPA is transferring the arsenic and mercury limits calculated based on the chemical precipitation technology option to biological technology option for FGD wastewater (see Section 13 of the Technical Development Document for a detailed discussion of the transfer of limits).

The following provides a detailed summary of the available data for each plant. The available data from each plant came from the following three sources: (i) plant self-monitoring, (ii) EPA sampling, and (iii) CWA 308 sampling. As explained in Section 2.3, EPA combined the multiple sources of data at each plant into a single dataset for the plant. The data described below includes all the available data prior to any of the exclusions.

Allen Sampling Data

The sampling data were collected at three sampling locations: FGD purge, bioreactor influent, and bioreactor effluent. The bullets below provide a brief summary of the data:

- Plant self-monitoring data collected by the plant over a period of several years. The data provided were collected between 03/03/2009 and 10/22/2013.
- EPA sampling data collected by EPA between 08/02/2010 and 08/06/2010.
- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 10/5/2010, 11/1/2010, 12/6/2010, and 01/12/2011.

Belews Creek Sampling Data

The sampling data were collected at three sampling locations: FGD purge, bioreactor influent, and bioreactor effluent. The bullets below provide a brief summary of the data:

- Plant self-monitoring data collected by the plant over a period of several years. The data provided were collected between 02/06/2008 and 11/28/2013.
- EPA sampling data collected by EPA between 06/07/2010 and 06/11/2011.
- CWA 308 sampling data collected by the plant one day per month for four consecutive months. These data were collected on 10/6/2010, 11/3/2010, 12/8/2010, and 01/17/2011.

EPA was able to estimate the autocorrelations for use in the calculation of the limits at Allen and Belews Creek (at the bioreactor effluent sampling location) because several years of data were available for these plants. See DCN SE06279 for the statistical method and results of the autocorrelation values for each pollutant. Thus, the estimated autocorrelation values were used in developing limits for each pollutant for this technology option. In addition, an autocorrelation value of zero (0) was also used to assess the sensitivity of the limits to the correlation values used. The effluent limits calculated using both approaches are presented below. The limits for this technology option are based on the calculations that incorporated the estimated autocorrelations.

The sections below provide the following for each of the pollutants at each of the plants: longitudinal plots of the data (baseline adjusted data only) and summary statistics. Also provided in the sections below are the plant-specific and option long-term averages, plant-specific and option variability factors, and effluent limits for nitrate-nitrite as N and selenium. All exclusions, baseline substitutions, and aggregation of data were made prior to conducting the analyses described below.

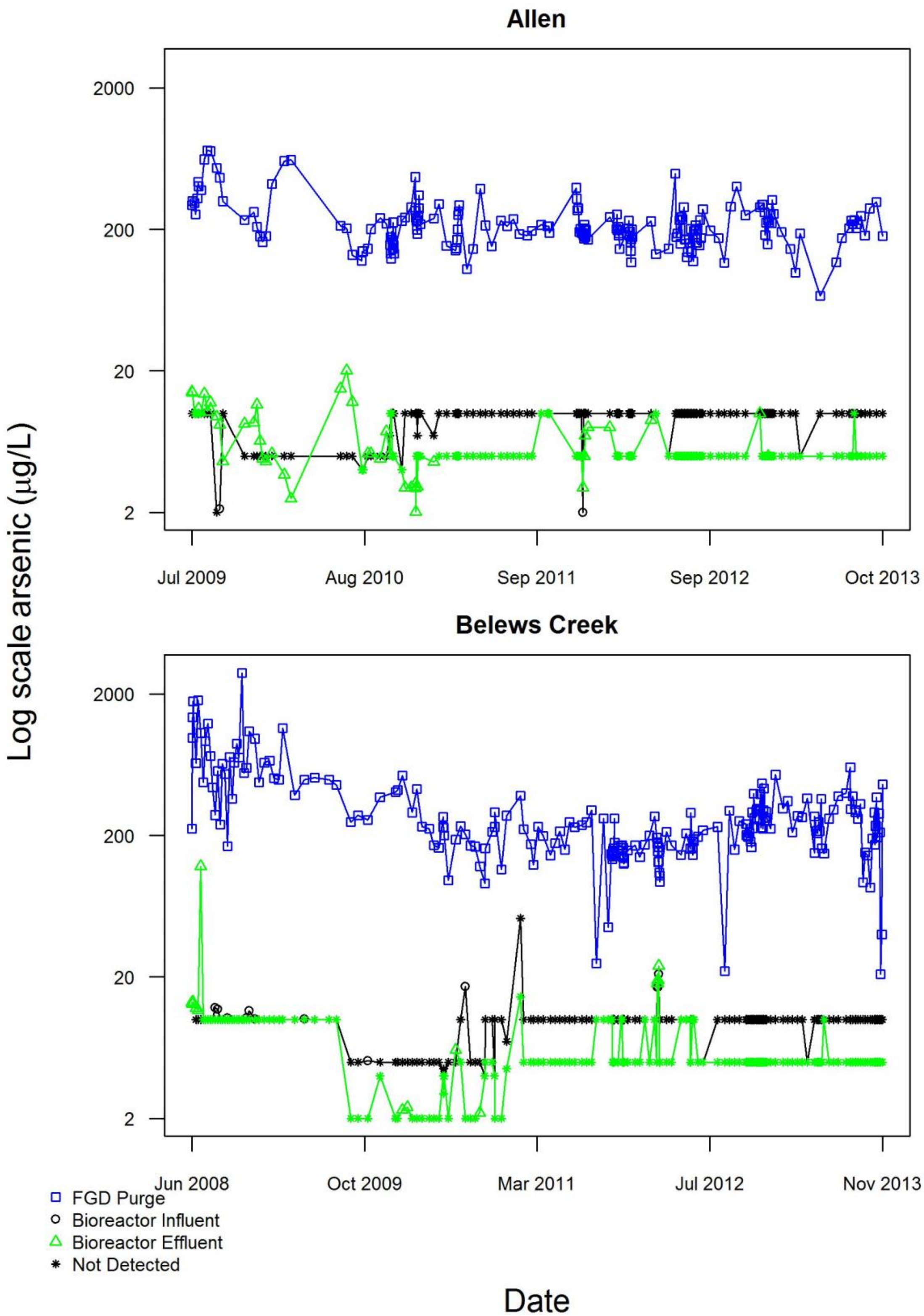
7.1 Biological Treatment for FGD Wastewater: Arsenic

Sections below provide the longitudinal plots and summary statistics for arsenic. Because these two plants do not represent BAT/NSPS level of treatment for arsenic, EPA did not calculate the limits for arsenic using the Allen and Belews Creek data. Instead, EPA is transferring the arsenic limits calculated based on the chemical precipitation technology option to the biological technology option for FGD wastewater (see Section 13 of the Technical Development Document for a detailed discussion of the transfer of limits).

7.1.1 Longitudinal Plots of the Data for Arsenic (µg/L)

Below are the longitudinal plots of the arsenic concentrations (on a logarithmic scale) for Allen and Belews Creek. The plot for Allen shows the concentrations from 7/15/2009 to 10/22/2013, while the plot for Belews Creek shows the concentrations for 6/12/2008 to 11/28/2013. Note that the data collected in the first several months of operation for the treatment systems at Allen and Belews Creek were excluded because they represent the initial commissioning period for the treatment system.

Figure 3. Plot of arsenic (µg/L) data on a logarithmic scale for Allen and Belews Creek



7.1.2 Summary Statistics for Arsenic (µg/L)

Table 13 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 13. Numbers of detected and non-detected observations and sample-specific detection limits for arsenic (µg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limits for Arsenic (µg/L)								
				2	3	4	4.5	5	7	10	14.5	52
Allen[1]	FGD Purge (N = 173)	0 or 2	D (n = 184)									
	Bioreactor Influent (N = 173)	0 or 2	D (n = 2)									
		0 or 2	ND (n = 182)	1		5		18	3	155		
	Bioreactor Effluent (N = 170)	0 or 2	D (n = 42)									
			ND (n = 139)			5		119		15		
Belews Creek[1]	FGD Purge (N = 201)	0 or 2	D (n = 211)									
	Bioreactor Influent (N = 202)	0 or 2	D (n = 15)									
			ND (n = 193)			5	1	22	1	163		1
	Bioreactor Effluent (N = 201)	0 or 2	D (n = 17)									
			ND (n = 194)	17	1	6	1	116		52	1	

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 14 provides summary statistics for all observations (detected and non-detected combined) for arsenic concentrations by sampling location and plant.

Table 14. Summary statistics of arsenic concentration (µg/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Arsenic (µg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Allen[1]	FGD Purge	0 or 2	184	68.0	230.3	203.0	725.0	104.9
	Bioreactor Influent	0 or 2	184	2.0	9.2	10.0	10.0	2.0
	Bioreactor Effluent	0 or 2	181	2.0	5.9	5.0	20.1	2.5
Belews Creek[1]	FGD Purge	0 or 2	211	21.0	324.2	230.0	2820.0	313.6
	Bioreactor Influent	0 or 2	208	4.0	9.8	10.0	52.0	3.8
	Bioreactor Effluent	0 or 2	211	2.0	7.2	5.0	121.0	8.7

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

7.2 Biological Treatment for FGD Wastewater: Mercury

Sections below provide the longitudinal plots and summary statistics for mercury. Because these two plants do not represent BAT/NSPS level of treatment for mercury, EPA did not calculate the limits for mercury using the Allen and Belews Creek data. Instead, EPA is transferring the mercury limits calculated based on the chemical precipitation technology option to the biological technology option for FGD wastewater (see Section 13 of the Technical Development Document for a detailed discussion of the transfer of limits).

7.2.1 Longitudinal Plots of the Data for Mercury (ng/L)

Below are the longitudinal plots of the mercury concentrations (on a logarithmic scale) for Allen and Belews Creek.

7.2.2 Summary Statistics for Mercury (ng/L)

All observations at each of the sampling locations Belews Creek were detected. Table 15 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits for Allen by sample location.

Figure 4. Plot of mercury (ng/L) data on a logarithmic scale for Allen and Belews Creek

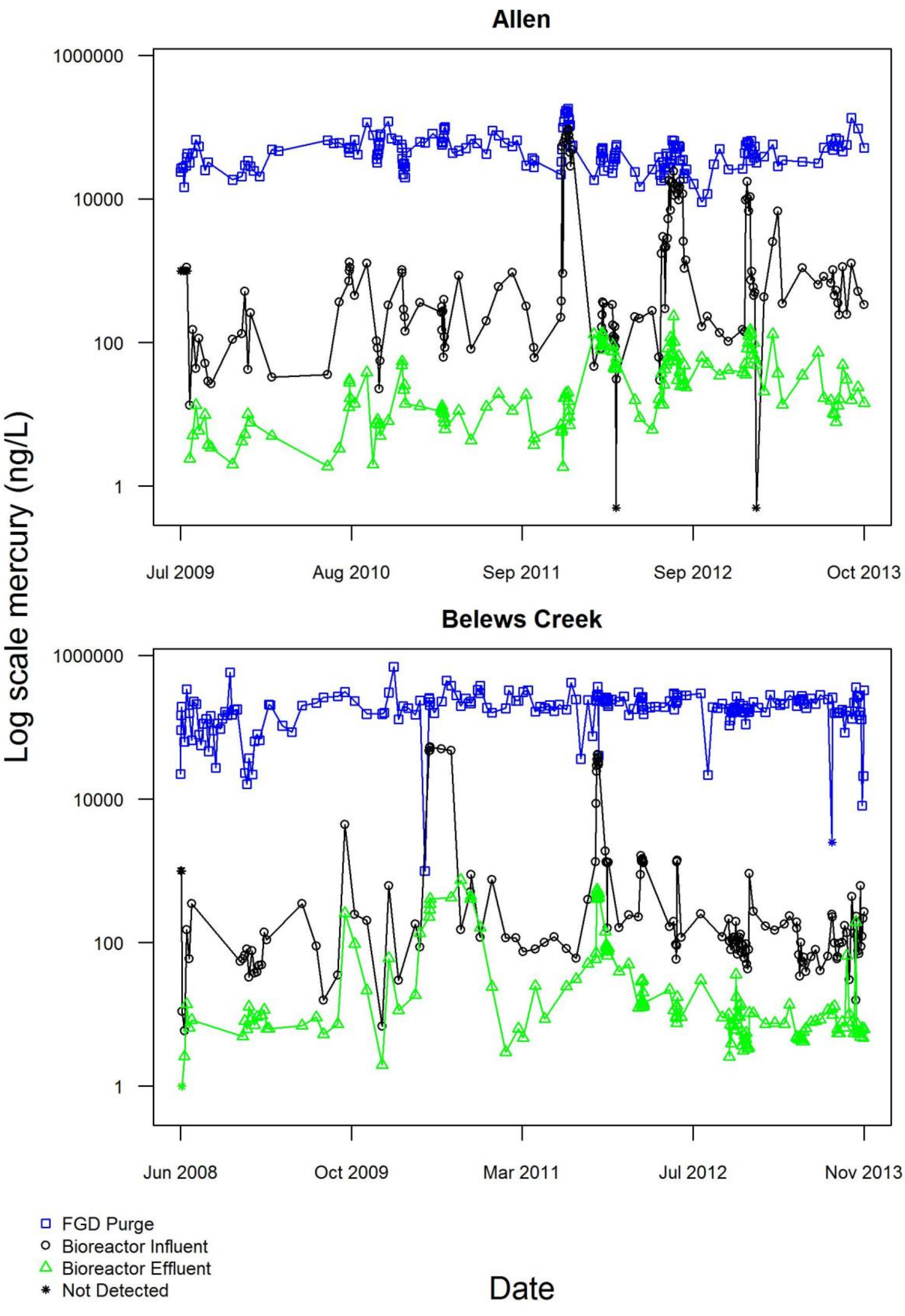


Table 15. Numbers of detected and non-detected observations and sample-specific detection limits for mercury (ng/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limits for Mercury (ng/L)				
				0.15	0.5	1	1000	2500
Allen[1]	FGD Purge (N = 183)	0 or 0.5	D (n = 183)					
	Bioreactor Influent (N = 153)	0	D (n = 146)					
			ND (n = 7)	1			6	
		0.5	D (n = 145)					
			ND (n = 8)		2		6	
	Bioreactor Effluent (N = 143)	0 or 0.5	D (n = 143)					
Belews Creek[1]	FGD Purge (N = 210)	0 or 0.5	D (n = 209)					
			ND(n=1)					1
	Bioreactor Influent (N = 160)	0 or 0.5	D (n = 156)					
			ND (n = 4)				4	
	Bioreactor Effluent (N = 153)	0 or 0.5	D (n = 152)					
			ND (n = 1)			1		

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 16 provides summary statistics for all observations for mercury concentrations by sampling location and plant.

Table 16. Summary statistics of mercury concentration (ng/L) for all detected and non-detected samples combined by plant and sampling location

Plant Name	Sampling Location	Baseline [2]	Summary Statistics for Mercury (ng/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Allen[1]	FGD Purge	0 or0.5	183	9,050.0	51,127.6	44,400.0	180,000.0	29,732.4
	Bioreactor Influent	0	153	0.2	7,850.5	450.0	93,100.0	19,709.5
		0.5	153	0.5	7,850.5	450.0	93,100.0	19,709.5
	Bioreactor Effluent	0 or0.5	143	1.9	38.8	22.0	234.0	39.8
Belews Creek[1]	FGD Purge	0 or0.5	210	1,000.0	199,907.1	198,500.0	697,000.0	91,347.8
	Bioreactor Influent	0 or0.5	160	5.9	3,946.5	136.6	53,300.0	11,709.0
	Bioreactor Effluent	0 or0.5	153	1.0	66.4	9.8	746.0	136.4

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

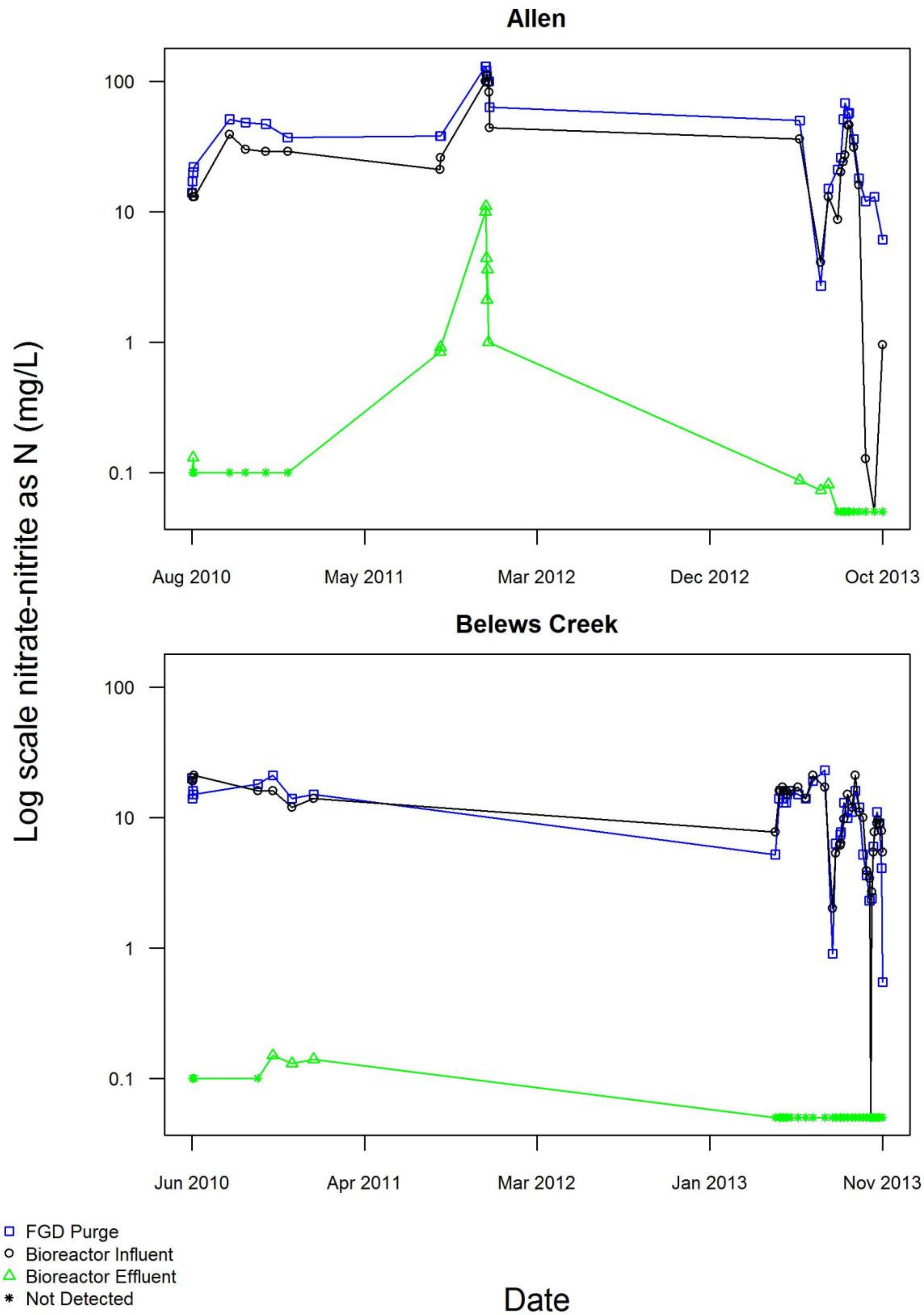
[3]: Detected and non-detected observations combined (all observations were detected).

7.3 Biological Treatment for FGD Wastewater: Nitrate-nitrite as N

7.3.1 Longitudinal Plots of the Data for Nitrate-nitrite as N (mg/L)

Below are the longitudinal plots of the nitrate-nitrite as N concentrations (on a logarithmic scale) for Allen and Belews Creek.

Figure 5. Plot of nitrate-nitrite as N (mg/L) data on a logarithmic scale for Allen and Belews Creek



7.3.2 Summary Statistics for Nitrate-nitrite as N (mg/L)

Table 17 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 17. Number of detected, non-detected, and sample-specific detection limits for nitrate-nitrate as N (mg/L) by plant and sampling location

Plant Name	Sampling Location	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limit for Nitrate-nitrite as N (mg/L)		
	(Total Observations[2])			0.01	0.05	0.1
Allen[1]	FGD Purge (N = 32)	0 or 0.05	D (n = 32)			
	Bioreactor Influent (N = 32)	0	D (n = 31)			
			ND (n=1)	1		
		0.05	D (n = 31)			
			ND (n=1)		1	
	Bioreactor Effluent (N = 30)	0	D (n = 12)			
			ND (n=18)	11		7
		0.05	D (n = 12)			
			ND (n=18)		11	7
Belews Creek[1]	FGD Purge (N = 38)	0 or 0.05	D (n = 38)			
	Bioreactor Influent (N = 41)	0	D (n = 40)			
			ND (n=1)	1		
		0.05	D (n = 40)			
			ND (n=1)		1	
	Bioreactor Effluent (N = 40)	0	D (n = 4)			
			ND (n = 36)	31		5
		0.05	D (n = 3)			
			ND (n = 37)		32	5

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 18 provides summary statistics for all observations (detected and non-detected combined) for nitrate-nitrite as N concentrations by sampling location and plant.

Table 18. Summary statistics of nitrate-nitrite as N concentration (mg/L) for all detected and non-detected samples combined by plant and sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Nitrate-nitrite as N (mg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Allen[1]	FGD Purge	0 or 0.05	32	2.70	50.53	42.50	130.00	37.99
	Bioreactor Influent	0	32	0.01	39.15	28.00	110.00	35.90
		0.05	32	0.05	39.15	28.00	110.00	35.90
	Bioreactor Effluent	0	30	0.01	1.17	0.10	11.00	2.75
		0.05	30	0.05	1.18	0.10	11.00	2.74
Belews Creek[1]	FGD Purge	0 or 0.05	38	0.55	11.54	13.00	23.00	5.83
	Bioreactor Influent	0	41	0.10	11.90	12.00	21.00	5.86
		0.05	41	0.05	11.90	12.00	21.00	5.86
	Bioreactor Effluent	0	40	0.01	0.03	0.01	0.15	0.04
		0.05	40	0.05	0.06	0.05	0.15	0.03

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

7.3.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for Nitrate-nitrite as N (mg/L)

Table 19 provides the plant-specific long-term averages, plant-specific variability factors, option long-term averages, option variability factors, and effluent limits for nitrate-nitrite as N in bioreactor effluent.

Table 19. Lag-1 autocorrelation values, plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for nitrate-nitrite as N (mg/L) in bioreactor effluent

Baseline Adjusted[1]	Autocorrelation Value[2]	TYPE	N[3]	Plant Name	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0	0	Plant-Specific	30 (D=12, ND=18)	Allen[4]	2.032	16.773	3.937		
			40 (D=4, ND=36)	Belews Creek[4]	0.035	9.360	2.879		
		Option			1.033	13.066	3.408	13.503	3.522
0	0.69	Plant-Specific	30 (D=12, ND=18)	Allen[4]	2.549	16.876	3.841		
			40 (D=4, ND=36)	Belews Creek[4]	0.035	9.360	2.892		
		Option			1.292	13.118	3.366	16.950	4.350
0.05	0	Plant-Specific	30 (D=12, ND=18)	Allen[4]	2.047	16.652	3.932		
			40 (D=3, ND=37)	Belews Creek[4]	0.063	2.402	1.417		
		Option			1.055	9.527	2.675	10.049	2.821
0.05	0.67	Plant-Specific	30 (D=12, ND=18)	Allen[4]	2.531	16.779	3.846		
			40 (D=3, ND=37)	Belews Creek[4]	0.063	2.402	1.454		
		Option			1.297	9.590	2.650	12.441	3.437

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: D = detected and ND = non-detected.

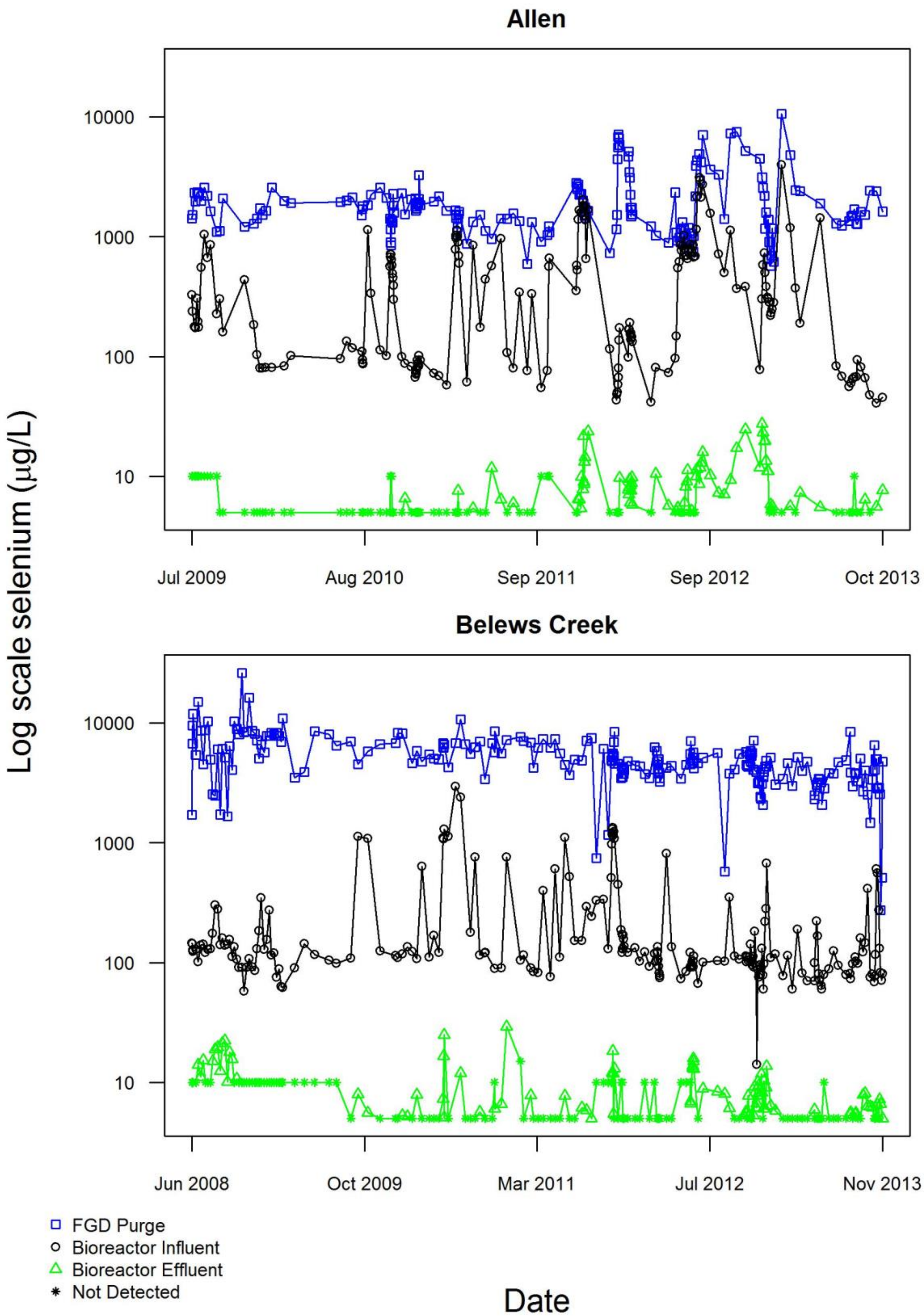
[4]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

7.4 Biological Treatment for FGD Wastewater: Selenium

7.4.1 Longitudinal Plots of the Data for Selenium (µg/L)

Below are the longitudinal plots of the selenium concentrations (on a logarithmic scale) for Allen and Belews Creek.

Figure 6. Plot of selenium (µg/L) data on a logarithmic scale for Allen and Belews Creek



7.4.2 Summary Statistics for Selenium (µg/L)

Table 20 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 20. Number of detected, non-detected, and sample-specific detection limits for selenium (µg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limits for Selenium (µg/L)							
				1	2	4	4.5	5	10	14.5	15
Allen[1]	FGD Purge (N = 184)	0 or 5	D (n = 184)								
	Bioreactor Influent (N = 184)	0 or 5	D (n = 184)								
	Bioreactor Effluent (N = 182)	0	D (n = 82)								
			ND (n =100)	1	6	5	2	65	21		
		5	D (n = 66)								
			ND (n =116)					95	21		
Belews Creek[1]	FGD Purge (N =217)	0 or 5	D (n = 217)								
	Bioreactor Influent (N = 216)	0 or 5	D (n = 216)								
	Bioreactor Effluent (N = 216)	0	D (n = 96)								
			ND (n = 120)		2	2		67	48	1	
		5	D (n = 86)								
			ND (n = 130)					81	48		1

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 21 provides summary statistics for all observations (detected and non-detected combined) for selenium by sampling location and plant.

Table 21. Summary statistics of selenium concentration (µg/L) for all detected and non-detected samples combined by plant and sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Selenium (µg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Allen[1]	FGD Purge	0 or 5	184	572.0	2089.2	1655.0	10600.0	1484.7
	Bioreactor Influent	0 or 5	184	40.6	528.5	292.0	3980.0	634.2
	Bioreactor Effluent	0	182	1.0	7.1	5.0	27.6	4.3
		5	182	5.0	7.4	5.0	27.6	4.1
Belews Creek[1]	FGD Purge	0 or 5	217	274.0	5297.2	4820.0	26200.0	2675.9
	Bioreactor Influent	0 or 5	216	14.1	256.1	118.0	2940.0	382.8
	Bioreactor Effluent	0	216	2.0	7.9	6.2	29.4	4.1
		5	216	5.0	8.0	6.2	29.4	4.0

[1]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

7.4.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for Selenium (µg/L)

Table 22 provides the plant-specific long-term averages, plant-specific variability factors, option long-term averages, option variability factors, and effluent limits for selenium in bioreactor effluent.

Table 22. Lag-1 autocorrelation values, plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for selenium (µg/L) in bioreactor effluent

Baseline Adjusted[1]	Autocorrelation Value[2]	TYPE	N[3]	Plant Name	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0	0	Plant-Specific	182 (D=82, ND=100)	Allen[4]	7.126	3.265	1.556		
		Plant-Specific	216 (D=96, ND=120)	Belews Creek[4]	7.920	2.771	1.453		
		Option			7.523	3.018	1.504	22.703	11.318
0	0.69	Plant-Specific	182 (D=82, ND=100)	Allen[4]	7.134	3.283	1.589		
		Plant-Specific	216 (D=96, ND=120)	Belews Creek[4]	7.923	2.779	1.480		
		Option			7.528	3.031	1.535	22.819	11.554
5	0	Plant-Specific	182 (D=66, ND=116)	Allen[4]	7.386	2.856	1.466		
		Plant-Specific	216 (D=86, ND=130)	Belews Creek[4]	8.010	2.610	1.420		
		Option			7.698	2.733	1.443	21.040	11.110
5	0.67	Plant-Specific	182 (D=66, ND=116)	Allen[4]	7.391	2.873	1.492		
		Plant-Specific	216 (D=86, ND=130)	Belews Creek[4]	8.013	2.618	1.442		
		Option			7.702	2.746	1.467	21.146	11.299

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: D = detected and ND = non-detected.

[4]: Combination of EPA sampling, CWA 308 sampling, and plant self-monitoring data.

7.5 Biological Treatment for FGD Wastewater: Summary of the Option Long-term Averages, Variability Factors, and Effluent Limits

Table 23 summarizes the option long-term average, option variability factors, and effluent limits for each pollutant for biological treatment technology option for FGD wastewater. It should be noted that the option long-term averages and variability factors, and effluent limits presented in previous tables also included values assuming zero autocorrelation. As described in 5.3, EPA was able to evaluate and estimate an autocorrelation for selenium based on several years of data from Allen and Belews Creek. The selenium limit set for this rulemaking therefore are based on the autocorrelation obtained from the data. Limited data were available for nitrate-nitrite as N from these two plants. However, since the removal process are similar for selenium and nitrate-nitrite as N, EPA transferred selenium autocorrelation to nitrate-nitrite as N. It is also appropriate to use zero autocorrelations when there is not enough data to reliably estimate the autocorrelation. The table below presents the results for the option long-term averages, option variability factors, and daily maximum and monthly average limits that incorporated the autocorrelations. As described above, EPA is transferring the arsenic and mercury limits from the chemical precipitation technology option to biological technology option. Thus, the table below presents the arsenic and mercury limits based on the chemical precipitation technology option.

Table 23. Summary of option long-term averages, variability factors, and effluent limits for biological FGD wastewater treatment technology

Pollutant	Baseline[1]	Autocorrelation Value[2]	Option LTA	Option Daily Variability Factor	Option Monthly Variability Factor	Daily Limit[3]	Monthly Average Limit[3]
Arsenic (µg/L)	0	0.86	5.976	1.760	1.336	11	8
	2		5.976	1.756	1.324	11	8
Mercury (ng/L)	0 or 0.5	0.89	159.345	4.940	2.233	788	356
Nitrate-Nitrite as N (mg/L)	0	0.69	1.292	13.118	3.366	17.0	4.4
	0.05	0.67	1.297	9.590	2.650	12.5	3.5
Selenium (µg/L)	0	0.69	7.528	3.031	1.535	23	12
	5	0.67	7.702	2.746	1.467	22	12

[1]: Baseline value of 0 indicates no adjustment for baseline.
[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.
[3]: Effluent limitations have been rounded upward to the next highest integer for all except nitrate-Nitrite as N, which have been rounded upward to the tenth decimal.

8 Treatment Technology Option for FGD Wastewater: Vapor-compression Evaporation System

EPA used data from Brindisi power plant to calculate the effluent limits for the chemical precipitation followed by vapor-compression evaporation treatment technology option for FGD wastewater. The pollutants for which the effluent limits are calculated are arsenic, mercury, selenium, and total dissolved solids.

The effluent limits were calculated for the following two sampling locations: (i) brine concentrator distillate and (ii) crystallizer condensate. The effluent limits for this technology option were based on the sampling location that produced the higher effluent limits. Setting the effluent limits on the higher concentration stream is appropriate for this technology to ensure plants operating a well-designed and well-operated evaporator system can meet the effluent limits prior to discharge or reuse of the FGD wastewater in another plant process, regardless of whether they sample the effluent streams separately or as a combined stream (see Section 13 of the Technical Development Document for a detailed discussion).

Brindisi sampling data were collected by EPA between 04/05/2011 and 04/07/2011. Data were available at the following sampling locations: FGD Purge, brine concentrator distillate, and crystallizer condensate.

EPA attempted to use the available data to estimate the autocorrelation. However, for Brindisi, EPA was not able to perform an evaluation of the autocorrelation because there were too few observations available at the plant. Thus, EPA set the autocorrelation to zero in developing the limits for the reasons described in section 5.3.

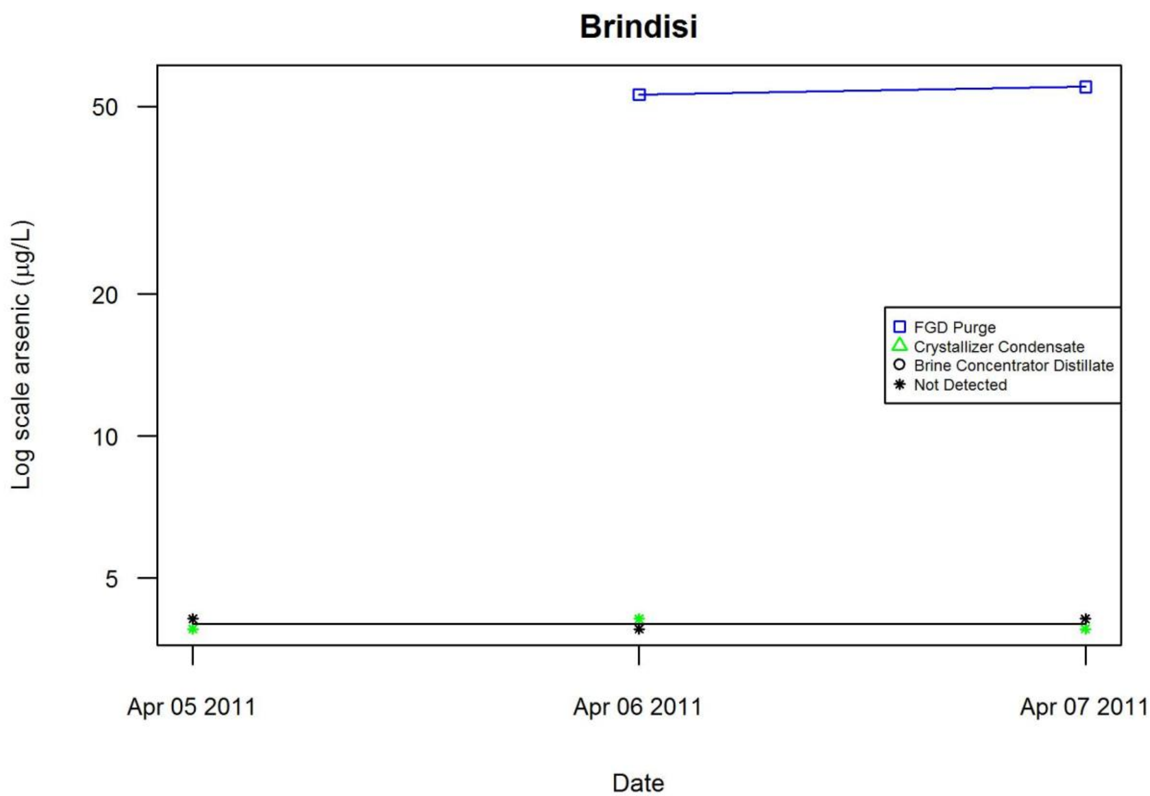
The sections below provide the following for each of the pollutants: longitudinal plots of the data (baseline adjusted data only), summary statistics, and plant-specific long-term average and variability factors (see Appendix B for an overview of the statistical model and the procedures used to estimate the plant-specific long term average and variability factors). Since only one plant was used, the option long-term average and option variability factors are the same as the plant-specific long-term average and variability factors.

8.1 Vapor-compression Evaporation for FGD Wastewater: Arsenic

8.1.1 Longitudinal Plots of the Data for Arsenic (µg/L)

Below is the longitudinal plot of the arsenic concentrations (on a logarithmic scale) for Brindisi.

Figure 7. **Plot of arsenic (µg/L) data on a logarithmic scale for Brindisi. The Brine Concentrator Distillate and Crystallizer Condensate data were jittered slightly to enhance visibility**



8.1.2 Summary Statistics for Arsenic (µg/L)

Table 24 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits for each sample location.

Table 24. Numbers of detected and non-detected observations and sample-specific detection limits for arsenic (µg/L) by sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample Specific Detection Limits for Arsenic (µg/L): Detection Limit = 4
Brindisi[1]	FGD Purge (N = 2)	0 or 2	D (n=2)	
	Brine Concentrator Distillate (N = 3)	0 or 2	D (n=0)	
			ND (n=3)	3
	Crystallizer Condensate (N = 3)	0 or 2	D (n=0)	
			ND (n=3)	3

[1]: EPA sampling data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 25 provides summary statistics for all observations (detected and non-detected combined) for each of sampling location.

Table 25. Summary statistics of arsenic concentration (µg/L) for all detected and non-detected samples combined by sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Arsenic (µg/L): N[3]	Minimum	Mean	Median	Maximum	Std
Brindisi [1]	FGD Purge	0 or 2	2	53.0	54.0	54.0	55.0	1.4
	Brine Concentrator Distillate	0 or 2	3	4.0	4.0	4.0	4.0	0.0
	Crystallizer Condensate	0 or 2	3	4.0	4.0	4.0	4.0	0.0

[1]: EPA sampling data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

8.1.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for Arsenic (µg/L)

Table 26 provides the plant-specific long-term averages and variability factors, option long-term averages and variability factors, and effluent limits for arsenic at two sampling locations: brine concentrator distillate and crystallizer condensate.

Since all observations were non-detected, the statistical model was not used to obtain the long-term average and variability factors (see Sections 5.4, 5.5, and 5.6). The daily limits for both sampling locations were set based on the detection limit. The monthly average limits are not established when the daily limit is set equal to the detection limit.

Table 26. Plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for arsenic (µg/L) in brine concentrator distillate and crystallizer condensate

Baseline adjusted[1]	Plant Name	Sampling Location	Type	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 2	Brindisi	Brine Concentrator Distillate	Plant – Specific	3 (D=0, ND=3)	4.0[3]	NA[4]	NA[4]		
			Option		4.0[3]	NA[4]	NA[4]	4[5]	NA[6]
0 or 2		Crystallizer Condensate	Plant – Specific	3 (D=0, ND=3)	4.0[3]	NA[4]	NA[4]		
			Option		4.0[3]	NA[4]	NA[4]	4[5]	NA[6]

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: D = detected and ND = non-detected.

[3]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[4]: All observations were non-detected, so the variability factors could not be calculated.

[5]: Limit is set equal to the detection limit.

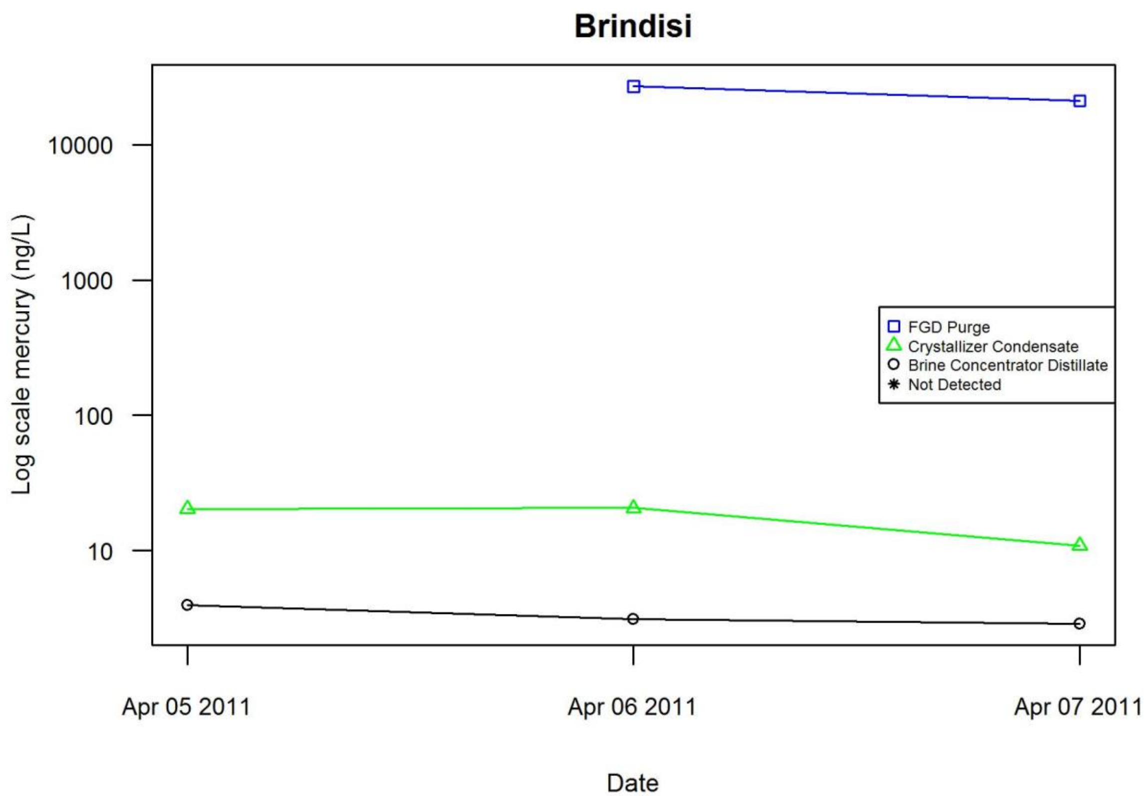
[6]: Monthly average limit is not established when the daily limit is equal to detection limit.

8.2 Vapor-compression Evaporation for FGD Wastewater: Mercury

8.2.1 Longitudinal Plots of the Data for Mercury (ng/L)

Below is the longitudinal plot of the mercury concentrations (on a logarithmic scale) for Brindisi.

Figure 8. Plot of mercury (ng/L) data on a logarithmic scale for Brindisi



8.2.2 Summary Statistics for Mercury (ng/L)

All observations at each of the sampling locations for Brindisi were detected. Table 27 provides summary statistics for all observations for each sampling location.

Table 27. Summary statistics of mercury concentration (ng/L) for all detected and non-detected samples combined by sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Mercury (ng/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Brindisi[1]	FGD Purge	0 or 0.5	2	21,100.0	24,000.0	24,000.0	26,900.0	4,101.2
	Brine Concentrator Distillate	0 or 0.5	3	2.9	3.3	3.1	4.0	0.6
	Crystallizer Condensate	0 or 0.5	3	10.9	17.3	20.4	20.7	5.6

[1]: EPA sampling data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

8.2.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for Mercury (ng/L)

Table 28 provides the plant-specific LTAs and plant-specific variability factors, option LTAs and variability factors, and limits for mercury at two sampling locations: brine concentrator distillate and crystallizer condensate.

Table 28. Plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for mercury (ng/L) in brine concentrator distillate and crystallizer condensate

Baseline adjusted[1]	Plant Name	Sampling Location	Type	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 0.5	Brindisi	Brine Concentrator Distillate	Plant – Specific	3 (D=3, ND=0)	3.348	1.453	1.144		
			Option		3.348	1.453	1.144	4.865	3.829
0 or 0.5		Crystallizer Condensate	Plant – Specific	3 (D=3, ND=0)	17.788	2.192	1.338		
			Option		17.788	2.192	1.338	38.989	23.800

[1]: Baseline value of 0 indicates no adjustment for baseline.

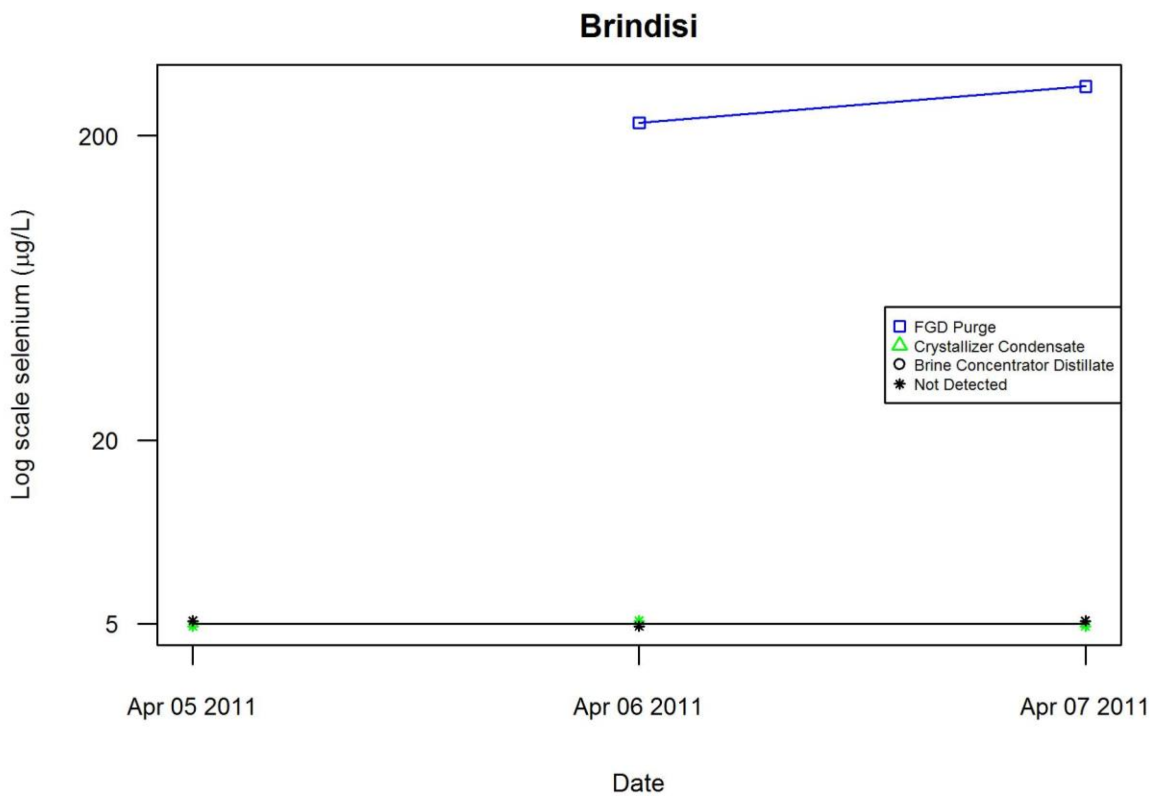
[2]: D = detected and ND = non-detected.

8.3 Vapor-compression Evaporation for FGD Wastewater: Selenium

8.3.1 Longitudinal Plots of the Data for Selenium (µg/L)

Below is the longitudinal plot of the selenium concentrations (on a logarithmic scale) for Brindisi.

Figure 9. Plot of selenium (µg/L) data on a logarithmic scale for Brindisi



8.3.2 Summary Statistics for Selenium (µg/L)

Table 29 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location.

Table 29. Number of detected, non-detected, and sample-specific detection limits for selenium (μg/L) by sampling location

Plant Name	Sampling Location (Total Observations[2])	Baseline[3]	Indicator (n)[4]	Sample-Specific Detection Limits for Selenium (μg/L)	
				Detection Limit = 4	Detection Limit = 5
Brindisi[1]	FGD Purge (N = 2)	0 or 5	D (n = 2)		
	Brine Concentrator Distillate (N = 3)	0	D (n = 0)		
			ND (n = 3)	3	
		5	D (n = 0)		
			ND (n = 3)		3
	Crystallizer Condensate (N = 3)	0	D (n = 0)		
			ND (n = 3)	3	
		5	D (n = 0)		
			ND (n = 3)		3

[1]: EPA sampling data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 30 provides summary statistics for all observations (detected and non-detected combined) for each sampling location.

Table 30. Summary statistics of selenium concentration (μg/L) for all detected and non-detected samples combined by sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Selenium (μg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Brindisi[1]	FGD Purge	0 or 5	2	220.0	255.0	255.0	290.0	49.5
	Brine Concentrator Distillate	0	3	4.0	4.0	4.0	4.0	0.0
		5	3	5.0	5.0	5.0	5.0	0.0
	Crystallizer Condensate	0	3	4.0	4.0	4.0	4.0	0.0
		5	3	5.0	5.0	5.0	5.0	0.0

[1]: EPA sampling data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

8.3.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for Selenium (µg/L)

Table 31 provides the option plant-specific LTAs and variability factors, option LTAs and variability factors, and effluent limits for selenium at two sampling locations: brine concentrator distillate and crystallizer condensate.

All observations were non-detected, so the statistical model was not used to obtain the long-term average and variability factors. The daily limits for both sampling locations were set based on the detection limit. The monthly average is not set when the daily limit is based on the detection limit.

Table 31. Plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for selenium (µg/L) in brine concentrator distillate and crystallizer condensate

Baseline adjusted[1]	Plant Name	Sampling Location	Type	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0	Brindisi	Brine Concentrator Distillate	Plant – Specific	3 (D=0, ND=3)	4.0[3]	NA[4]	NA[4]		
			Option		4.0[3]	NA[4]	NA[4]	4[5]	NA[6]
		Crystallizer Condensate	Plant – Specific	3 (D=0, ND=3)	4.0[3]	NA[4]	NA[4]		
			Option		4.0[3]	NA[4]	NA[4]	4[5]	NA[6]
5	Brindisi	Brine Concentrator Distillate	Plant – Specific	3 (D=0, ND=3)	5.0[3]	NA[4]	NA[4]		
			Option		5.0[3]	NA[4]	NA[4]	5[5]	NA[6]
		Crystallizer Condensate	Plant – Specific	3 (D=0, ND=3)	5.0[3]	NA[4]	NA[4]		
			Option		5.0[3]	NA[4]	NA[4]	5[5]	NA[6]

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: D = detected and ND = non-detected.

[3]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[4]: All observations were non-detected, so the variability factors could not be calculated.

[5]: Limit is set equal to the detection limit.

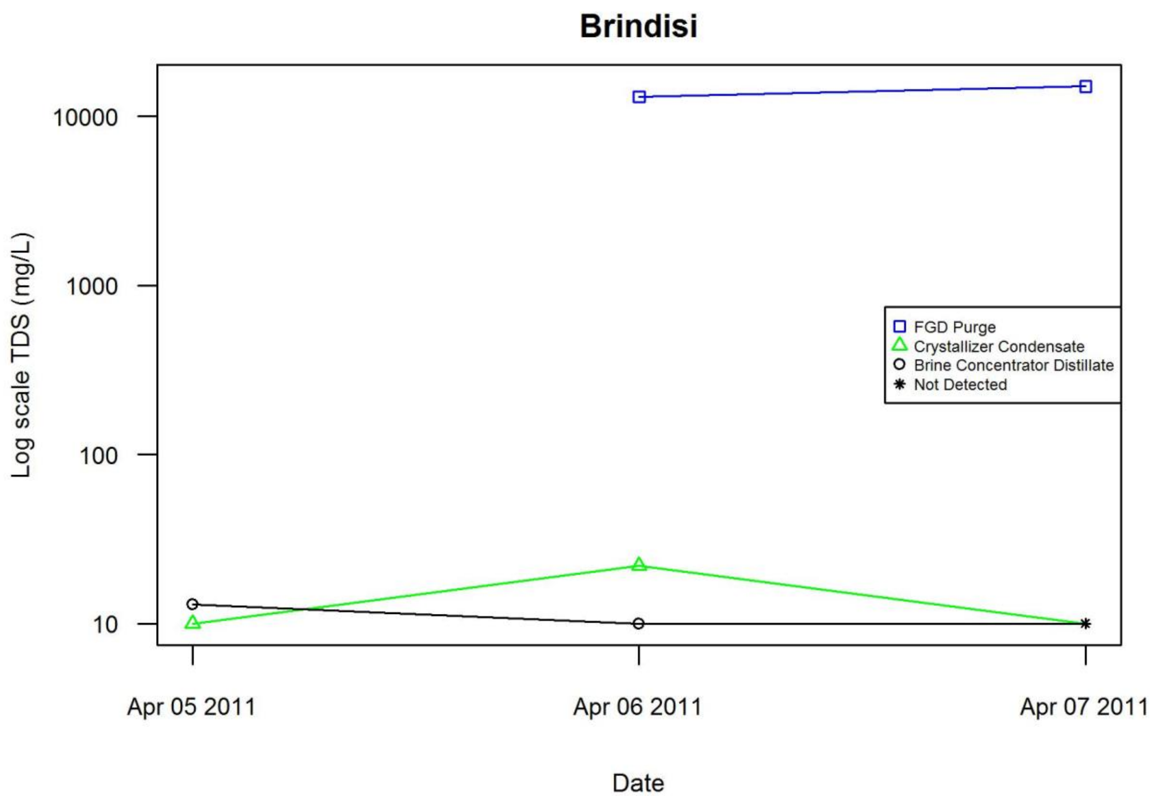
[6]: Monthly average limit is not established when the daily limit is equal to detection limit.

8.4 Vapor-compression Evaporation for FGD Wastewater: Total Dissolved Solids (TDS)

8.4.1 Longitudinal Plots of the Data for TDS (mg/L)

Below is the longitudinal plot of the TDS concentrations (on a logarithmic scale) for Brindisi.

Figure 10. Plot of TDS (mg/L) data on a logarithmic scale for Brindisi



8.4.2 Summary Statistics for TDS (mg/L)

Table 32 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location.

Table 32. Number of detected, non-detected, and sample-specific detection limits for total dissolved solid (mg/L) by sampling location

Plant Name	Sampling Location (Total Observations[1])	Baseline[3]	Indicator (n)[2]	Sample-Specific Detection Limits for TDS (µg/L) Detection Limit = 10
Brindisi[1]	FGD Purge (N = 2)	0 or 10	D (n = 2)	
	Brine Concentrator Distillate (N = 3)	0 or 10	D (n = 2)	
			ND (n = 1)	1
	Crystallizer Condensate (N = 3)	0 or 10	D (n = 2)	
			ND (n = 1)	1

[1]: EPA sampling data.

[2]: Detected and non-detected observations combined.

[3]: Baseline value of 0 indicates no adjustment for baseline.

[4]: D = detected and ND = non-detected.

Table 33 provides summary statistics for all observations (detected and non-detected combined) for each sampling location.

Table 33. Summary statistics of total dissolved solids concentration (mg/L) for all detected and non-detected samples combined by sampling location

Plant Name	Sampling Location	Baseline[2]	Summary Statistics for Total Dissolved Solids (mg/L)					
			N[3]	Minimum	Mean	Median	Maximum	Std
Brindisi[1]	FGD Purge	0 or 10	2	13,000.0	14,000.0	14,000.0	15,000.0	1,414.2
	Brine Concentrator Distillate	0 or 10	3	10.0	11.0	10.0	13.0	1.7
	Crystallizer Condensate	0 or 10	3	10.0	14.0	10.0	22.0	6.9

[1]: EPA sampling data.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: Detected and non-detected observations combined.

8.4.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Averages and Variability Factors, and Effluent Limits for TDS (mg/L)

Table 34 provides the plant-specific LTAs and variability factors, option LTAs and variability factors, and effluent limits for TDS at two sampling locations: brine concentrator distillate and crystallizer condensate.

Table 34. Plant-specific long-term averages and variability factors, option long-term averages and variability factors, and limits for TDS (mg/L) in brine concentrator distillate and crystallizer condensate

Baseline adjusted[1]	Plant Name	Sampling Location	Type	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 10	Brindisi	Brine Concentrator Distillate	Plant – Specific	3 (D=2, ND=1)	11.066	1.541	1.150		
			Option		11.066	1.541	1.150	17.054	12.722
0 or 10		Crystallizer Condensate	Plant – Specific	3 (D=2, ND=1)	14.884	3.341	1.572		
			Option		14.884	3.341	1.572	49.734	23.393

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: D = detected and ND = non-detected.

8.5 Vapor-compression Evaporation for FGD Wastewater: Summary of the Option Long-term Averages, Option Variability Factors, and Effluent Limits

Table 35 and Table 36 summarize the option long-term average, option variability factors, and limits for each of the pollutants for the chemical precipitation followed by vapor compression evaporation system for FGD wastewater. Table 35 provides the results for the brine concentrator distillate sampling location while Table 36 provides the results at the crystallizer condensate sampling location. Since only one plant was used, the option LTA and option variability factors are the same as the plant-specific LTA and variability factors. Note that the effluent limits for regulation for this technology option are based on the crystallizer condensate. See Section 13 of the Technical Development Document for a discussion of EPA's reasons for basing the effluent limits for this technology option on the crystallizer condensate rather than the effluent limits calculated at brine concentrator distillate.

Table 35. Summary of option long-term averages, variability factors, and limits for vapor-compression evaporation technology for FGD wastewater in brine concentrator distillate

Pollutant	Baseline[1]	Autocorrelation Level[2]	Option LTA	Option Daily Variability Factor	Option Monthly Variability Factor	Daily Limit[3]	Monthly Average Limit[3]
Arsenic (µg/L)	0 or 2	0	4.0[4]	NA[5]	NA[5]	4[6]	NA[7]
Mercury (ng/L)	0 or 0.5	0	3.348	1.453	1.144	5	4
Selenium (µg/L)	0	0	4.0 [4]	NA[5]	NA[5]	4[6]	NA[7]
	5	0	5.0 [4]	NA[5]	NA[5]	5[6]	NA[7]
TDS (mg/L)	0 or 10	0	11.066	1.541	1.150	18	13

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: Effluent limitations have been rounded upward to the next highest integer.

[4]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[5]: All observations were non-detected, so the variability factors could not be calculated.

[6]: Limit is set equal to the detection limit.

[7]: Monthly average limit is not established when the daily limit is equal to detection limit.

Table 36. Summary of option long-term averages, option variability factors, and limits for mechanical vapor-compression evaporation technology for FGD wastewater in crystallizer condensate

Pollutant	Baseline[1]	Autocorrelation Value[2]	Option LTA	Option Daily Variability Factor	Option Monthly Variability Factor	Daily Limit[3]	Monthly Limit[3]
Arsenic (µg/L)	0 or 2	0	4.0[4]	NA[5]	NA[5]	4[6]	NA[7]
Mercury (ng/L)	0 or 0.5	0	17.788	2.192	1.338	39	24
Selenium (µg/L)	0	0	4.0[4]	NA[5]	NA[5]	4[6]	NA[7]
	5	0	5.0[4]	NA[5]	NA[5]	5[6]	NA[7]
TDS (mg/L)	0 or 10	0	14.884	3.341	1.572	50	24

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: Effluent limitations have been rounded upward to the next highest integer.

[4]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[5]: All observations were non-detected, so the variability factors could not be calculated.

[6]: Limit is set equal to the detection limit.

[7]: Monthly average limit is not established when the daily limit is equal to detection limit.

9 Treatment Technology Option for Gasification Wastewater: Vapor-compression Evaporation

EPA used data from two power plants (Polk and Wabash River) to develop the effluent limits for the vapor-compression evaporation treatment technology for gasification wastewater. The four pollutants for which the limits are calculated are arsenic, mercury, selenium, and total dissolved solids. Arsenic and mercury data at Wabash River failed the data editing criteria, thus, EPA excluded the arsenic and mercury data from this plant in developing the limits for gasification wastewater treatment technology. Even though the Wabash River data for arsenic and mercury were not used to develop the limits, summary statistics and plots for these two pollutants at this plant are also presented in this section.

For this technology option, EPA considered limits at two sampling locations: (i) forced circulation evaporator condensate and (ii) vapor compression evaporator condensate. EPA is establishing the limits based on vapor compression evaporator condensate data since, as discussed at proposal, EPA determined that the data collected at forced circulation evaporator condensate do not demonstrate typical removal rates for pollutants generally well-treated by evaporation and therefore are not adequate to form the basis of the limits. Based on EPA's review of the treatment system, the data indicate that the evaporator (or at a minimum the forced circulation evaporation stage) at Polk was operating abnormally and allowing carryover of pollutants to the condensate effluent stream.[6] For this reason, EPA based the limits for this technology option on the limits calculated from the *vapor compression evaporator condensate* data (see Section 13 of the Technical Development Document). If EPA was to calculate limits using the data at the forced circulation evaporator condensate, it would follow the same methodology used to calculate the limits for vapor compression evaporator condensate data.

The following provides a detailed summary of the available data for calculating the numeric limits at each plant.

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[6] Comments on the proposed effluent guidelines from Tampa Electric Company (the owner/operator of Polk Power Station) did not dispute EPA's conclusion about abnormal operation of the evaporator, nor EPA's decision not to use data for the forced circulation evaporation condensate for calculating the effluent limits for gasification wastewater.

Polk Sampling Data

Polk sampling data were collected by the plant on the following dates: 10/18/2011, 10/19/2011, 10/26/2011, and 10/27/2011. Data were available at the following sampling locations: neutralized weak acid, vapor compression evaporator influent, forced circulation evaporator condensate, and vapor compression evaporator condensate.

Wabash River Sampling Data

Wabash River sampling data were collected by the plant between 02/21/2011 to 02/24/2011. Data were available at the following sampling locations: sour water treatment influent, steam stripper effluent, vapor compression evaporator influent (RCC evaporator influent), and vapor compression evaporator condensate (RCC evaporator condensate).

EPA attempted to use the available data to estimate the autocorrelation. However, for both of these plants, EPA was not able to perform an evaluation of the autocorrelation because there were too few observations available at each plant. Thus, EPA set that the autocorrelation value is zero in the calculation of the limits as described in Section 5.3.

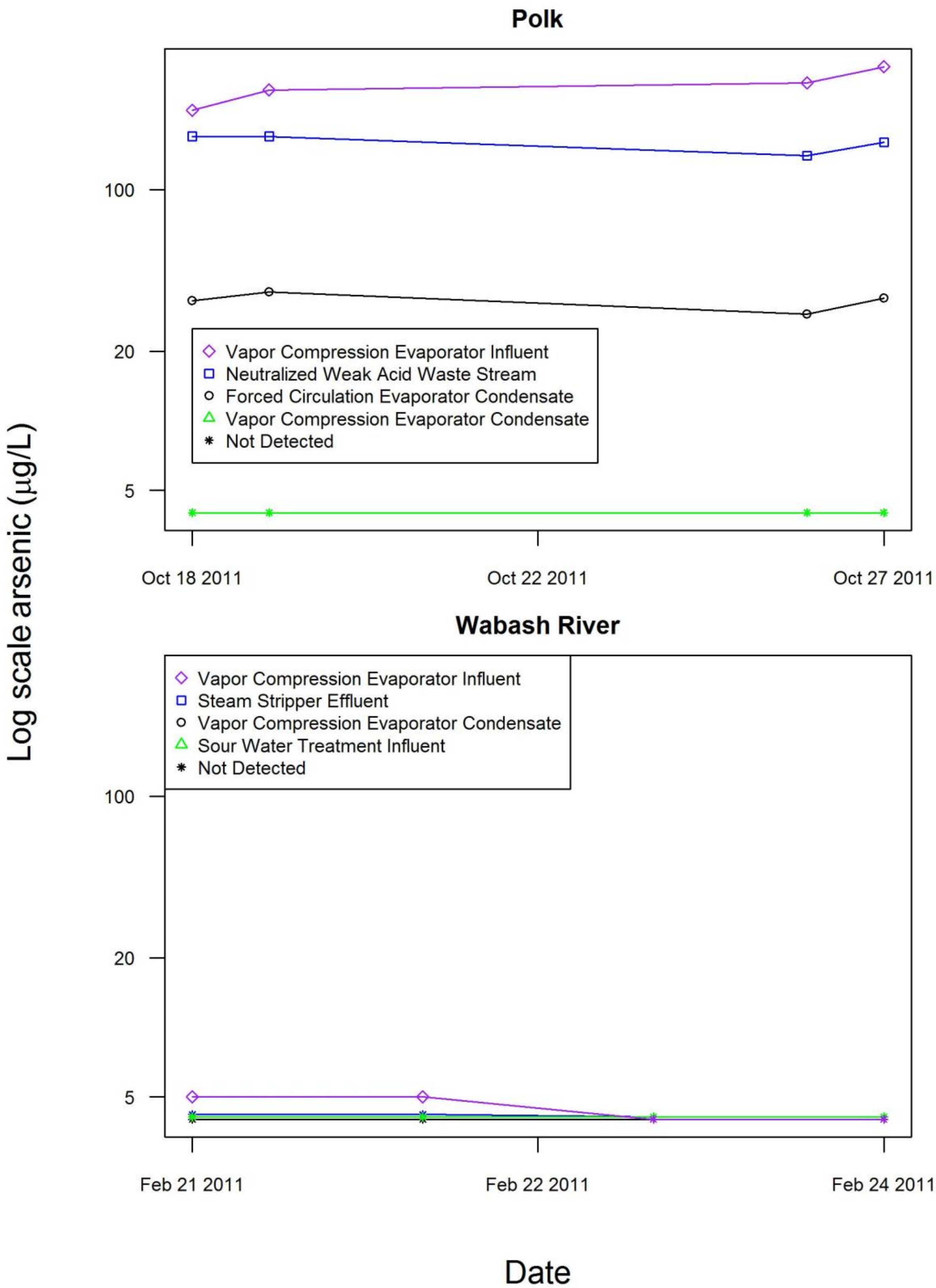
The sections below provide the following for each of the pollutants: longitudinal plots of the data (baseline adjusted data only), summary statistics, and plant-specific long-term average and variability factors (see Appendix B for an overview of the statistical model and the procedures used to estimate the plant-specific long term average and variability factors). Also provided in the sections below are the option long-term average, option variability factors, and effluent limits for each pollutant.

9.1 Vapor-compression Evaporation for Gasification: Arsenic

9.1.1 Longitudinal Plots of the Data for Arsenic (µg/L)

Below are the longitudinal plots of the arsenic concentrations (on a logarithmic scale) for Polk River.

Figure 11. Plot of arsenic (µg/L) data on a logarithmic scale for Polk and Wabash River



9.1.2 Summary Statistics for Arsenic (µg/L)

Table 37 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 37. Numbers of detected and non-detected observations and sample-specific detection limits for arsenic (µg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[1])	Baseline[2]	Indicator (n)[3]	Sample Specific Detection Limits for Arsenic (µg/L)		
				4	4.1	4.2
Polk	Neu. Weak Acid Waste Stream (N = 4)	0 or 2	D (n = 4)			
	Vapor Compr. Evap. Influent (N = 4)	0 or 2	D (n = 4)			
	Forced Cir. Evap. Condensate (N = 4)	0 or 2	D (n = 4)			
	Vapor Compr. Evap. Condensate (N = 4)	0 or 2	ND (n = 4)	4		
Wabash River	Sour Water Trt Influent (N = 4)	0 or 2	ND (n = 4)		4	
	Steam Stripper Effluent (N = 4)	0 or 2	ND (n = 4)		2	2
	Vapor Compr. Evap. Influent (N = 4)	0 or 2	D (n = 2)			
			ND (n = 2)	2		
	Vapor Compr. Evap. Condensate (N = 4)	0 or 2	ND (n = 4)	4		

[1]: Detected and non-detected observations combined.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: D = detected and ND = non-detected.

Table 38 provides summary statistics for all observations (detected and non-detected combined) for each sampling location at each of the plants.

Table 38. Summary statistics of arsenic concentration (µg/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[1]	Summary Statistics for Arsenic (µg/L)					
			N[2]	Minimum	Mean	Median	Maximum	Std
Polk	Neu. Weak Acid Waste Stream	0 or 2	4	140.0	160.0	165.0	170.0	14.1
	Vapor Compr. Evap. Influent	0 or 2	4	220.0	280.0	280.0	340.0	49.7
	Forced Cir. Evap. Condensate	0 or 2	4	29.0	33.0	33.5	36.0	2.9
	Vapor Compr. Evap. Condensate	0 or 2	4	4.0	4.0	4.0	4.0	0.0
Wabash River	Sour Water Trt Influent	0 or 2	4	4.1	4.1	4.1	4.1	0.0
	Steam Stripper Effluent	0 or 2	4	4.1	4.2	4.2	4.2	0.1
	Vapor Compr. Evap. Influent	0 or 2	4	4.0	4.5	4.5	5.0	0.6
	Vapor Compr. Evap. Condensate	0 or 2	4	4.0	4.0	4.0	4.0	0.0

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Detected and non-detected observations combined.

9.1.3 Plant-specific Long-term Average and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for Arsenic (µg/L)

Table 39 provides the plant-specific LTA, plant-specific variability factors, option LTA and variability factors, and numeric limits for arsenic at vapor compression evaporator condensate (using Polk data only). As described above, the arsenic data for Wabash River failed the data editing criteria, so, EPA excluded the arsenic dataset from Wabash River in developing the limits for this technology option.

Table 39. Plant-specific long-term average and variability factors, option long-term average and variability factors, and limits for arsenic (µg/L) in vapor compression evaporator condensate

Baseline Adjusted[1]	TYPE	Plant Name	Sampling Location	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 2	Plant-Specific	Polk	Vapor Compr. Evap. Condensate	4 (D=0, ND=4)	4.00[3]	NA[4]	NA[4]		
	Option		Vapor Compr. Evap. Condensate		4.00[3]	NA[4]	NA[4]	4[5]	NA[6]

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: D = detected and ND = non-detected.

[3]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[4]: All observations were non-detected, so the variability factors could not be calculated.

[5]: Limit is set equal to the detection limit.

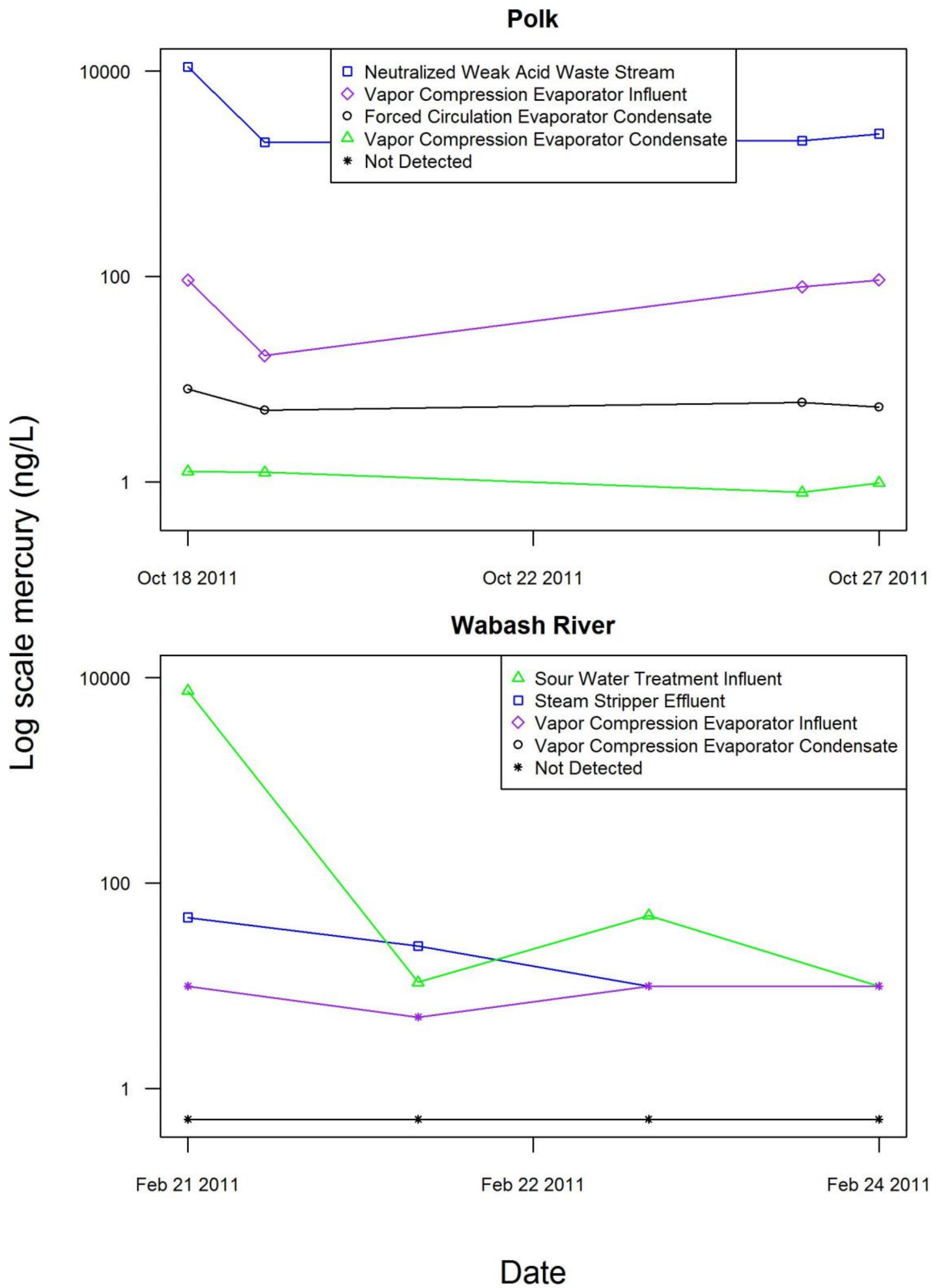
[6]: Monthly average limit is not established when the daily limit is equal to detection limit.

9.2 Vapor-compression Evaporation for Gasification: Mercury

9.2.1 Longitudinal Plots of the Data for Mercury (ng/L)

Below are the longitudinal plots of the mercury concentrations (on a logarithmic scale) for Polk River.

Figure 12. Plot of mercury (ng/L) data on a logarithmic scale for Polk and Wabash River



9.2.2 Summary Statistics for Mercury (ng/L)

Table 40 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 40. Numbers of detected and non-detected observations and sample-specific detection limits for mercury (ng/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[1])	Baseline[2]	Indicator (n)[3]	Sample Specific Detection Limits for Mercury (ng/L)		
				0.5	4.95	9.9
Polk	Neu. Weak Acid Waste Stream (N = 4)	0 or 0.5	D (n = 4)			
	Vapor Compr. Evap. Influent (N = 4)	0 or 0.5	D (n = 4)			
	Forced Cir. Evap. Condensate (N = 4)	0 or 0.5	D (n = 4)			
	Vapor Compr. Evap. Condensate (N = 4)	0 or 0.5	D (n = 4)			
Wabash River	Sour Water Trt Influent (N = 4)	0 or 0.5	D (n = 3)			
			ND (n = 1)			1
	Steam Stripper Effluent (N = 4)	0 or 0.5	D (n = 2)			
		0 or 0.5	ND (n = 2)			2
	Vapor Compr. Evap. Influent (N = 4)	0 or 0.5	ND (n = 4)		1	3
	Vapor Compr. Evap. Condensate (N = 4)	0 or 0.5	ND (n = 4)	4		

[1]: Detected and non-detected observations combined.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: D = detected and ND = non-detected.

Table 41 provides summary statistics for all observations (detected and non-detected combined) for each sampling location at each of the plants.

Table 41. Summary statistics of mercury concentration (ng/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[1]	Summary Statistics for Mercury (ng/L)					
			N[2]	Minimum	Mean	Median	Maximum	Std
Polk	Neu. Weak Acid Waste Stream	0 or 0.5	4	2,030.0	4,392.5	2,270.0	11,000.0	4,408.9
	Vapor Compr. Evap. Influent	0 or 0.5	4	17.0	70.4	85.9	92.7	36.2
	Forced Cir. Evap. Condensate	0 or 0.5	4	5.0	6.1	5.7	8.0	1.3
	Vapor Compr. Evap. Condensate	0 or 0.5	4	0.8	1.1	1.1	1..26	0.2
Wabash River	Sour Water Trt Influent	0 or 0.5	4	9.9	1,872.3	29.6	7,420.0	3,698.5
	Steam Stripper Effluent	0 or 0.5	4	9.9	22.6	17.2	46.3	17.2
	Vapor Compr. Evap. Influent	0 or 0.5	4	5.0	8.7	9.9	9.9	2.5
	Vapor Compr. Evap. Condensate	0 or 0.5	4	0.5	0.5	0.5	0.5	0.0

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Detected and non-detected observations combined.

9.2.3 Plant-specific Long-term Average and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for Mercury (ng/L)

Table 42 provides the plant-specific LTA, plant-specific variability factors, option LTA and variability factors, and effluent limits for mercury at vapor compression evaporator condensate (using Polk data only). Because the mercury data at Wabash River failed the data editing criteria, EPA excluded the data in developing the limits for this technology option. Thus, the mercury limits are based on Polk data only.

Table 42. Plant-specific long-term average and variability factors, option long-term average and variability factors, and limits for mercury (ng/L) in vapor compression evaporator condensate

Baseline Adjusted[1]	TYPE	Plant Name	Sampling Location	N[2]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 0.5	Plant-Specific	Polk	Vapor Compr Evap. Condensate	4 (D=4, ND=0)	1.075	1.632	1.194		
	Option		Vapor Compr. Evap. Condensate		1.075	1.632	1.194	1.754	1.283

[1]: Baseline value of 0 indicates no adjustment for baseline.

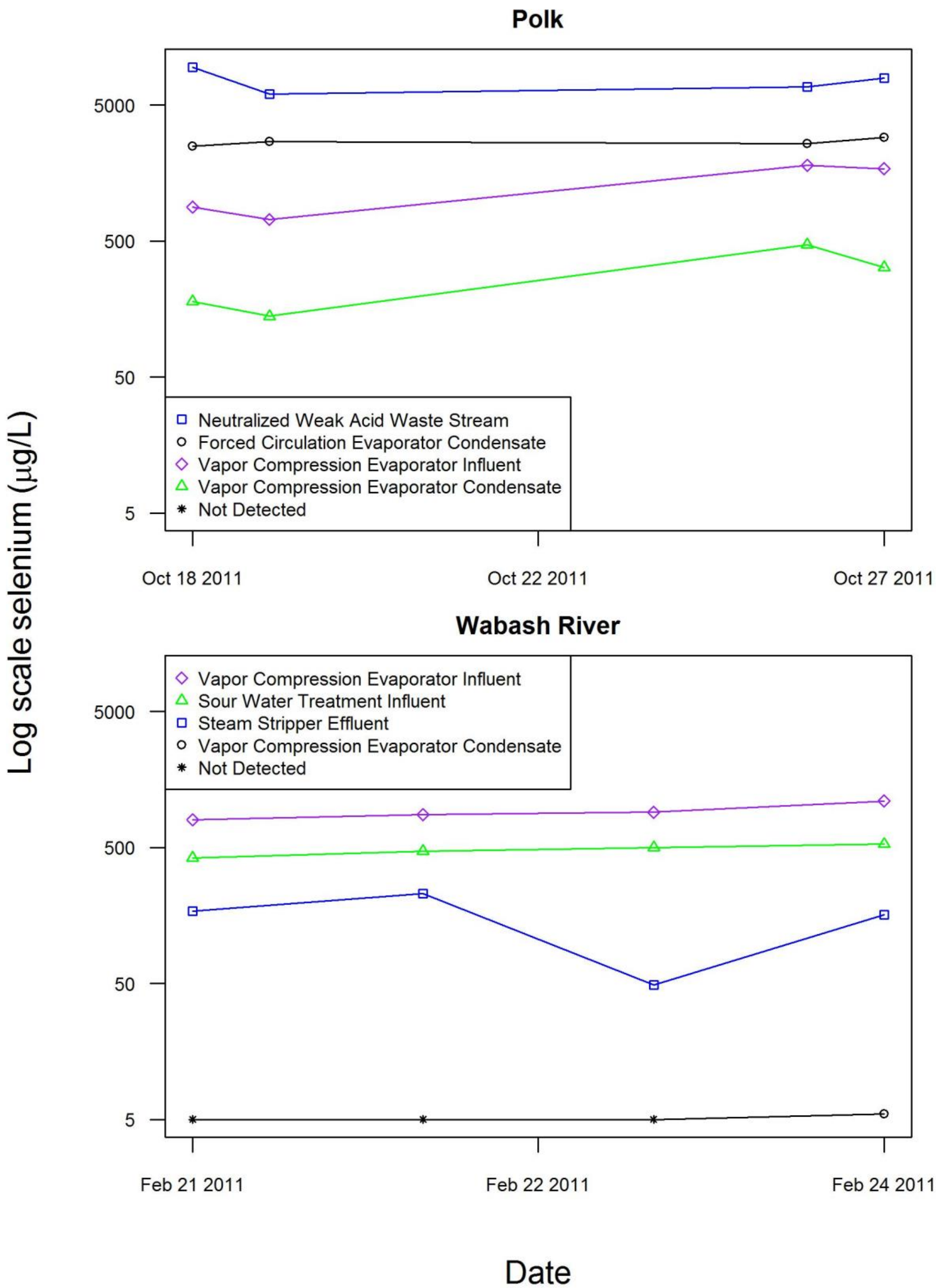
[2]: D = detected and ND = non-detected.

9.3 Vapor-compression Evaporation for Gasification: Selenium

9.3.1 Longitudinal Plots of the Data for Selenium (µg/L)

Below are the longitudinal plots of the selenium concentrations (on a logarithmic scale) for Polk and Wabash River.

Figure 13. Plot of selenium (μg/L) data on a logarithmic scale for Polk and Wabash River



9.3.2 Summary Statistics for Selenium (µg/L)

Table 43 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 43. Numbers of detected and non-detected observations and sample-specific detection limits for selenium (µg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[1])	Baseline[2]	Indicator[3]	Sample-Specific Detection Limits for Selenium (µg/L): Detection Limit = 5
Polk	Neu. Weak Acid Waste Stream (N = 4)	0 or 5	D (n = 4)	
	Vapor Compr. Evap. Influent (N = 4)	0 or 5	D (n = 4)	
	Forced Cir. Evap. Condensate (N = 4)	0 or 5	D (n = 4)	
	Vapor Compr. Evap. Condensate (N = 4)	0 or 5	D (n = 4)	
Wabash River	Sour Water Trt Influent (N = 4)	0 or 5	D (n = 4)	
	Steam Stripper Effluent (N = 4)	0 or 5	D (n = 4)	
	Vapor Compr. Evap. Influent (N = 4)	0 or 5	D (n = 4)	
	Vapor Compr. Evap. Condensate (N = 4)	0	D (n = 4)	
		5	D (n = 1)	
			ND (n = 3)	3

[1]: Detected and non-detected observations combined.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: D = detected and ND = non-detected.

Table 44 provides summary statistics for all observations for each sampling location at each of the plants.

Table 44. Summary statistics of selenium concentration (µg/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[1]	Summary Statistics for Selenium (µg/L)					
			N[2]	Minimum	Mean	Median	Maximum	Std
Polk	Neu. Weak Acid Waste Stream	0 or 5	4	6,000.0	7,550.0	7,350.0	9,500.0	1,515.5
	Vapor Compr. Evap. Influent	0 or 5	4	720.0	1,277.5	1,295.0	1,800.0	551.5
	Forced Cir. Evap. Condensate	0 or 5	4	2,500.0	2,675.0	2,650.0	2,900.0	170.8
	Vapor Compr. Evap. Condensate	0 or 5	4	140.0	277.5	250.0	470.0	149.8
Wabash River	Sour Water Trt Influent	0 or 5	4	420.0	480.0	485.0	530.0	46.9
	Steam Stripper Effluent	0 or 5	4	49.0	152.3	165.0	230.0	75.5
	Vapor Compr. Evap. Influent	0 or 5	4	800.0	920.0	890.0	1,100.0	128.3
	Vapor Compr. Evap. Condensate	0	4	4.1	4.5	4.3	5.5	0.7
		5	4	5.0	5.1	5.0	5.5	0.3

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Detected and non-detected observations combined (all were detected).

9.3.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for Selenium (µg/L)

Table 45 provides the plant-specific LTA, plant-specific variability factors, option LTA and variability factors, and numeric limits for selenium at vapor compression evaporator condensate (using both Polk and Wabash River data).

Table 45. Plant-specific long-term averages and variability factors, option long-term average and variability factors, and limits for selenium (µg/L) in vapor compression evaporator condensate

Baseline Adjusted[1]	TYPE	Plant Name	Sampling Location	N[3]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0	Plant-Specific	Polk	Vapor Compr Evap. Condensate	4 (D=4, ND=0)	288.434	3.083	1.545		
		Wabash River	Vapor Compr Evap. Condensate	4 (D=4, ND=0)	4.534	1.360	1.116		
	Option		Vapor Compr. Evap. Condensate[2]		146.484	2.222	1.331	325.469	194.948
5	Plant-Specific	Polk	Vapor Compr Evap. Condensate	4 (D=4, ND=0)	288.434	3.083	1.545		
		Wabash River	Vapor Compr Evap. Condensate	4 (D=1, ND=3)	5.125	NA[4]	NA[4]		
	Option		Vapor Compr. Evap. Condensate[2]		146.780	3.083	1.545	452.560	226.808

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Polk and Wabash River combined.

[3]: D = detected and ND = non-detected.

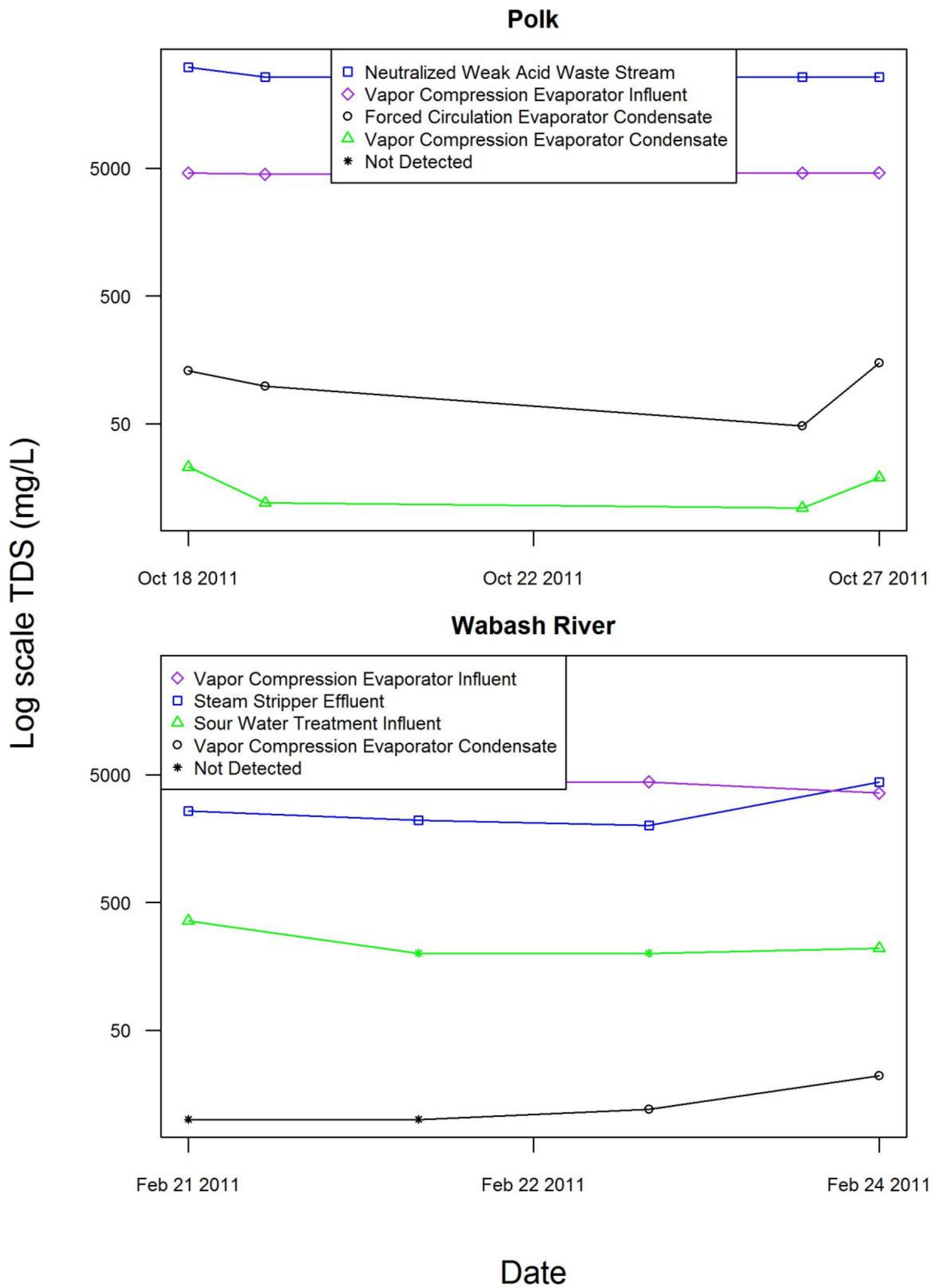
[4]: Nearly all observations were non-detected, so the variability factors could not be calculated.

9.4 Vapor-compression Evaporation for Gasification: Total Dissolved Solids (TDS)

9.4.1 Longitudinal Plots of the Data for TDS (mg/L)

Below are the longitudinal plots of the TDS concentrations (on a logarithmic scale) for Polk and Wabash River.

Figure 14. Plot of TDS (mg/L) data on a logarithmic scale for Polk and Wabash River



9.4.2 Summary Statistics for TDS (mg/L)

Table 46 provides summary statistics for the numbers of detected and non-detected observations together with the sample-specific detection limits by sample location and plant.

Table 46. Numbers of detected and non-detected observations and sample-specific detection limits for TDS (mg/L) by plant and sampling location

Plant Name	Sampling Location (Total Observations[1])	Baseline[2]	Indicator (n)[3]	Sample-Specific Detection Limits for TDS (mg/L)	
				10	200
Polk	Neu. Weak Acid Waste Stream (N = 4)	0 or 10	D (n = 4)		
	Vapor Compr. Evap. Influent (N = 4)	0 or 10	D (n = 4)		
	Forced Cir. Evap. Condensate (N = 4)	0 or 10	D (n = 4)		
	Vapor Compr. Evap. Condensate (N = 4)	0 or 10	D (n = 4)		
Wabash River	Sour Water Trt Influent (N = 4)	0 or 10	D (n = 2)		
			ND (n = 2)		2
	Steam Stripper Effluent (N = 4)	0 or 10	D (n = 4)		
	Vapor Compr. Evap. Influent (N = 4)	0 or 10	D (n = 4)		
	Vapor Compr. Evap. Condensate (N = 4)	0 or 10	D (n = 2)		
			ND (n = 2)	2	

[1]: Detected and non-detected observations combined.

[2]: Baseline value of 0 indicates no adjustment for baseline.

[3]: D =detected and ND = non-detected.

Table 47 provides summary statistics for all observations (detected and non-detected combined) for each sampling location at each of the plants.

Table 47. Summary statistics of TDS concentration (mg/L) for all detected and non-detected samples combined, by plant and sampling location

Plant Name	Sampling Location	Baseline[1]	Summary Statistics for TDS (mg/L)					
			N[2]	Minimum	Mean	Median	Maximum	Std
Polk	Neu. Weak Acid Waste Stream	0 or 10	4	26,000.0	27,250.0	26,000.0	31,000.0	2,500.0
	Vapor Compr. Evap. Influent	0 or 10	4	4,500.0	4,575.0	4,600.0	4,600.0	50.0
	Forced Cir. Evap. Condensate	0 or 10	4	48.0	106.5	114.0	150.0	44.5
	Vapor Compr. Evap. Condensate	0 or 10	4	11.0	16.3	15.5	23.0	5.7
Wabash River	Sour Water Trt Influent	0 or 10	4	200.0	245.0	210.0	360.0	77.2
	Steam Stripper Effluent	0 or 10	4	2,000.0	2,800.0	2,400.0	4,400.0	1,095.5
	Vapor Compr. Evap. Influent	0 or 10	4	3,600.0	4,225.0	4,400.0	4,500.0	419.3
	Vapor Compr. Evap. Condensate	0 or 10	4	10.0	13.5	11.0	22.0	5.7

1: Baseline value of 0 indicates no adjustment for baseline.

2: Detected and non-detected observations combined.

9.4.3 Plant-specific Long-term Averages and Variability Factors, Option Long-term Average and Variability Factors, and Effluent Limits for TDS (mg/L)

Table 48 provides the plant-specific LTA, plant-specific variability factors, option LTA and variability factors, and numeric limits for TDS at vapor compression evaporator condensate (using both Polk and Wabash River data).

Table 48. Plant-specific long-term averages and variability factors, option long-term average and variability factors, and numeric limits for TDS (mg/L) in vapor compression evaporator condensate

Baseline Adjusted[1]	TYPE	Plant Name	Sampling Location	N[3]	LTA	Daily Variability Factor	Monthly Variability Factor	Limits	
								Daily	Monthly
0 or 10	Plant-Specific	Polk	Vapor Compr Evap. Condensate	4 (D=4, ND=0)	16.512	2.149	1.327		
		Wabash River	Vapor Compr. Evap. Condensate	4 (D=2, ND=2)	13.906	2.818	1.450		
	Option		Vapor Compr. Evap. Condensate[2]		15.209	2.483	1.389	37.767	21.122

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Polk and Wabash River combined.

[3]: D = detected and ND = non-detected.

9.5 Vapor-compression Evaporation for Gasification: Summary of the Option Long-term Average, Option Variability Factors, and Effluent Limits

Table 49 summarizes the option long-term averages, option variability factors, and effluent limits for vapor compression-evaporation technology option. Note that EPA is deciding that the daily and monthly average limitations for mercury for gasification wastewater be rounded to two decimal places instead of rounding to the next highest integer in order to avoid having the same value for the daily and monthly average limitation.

Table 49. Summary of option long-term averages, option variability factors, and limits for vapor-compression evaporation technology for gasification wastewater

Pollutant	Baseline[1]	Autocorrelation Value[2]	Option LTA	Option Daily Variability Factor	Option Monthly Variability Factor	Daily Limit[3]	Monthly Limit[3]
Arsenic (µg/L)	0 or 2	0	4.0[4]	NA[5]	NA[5]	4[6]	NA[7]
Mercury (ng/L)	0 or 0.5	0	1.075	1.632	1.194	1.8	1.3
Selenium (µg/L)	0	0	146.484	2.222	1.331	326	195
	5	0	146.780	3.083	1.545	453	227
TDS (mg/L)	0 or 10	0	15.209	2.483	1.389	38	22

[1]: Baseline value of 0 indicates no adjustment for baseline.

[2]: Correlation ranges from -1 to 1, with a value of 0 indicating that EPA assumed no correlation in the data.

[3]: Effluent limitations have been rounded upward to the next highest integer, except for limits for mercury, which were rounded to the next highest tenth decimal place.

[4]: Long-term average is the arithmetic mean since all observations were non-detected (not able to estimate the variance of the distribution).

[5]: All observations were non-detected, so the variability factors could not be calculated.

[6]: Limit is set equal to the detection limit.

[7]: Monthly average limit is not established when the daily limit is equal to detection limit.

10 Summary of Effluent Limits for FGD Wastewater, Gasification Wastewater, and Combustion Residual Leachate

Sections 6, 7, 8, and 9 above present detailed summary statistics of the data together with the long-term averages, variability factors, and effluent limits for each treatment technology option for FGD and gasification wastewaters and combustion residual leachate. This section provides an overall summary of the option long-term averages, option variability factors, and limits for those technology options selected as the basis for the limits in the final rule. In addition, this section also summarizes the regulation for leachate.

The bullets below provide some important items that are discussed both in previous sections and again in this section.

- For BAT for FGD wastewater, EPA is transferring the effluent limits for arsenic and mercury calculated from the chemical precipitation technology option to the biological technology option (see Section 13 of the TDD for the rationale for this transfer of limits).
- For NSPS for FGD wastewater (and BAT for the voluntary incentive program), which is based on the chemical precipitation followed by vapor-compression evaporation treatment technology option, the effluent limits are based on the data from crystallizer condensate sampling location. As explained in Section 8 above, EPA calculated limits for this technology option at two separate sampling locations: (i) brine concentrator distillate and (ii) crystallizer condensate. The limits selected for the rulemaking are based on the stream (i.e., crystallizer condensate) with the higher pollutant concentrations.
- For NSPS for combustion residual leachate, which is based on the chemical precipitation technology option, EPA is transferring the effluent limits from the chemical precipitation technology option for FGD wastewater (see Section 13 of the TDD for more information).
- In most cases, the limits were rounded upward to the next highest integer. Gasification wastewater limits for mercury, and FGD wastewater limits for nitrate-nitrite as N, were rounded to the nearest tenth decimal place.

Tables 50 and 51 provides the option long-term average, option variability factors, and limitations for each of the FGD, gasification, and combustion residual leachate technology options selected as the basis for the final rule.

Table 50. BAT/PSES limits for existing sources: Summary of the option long-term averages, variability factors, and limits for FGD and gasification wastewater

Treatment Technology Option	Pollutant	Baseline	Option LTA	Daily Variability Factor	Monthly Variability Factor	Daily Limitation[4]	Monthly Limitation[4]
FGD wastewater (Based on Chemical Precipitation and Biological Treatment)	Arsenic (µg/L)[1]	0	5.976	1.760	1.336	11	8
	Mercury (ng/L)[1]	0 or 0.5	159.345	4.940	2.233	788	356
	Nitrate-nitrite (mg/L)	0	1.292	13.118	3.366	17.0	4.4
	Selenium (µg/L)	0	7.528	3.031	1.535	23	12
Voluntary Incentive Program BAT Limits for FGD wastewater (Based on Chemical Precipitation and Evaporation)	Arsenic (µg/L)	0 or 2	4.0[2]	NA[3]	NA[3]	4[5]	NA[6]
	Mercury (ng/L)	0 or 0.5	17.788	2.192	1.338	39	24
	Selenium (µg/L)	5	5.0[2]	NA[3]	NA[3]	5[5]	NA[6]
	TDS (mg/L)	0 or10	14.884	3.341	1.572	50	24
Gasification wastewater (Based on Vapor-Compression Evaporation for Gasification	Arsenic (µg/L)	0 or 2	4.0[2]	NA[3]	NA[3]	4[5]	NA[6]
	Mercury (ng/L)	0 or 0.5	1.075	1.632	1.194	1.8	1.3
	Selenium (µg/L)	5	146.78	3.083	1.545	453	227
	TDS (mg/L)	0 or 10	15.209	2.483	1.389	38	22

[1]: Option LTA, variability factors, and effluent limits were transferred from chemical precipitation technology option for FGD wastewater. See sections 6 and 7 of this report and section 13 of the Technical Development Document.

[2]: Long-term average is the arithmetic mean since all observations were non-detected.

[3]: All observations were non-detected, so variability factors could not be calculated.

[4]: Effluent limits have been rounded upward to the next highest integer, except for effluent limits for nitrate-Nitrite as N based on chemical precipitation and biological treatment technology option for FGD wastewater and mercury based on the vapor-compression evaporation treatment technology option for gasification wastewater, which have been rounded upward to the tenth decimal.

[5]: Limit is set equal to the detection (quantitation) limit.

[6]: Monthly average limits are not established when the daily maximum limitation is based on the detection limit.

Table 51. NSPS/PSNS limits for new sources: Summary of the option long-term averages, variability factors, and limits for FGD wastewater, gasification wastewater, and combustion residual leachate

Treatment Technology Option	Pollutant	Baseline	Option LTA	Daily Variability Factor	Monthly Variability Factor	Daily Limitation [4]	Monthly Limitation [4]
FGD wastewater (Based on Chemical Precipitation and Evaporation)	Arsenic (µg/L)	0 or 2	4.0[2]	NA[3]	NA[3]	4[5]	NA[6]
	Mercury (ng/L)	0 or 0.5	17.788	2.192	1.338	39	24
	Selenium (µg/L)	5	5.0[2]	NA[3]	NA[3]	5[5]	NA[6]
	TDS (mg/L)	0 or10	14.884	3.341	1.572	50	24
Gasification wastewater (Based on Vapor-Compression Evaporation)	Arsenic (µg/L)	0 or 2	4.0 [2]	NA[3]	NA[3]	4[5]	NA[6]
	Mercury (ng/L)	0 or 0.5	1.075	1.632	1.194	1.8	1.3
	Selenium (µg/L)	5	146.78	3.083	1.545	453	227
	TDS (mg/L)	0 or 10	15.209	2.483	1.389	38	22
Leachate (Based on Chemical Precipitation)	Arsenic (µg/L) [1]	0	5.976	1.760	1.336	11	8
	Mercury (ng/L) [1]	0 or 0.5	159.345	4.940	2.233	788	356

[1]: Option LTA, option variability factors, and effluent limits were transferred from chemical precipitation technology option for FGD wastewater. See section 6 of this report and section 13 of the Technical Development Document.

[2]: Long-term average is the arithmetic mean since all observations were non-detected.

[3]: All observations were non-detected, so variability factors could not be calculated.

[4]: Effluent limits have been rounded upward to the next highest integer, except for effluent limits for mercury based on the vapor-compression evaporation treatment technology option for gasification wastewater which have been rounded up to the next highest tenth decimal place.

[5]: Limit is set equal to the detection (quantitation) limit.

[6]: Monthly average limits are not established when the daily maximum limitation is based on the detection limit.

11 Engineering Review of the Effluent Limits

Plants that install treatment technologies to comply with the newly promulgated limitations will need to design and operate the systems to meet the limitations at all times. In summary, this means:

1. A treatment system that includes the necessary process equipment and chemical additives that is sized to accommodate the wastewater flows, and that is designed to target removing the regulated pollutants to meet the long-term average; and

2. Proper monitoring and operation that targets chemical addition rates and other operational conditions to the long-term average for the regulated pollutants, considers fluctuations in influent wastewater flows and pollutant concentrations, and that proactively monitors for and responds to fluctuations in effluent pollutant concentrations due to abnormal conditions or treatment system upsets.

A properly designed and operated treatment system that represents best available technology or best available demonstrated control technology includes characteristics such as proper chemical usage, periodic inspection and repair of equipment, use of appropriate redundant equipment such as backup pumps, sufficient staffing by trained operators, communications and coordination among production and wastewater treatment personnel, close attention to treatment system operating parameters and effluent quality. Properly designed and operated systems recognize and correct periods of degraded or abnormal operation.

Proper design does not include inappropriately designed or inadequately sized treatment facilities, such as systems targeted to meet the limitations themselves rather than the long-term averages. For example, treatment systems that lack sufficient equalization tank capacity to mitigate fluctuations in wastewater flow rates or pollutant concentrations. Proper design does not include treatment systems that do not include key process equipment or chemical additives necessary to achieve effluent limits such as the organosulfides used to enhance precipitation of dissolved mercury.

As part of its review of the final limitations, EPA carefully considers the data from the model plants to see if the data demonstrate that the plants can comply with the final limitations. It is not unusual for EPA to find that one or all of the model plants may need to make treatment technology upgrades or improvements to their operation in order to comply with the final limitations. Although most observations in the datasets used to calculate the effluent limitations are below the limitations, some observations typically will exist above the limitations. This is reasonable in datasets used to calculate effluent limitations and does not mean that the calculated limits cannot be met. In such cases, there are specific steps that plants can take that would enable them to improve treatment system performance so that effluent concentrations would be in compliance with the limitations at all times. Although EPA selects model plants as representing the best available technology or best available demonstrated control technology, and they provide the best available data for establishing limitations that reflect BAT/NSPS level of treatment, it does not necessarily mean that the plants have the systems fully optimized. For example, the NPDES permit for a model plant may not include limitations for the regulated pollutant or the NPDES permit limitations may be well above the final limitations and what other systems are achieving. Thus, these plants would be expected to have some observations above the limitations which do not reflect BAT/NSPS level of control, not because the systems are incapable of meeting the limitations but rather because the existing permit limitations do not drive the plants to optimize the performance of the treatment system and increase the pollutant removals. If EPA's review demonstrates that a model plant is not consistently achieving the final limitations, EPA looks at the treatment system design and operation for the model plant to determine if it currently meets EPA's expectations for proper design and operation.[7] In this way, EPA confirms that the final limitations are reasonable and will be achieved by properly designed and operated systems.

For this final rule, EPA performed an engineering review to verify that the effluent limits are reasonable based upon the design and expected operation of the control technologies. As part of this review, EPA performed two types of comparisons. First, EPA compared the effluent limits for each pollutant against the effluent data from the model plants used to develop the limits. This type of comparison helps to evaluate how reasonable the limits are from an engineering perspective. Second, EPA compared the limits for each pollutant to the influent data at the model plants. This second comparison helps evaluate whether the influent concentrations were generally well-controlled by the treatment system.

Section 11.1 presents the results of the comparisons between the limits and all effluent data that were used to calculate the limits for each technology option. Section 11.2 presents the results of the comparisons between the effluent limits and the influent data values for each technology option. See Appendix 7 for a listing of all daily effluent values that are above the daily limits. Appendix 7 also presents a comparison of the effluent values to the monthly average limits, for those periods where there were sufficient data to represent weekly monitoring, showing those periods where the average of the daily values for the month were above the monthly average limit. Plots comparing the effluent data to the daily maximum and monthly average limits are also presented in Appendix 7.

[7] If they do not, EPA includes costs for the model plants to do so.

11.1 Comparison of the Limits to Effluent Data Used as the Basis for the Limits

First, EPA compared the daily effluent concentrations to the daily limits to identify any observations that were above the daily limit. The plots prepared for this first comparison also provide insight on how other data (i.e., daily values below the daily limit) compare to the limit. Next, EPA compared the daily concentrations to the monthly average limits, for those periods where there are sufficient data to represent weekly monitoring,[8] and identified those months where the average of all daily values for the month is above the monthly limit. As was the case for the comparison to the daily limits, the prepared plots also provide insight to how monthly averages below the monthly limit compare to the limit.

After thoroughly evaluating the results of the comparison between the limits and the effluent values used to calculate the limits (see details below), EPA determined that the statistical distributional assumptions used to develop the limits are appropriate for the data (that is, they provide a reasonable "fit" to the actual effluent data) and the limits for each wastestream are reasonable and achievable. (This conclusion is also true for the leachate limits based on the chemical precipitation technology since the leachate limits were transferred from the FGD wastewater technology option.) If a plant properly designs and operates its wastewater treatment system to achieve the long-term average for the model technology (rather than targeting performance at the effluent limits themselves), it will be able to comply with the limits.

EPA methodology for establishing effluent limits based on certain percentiles of the statistical distributions, as well as the presentation of the analyses described below in section 11.1, may give the impression that EPA expects occasional exceedances of the limitations. This conclusion is incorrect. EPA promulgates limitations that facilities are capable of complying with at all times by properly operating and maintaining their treatment technologies. These limitations are based upon statistical modeling of the data and engineering review of the limitations and data.

[8] This approach is consistent with the manner in which EPA calculated the limits and anticipates plants will monitor for compliance with NPDES permits. It is also consistent with the monitoring frequency EPA has generally observed in NPDES permits, for those pollutants for which the permit includes effluent limits. Additionally, it is consistent with EPA's methodology for estimating compliance costs for the final rule, which includes estimated O&M costs for weekly compliance monitoring. Furthermore, it is a reasonable approach for conducting the engineering review because an assessment that uses data from less frequent monitoring may more closely reflect the daily variability than the monthly variability and therefore would not accurately reflect whether the monthly limit would have been met. For example, comparing with the limits calculated for arsenic, the 4 weekly samples collected from Hatfield's Ferry in February 2010 are all equal to or below the daily limit of 11 μg/L. One of these observations (11 μg/L) is higher than the monthly limit of 8 μg/L. However the average of all daily values for the month is 7.5 μg/L, which is below the monthly limit.

Statistical methodology is used as a framework to establish limitations based on percentiles of the effluent data. Statistical methods provide a logical and consistent framework for analyzing a set of effluent data and determining values from the data that form a reasonable basis for effluent limits. In conjunction with the statistical methods, EPA's engineering review verifies that the limits are reasonable based upon the design and expected operation of the control technologies and the facility process conditions. As part of that review, EPA examines the range of performance by the facility data sets used to calculate the limits. The facility data sets represent operation of the best available/demonstrated technology. However, although these facilities were operating the best available (or best demonstrated) technology, in some cases these data sets, or periods of time within a data set, may not necessarily represent the optimized performance of the technology. As described in Section 3.2 and Appendix 2, EPA excluded certain data from the data sets used to calculate the effluent limits. At the same time, however, data used by EPA to calculate effluent limits still retain some other data that might reflect less than optimal performance. By retaining these data in developing the limits, EPA has chosen a more conservative approach because these data help to fully characterize the variability in treatment system effluent.

To the extent that a facility's data indicated periods of less than optimal performance or the need for changes to facilitate targeting effluent performance toward the long-term average, EPA evaluated the degree to which the facility could upgrade its design, operating, and maintenance conditions to improve effluent performance as necessary to meet the limits at all times, and included costs for such upgrades (e.g., additional labor or chemicals) in its estimated costs for the rulemaking. As a result of the combined statistical modeling and engineering review used to establish the limits, EPA expects that facilities will be able to design and operate wastewater treatment systems in a manner that ensures compliance with the limitations. EPA does not expect facilities to violate the limitations at some pre-set rate merely because probability models are used to develop limitations.

EPA concludes that all facilities properly operating and maintaining the appropriate technology will be capable of complying with the limitations, even though some values in the data used to develop the limitations are higher than the limitations, for the following reasons. EPA included data from facilities using the BAT/NSPS technology that in most cases do not have effluent limits for the regulated pollutants in their NPDES permits. EPA reviewed the data and other information in the record and determined that observations exceeding the limitations identified during the engineering review were a result of quality-control problems or upsets resulting from "loosely" controlled performance due to very high NPDES permit limits (when the permit includes a limit for the pollutant) or that reflect operation of systems that optimize the removal of other pollutants (such as TSS) but not the pollutants regulated by the limitations established by this rule.

Tables A7.1 through A7.8 in Appendix 7 list the pollutants and the corresponding technology options and plants for which EPA identified observations above the effluent limits. Observations that are equal to or below the effluent limits can be determined by comparing the observations shown in Appendix 7 to the data listed in DCN SE06277; these values are not listed in Appendix 7.

In comparing the effluent data to the limits, EPA noted there are instances where one or more daily values in a month are higher than the monthly limit, but the average of all results in a month are equal to or less than the monthly average limit and as such the facility would be in compliance with the monthly limit. Instances such as these are normal and consistent with the way effluent limits are calculated and implemented in NPDES permits. This is illustrated in the effluent arsenic concentration data from Hatfield's Ferry during February 2010, described in section 11.1. Also, EPA identified some cases where only one sample was taken during a month and the resulting concentration value for that one sample is above the monthly limit. In such cases, additional monitoring of the effluent (e.g., at weekly intervals) would likely result in a monthly average that would fall below the monthly average limit.

Based on the results described in the sections below for the comparisons of effluent and influent data to the limits, and information described elsewhere in the record for the ELGs, EPA determined that the statistical distributional assumptions are appropriate for the effluent data and that the daily maximum and monthly average limits for the rule are reasonable and achievable.

Arsenic and Mercury Limits for FGD Wastewater, Based on Performance of Chemical Precipitation Technology

EPA calculated effluent limits for arsenic and mercury in FGD wastewater, based on the performance of chemical precipitation treatment technology. These limitations were transferred to the biological treatment technology option and thus form the bases for the BAT/PSES arsenic and mercury limitations applicable to FGD wastewater. EPA calculated the limits using data from four plants: Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie.

Arsenic -- Comparison of effluent data to the daily maximum limit of 11 ug/L:

All observations for two plants were equal to or below the daily maximum limit (24 observations at Keystone; 9 observations at Miami Fort). At Pleasant Prairie, all but one of the 20 observations were equal to or below the daily limit. At Hatfield's Ferry, 102 observations were equal to or below the daily limit; 28 of the 130 total observations at Hatfield's Ferry were above the daily limit.

Arsenic – Comparison of effluent data to the monthly average limit of 8 ug/L:

Only Keystone and Hatfield's Ferry collected effluent samples with sufficient frequency within a month to represent weekly sampling. For the time periods where there were sufficient data, EPA calculated the average of the daily values collected within a month, and compared that average value to the monthly average limit. For Keystone, all such monthly average values were below the limit. In fact, every daily observation at Keystone was below the monthly limit. For Hatfield's Ferry, there were 12 months when the average value was equal to or below the limit; there were 15 months when the average value was above the monthly limit (most of those were 1-2 ug/L above the monthly limit). Although Miami Fort did not collect samples with sufficient frequency to calculate monthly averages, all of the daily observations for the plant were equal to or below the monthly limit and, therefore, EPA did not identify any periods of time when the effluent concentrations were higher than the limit.

Mercury -- Comparison of effluent data to the daily maximum limit of 788 ng/L:

All observations at Keystone and Miami Fort were below the daily maximum limit (8 observations at Keystone; 68 observations at Miami Fort). At Hatfield's Ferry, 217 observations were below the daily limit; 2 of the 219 total observations at Hatfield's Ferry were above the daily limit. At Pleasant Prairie, 370 observations were below the daily limit; 5 of the 375 total observations at Pleasant Prairie were above the daily maximum limit.

Mercury – Comparison of effluent data to the monthly average limit of 356 ng/L:

Only Hatfield's Ferry and Pleasant Prairie collected effluent samples with sufficient frequency within a month to represent weekly sampling. For the time periods where there were sufficient data, EPA calculated the average of the daily values collected within a month, and compared that average value to the monthly average limit. At Hatfield's Ferry, all but one of the monthly average values were below the limit (39 of the 40 monthly values). For Pleasant Prairie, there were 27 months when the average value was below the limit; there were 3 months when the average value was above the monthly limit. Although Keystone did not collect samples with sufficient frequency to calculate monthly averages, all of the daily observations for the plant were equal to or below the monthly limit and, therefore, EPA did not identify any periods of time when the effluent concentrations were higher than the limit. Miami Fort also did not collect samples with sufficient frequency to calculate monthly averages; however, it is worth noting that 61 of the 68 daily observations for the plant were below the monthly limit.

EPA determined that all power plants discharging FGD wastewater, including the plants discussed here, are capable of meeting the effluent limits for arsenic and mercury. While there are certain instances where the model plants' effluent data concentrations are higher than the limits, based on its engineering judgment developed over years of evaluating wastewater treatment processes for power plants and other industrial sectors, EPA determined that the combination of additional monitoring, closer operator attention, and optimizing treatment system performance to target the effluent concentrations at the technology option long-term averages will result in lower effluent concentrations that would be in compliance with the effluent limits.

Although most observations in the datasets used to calculate the effluent limits were below the limits, there were some observations above the limits. As explained above, it is reasonable for this situation to arise in datasets used to calculate limits for the rule and there are specific steps that the plants can take that would enable them to improve treatment system performance so that effluent concentrations would be in compliance with the limits at all times. Although EPA selected these plants as representing the best available technology and they provide the best available data for establishing arsenic and mercury effluent limits that reflect BAT level of treatment for FGD wastewater, it does not necessarily mean that the plants' systems are fully optimized, especially since the NPDES permits for these plants either do not include limits for arsenic or mercury in their discharges of FGD wastewater or because their NPDES permit limits are well above what the system is capable of achieving.[9, 10, 11, 12] This is supported by Duke Energy's comments on the proposed effluent guidelines, which state that the "performance of the chemical precipitation

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[9] Pleasant Prairie's NPDES permit (WI-0043583-06-1) FGD wastewater monitoring requirements include both in-plant requirements (Outfall 102, effluent from the FGD blowdown wastewater treatment system) and final outfall requirements (Outfall 001, combined discharge to Lake Michigan for 5 internal outfalls, including cooling tower blowdown and FGD wastewater). Outfall 102 includes no effluent limits for arsenic (requiring only that the plant monitor for the pollutant monthly); mercury has a daily limit of 1,500 ng/L (monitored twice weekly), but no monthly limit. Outfall 001 includes a daily maximum limit for mercury (and a monitoring requirement but no effluent limit for arsenic), but the NPDES permits specifically states that "the FGD effluent may only discharge when sufficient flow from other wastewater streams (cooling tower blowdown, low volume wastewater, coal pile runoff, or metal cleaning waste basin) is available if necessary to comply with the water quality based effluent limits at Outfall 001."

[10] Miami Fort's NPDES permit (OH0009873) FGD wastewater monitoring requirements include both in-plant requirements (Outfall 608, FGD wastewater treatment system discharge prior to the ash pond) and final outfall requirements (Outfall 002, ash pond discharge, including FGD wastewater, prior to the Ohio River). Outfall 608 includes no effluent limits for arsenic or mercury, requiring only that the plant monitor the concentrations of these pollutants monthly. Outfall 002 similarly includes no effluent limits for arsenic or mercury, requiring only that the plant monitor the concentrations of these pollutants quarterly.

[11] Hatfield's Ferry Power Station's NPDES permit (PA0002941) FGD wastewater monitoring requirements include both in-plant requirements (Outfall IMP 306, effluent from the FGD scrubber blowdown wastewater treatment plant) and final outfall requirements (Outfall 006, which includes ash transport water, coal pile runoff, low volume waste and FGD wastewater treatment system effluent). Outfall IMP 306 includes no effluent limit for arsenic, requiring only that the plant monitor for the pollutant weekly; the permit includes a mercury daily limit of 10,000 ng/L and a monthly average limit of 5,000 ng/L (monitored weekly). Outfall 006 includes no effluent limit or monitoring requirement for arsenic; the permit includes a mercury daily limit of 4,000 ng/L and a monthly average limit of 2,000 ng/L (monitored weekly).

[12] Keystone's NPDES permit (PA0002062) FGD wastewater monitoring requirements include both in-plant requirements (IMP 101, discharge from the FGD scrubber blowdown wastewater treatment plant) and final outfall requirements (Outfall 001, which includes discharges from the pipeline pigging wastewater treatment facility and FGD scrubber blowdown wastewater treatment plant). IMP 101 includes no effluent limit for arsenic, requiring only that the plant monitor for the pollutant weekly; the permit includes a mercury daily limit of 8,000 ng/L and a monthly average limit of 4,000 ng/L (monitored weekly). Outfall 001 includes similar effluent monitoring/limits, with monitoring only required when pigging wastewater is discharged.

treatment systems from which EPA's data relies were optimized to meet current facility NPDES permit requirements and may not reflect the system's maximum performance."[13]

The two plants that have observations above the limits for arsenic do not have specific limits in their NPDES permits for discharges of arsenic in FGD wastewater. Also, only three of the plants have NPDES permit limits for mercury, and for two of these plants the permit limits are more than 10 times higher than the BAT effluent limits established by the final ELGs. For this reason, these plants currently do not need to closely monitor the concentrations of arsenic and mercury in the treatment system effluent, nor do they need to take steps to optimize the removal of these pollutants. This is illustrated by the plants' operational practices for their FGD wastewater treatment systems. Other than Pleasant Prairie targeting an effluent concentration that would allow discharges containing mercury at double the concentration established for the final ELGs, none of the plants reported having operational target parameters for the allowable level of mercury and arsenic in their effluent.[14, 15, 16]

The data in the record supports EPA's determination that these plants would be able to meet the limits established for the final ELGs, although certain plants may need to make some adjustments to

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[13] Duke Energy's comments state that "[t]he operation and performance of chemical precipitation systems for FGD water treatment is continuing to evolve and improve. The industry's current chemical precipitation system performance data does not accurately reflect optimized performance…." "The performance of the chemical precipitation treatment systems from which EPA's data relies were optimized to meet current facility NPDES permit requirements and may not reflect the system's maximum performance. For example, operating these systems at higher pH levels can increase the percentage of metal removal. Improved treatment chemicals, improved clarification and filtration can further increase removal percentages. If necessary, modifications to chemical precipitation systems towards optimizing removal of specific constituents, not currently permitted, can result in more effective treatment of FGD wastewater." Duke Energy goes on to state that "Miami Fort has implemented several improvements to their chemical precipitation process to improve mercury removal. Increasing pH from initial startup settings, adding coagulants, and organosulfide metal precipitants have led in favorable results. Polymer delivery systems have been modified and the baffling inside the clarifier have also been changed to improve solids settling and reduce the Total Suspended Solids (TSS)." Comments of Duke Energy to the United States Environmental Protection Agency, p. 13. September 19, 2013.

[14] When asked about the operational target parameters for the treatment system, Pleasant Prairie reported that they target achieving an effluent concentration below 1,000 ng/L in the effluent from the secondary clarifier. If the measured concentration is below 1,000 ng/L, discharge is continuous. If clarifier effluent concentration is in the range 1,000-1,500 ng/L, continuous discharge ceases and depending on samples collected from the effluent tank the wastewater is either discharged (if <1,500 ng/L) or recirculated for further processing (if >1,500 ng/L). If the clarifier effluent is above 1,500 ng/L, the wastewater is recirculated to the absorber or treatment system equalization tank for further processing. DCN SE04328.

[15] When asked about the operational target parameters for the treatment system, Miami Fort reported that they make day-to-day adjustments based on pH, turbidity, and TSS to make sure there is good settling and clarification. Depending on settling performance, they may adjust the organosulfide addition. Miami Fort reported that they do not target specific metals concentrations for the treatment system effluent. DCN SE04331.

[16] FirstEnergy stated that the plant did not have any specific operational targets for metals. The FGD wastewater treatment system was operated based on maintaining the pH, floc in the clarifier, and TSS in the effluent from the sand filter. DCN SE04316.

their operating practices. The effluent concentrations for both Keystone and Miami Fort were below the effluent limits for arsenic and mercury. Both Pleasant Prairie and Hatfield's Ferry had some observations above the limits for arsenic or mercury, but these can be attributed to their current operating practices.

As noted above, the NPDES permit for Hatfield's Ferry includes no arsenic limits for the effluent from the FGD wastewater treatment system. The NPDES permit daily maximum limit for mercury is 10,000 ng/L (5,000 ng/L monthly limit). Additionally, the plant did not operate its treatment system to achieve any specific operational targets for arsenic, nor for any other metal. Instead, the treatment system is operated to maintain pH within an operational range, ensure the clarifier indicates good settling of the precipitated floc, and provide adequate removal of TSS in the effluent from the sand filters. It is reasonable to expect that the chemical addition rates for sodium hydroxide, organosulfide, and other additives are not optimized for arsenic removal because they are optimized only to maintain pH and TSS. Pleasant Prairie's NPDES permit includes a daily maximum limit for mercury at 1,500 ng/L in the treatment system effluent, but no monthly limit. The plant's operational target of 1,000 ng/L mercury for the treatment system effluent is very close to the permit limit but significantly higher than the limits established by the ELGs. Given the high permit limit and operational target, it is not surprising that a small number of observations are above the limits established by the ELGs.

Both plants could take steps to ensure compliance with the effluent limits by making adjustments to the treatment system operation to target the long-term average performance that the effluent limits are based upon (i.e., 5.98 μg/L for arsenic and 159 ng/L for mercury). Operator attention to effluent quality and process control indicators (e.g., wastewater flowrates, conductivity, clarifier bed levels, TSS) facilitate steady state operation of the treatment system, as well as alerting operators of system abnormalities or fluctuations in influent quality or flowrate. EPA's review of chemical precipitation systems for this industry noted that plants could benefit from using an in-house mercury analyzer to monitor the performance of the system on a daily basis (this was included as part of the cost basis for the technology option). Mercury analyzers have been effectively used at Pleasant Prairie to alert operators when mercury concentrations begin trending upward so that they may take steps (such as altering the dosage rates for chemical additives) to adjust treatment system performance to meet their current permit limitations.

Optimizing the treatment system to target effluent concentrations at the long-term average is important, and is relevant to the evaluation of the effluent data for Hatfield's Ferry and Pleasant Prairie. EPA evaluated the results of testing of a chemical precipitation treatment system at a power plant that, although the treatment system had been in operation for more than a year and was operating at a steady state condition, the plant was able to significantly improve the pollutant removal performance merely by altering the dosage rates for the wastewater treatment chemical additives.[17] The results of this study, as well as other information in the record, supports EPA's determination that these plants can improve treatment system performance and meet the ELG limits at all times. EPA notes that its compliance cost estimates for the final rule include costs for mercury analyzers, organosulfide addition, proper dosing of treatment system chemical additives, and increased staffing to operate the treatment system.

It is important to note that although the BAT limits and PSES for arsenic and mercury in the final ELGs are based on chemical precipitation technology,[18] the selected BAT/PSES technology option for FGD wastewater is actually comprised of the combination of chemical precipitation followed by biological treatment, which is more effective than chemical precipitation treatment alone. The data in the record for the final rule demonstrate that the biological treatment stage provides pollutant reductions for arsenic and mercury (and other pollutants of concern with similar removal mechanisms) in addition to the pollutant removals that occur in the chemical precipitation stage of the biological treatment technology option (see, e.g., the data plots and tables in Sections 7.1 and 7.2, showing an average of 31 percent removal of arsenic and 99 percent removal of mercury across the biological treatment stage at Allen and Belews Creek).

These additional pollutant removals are corroborated by the results of pilot testing conducted at Indianapolis Power and Light's Petersburg power plant, which showed that both arsenic and

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[17] AEP's Mountaineer plant operated a chemical precipitation system to treat FGD wastewater, with operation targeted to meet only the BPT-based limitations for TSS, pH, and oil and grease. In 2008, one year after the start-up of the FGD scrubbers and the FGD wastewater treatment system, the plant went through a permit renewal process whereby the permitting authority proposed to add a water quality-based effluent limit for mercury. Based on the mercury limitations in the draft permit, AEP conducted a pilot study evaluating three different technologies that could be installed to further treat the effluent from the chemical precipitation system. AEP conducted the pilot study from July through December 2008. During the first three months of the study, the mercury concentrations of the chemical precipitation system effluent feeding the pilot tests averaged 1,300 ng/L. Since none of the three technologies were achieving the targeted effluent concentrations for the pilot testing, AEP took steps to optimize the precipitation of dissolved metals and the removal of precipitants and other suspended solids in the chemical precipitation system, including adding additional polymers and organosulfide. Using these optimization steps, AEP noted that "[t]he combination of supplemental coagulation and organosulfide addition consistently yielded approximately 80 percent of additional mercury reduction…" within the chemical precipitation system. American Electric Power Mercury Removal Effectiveness Report. (January 29, 2010). DCN SE02008.

[18] See Section 13 of the Technical Development Document for a discussion of the transfer of effluent limits for arsenic and mercury from chemical precipitation technology to the selected BAT technology option (chemical precipitation followed by biological treatment).

mercury were effectively removed by the biological treatment stage.[19] Data for a full-scale FGD wastewater treatment system at AEP's Mountaineer plant similarly shows both arsenic and mercury are effectively removed by the biological treatment stage.[20] Thus, plants employing and optimally operating all components of the biological treatment technology option (including adding organosulfide to achieve sulfide precipitation) should achieve pollutant removals for arsenic and mercury (and other pollutants with similar removal mechanisms) that are even greater than the removals based on chemical precipitation technology alone.

Selenium and Nitrate-nitrite as N Limits for FGD Wastewater, Based on Chemical Precipitation Followed by Biological Treatment Technology Option for FGD Wastewater

The ELGs establish BAT limits and PSES for arsenic, mercury, nitrate-nitrite as N, and selenium in FGD wastewater based on the biological treatment technology option. As mentioned above, the limits for arsenic and mercury were transferred from the chemical precipitation technology option. See the discussion above for the comparison of effluent data to the limits for these two pollutants. The effluent limits for selenium and nitrate-nitrite as N were calculated using data from two plants: Allen and Belews Creek.

Nitrate-nitrite as N -- Comparison of effluent data to the daily maximum limit of 17.0 mg/L:

For both Allen and Belews Creek, all observations were below the daily limit (30 observations at Allen; 40 observations at Belews Creek).

Nitrate-nitrite as N – Comparison of effluent data to the monthly average limit of 4.4 mg/L:

Only Belews Creek collected effluent samples with sufficient frequency within a month to represent weekly sampling. For the time periods where there were sufficient data, EPA calculated the average of the daily values collected within a month, and compared that average value to the monthly average limit. All of the monthly average values for Belews Creek were below the limit. Although Allen did not collect samples with sufficient frequency to calculate monthly averages, all but two of the 30 daily observations for the plant were below the monthly limit. The two daily observations that were above the monthly limit are associated with a spike in effluent concentration that occurred in December 2011.

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[19] Higgins, T., et al. "Recent Applications of Meeting Compliance Challenges through Flue Gas Desulfurization (FGD) Wastewater," Presented at the Power Plant Pollutant Control "MEGA" Symposium. August 19-21, 2014. Also see June 6, 2015 email from Tom Higgins (CH2M Hill), presenting data showing the biological treatment stage removed 87% of the mercury and 84% of the arsenic entering that stage.

[20] The FGD wastewater treatment system at AEP's Mountaineer plant includes chemical precipitation (both hydroxide and sulfide precipitation, as well as iron coprecipitation) followed by anoxic/anaerobic biological treatment designed to remove selenium. DCN SE05664/SE05645.

> *Selenium -- Comparison of effluent data to the daily maximum limit of 23 ug/L:*
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> At Allen, 178 observations were below the daily limit; 4 of the 182 total observations at Allen were above the daily limit. At Belews Creek, 214 observations were below the daily limit; 2 of the 216 total observations at Belews Creek were above the daily maximum limit.
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> *Selenium – Comparison of effluent data to the monthly average limit of 12 ug/L:*
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> All monthly averages for Allen were below the monthly average. At Belews Creek, there were 10 months when the monthly average was equal to or below the monthly limit; there were 2 months when the average was above the limit. Both of these months occurred shortly after the end of the initial commissioning period for the treatment system (the initial commissioning period ended 6/11/2008; the two monthly averages above the monthly limit were in August and September 2008).

EPA determined that all power plants discharging FGD wastewater, including the plants discussed here, are capable of meeting the effluent limits for selenium and nitrate-nitrite as N. While there were certain instances where the plants' effluent data are higher than the limits, based on its engineering judgment developed over years of evaluating wastewater treatment processes for power plants and other industrial sectors, including both physical/chemical and biological treatment technologies, EPA determined that the combination of additional monitoring, closer operator attention, and optimizing treatment system performance to target the effluent concentrations at the technology option long-term averages will result in lower effluent concentrations that would be in compliance with the effluent limits.

Although most observations in the datasets used to calculate the effluent limits were below the limits, there were some observations above the limits. It is reasonable for this situation to arise in datasets used to calculate limits for ELGs, particularly when the data are from plants that do not have NPDES limits for the pollutants, and when there are specific steps that the plants can take that would enable them to improve treatment system performance so that effluent concentrations would be in compliance with the limits at all times. Although EPA selected these plants as representing the best available technology, neither plants' system is fully optimized for removal of selenium or nitrate-nitrite because they are not targeting specific effluent levels for these pollutants, nor are they operationally controlling the treatment system (e.g., adjusting dosages for chemical additives or altering bioreactor bed contact time) to maintain effluent concentrations below specified concentrations. Neither plants' NPDES permits include effluent limits or monitoring requirements nitrate-nitrite. The NPDES permits for these plants also do not include effluent limits for selenium, although they do include require them to periodically monitor effluent concentrations of selenium.[21, 22]

For selenium at Allen and Belews Creek, EPA identified a small number of observations that are above the daily limit, or where the monthly average is above the monthly limit. As EPA explained above, there are steps plants can take to achieve better treatment system performance to ensure compliance with the effluent limits. After evaluating all selenium data for the biological treatment technology option (more than five years of data for Belews Creek and more than four years for Allen, excluding the initial commissioning periods for the treatment systems), EPA concluded that the observations above the daily limit are reflective of periods of less than optimum performance of the treatment system and were due either to the inexperience of operators with this type of treatment system, operators not targeting their treatment systems to attain a specific effluent concentration, failure on the part of operators to either closely monitor treatment system performance or to respond in a timely manner to restore the system to steady state condition, or a combination thereof.[23] For example, the monthly averages at Belews Creek that are above the limits occurred only 2-3 months following the end of the initial commissioning period and are associated with daily observations that are significantly elevated relative to other observations in the months immediately following that time, as well as nearly every other daily observation for Belews Creek. Likewise, the observations at Allen that are above the daily limit are associated with two periods where the effluent selenium concentrations spike upward significantly, and a sudden upward spike in

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[21] Plant Allen Steam Station's NPDES permit (NC0004979) FGD wastewater monitoring requirements include both in-plant requirements (Internal Outfall 005, effluent from the FGD wet scrubber wastewater treatment system) and final outfall requirements (Outfall 002, ash pond effluent including FGD wastewater and other wastestreams). Internal Outfall 005 includes no effluent limits or monitoring requirement for nitrate-nitrite as N; selenium also has no effluent limit and is required to be monitored monthly. Outfall 002 also includes no effluent limits or monitoring requirement for nitrate-nitrite as N; selenium has no effluent limit and is required to be monitored monthly.

[22] Belews Creek's NPDES permit (NC0024406) FGD wastewater monitoring requirements include both in-plant requirements (Internal Outfall 002, treated FGD wet scrubber wastewater to ash settling basin) and final outfall requirements (Outfall 003, discharge to the Dan River from the ash settling pond, which contains treated FGD wastewater and other wastes). Internal Outfall 002 includes no effluent limits or monitoring requirement for nitrate-nitrite as N; selenium also has no effluent limit but must be monitored quarterly. Outfall 003 also includes no effluent limits or monitoring requirement for nitrate-nitrite as N; selenium has no effluent limit but must be monitored monthly.

[23] Note that although the Belews Creek selenium data (and other pollutant as well) from mid-2008 may be influenced by the initial commissioning period for the treatment system, EPA used these data when calculating the final effluent limitations for the biological treatment technology option for FGD wastewater. EPA has used these data because although EPA believes that, as a general rule, the initial commissioning period duration will be on the order of 3-4 months, and certainly no more than 6 months except in unique circumstances; EPA has not confirmed that the initial commissioning for Belews Creek was of such exceptional duration. Comments on the proposed ELGs stated that the treatment system operators at Belews Creek reported 6/11/2008 as the end of the initial commissioning period. Without the information to confirm the commissioning period was still in progress, EPA concluded that the sampling data should be used when calculating effluent limits.

effluent concentrations of nitrate-nitrite also occurred during one of those periods. These effluent spikes indicate that the nutrient feed may have been insufficient or the bed contact time may not have been long enough to allow the microorganisms in the bioreactor to complete the biochemical reduction processes for nitrate-nitrite and selenium.

Both plants could take steps to ensure compliance with the limits by making adjustments to the treatment system operation to target the long-term average performance that the effluent limits are based upon (i.e., 1.3 mg/L for nitrate-nitrite as N and 7.5 µg/L for selenium). Operator attention to influent and effluent quality and process control indicators (e.g., wastewater flowrates, ORP, TSS, turbidity, gas production rates) facilitate steady state operation of the treatment system, as well as alerting operators of system abnormalities or fluctuations in wastewater flowrate or quality (influent or effluent). Significant changes in wastewater flowrate, if not managed properly, can affect effluent quality because it will affect the bed contact time, as well as potentially affecting the appropriate nutrient dosage. The influent ORP provides insight to the amount of nutrient that should be added to maintain the appropriate carbon to nitrogen (C:N) ratio to support the microbial activity needed to reduce nitrate-nitrite and selenium. ORP within the bioreactor should be monitored to ensure that the wastewater has sufficient bed contact time with the biomass at low (-300 to -400 mV) ORP for sufficient time for selenium reduction. Properly operating the system includes being attentive to changes in pressure drop across the system to ensure the routine flush/backwash cycles are occurring with sufficient frequency.

EPA notes that the compliance cost estimates for the final rule include costs for ORP monitoring of the wastewater influent and within the bioreactor, proper dosing of the nutrient additive, chemical feed system to remove free oxidants prior to the bioreactor, and increased staffing to operate the treatment system. Although not necessary to operate the treatment system properly, some plants may find it desirable to implement additional process controls, such as frequent monitoring of nitrates or selenium (e.g., daily or once per shift) with available test kits or analyzers which, although some of these may not be approved in 40 CFR 136 for NPDES purposes, their analytical results can be correlated to approved methods (such as ICP-MS analysis for selenium) and used as another real-time indicator of treatment system influent or effluent characteristics for enhanced process control.[24]

[24] Similar to the mercury analyzer included as part of the technology basis for the effluent limits, these additional process control options can provide treatment system operators with additional information, such as the influent nitrate-nitrite concentrations (for use in addition to ORP to confirm the appropriate nutrient dosage), between stage or effluent nitrate-nitrite concentrations (further confirmation of the nutrient dosage to support microbial activity for pollutant reduction), or effluent selenium concentrations.

Additionally, inexpensive test kits for measuring for oxidants in the treatment system influent are available and can be used as another source of information about wastewater characteristics.

Based on the results of this comparison for the biological treatment technology option, EPA determined that the statistical distributional assumptions are appropriate for the effluent data and that the limits are reasonable.

Limits for FGD Wastewater Based on Chemical Precipitation Followed By Vapor-Compression Evaporation (Arsenic, Mercury, Selenium and TDS)

The final rule establishes NSPS/PSNS for arsenic, mercury, selenium and TDS in FGD wastewater, based on the performance of chemical precipitation followed by vapor-compression evaporation treatment using data from Brindisi plant.[25] All daily concentration values are equal to or below the daily limits for all parameters. (The data for this plant were not collected at sufficient frequency to represent weekly sampling; thus, monthly averages could not be calculated for comparison to the monthly limit.) After thoroughly reviewing the data, EPA determined that the statistical distributional assumptions are appropriate for the effluent data and that the limits are reasonable and achievable.

Limits for Gasification Wastewater Based on Vapor-Compression Evaporation (Arsenic, Mercury, Selenium and TDS)

The final rule establishes BAT/PSES and NSPS/PSNS for arsenic, mercury, selenium and TDS in gasification wastewater based on vapor-compression evaporation treatment. The limits for selenium and TDS were calculated using data from two plants: Polk and Wabash River plants. The limits for arsenic and mercury were based only on data from Polk, because the arsenic and mercury data from Wabash River failed the LTA test (see section 4 for a discussion of the LTA test).

For arsenic and mercury, the daily concentration values used to calculate the limits (i.e., from Polk) are below the daily limits.[26] For TDS, all observations for both Polk and Wabash River are below the daily limit.

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[25] The final rule also establishes BAT limitations for FGD wastewater that are the same as the NSPS for FGD wastewater for plants who opt into the voluntary incentives program.

[26] Although the arsenic and mercury data for the vapor-compression evaporator condensate at Wabash River were not used to calculate the limits, due to failing the LTA test, EPA nevertheless compared these data to the limits and found that all observations were equal to or below both the daily and monthly limits.

For selenium, all observations for Wabash River were below the daily limit. At Polk, there is one observation above the daily limit. As discussed above in section 9, the data for the Polk treatment system indicates that the evaporator (or at a minimum the forced circulation evaporation stage) was operating abnormally and allowing carryover of pollutants to the condensate effluent stream.[27] Based upon its review of the data, EPA concluded if the plant designs and operates its treatment system to achieve the option long-term average for the model technology, then the plant will be able to comply with the limits. Furthermore, EPA notes that Polk reuses all treated gasification wastewater (i.e., condensate) in the gasification process and does not discharge any gasification wastewater. As such, the plant's treatment objective is to ensure the wastewater is of sufficient quality for reuse in the process rather than to comply with a NPDES permit limit.

The data for these plants were not collected at sufficient frequency to represent weekly sampling; thus, monthly averages could not be calculated for comparison to the monthly limits.

After thoroughly reviewing the data, EPA concluded that the statistical distributional assumption is appropriate for the effluent data and that the limits are reasonable.

11.2 Comparison of the Effluent Limits to Influent Data

In addition to comparing the limits to the effluent data used to develop the limits, EPA also compared the pollutant concentrations for the treatment system influent to the daily limits. This comparison helps evaluate whether the limits are set at a level that ensures that treatment of the wastewater and that the influent concentrations were generally well-controlled by the treatment system See Appendix 7 for a detailed listing of the summary statistics for the influent data for each pollutant in each treatment technology option (Tables A7.6 to A7.9).

For all treatment technology options for both FGD and gasification wastewater, the minimum, average, and maximum influent concentration values were much higher than the long-term average and limits. EPA found that influent concentrations were generally well-controlled by the treatment plant for all plants with the model technology. In general, the treatment systems adequately treated even the extreme influent values, and the high effluent values did not appear to be the result of high influent discharges.

[27] Polk's data for the forced circulation evaporator condensate were not used to calculate the limits due to that portion of the treatment system being in an upset condition; therefore, these data were not compared to the effluent limits.

Appendix 1. List of All Observations that Were Corrected Before Calculating the Limits

Table of Contents

This appendix contains the listing of all data corrections that were made to the self-monitoring data provided by the industry for the proposed and final rulemaking. Since the data EPA used for the proposed rule are also used for the final rule, the "pre-proposal corrections" are included here along with the "post-proposal corrections." For details about the "pre-proposal corrections," see the listing in Appendix 1 of "Steam Electric Proposed Effluent Limits_10_20_2012.docx" (DCN SE01999).

Table A1.1 lists the corrections made to the detection indicator for data at Belews Creek and Keystone prior to calculating effluent limits (Duke Energy and NRG confirmed that the errors were due to the data entry errors). The data are arranged by plant, sampling location, pollutant, and sampling date.

Table A1.1 Summary of the corrected detection indicators for the Belews Creek and Keystone self-monitoring data, arranged by plant, sampling location, pollutant, and sampling date

Plant	Sampling Location	Pollutant	Date	Original Indicator[1]	Corrected Indicator[1]
Belews Creek	Bio 1 In (Bioreactor Influent)	Mercury	2/6/2008	D	ND
			2/9/2008	D	ND
		Selenium	1/17/2011	N	ND
	Bio 2 Eff (Bioreactor Effluent)	arsenic	2/7/2008	ND	D
			2/8/2008	ND	D
			2/10/2008	ND	D
			2/12/2008	ND	D
			2/13/2008	ND	D
			2/14/2008	ND	D
			2/15/2008	ND	D
			2/16/2008	ND	D
			2/17/2008	ND	D
			2/21/2008	ND	D
		Mercury	2/6/2008	D	ND
			9/29/2008	ND	D
			8/11/2010	ND	D
			9/8/2010	ND	D
			10/7/2010	ND	D
		Selenium	3/3/2008	ND	D
Keystone	Chemical Precipitation Effluent	Mercury	4/10/2012	D	ND
			4/11/2012	D	ND
			4/12/2012	D	ND
			4/15/2013	D	ND

[1]D = detected and ND = non-detected.

Table A1.2 lists the corrections made to concentration values for data from Allen, Belews Creek, and Keystone prior to performing the statistical analyses, based on information provided by Duke Energy and NRG.

Table A1.2 Summary of the data corrections for the Allen, Belews Creek, and Keystone self-monitoring data, arranged by plant, sampling location, pollutant, and sampling date

Plant	Sampling Location	Pollutant (Unit)	Date	Original Concentration Value (Indicator)[1]	Corrected Concentration Value (Indicator)[1]
Allen	Bio 2 Eff (Bioreactor Effluent)	Nitrate-Nitrite as N (mg/L)	12/20/2011	97(D)	1(D)
Belews Creek	Bio 1 In (Bioreactor Influent)	Mercury (ng/L)	6/9/2010	59.3(D)	59,300(D)
			7/14/2010	49.9(D)	49,900(D)
			8/11/2010	47.7(D)	47,700(D)
	Bio 2 Eff (Bioreactor Effluent)	Mercury (ng/L)	5/12/2010	1000(ND)	136(D)
			5/26/2010	136(D)	-
Keystone	Chemical Precipitation Effluent	Arsenic (µg/L)	7/24/2012	20 (D)	21.2 (D)
			8/12/2013	20 (D)	23.7 (D)

[1]D = detected and ND = non-detected.

[2]No data available for this date.

Table A1.3 lists the corrections made to sample collection date for data from Belews Creek prior to performing the statistical analyses, based on information provided by Duke Energy.

Table A1.3 Summary of the corrected dates for the Belews Creek plant self-monitoring data, arranged by sampling location, pollutant, and sampling date

Sampling Location	Pollutant	Original Date	Corrected Date
Bio 1 In (Bioreactor Influent)	Arsenic	4/26/2011	4/27/2011
	Selenium	4/26/2011	4/27/2011

Appendix 2. List of All Observations that Were Excluded Before Calculating the Limits for the Final Rulemaking

Table of Contents

Table		Page

This appendix contains listing of all observations that were excluded prior to calculating limits for the final rulemaking. The data excluded are listed by plant and analyte. The reasons for exclusion are listed below and the rationales for each of the exclusions are detailed in the tables:

- Analytical Interferences
- Analytical anomalies
- Associated with TMT 15
- Data Entry Error
- Decommissioning Period
- Failed data editing criteria
- Insufficiently-sensitive analytical method
- Not Approved NPDES Compliance Monitoring Method
- Problem associated with start-up
- Questionable results due to QA/QC issues
- Sampling or Analytical Error
- Secondary clarifier sampling location not representative of effluent discharge
- Start-up or commissioning period
- System upset due to pipe broke. Exclude all data
- Treatment system upset or abnormal operation
- Unable to Confirm the Validity of the Results
- Unable to validate the results due to contradictory information

Table A2.1 List of excluded plant self-monitoring data at Allen

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Arsenic, Mercury, Selenium	3/3/2009 to 7/13/2009	All Locations			Start-up or commissioning period EPA excluded data associated with the initial start-up or commissioning period for a new wastewater treatment system because the data tend to exhibit relatively high variability not representative of typical operation. During the initial commissioning period, the treatment system undergoes a variety of testing to demonstrate that hydraulic flows through the system and equipment such as pumps, valves, and other equipment operate as designed. During this period, it is common for changes in process operations to occur as the treatment system undergoes performance verification testing (sometimes referred to as acceptance testing) and the operation is modified to identify approaches to optimize (i.e., minimize) operational costs or to make adjustments to improve pollutant reductions. Refinements that may take place during the commissioning period include adjustments to chemical feed locations and/or feed rates; evaluating different pump cycles, filter backwash cycles, clarifier overflow rates, or sludge removal cycles; and changes to the chemicals used. Generally, this initial period of operation also serves as a time when the operators gain familiarity with the intricacies of the treatment system operation. During this acclimation and optimization period the effluent concentration values may exhibit higher variability than would typically be observed for a well-operated treatment system, producing occasional extreme values (either high or low concentrations). After this initial adjustment period, a well-operated system should operate at steady state (or more precisely, a “quasi-steady state”) with relatively low variability around a long-term average. This period of instability affects the pollutant removal efficacy and is not reflective of BAT/NSPS level of performance and therefore data associated with the initial commissioning period are excluded. The end of the initial commissioning period was the date specified by the treatment system operators (as reported in UWAG comments on the proposed rule).

Table A2.1 List of excluded plant self-monitoring data at Allen (continued)

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Mercury (ng/L)	12/29/2009	Bio Treatment Influent	D	710	Questionable results due to QA/QC issues EPA excluded mercury data that Duke Energy identified as questionable due to quality control issues. Duke Energy stated that these data are questionable because they suspected that the matrix spike/matrix spike duplicate (MS/MSD) were not conducted using the FGD wastewater matrix or the MS/MSD indicated inadequate recoveries. EPA lacked sufficient laboratory quality control data for these results to make an independent assessment of whether these mercury results should have been retained and included in the statistical analyses.
	12/29/2009	Bio Treatment Effluent	D	11	
	1/11/2010	Bio Treatment Influent	D	92	
	1/11/2010	Bio Treatment Effluent	D	14.2	
Mercury (ng/L)	7/15/2009	Bio Treatment Effluent	ND	1000	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo
	7/16/2009	Bio Treatment Effluent	ND	1000	
	7/21/2009	Bio Treatment Effluent	ND	1000	
	7/23/2009	Bio Treatment Effluent	ND	1000	
	7/27/2009	Bio Treatment Effluent	ND	1000	
	7/29/2009	Bio Treatment Effluent	ND	1000	
	7/30/2009	Bio Treatment Effluent	ND	1000	
	6/29/2010	Bio Treatment Effluent	ND	1000	
	8/23/2010	Bio Treatment Effluent	ND	1000	
	10/5/2010	Bio Treatment Effluent	ND	1000	
	10/6/2010	Bio Treatment Effluent	ND	1000	
	10/7/2010	Bio Treatment Effluent	ND	1000	
	10/9/2010	Bio Treatment Effluent	ND	1000	
	10/10/2010	Bio Treatment Effluent	ND	1000	
	10/12/2010	Bio Treatment Effluent	ND	1000	
	10/13/2010	Bio Treatment Effluent	ND	1000	
	12/1/2010	Bio Treatment Effluent	ND	1000	
	12/4/2010	Bio Treatment Effluent	ND	1000	
	12/7/2010	Bio Treatment Effluent	ND	1000	
	1/12/2011	Bio Treatment Effluent	ND	1000	
	1/24/2011	Bio Treatment Effluent	ND	1000	
	4/27/2011	Bio Treatment Effluent	ND	1000	

Table A2.1 List of excluded plant self-monitoring data at Allen (continued)

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Mercury (ng/L) (cont'd)	12/27/2011	Bio Treatment Effluent	D	3010	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo (cont'd)
	10/17/2012	Bio Treatment Effluent	ND	1000	
	11/13/2012	Bio Treatment Effluent	ND	1000	
	11/26/2012	Bio Treatment Effluent	ND	1000	
	12/16/2012	Bio Treatment Effluent	ND	1000	
	3/8/2013	Bio Treatment Effluent	ND	1000	
Arsenic, Mercury, Selenium	3/8/2010 to 5/25/2010	All Locations			System upset due to pipe broke. Exclude all data Piping within the treatment system broke, resulting in a treatment system upset and degraded pollutant removal performance. EPA excluded all of the data collected at Allen on dates 3/8/10, 3/22/10, 4/5/10, 4/26/10, 5/10/10, and 5/25/10 for this reason. When reviewing the data, EPA observed periodic occurrences in early 2010 of unusually high concentrations of arsenic in the bioreactor effluent relative to effluent from the bioreactor influent treatment stage. According to Duke Energy personnel, the treatment system suffered an upset condition beginning 3/2/10, that particularly impacted arsenic concentrations exiting the bioreactor. The treatment system suffered pipe failures in the bioreactor on 3/2/10 and 3/11/10, dislodging a portion of the carbon within the bioreactor cells. It took approximately four weeks for repairs to be completed, and additional time for the treatment system performance to stabilize. According to Duke Energy, elevated arsenic concentrations in the bioreactor effluent during the period March through May 2010 are likely attributable to the pipe breakages and related repair activities. Since the overall performance of the treatment system was degraded during this period, EPA excluded all data collected from date of the first pipe failure until the end of May.

[1] D=Detected, ND=Non-detected.

Table A2.2 List of excluded data at Belews Creek

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring	Arsenic, Mercury, Selenium	2/6/2008 to 6/11/2008	All locations			Start-up or commissioning period EPA excluded data associated with the initial start-up or commissioning period for a new wastewater treatment system because the data tend to exhibit relatively high variability not representative of typical operation. During the initial commissioning period, the treatment system undergoes a variety of testing to demonstrate that hydraulic flows through the system and equipment such as pumps, valves, and other equipment operate as designed. During this period, it is common for changes in process operations to occur as the treatment system undergoes performance verification testing (sometimes referred to as acceptance testing) and the operation is modified to identify approaches to optimize (i.e., minimize) operational costs or to make adjustments to improve pollutant reductions. Refinements that may take place during the commissioning period include adjustments to chemical feed locations and/or feed rates; evaluating different pump cycles, filter backwash cycles, clarifier overflow rates, or sludge removal cycles; and changes to the chemicals used. Generally, this initial period of operation also serves as a time when the operators gain familiarity with the intricacies of the treatment system operation. During this acclimation and optimization period the effluent concentration values may exhibit higher variability than would typically be observed for a well-operated treatment system, producing occasional extreme values (either high or low concentrations). After this initial adjustment period, a well-operated system should operate at steady state (or more precisely, a “quasi-steady state”) with relatively low variability around a long-term average. This period of instability affects the pollutant removal efficacy and

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)						is not reflective of BAT/NSPS level of performance and therefore data associated with the initial commissioning period are excluded. The end of the initial commissioning period was the date specified by the treatment system operators (as reported in UWAG comments on the proposed rule).
Plant Self-Monitoring	Mercury (ng/L)	8/4/2008	Bio Treatment Influent	D	4.9	Questionable results due to QA/QC issues EPA excluded mercury data that Duke Energy identified as questionable due to quality control issues. Duke Energy stated that these data are questionable because they suspected that the matrix spike/matrix spike duplicate (MS/MSD) were not conducted using the FGD wastewater matrix or the MS/MSD indicated inadequate recoveries. EPA lacked sufficient laboratory quality control data for these results to make an independent assessment of whether these mercury results should have been retained and included in the statistical analyses.
		8/4/2008	Bio Treatment Effluent	D	2.4	
		8/11/2008	Bio Treatment Influent	D	4.8	
		8/11/2008	Bio Treatment Effluent	D	2.7	
		8/18/2008	Bio Treatment Influent	D	24	
		8/18/2008	Bio Treatment Effluent	D	5.3	
		8/25/2008	Bio Treatment Influent	D	27	
		8/25/2008	Bio Treatment Effluent	D	6.4	
		9/2/2008	Bio Treatment Influent	D	3.1	
		9/2/2008	Bio Treatment Effluent	D	2.1	
		9/8/2008	Bio Treatment Influent	D	2.7	
		9/8/2008	Bio Treatment Effluent	D	4.1	
		9/15/2008	Bio Treatment Influent	D	12	
		9/15/2008	Bio Treatment Effluent	ND	1	
		9/22/2008	Bio Treatment Influent	D	8.1	
		9/22/2008	Bio Treatment Effluent	ND	1	
		9/29/2008	Bio Treatment Influent	D	3.4	
		9/29/2008	Bio Treatment Effluent	D	3.7	
		12/3/2008	FGD Purge	D	16000	
		12/3/2008	Bio Treatment Influent	D	19	
		12/3/2008	Bio Treatment Effluent	D	3.6	
		12/10/2008	FGD Purge	D	44000	
		12/10/2008	Bio Treatment Influent	D	15	
		12/10/2008	Bio Treatment Effluent	D	2	
		12/17/2008	Bio Treatment Influent	D	7.6	
		12/17/2008	Bio Treatment Effluent	D	2.9	
		12/22/2008	Bio Treatment Influent	D	20	

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)		12/22/2008	Bio Treatment Effluent	D	1.4	Questionable results due to QA/QC issues EPA excluded mercury data that Duke Energy identified as questionable due to quality control issues. Duke Energy stated that these data are questionable because they suspected that the matrix spike/matrix spike duplicate (MS/MSD) were not conducted using the FGD wastewater matrix or the MS/MSD indicated inadequate recoveries. EPA lacked sufficient laboratory quality control data for these results to make an independent assessment of whether these mercury results should have been retained and included in the statistical analyses. (cont'd)
		12/29/2008	Bio Treatment Influent	D	12	
		12/29/2008	Bio Treatment Effluent	D	2.4	
		1/7/2009	Bio Treatment Influent	D	5	
		1/7/2009	Bio Treatment Effluent	D	2.8	
		1/14/2009	Bio Treatment Influent	D	15	
		1/14/2009	Bio Treatment Effluent	D	2.3	
		1/22/2009	Bio Treatment Influent	D	4.7	
		1/22/2009	Bio Treatment Effluent	D	3.9	
		1/28/2009	Bio Treatment Influent	D	12	
		1/28/2009	Bio Treatment Effluent	D	2.6	
Plant Self-Monitoring	Mercury (ng/L)	6/12/2008-6/15/2008	Bio Treatment Effluent	ND	1000	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo
		1/27/2010	Bio Treatment Effluent	ND	1000	
		2/24/2010	Bio Treatment Effluent	ND	1000	
		3/24/2010	Bio Treatment Effluent	ND	1000	
		4/7/2010	Bio Treatment Effluent	ND	1000	
		6/23/2010	Bio Treatment Effluent	ND	1000	
		7/14/2010	Bio Treatment Effluent	ND	1000	
		7/28/2010	Bio Treatment Effluent	ND	1000	
		8/25/2010	Bio Treatment Effluent	ND	1000	
		9/22/2010	Bio Treatment Effluent	ND	1000	
		10/27/2010	Bio Treatment Effluent	ND	1000	
		11/4/2010	Bio Treatment Effluent	ND	1000	
		11/23/2010	Bio Treatment Effluent	ND	1000	
		12/8/2010	Bio Treatment Effluent	ND	1000	
		1/17/2011	Bio Treatment Effluent	ND	1000	
		1/26/2011	Bio Treatment Effluent	ND	1000	
		2/16/2011	Bio Treatment Effluent	ND	1000	
		3/23/2011	Bio Treatment Effluent	ND	1000	
		4/27/2011	Bio Treatment Effluent	ND	1000	

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)	Mercury (ng/L) (cont'd)	5/25/2011	Bio Treatment Effluent	ND	1000	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo (cont'd)
		6/8/2011	Bio Treatment Effluent	ND	1000	
		6/22/2011	Bio Treatment Effluent	ND	1000	
		7/13/2011	Bio Treatment Effluent	ND	1000	
		7/27/2011	Bio Treatment Effluent	ND	1000	
		8/10/2011	Bio Treatment Effluent	ND	1000	
		8/24/2011	Bio Treatment Effluent	ND	1000	
		9/14/2011	Bio Treatment Effluent	ND	1000	
		9/28/2011	Bio Treatment Effluent	ND	1000	
		10/7/2011	Bio Treatment Effluent	ND	1000	
		10/8/2011	Bio Treatment Effluent	ND	1000	
		10/9/2011	Bio Treatment Effluent	ND	1000	
		10/10/2011	Bio Treatment Effluent	ND	1000	
		10/11/2011	Bio Treatment Effluent	ND	1000	
		10/12/2011	Bio Treatment Effluent	ND	1000	
		10/13/2011	Bio Treatment Effluent	ND	1000	
		10/14/2011	Bio Treatment Effluent	ND	1000	
		10/15/2011	Bio Treatment Effluent	ND	1000	
		10/16/2011	Bio Treatment Effluent	ND	1000	
		10/26/2011	Bio Treatment Effluent	ND	1000	
		11/4/2011	Bio Treatment Effluent	ND	1000	
		11/6/2011	Bio Treatment Effluent	ND	1000	
		11/7/2011	Bio Treatment Effluent	ND	1000	
		11/8/2011	Bio Treatment Effluent	ND	1000	
		11/9/2011	Bio Treatment Effluent	ND	1000	
		11/10/2011	Bio Treatment Effluent	ND	1000	
		11/11/2011	Bio Treatment Effluent	ND	1000	
		11/12/2011	Bio Treatment Effluent	ND	1000	
		11/13/2011	Bio Treatment Effluent	ND	1000	
		11/23/2011	Bio Treatment Effluent	ND	1000	
		12/14/2011	Bio Treatment Effluent	ND	1000	
		12/28/2011	Bio Treatment Effluent	ND	1000	

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)	Mercury (ng/L) (cont'd)	1/11/2012	Bio Treatment Effluent	ND	1000	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo (cont'd)
		1/25/2012	Bio Treatment Effluent	ND	1000	
		2/8/2012	Bio Treatment Effluent	ND	1000	
		2/15/2012	Bio Treatment Effluent	ND	2500	
		2/16/2012	Bio Treatment Effluent	ND	1000	
		2/17/2012	Bio Treatment Effluent	ND	1000	
		2/18/2012	Bio Treatment Effluent	ND	1000	
		2/19/2012	Bio Treatment Effluent	ND	1000	
		2/20/2012	Bio Treatment Effluent	ND	1000	
		2/21/2012	Bio Treatment Effluent	ND	1000	
		2/22/2012	Bio Treatment Effluent	ND	1000	
		2/23/2012	Bio Treatment Effluent	ND	1000	
		2/24/2012	Bio Treatment Effluent	ND	1000	
		3/14/2012	Bio Treatment Effluent	ND	1000	
		3/28/2012	Bio Treatment Effluent	ND	1000	
		4/25/2012	Bio Treatment Effluent	ND	1000	
		5/22/2012	Bio Treatment Effluent	ND	1000	
		5/23/2012	Bio Treatment Effluent	ND	1000	
		5/28/2012	Bio Treatment Effluent	ND	1000	
		5/30/2012	Bio Treatment Effluent	ND	1000	
		5/31/2012	Bio Treatment Effluent	ND	1000	
		6/1/2012	Bio Treatment Effluent	ND	1000	
		6/13/2012	Bio Treatment Effluent	ND	1000	
		6/27/2012	Bio Treatment Effluent	ND	1000	
		8/8/2012	Bio Treatment Effluent	ND	1000	
		8/29/2012	Bio Treatment Effluent	ND	1000	
		9/12/2012	Bio Treatment Effluent	ND	1000	
		9/26/2012	Bio Treatment Effluent	ND	1000	
		10/10/2012	Bio Treatment Effluent	ND	1000	
		1/9/2013	Bio Treatment Effluent	ND	1000	
		1/23/2013	Bio Treatment Effluent	ND	1000	
		2/13/2013	Bio Treatment Effluent	ND	1000	
		2/27/2013	Bio Treatment Effluent	ND	1000	

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
		3/13/2013	Bio Treatment Effluent	ND	1000	
Plant Self-Monitoring	Mercury (ng/L)	5/9/2012	Bio Treatment Effluent	D	2500	Data Entry Error The reported value of 2500 ng/L is inconsistent with the other reported observation for that day (22.1 ng/L). Additionally, the 2500 ng/L observation is orders of magnitude higher than other observations for Bio Treatment Effluent in the preceding and following months, while the 22.1 ng/L observation for 5/9/2012 is consistent with observations reported for the preceding and following months. Therefore, the 2500 ng/L observation was excluded as an analytical anomaly or data entry error.
EPA Sampling	Mercury (ng/L)	6/9/2010	Bio Treatment Effluent Dup	D	6440	Analytical anomalies The reported value of 6440 ng/L mercury is inconsistent with the other reported observations for that day (247 ng/L for EPA split sample; 333 ng/L for industry self-monitoring split sample). Additionally, the 6440 ng/L observation is an order of magnitude higher than other observations for Bio Treatment Effluent in the preceding months and following days and months, in contrast to the other observations for 6/9/2010. Therefore, the 6440 ng/L observation was excluded as an analytical anomaly.

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring	Selenium (µg/L)	7/14/2010	Bio Treatment Effluent	D	299	Upset condition or analytical anomaly The reported value of 299 ug/L selenium is much higher than any other observation in the remainder of dataset for Belews Creek. EPA evaluated the selenium contributions in the FGD purge and bioreactor influent (total and dissolved selenium, as well as concentrations of selenate and selenite), and the values for total selenium, selenite, and selenate in the bioreactor effluent (there are no dissolved selenium results for the bioreactor effluent on that date). In addition, EPA evaluated the concentrations for total selenium, dissolved selenium, selenite, and selenate at all three sampling locations for the months preceding and following the July 14 sampling event. EPA also evaluated electricity generation, absorber and wastewater pH data, bioreactor influent ORP, and bioreactor influent and effluent nitrate concentrations for 7/14/2010 and the months preceding and following that date for indications of changes or abnormalities. There were no significant changes in ORP to suggest the wastewater characteristics reflected the effects of high oxidizing conditions in the scrubber, so the commenter's suggestion in that regard is unlikely. EPA noted that the bioreactor influent nitrate concentrations rose somewhat in the days preceding the observation; however, the increase was not large and the bioreactor effluent nitrate concentrations were non-detect at <2.3 mg/L, showing that the bioreactor was effectively denitrifying the wastewater.

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)						The high effluent selenium observation also coincided with elevated selenate in the effluent (217 ug/L). There were also substantial increases in total selenium and selenate in the bioreactor influent and the FGD purge, showing that the bioreactor did experience an increased pollutant load. However, even taking into account the concentration of selenate present in the FGD purge and bioreactor influent samples, the bioreactor effluent is substantially higher than would be expected based on the demonstrated performance of the Belews Creek biological treatment system, as well as the performance observed for the biological treatment system at Allen. For example, the selenium in the bioreactor influent on 7/14/2010 was less than 3 times higher than the influent concentration for the previous observation on 6/23/2010; yet when the bioreactor influent selenium load increased by 10 times in May 2011 there was little effect on effluent concentrations (rising from <5 ug/L to 7/7 ug/L). Similar examples can be found at Belews Creek for selenate, where a large change in selenate (relative to the change observed for 7/14/2010) was not accompanied by increased effluent selenium or selenate. See, e.g., data for October 2011 and December 2012. These observations for Belews Creek are supported by the data for the biological treatment system at Allen. There were multiple occasions at Allen when the bioreactor influent selenium and selenate increased sharply, with the concentrations rising 10-15 times higher in a short period of time, yet with little if any observable effect on the bioreactor effluent concentrations. See, e.g., Allen data for August 2010, March 2011, December 2011, September 2012, and

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)						March 2013. In addition, the influent selenium concentrations at Allen in September 2012 and March 2013 were even higher than observed at Belews Creek on 7/14/2010. The 299 ug/L observation is 10 times higher than any of the other 398 observations for the treatment systems at Belews Creek and Allen, which represent more than 5 years of operation at Belews Creek and more than 4 years of operation at Allen. Excluding the 7/14/2010 observation, there are 216 observations for selenium in the bioreactor effluent; the maximum value is 29.4 ug/L and the median is 6.2 ug/L (i.e., half of all data are lower than 6.2 ug/L). There are 182 observations for selenium in the bioreactor effluent at Allen; the maximum value is 27.6 ug/L and the median is 5.0 ug/L. Based upon a thorough review of the bioreactor performance data for Allen and Belews Creek, EPA concluded that the 7/14/2010 observation should be excluded when calculating the effluent limitations for the final rule because the unusually high value is the result of a treatment system upset condition or other abnormal operation, such as would result from inadequate operator control of the biological process. This is consistent with information EPA obtained during a site visit to Allen Station on October 22, 2009: *"Allen stated that the major improvement of the Allen biological treatment system over the Belews Creek system is the inclusion of oxidation-reduction potential (ORP) and pH probes on each individual cell (the Belews Creek system has one ORP probe for each stage).*

Table A2.2 List of excluded data at Belews Creek (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Plant Self-Monitoring (cont'd)						*Additionally, the Allen system has sampling points on the effluent from the second stage (Belews Creek has sampling points on the effluent from the second stage recycle). These improvements have resulted in greater ease of operations for the biological treatment system at Allen." DCN EPA-HQ-OW-2009-0819-0598* A properly operated treatment system includes close operator attention to influent wastewater characteristics, key process control parameters and effluent quality. See DCN SE05846 (memorandum Variability in Flue Gas Desulfurization Wastewater: Monitoring and Response). Since no plausible explanation validating the extreme observation could be determined, EPA excluded the bioreactor effluent selenium observation for July 14, 2010.

[1] D=Detected, ND=Non-detected.

Table A2.3 List of excluded data at Hatfield's Ferry

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Plant Self-Monitoring	Arsenic (µg/L)	12/6/2011 to 10/1/2013	Chem Precipitation Effluent			Analytical Interferences See Analytical Methods Review Memo
Plant Self-Monitoring	Mercury (ng/L)	2/17/2012	Chem Precipitation Effluent	D	35.4	Data Entry Error EPA excluded this observation because conflicting information results in uncertainty about the correct value. FirstEnergy reported conflicting information in its 5/2/2014 and 5/13/2014 submittals.
Plant Self-Monitoring	Arsenic, Mercury	10/8/2013 to 12/10/2013	Chem Precipitation Effluent			Decommissioning Period See Analytical Methods Review Memo
Plant Self-Monitoring	Mercury (ng/L)	11/29/2012	Chem Precipitation Effluent	ND	200	Insufficiently-sensitive analytical method (Method 245.1) See Analytical Methods Review Memo
		12/19/2012		D	270	
		12/21/2012		D	430	
CWA 308 Sampling	Mercury (ng/L)	10/5/2010	Chem Precipitation Effluent	D	978	Sampling or Analytical Error. EPA excluded mercury data collected on 10/5/10 at the chemical precipitation effluent at Hatfield's Ferry. This exclusion was due to an unusually high analytical result inconsistent with proper operation of the BAT/NSPS chemical precipitation treatment technology. Specifically, based on information in the record, the sampling result indicates that the sample may have been contaminated during sample collection or was adversely affected by treatment system upset. The decision to exclude the analytical result (978 ng/L) is supported by the plant's NPDES compliance monitoring data for that time period. The maximum daily value reported for FGD wastewater treatment system effluent for the month of October 2010 was 127 ng/L. If the excluded value accurately represented the mercury concentration in the plant's FGD treatment system effluent, due to the hydraulic residence times and mixing that occurs in the FGD absorber and the wastewater treatment system, similarly high concentrations of mercury should have been reflected in the plant's NPDES compliance monitoring samples. Furthermore, the maximum daily values reported by the plant for each monthly reporting period for August 2010 through

Table A2.3 List of excluded data at Hatfield's Ferry (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
CWA 308 Sampling (cont'd)						February 2011 were also substantially lower than the excluded value, ranging from 108 ng/L to 268 ng/L. The excluded value may be the result of sample contamination occurring during sample collection. EPA used "clean sampling" techniques for its field sampling program, including requiring plant staff to also use such procedures when collecting the CWA 308 samples. These clean sampling procedures are intended to minimize the potential for contaminating samples, particularly in environments where dust and other contaminants are present. For all plants in the field sampling program, except Hatfield's Ferry, the CWA 308 sampling was conducted after EPA had first conducted its on-site field sampling program. This approach enabled plant staff to become familiar with the specialized sampling collection protocols used for "clean sampling" prior to initiating their CWA 308 sampling. However, in the case of Hatfield's Ferry, the plant initiated the CWA 308 sampling prior to the EPA field sampling and unfamiliarity with the clean sampling protocols may have allowed the October 2010 sample to become contaminated. If the excluded result is not associated with sample contamination, then it indicates that the plant did not exercise good control of the treatment system during startup following a shutdown period. All three generating units had been shutdown for at least a week preceding the December 2010 sampling event. Unit 3 then started up on October 3, generating electricity at approximately one-third capacity for the unit. Unit 3 then operated at nearly full load on October 4 and approximately two-thirds load on October 5, but then shutdown again on October 6. Based on the information in the record, the FGD wastewater treatment system likely was not operating in a stable manner during this period. In their comments on the proposed effluent guidelines, FirstEnergy (operator for Hatfield's Ferry) did not dispute EPA's determination that the 978 ng/L observation should be excluded, nor the reasons for doing so.

Table A2.3 List of excluded data at Hatfield's Ferry (continued)

Data Source	Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Plant Self-Monitoring	Arsenic (µg/L)	1/5/2010	Chem Precipitation Effluent	D	8	Treatment system upset or abnormal operation See Figure A5.1 in Appendix 5 Observations during the time period including 1/5/2010 to 1/19/2010 are an order of magnitude higher than the preceding and following weeks. FirstEnergy stated that they do not know what caused the large spikes in mercury concentrations. Since the treatment system was undergoing an upset or other abnormal operation, all results for the affected days were excluded.
		1/12/2010		D	7	
		1/19/2010		D	9	
	Mercury (ng/L)	1/5/2010		D	1440	
		1/12/2010		D	3310	
		1/19/2010		D	2030	
		2/28/2012		D	1520	Observations during the time period including 2/28/2012 to 3/27/2012 are substantially higher (hundreds or thousands ppt) than observations for the preceding and following weeks. FirstEnergy stated that they do not know what caused the large spikes in mercury concentrations. FirstEnergy noted that they occasionally had problems with the sand filters. FirstEnergy also noted that the wastewater treatment operators were changing frequently during the time period because of training and that it could have led to multiple operators making various changes that may have impacted the performance of the treatment system.
		3/6/2012		D	466	
		3/13/2012		D	1160	
		3/20/2012		D	1710	
		3/27/2012		D	1320	
		4/3/2012		D	3400	
		3/19/2013		D	1430	Observations for the time period including 3/19/2013 to 6/4/2013 are substantially higher than observations for the preceding and following periods. FirstEnergy was unable to explain the reason for the spikes in mercury concentration and variable performance of the treatment system, particularly in relation to the system's typical performance. There were no changes in power plant operation, such as changes in coal source or operation of FGD or other systems, coinciding with the time period.
		3/26/2013		D	194	
		4/3/2013		D	2110	
		5/14/2013		D	1410	
		5/21/2013		D	573	
		5/29/2013		D	518	
		6/4/2013		D	1900	

D=Detected, ND=Non-detected.

Table A2.4 List of excluded data at Keystone

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Arsenic (µg/L)	1/3/2012 to 1/6/2014	Chem Precipitation Effluent			Insufficiently-sensitive analytical method (Method 200.7) See Analytical Methods Review Memo
Mercury (ng/L)	1/3/2012 to 4/28/2014	Chem Precipitation Effluent			Insufficiently-sensitive analytical method (Method SM 3112B) See the Analytical Methods Review Memo
Arsenic (µg/L)	2/21/2013	Chem Precipitation Effluent	ND	5	Not an Approved NPDES Compliance Monitoring Method See the Analytical Methods Review Memo

[1] D=Detected, ND=Non-detected.

Table A2.5 List of excluded plant self-monitoring data at Miami Fort

Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Arsenic (µg/L)	7/13/2009	Chem Precipitation Effluent	ND	50	Insufficiently-sensitive analytical method (Method 200.8) See the Analytical Methods Review Memo.
	8/3/2009		ND	20	
	9/1/2009		ND	20	
	10/5/2009		ND	20	
	11/2/2009		ND	20	
	12/1/2009		ND	20	
	1/5/2010		ND	20	
	2/2/2010		ND	20	
	3/2/2010		ND	40	
	4/6/2010		ND	20	
	5/4/2010		ND	20	
	6/1/2010		ND	20	
	7/6/2010		ND	20	
	8/3/2010		ND	20	
	9/7/2010		ND	20	
	10/5/2010		ND	20	
	11/2/2010		ND	20	
	12/7/2010		ND	20	
	12/7/2010		ND	20	
	1/4/2011		ND	20	
	2/1/2011		ND	20	
	3/1/2011		ND	20	
	4/5/2011		ND	20	
	5/9/2011		ND	20	
	6/7/2011		ND	20	
	7/5/2011		ND	20	
	8/2/2011		ND	20	
	9/6/2011		ND	20	
	10/4/2011		ND	20	
	11/1/2011		ND	20	
	12/6/2011		ND	20	
	1/3/2012		ND	20	
	2/7/2012		ND	20	

Table A2.5 List of excluded plant self-monitoring data at Miami Fort (continued)

Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Arsenic (µg/L) (cont'd)	3/6/2012		ND	20	Insufficiently-sensitive analytical method (Method 200.8) See the Analytical Methods Review Memo. (cont'd)
	4/3/2012		ND	20	
	5/1/2012		ND	20	
	6/5/2012		ND	20	
	7/2/2012		ND	20	
	8/7/2012		ND	20	
	9/4/2012		ND	20	
	10/2/2012		ND	20	
	11/6/2012		ND	20	
	12/4/2012		ND	20	
	1/2/2013		ND	20	
	2/5/2013		ND	20	
	3/5/2013		ND	20	
	4/2/2013		ND	20	
	5/7/2013		ND	20	
	6/4/2013		ND	20	
	7/2/2013		ND	20	
	8/6/2013		ND	20	
	9/3/2013		ND	20	
	10/1/2013		ND	20	
	11/5/2013		ND	20	
	12/3/2013		ND	20	
Arsenic (µg/L)	5/8/2013	Chem Precipitation Effluent	ND	5	Unable to Confirm the Validity of the Results See the Analytical Methods Review Memo
	5/8/2013		ND	5	
	5/8/2013		D	46	
	5/8/2013		ND	500	

Table A2.5 List of excluded plant self-monitoring data at Miami Fort (continued)

Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Arsenic (µg/L)	7/31/2012	Chem Precipitation Effluent	D	5.44	Unable to validate the results due to contradictory information
	7/31/2012		ND	10	Contradictory information about these observations make them unusable. Originally, Duke reported all four results as ND, with first 7/31/2012 and 8/1/2012 at 20 ug/L and 8/8/2012 and 8/9/2012 at 10 ug/L. UWAG reported all four results as ND at 10 ug/L. When Duke was asked to verify discrepancy for first two results, they instead reported all four observations as detected with new values (5.44, 5.86, 7.29, and 6.49 ug/L). Furthermore, Duke's spreadsheet included text showing that the samples were altered (diluted) in the field during collection. *[["Special field sample prep. Sample was diluted in field by URS and diluted in lab by Applied Speciation." Note that Duke did not provide supporting documentation for dilutions and corrections to results.]]* Based on this conflicting information and concerns about field-altered samples, all results for the four samples are considered invalid.
	8/1/2012		D	5.86	
	8/1/2012		ND	10	
	8/8/2012		D	7.29	
	8/8/2012		ND	10	
	8/9/2012		D	6.49	
	8/9/2012		ND	10	

[1]D=Detected, ND=Non-detected.

Table A2.6 List of excluded plant self-monitoring data at Pleasant Prairie

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Mercury (ng/L)	11/7/2007 to 4/15/2009	Chem Precipitation Effluent			Associated with TMT 15 Associated with TMT-15 organosulfide usage, which We Energies determined is less effective at removing mercury from Pleasant Prairie wastewater than other organosulfide formulations (i.e., Nalmet, Metclear). Pleasant Prairie switched from TMT-15 to Nalmet during the week of March 30, 2009. Effluent mercury concentrations rapidly decreased over an initial transition period, which based on review of the effluent data and engineering judgment continued into mid-April. As a result, mercury data associated with TMT-a5 use does not reflect BAT/NSPS operation of the treatment system at Pleasant Prairie and the data were excluded.
Arsenic (µg/L)	11/13/2007	Chem Precipitation Effluent	D	21	Problem associated with start-up Elevated concentration associated with initial start-up of the treatment system. The FGD system was operated in recirculation mode for an extended period of time as chlorides were allowed to build up in the scrubber and the wastewater treatment system was tuned to improve mercury removals. Discharge did not begin until November 2007 (and even then was irregular) and wastewater pollutant concentrations were elevated due to the extended recirculation period. The extended recirculation of the FGD wastewater resulted in fines building up in the system, which were then difficult for the plant to remove in the clarifier, resulting in elevated effluent concentrations. Data from this period do not reflect BAT/NSPS operation of the treatment system and were excluded.
Arsenic, Mercury	10/4/2007 to 5/7/2013	Secondary Clarifier Effluent			Secondary clarifier sampling location not representative of effluent discharge. (Certain mercury data 10/4/2007 to 4/15/2009 are also associated with TMT-15 additive, which is not representative of BAT/NSPS operation.) Much of the secondary clarifier data is associated with time periods when the plant was not discharging FGD wastewater. This is evident because the plant is required to monitor the discharge twice per week, and there are many time periods where there are purge and secondary clarifier samples, but no chem precip effluent. Furthermore, having secondary clarifier samples but no effluent samples is consistent with the plant's operational practice of recirculating the FGD wastewater when it is not in spec. Since EPA is unable to positively determine for each secondary clarifier sample whether it is associated with a discharge event or recirculation, all secondary clarifier data were excluded. (Note that numerous secondary clarifier samples exceed the permit effluent limits.)

Table A2.6 List of excluded plant self-monitoring data at Pleasant Prairie (continued)

Pollutant (unit)	Date	Sampling Location	Indicator[1]	Concentration	Exclusion Rationale
Mercury	6/13/2012	Chem Precipitation Effluent	D	2900	Treatment system upset or abnormal operation
	6/27/2012		D	595	Permit exceedance (out of compliance), due to treatment system upset/abnormal operation.
	6/28/2012		D	640	
	7/2/2012		D	490	
	7/3/2012		D	555	The time period for these observations, plus a 8300 ng/L secondary clarifier result, includes an exceedance of the NPDES permit limit and other observations of high effluent mercury concentrations. According to We Energies, the higher concentrations are associated with startup following a dual-unit outage and a 4-week FGD system shutdown. We Energies stated that storage of the FGD absorber slurry in a holding tank for 4 weeks without aeration led to reduction and dissolution of some of the oxidized particulate mercury, resulting in an abnormally high proportion of dissolved mercury in the FGD blowdown. The treatment system ultimately was operated in recirculation mode to aid in precipitating the mercury. (Note: Situation could have been avoided/mitigated by either providing aeration to the holding tank or placing the treatment system in recirculation until effluent concentrations were at typical levels.)

[1] D=Detected, ND=Non-detected.

Table A2.7 List of excluded CWA 308 sampling data at Wabash River

Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Arsenic (µg/L)	2/21/2011	Sour Water Treatment Influent	ND	4.1	Failed data editing criteria While performing the LTA test, EPA found that all the datasets passed the LTA test except for arsenic and mercury data at Wabash River. Thus, data for arsenic and mercury at Wabash River were excluded from the calculation of the limits. See Section 4 for discussion of the data editing criteria.
	2/21/2011	Steam Stripper Effluent	ND	4.2	
	2/21/2011	Vapor Compression Evaporator Influent	D	5	
	2/21/2011	Vapor Compression Evaporator Condensate	ND	4	
	2/22/2011	Sour Water Treatment Influent	ND	4.1	
	2/22/2011	Steam Stripper Effluent	ND	4.2	
	2/22/2011	Vapor Compression Evaporator Influent	D	5	
	2/22/2011	Vapor Compression Evaporator Condensate	ND	4	
	2/23/2011	Sour Water Treatment Influent	ND	4.1	
	2/23/2011	Steam Stripper Effluent	ND	4.1	
	2/23/2011	Vapor Compression Evaporator Influent	ND	4	
	2/23/2011	Vapor Compression Evaporator Condensate	ND	4	
	2/24/2011	Sour Water Treatment Influent	ND	4.1	
	2/24/2011	Steam Stripper Effluent	ND	4.1	
	2/24/2011	Vapor Compression Evaporator Influent	ND	4	
	2/24/2011	Vapor Compression Evaporator Condensate	ND	4	
Mercury (ng/L)	2/21/2011	Sour Water Treatment Influent	D	7420	
	2/21/2011	Steam Stripper Effluent	D	46.3	
	2/21/2011	Vapor Compression Evaporator Influent	ND	9.9	
	2/21/2011	Vapor Compression Evaporator Condensate	ND	0.5	
	2/22/2011	Sour Water Treatment Influent	D	10.8	
	2/22/2011	Steam Stripper Effluent	D	24.4	

Table A2.7 List of excluded CWA 308 sampling data at Wabash River (continued)

Pollutant (unit)	Date	Sampling Location	Indicator	Concentration	Exclusion Rationale
Mercury (ng/L) (cont'd)	2/22/2011	Vapor Compression Evaporator Influent	ND	4.95	
	2/22/2011	Vapor Compression Evaporator Condensate	ND	0.5	
	2/23/2011	Sour Water Treatment Influent	D	48.3	
	2/23/2011	Steam Stripper Effluent	ND	9.9	
	2/23/2011	Vapor Compression Evaporator Influent	ND	9.9	
	2/23/2011	Vapor Compression Evaporator Condensate	ND	0.5	
	2/24/2011	Sour Water Treatment Influent	ND	9.9	
	2/24/2011	Steam Stripper Effluent	ND	9.9	
	2/24/2011	Vapor Compression Evaporator Influent	ND	9.9	
	2/24/2011	Vapor Compression Evaporator Condensate	ND	0.5	

[1]D=Detected, ND=Non-detected.

Appendix 3. Plots of Plant Self-monitoring Data with Smoothed Curves to Aid in Determining Initial Commissioning Period for the Treatment System

Table of Contents

Figures | **Page**

Table of Contents (continued)

Figures **Page**

Table of Contents (continued)

Table of Contents (continued)

Figures **Page**

As explained in Section 3.2, EPA excluded some data collected during the initial commissioning period of the treatment system from the plant self-monitoring data from Allen and Belews Creek. The initial commissioning period was determined from an engineering perspective based on extensive experience evaluating treatment systems at power plants and other industry sectors and knowledge of the physical, chemical, and biological treatment processes employed and by looking at the longitudinal plots of all the data. In addition to the longitudinal plots of the data, smooth curves obtained by LOWESS (Cleveland, 1979 and 1981) superimposed on the individual data plots were also examined to help determine when the treatment system appeared to stabilize. In examining the longitudinal plots, EPA looked at two types of plots: plots of all the available plant self-monitoring data and plots of data after the exclusions for plant self-monitoring data due to reasons other than initial commissioning period described in Section 3.2. The conclusions from both of these approaches were consistent. The initial six months of operation was determined to represent a reasonable estimate of the commissioning period for the treatment systems.

This Appendix contains the longitudinal plots for arsenic, mercury, and selenium that engineers used as aids in determining the commissioning period for Allen and Belews Creek. Four sets of plots are given for each pollutant and each plant in this Appendix. The first set of plots shows all the available data points for the plant self-monitoring (before excluding any data for Allen and Belews Creek). The second set of plots is based on all available data (as in the first plot) with smooth curves (obtained by LOWESS) superimposed on the individual data. The third set of plots show the self-monitoring data after all necessary exclusions other than the initial commissioning period for the wastewater treatment system (as described in Section 3.2). The fourth set of plots show the data presented in the third set of plots, but with smooth curves (obtained by LOWESS) superimposed on the individual data points. The red vertical lines indicate the end of the commissioning period, thus the commissioning period is represented by the data to the left of the red vertical line.

For Allen, the two plots show concentrations from March 3, 2009 to October 22, 2013. For Belews Creek, the plots show concentrations from February 6, 2008 to November 28, 2013. For each plant, the upper plot shows the concentrations collected at all three sampling locations, while the lower plot shows the concentrations only at the bioreactor influent and bioreactor effluent.

Figure A3.1.1 Plot of all self-monitoring data for arsenic (µg/L) for Allen. The red vertical line indicates the end of the commissioning period

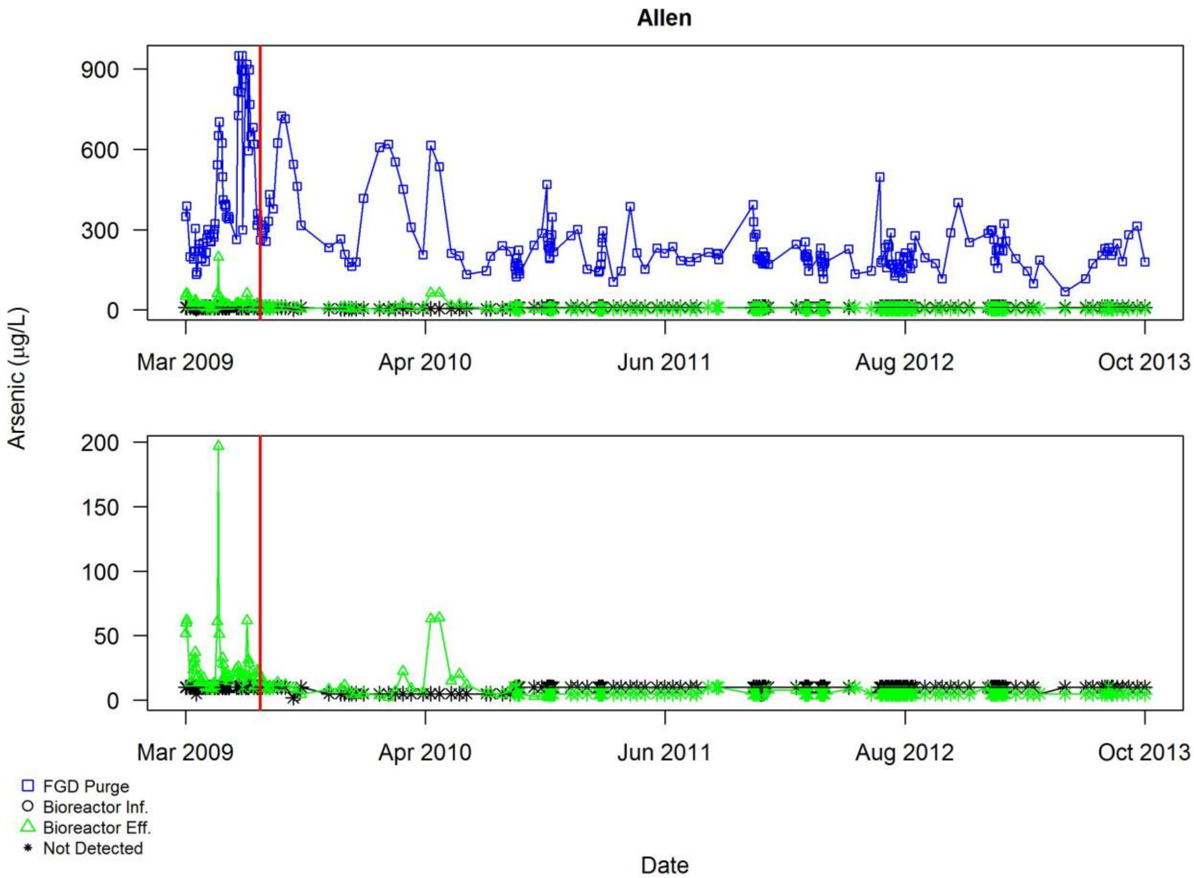


Figure A3.1.2 Plot of all self-monitoring data for arsenic (μg/L) for Allen superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

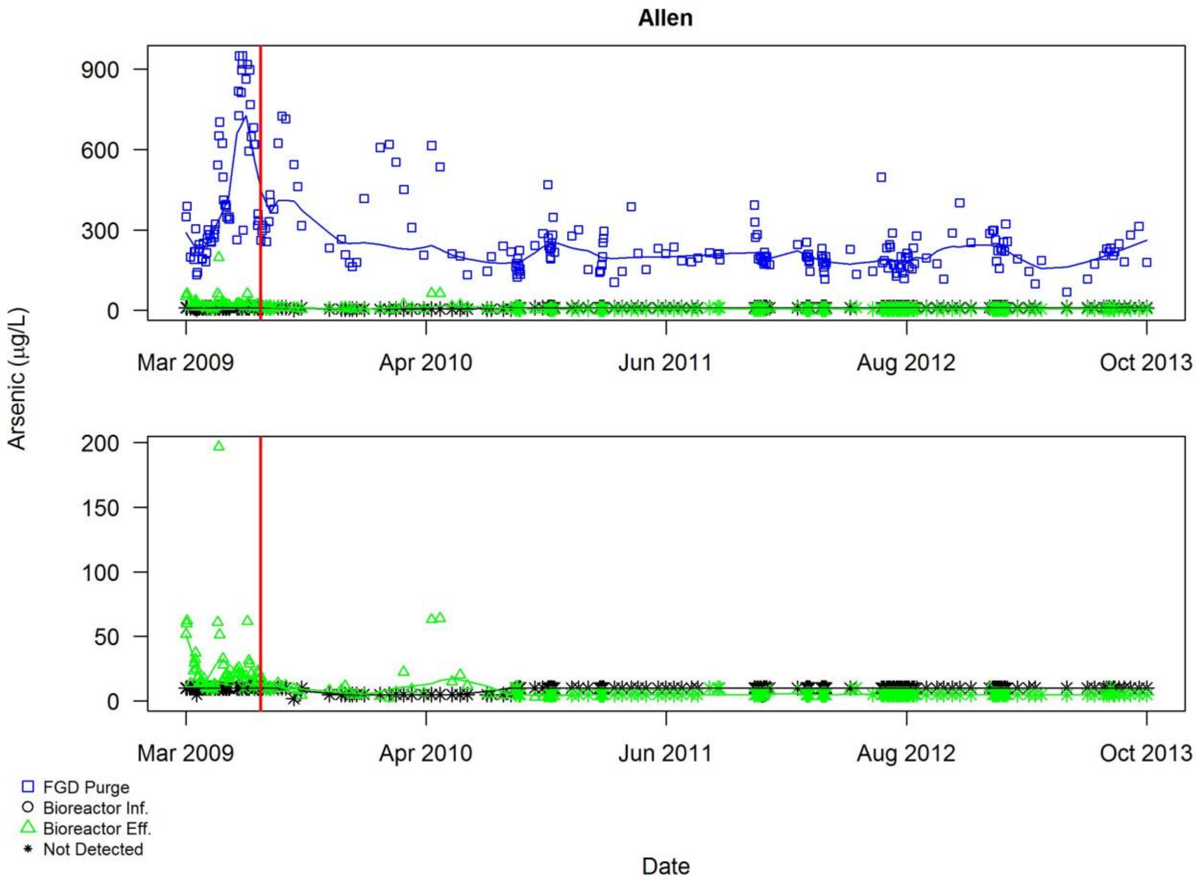


Figure A3.1.3 Plot of self-monitoring data for arsenic (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

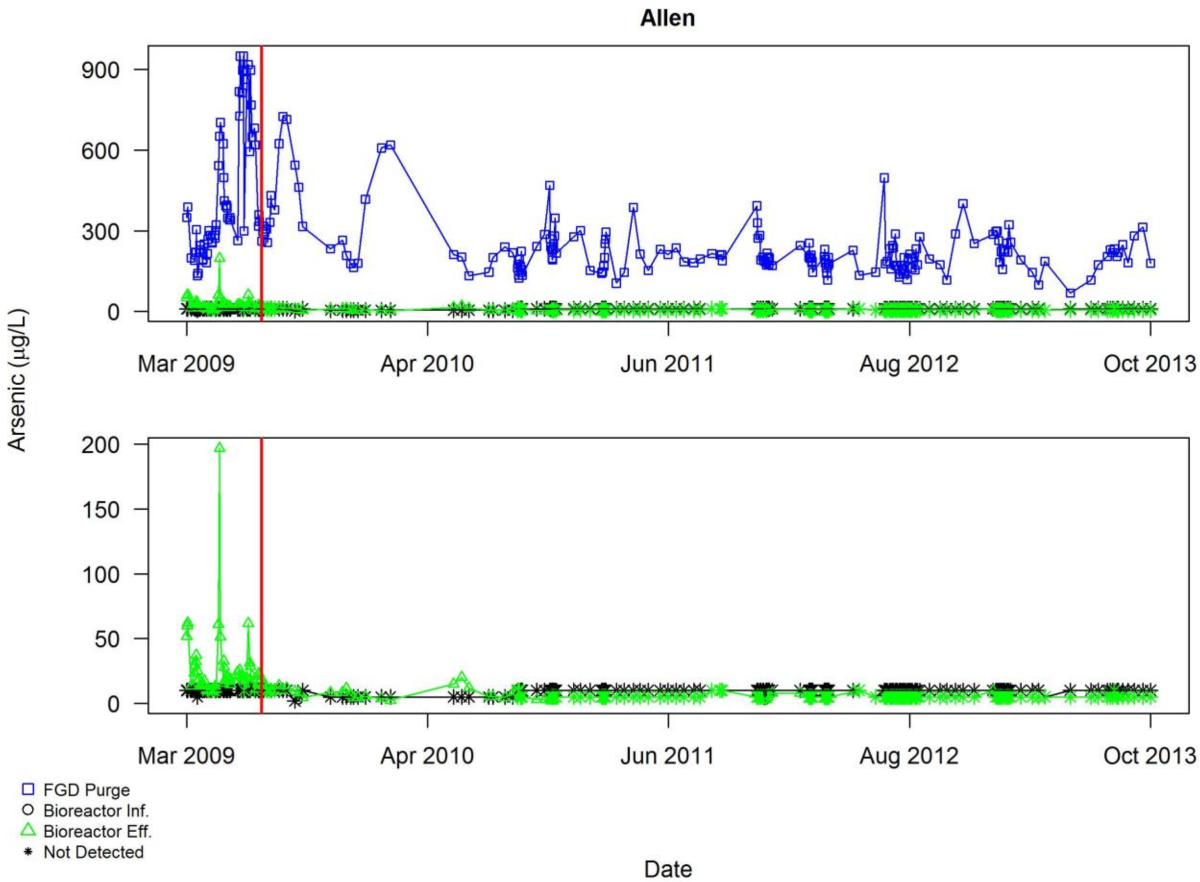


Figure A3.1.4 Plot of self-monitoring data for arsenic (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

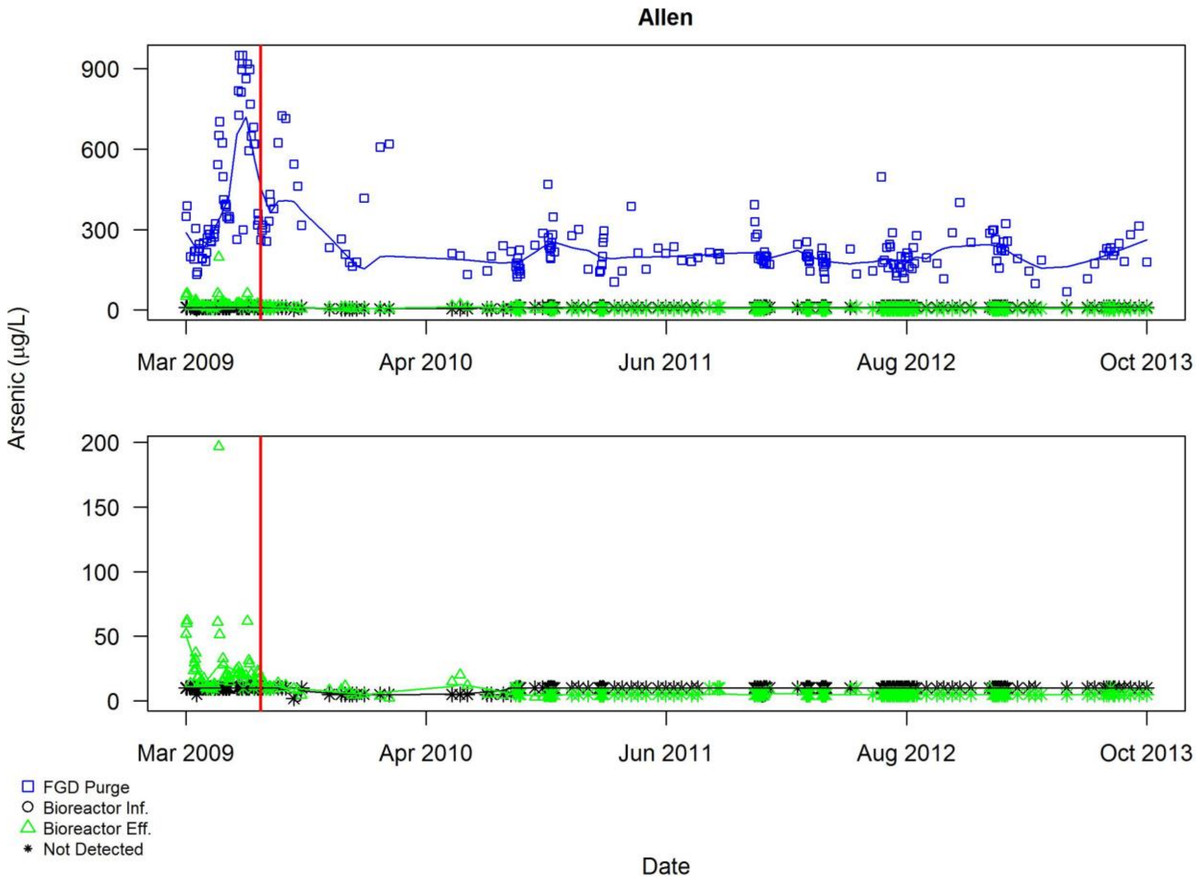


Figure A3.1.5 Plot of all self-monitoring data for mercury (ng/L) for Allen. The red vertical line indicates the end of the commissioning period

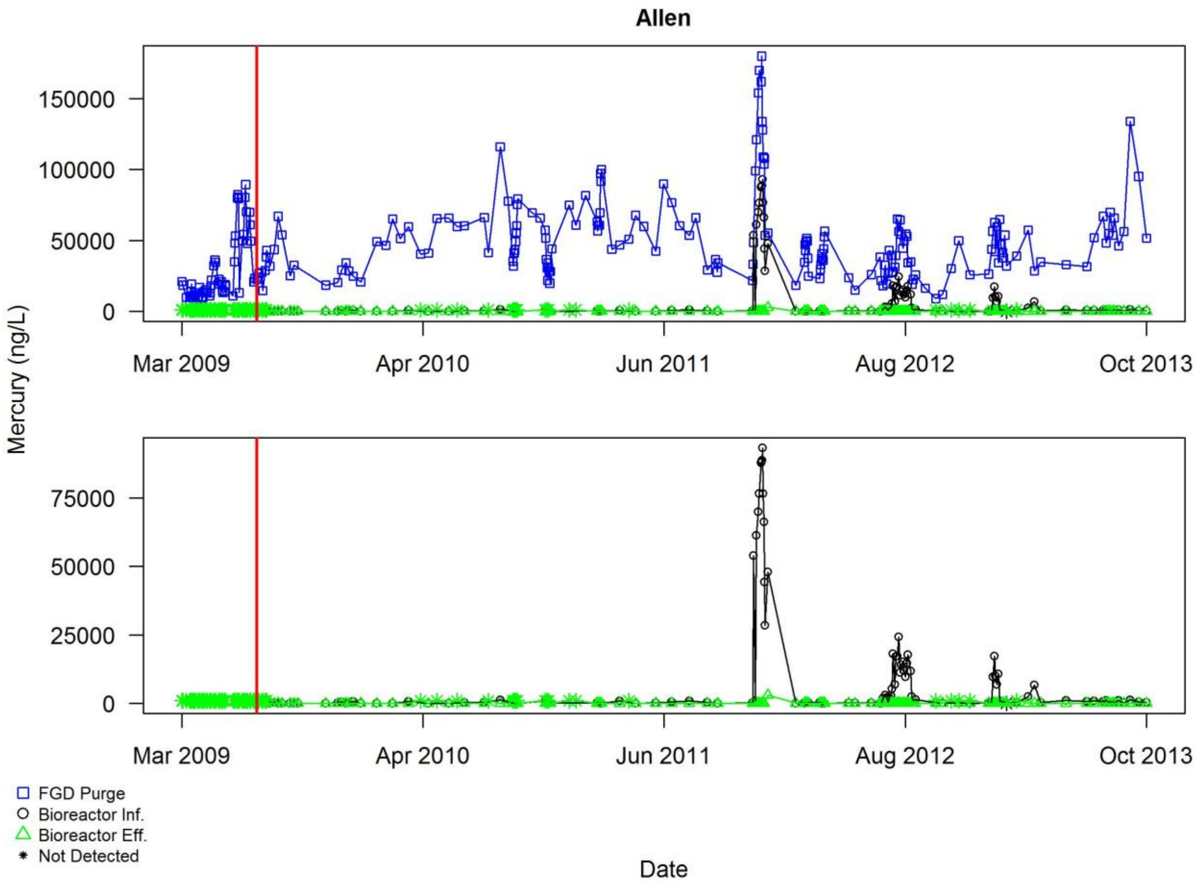


Figure A3.1.6 Plot of all self-monitoring data for mercury (ng/L) for Allen superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

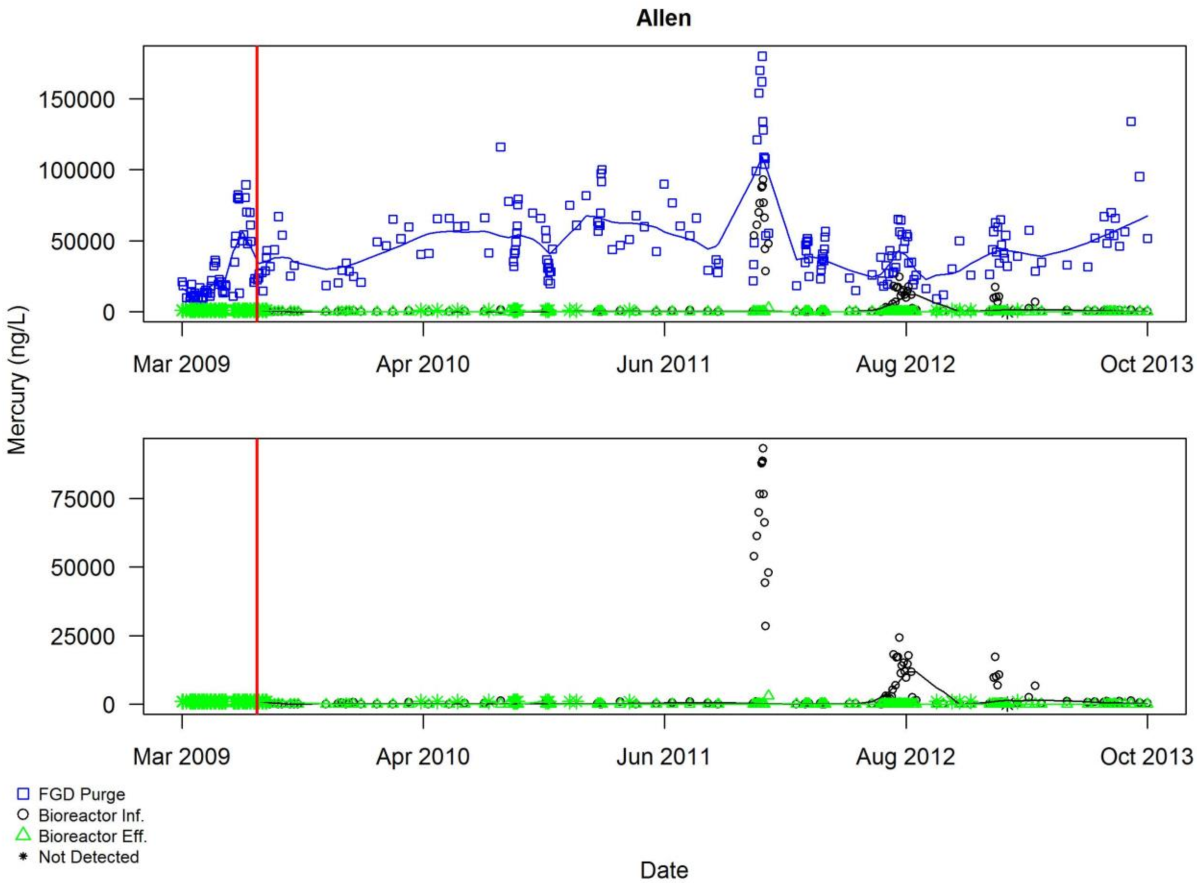


Figure A3.1.7 Plot of self-monitoring data for mercury (ng/L) for Allen after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

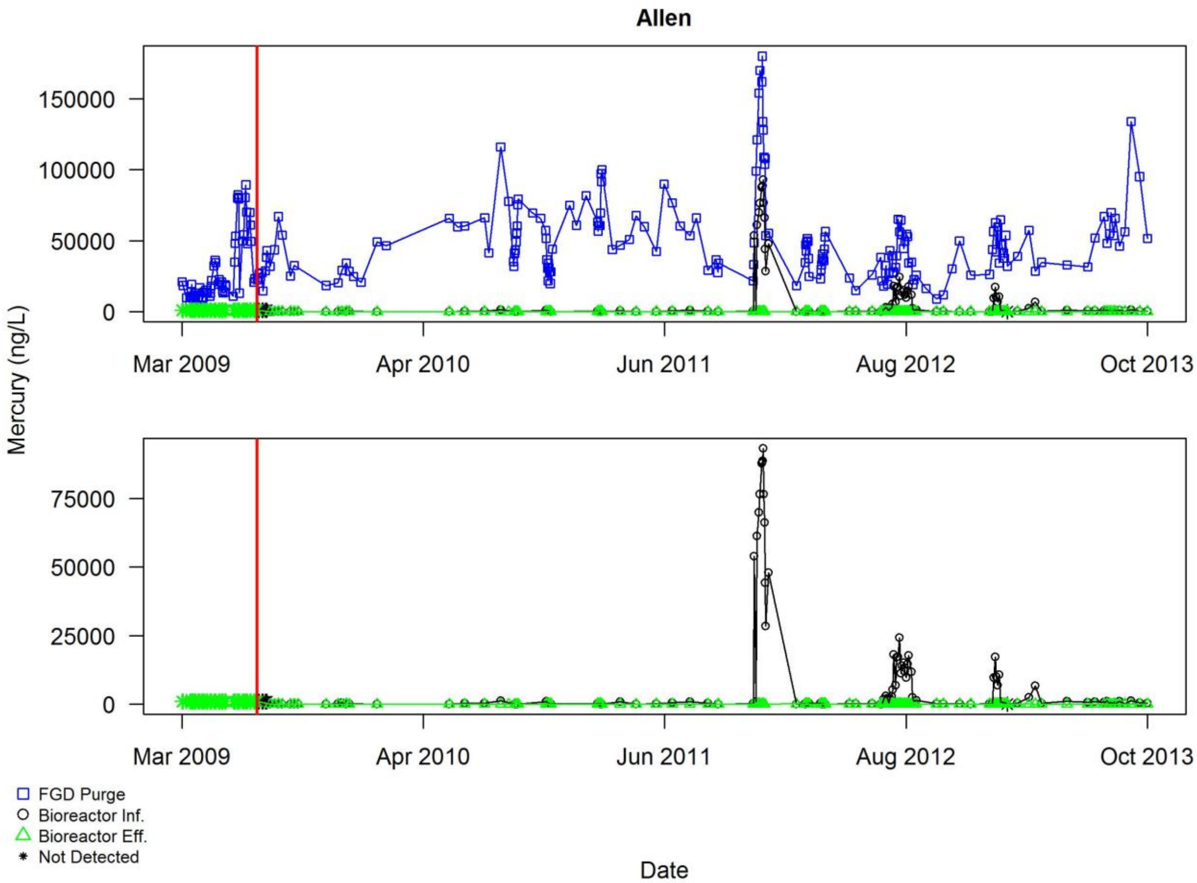


Figure A3.1.8 Plot of self-monitoring data for mercury (ng/L) for Allen after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

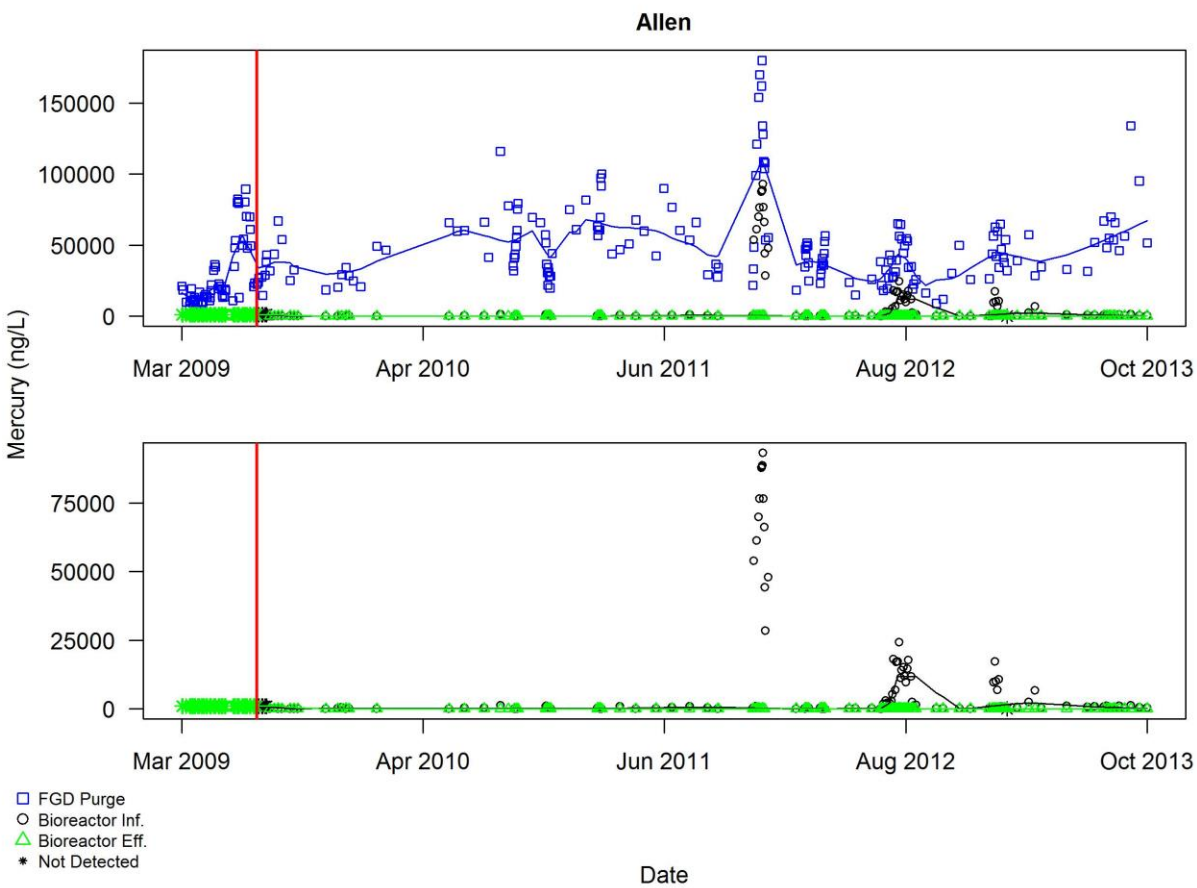


Figure A3.1.9 Plot of all self-monitoring data for Nitrate-Nitrite as N (mg/L) for Allen

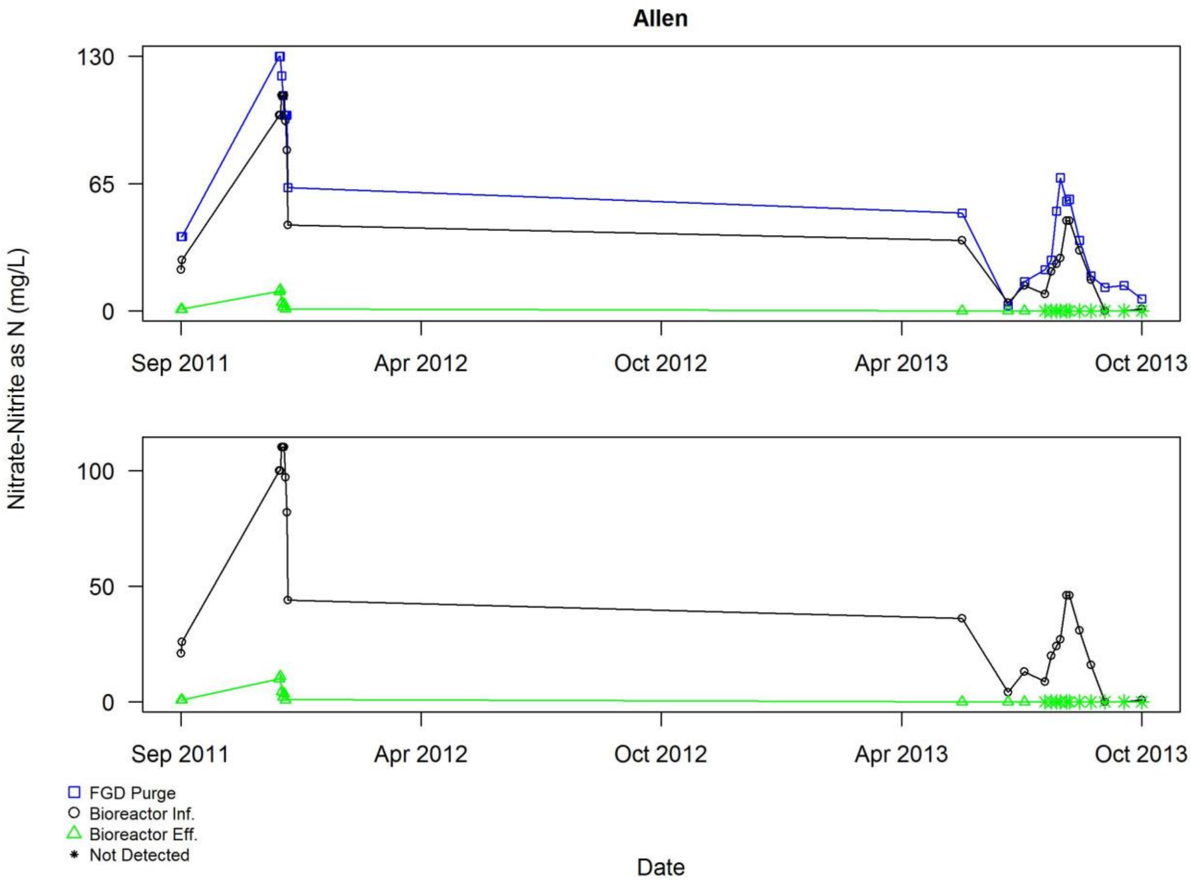


Figure A3.1.10 Plot of all self-monitoring data for Nitrate-Nitrite as N (mg/L) for Allen superimposed with smooth curves using LOWESS

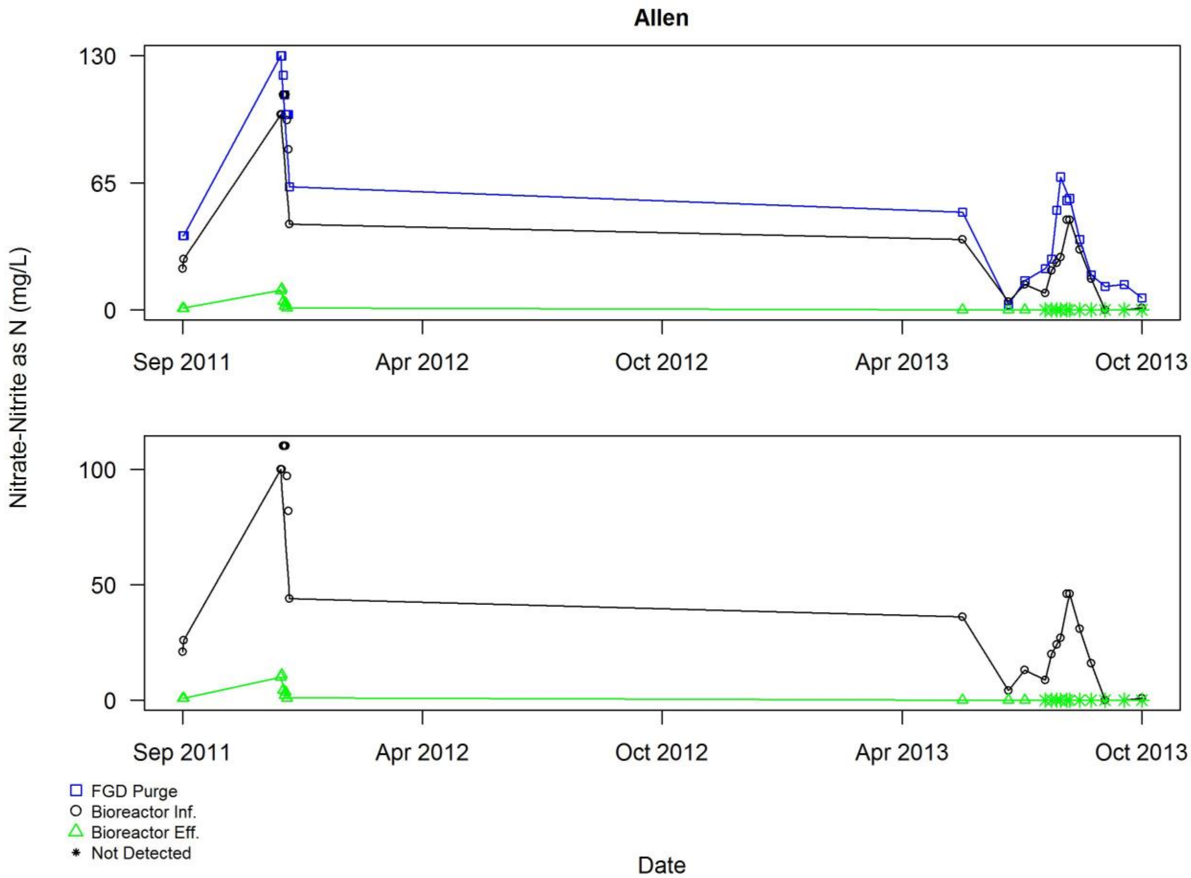


Figure A3.1.11 Plot of self-monitoring data for Nitrate-Nitrite as N (mg/L) for Allen after exclusions other than commissioning period described in Section 3.2

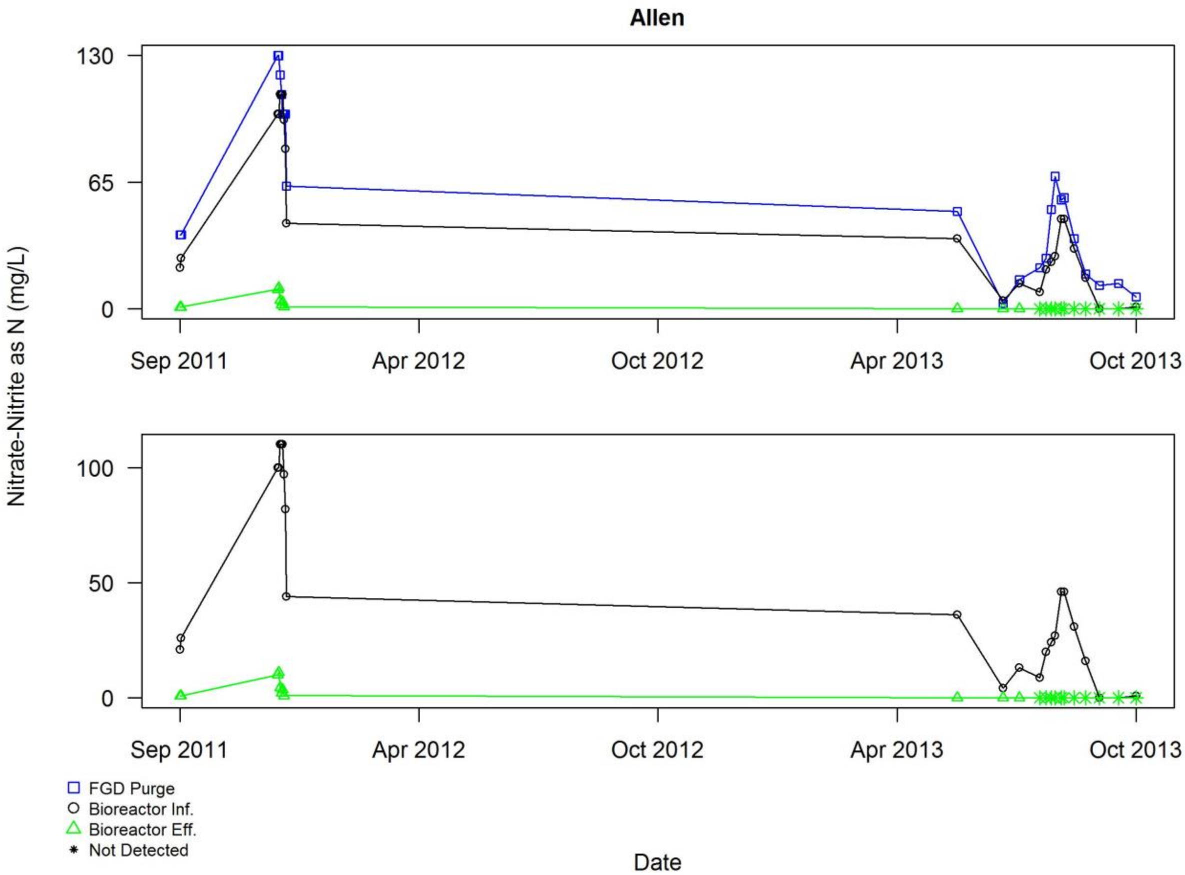


Figure A3.1.12 Plot of self-monitoring data for Nitrate-Nitrite as N (mg/L) for Allen after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS

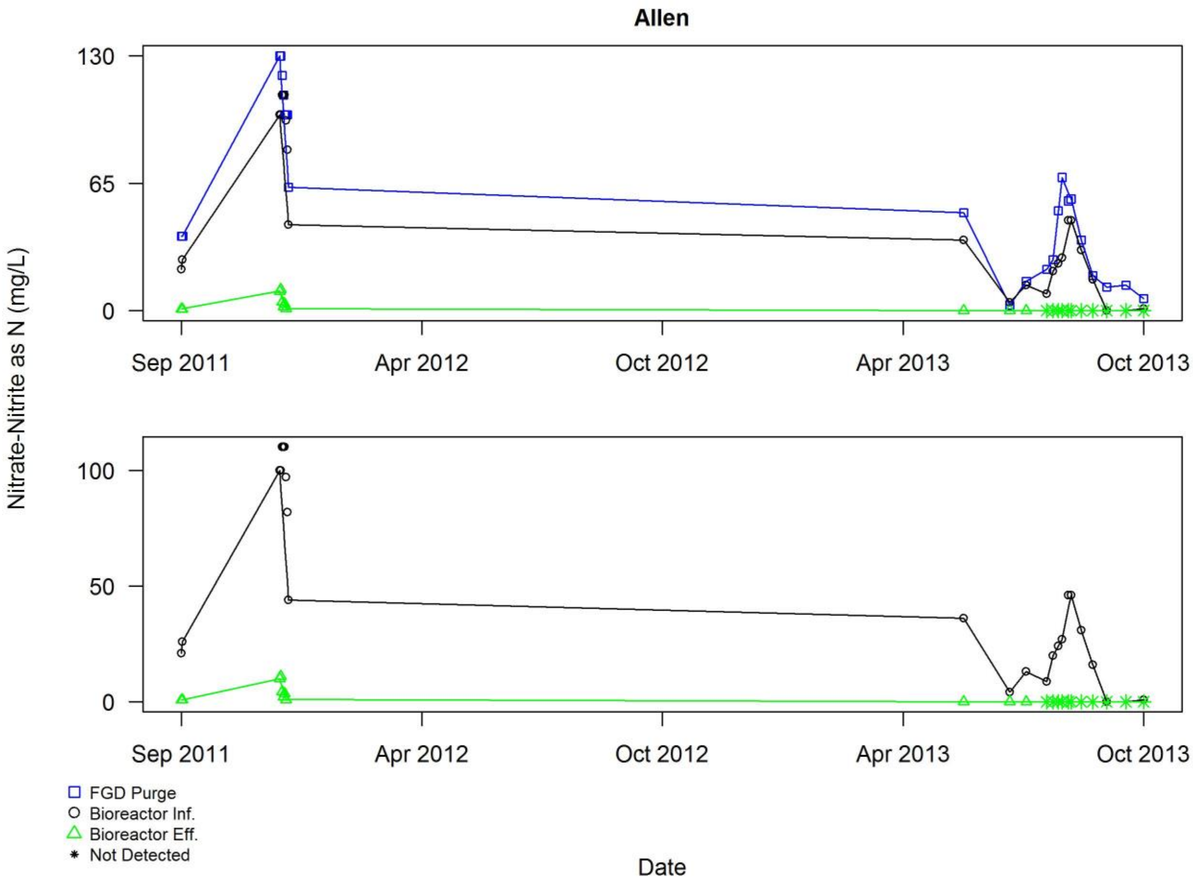


Figure A3.1.13 Plot of all self-monitoring data for selenium (µg/L) for Allen. The red vertical line indicates the end of the commissioning period

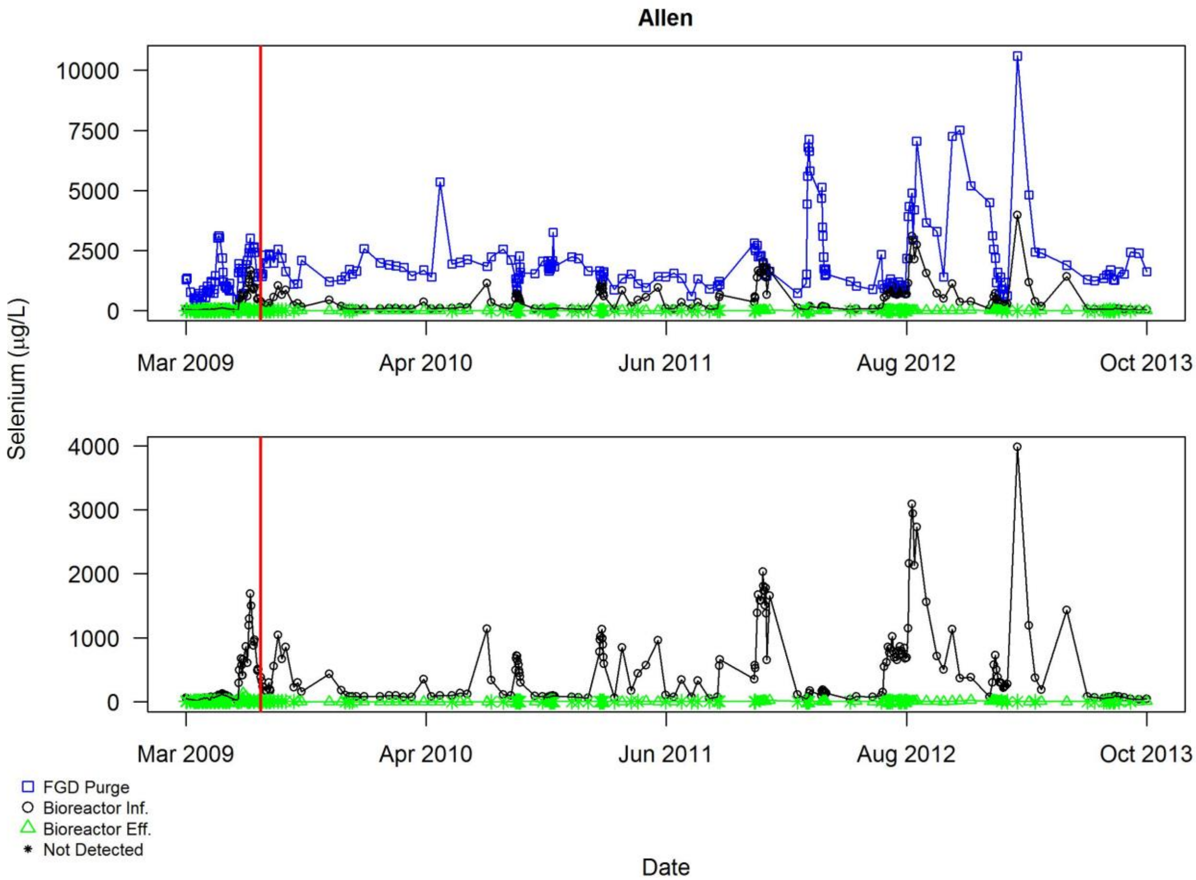


Figure A3.1.14 Plot of all self-monitoring data for selenium (µg/L) for Allen superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

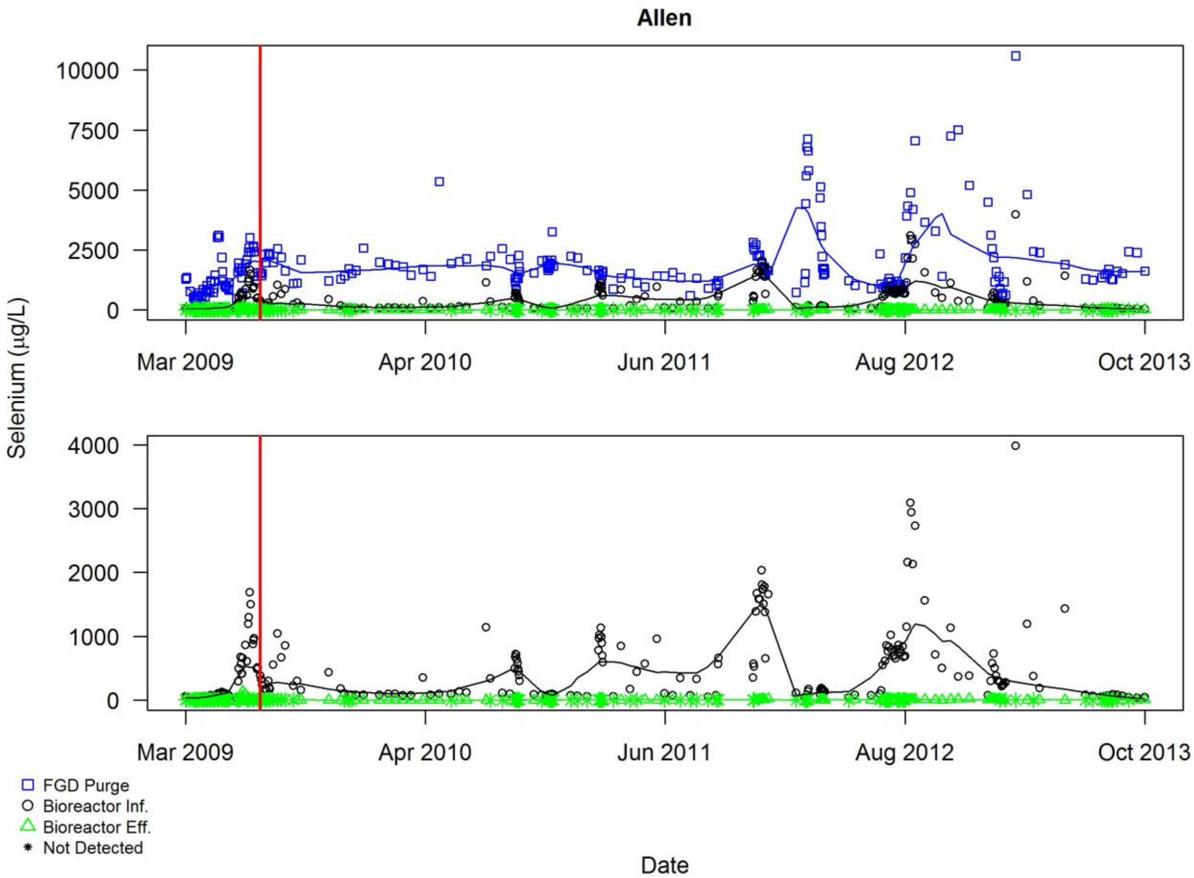


Figure A3.1.15 Plot of self-monitoring data for selenium (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

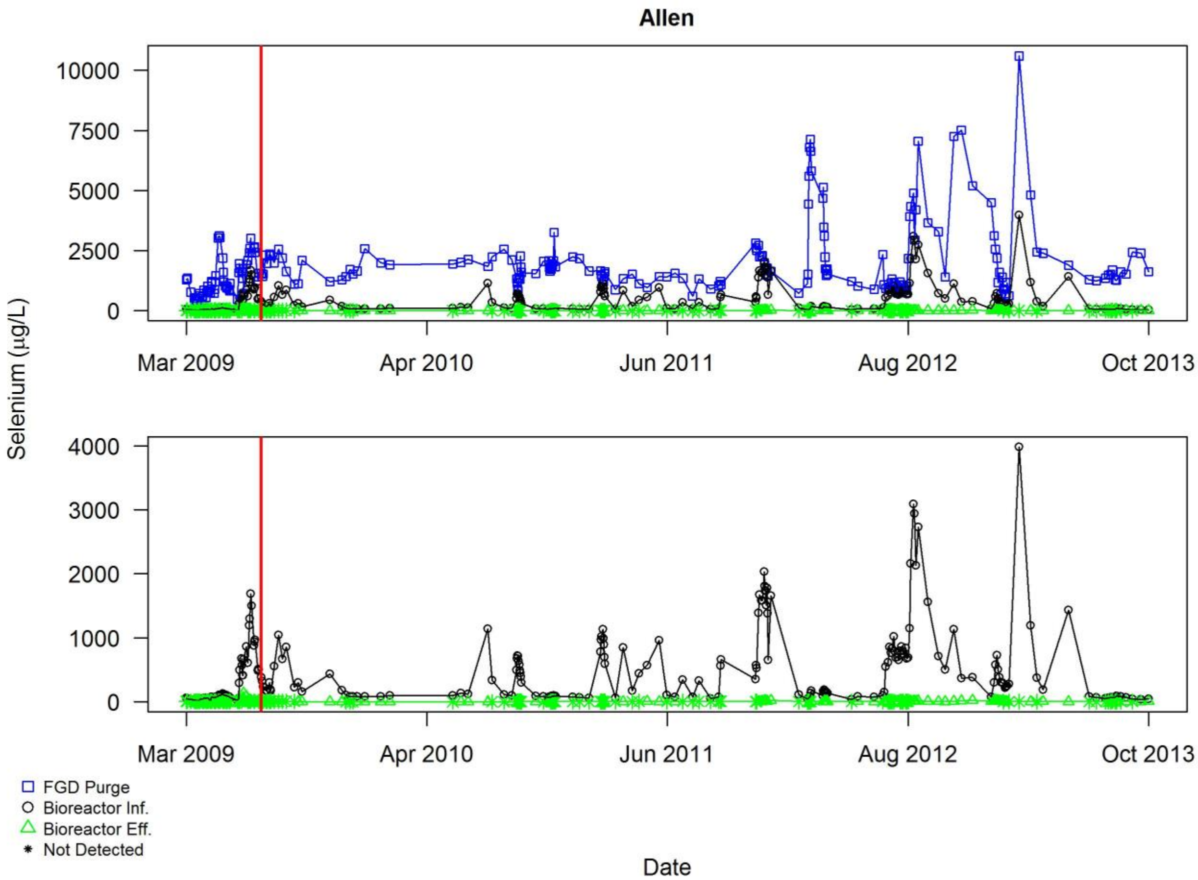


Figure A3.1.16 Plot of self-monitoring data for selenium (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

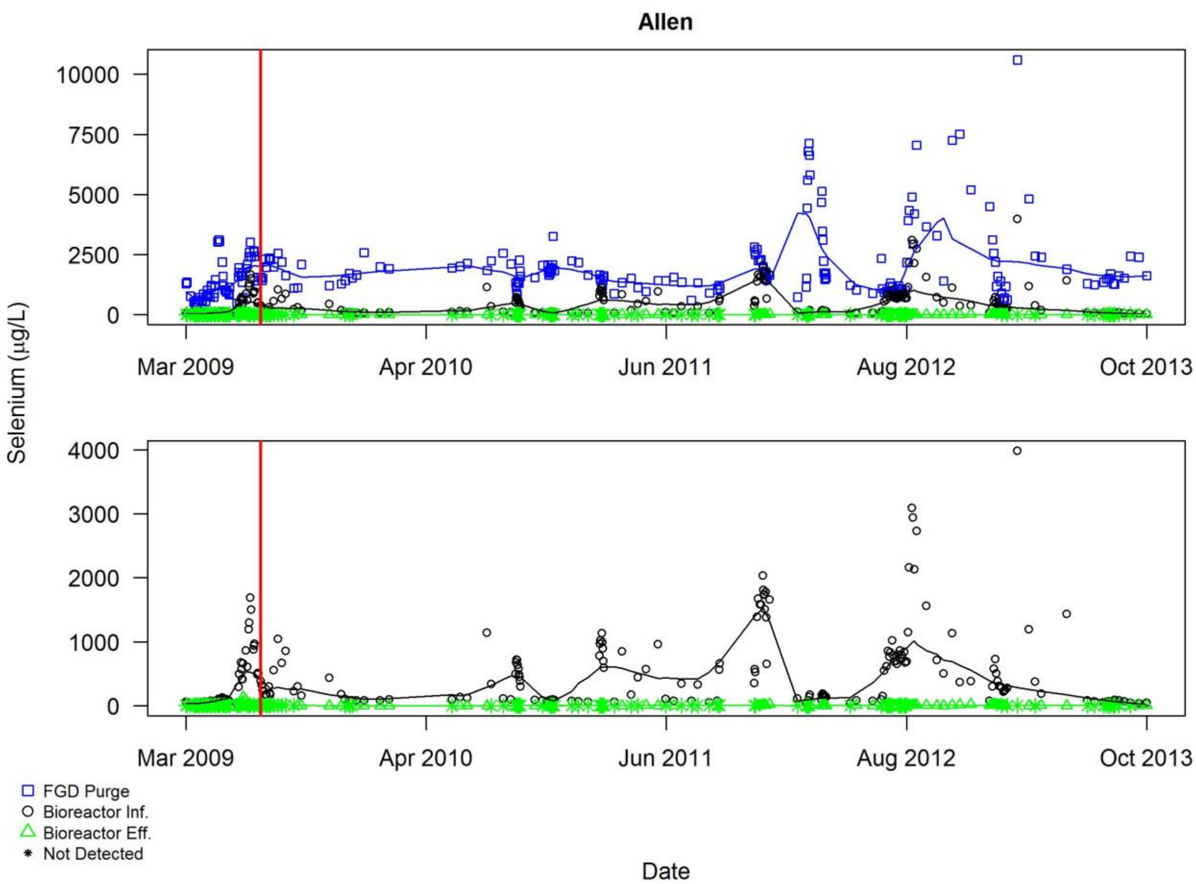


Figure A3.1.17 Plot of all self-monitoring data for selenium (µg/L) for Allen, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

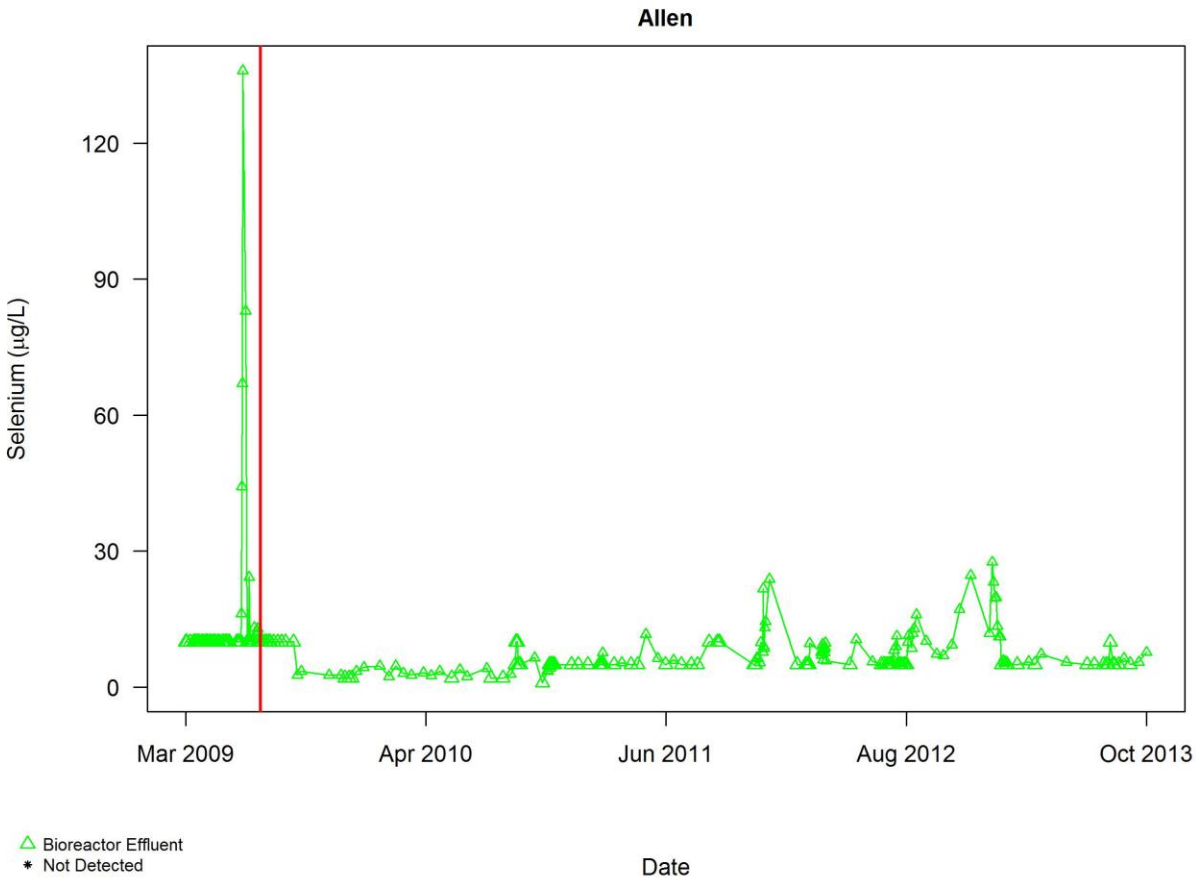


Figure A3.1.18 **Plot of all self-monitoring data for selenium (µg/L) for Allen superimposed with smooth curves using LOWESS, bioreactor effluent only. The red vertical line indicates the end of the commissioning period**

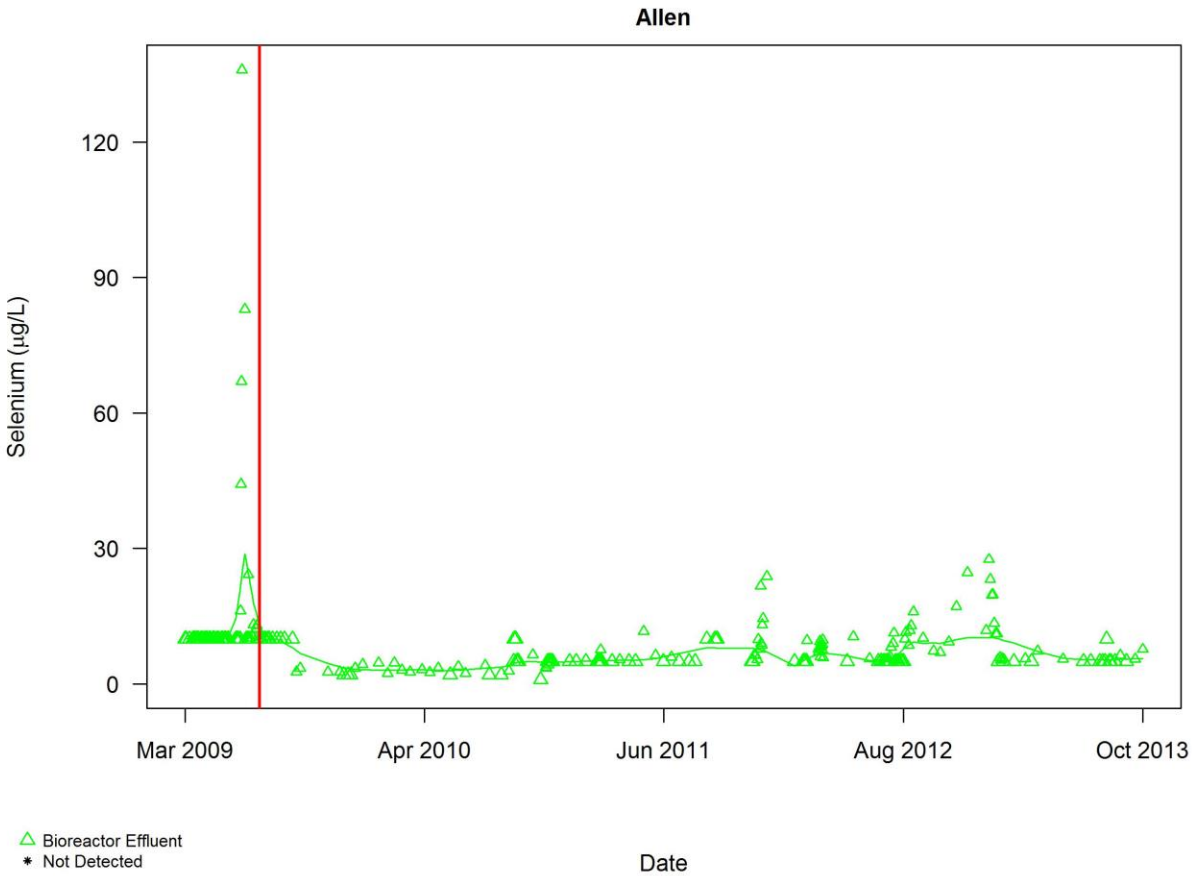


Figure A3.1.19 Plot of self-monitoring data for selenium (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

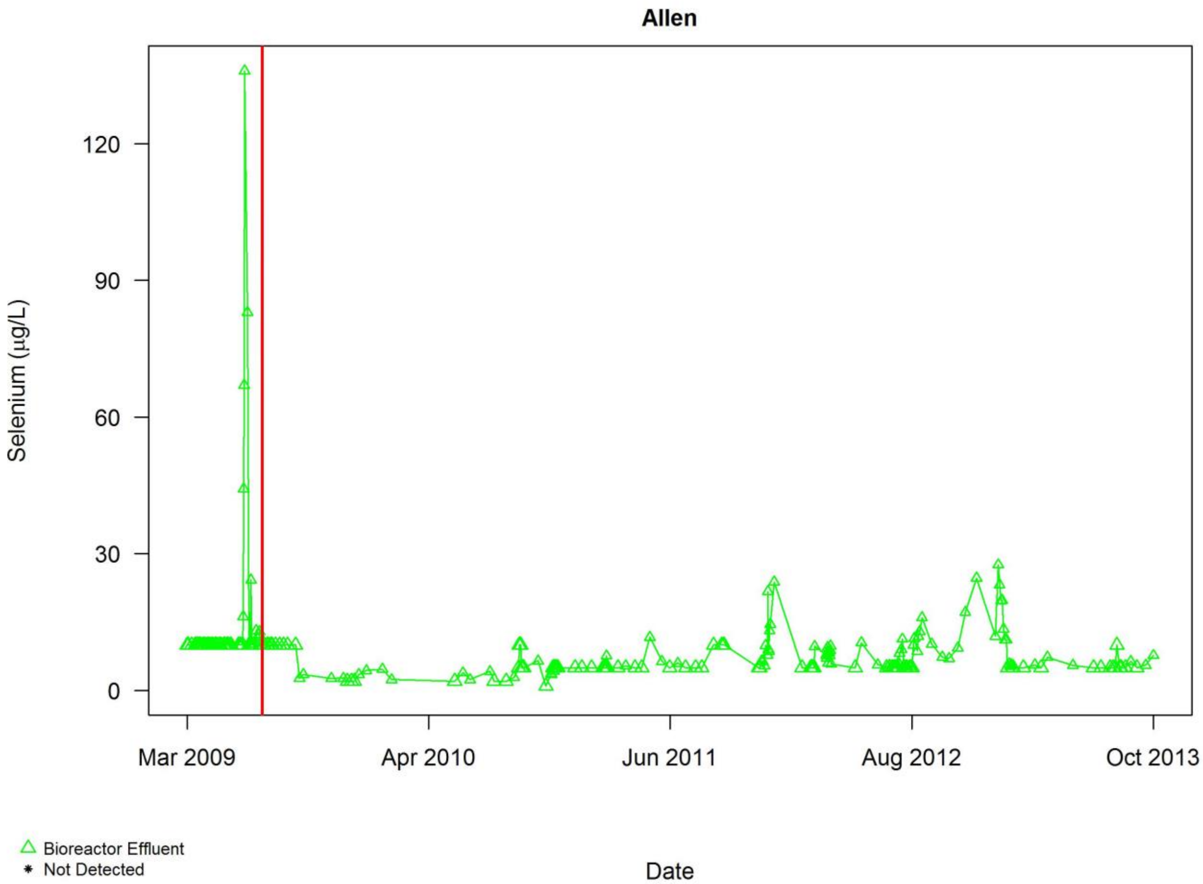


Figure A3.1.20 Plot of self-monitoring data for selenium (µg/L) for Allen after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS,, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

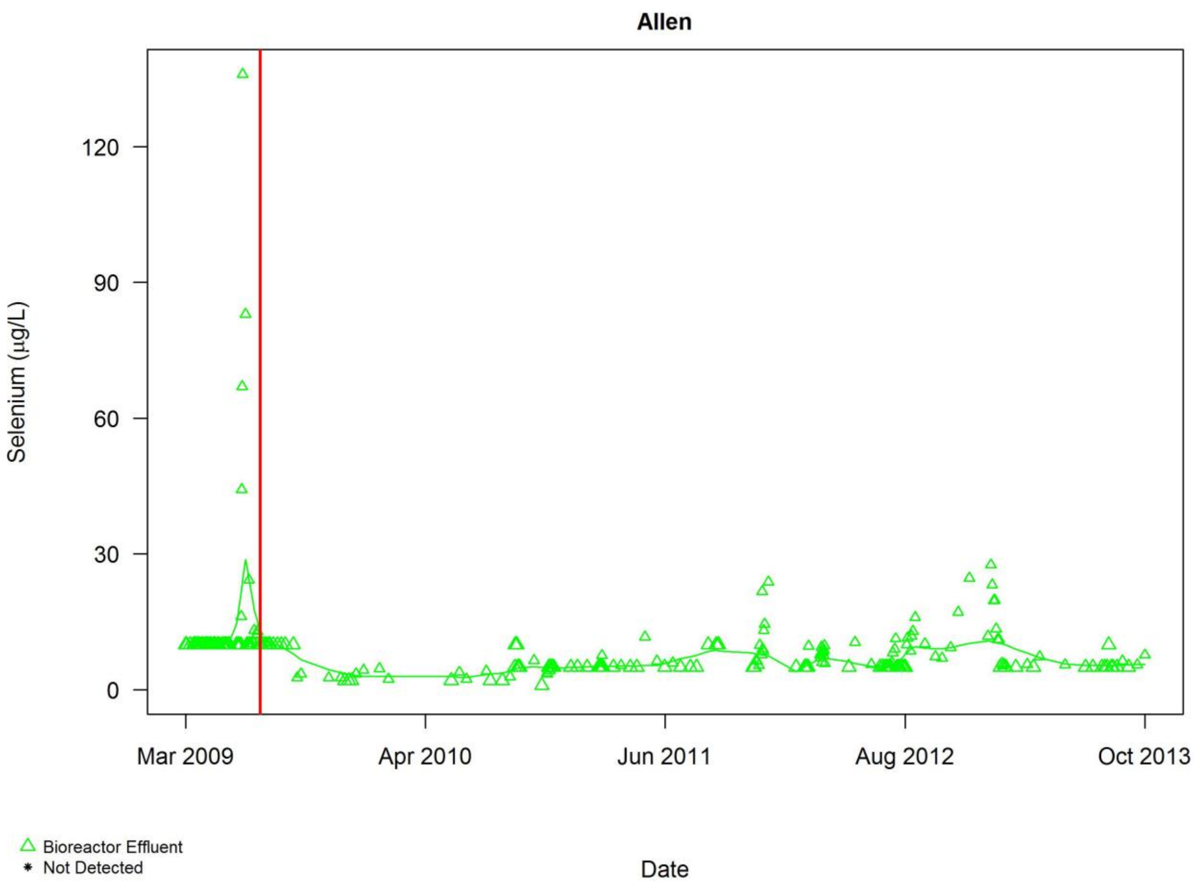


Figure A3.2.1 Plot of all self-monitoring data for arsenic (µg/L) for Belews Creek. The red vertical line indicates the end of the commissioning period

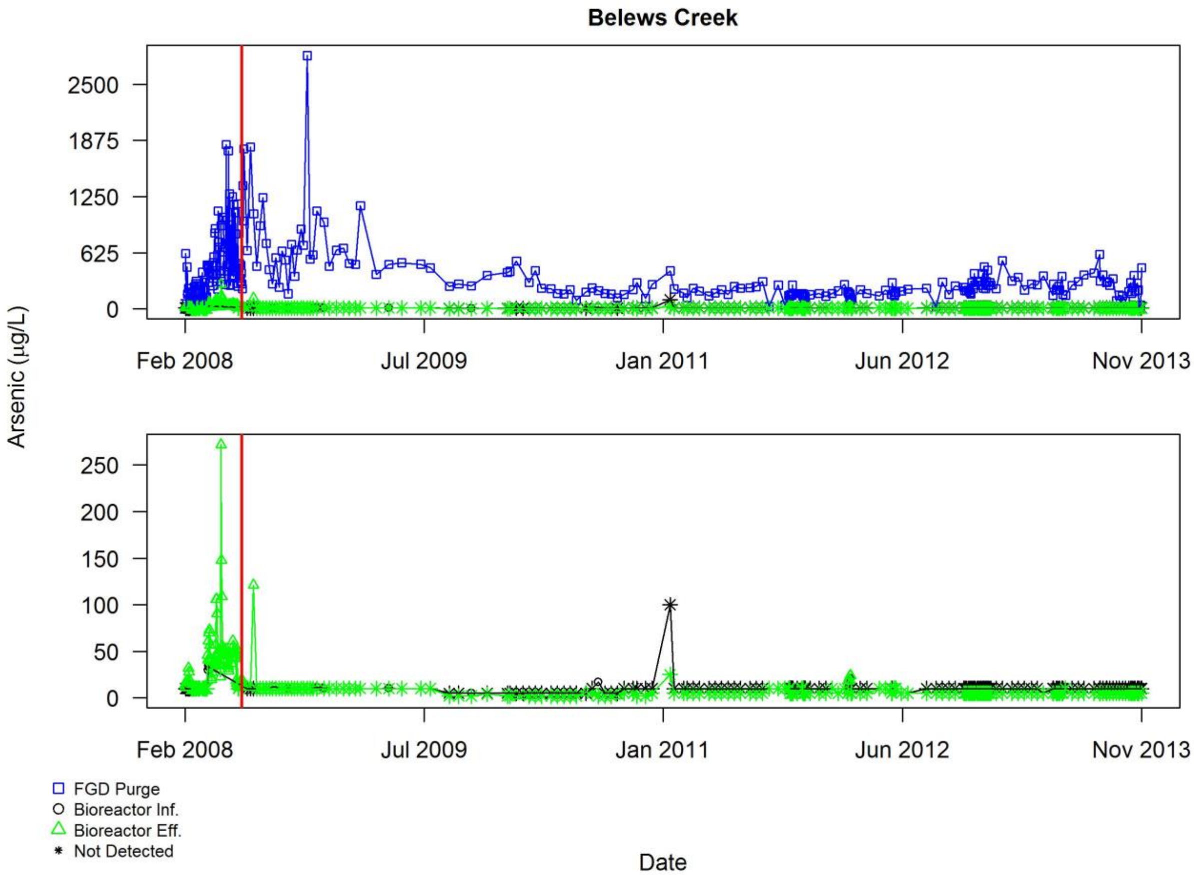


Figure A3.2.2 Plot of all self-monitoring data for arsenic (µg/L) for Belews Creek superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

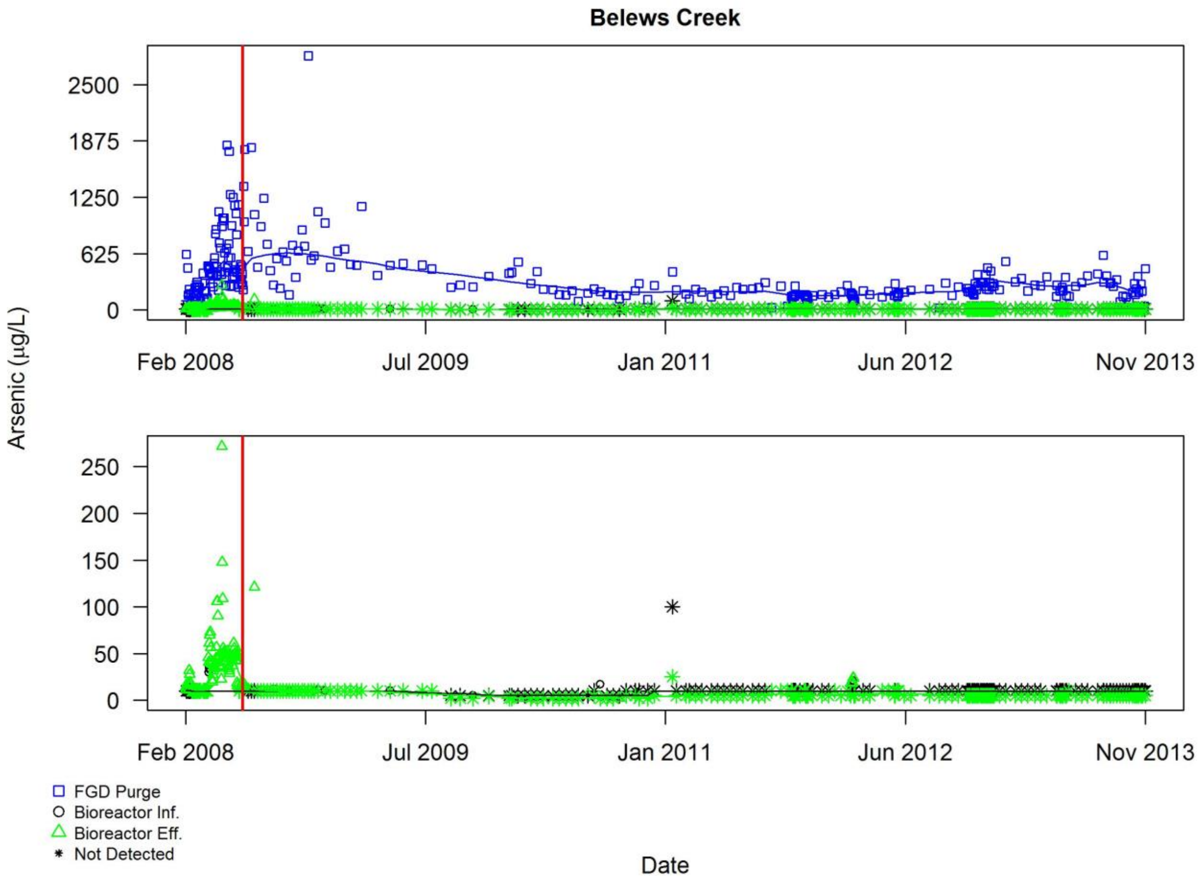


Figure A3.2.3 Plot of self-monitoring data for arsenic (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

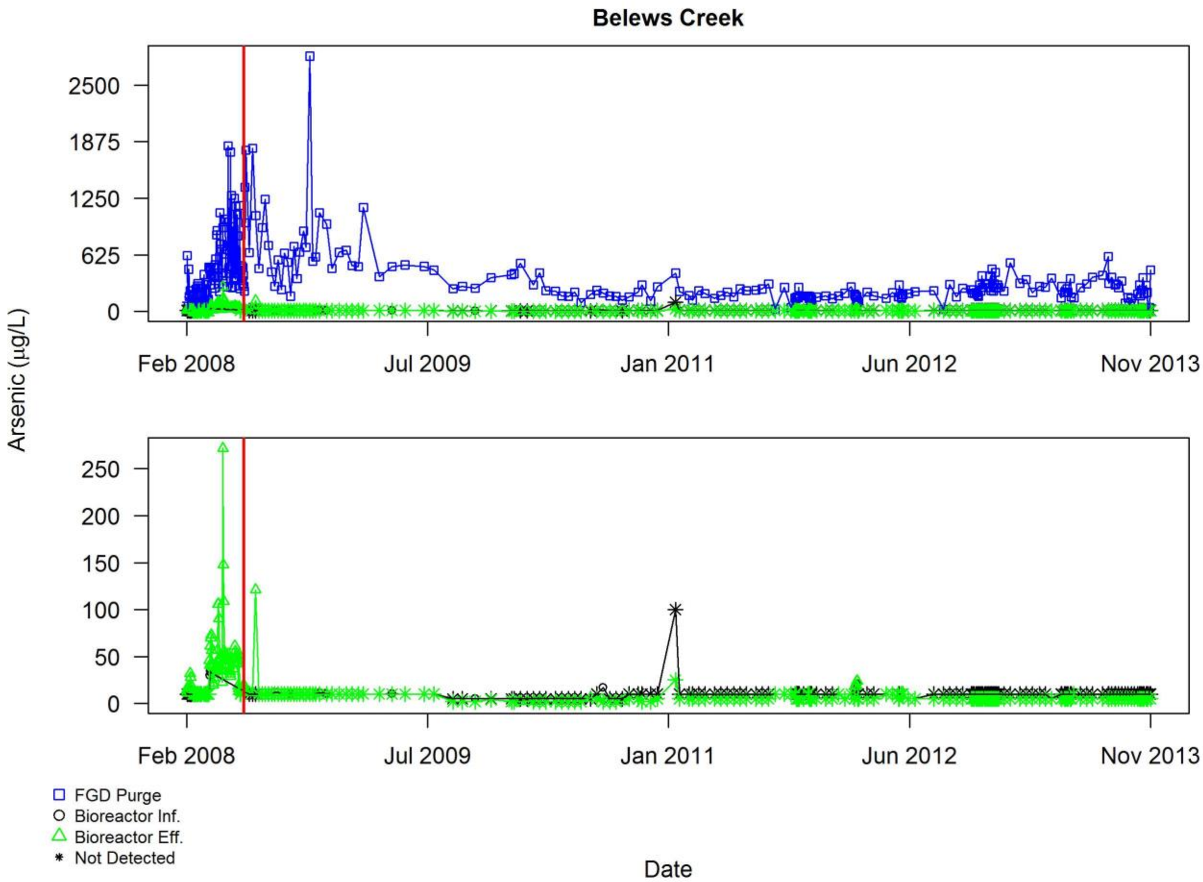


Figure A3.2.4 Plot of self-monitoring data for arsenic (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

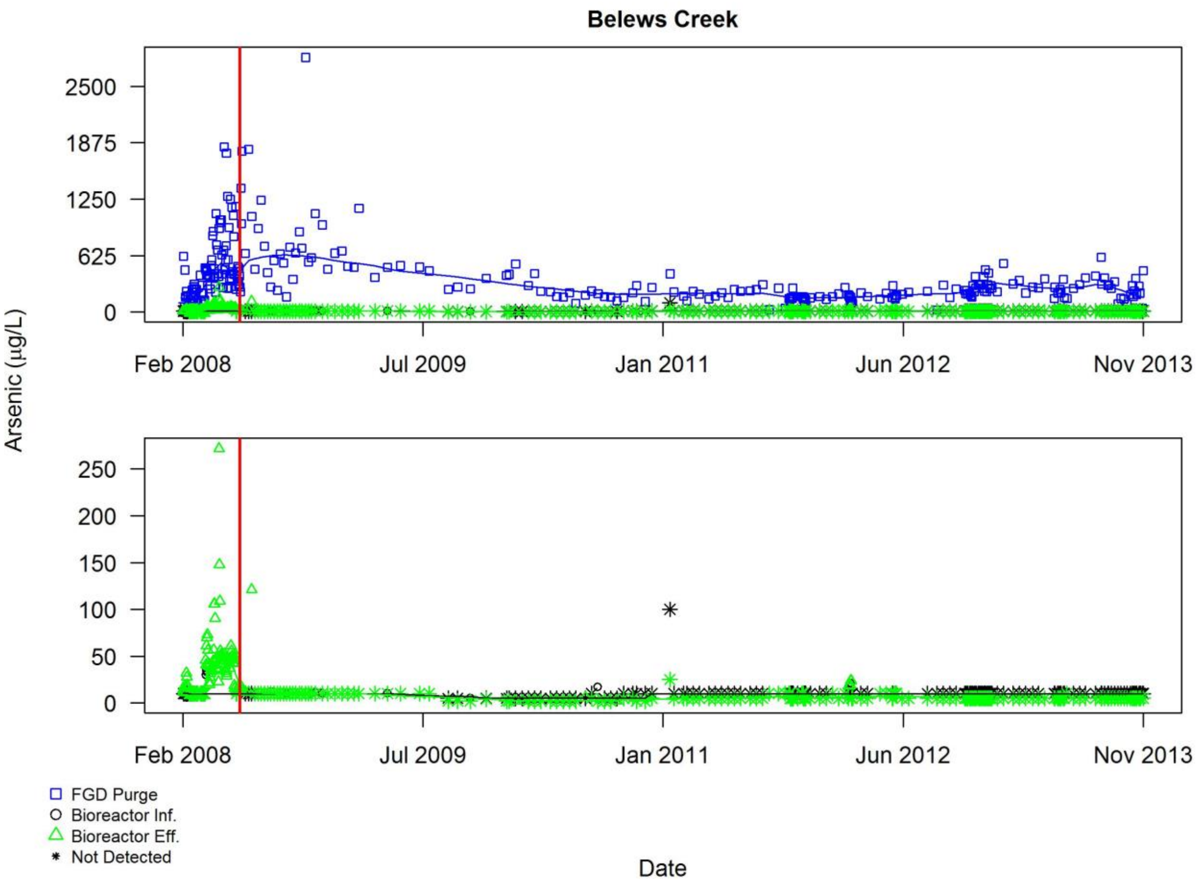


Figure A3.2.5 Plot of all self-monitoring data for mercury (ng/L) for Belews Creek. The red vertical line indicates the end of the commissioning period

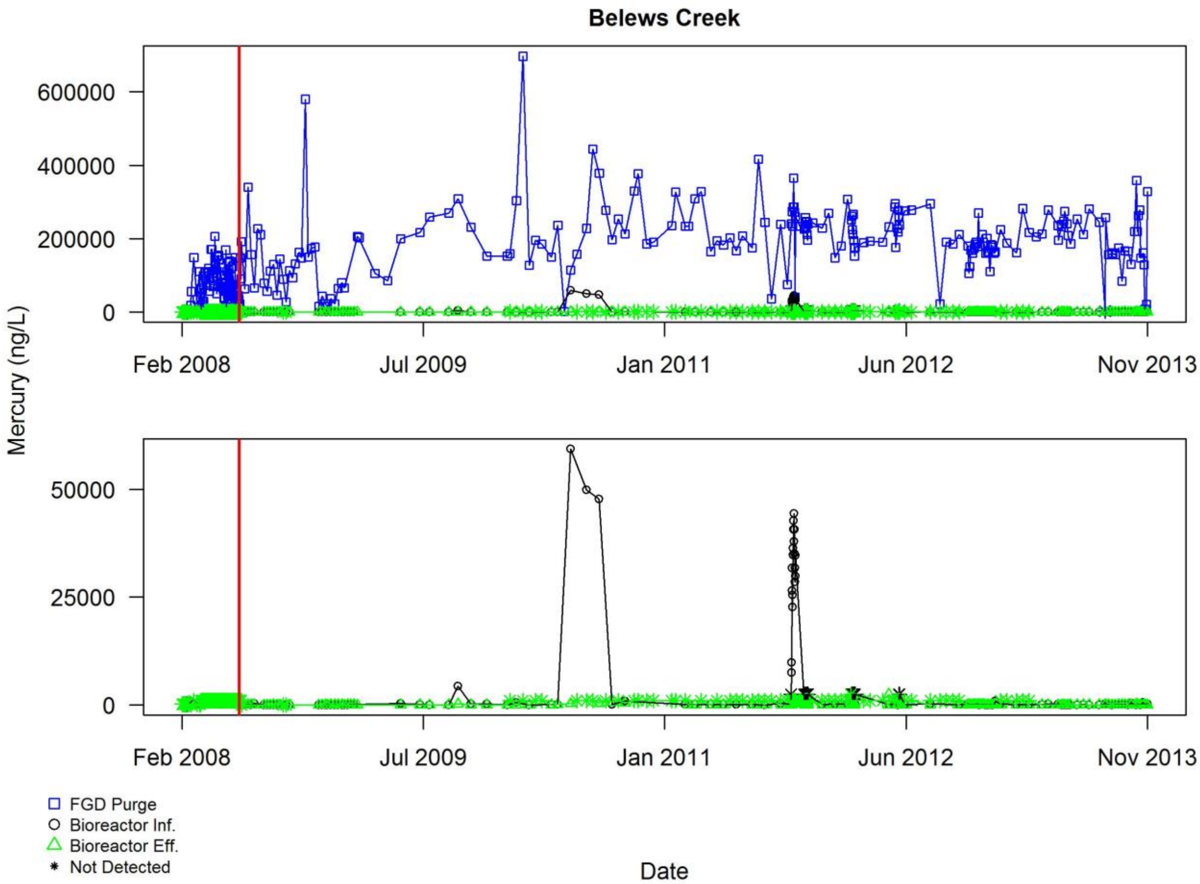


Figure A3.2.6 Plot of all self-monitoring data for mercury (ng/L) for Belews Creek superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

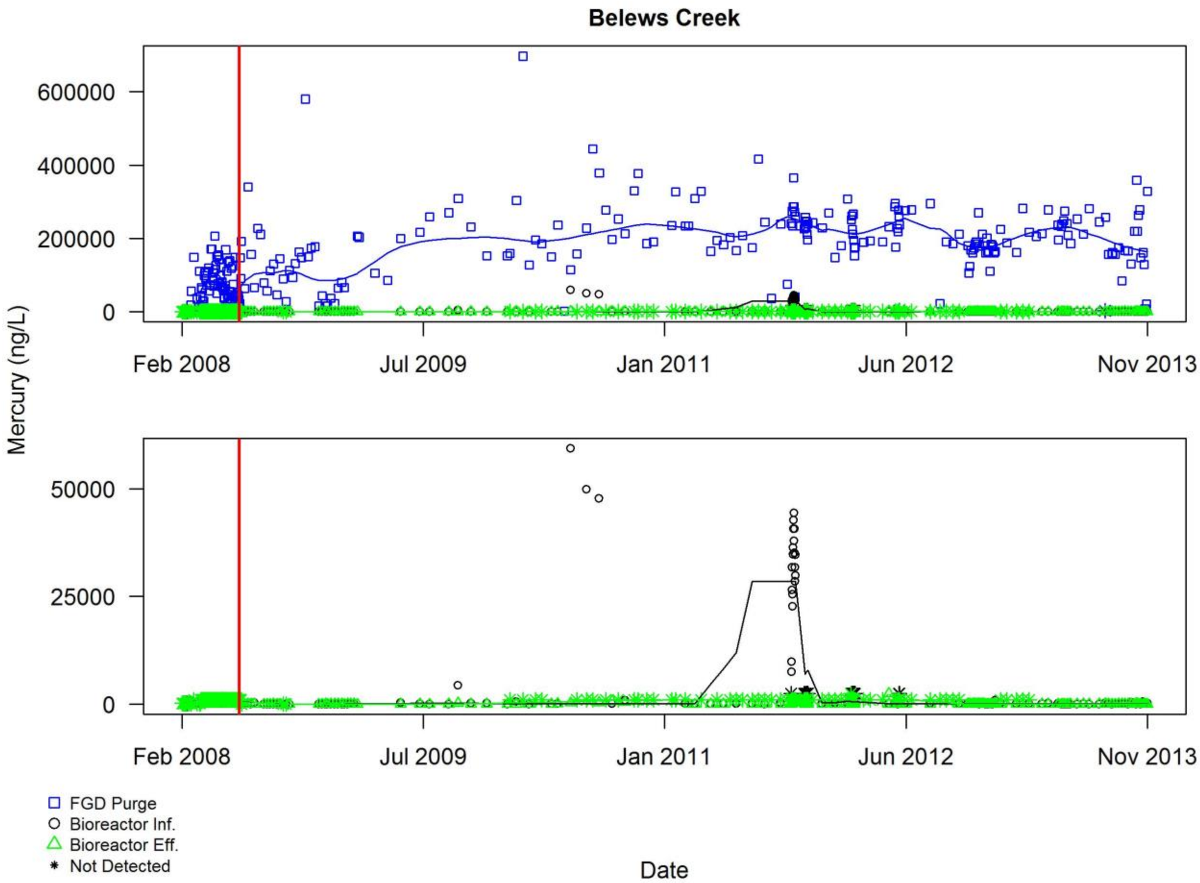


Figure A3.2.7 Plot of self-monitoring data for mercury (ng/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

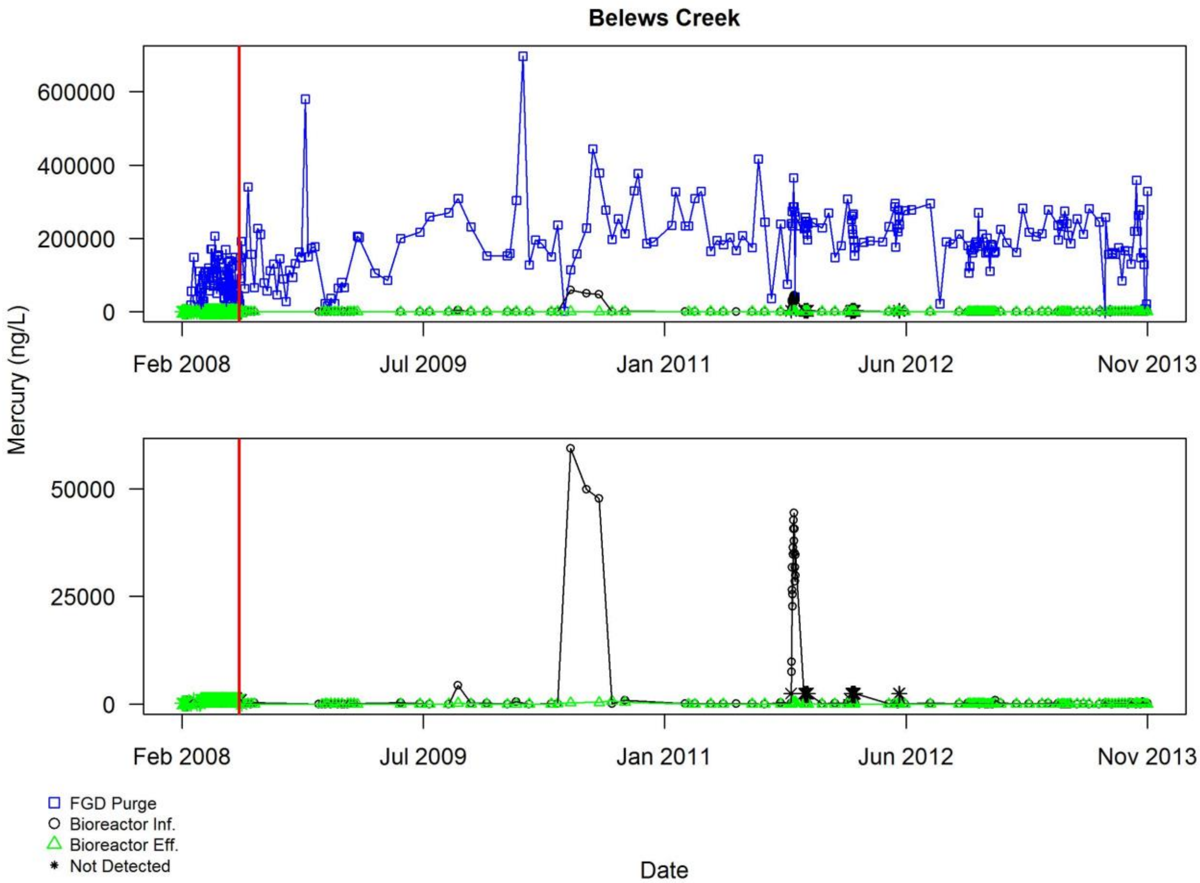


Figure A3.2.8 Plot of self-monitoring data for mercury (ng/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

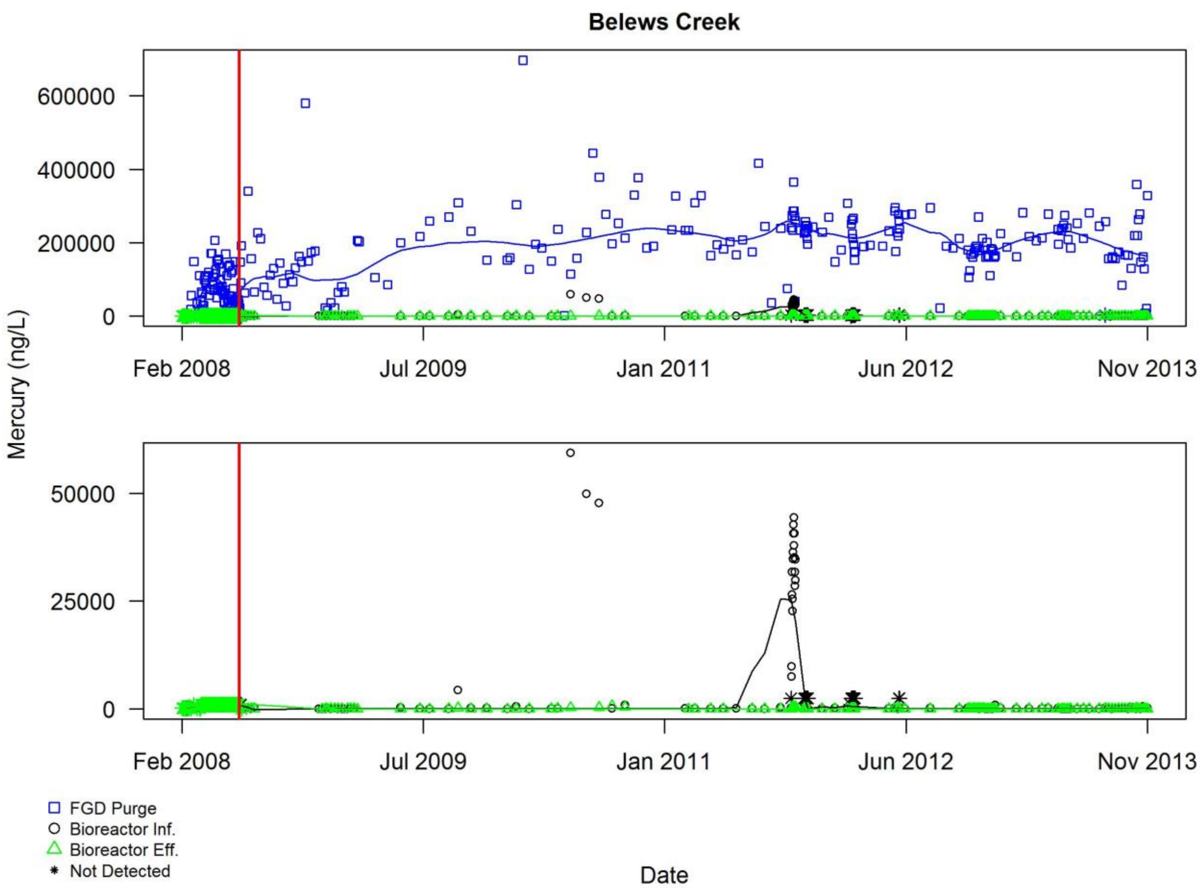


Figure A3.2.9 Plot of all self-monitoring data for Nitrate-Nitrite as N (mg/L) for Belews Creek

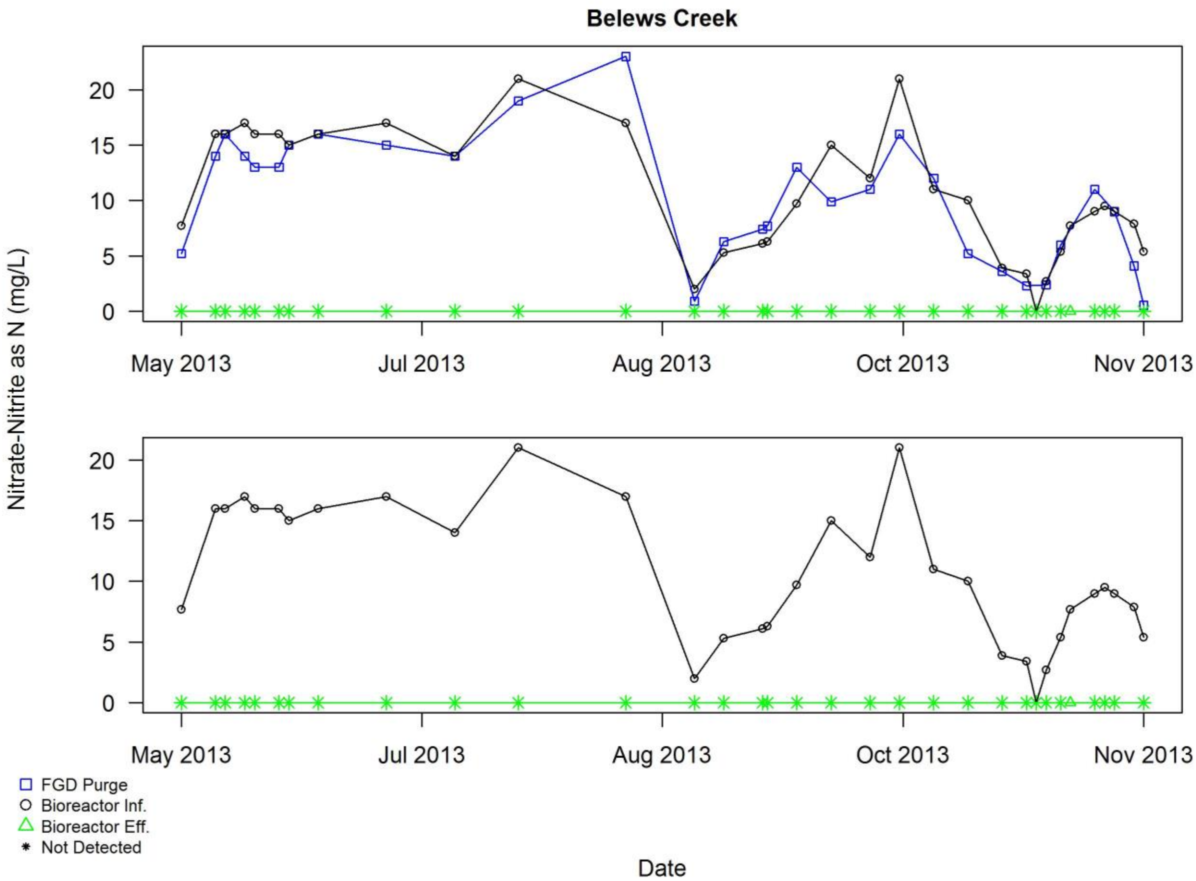


Figure A3.2.10 Plot of all self-monitoring data for Nitrate-Nitrite as N (mg/L) for Belews Creek superimposed with smooth curves using LOWESS

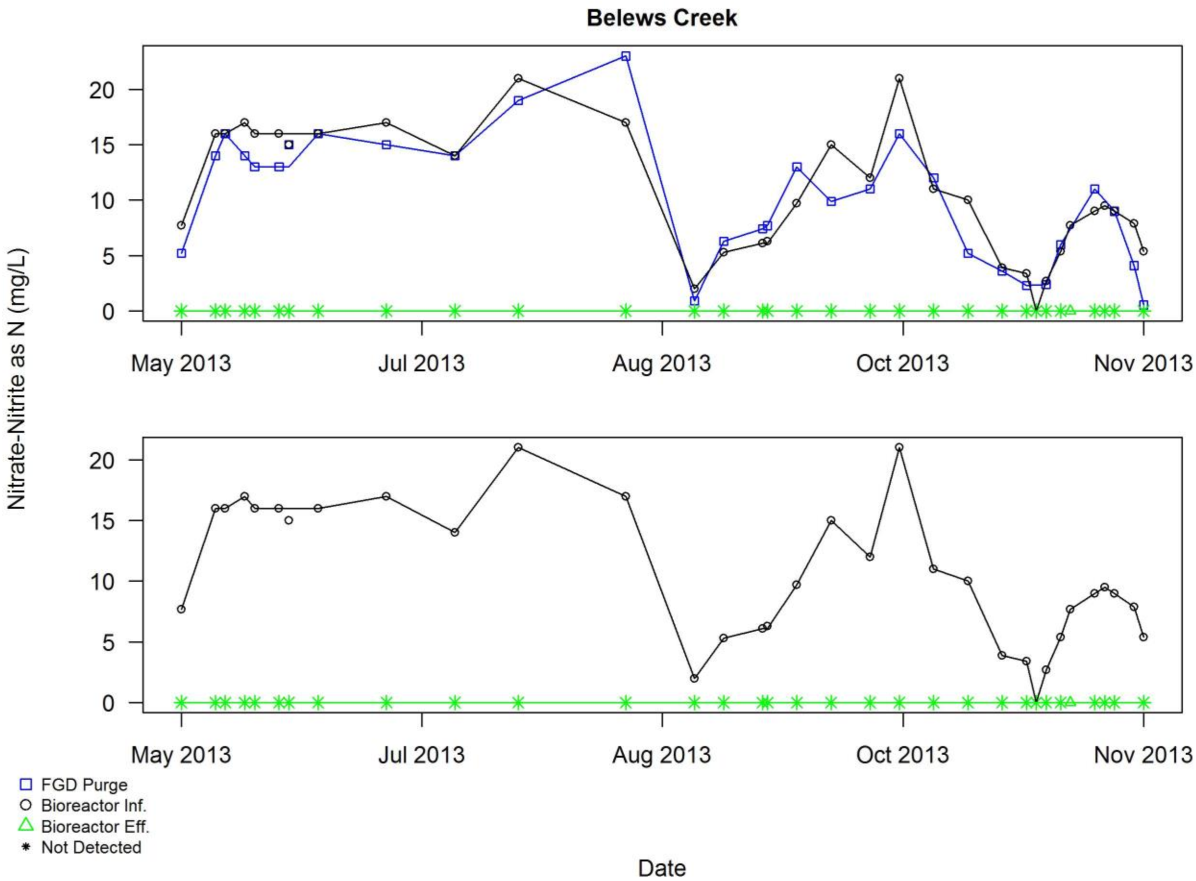


Figure A3.2.11 Plot of self-monitoring data for Nitrate-Nitrite as N (mg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2

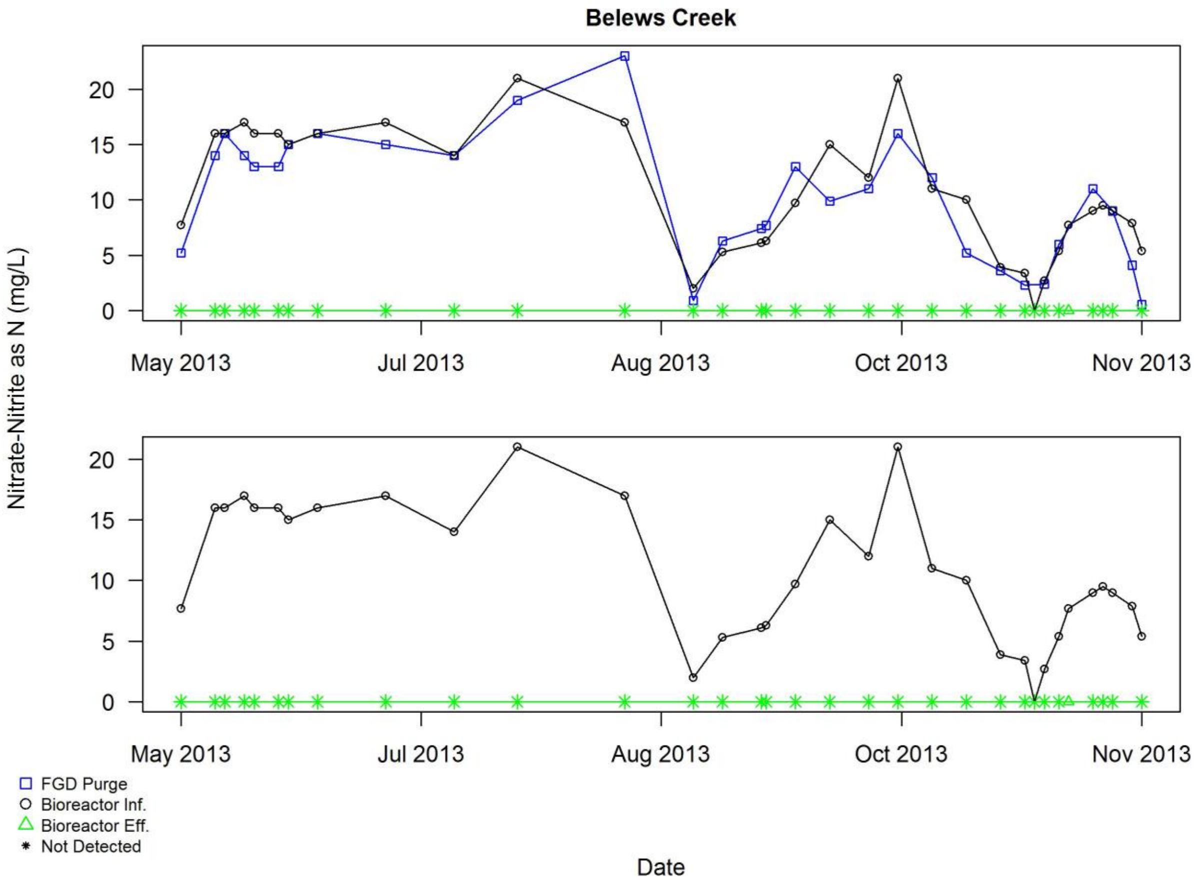


Figure A3.2.12 Plot of self-monitoring data for Nitrate-Nitrite as N (mg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS

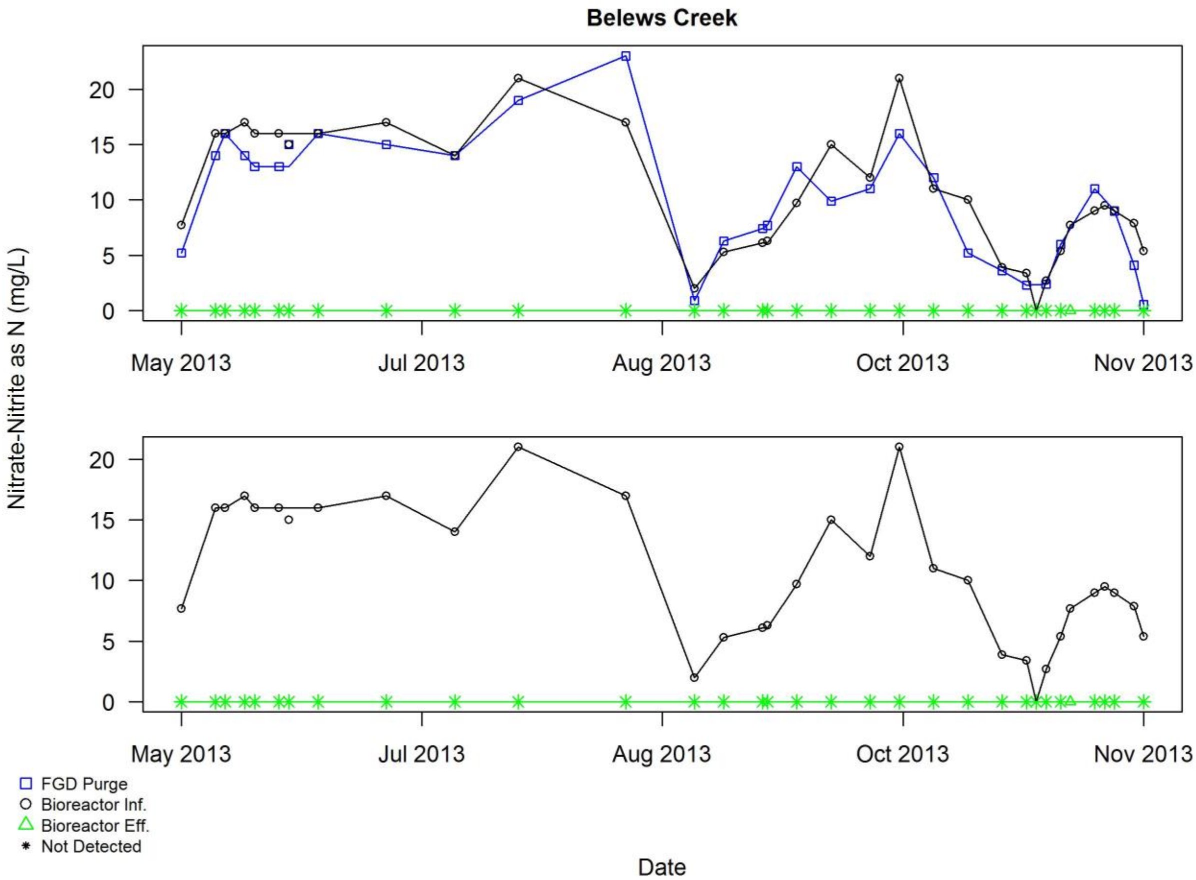


Figure A3.2.13 Plot of all self-monitoring data for selenium (µg/L) for Belews Creek. The red vertical line indicates the end of the commissioning period

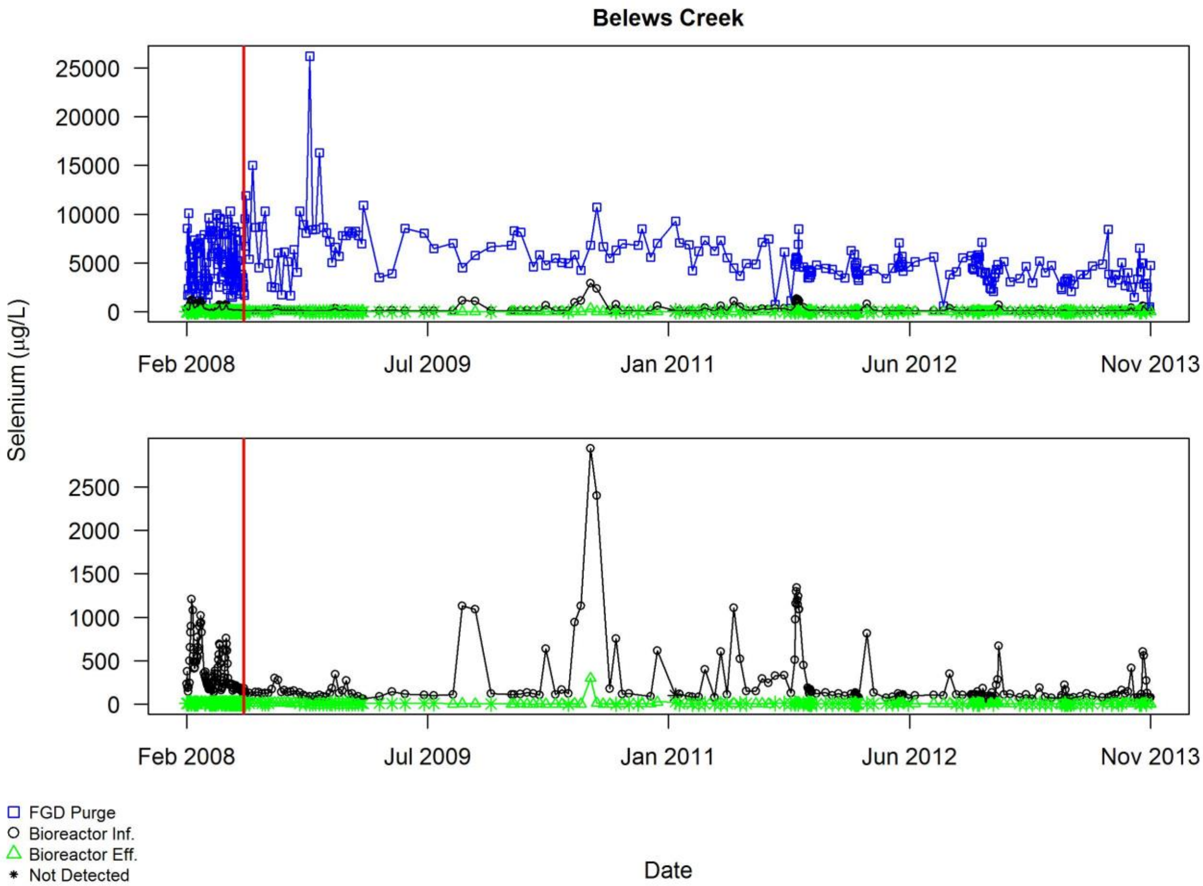


Figure A3.2.14 Plot of all self-monitoring data for selenium (µg/L) for Belews Creek superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period.

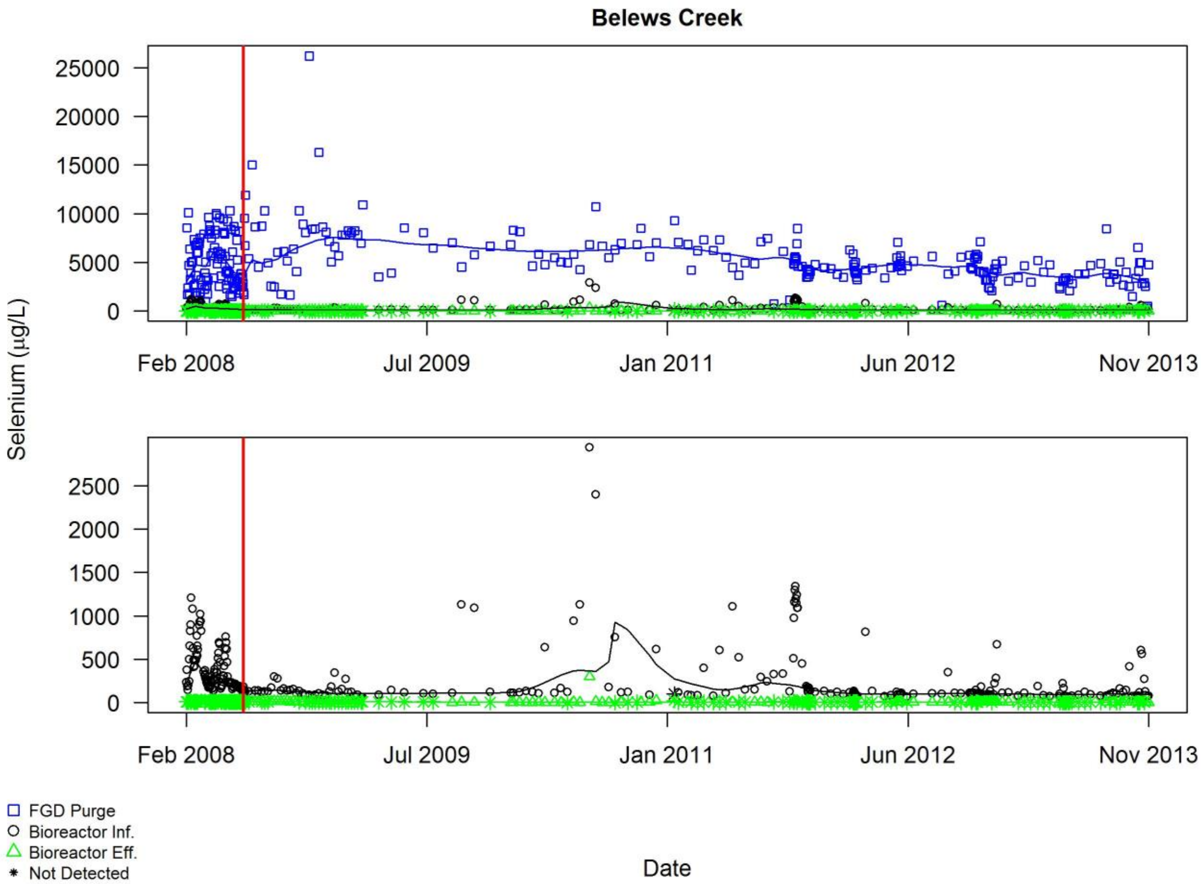


Figure A3.2.15 Plot of self-monitoring data for selenium (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2. The red vertical line indicates the end of the commissioning period

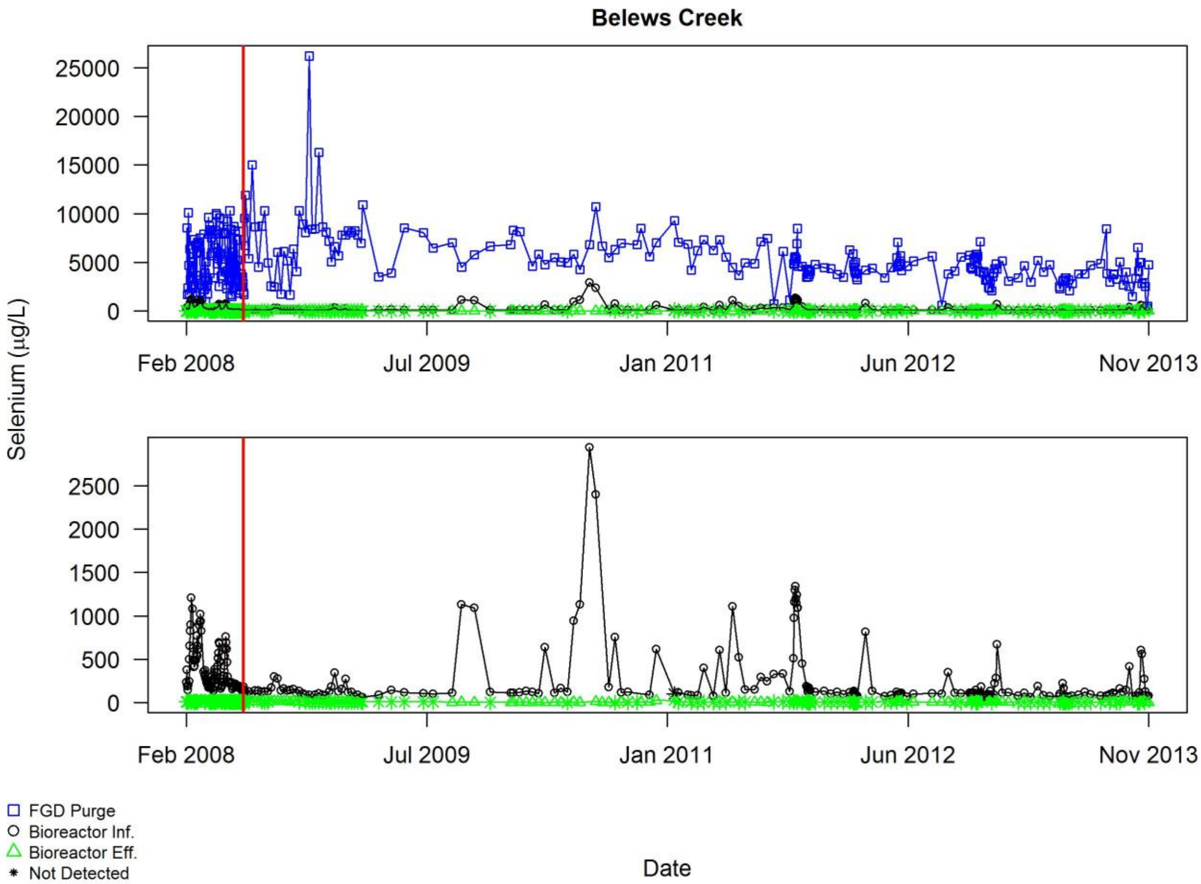


Figure A3.2.16 Plot of self-monitoring data for selenium (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS. The red vertical line indicates the end of the commissioning period

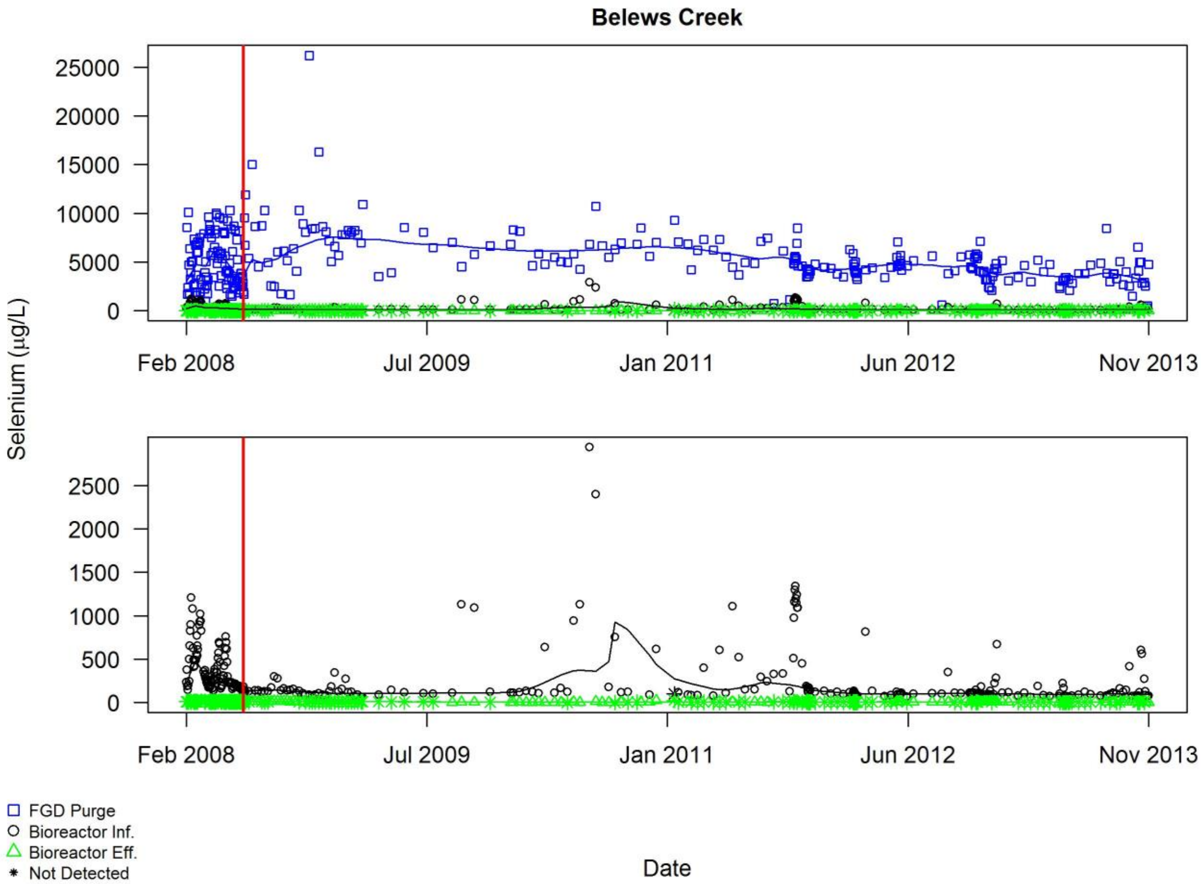


Figure A3.2.17 Plot of all self-monitoring data for selenium (µg/L) for Belews Creek, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

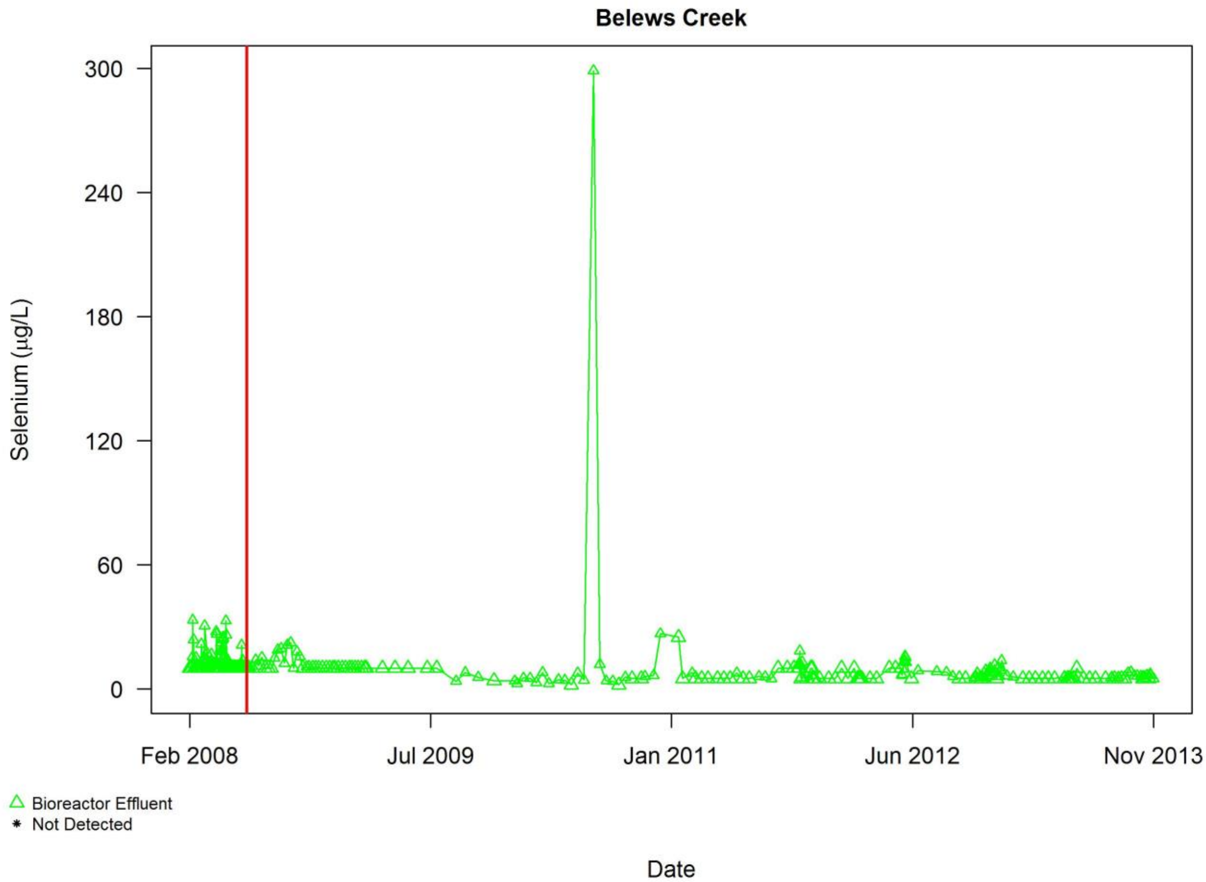


Figure A3.2.18 Plot of all self-monitoring data for selenium (µg/L) for Belews Creek superimposed with smooth curves using LOWESS, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

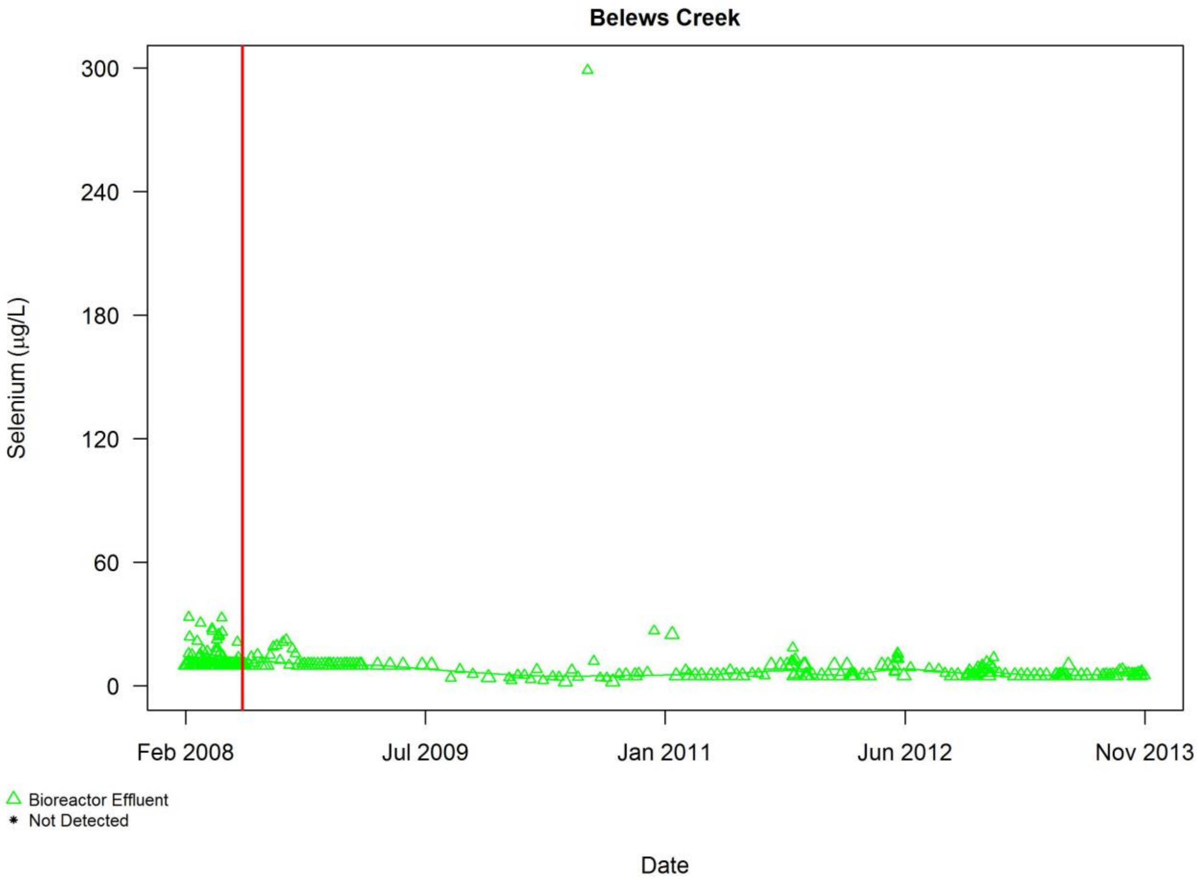


Figure A3.2.19 Plot of self-monitoring data for selenium (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2, bioreactor effluent only. The red vertical line indicates the end of the commissioning period

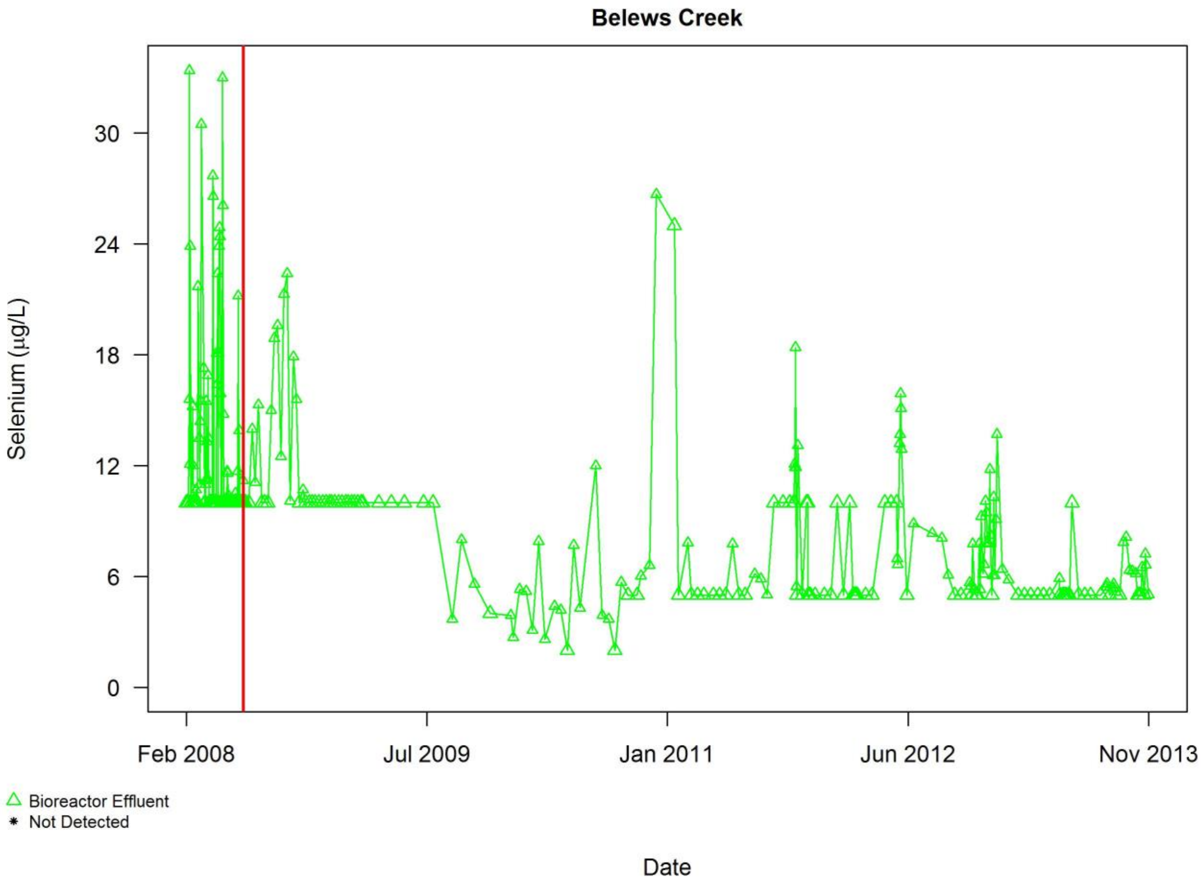
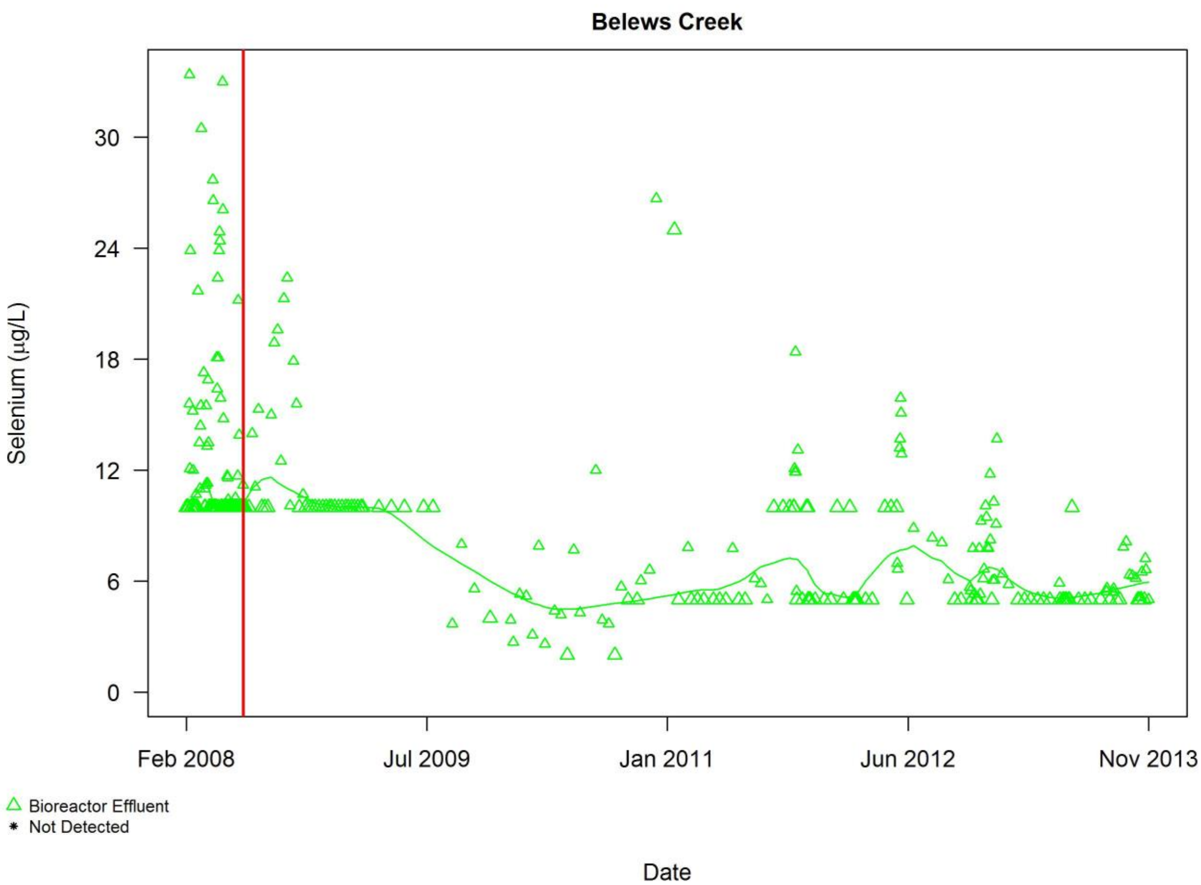


Figure A3.2.20 Plot of self-monitoring data for selenium (µg/L) for Belews Creek after exclusions other than commissioning period described in Section 3.2 and superimposed with smooth curves using LOWESS, bioreactor effluent only. The red vertical line indicates the end of the commissioning period



References:

Cleveland, W. S. (1979) Robust locally weighted regression and smoothing scatterplots. *J. Amer. Statist. Assoc.* 74, 829–836.

Cleveland, W. S. (1981) LOWESS: A program for smoothing scatterplots by robust locally weighted regression. *The American Statistician*, 35, 54.

Appendix 4. Plots of Available Data for Each Plant for Calculating Limits Prior to Any Exclusions

Table of Contents

Table of Contents (continued)

Figures **Page**

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

This Appendix contains plots of all available data for each plant used in calculating the limits for FGD wastewater based on the chemical precipitation or biological treatment technology options, prior to any exclusion (described in Section 3.2). Specifically, plots of the available data are shown for the following plants: Allen, Belews Creek, Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie. Plots of all available data for Brindisi, Polk, and Wabash River are presented in Sections 8 and 9 of this document. For each plant, the data are plotted on two different scales, linear and logarithmic. The purpose of the logarithmic is to stretch the scale so that the data are easier to visualize.

- For Hatfield's Ferry, the purple vertical line indicates the point when the plant changed analytical laboratories, and the red vertical line indicates the start of the decommissioning period for the plant.

- For Hatfield's Ferry, arsenic or mercury in some chemical precipitation effluent samples was measured at zero. They are plotted at half the lowest non-zero value in the log scale plot to illustrate that they are at low level but not to the point that the remainder of the plot is distorted.

- For Pleasant Prairie, the secondary clarifier data are not included in the plot.

Figure A4.1.1 FGD Purge and Chemical precipitation effluent data of arsenic for Hatfield's Ferry, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The purple vertical line indicates the point when the plant changed analytical laboratories, and the red vertical line indicates the start of decommissioning period

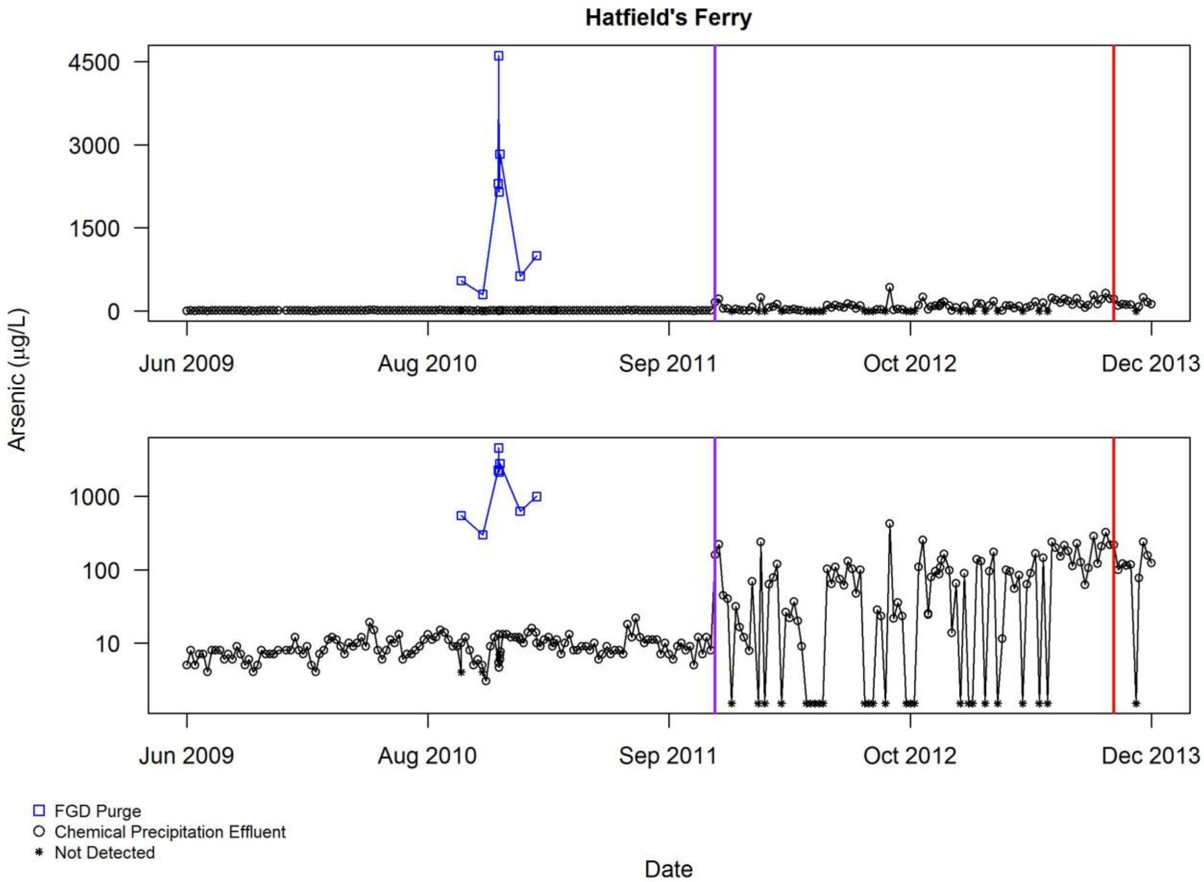


Figure A4.1.2 Chemical precipitation effluent data of arsenic for Hatfield's Ferry, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The purple vertical line indicates the point when the plant changed analytical laboratories, and the red vertical line indicates the start of decommissioning period

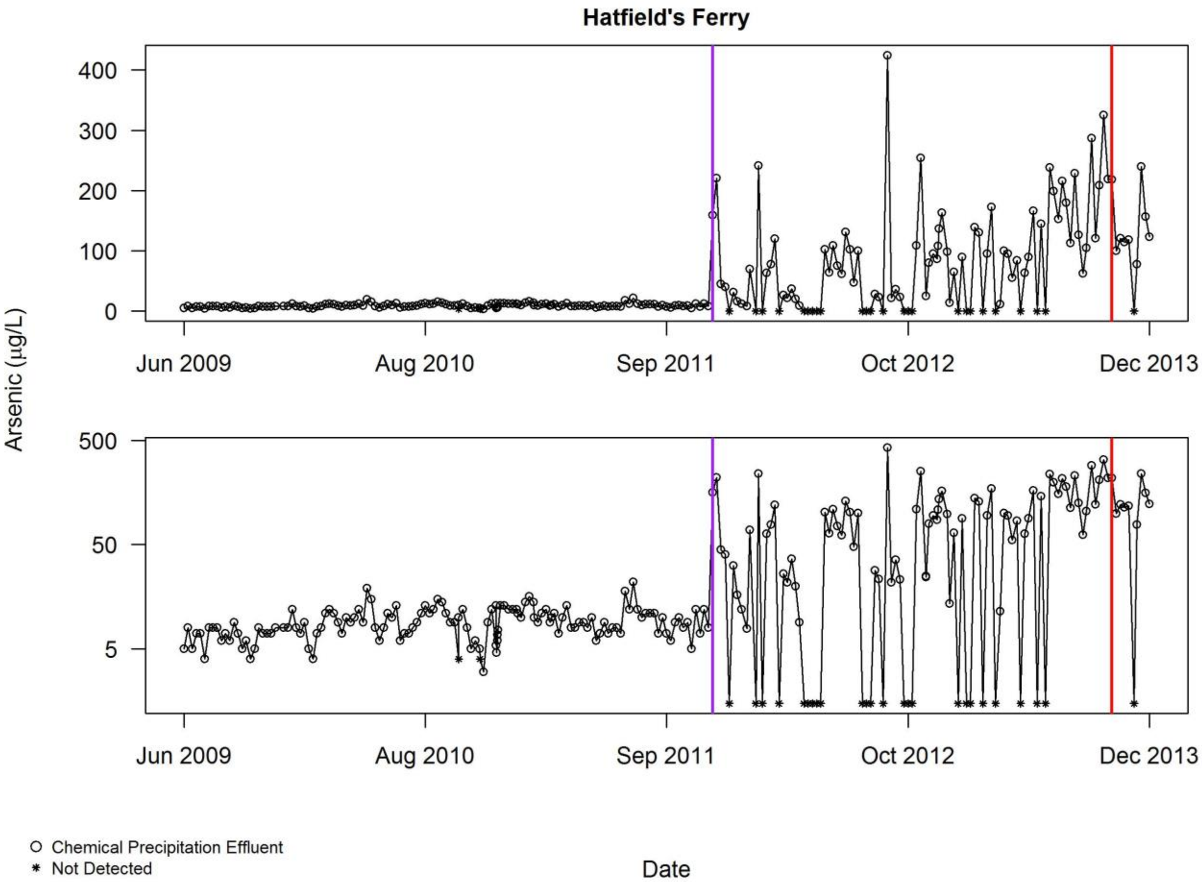


Figure A4.1.3 FGD Purge and Chemical precipitation effluent data of mercury for Hatfield's Ferry, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The purple vertical line indicates the point when the plant changed analytical laboratories, and the red vertical line indicates the start of decommissioning period

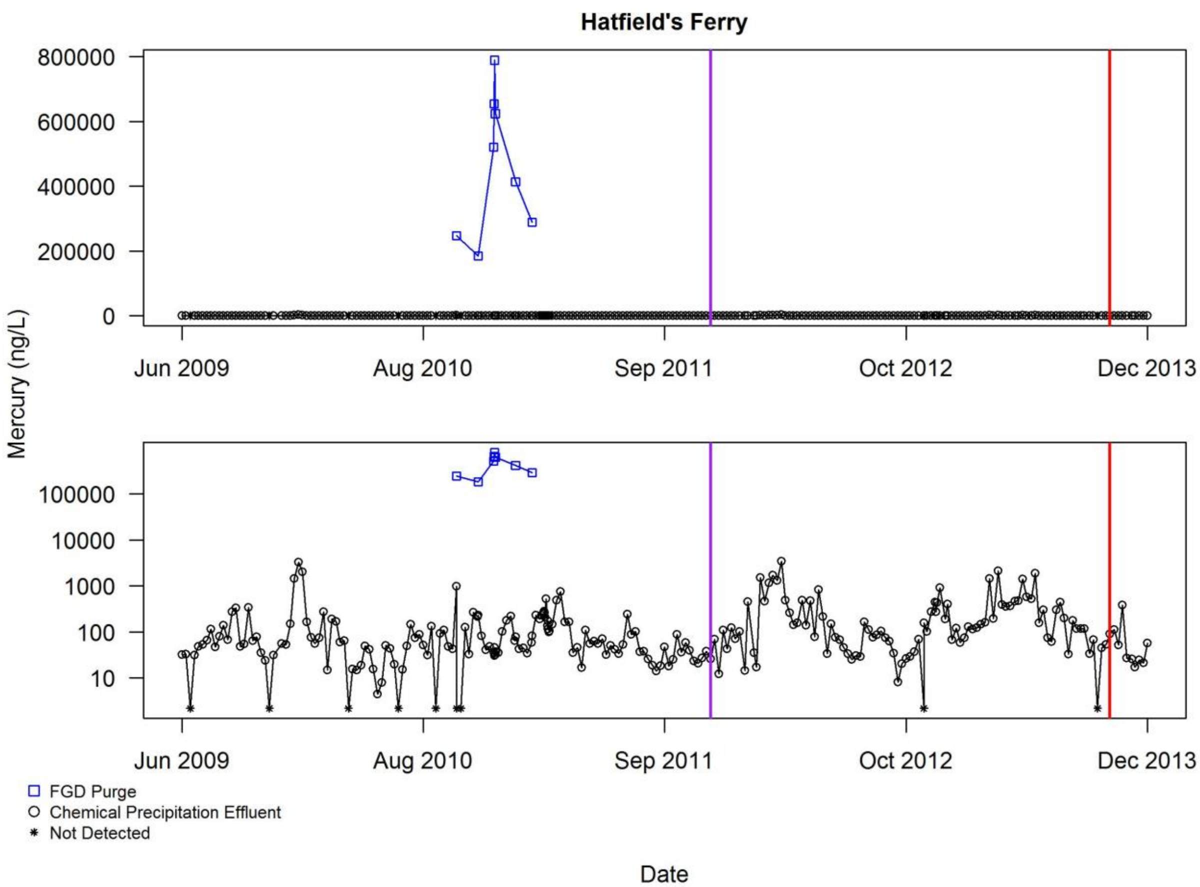


Figure A4.1.4 Chemical precipitation effluent data of mercury for Hatfield's Ferry, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The purple vertical line indicates the point when the plant changed analytical laboratories, and the red vertical line indicates the start of decommissioning period

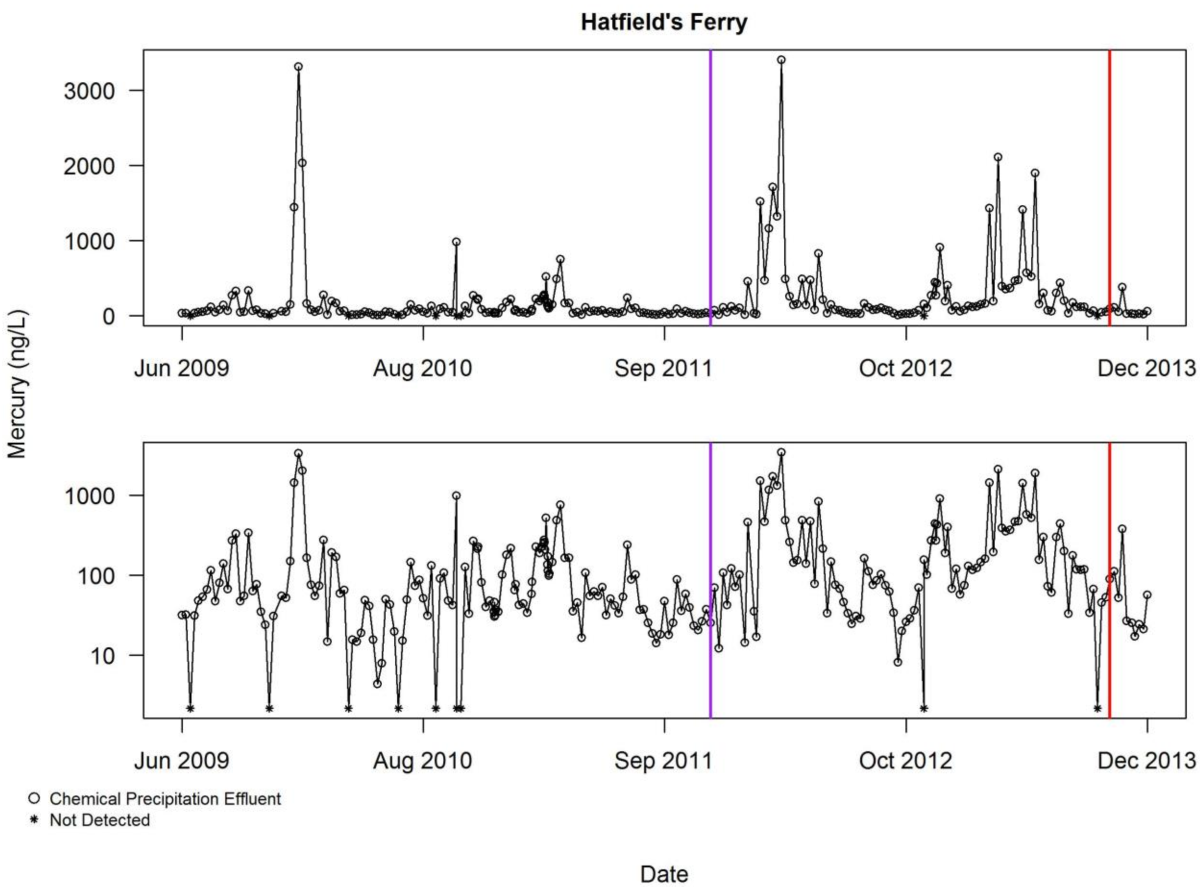


Figure A4.2.1 FGD Purge and Chemical precipitation effluent data of arsenic for Keystone, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

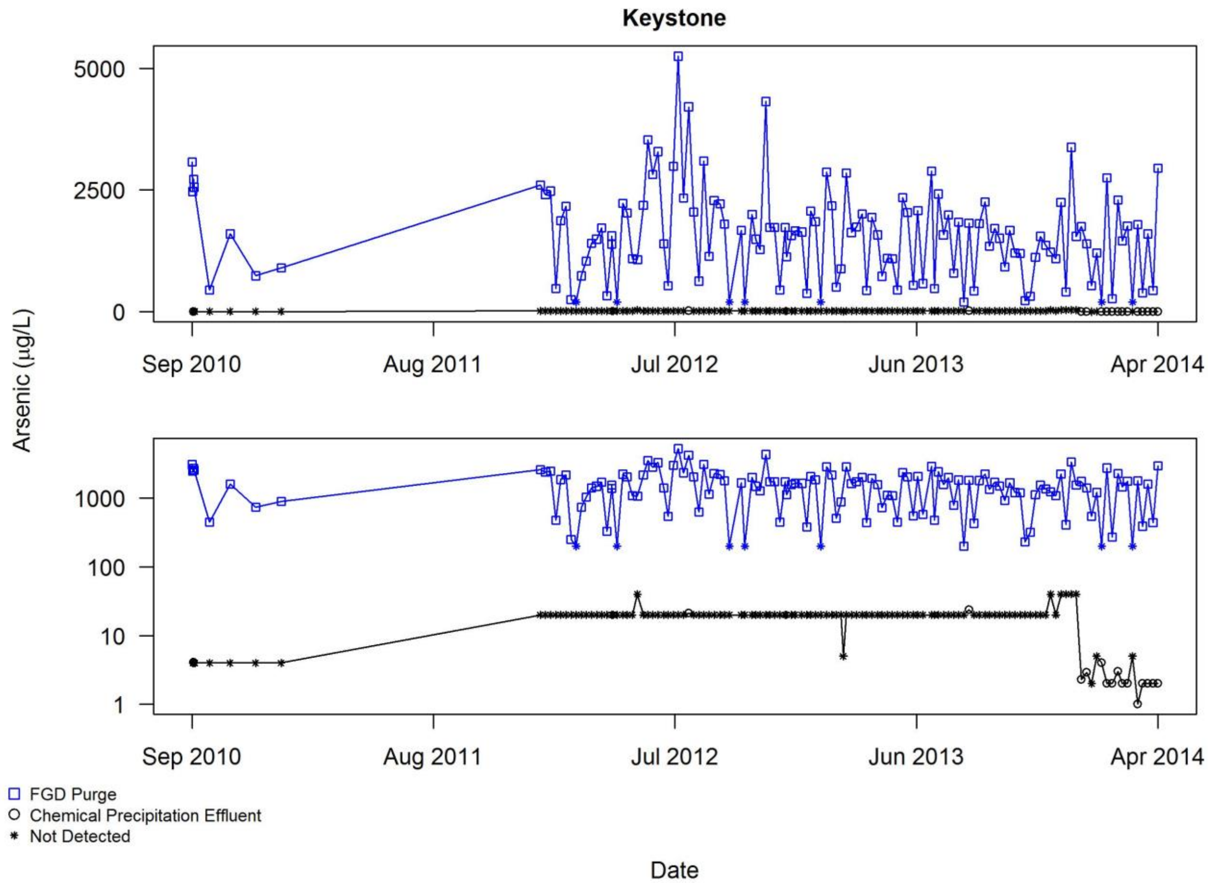


Figure A4.2.2 Chemical precipitation effluent data of arsenic for Keystone, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

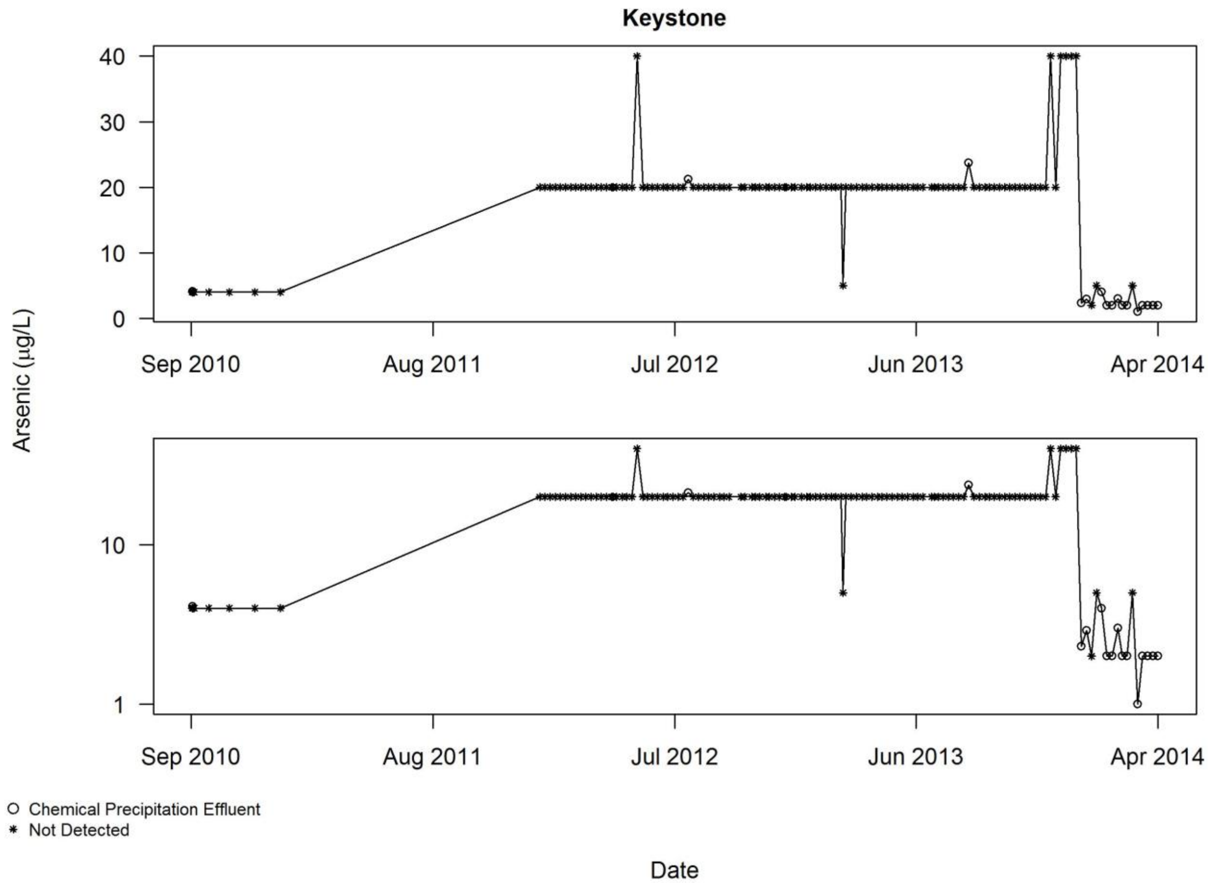


Figure A4.2.3 FGD Purge and Chemical precipitation effluent data of mercury for Keystone, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

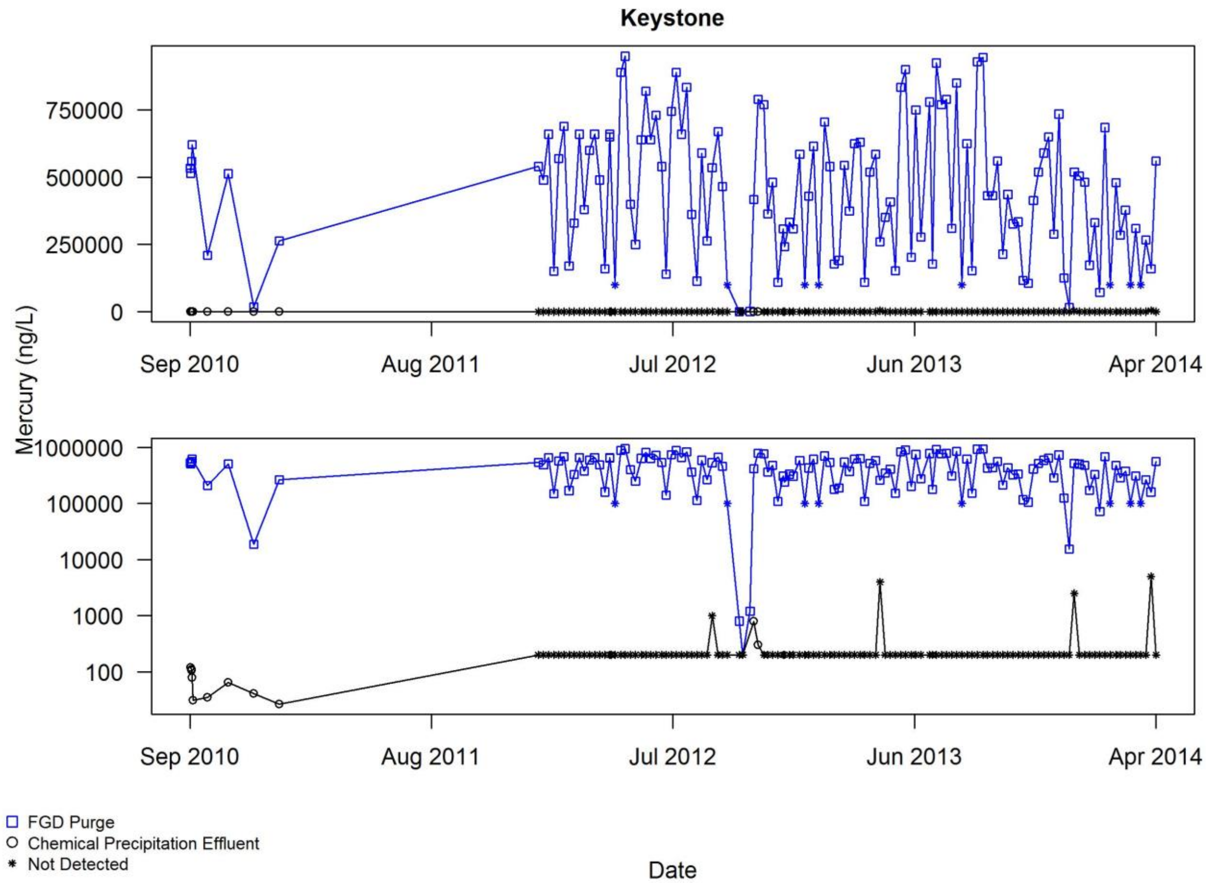


Figure A4.2.4 Chemical precipitation effluent data of mercury for Keystone, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

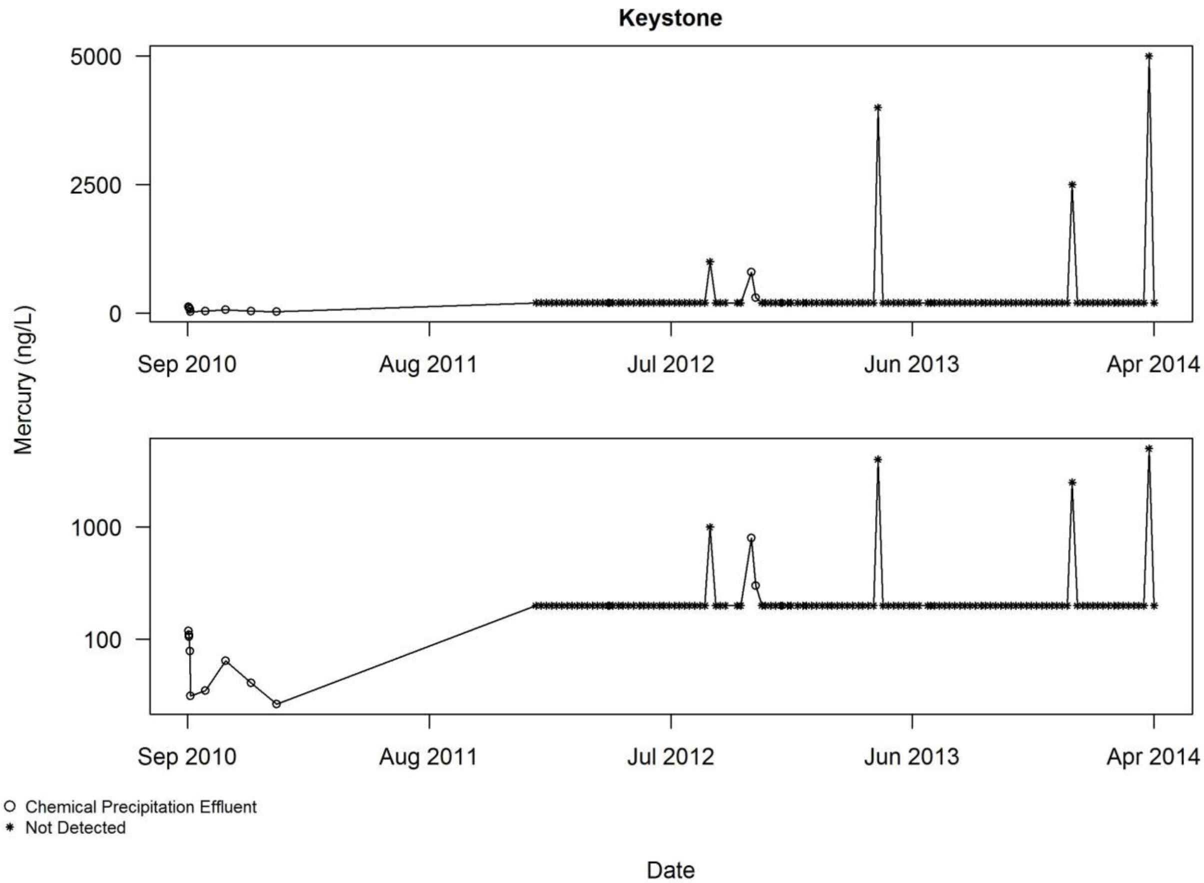


Figure A4.3.1 FGD Purge and Chemical precipitation effluent data of arsenic for Miami Fort, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

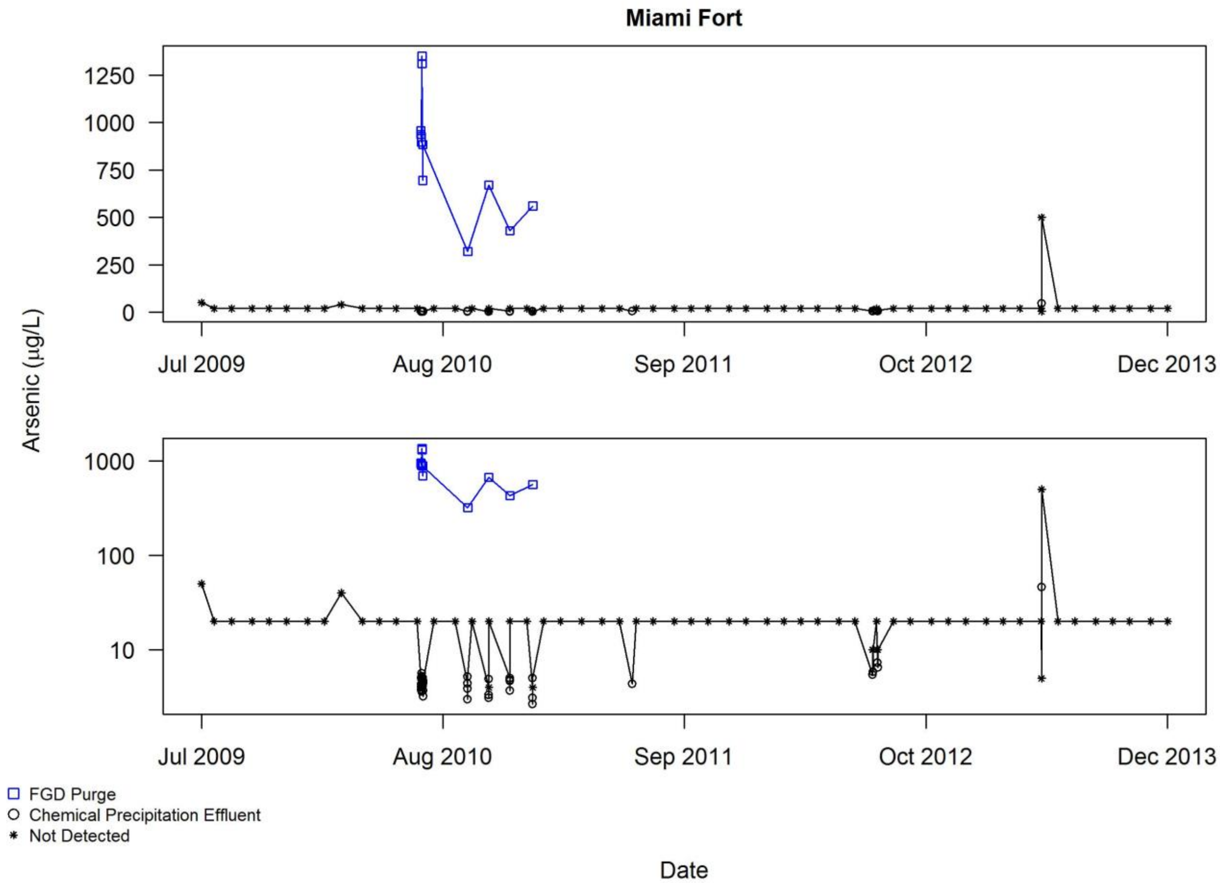


Figure A4.3.2 Chemical precipitation effluent data of arsenic for Miami Fort, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

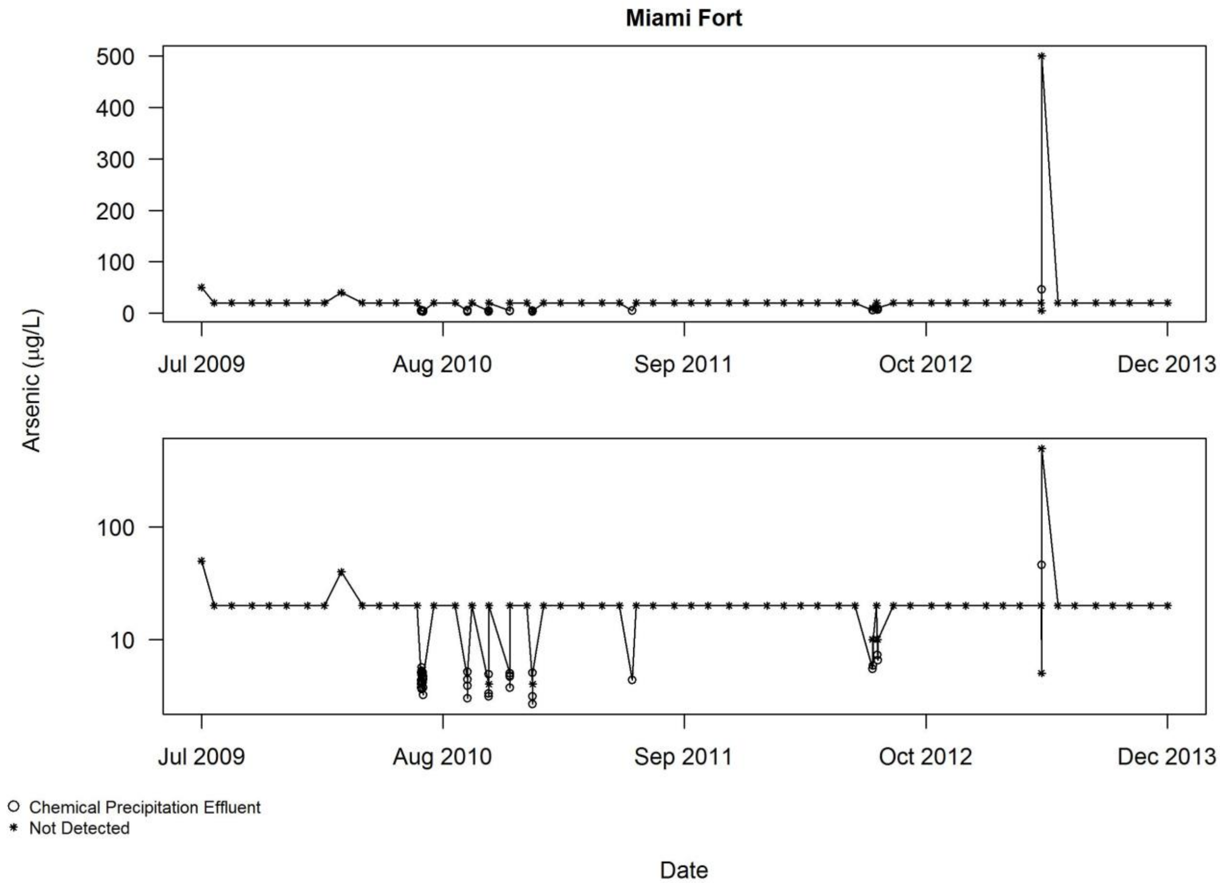


Figure A4.3.3 FGD Purge and Chemical precipitation effluent data of mercury for Miami Fort, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

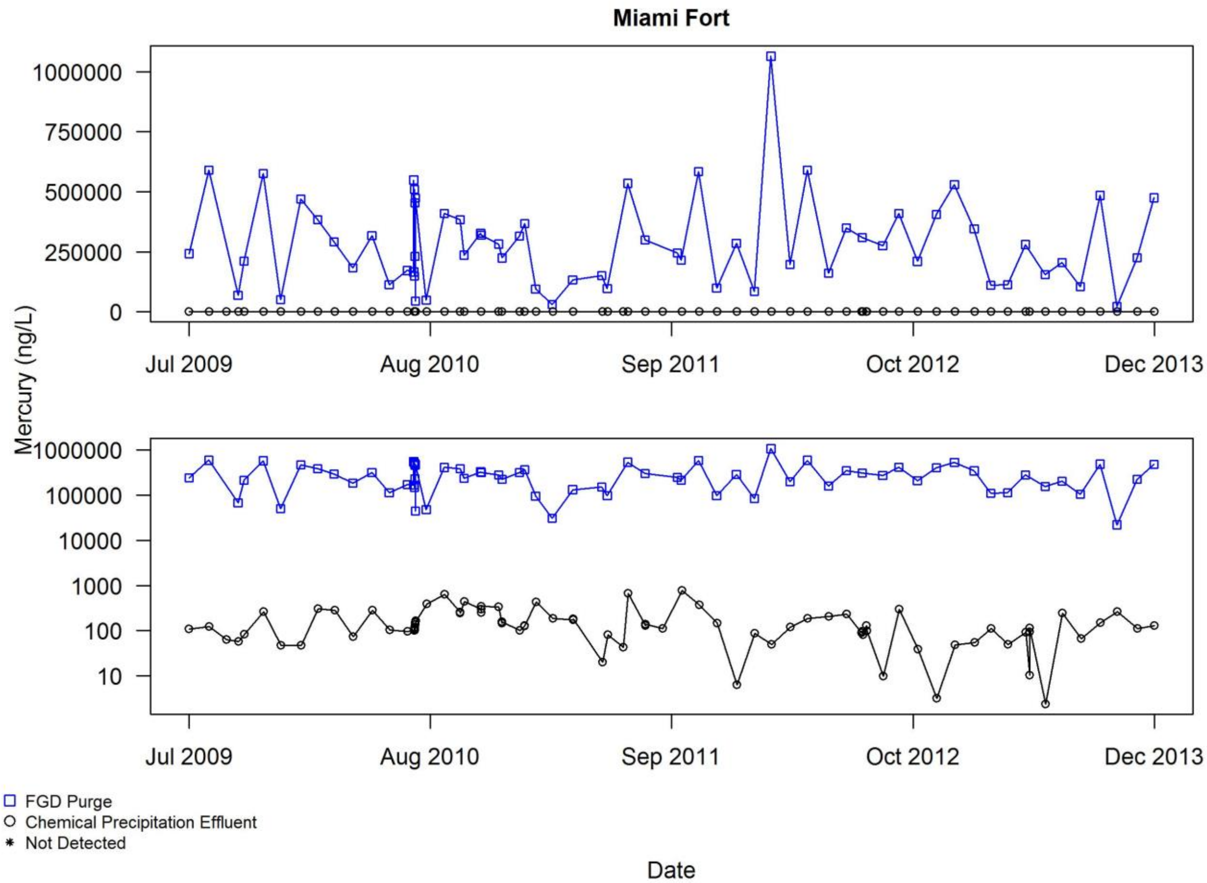


Figure A4.3.4 Chemical precipitation effluent data of mercury for Miami Fort, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

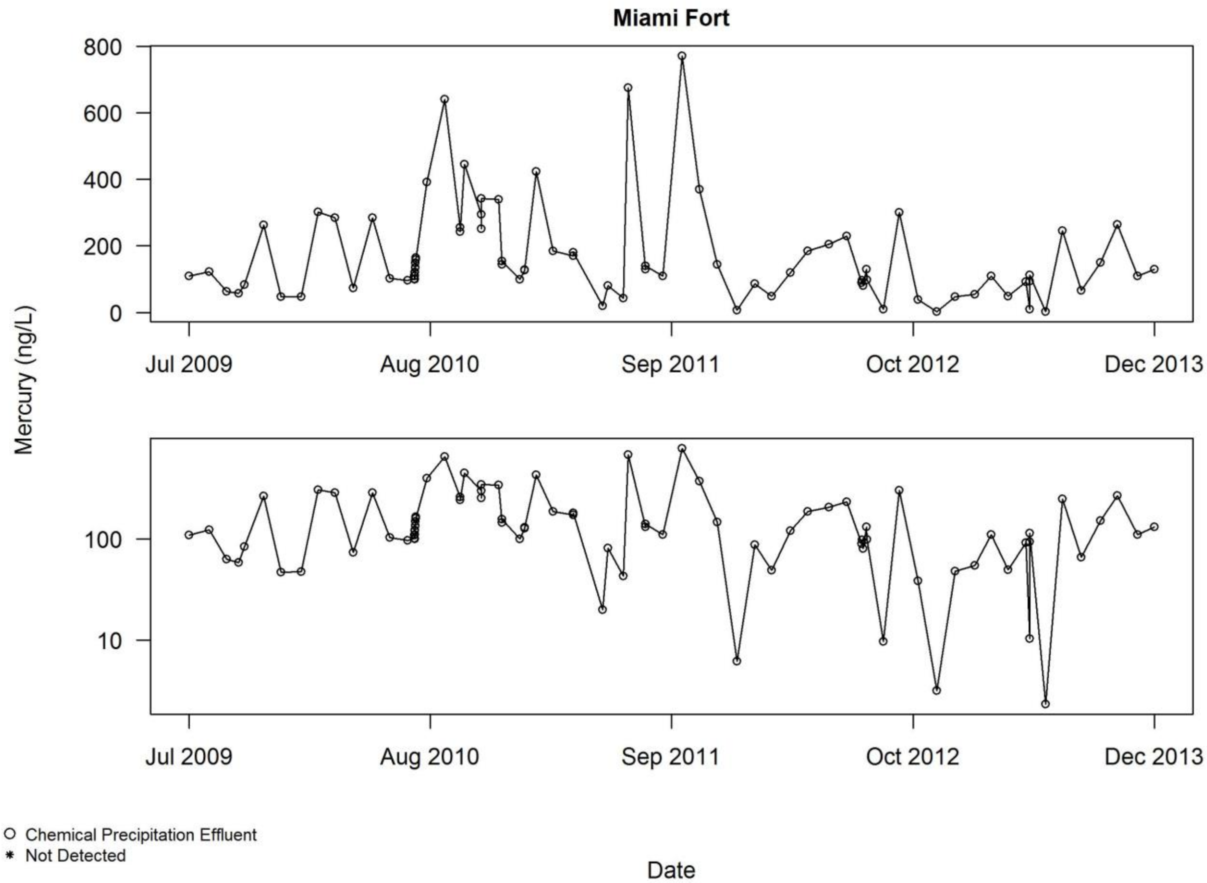


Figure A4.4.1 FGD Purge and Chemical precipitation effluent data of arsenic for Pleasant Prairie, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

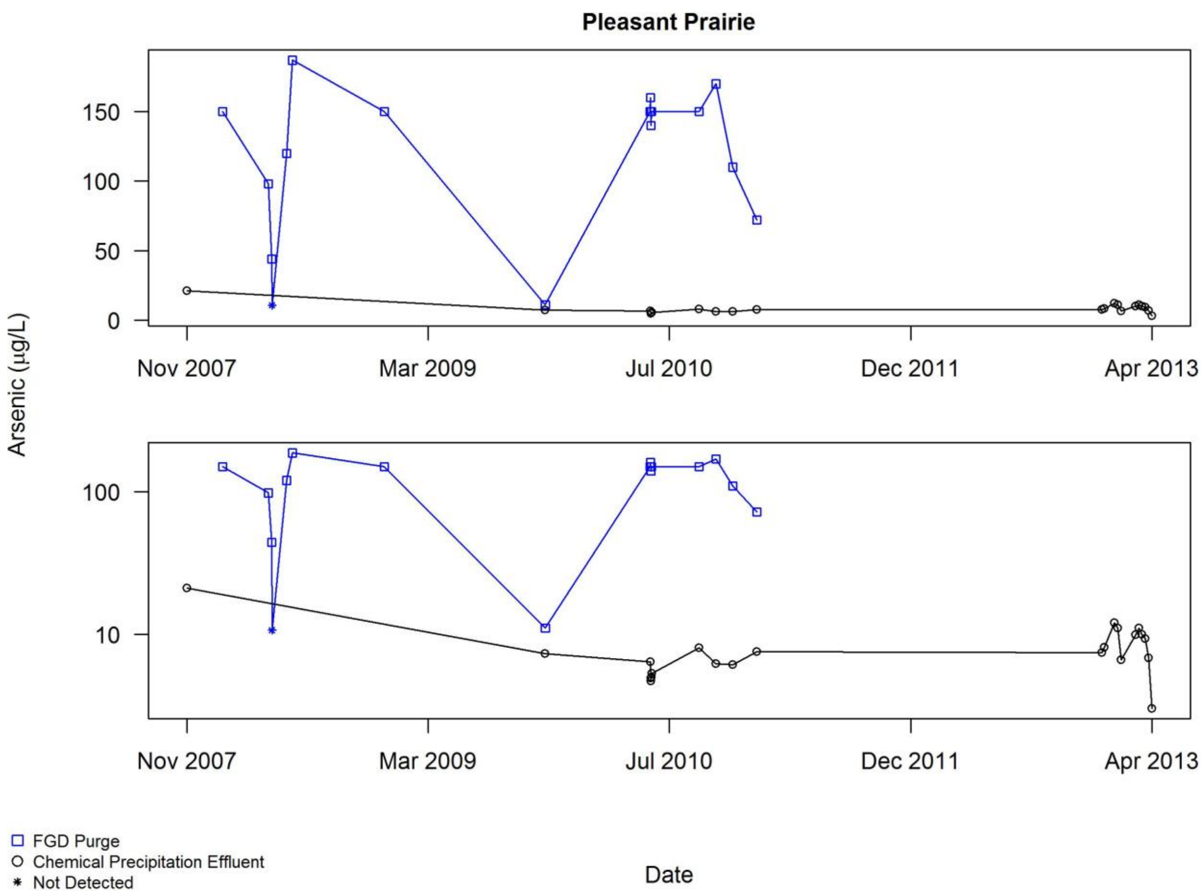


Figure A4.4.2 Chemical precipitation effluent data of arsenic for Pleasant Prairie, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

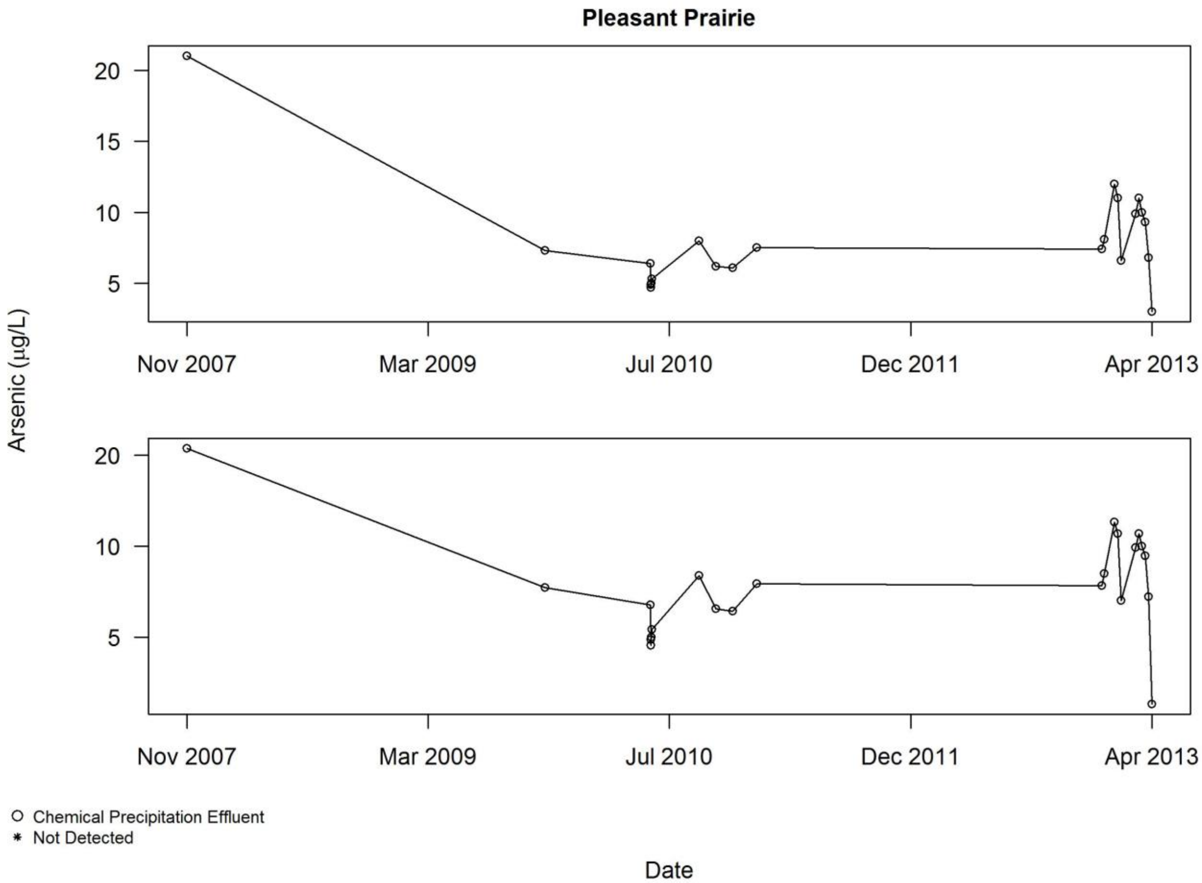


Figure A4.4.3 FGD Purge and Chemical precipitation effluent data of mercury for Pleasant Prairie, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

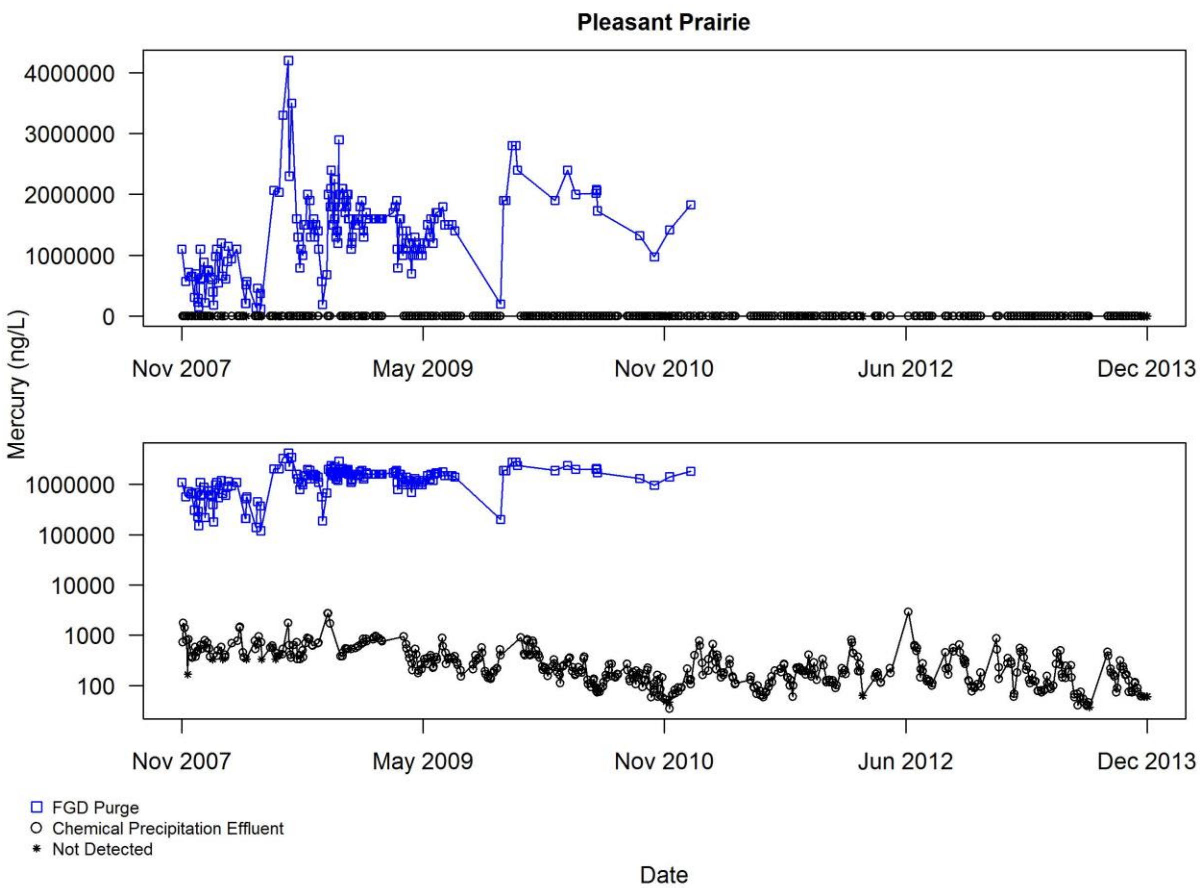


Figure A4.4.4 Chemical precipitation effluent data of mercury for Pleasant Prairie, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

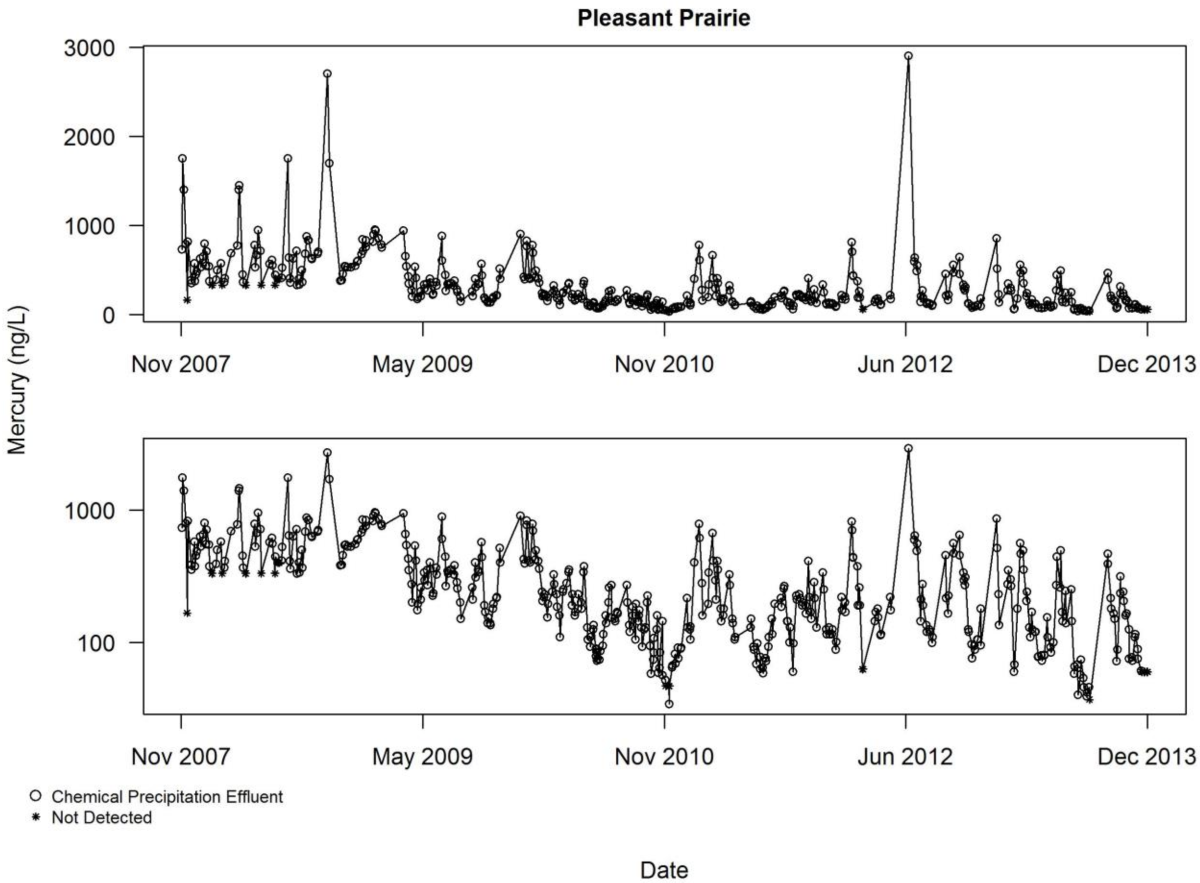


Figure A4.5.1 FGD Purge, Bioreactor influent, and Bioreactor effluent data of arsenic for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

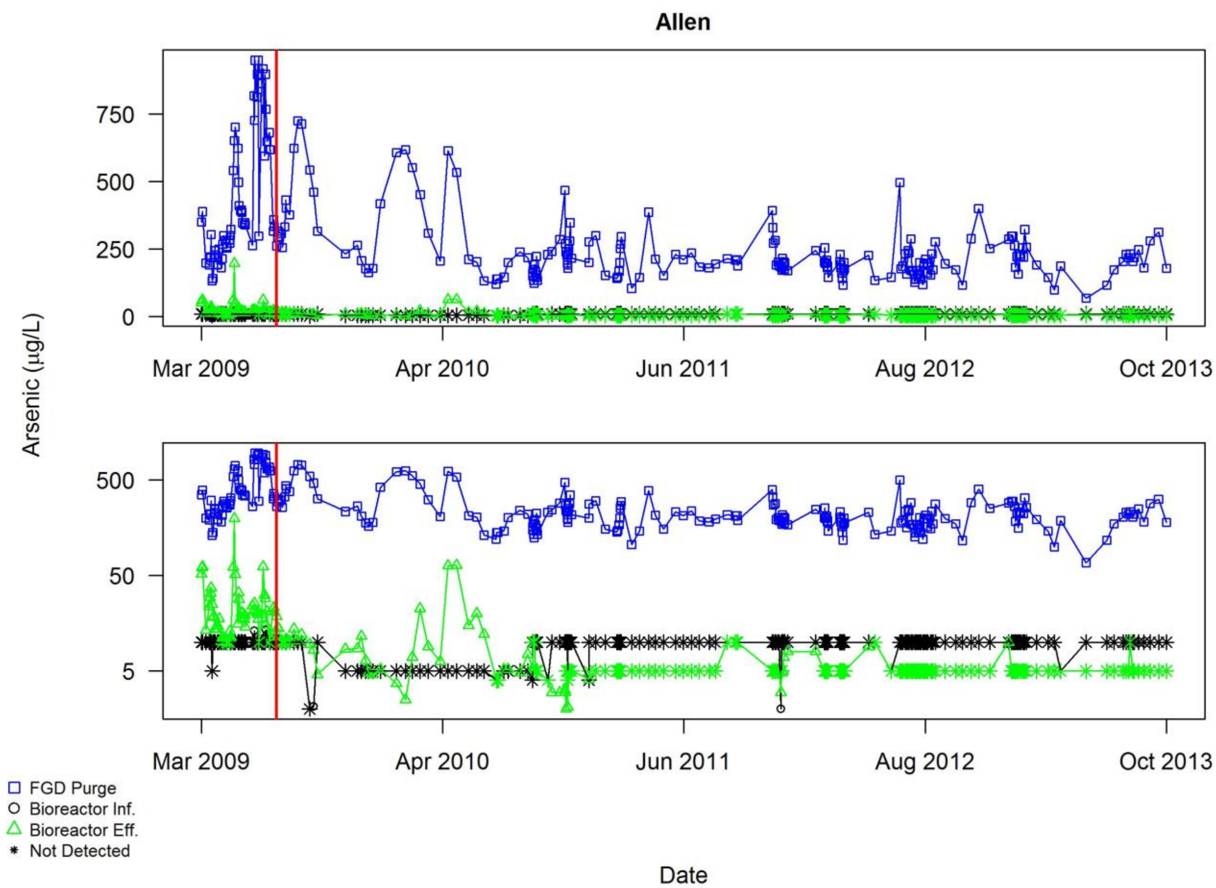


Figure A4.5.2 Bioreactor influent and Bioreactor effluent data of arsenic for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

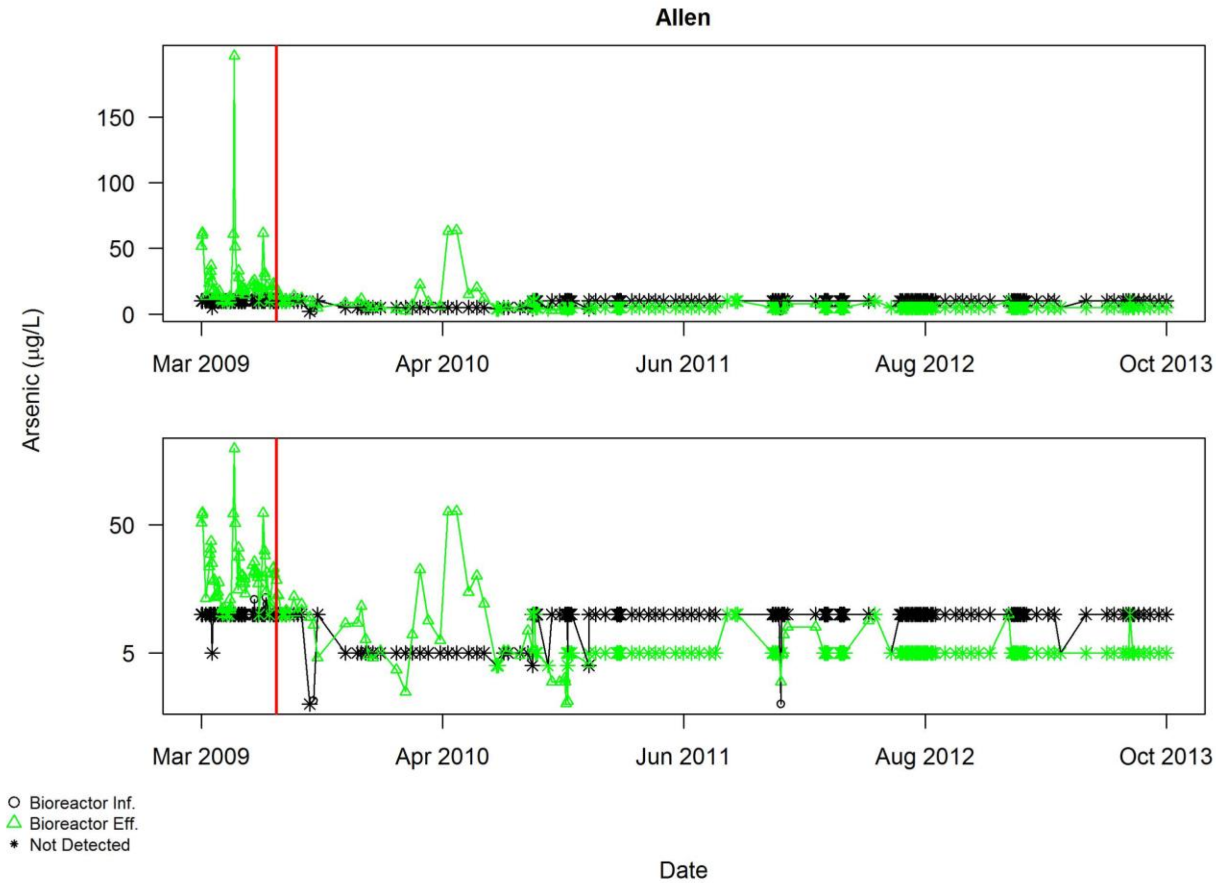


Figure A4.5.3 Bioreactor effluent data of arsenic for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

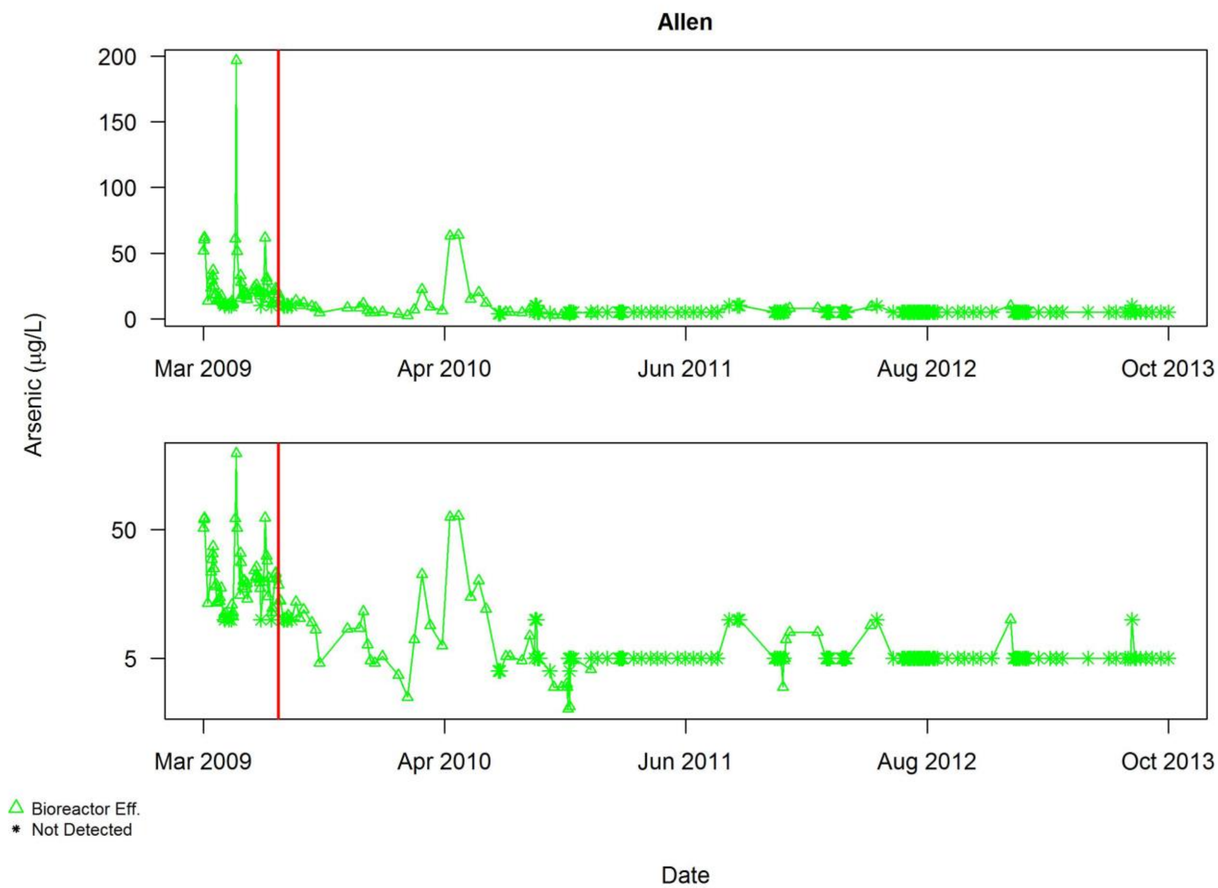


Figure A4.5.4 FGD Purge, Bioreactor influent, and Bioreactor effluent data of mercury for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot; log scale in the lower plot. The red vertical line indicates the end of the commissioning period

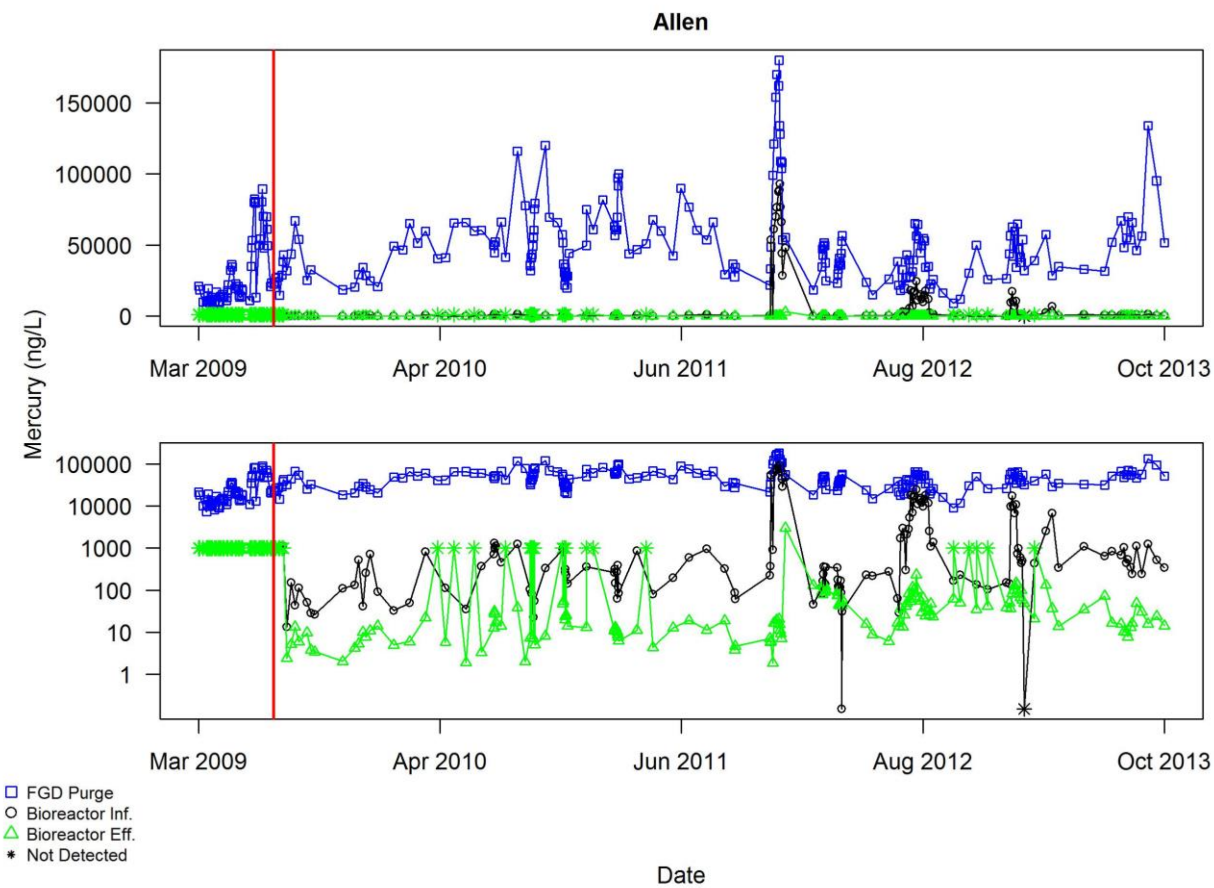


Figure A4.5.5 Bioreactor influent and Bioreactor effluent data of mercury for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

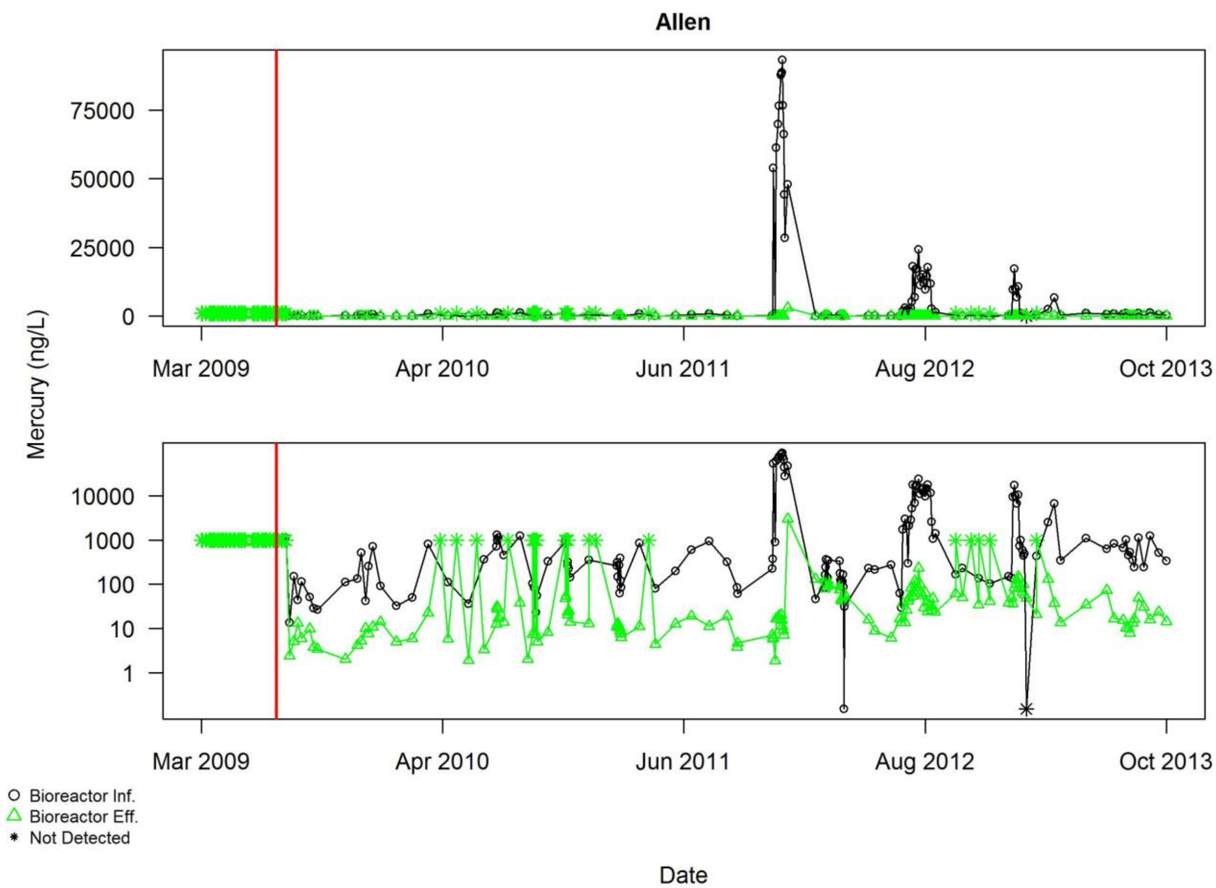


Figure A4.5.6 Bioreactor effluent data of mercury for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

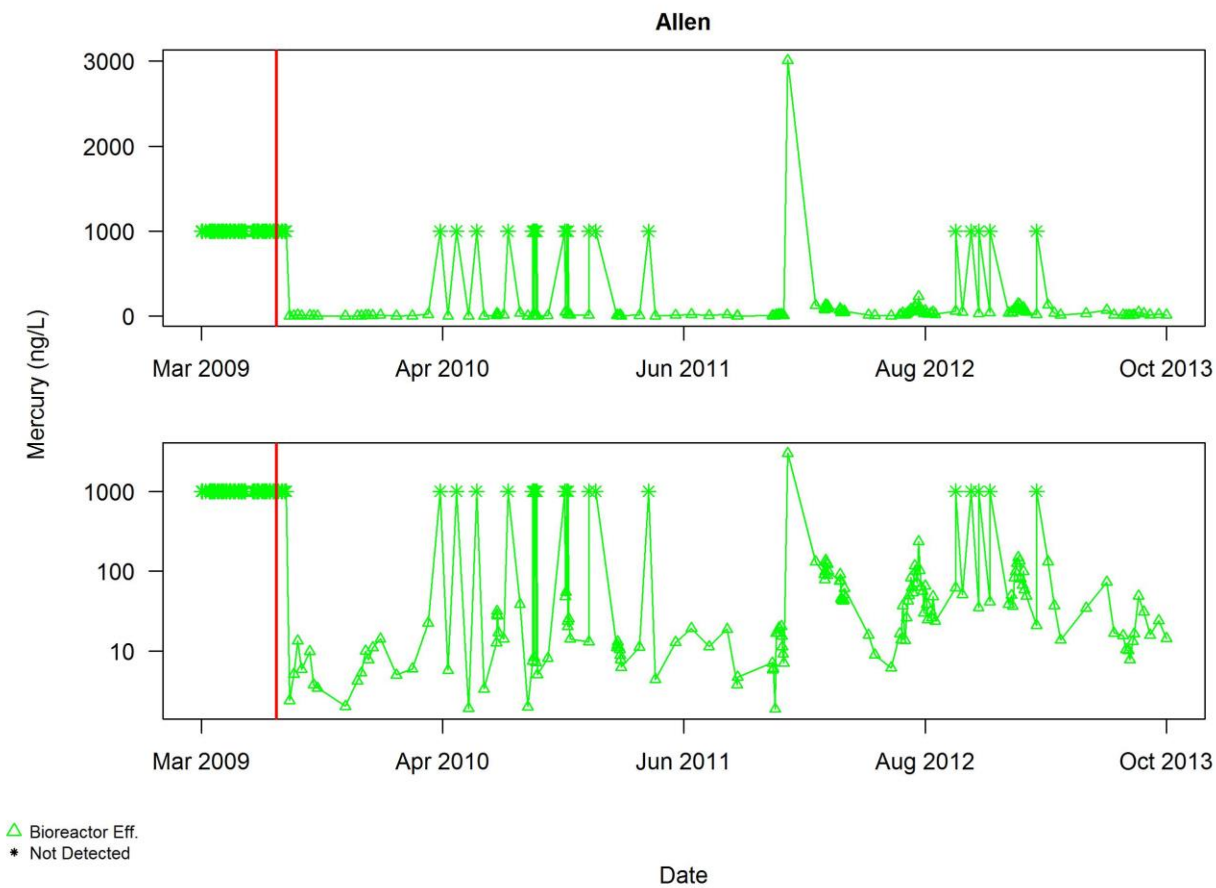


Figure A4.5.7 FGD Purge, Bioreactor influent, and Bioreactor effluent data of Nitrate-Nitrite as N for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

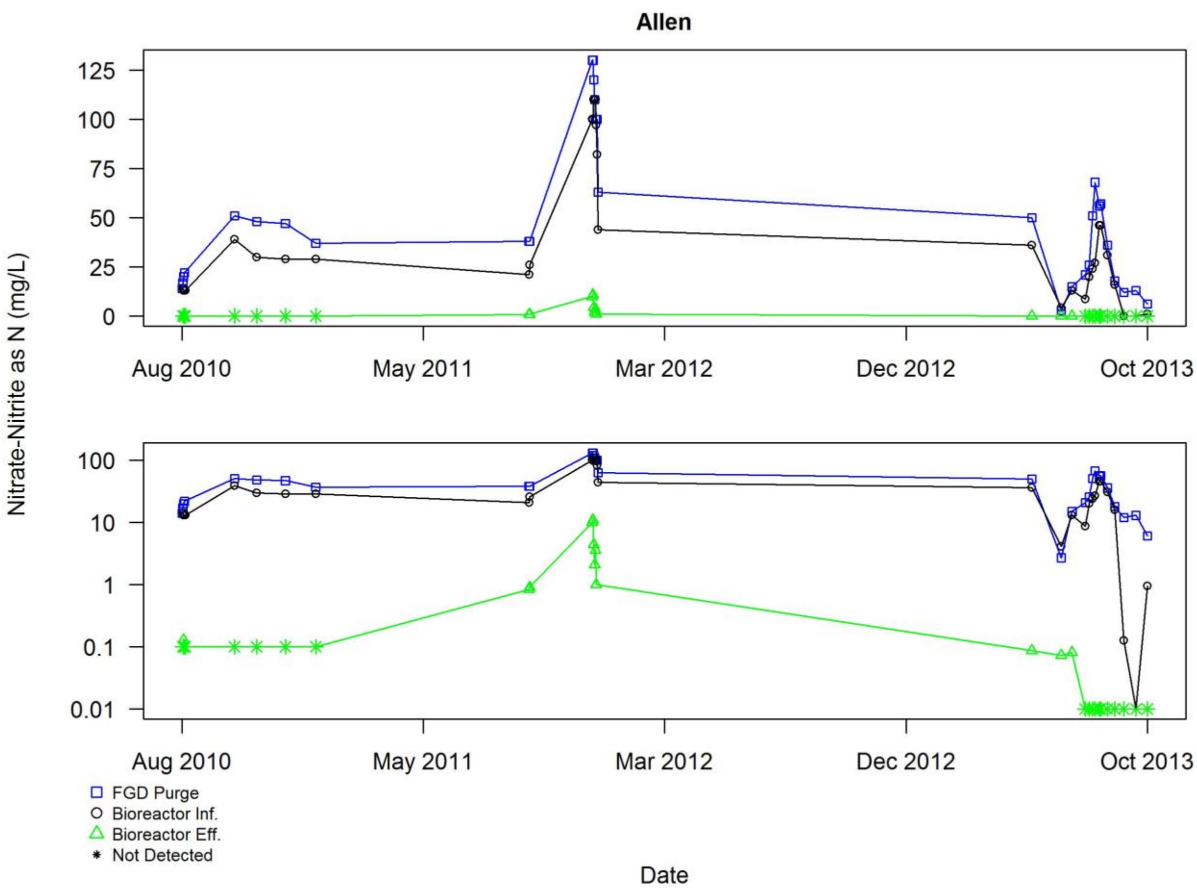


Figure A4.5.8 Bioreactor influent and Bioreactor effluent data of Nitrate-Nitrite as N for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

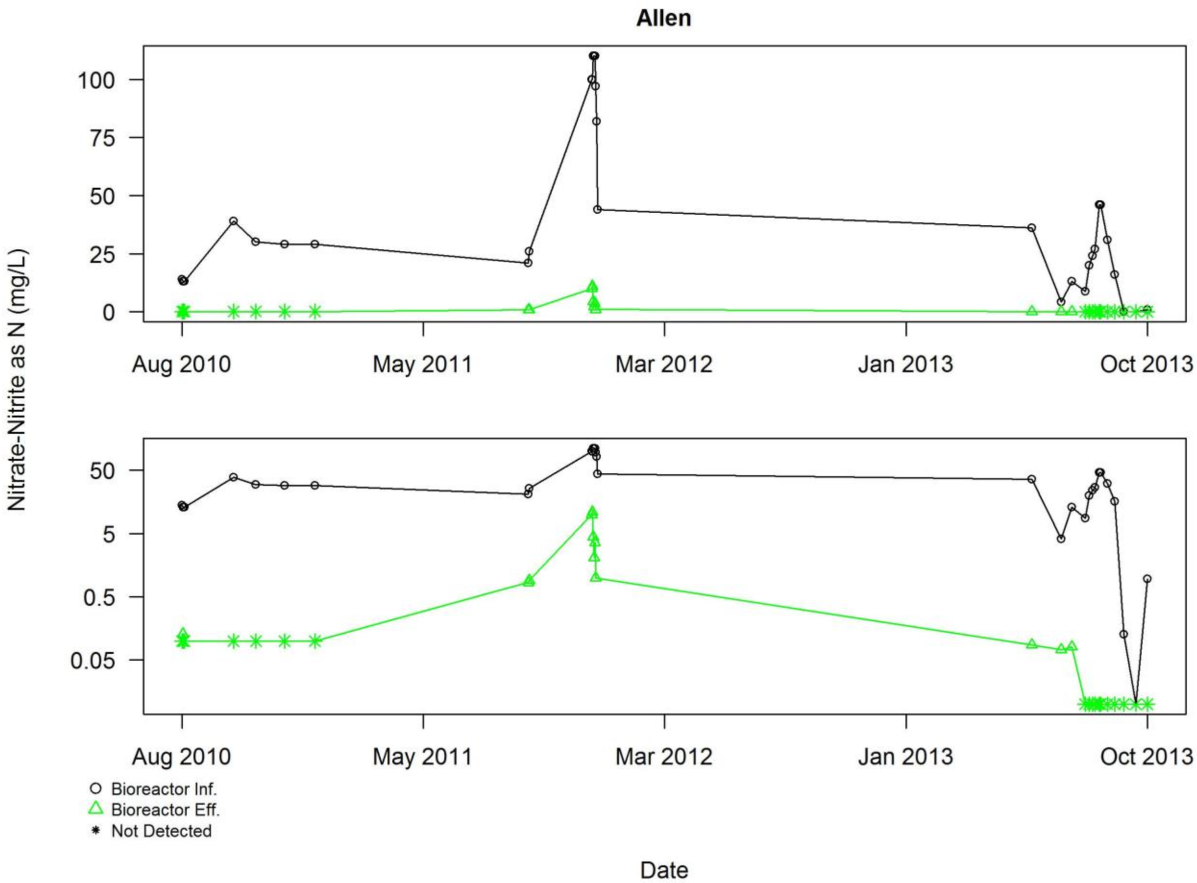


Figure A4.5.9 Bioreactor effluent data of Nitrate-Nitrite as N for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

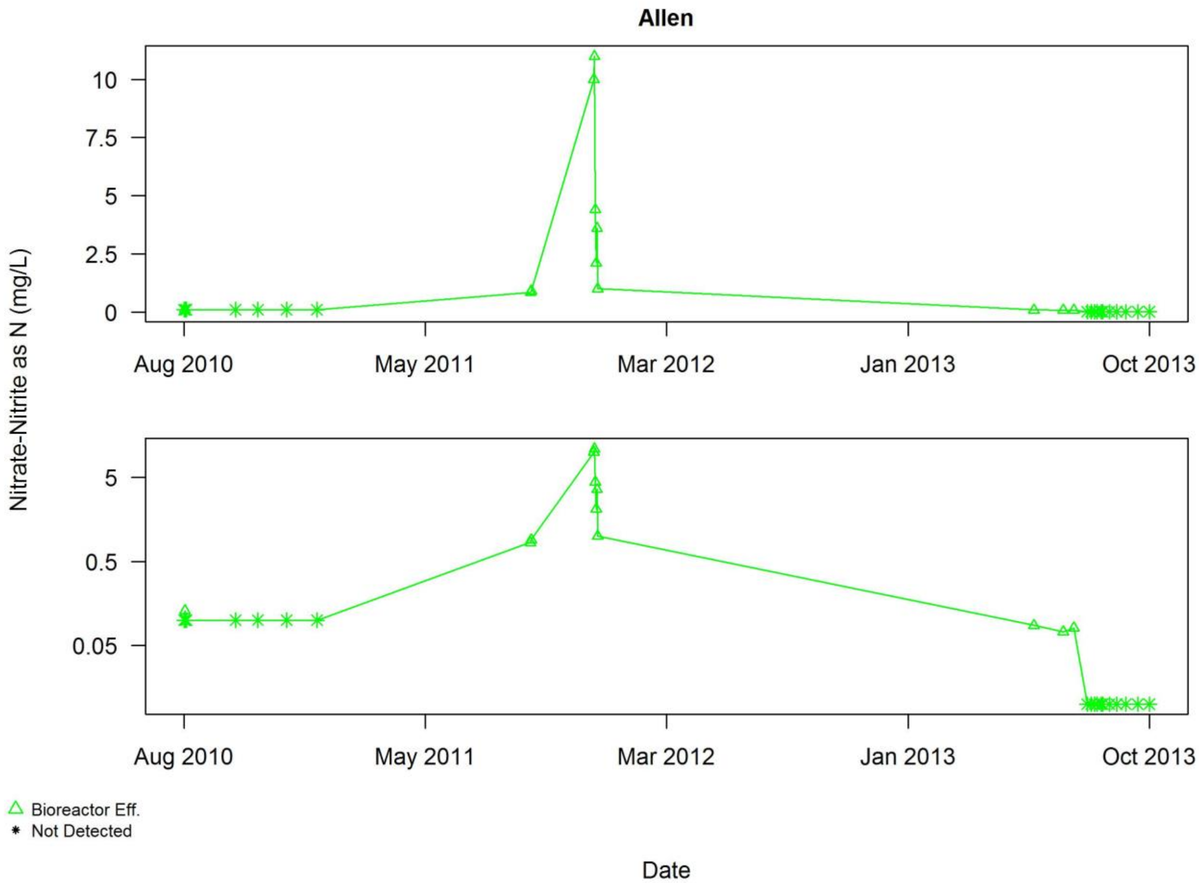


Figure A4.5.10 FGD Purge, Bioreactor influent, and Bioreactor effluent data of selenium for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

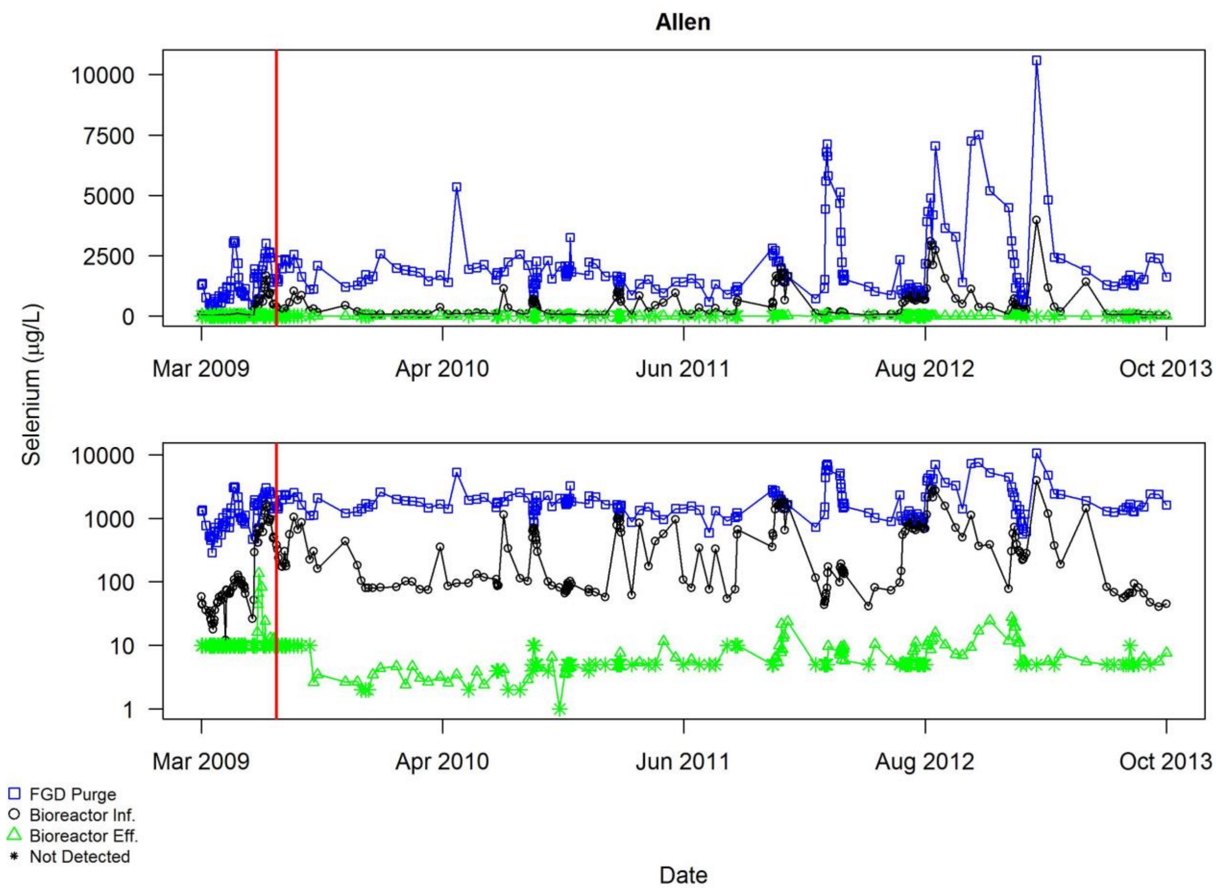


Figure A4.5.11 Bioreactor influent and Bioreactor effluent data of selenium for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

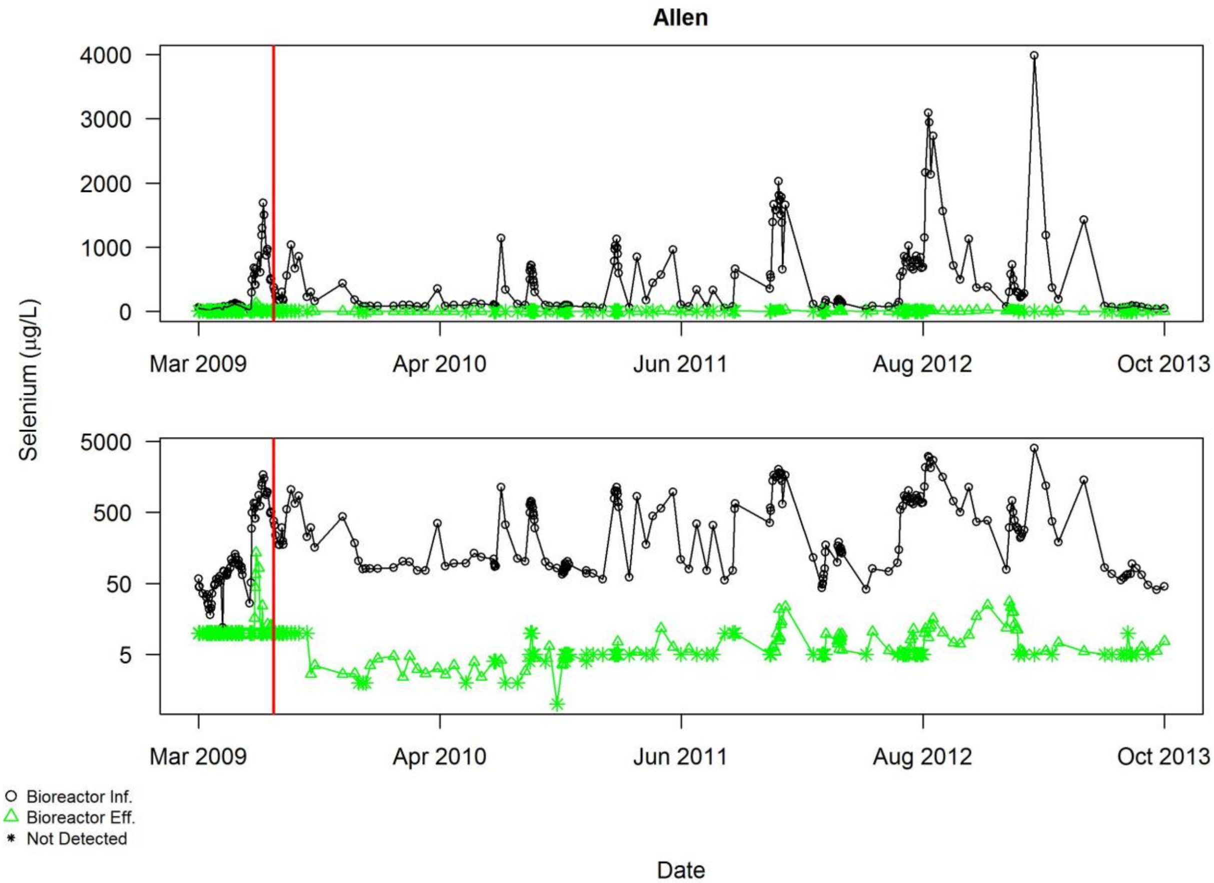


Figure A4.5.12 Bioreactor effluent data of selenium for Allen, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

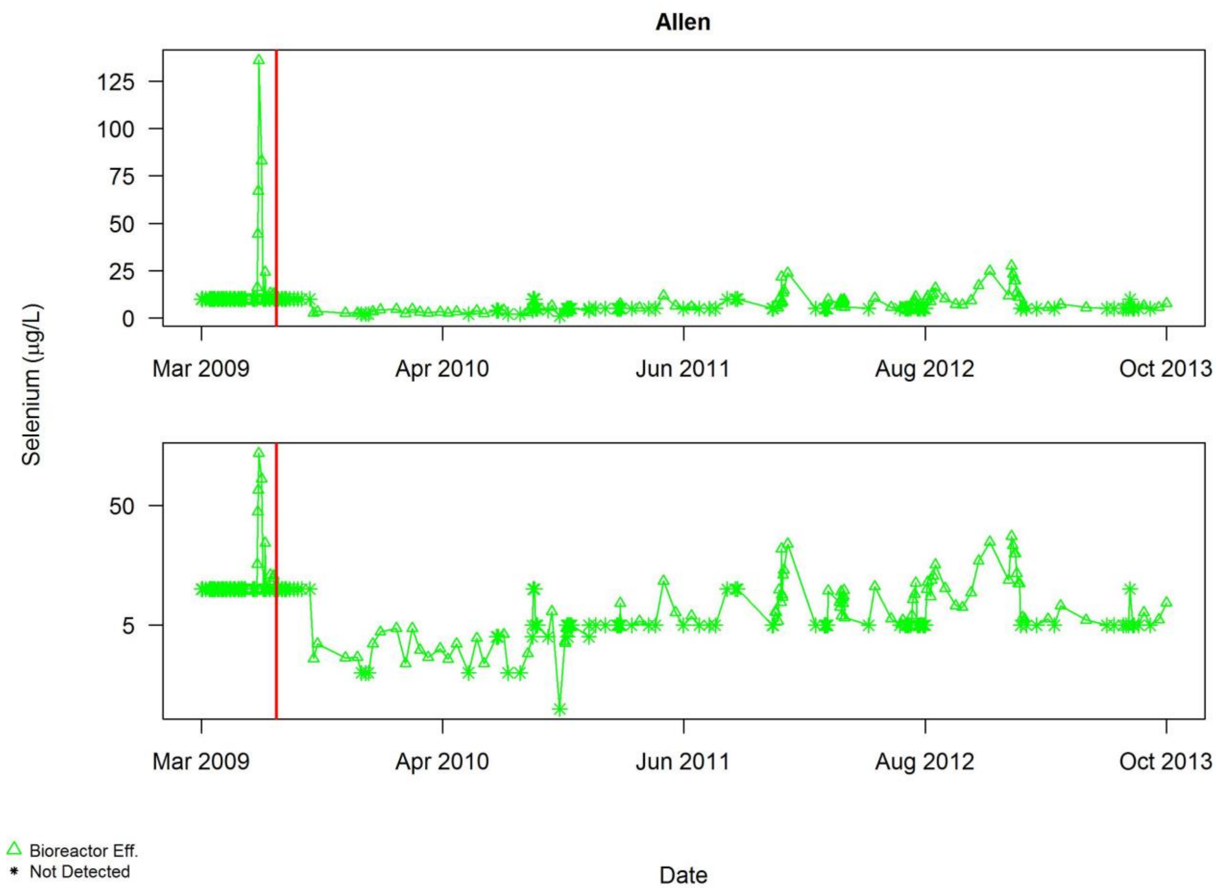


Figure A4.6.1 FGD Purge, Bioreactor influent, and Bioreactor effluent data of arsenic for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

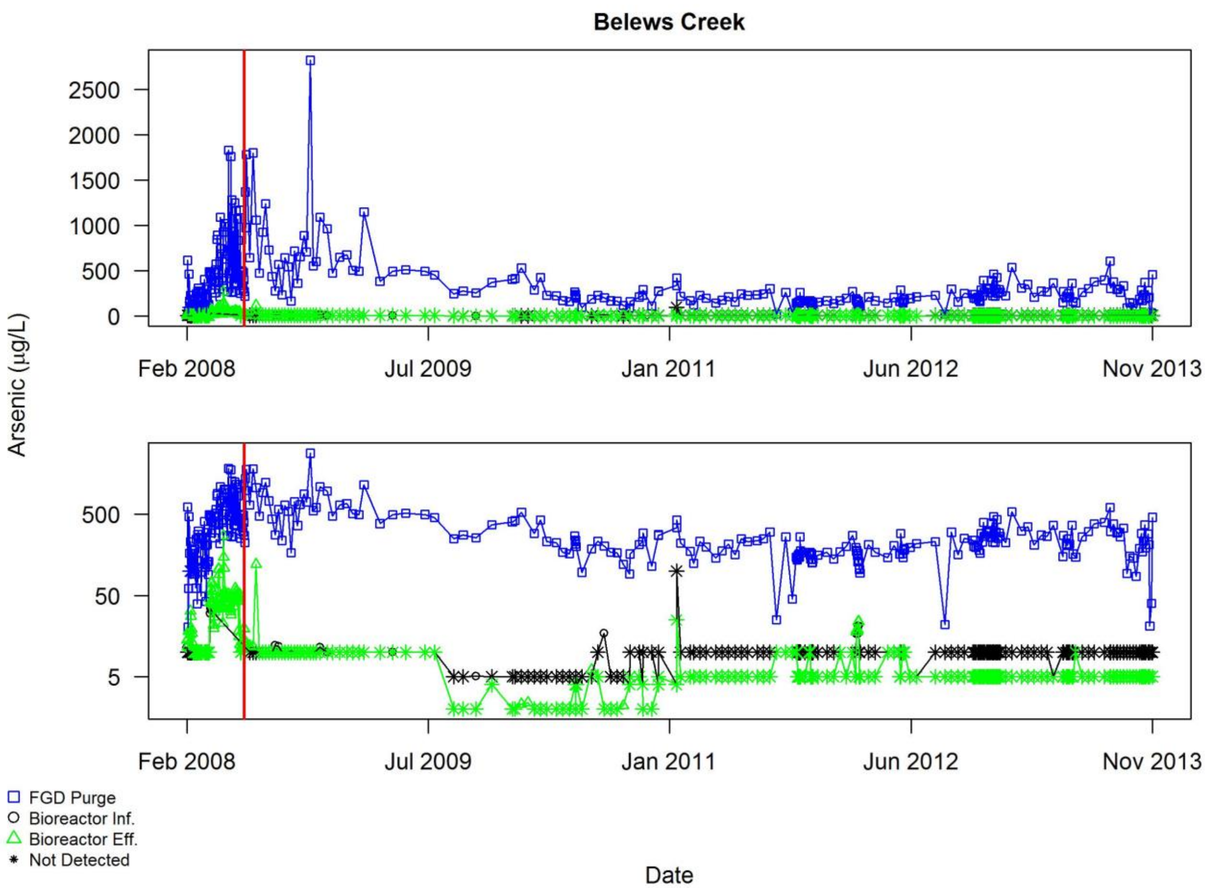


Figure A4.6.2 Bioreactor influent and Bioreactor effluent data of arsenic for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

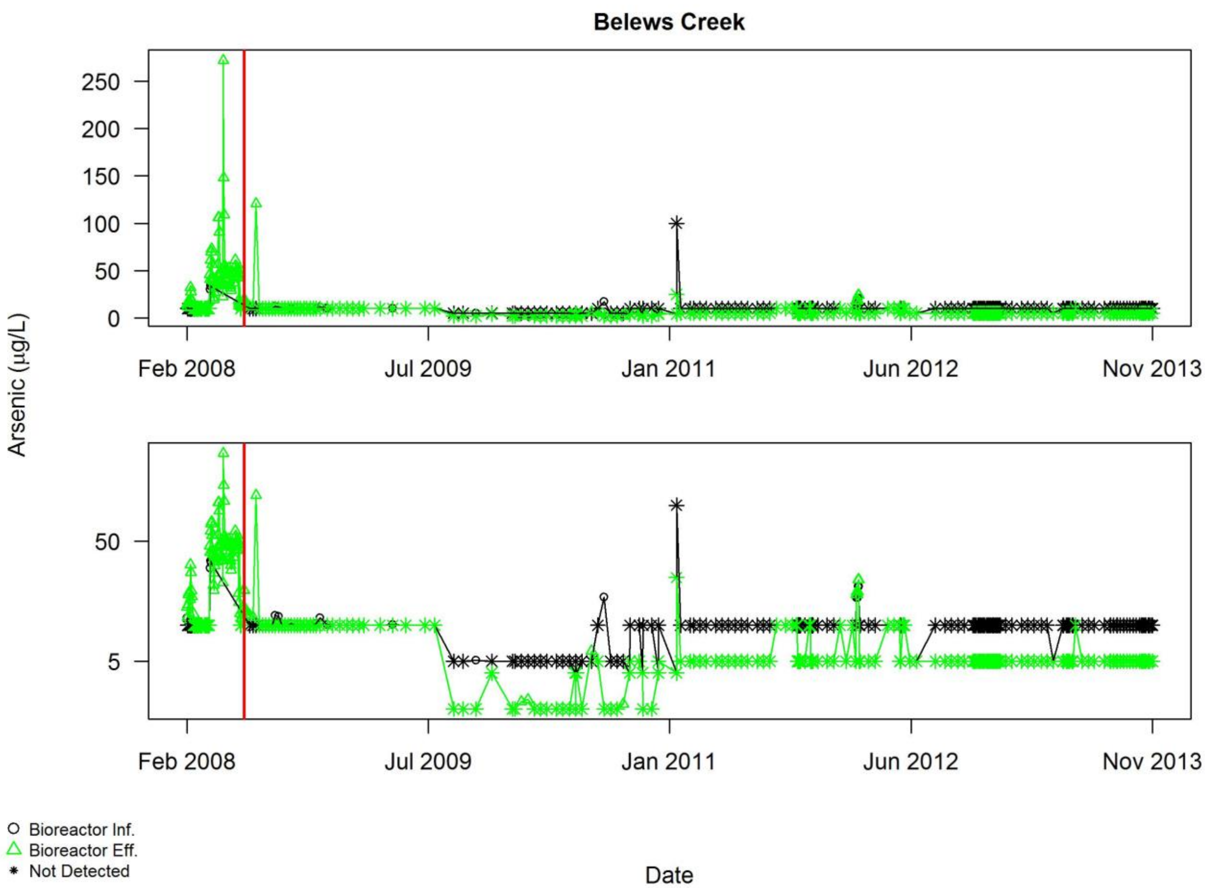


Figure A4.6.3 Bioreactor effluent data of arsenic for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

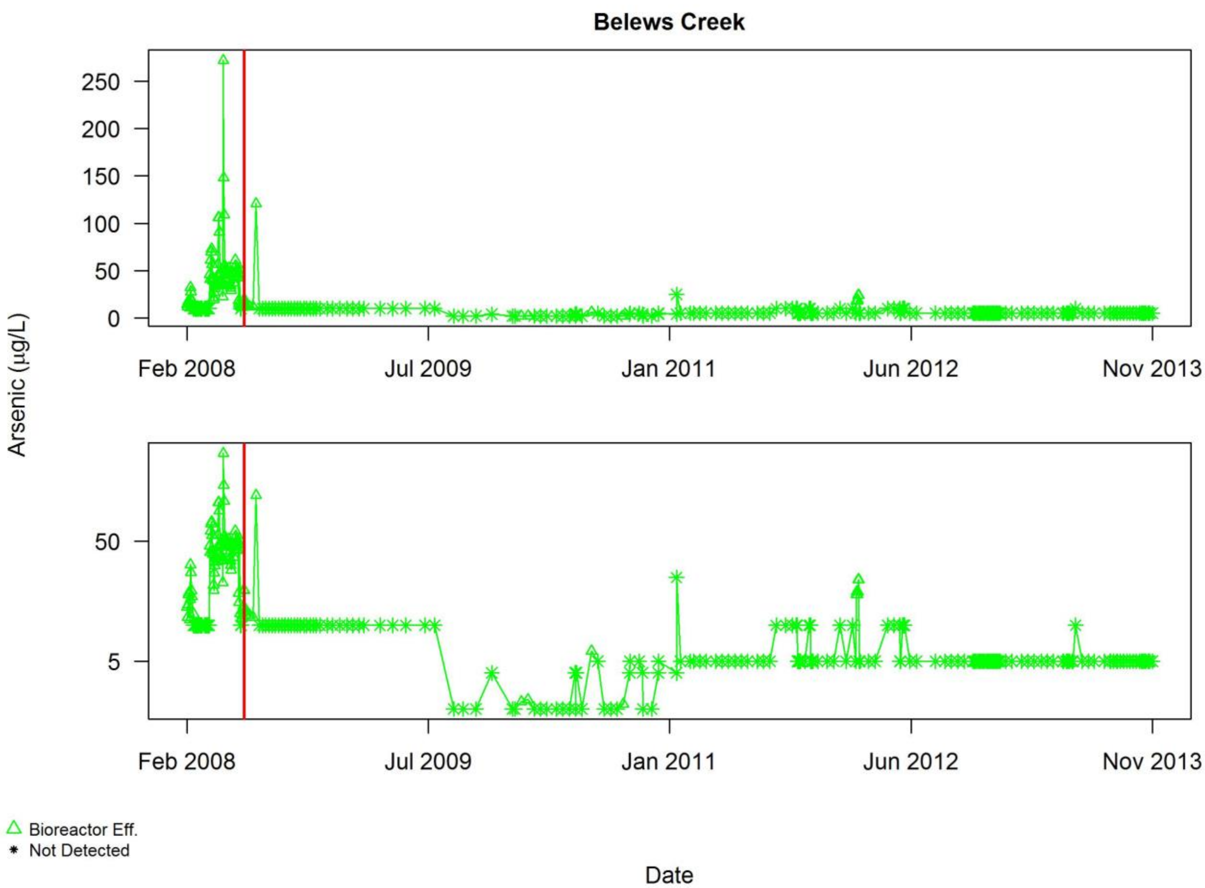


Figure A4.6.4 FGD Purge, Bioreactor influent, and Bioreactor effluent data of mercury for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

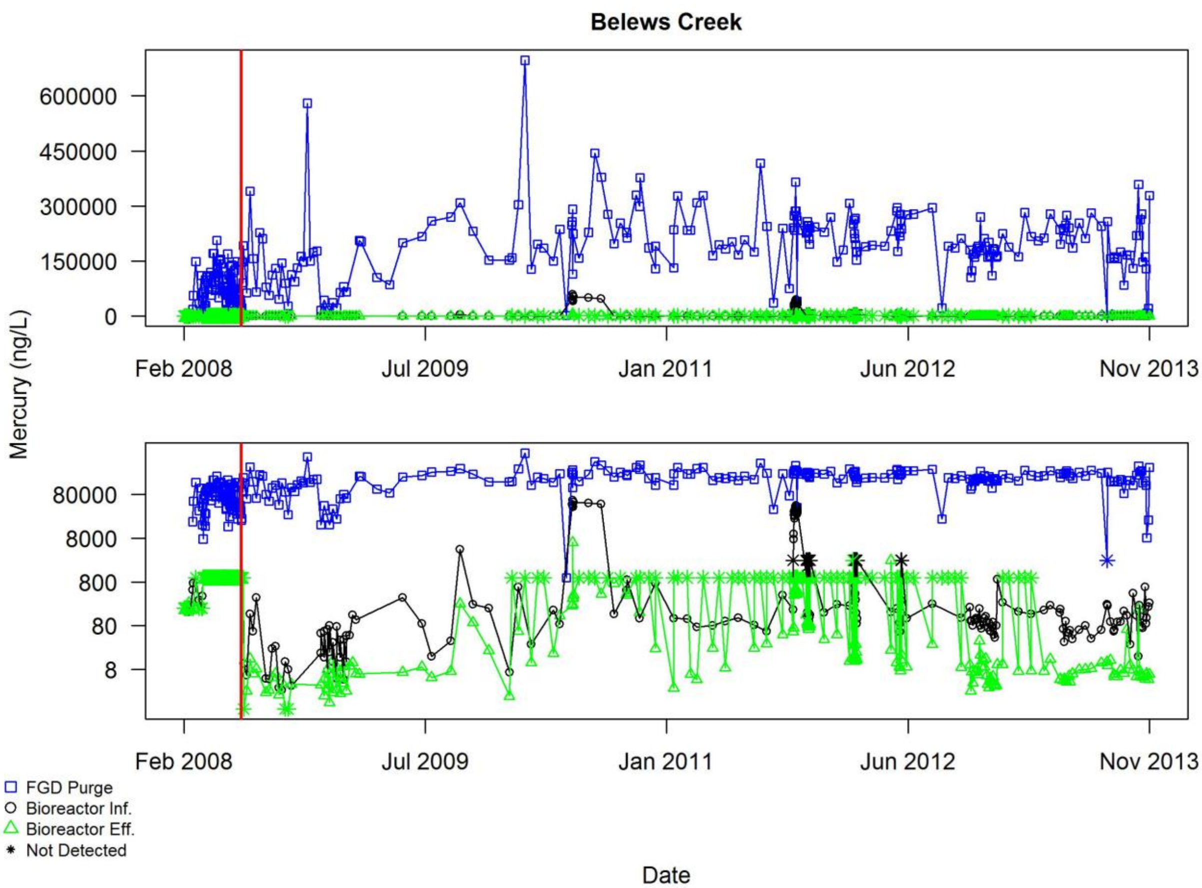


Figure A4.6.5 Bioreactor influent and Bioreactor effluent data of mercury for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

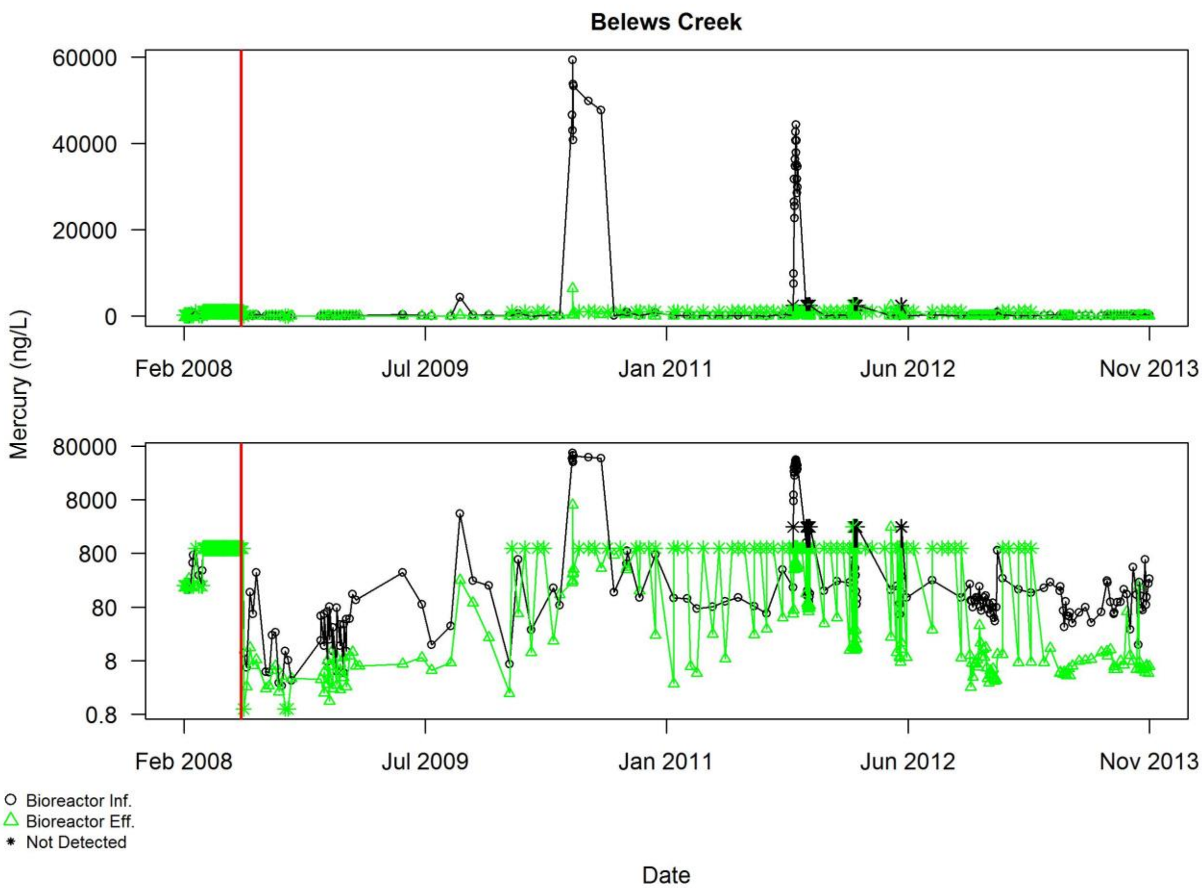


Figure A4.6.6 Bioreactor effluent data of mercury for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot log scale in the lower plot. The red vertical line indicates the end of the commissioning period

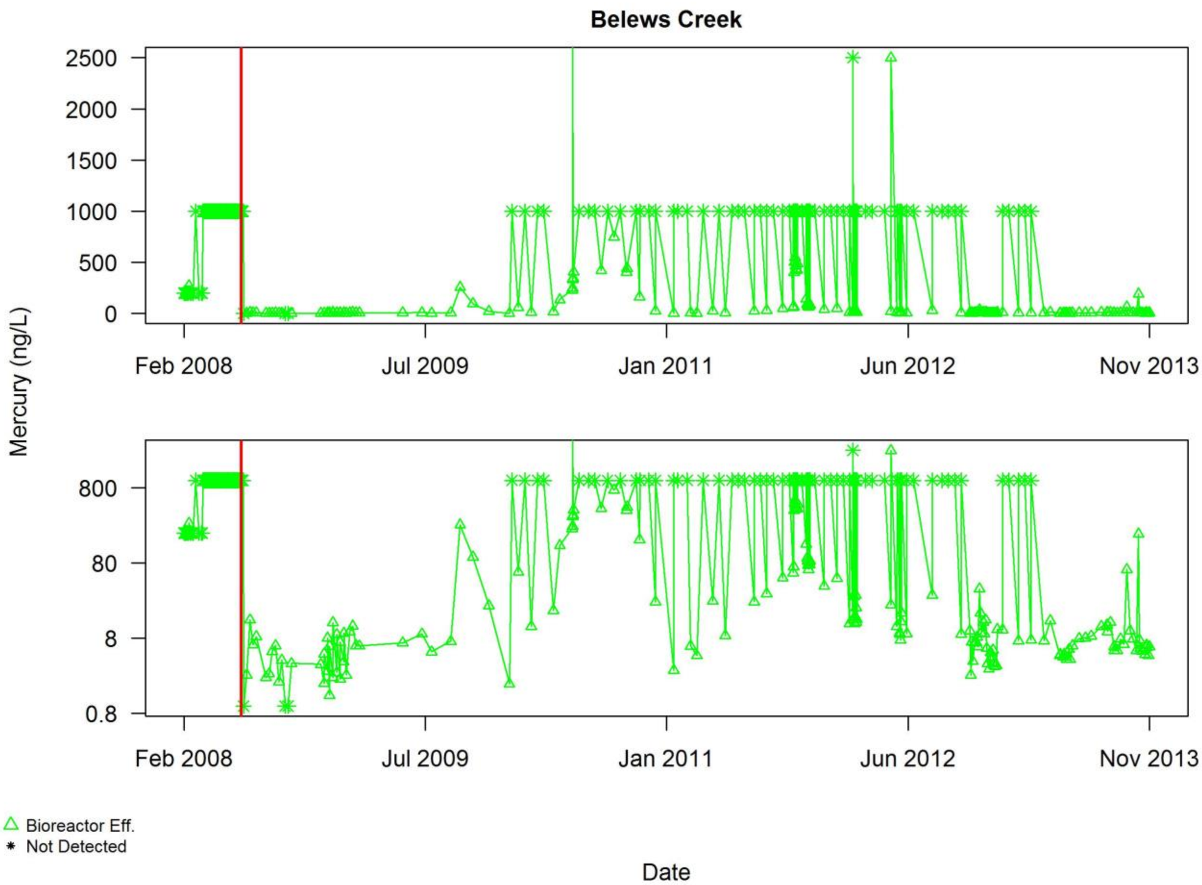


Figure A4.6.7 FGD Purge, Bioreactor influent, and Bioreactor effluent data of Nitrate-Nitrite as N for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

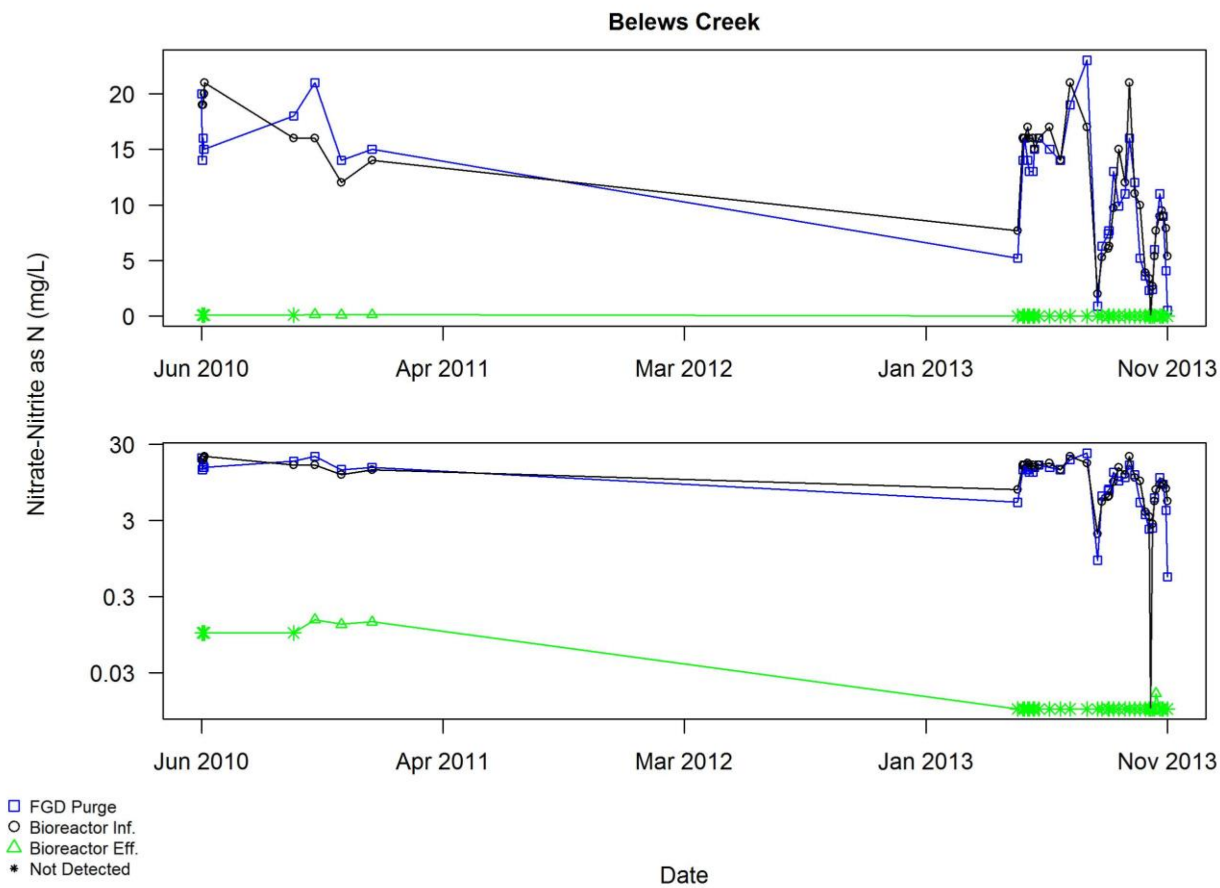


Figure A4.6.8 Bioreactor influent and Bioreactor effluent data of Nitrate-Nitrite as N for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

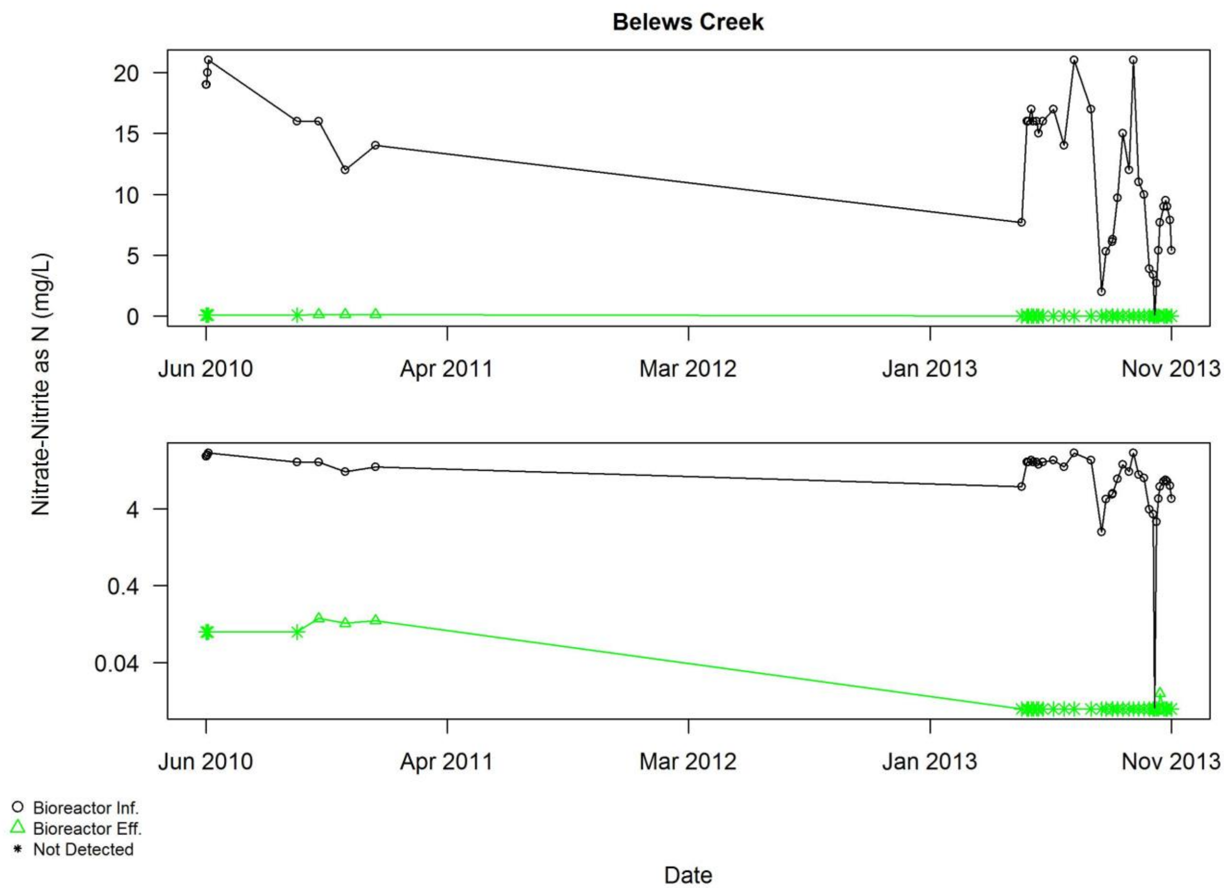


Figure A4.6.9 Bioreactor effluent data of Nitrate-Nitrite as N for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot

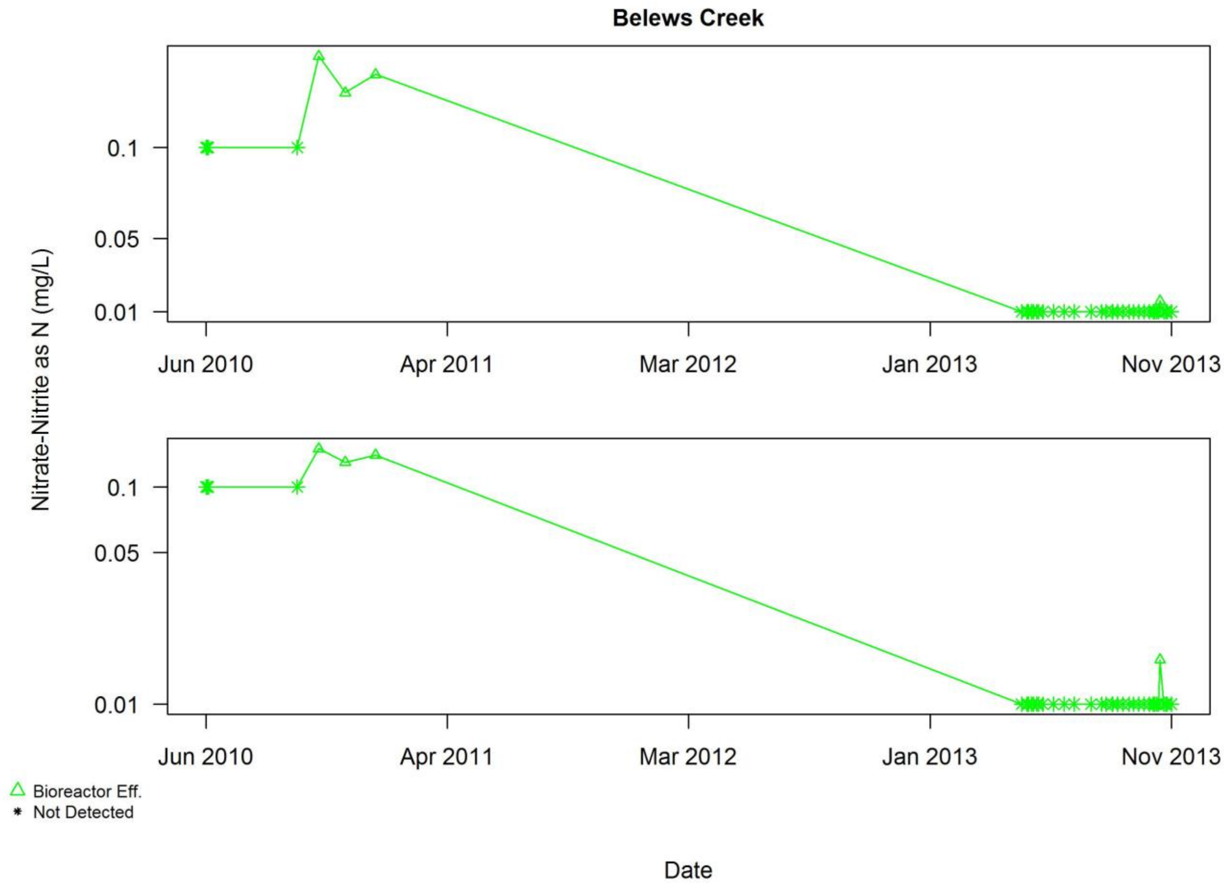


Figure A4.6.10 FGD Purge, Bioreactor influent, and Bioreactor effluent data of selenium for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

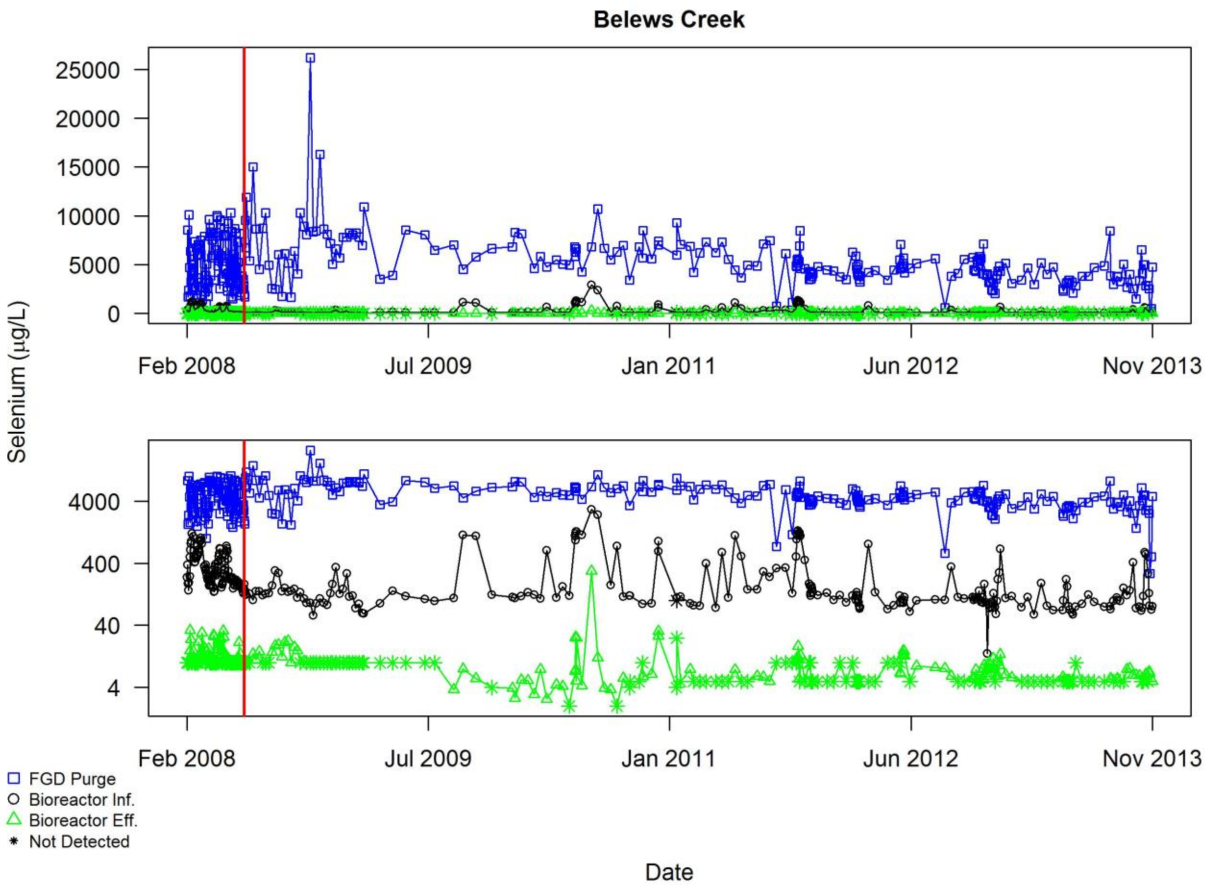


Figure A4.6.11 Bioreactor influent and Bioreactor effluent data of selenium for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period

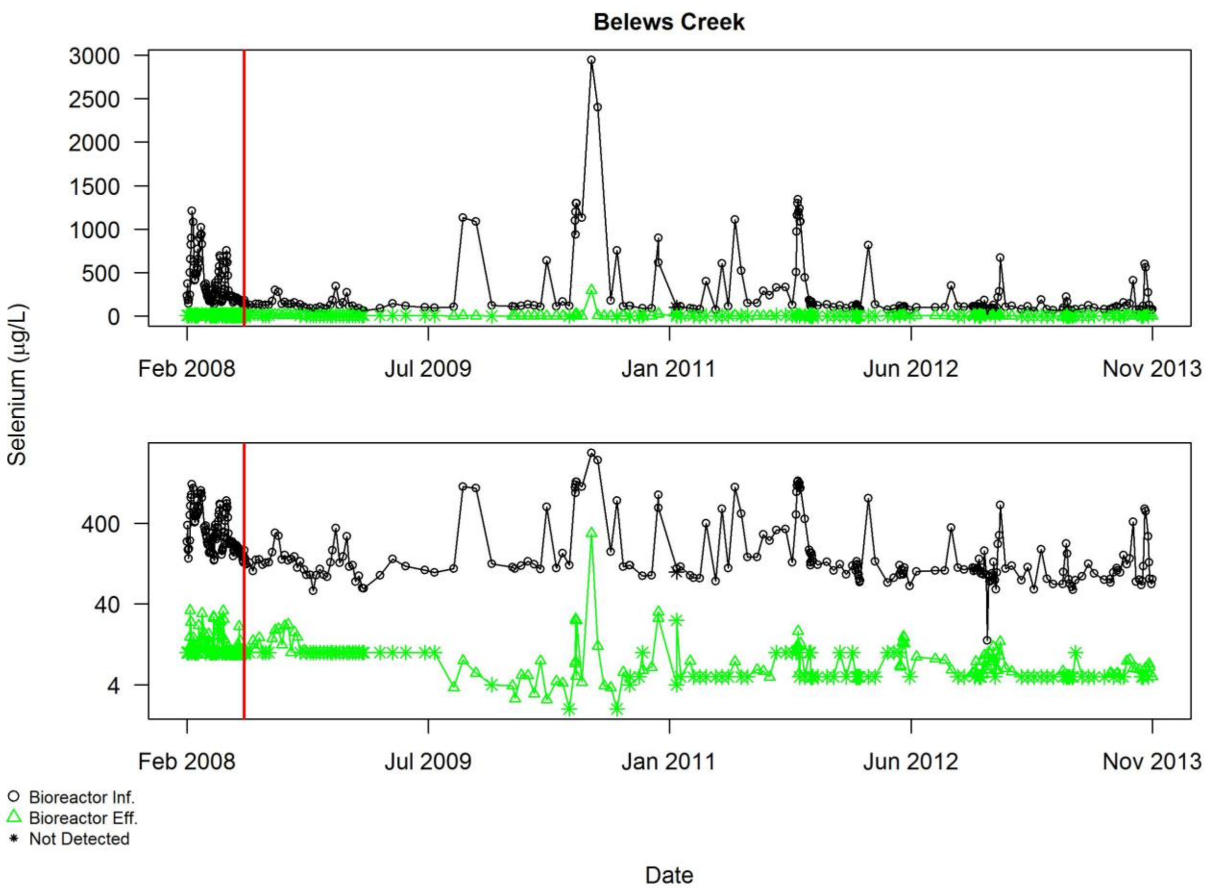
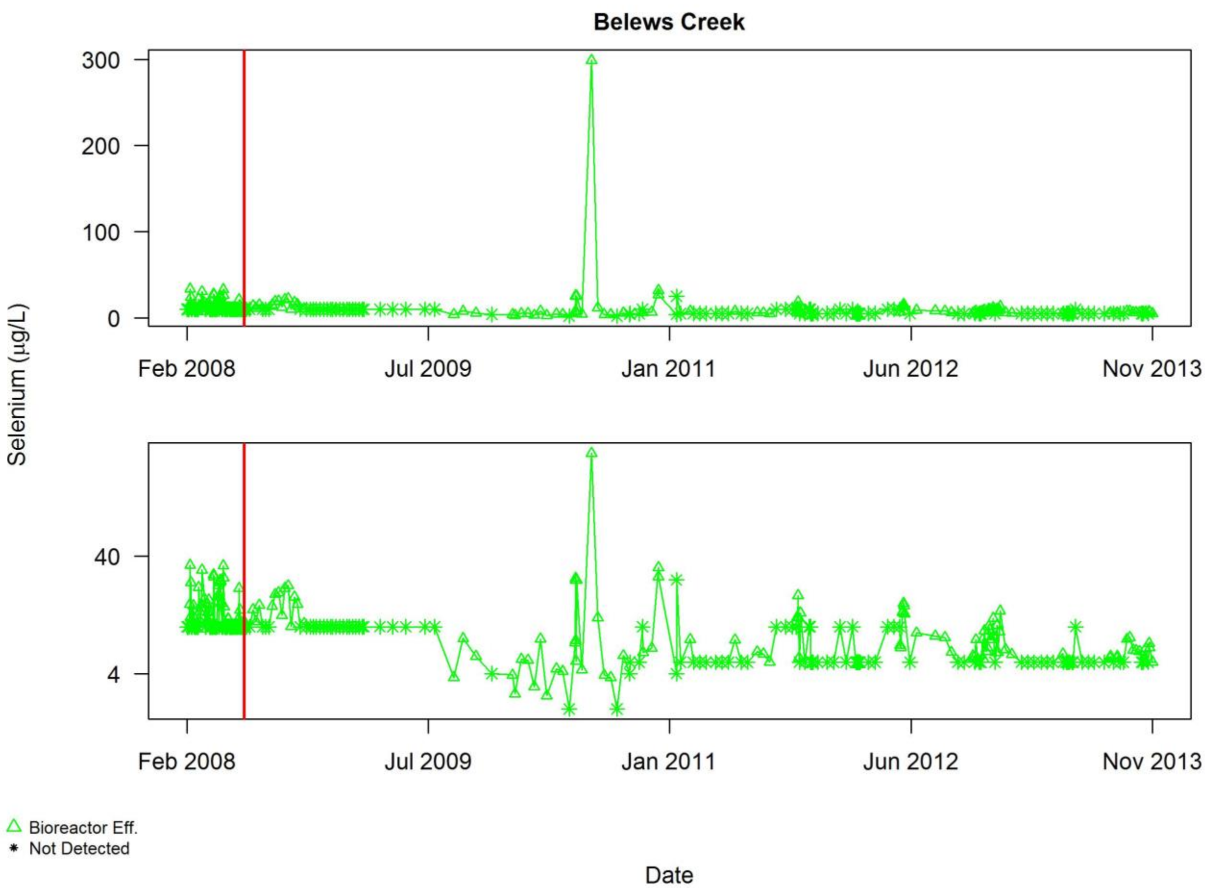


Figure A4.6.12 Bioreactor effluent data of selenium for Belews Creek, prior to excluding any data for reasons described in Section 3.2. Pollutant concentrations are shown on a linear scale in the upper plot, log scale in the lower plot. The red vertical line indicates the end of the commissioning period



Appendix 5. Plots to Identify Potential Outlier Observations Not Consistent with BAT/NSPS Operation of the Treatment System

Table of Contents

The plots in this appendix are intended as an aid to help identify observations that are outliers to facilitate evaluating whether the observations are consistent with data for a properly operated BAT/NSPS model treatment system. The plots presented already exclude data that were already determined to warrant exclusion, such as those with problem associated with the initial commissioning period for the treatment system, treatment system upset due to pipe broken, plant decommissioning period, analytical issues (e.g., analytical interferences, analytical methods not approved for NPDES purposes, etc.), or other previously identified abnormal operation. These known data abnormalities were excluded from the plots in this appendix because they distort the observed data. The resulting plots presented here in Appendix 5 are therefore helpful in identifying and illustrating the outliers.

- Concentrations of arsenic and mercury in the chemical precipitation effluent are plotted for Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie. Mercury data associated with the use of TMT-15 in the treatment system at Pleasant Prairie, arsenic data with problem associated with start up at Pleasant Prairie, and arsenic and mercury data associated with treatment system update or abnormal operation at Hatfield's Ferry and Pleasant, are highlighted in pink.

- Concentrations of selenium and nitrate-nitrite as N in the bioreactor effluent are plotted for Allen and Belews Creek.

Figure A5.1 Plot of available effluent arsenic and mercury data for Hatfield's Ferry after excluding all data that warranted exclusion except outliers

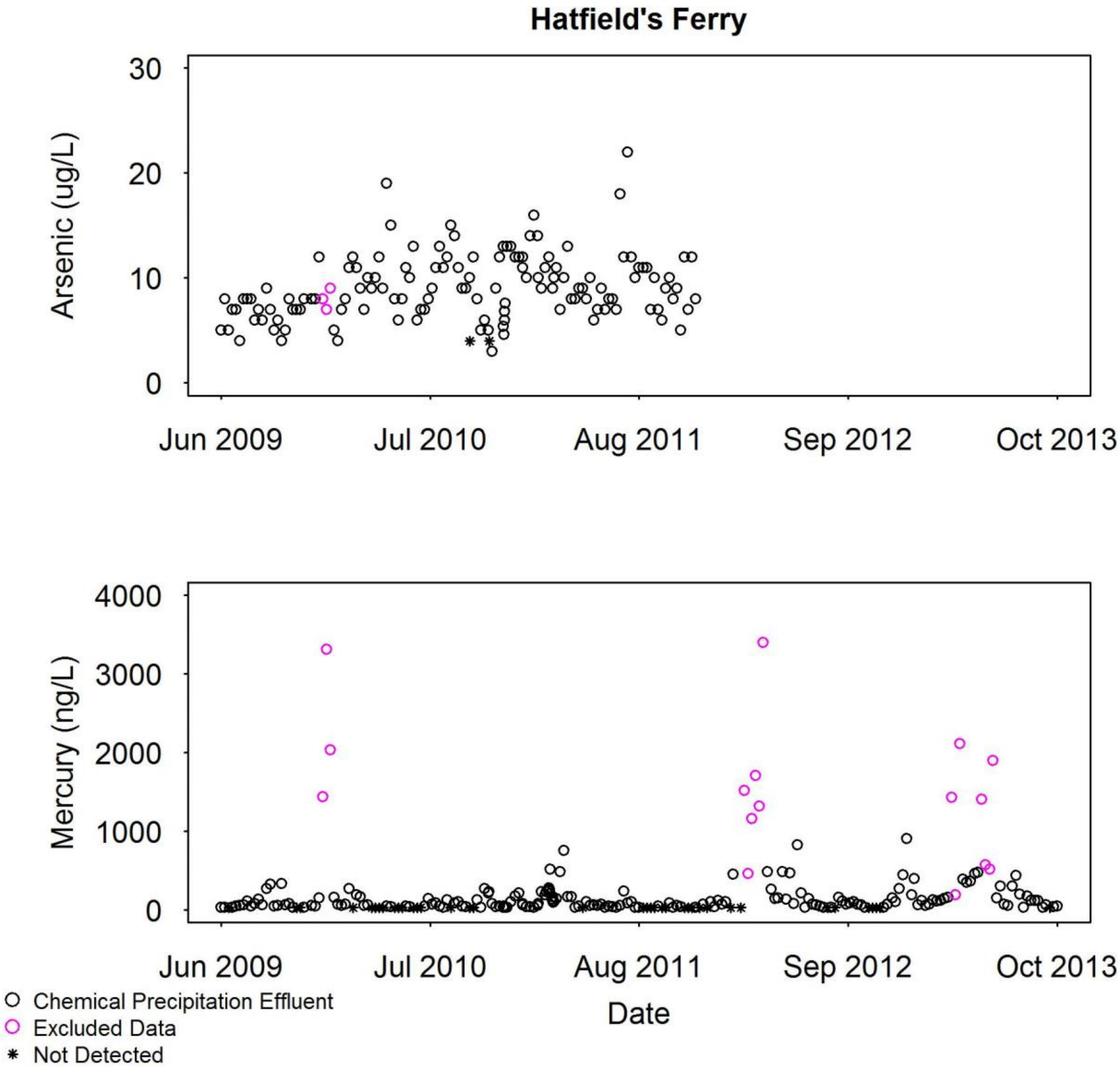


Figure A5.2 Plot of available effluent arsenic and mercury data for Keystone after excluding all data that warranted exclusion except outliers

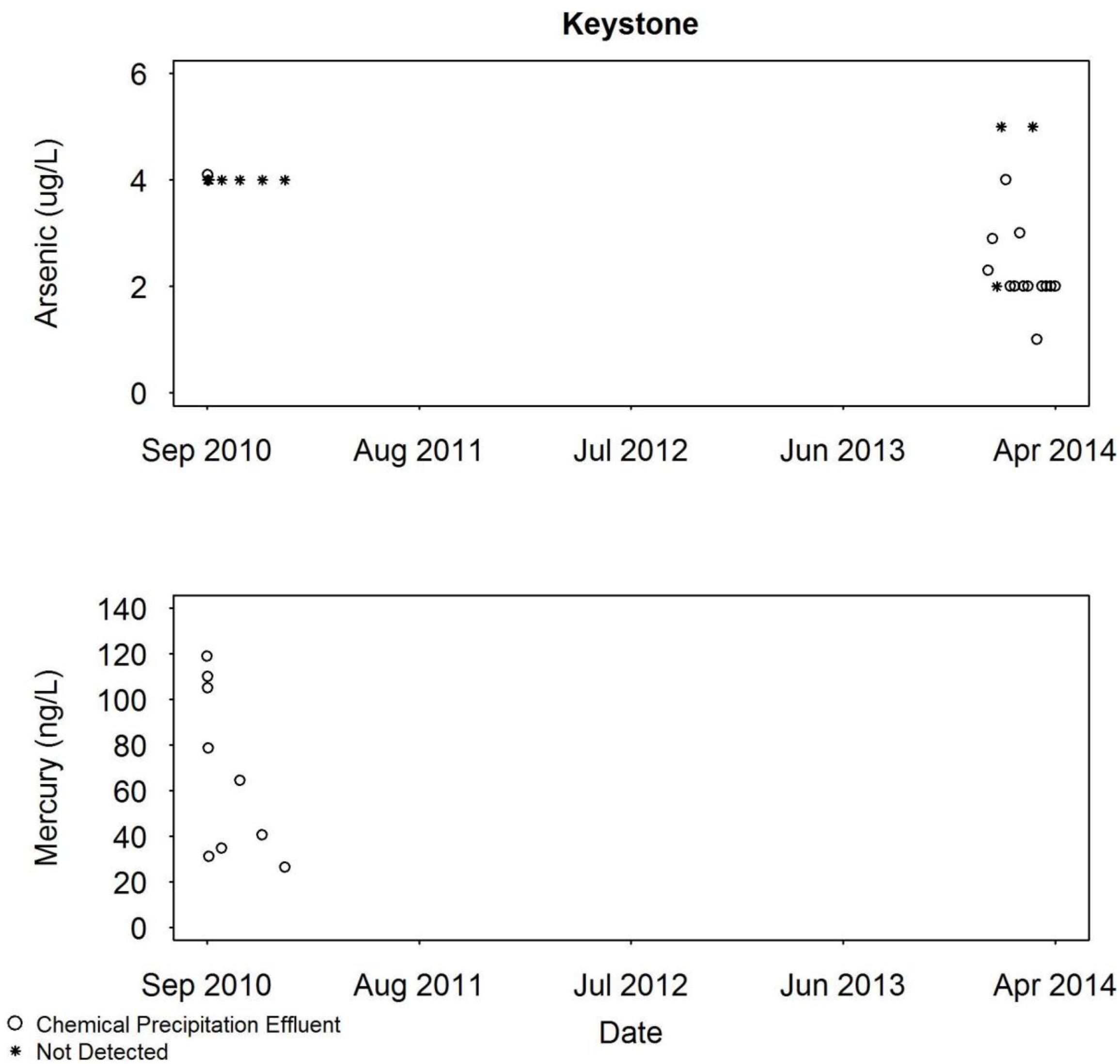


Figure A5.3 Plot of available effluent arsenic and mercury data for Miami Fort after excluding all data that warranted exclusion except outliers

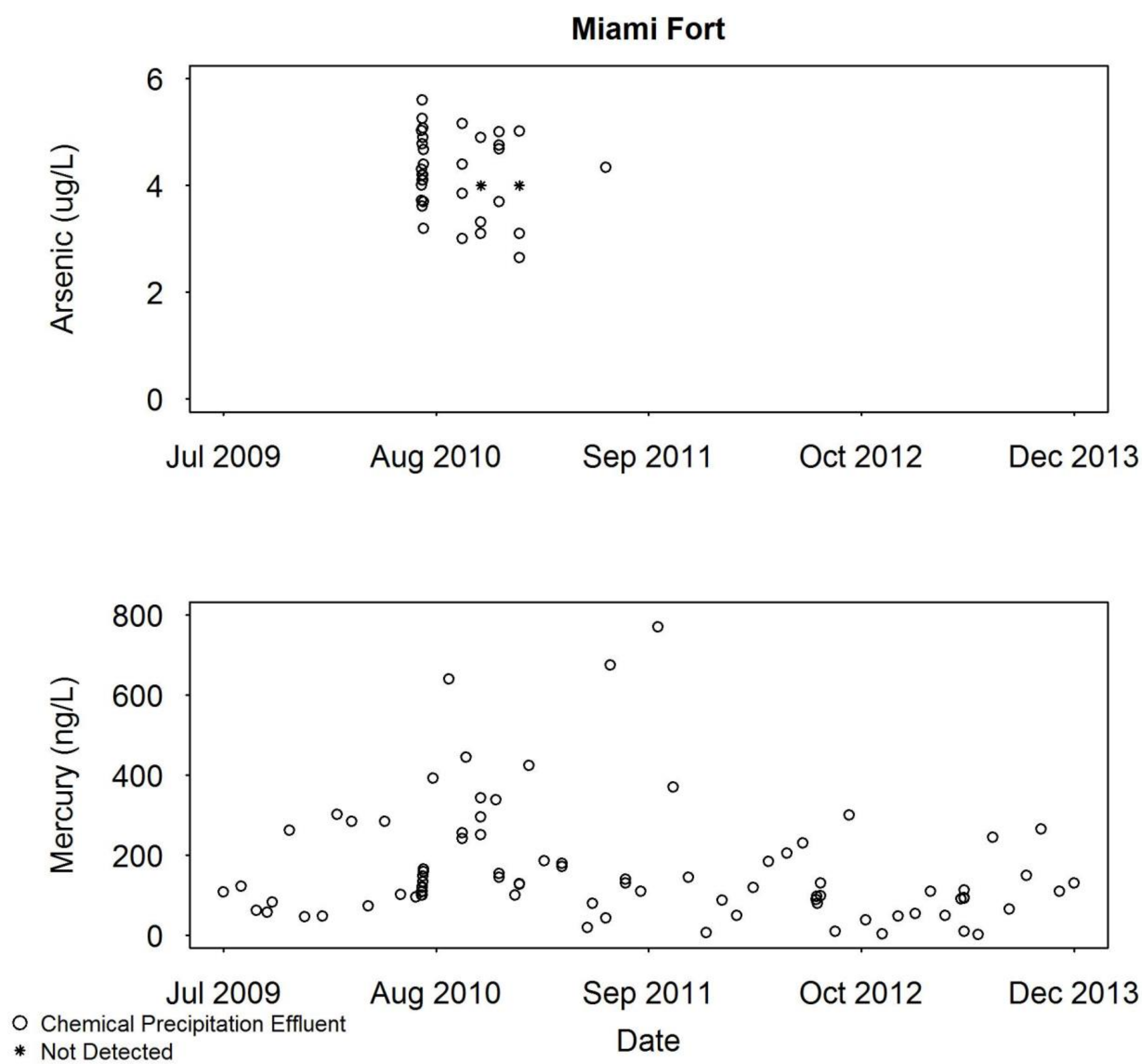


Figure A5.4 Plot of available effluent arsenic and mercury data for Pleasant Prairie after excluding all data that warranted exclusion except outliers. The red vertical line indicates the end of TMT 15 use

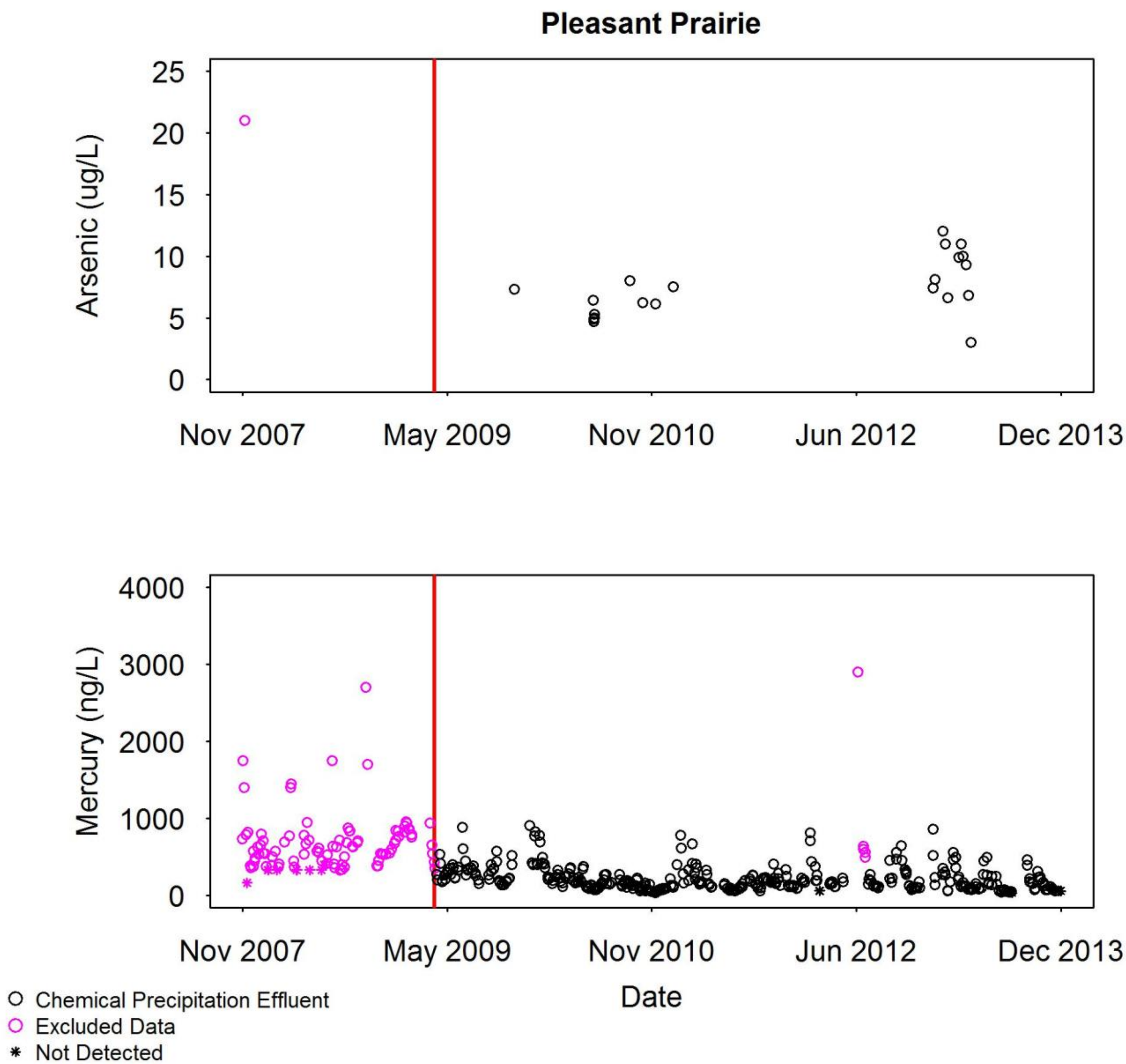


Figure A5.5 Plot of available effluent Nitrate-Nitrite as N and selenium data for Allen after excluding all data that warranted exclusion except outliers

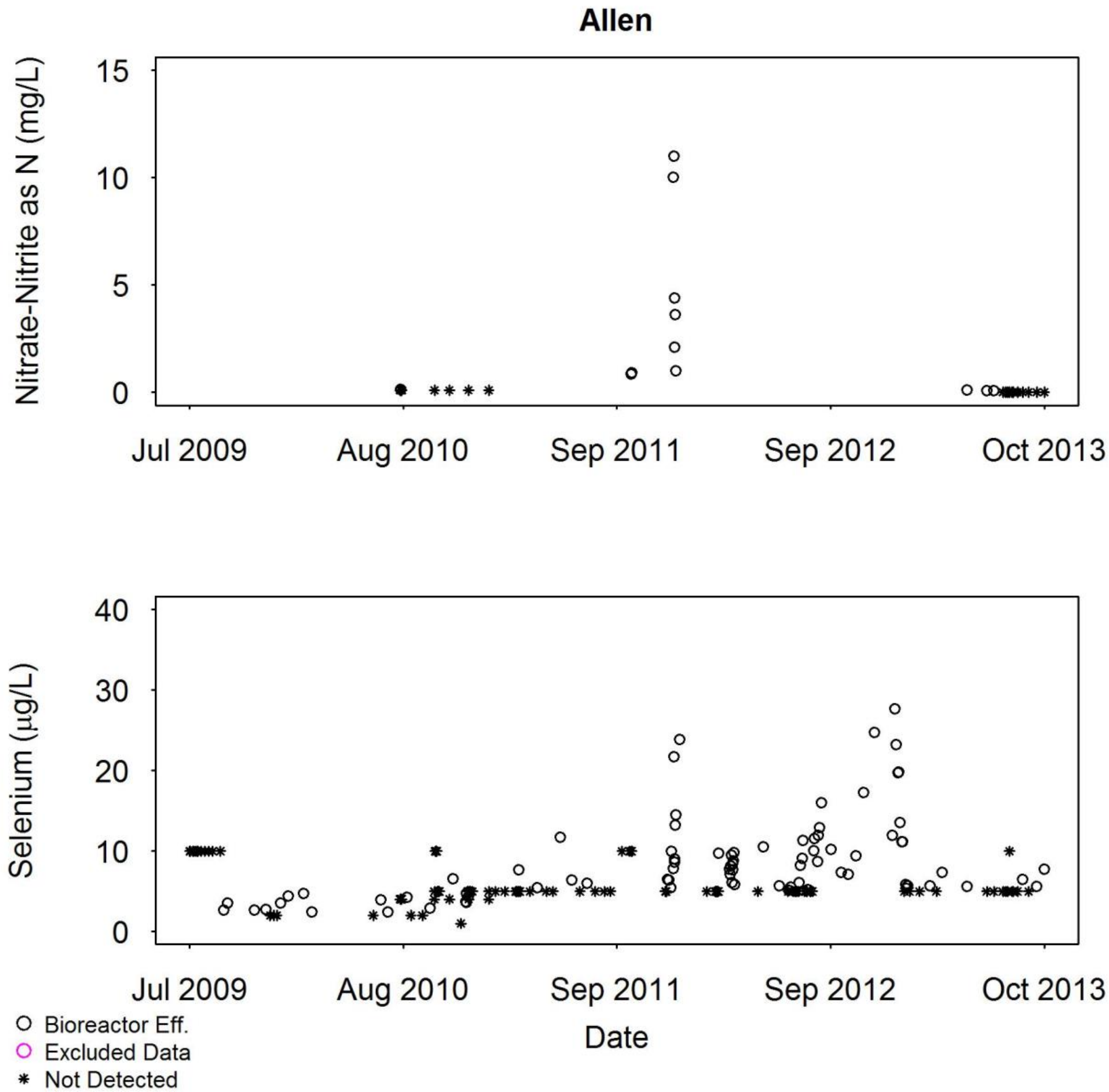
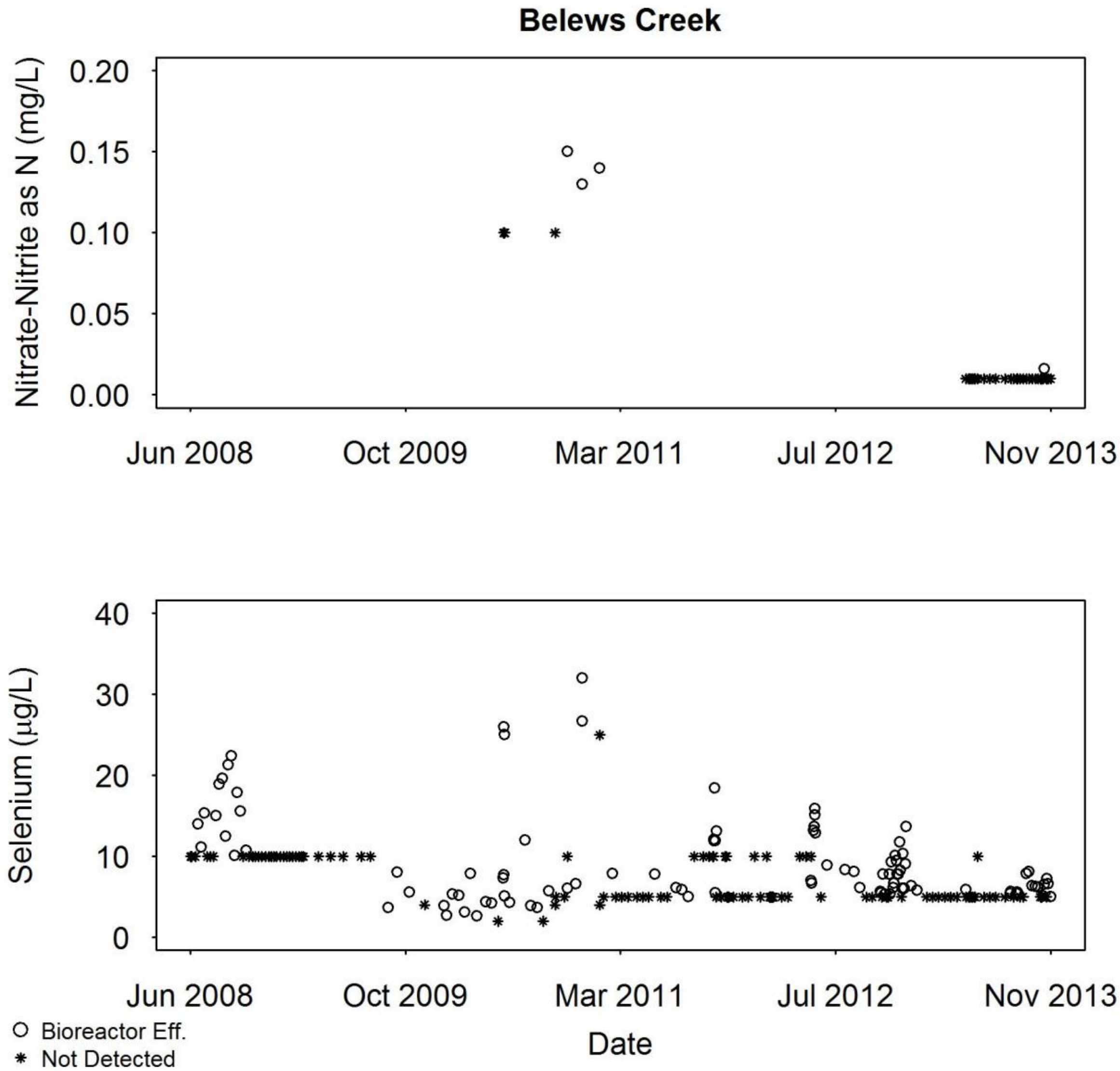


Figure A5.6 Plot of available effluent Nitrate-Nitrite as N and selenium data for Belews Creek after excluding all data that warranted exclusion except outliers



Appendix 6. Data Editing Criteria Results

Table of Contents

This appendix contains a summary of the results of the data editing criteria on a pollutant-by-pollutant basis to select a dataset at each plant to be used for calculating the effluent limits for each technology option (described in Section 4 of the document). These criteria are referred to as the long-term average test (or LTA test). EPA established the LTA test to ensure that the pollutants for which limits are being set were present in the influent at sufficient concentrations to evaluate treatment effectiveness at the plant. The data editing procedure is specified as follows: first, the influent had to pass a basic requirement that 50% of the influent measurements for the pollutant have to be detected at any concentration. If the dataset for a pollutant at a plant passed the basic requirement, it then had to pass one of the following two criteria to pass the LTA test:

> Criterion 1. At least 50% of the influent measurements in a dataset at a plant are detected at levels equal to or greater than 10 times the baseline value (shown in Section 3.3).
>
> Criterion 2. At least 50% of the influent measurements in a dataset at a plant are detected at any concentration and the influent arithmetic average equal to or greater than 10 times the baseline value (shown in Section 3.3).

If the dataset at a plant failed the basic requirement, then EPA automatically set both Criteria 1 and 2 to "fail." If the dataset for a plant failed the basic requirement, or passed the basic requirement but failed both criteria, EPA would exclude the plant's effluent data for that pollutant when calculating the limits. Through the application of the LTA test, EPA ensures that the limits result from treatment of the wastewater and not simply the absence or substantial dilution of that pollutant in the waste stream.

Table A6.1 shows how each pollutant at each plant fared with respect to the basic requirement and the two criteria of the LTA test. The bullets below provide a brief description for the important columns in the table:

- Column "N" presents the total number of influent observations (detected and non-detected combined)
- Column "Percent Detected for Influent (%)" shows the percent of influent observations that are detected.
- Column "Basic Requirement" contains an indicator of whether the dataset passed (or failed) the basic requirement in the data editing criteria.
- Column "Baseline Value" shows the baseline value for each pollutant.
- Column "% Influent values ≥10*baseline value" contains the percent of influent observations that are at least 10 times the baseline values.

- Column "Criterion 1" contains an indicator of whether the dataset passed (or failed) criterion 1 of the LTA test.
- Column "Mean Influent" shows the mean of the influent concentrations.
- Column "Criterion 2" contains an indicator of whether the dataset passed (or failed) criterion 2 of the LTA test.

The influent sampling location at each plant is given in the bullets below:

- FGD Purge: Allen, Belews Creek, Hatfield's Ferry, Keystone, Miami Fort, and Brindisi.
- Vapor Compression Evaporator Influent: Polk and Wabash River.

As shown in Table A6.1, the data for each pollutant at each of the plants all passed the LTA test, except for arsenic and mercury at Wabash River. Since the data for these pollutants failed the LTA test, EPA excluded the Wabash River data for these pollutants in developing the limits for gasification wastewater.

Table A6.1 Summary of the results for data editing procedure performed to select a dataset for pollutant at each plant in calculating the limits

Plant Name	Pollutant (unit)	N[1]	Percent Detected for Influent (%)	Basic Requirement[2]	Baseline Value	% Influent values ≥ 10*baseline (%)	Criterion[1]	Mean Influent	Criterion[2]
Allen	Arsenic (µg/L)	173	100	Passed	2	100	Passed	217.3	Passed
Allen	Mercury (ng/L)	172	100	Passed	0.5	100	Passed	52,073.0	Passed
Allen	Nitrate Nitrite as N (mg/L)	32	100	Passed	0.05	100	Passed	50.5	Passed
Allen	Selenium (µg/L)	173	100	Passed	5	100	Passed	2,091.5	Passed
Belews Creek	Arsenic (µg/L)	201	100	Passed	2	100	Passed	288.1	Passed
Belews Creek	Mercury (ng/L)	199	100	Passed	0.5	100	Passed	203,333.2	Passed
Belews Creek	Nitrate Nitrite as N (mg/L)	38	100	Passed	0.05	100	Passed	11.5	Passed
Belews Creek	Selenium (µg/L)	207	100	Passed	5	100	Passed	5,155.0	Passed
Hatfield's Ferry	Arsenic (µg/L)	8	100	Passed	2	100	Passed	1,796.3	Passed
Hatfield's Ferry	Mercury (ng/L)	7	100	Passed	0.5	100	Passed	496,285.7	Passed
Keystone	Arsenic (µg/L)	130	94.6	Passed	2	100	Passed	1,569.9	Passed
Keystone	Mercury (ng/L)	130	93.1	Passed	0.5	100	Passed	438,659.2	Passed
Miami Fort	Arsenic (µg/L)	8	100	Passed	2	100	Passed	744.8	Passed
Miami Fort	Mercury (ng/L)	62	100	Passed	0.5	100	Passed	286,137.9	Passed
Pleasant Prairie	Arsenic (µg/L)	16	93.8	Passed	2	87.5	Passed	117.0	Passed
Pleasant Prairie	Mercury (ng/L)	166	100	Passed	0.5	100	Passed	1,382,747.0	Passed
Brindisi	Arsenic (µg/L)	2	100	Passed	2	100	Passed	54.0	Passed
Brindisi	Mercury (ng/L)	2	100	Passed	0.5	100	Passed	24,000.0	Passed
Brindisi	Selenium (µg/L)	2	100	Passed	5	100	Passed	255.0	Passed
Brindisi	TDS (mg/L)	2	100	Passed	10	100	Passed	14,000.0	Passed
Polk	Arsenic (µg/L)	4	100	Passed	2	100	Passed	280.0	Passed
Polk	Mercury (ng/L)	4	100	Passed	0.5	100	Passed	70.4	Passed
Polk	Selenium (µg/L)	4	100	Passed	5	100	Passed	1,277.5	Passed
Polk	TDS (mg/L)	4	100	Passed	10	100	Passed	4,575.0	Passed
Wabash River	Arsenic (µg/L)	4	50	Passed	2	0	Failed	4.5	Failed
Wabash River	Mercury (ng/L)	4	0	Failed	0.5	75	Failed	8.7	Failed
Wabash River	Selenium (µg/L)	4	100	Passed	5	100	Passed	920.0	Passed
Wabash River	TDS (mg/L)	4	100	Passed	10	100	Passed	4,225.0	Passed

[1]Total number of observations (detected and non-detected combined).

[2]if a dataset fails the basic requirement, EPA automatically set both Criteria 1 and 2 to Failed.

Appendix 7. Summary of the Results for the Engineering Review of the Limits

Table of Contents

Tables		Page

Table of Contents (continued)

Figures **Page**

Table of Contents (continued)

Table of Contents (continued)

Figures **Page**

Table of Contents (continued)

Figures | **Page**

As described in Section 11, to evaluate whether the limits are reasonable, EPA performed an engineering review to verify that the limits are reasonable based upon the design and expected operation of the control technologies. EPA performed two types of comparisons for this evaluation. First, EPA compared the limits to the effluent data used to develop the limits. Second, EPA compared the limits to the influent data.

Section 1 of this appendix presents the results of the comparisons between the limits and all effluent data that were used to calculate the limits for each technology option. A series of plots is presented for each technology option, showing how each of the daily observations compare to the daily limit. All daily observations that were above the daily limit are summarized in a table following the plots of daily data. Another series of plots is presented for each technology option, showing how the effluent values compare to the monthly average limits, for those periods where there were sufficient data to represent weekly monitoring. Values for those months where the average exceeds the monthly limit, along with each daily observation for those months, are presented in a table following the plots of monthly averages.

Section 2 of this appendix contains the results of the comparisons between the limits and influent data for each technology option.

1. Comparison of the Limits to the Effluent Data Used as the Basis for the Limits

A series of plots is presented for each regulated parameter, showing how each of the daily observations compare to the daily limit. For limits based on data from more than one plant, the first plot in a series presents the data for all of the plants (for example, see Figure A7.1). Each grey panel on that plot has data from one plant, indicated by the label on the horizontal axis. Within each grey panel, the thin dashed line shows the plant-specific LTA. The wider dashed line that crosses the data from all plants is the LTA for the technology option. The solid line shows the limitation established for the parameter and technology option. Within each grey panel the observed concentrations are ordered by date and plotted by order; thus observations that are relatively far apart in time may plot next to each other. Following the first plot in a series are additional plots that show the data for each plant individually (for example, see Figures A7.2 through A7.5). These plots use the sample collection date for the horizontal axis. As is the case for the first plot in a series, the plots include horizontal lines depicting the plant-specific LTA, option-level LTA, and the limitation.

Following all plots for a technology option comparing the daily observations to the daily limit, all daily observations that were above the daily limit are summarized in a table (for example, see Table A7.1).

Another series of plots is presented for each technology option, showing how the effluent values compare to the monthly average limits, for those periods where there were sufficient data to represent weekly monitoring. Values for those months where the average of all daily values is above the monthly limit, along with each daily observation for those months, are presented in a table following the plots of monthly averages. Again, a series of plots is presented for each regulated parameter, showing how the monthly averages calculated for each calendar month compare to the monthly limit, for those periods where there are sufficient data to represent weekly monitoring. For limits based on data from more than one plant, the first plot in a series presents the data for all of the plants (for example, see Figure A7.11). Each grey panel on that plot has data from one plant, indicated by the label on the horizontal axis. Following the first plot in a series are additional plots that show the data for each plant individually, with the sample collection date on the horizontal axis (for example, see Figures A7.12 and A7.13). As is the case for the first plot in a series, the plots include horizontal lines depicting the plant-specific LTA, option-level LTA, and the limitation.

For each plant and analyte, monthly averages for calendar months were calculated using all daily effluent values within the calendar month. As described in Section 11, this comparison to the monthly limit requires that the observations are representative of weekly monitoring. EPA accounted for this by calculating monthly averages for all time periods where there were at least four daily values with the sample dates spread across a period of at least several weeks (i.e., that spanned a range of at least 21 days and for which the maximum number of days between sequential samples was 10 days or less). Data not representative of weekly (or more frequent) monitoring generally were not valid for this evaluation. As a result, samples collected in a short time frame, or samples that were not spread across the month were not used when comparing the monthly averages to the monthly limits.

Following all plots for a technology option comparing the monthly average to the monthly limit, all results above the monthly limit, along with all daily observations for the month, are summarized in a table (for example, see Table A7.2).

Arsenic and Mercury Limits for FGD Wastewater, Based on Chemical Precipitation Treatment Technology

The limitations based on chemical precipitation treatment for FGD wastewater were calculated using data without adjusting for baseline substitution. As a result, the effluent limits were compared to the reported concentrations without baseline adjustment.

Figures A7.1 through A7.5 show the arsenic daily limitation and daily effluent concentrations used to calculate the arsenic limitations for FGD wastewater, based on chemical precipitation treatment. All observations for two plants were equal to or below the daily maximum limit (24 observations at Keystone; 9 observations at Miami Fort). At Pleasant Prairie, all but one of the 20 observations were equal to or below the daily limit. At Hatfield's Ferry, 102 observations were equal to or below the limit; 28 of the 130 observations were above the daily limit.

Figures A7.6 through A7.10 show the mercury daily limitation and daily effluent concentrations used to calculate the mercury limitations for FGD wastewater, based on chemical precipitation treatment. All observations for two plants were equal to or below the daily maximum limit (8 observations at Keystone; 68 observations at Miami Fort). At Pleasant Prairie, 370 of the 375 observations were equal to or below the daily limit; only 5 observations were above the limit. At Hatfield's Ferry, 217 of the 219 observations were equal to or below the limit; only 2 observations were above the daily limit. All values above the daily limit are listed in Table A7.1.

The observations that are equal to or below the arsenic and mercury daily limits can be determined by comparing the observations in Table A7.1 to the data listed in DCN SE06277.

Figure A7.1 Arsenic daily limitation and daily concentrations (µg/L) at Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

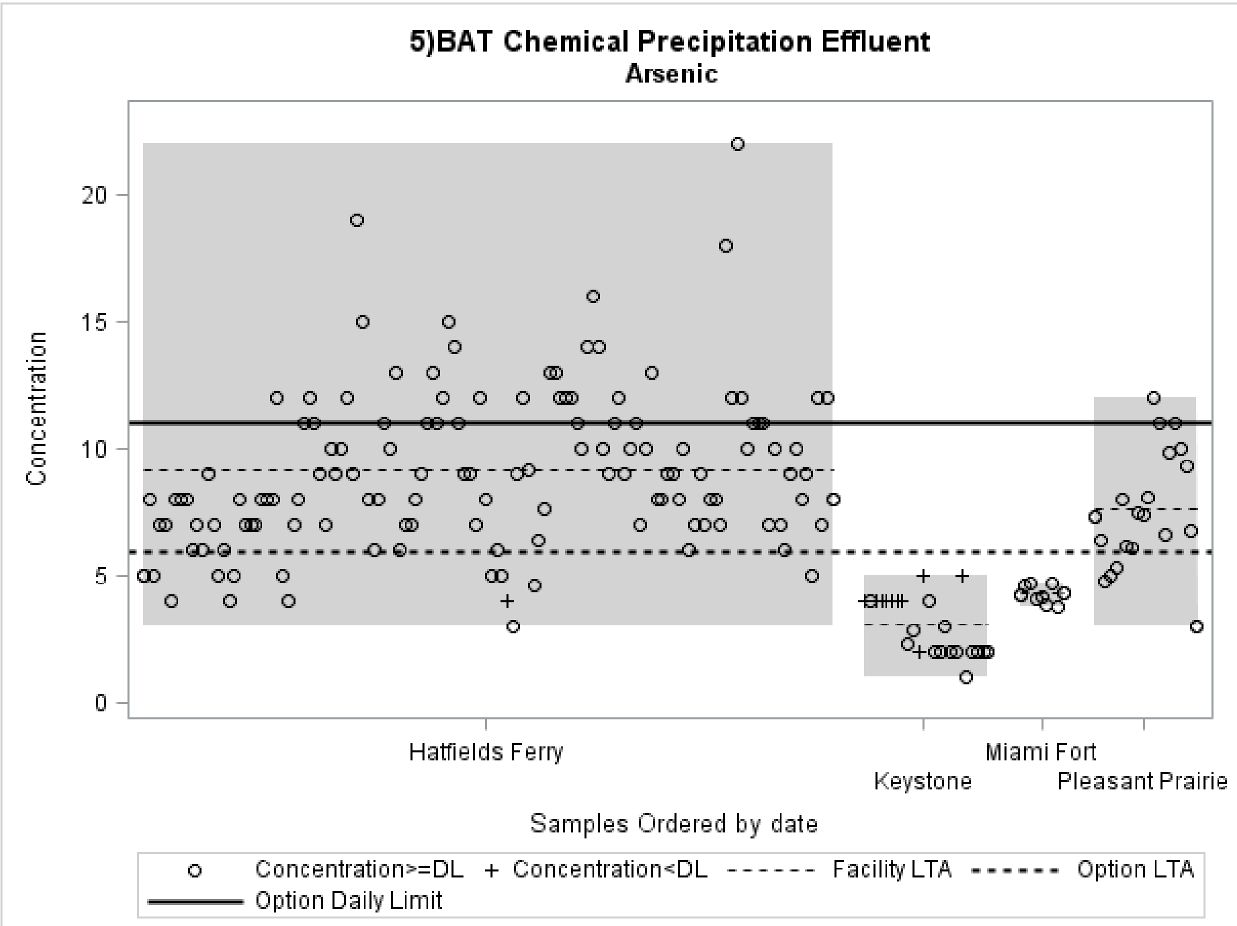


Figure A7.2 **Arsenic daily limitation and daily concentrations (µg/L) at Hatfield's Ferry used to calculate the limitations based on chemical precipitation treatment of FGD wastewater**

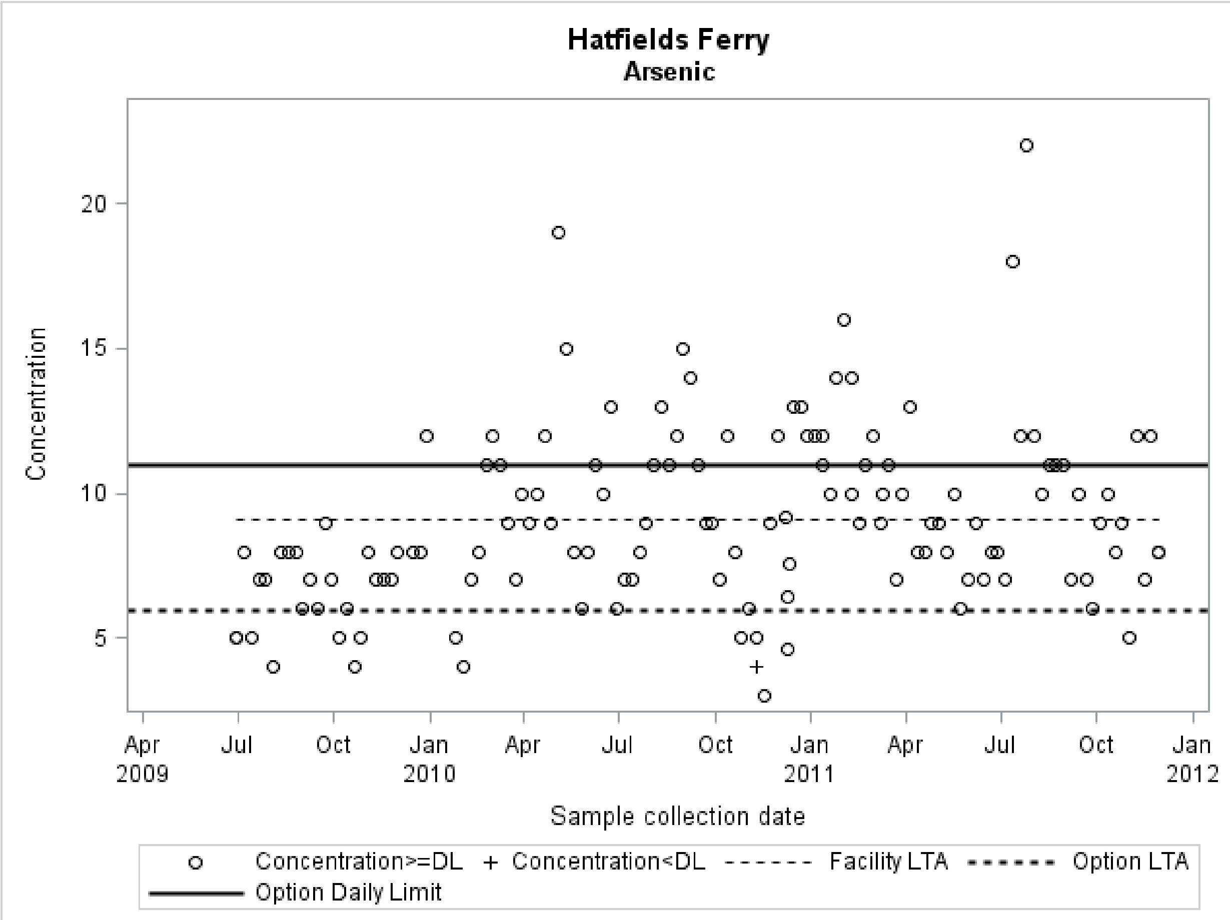


Figure A7.3 Arsenic daily limitation and daily concentrations (µg/L) at Keystone used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

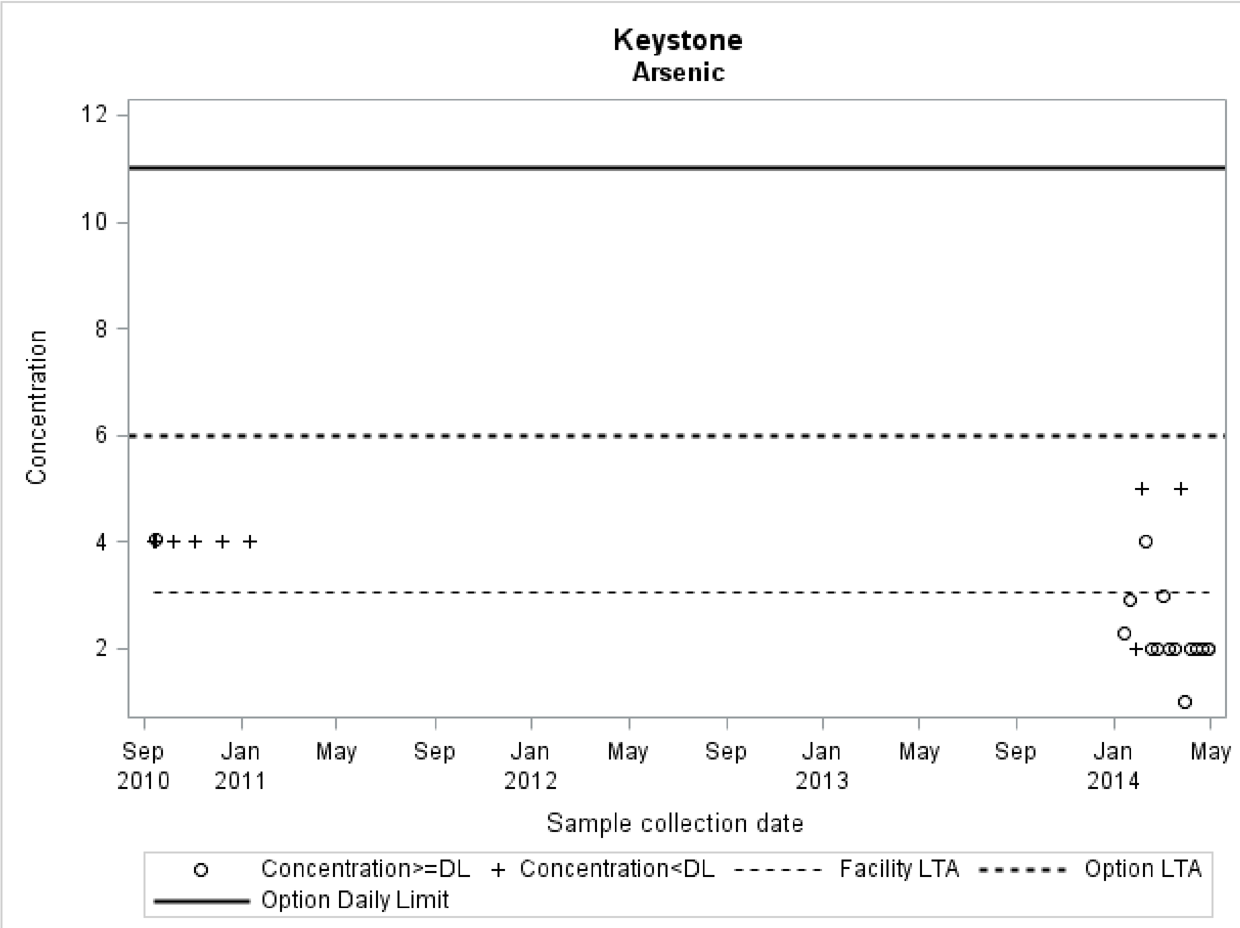


Figure A7.4 Arsenic daily limitation and daily concentrations (µg/L) at Miami Fort used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

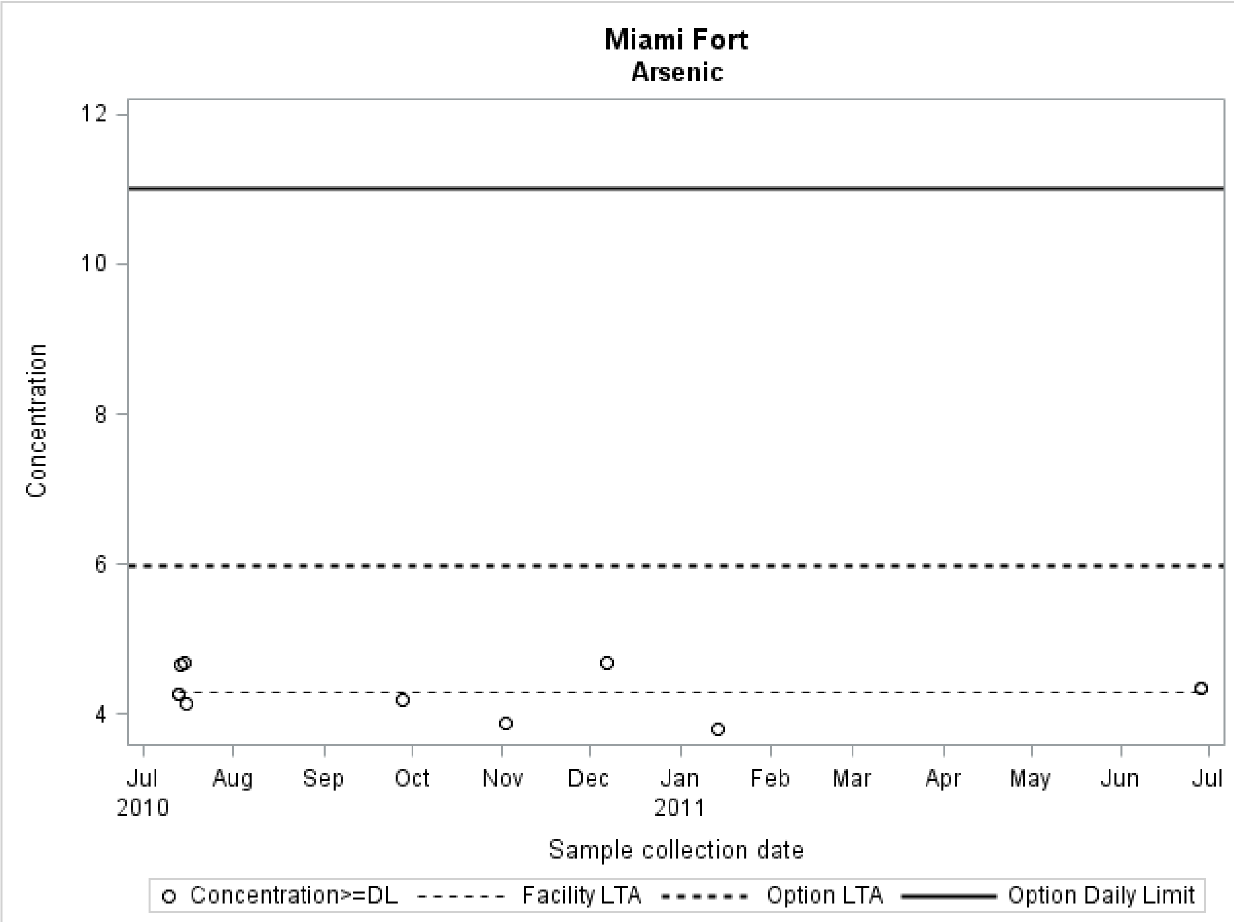


Figure A7.5 **Arsenic daily limitation and daily concentrations (µg/L) at Pleasant Prairie used to calculate the limitations based on chemical precipitation treatment of FGD wastewater**

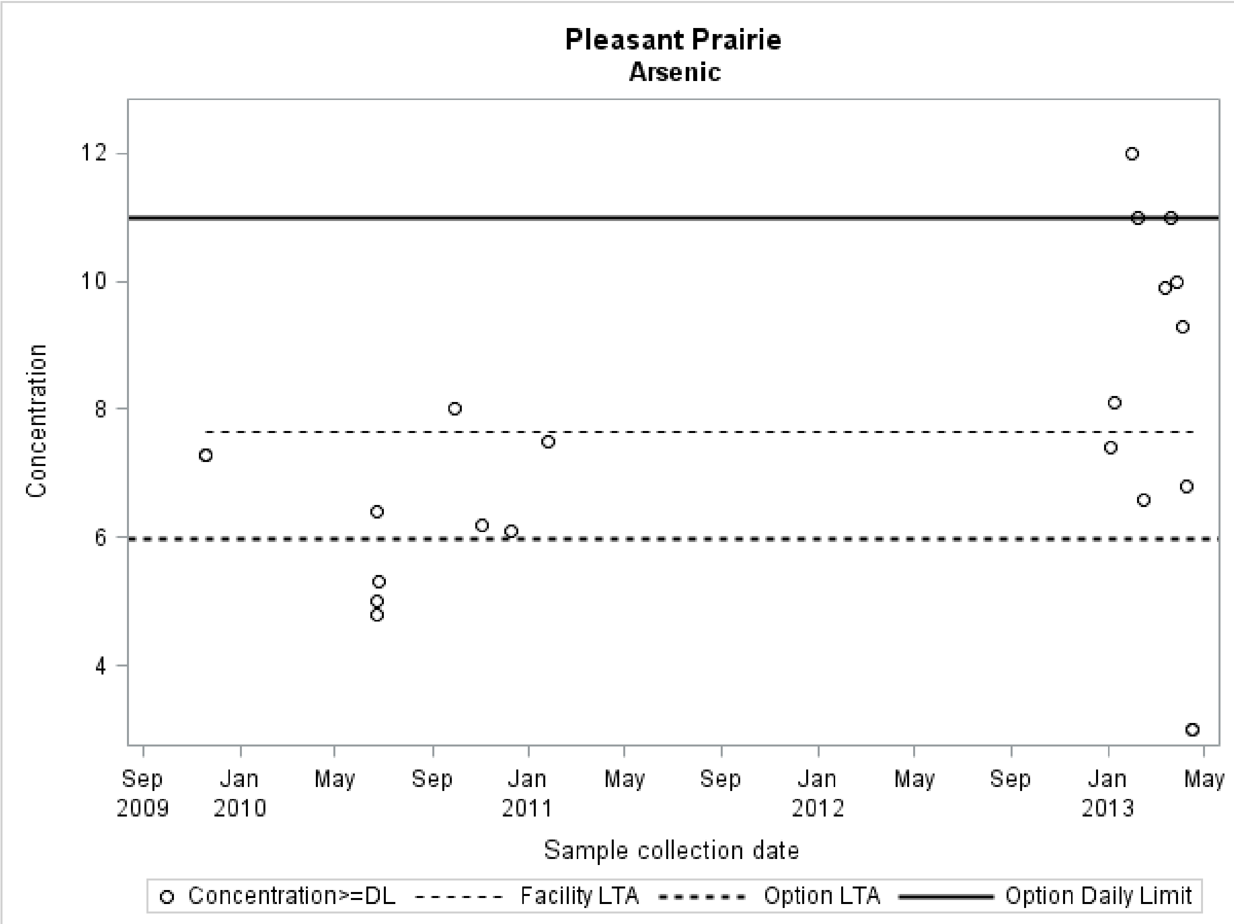


Figure A7.6 **Mercury daily limitation and daily concentrations (ng/L) at Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie used to calculate the limitations based on chemical precipitation treatment of FGD wastewater**

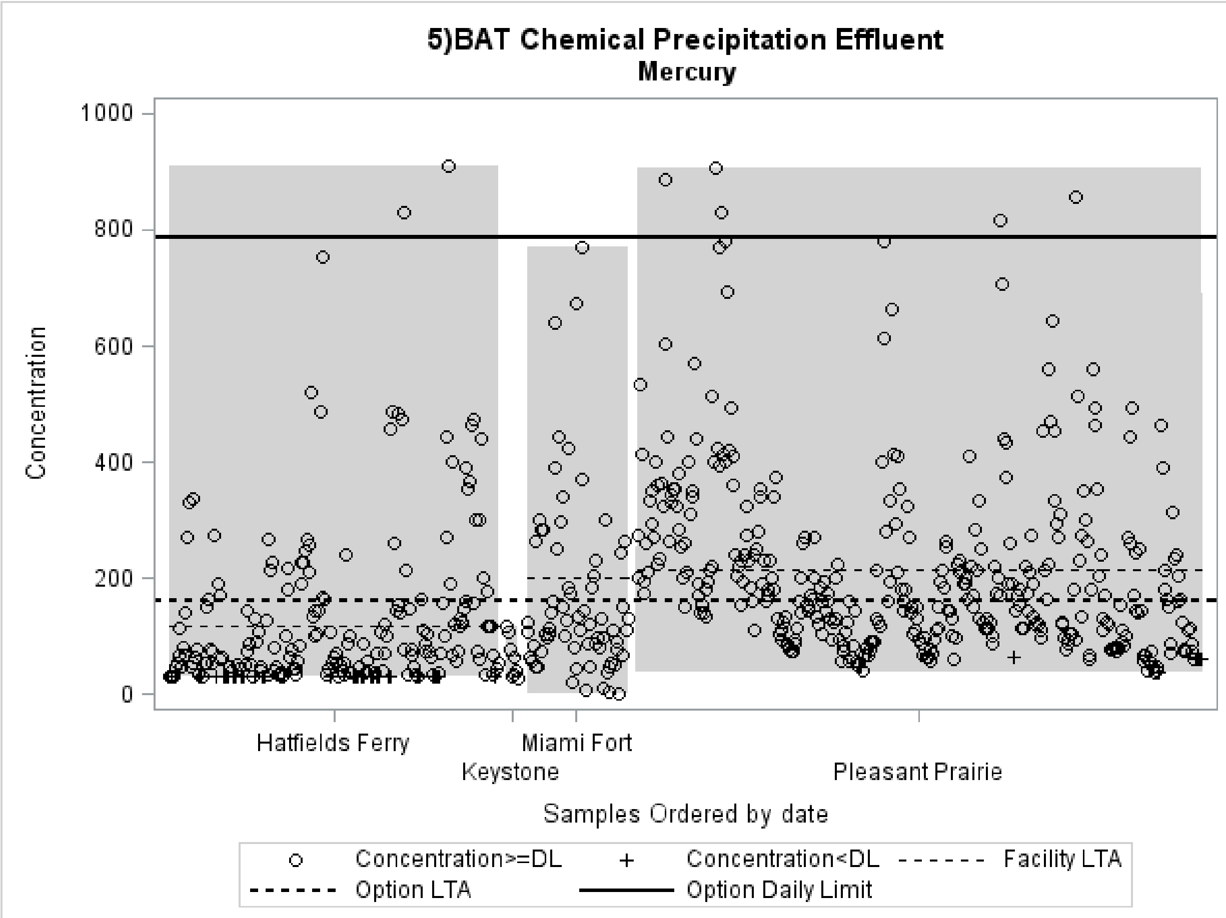


Figure A7.7 Mercury daily limitation and daily concentrations (ng/L) at Hatfield's Ferry used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

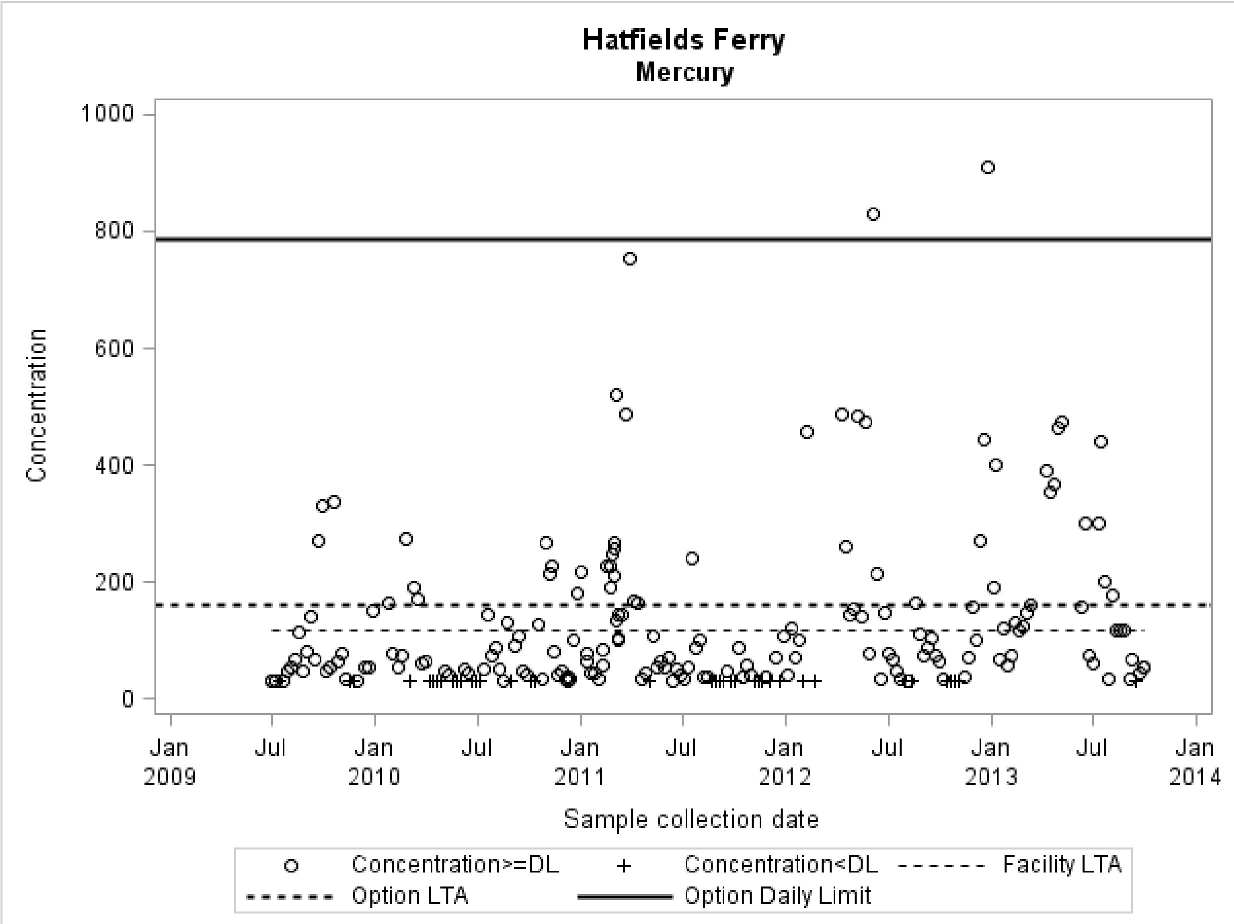


Figure A7.8 Mercury daily limitation and daily concentrations (ng/L) at Keystone used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

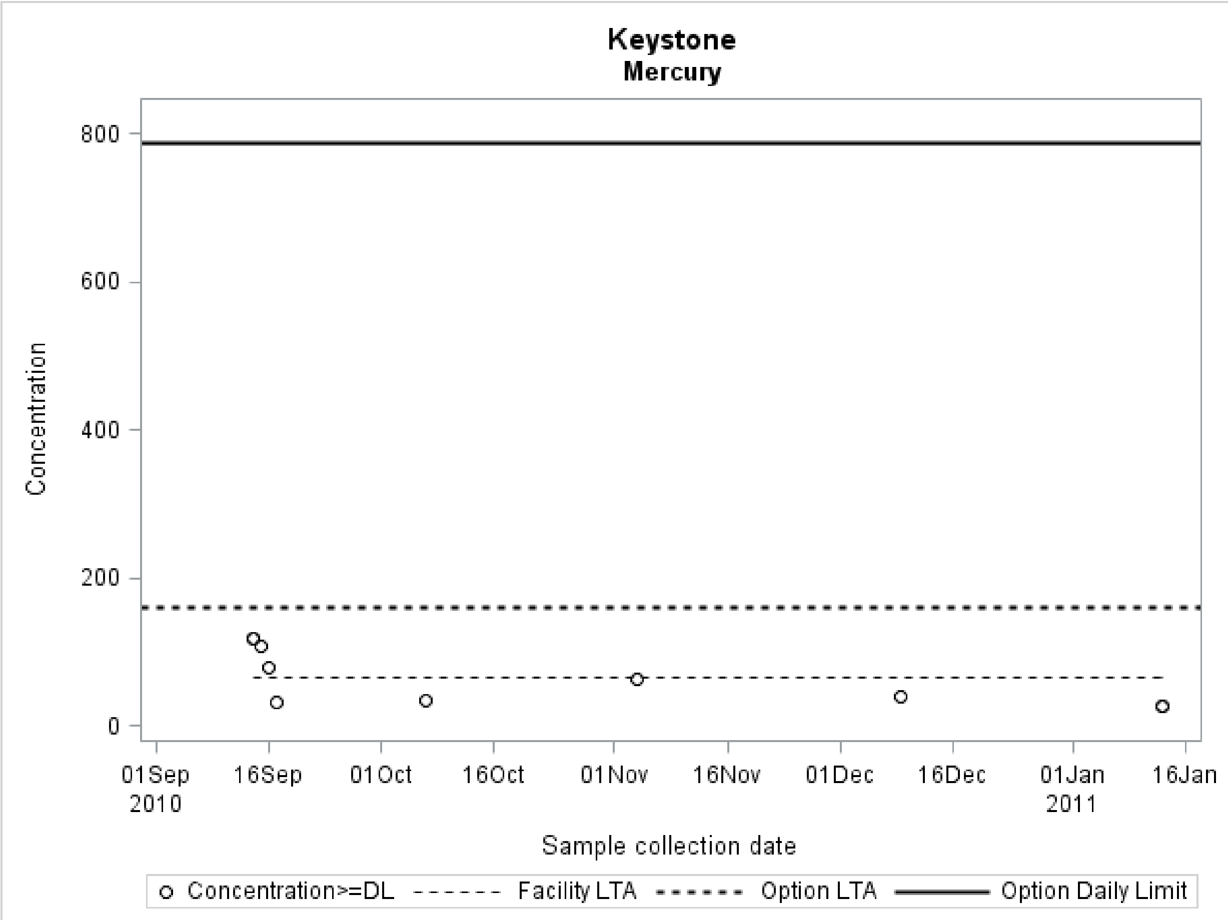


Figure A7.9 Mercury daily limitation and daily concentrations at Miami Fort (ng/L) used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

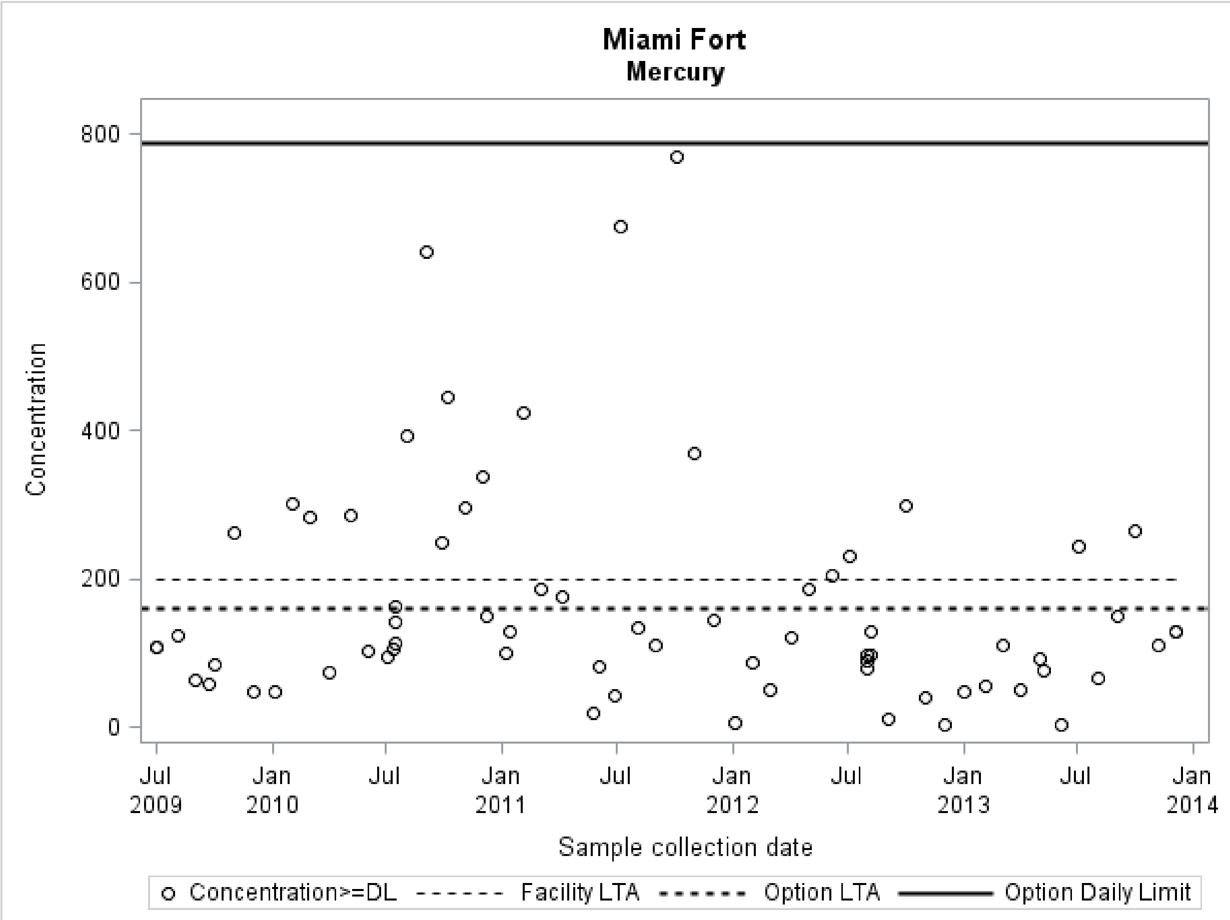


Figure A7.10 Mercury daily limitation and daily concentrations at Pleasant Prairie (ng/L) used to calculate the limitations based on chemical precipitation treatment of FGD wastewater

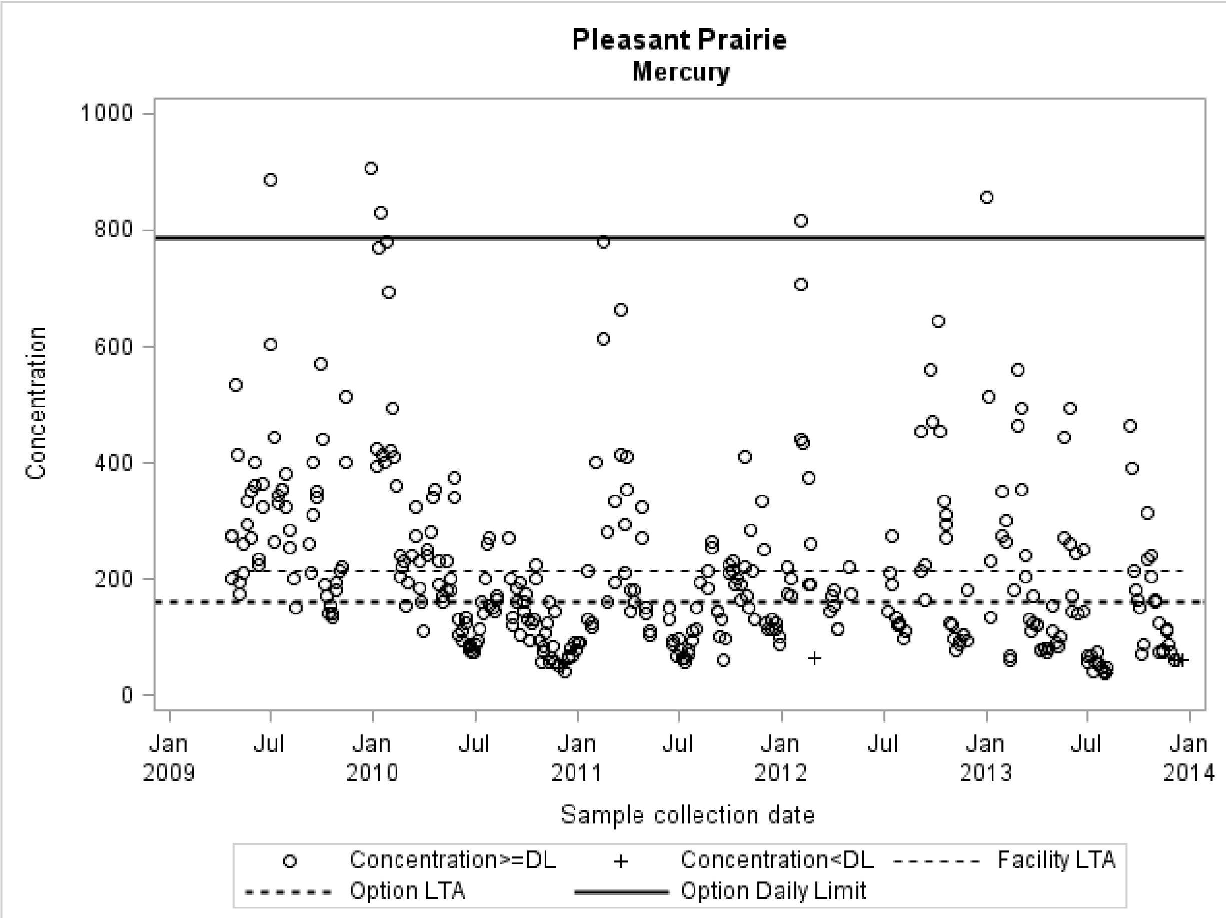


Table A7.1 List of all daily values that are above the daily limits for arsenic and mercury based on chemical precipitation treatment for FGD wastewater

Plant	Pollutant (Unit)	Daily Limit	Date	Concentration	Indicator
Hatfield's Ferry	Arsenic (µg/L)	11.00	12/29/2009	12	D
			03/02/2010	12	D
			04/20/2010	12	D
			05/04/2010	19	D
			05/11/2010	15	D
			06/22/2010	13	D
			08/10/2010	13	D
			08/24/2010	12	D
			08/31/2010	15	D
			09/07/2010	14	D
			10/12/2010	12	D
			11/30/2010	12	D
			12/14/2010	13	D
			12/21/2010	13	D
			12/28/2010	12	D
			01/04/2011	12	D
			01/11/2011	12	D
			01/25/2011	14	D
			02/01/2011	16	D
			02/08/2011	14	D
			03/01/2011	12	D
			04/05/2011	13	D
			07/12/2011	18	D
			07/19/2011	12	D
			07/26/2011	22	D
			08/02/2011	12	D
			11/08/2011	12	D
			11/22/2011	12	D
	Mercury (ng/L)	788.00	06/05/2012	830	D
			12/26/2012	909	D
Pleasant Prairie	Arsenic (µg/L)	11.00	01/30/2013	12	D
	Mercury (ng/L)	788.00	06/30/2009	885	D
			12/29/2009	905	D
			01/13/2010	830	D
			02/03/2012	815	D
			01/03/2013	855	D

[1]Daily limit set for each pollutant.

[2]D = detected and ND = non-detected.

Figures A7.11 through A7.13 show the monthly average arsenic concentrations for Hatfield's Ferry and Keystone and the monthly limitation for FGD wastewater, based on chemical precipitation treatment. Monthly averages could not be calculated for Miami Fort and Pleasant Prairie because samples were not collected with sufficient frequency at these plants to represent weekly monitoring. These plots use a format similar to the format used in Figures A7.1 through A7.10, but with one additional feature that shows each monthly average indicated by a plus (+) sign surrounded by a circle. The size of the circle is proportional to the number of daily observations that were used to calculate the monthly average. For Hatfield's Ferry and Keystone, EPA calculated monthly averages for the time periods where there were sufficient data. For Keystone, all such monthly averages were below the monthly limit. For Hatfield's Ferry, there were 12 months when the average value was equal to or below the monthly limit; there were 15 months when the average value was above the monthly limit (for 8 of those 15 months, the average was only 1-2 ug/L above the limit).

Figures A7.14 through A7.16 show the monthly average mercury concentrations for Hatfield's Ferry and Pleasant Prairie and the monthly limitation for FGD wastewater, based on chemical precipitation treatment. Monthly averages for could not be calculated for Keystone and Miami Fort because samples were not collected with sufficient frequency at these plants to represent weekly monitoring For Hatfield's Ferry and Pleasant Prairie, EPA calculated monthly averages for the time periods where there were sufficient data. For Hatfield's Ferry, all but one of the 40 monthly averages were below the monthly limit For Pleasant Prairie, there were 27 months when the average value was equal to or below the monthly limit; there were 3 months when the average value was above the monthly limit (for one of these months, the average is only 4 ng/L above the 356 ng/L limit). Although Keystone did not collect samples with sufficient frequency to calculate monthly averages, all of the daily observations for the plant were equal to or below the monthly limit and, therefore, EPA did not identify any periods of time when the effluent concentrations were higher than the limit. Miami Fort also did not collect samples with sufficient frequency to calculate monthly averages; however, it is worth noting that 61 of the 68 daily observations for the plant were below the monthly limit.

Table A7.2 lists all results above the monthly limits for arsenic and mercury, along with all daily observations for the month.

Figure A7.11 Arsenic monthly limitation and monthly average concentrations (µg/L) at Hatfield's Ferry and Keystone for chemical precipitation treatment of FGD wastewater

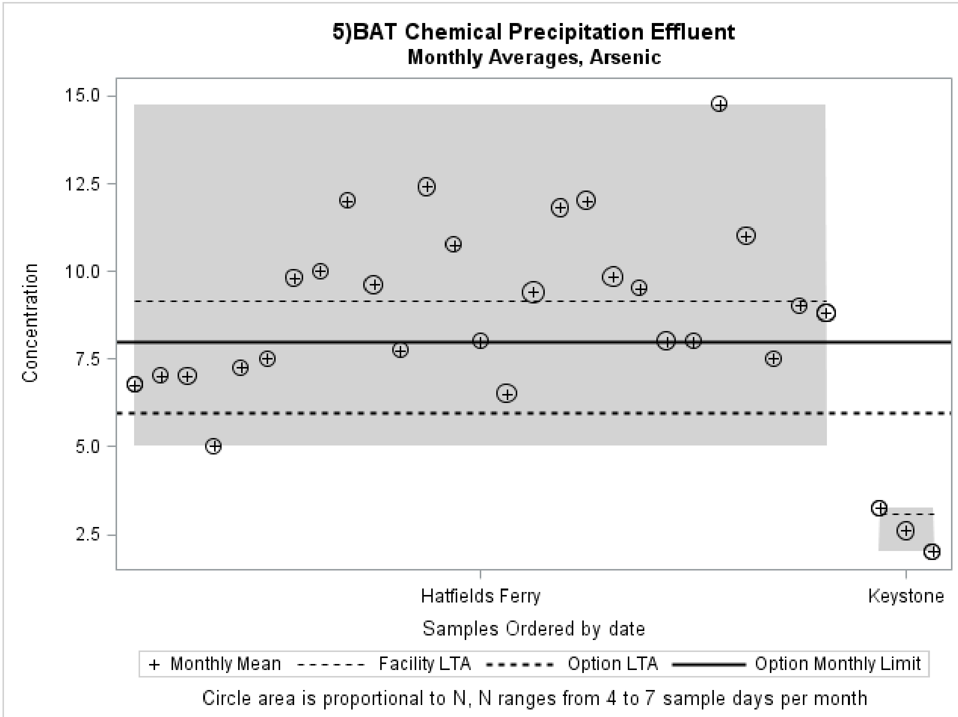


Figure A7.12 Arsenic monthly limitation and monthly average concentrations (µg/L) at Hatfield's Ferry for chemical precipitation treatment of FGD wastewater

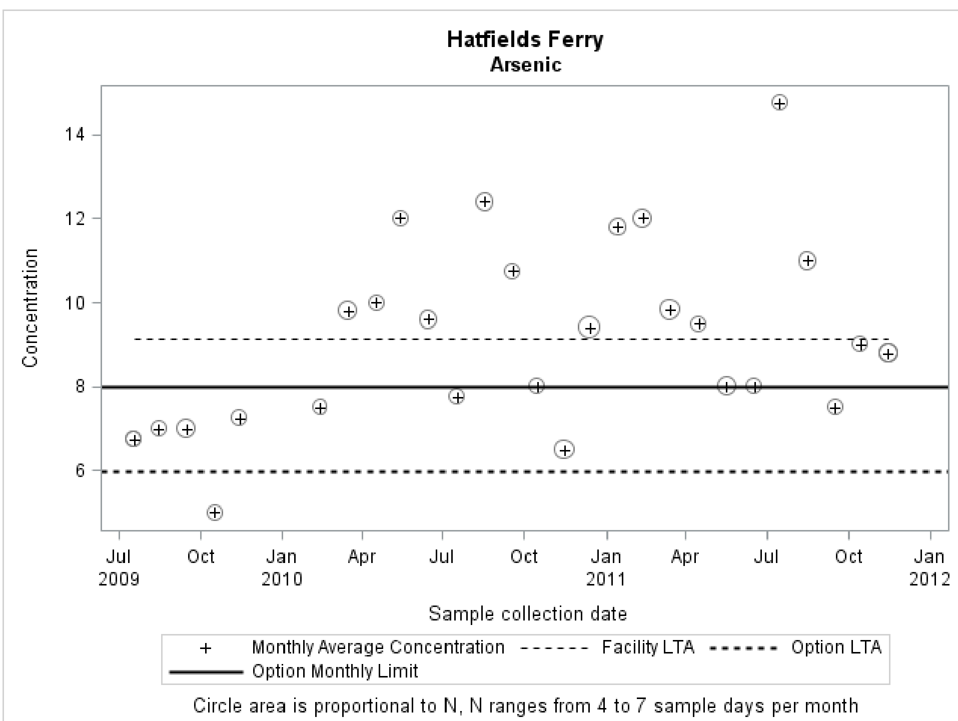


Figure A7.13 Arsenic monthly limitation and monthly average concentrations (µg/L) at Keystone for chemical precipitation treatment of FGD wastewater

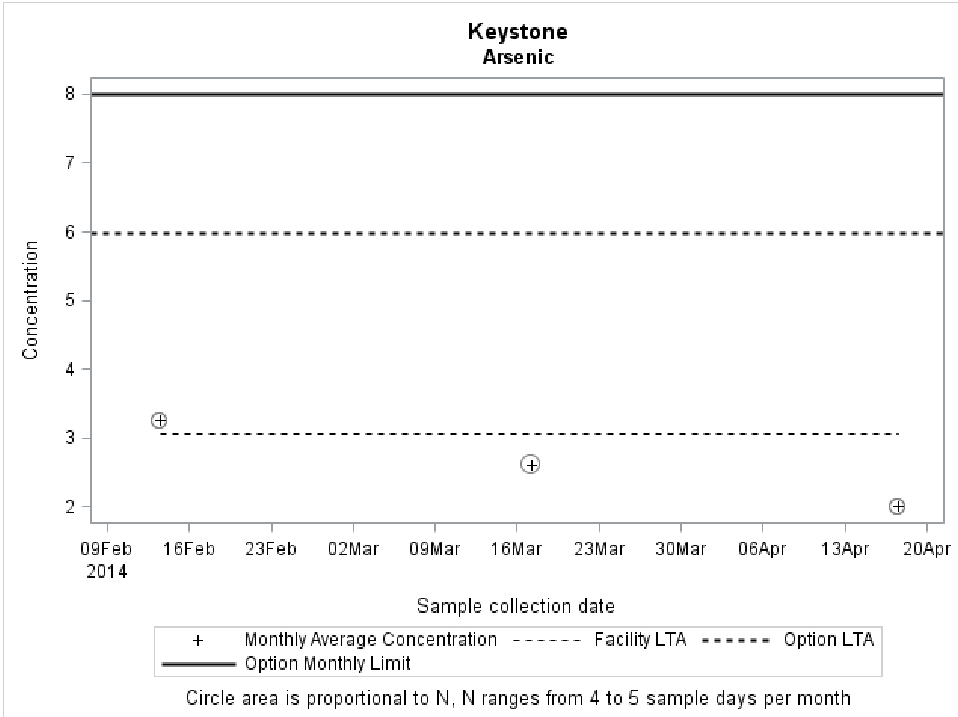


Figure A7.14 Mercury monthly limitation and monthly average concentrations (ng/L) at Hatfield's Ferry and Pleasant Prairie for chemical precipitation treatment of FGD wastewater

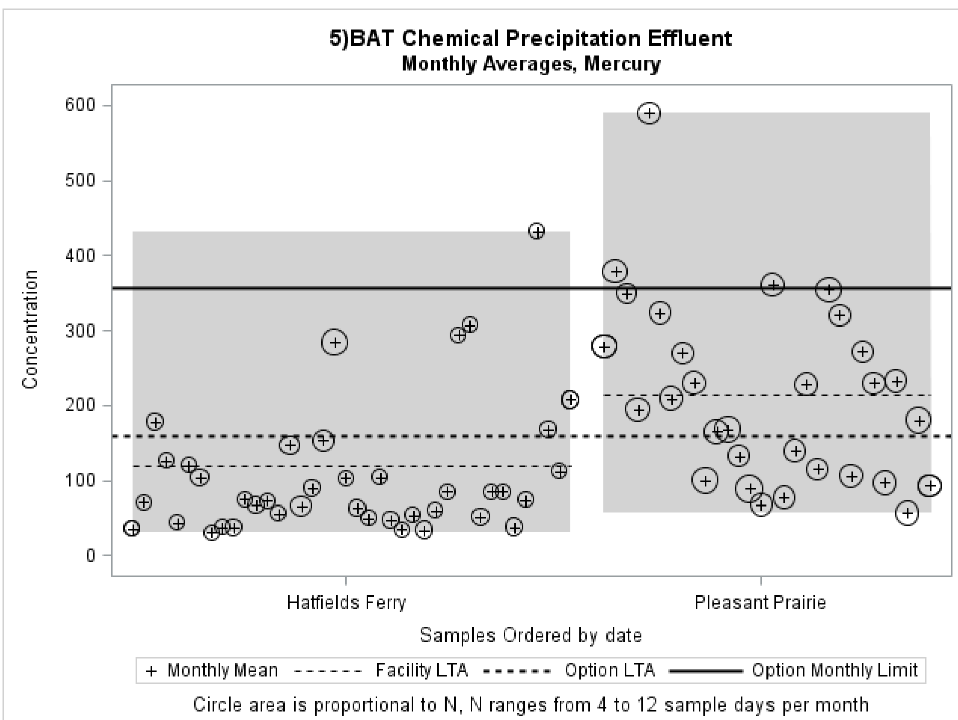


Figure A7.15 Mercury monthly limitation and monthly average concentrations (ng/L) at Hatfield's Ferry for chemical precipitation treatment of FGD wastewater

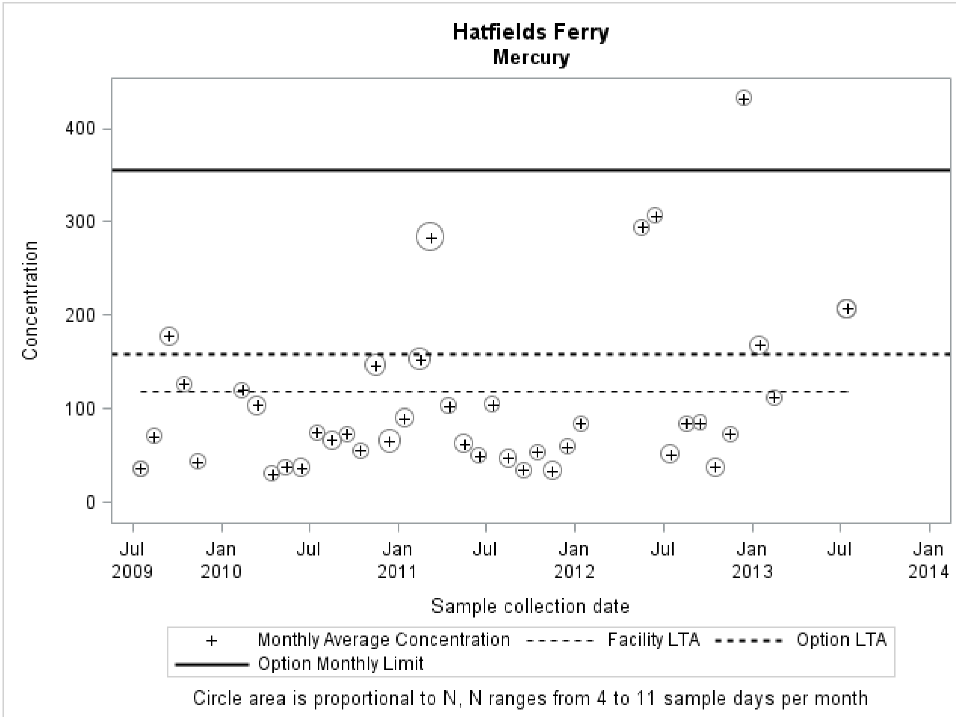


Figure A7.16 Mercury monthly limitation and monthly average concentrations (ng/L) at Pleasant Prairie for chemical precipitation treatment of FGD wastewater

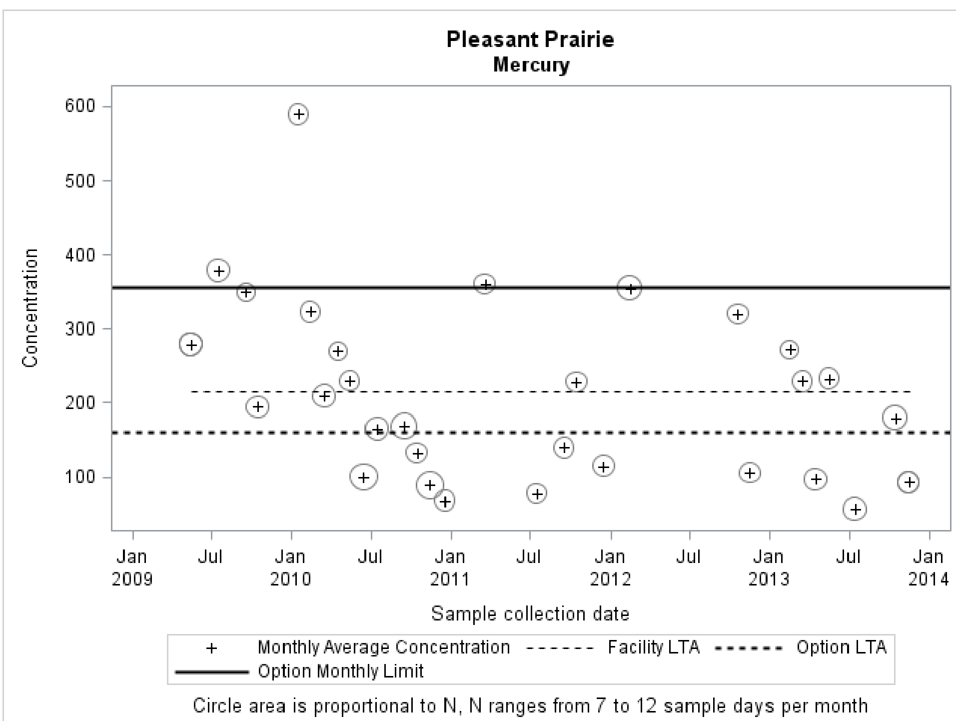


Table A7.2 List of monthly averages that are above the monthly limitation for arsenic and mercury and the daily values that went into the monthly average

Plant	Pollutant (Unit)	Daily Limit	Monthly Limit	Monthly Average	Date	Concentration
Hatfield's Ferry	Arsenic (µg/L)	11.00	8.00	9.800	03/02/2010	12.0
					03/09/2010	11.0
					03/16/2010	9.0
					03/23/2010	7.0
					03/30/2010	10.0
				10.000	04/06/2010	9.0
					04/13/2010	10.0
					04/20/2010	12.0
					04/27/2010	9.0
				12.000	05/04/2010	19.0
					05/11/2010	15.0
					05/18/2010	8.0
					05/25/2010	6.0
				9.600	06/01/2010	8.0
					06/08/2010	11.0
					06/15/2010	10.0
					06/22/2010	13.0
					06/29/2010	6.0
				12.400	08/03/2010	11.0
					08/10/2010	13.0
					08/17/2010	11.0
					08/24/2010	12.0
					08/31/2010	15.0
				10.750	09/07/2010	14.0
					09/14/2010	11.0
					09/21/2010	9.0
					09/28/2010	9.0
				9.400	12/07/2010	9.2
					12/08/2010	4.6
					12/09/2010	6.4
					12/10/2010	7.6
					12/14/2010	13.0
					12/21/2010	13.0
					12/28/2010	12.0

Table A7.2 List of monthly averages that are above the monthly limitation for arsenic and mercury and the daily values that went into the monthly average (continued)

Plant	Pollutant (Unit)	Daily Limit	Monthly Limit	Monthly Average	Date	Concentration
Hatfield's Ferry (continued)	Arsenic (µg/L) (continued)	11.00	8.00	11.800	01/04/2011	12.0
					01/11/2011	12.0
					01/12/2011	11.0
					01/18/2011	10.0
					01/25/2011	14.0
				12.000	02/01/2011	16.0
					02/08/2011	14.0
					02/09/2011	10.0
					02/15/2011	9.0
					02/22/2011	11.0
				9.833	03/01/2011	12.0
					03/08/2011	9.0
					03/10/2011	10.0
					03/15/2011	11.0
					03/22/2011	7.0
					03/29/2011	10.0
				9.500	04/05/2011	13.0
					04/12/2011	8.0
					04/19/2011	8.0
					04/26/2011	9.0
				14.750	07/05/2011	7.0
					07/12/2011	18.0
					07/19/2011	12.0
					07/26/2011	22.0
				11.000	08/02/2011	12.0
					08/09/2011	10.0
					08/16/2011	11.0
					08/23/2011	11.0
					08/30/2011	11.0
				9.000	10/04/2011	9.0
					10/11/2011	10.0
					10/18/2011	8.0
					10/25/2011	9.0
				8.800	11/01/2011	5.0
					11/08/2011	12.0
					11/15/2011	7.0
					11/22/2011	12.0
					11/29/2011	8.0
	Mercury (ng/L)	788.00	356.00	431.750	12/04/2012	102.0
					12/11/2012	272.0
					12/18/2012	444.0
					12/26/2012	909.0

Table A7.2 List of monthly averages that are above the monthly limitation for arsenic and mercury and the daily values that went into the monthly average (continued)

Plant	Pollutant (Unit)	Daily Limit	Monthly Limit	Monthly Average	Date	Concentration
Pleasant Prairie	Mercury (ng/L)	788.00	356.00	378.333	07/01/2009	605.0
					07/08/2009	445.0
					07/09/2009	265.0
					07/14/2009	345.0
					07/15/2009	330.0
					07/21/2009	355.0
					07/22/2009	355.0
					07/28/2009	325.0
					07/29/2009	380.0
				588.750	01/06/2010	425.0
					01/08/2010	395.0
					01/12/2010	770.0
					01/13/2010	830.0
					01/18/2010	415.0
					01/20/2010	400.0
					01/26/2010	780.0
					01/27/2010	695.0
				360.000	03/08/2011	195.0
					03/09/2011	335.0
					03/18/2011	665.0
					03/19/2011	415.0
					03/25/2011	295.0
					03/26/2011	210.0
					03/29/2011	410.0
					03/30/2011	355.0

[1]Daily limit set for each pollutant.

[2]Monthly limit set for each pollutant.

Nitrate-nitrite as N and Selenium Limits for FGD Wastewater, Based on Chemical Precipitation Followed by Biological Treatment

The limitations for nitrate-nitrite as N and selenium based on chemical precipitation followed by biological treatment were calculated using data without adjusting for baseline substitution. As a result, the effluent limits were compared to the reported concentrations without baseline adjustment.

Figures A7.17 through A7.19 show the nitrate-nitrite as N daily limitation and daily effluent concentrations used to calculate the limitations for FGD wastewater. All observations for both Allen and Belews Creek were equal to or below the daily maximum limit (30 observations at Allen; 40 observations at Belews Creek).

Figures A7.20 through A7.23 show the selenium daily limitation and daily effluent concentrations used to calculate the limitations for FGD wastewater. At Allen, 178 of the 182 observations were equal to or below the daily limit; only 4 observations were above the limit. At Belews Creek, 214 of the 216 observations were equal to or below the limit; only 2 observations were above the daily limit. All values above the daily limit are listed in Table A7.3.

The observations that are equal to or below the nitrate-nitrite as N and selenium daily limits can be determined by comparing the observations in Table A7.3 to the data listed in DCN SE06277.

Figure A7.17 Nitrite Nitrate as N daily limitation and daily concentrations (mg/L) at Allen and Belews Creek used to calculate the limitations for the biological treatment of FGD wastewater

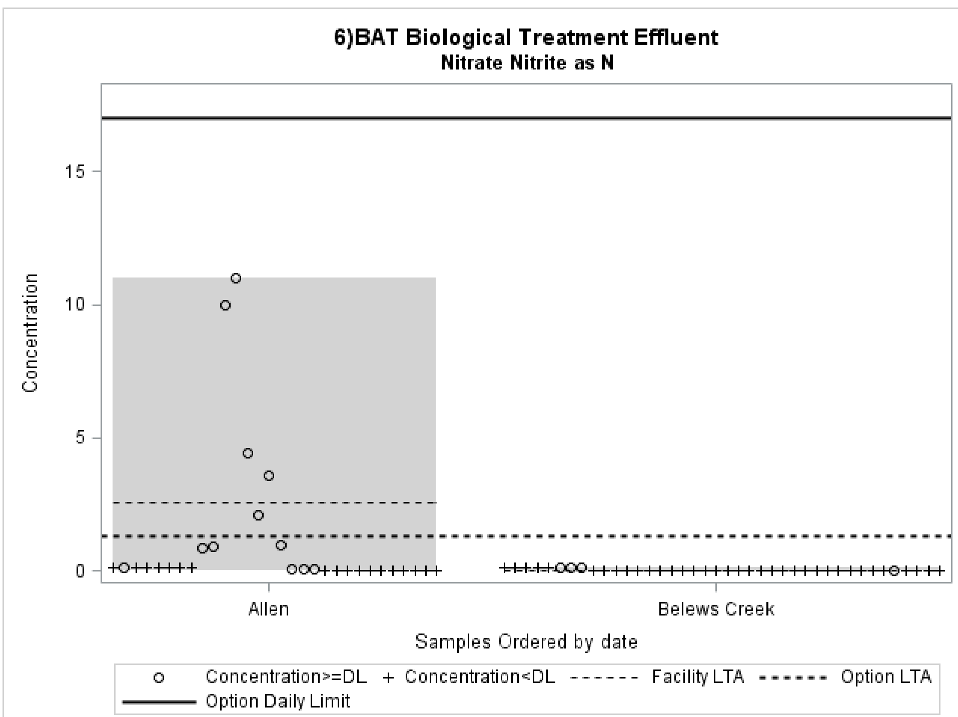


Figure A7.18 Nitrite Nitrate as N daily limitation and daily concentrations (mg/L) at Allen used to calculate the limitations for the biological treatment of FGD wastewater

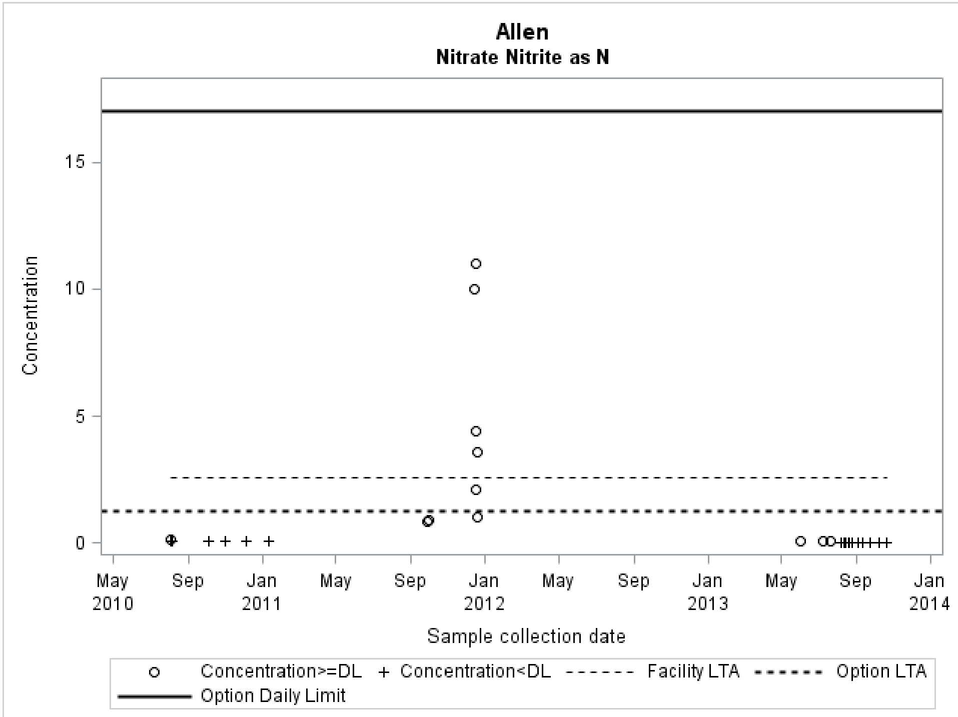


Figure A7.19 Nitrite Nitrate as N daily limitation and daily concentrations (mg/L) at Belews Creek used to calculate the limitations for the biological treatment of FGD wastewater

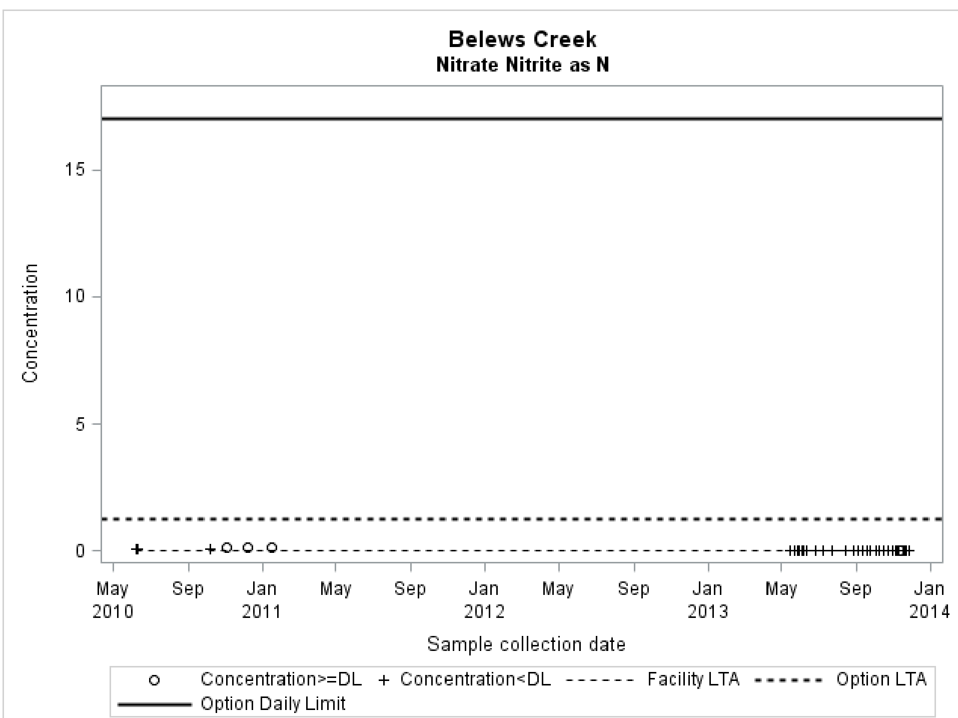


Figure A7.20 Selenium daily limitation and daily concentrations (μg/L) at Allen and Belews Creek used to calculate the limitations for biological treatment of FGD wastewater

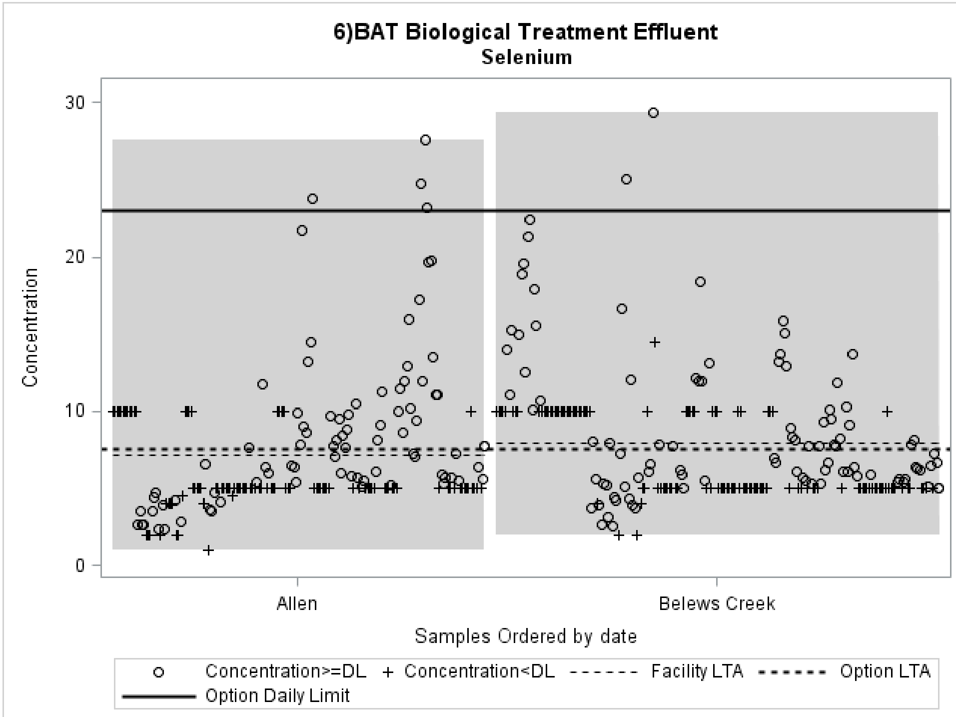


Figure A7.21 Selenium daily limitation and daily concentrations (μg/L) at Allen used to calculate the limitations for biological treatment of FGD wastewater

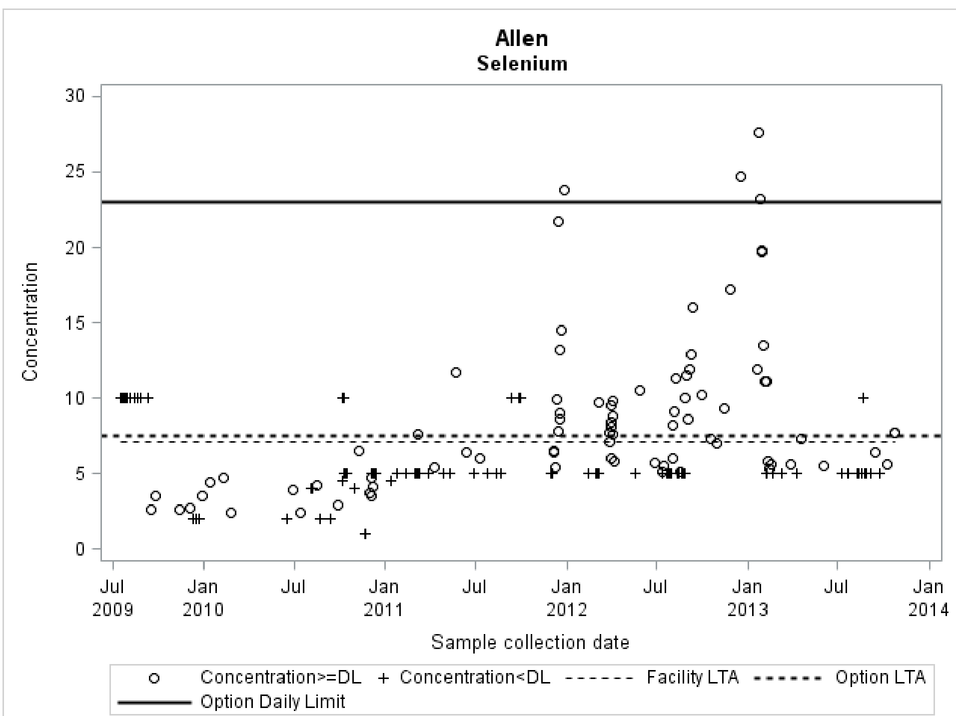


Figure A7.22 Selenium daily limitation and daily concentrations (µg/L) at Belews Creek used to calculate the limitations for biological treatment of FGD wastewater

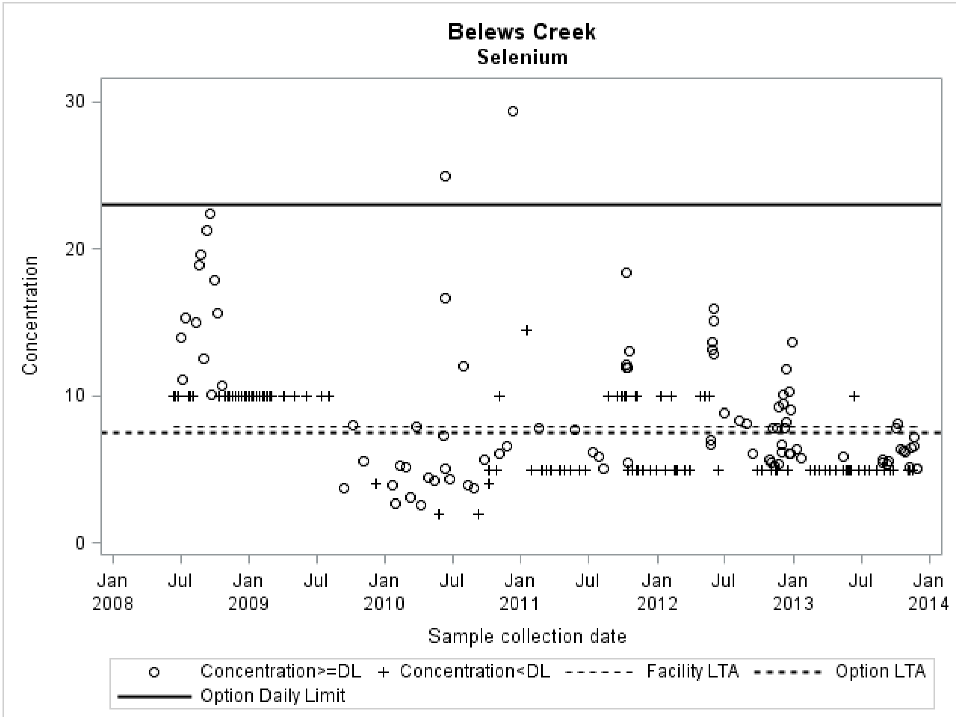


Table A7.3 List of all daily values that are above the daily limits for selenium for FGD wastewater

Plant	Pollutant Unit	Daily Limit[1]	Date	Concentration	Indicator[2]
Allen	Selenium (µg/L)	23.00	12/27/2011	23.80	D
			12/16/2012	24.70	D
			01/23/2013	27.60	D
			01/25/2013	23.20	D
Belews Creek	Selenium (µg/L)	23.00	06/11/2010	25.00	D
			12/08/2010	29.35	D

[1]Daily limit set for each pollutant.

[2]D = detected and ND = non-detected.

Figure A7.23 shows the Nitrate-Nitrite as N monthly limitation and monthly average concentrations for Belews Creek. All monthly averages were below the monthly limit. Monthly averages for Allen could not be calculated because the plant did not collect samples at sufficient frequency to represent weekly sampling.

Figures A7.24 through A7.26 show the selenium monthly limitation and monthly average concentrations for Allen and Belews Creek. All monthly averages for Allen were below the monthly average. At Belews Creek, there were 10 months when the monthly average was equal to or below the monthly limit; there were 2 months when the average was above the limit. Both of these months occurred shortly after the end of the initial commissioning period for the treatment system.

Table A7.4 lists all results above the monthly limit for selenium, along with all daily observations for the month.

Figure A7.23 Nitrite Nitrate as N monthly limitation and monthly average concentrations (mg/L) at Belews Creek for biological treatment of FGD wastewater

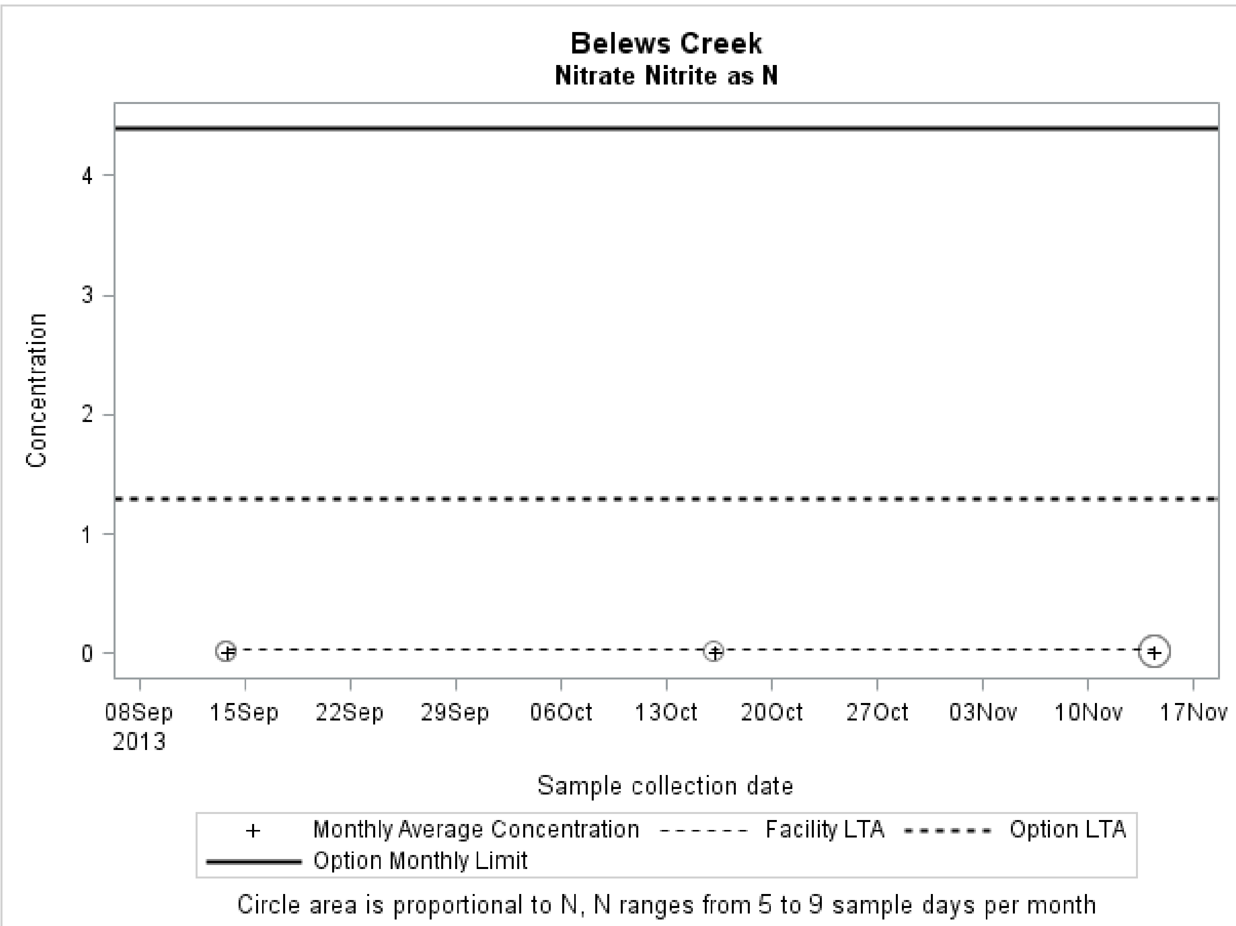


Figure A7.24 Selenium monthly limitation and monthly average concentrations (µg/L) at Allen and Belews Creek for biological treatment of FGD wastewater

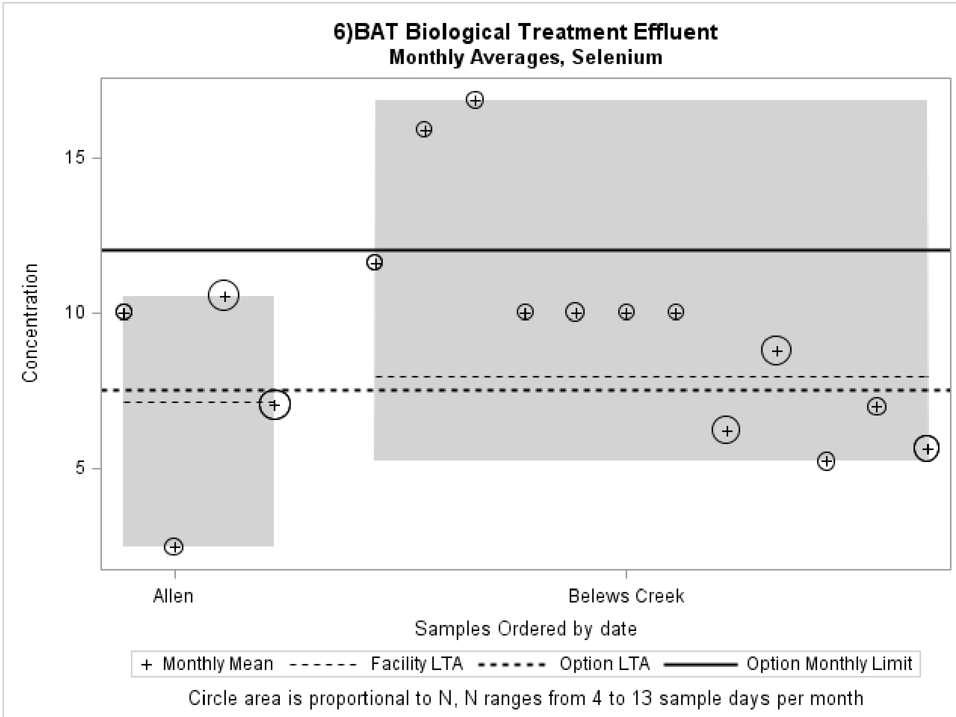


Figure A7.25 Selenium monthly limitation and monthly average concentrations (µg/L) at Allen for biological treatment of FGD wastewater

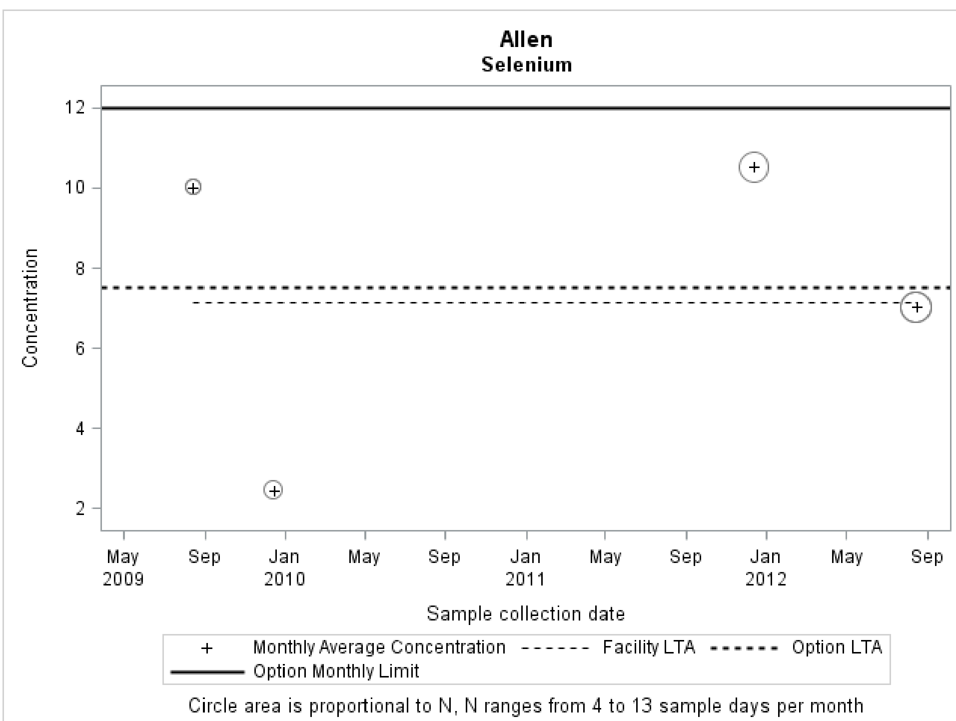


Figure A7.26 Selenium monthly limitation and monthly average concentrations (µg/L) at Belews Creek for biological treatment of FGD wastewater

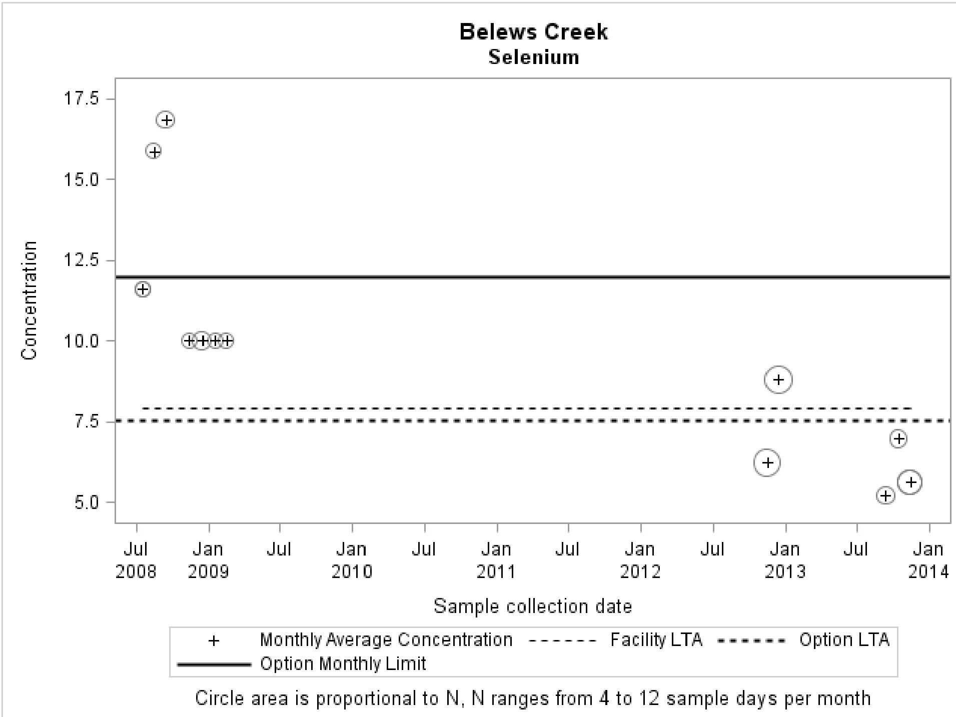


Table A7.4 List of monthly averages that are above the monthly limitation for selenium and the daily values that went into the monthly average

Plant	Pollutant (Unit)	Daily Limit	Monthly Limit	Monthly Average	Date	Concentration
Belews Creek	Selenium (µg/L)	23.00	12.00	15.875	08/04/2008	10.0
					08/11/2008	15.0
					08/18/2008	18.9
					08/25/2008	19.6
				16.840	09/02/2008	12.5
					09/08/2008	21.3
					09/15/2008	22.4
					09/22/2008	10.1
					09/29/2008	17.9

[1]Daily limit set for each pollutant.

[1]Monthly limit set for each pollutant.

Limits for FGD Wastewater Based on Chemical Precipitation Followed By Vapor-Compression Evaporation (Arsenic, Mercury, Selenium, and TDS)

The limitations for vapor-compression evaporation of FGD wastewater were calculated using baseline adjusted data. As a result, the effluent limits were compared to the reported concentrations after baseline adjustment.

Figures A7.27 through A7.30 show the daily limitation and daily concentrations from Brindisi for vapor-compression evaporation of FGD wastewater for arsenic, mercury, selenium, and total dissolved solids, respectively. These data are for the crystallizer condensate sampling location used for calculating the limitations. All observations (for both the brine concentrator distillate and crystallizer condensate) are below the daily limits. Note that although monthly average values were not calculated, all observations were below the monthly limits.

Figure A7.27 Arsenic daily limitation and daily concentrations (µg/L) at Brindisi used to calculate the limitations for Vapor-Compression Evaporation treatment for FGD wastewater

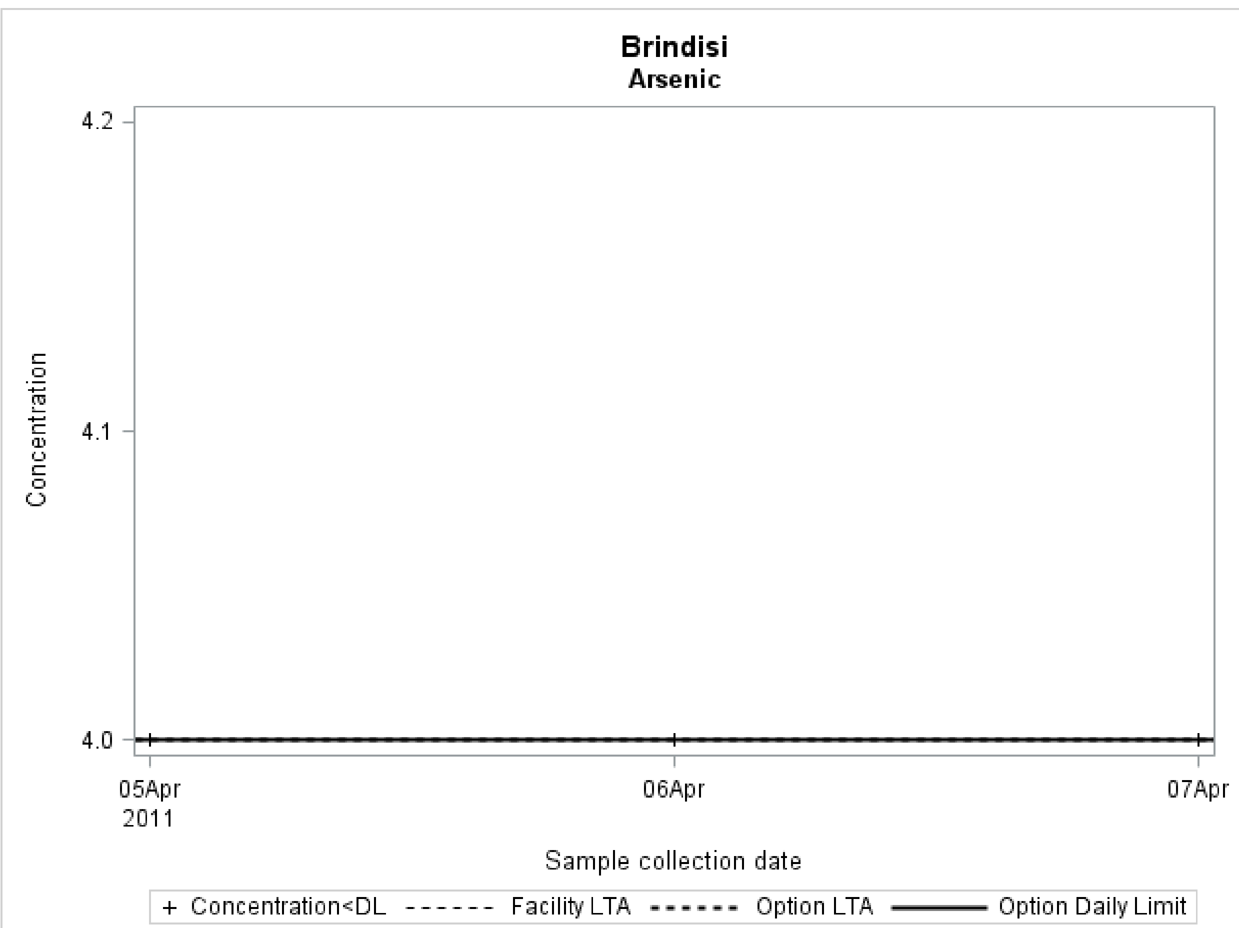


Figure A7.28 Mercury daily limitation and daily concentrations (ng/L) at Brindisi used to calculate the limitations for Vapor-Compression Evaporation treatment for FGD wastewater

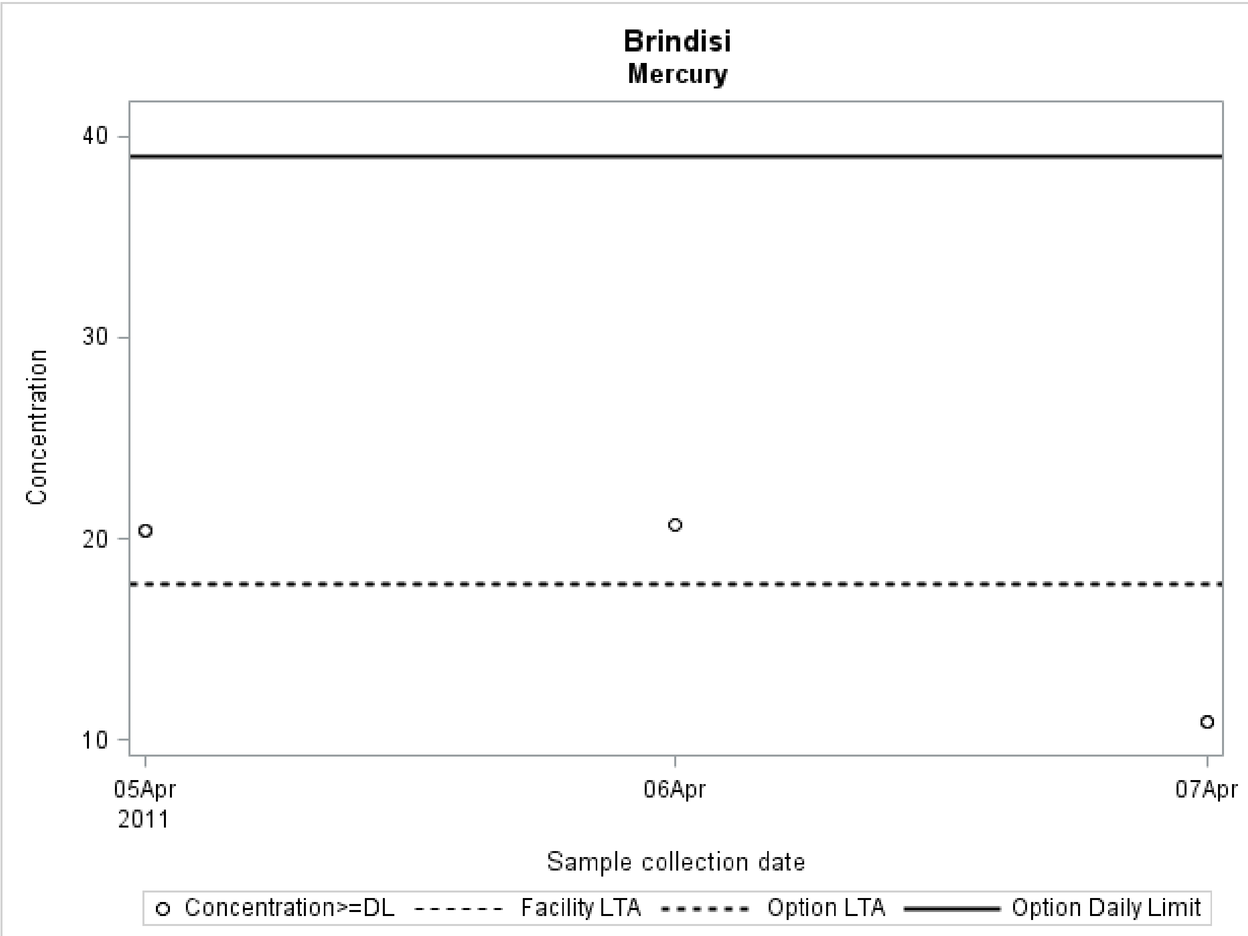


Figure A7.29 Selenium daily limitation and daily concentrations (µg/L) at Brindisi used to calculate the limitations for Vapor-Compression Evaporation treatment for FGD wastewater

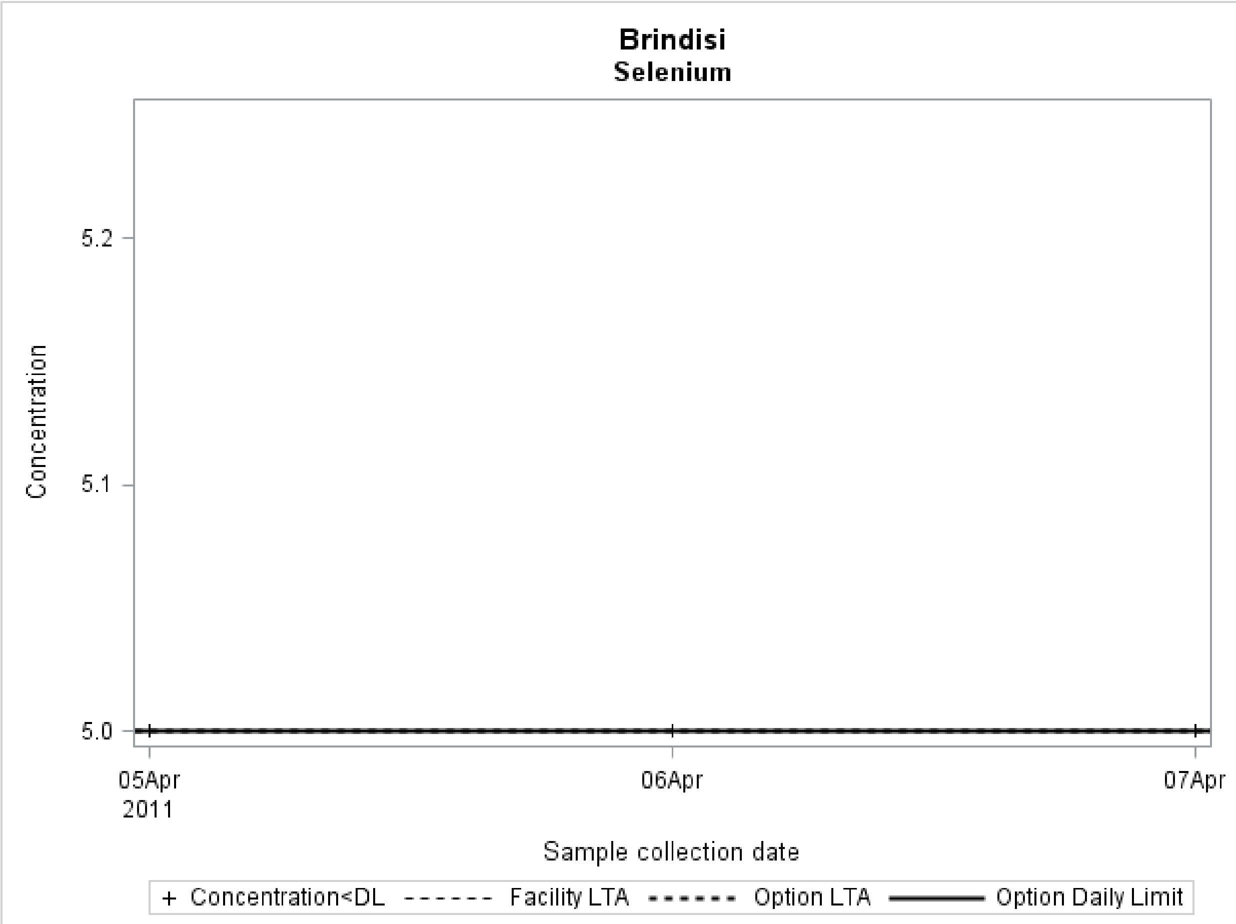
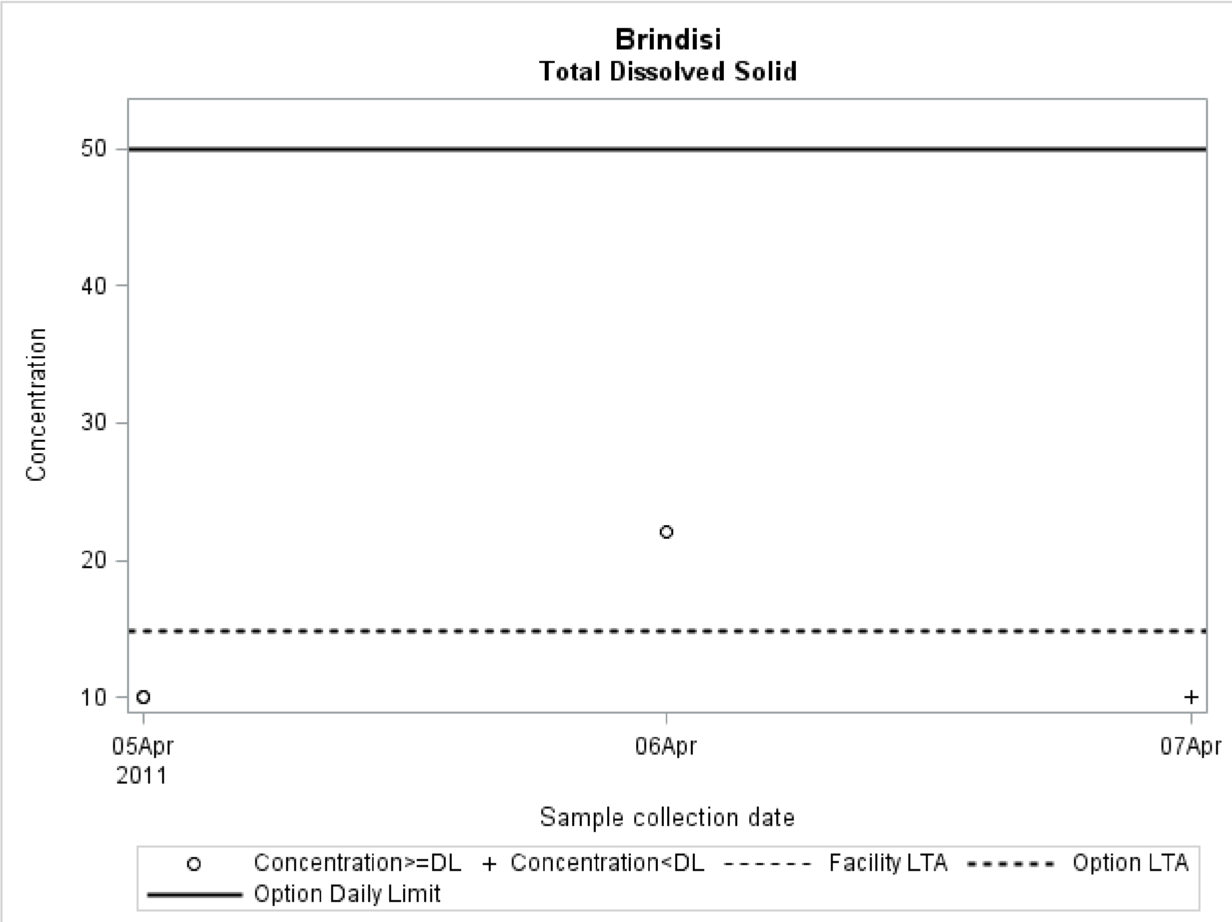


Figure A7.30 Total dissolved solid daily limitation and daily concentrations (mg/L) at Brindisi used to calculate the limitations for Vapor-Compression Evaporation treatment for FGD wastewater



Limits for Gasification Wastewater, Based on Vapor-Compression Evaporation (Arsenic, Mercury, Selenium, and TDS)

The limitations for vapor-compression evaporation treatment of gasification wastewater were calculated using baseline adjusted data. As a result, the effluent limits were compared to the reported concentrations after baseline adjustment.

Figures A7.31 and A7.32 show the daily limitation and daily concentrations from Polk for arsenic and mercury, respectively. Limitations for these pollutants for gasification wastewater were based on data from Polk. All observations for these pollutants were equal to or below the daily limits.

Figures A7.33 through A7.35 show the selenium daily limitation and daily effluent concentrations used to calculate the limitations for gasification wastewater. All observations from Wabash River were below the daily limit. For Polk, three of the four observations were below the daily limit.

Figures A7.36 through A7.38 show the total dissolved solid daily limitation and daily effluent concentrations used to calculate the limitations for gasification wastewater. All observations for both plants were below the daily limits.

Table A7.5 lists all daily data that are above the maximum daily limits for each pollutant.

There were too few observations to calculate monthly averages for comparison to the monthly limits for gasification wastewater.

Figure A7.31 Arsenic daily limitation and daily concentrations (µg/L) at Polk used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

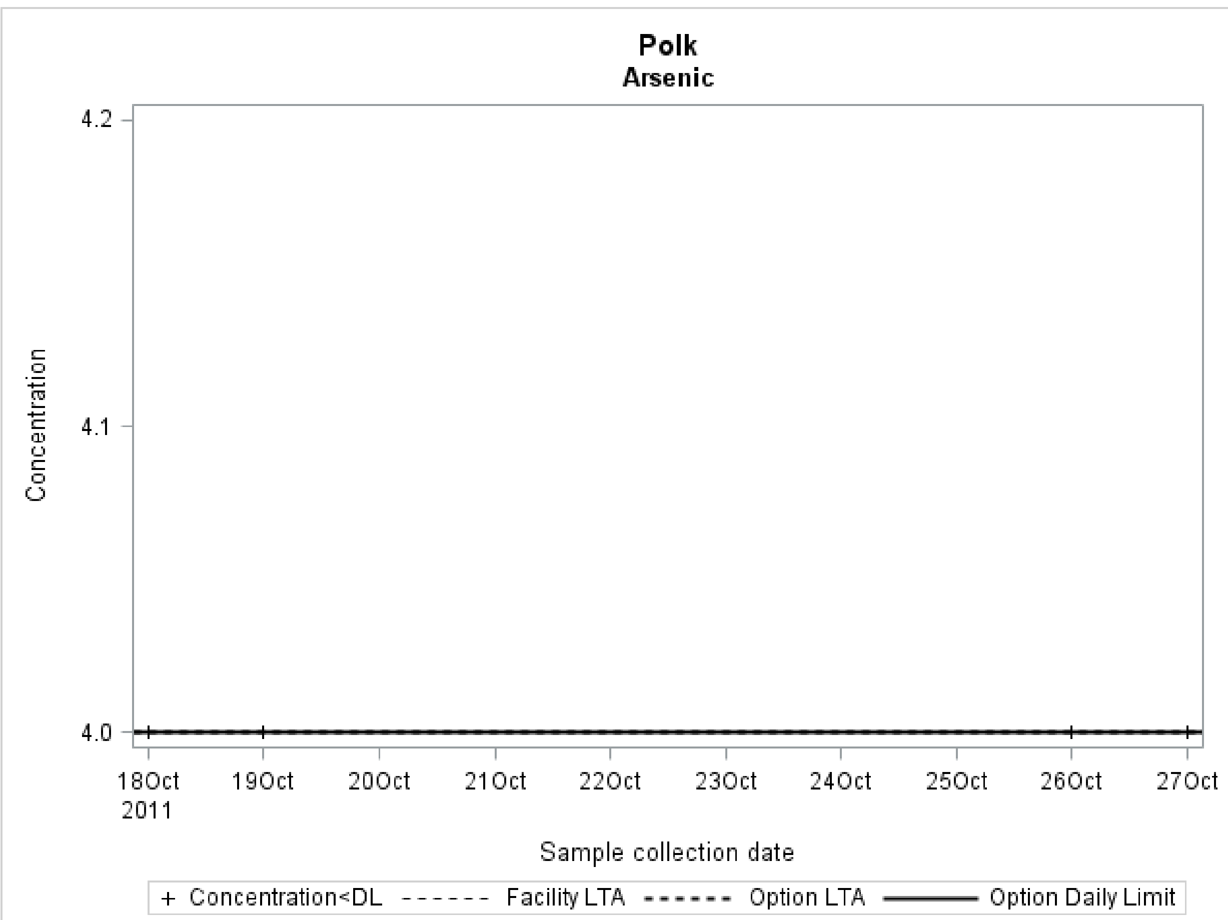


Figure A7.32 Mercury daily limitation and daily concentrations (ng/L) at Polk used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

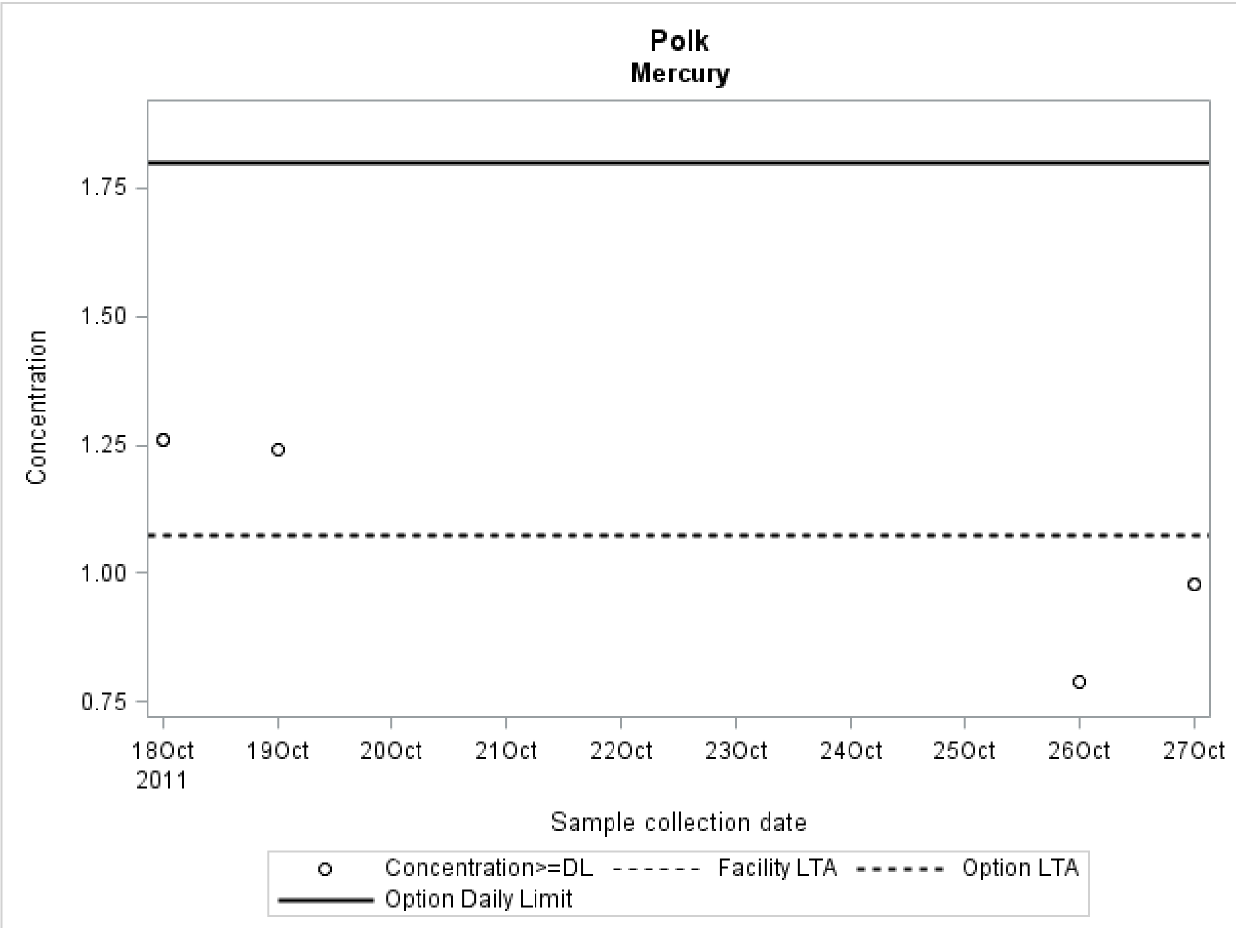


Figure A7.33 Selenium daily limitation and daily concentrations (μg/L) at Polk and Wabash River used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

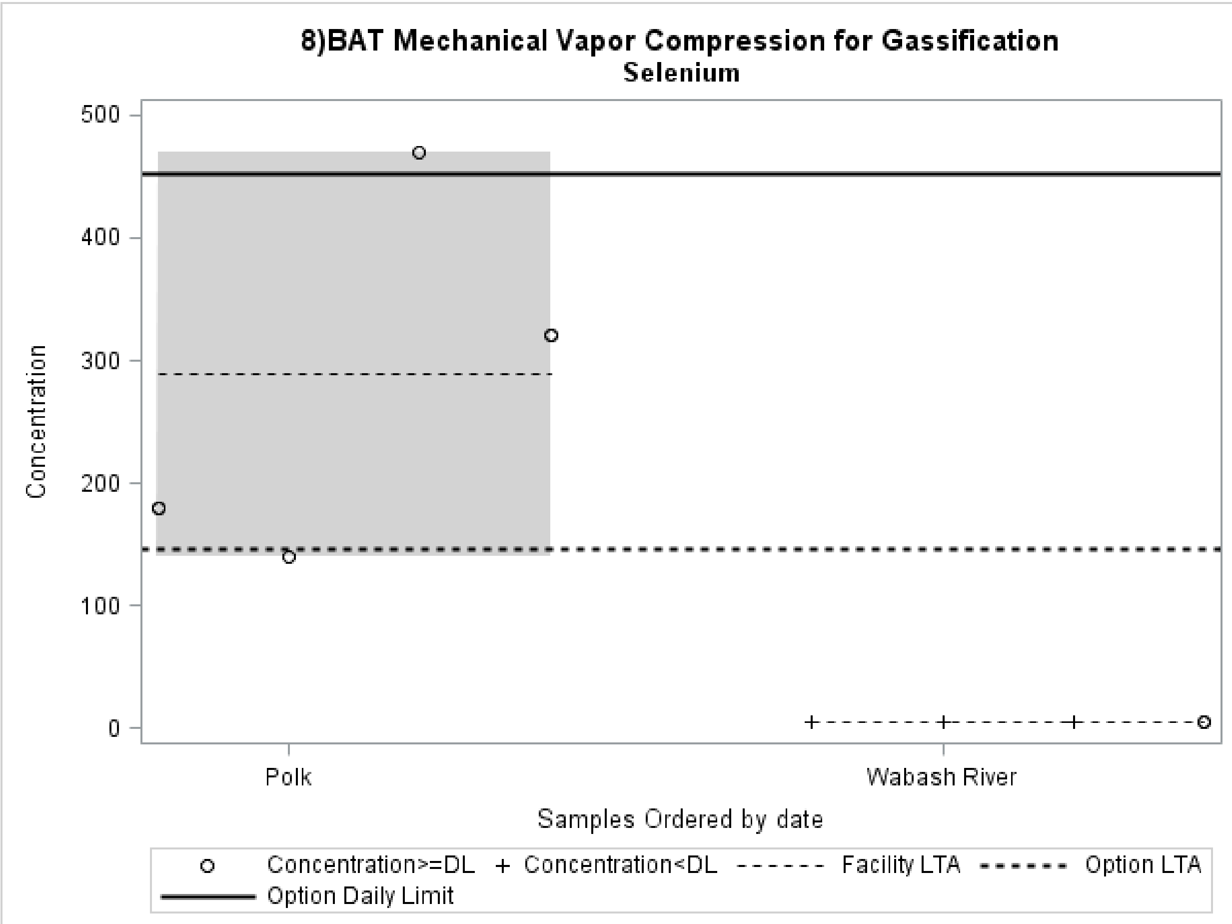


Figure A7.34 Selenium daily limitation and daily concentrations (µg/L) at Polk used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

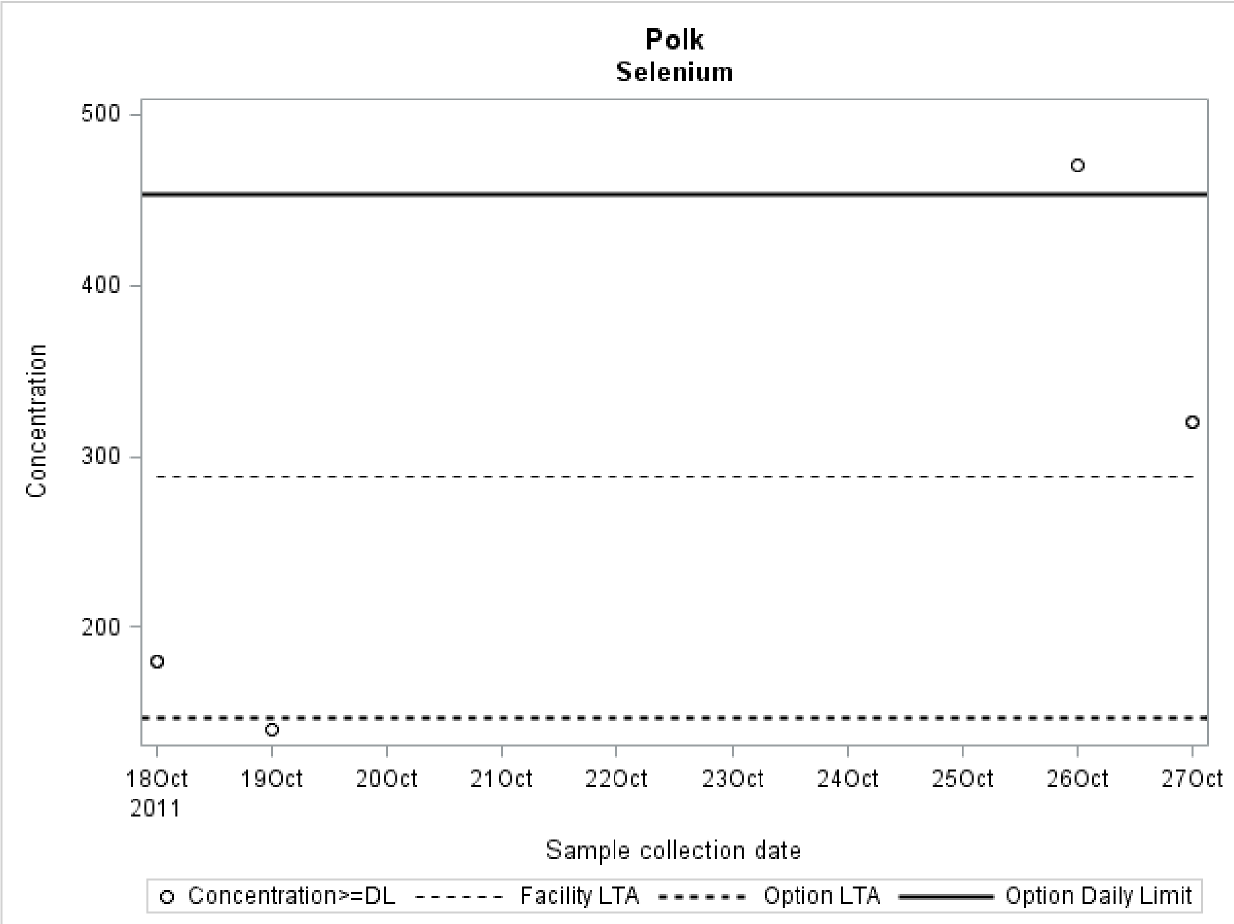


Figure A7.35 Selenium daily limitation and daily concentrations (µg/L) at Wabash River used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

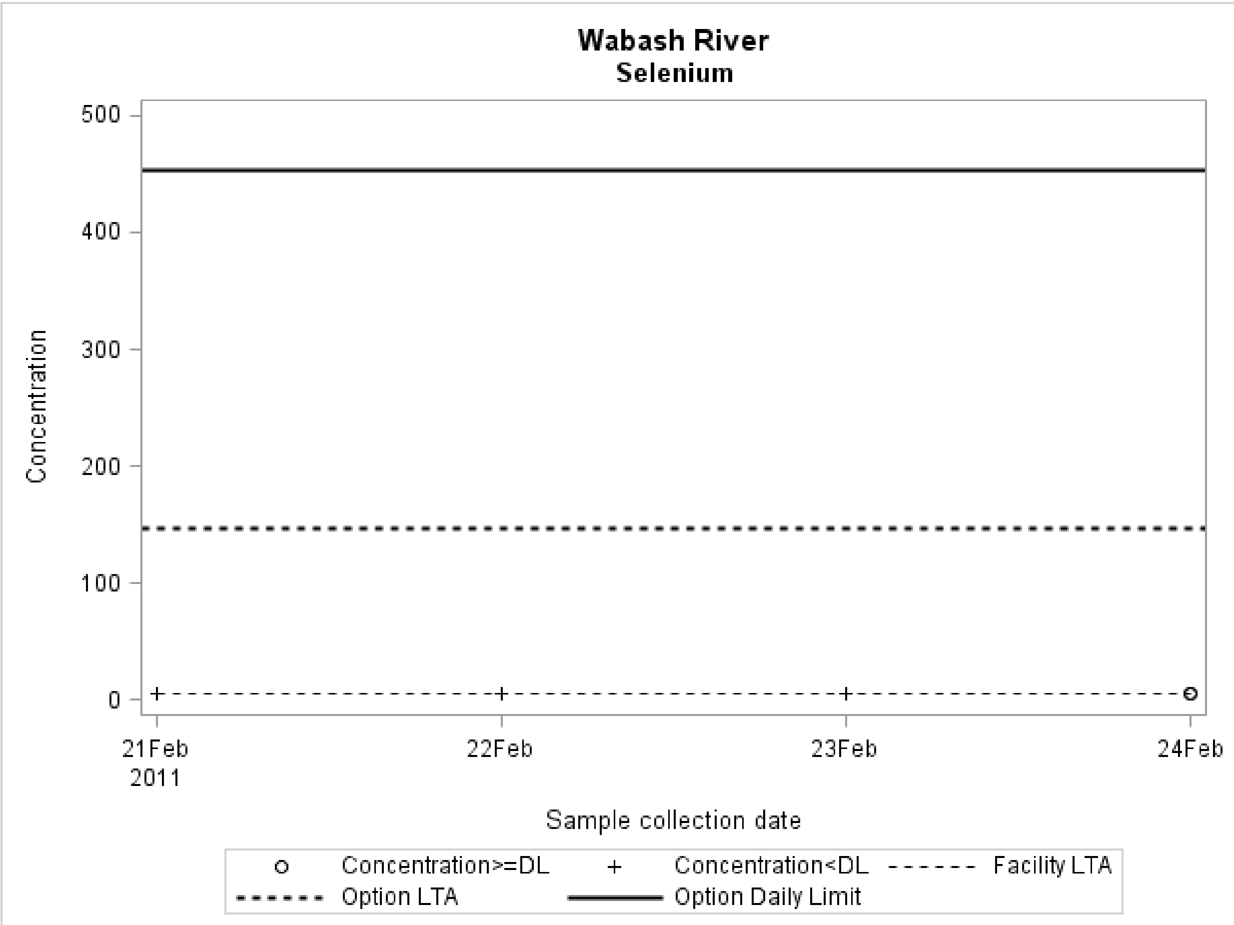


Figure A7.36 Total dissolved solid daily limitation and daily concentrations (mg/L) at Polk and Wabash River used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

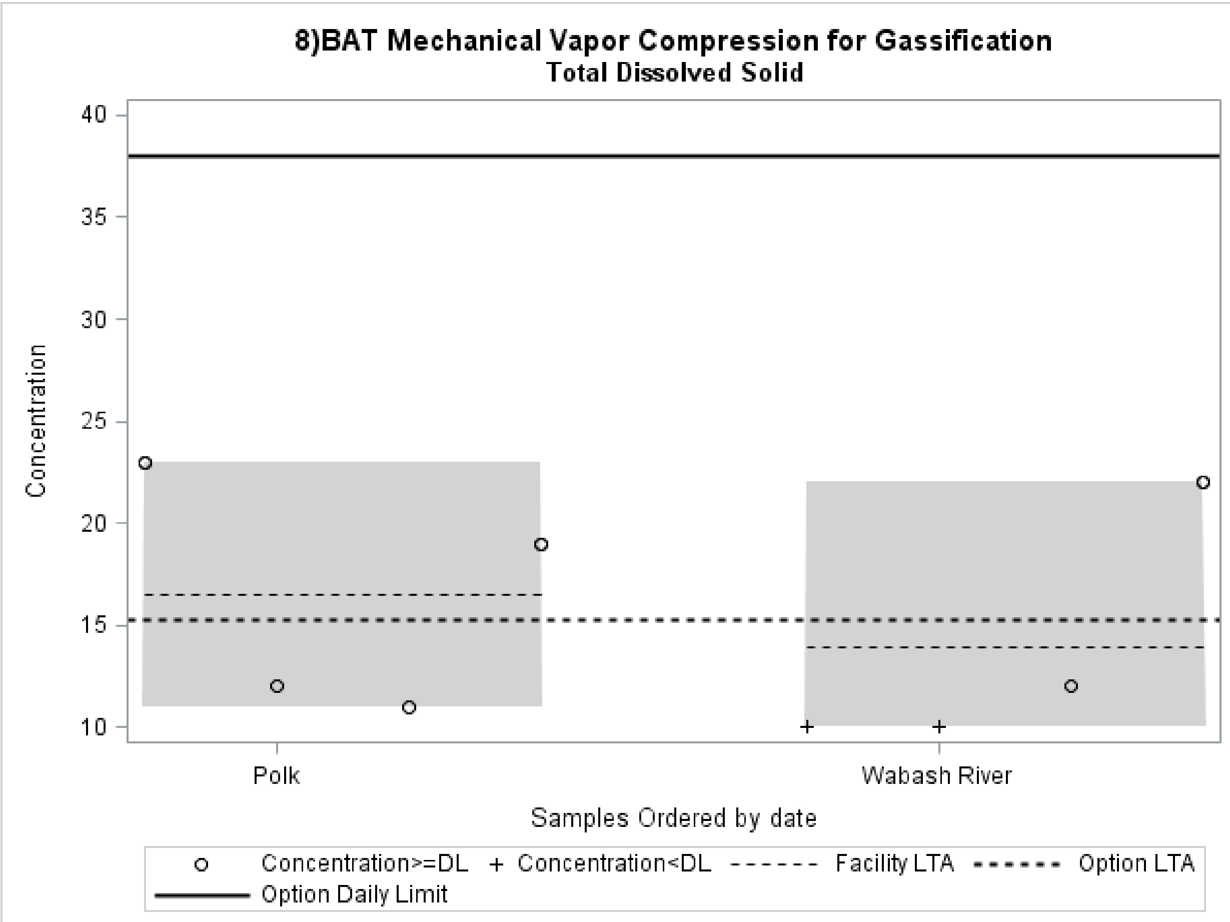


Figure A7.37 Total dissolved solid daily limitation and daily concentrations (mg/L) at Polk used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

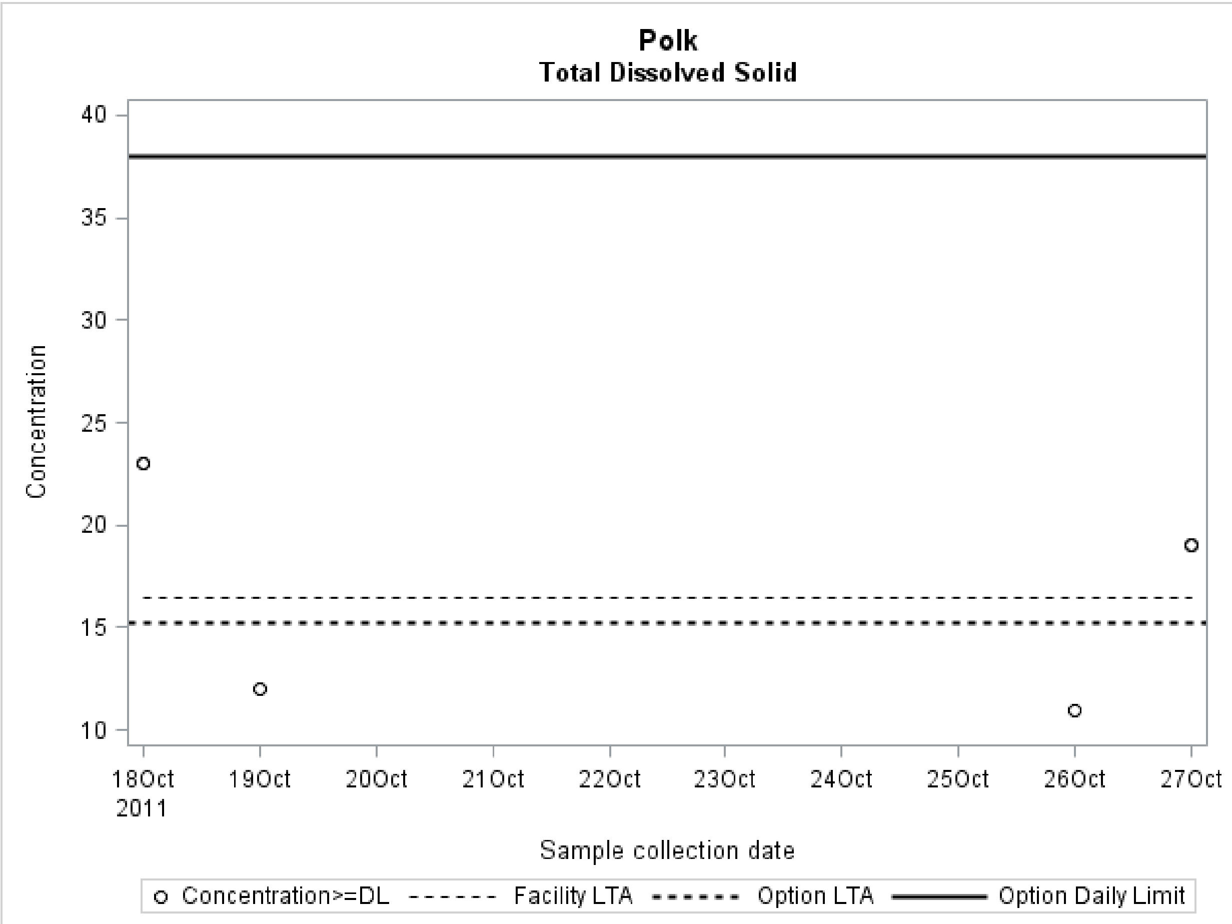


Figure A7.38 Total dissolved solid daily limitation and daily concentrations (mg/L) at Wabash River used to calculate the limitations for the vapor-compression evaporation treatment technology option for gasification wastewater

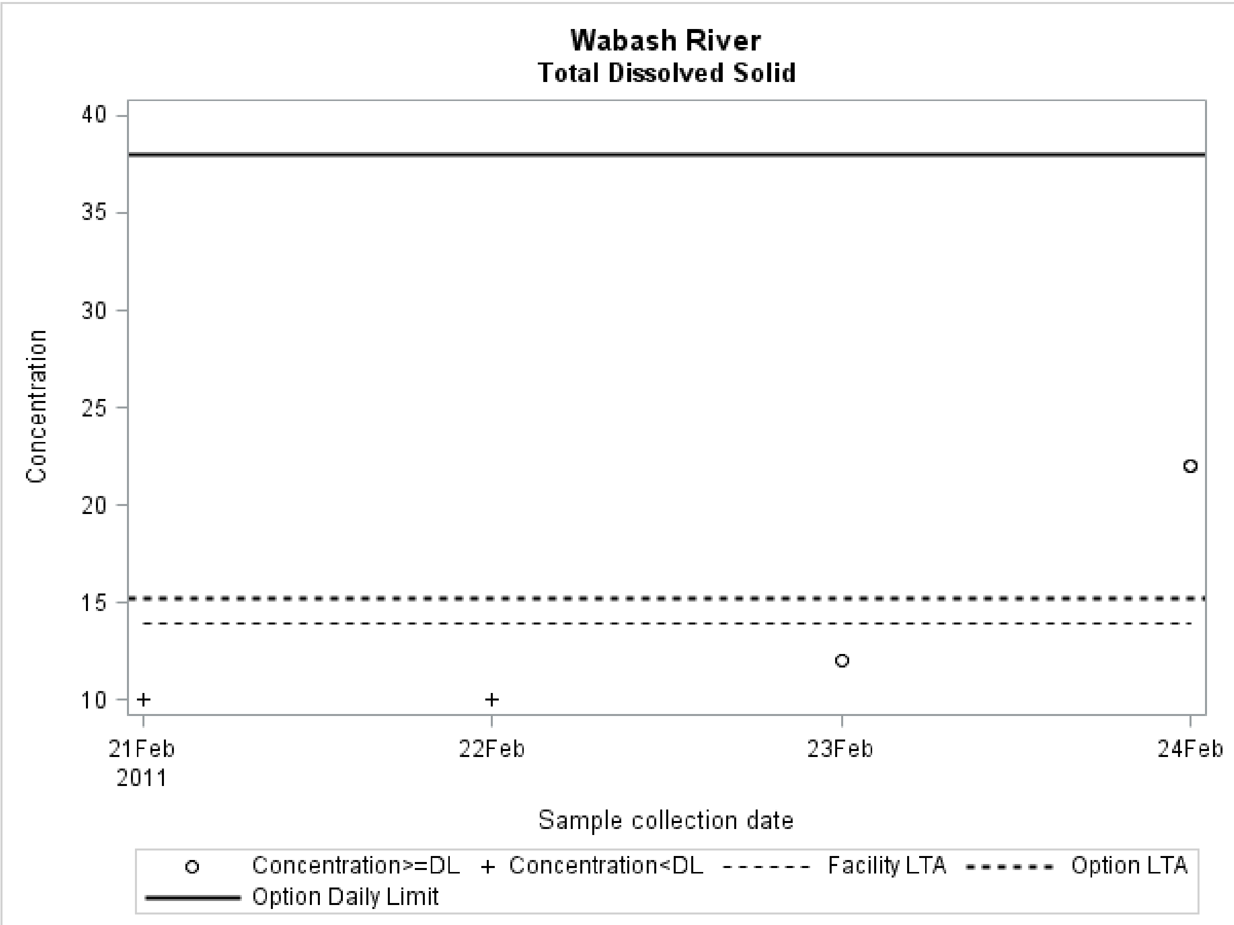


Table A7.5 Listing of all daily values that are above the daily limits for vapor-compression evaporation treatment for gasification wastewater

Plant	Pollutant Unit	Daily Limit[1]	Date	Concentration	Indicator[2]
Polk	Selenium µg/L	453.00	10/26/2011	470	D

[1]Daily limit set for each pollutant.

[2]D = detected and ND = non-detected.

2. Comparison of the Effluent Limits to Influent Data

In addition to comparing the limits to the effluent data used to develop the limits, EPA also compared the limits to the influent data for the plants. Sections below provide the influent summary statistics for all plants from which the data were used as the basis for calculating the limits.

Arsenic and Mercury Limits for FGD Wastewater, Based on Chemical Precipitation Treatment Technology

Table A7.6 presents summary statistics for the treatment system influent (FGD Purge) for arsenic and mercury at Hatfield's Ferry, Keystone, Miami Fort, and Pleasant Prairie. Also provided in the table are the daily maximum limits for each pollutant.

Table A7.6 Summary statistics for the influent (FGD Purge) concentrations for plants from which the data were used as the basis for calculating the limits for chemical precipitation treatment technology option for FGD wastewater

Pollutant (daily limits)	Plant Name	Summary Statistics for influent by Pollutant and Plant Name				
		N	Minimum	Median	Mean	Maximum
Arsenic (Daily Limit = 11 µg/L)	Hatfield's Ferry	8	300.0	1,575.0	1,796.3	4,610.0
	Keystone	130	200.0	1,580.0	1,569.9	5,250.0
	Miami Fort	8	320.0	729.8	744.8	1,330.0
	Pleasant Prairie	16	10.7	145.0	117.0	187.0
Mercury (Daily Limit = 788 ng/L)	Hatfield's Ferry	8	184,000.0	467,000.0	465,125.0	789,000.0
	Keystone	130	200.0	434,000.0	438,659.2	950,000.0
	Miami Fort	62	22,000.0	277,500.0	286,137.9	1,065,000
	Pleasant Prairie	166	120,000.0	1400,000.0	1,382,747.0	4200,000.0

Nitrate-nitrite as N and Selenium Limits for FGD Wastewater, Based on Chemical Precipitation Followed By Biological Treatment

Table A7.7 presents the influent (FGD Purge) summary statistics for all plants from which the data were used as the basis for calculating the limits. Also provided in the table are the daily limits for each pollutant.

Table A7.7 Summary statistics for the influent (FGD Purge) concentrations for plants from which the data were used as the basis for calculating the limits for biological treatment technology option for FGD wastewater

Pollutant (daily limits)	Plant Name	Summary Statistics for influent by Pollutant and Plant Name				
		N	Minimum	Median	Mean	Maximum
Nitrate-nitrite as N (Daily Limit = 17.0 mg/L)	Allen	32	2.7	42.5	50.5	130.0
	Belews Creek	38	0.5	13	11.5	23
Selenium (Daily Limit = 23 µg/L)	Allen	184	572.0	1,655.0	2,089.2	10,600.0
	Belews Creek	217	274.0	4,820.0	5,297.2	26,200.0

Limits for FGD Wastewater Based on Chemical Precipitation Followed By Vapor-Compression Evaporation (Arsenic, Mercury, Selenium, and TDS)

Table A7.8 presents the influent (FGD Purge) summary statistics for all plants from which the data were used as the basis for calculating the limits. Also provided in the table are the daily limits for each pollutant.

Table A7.8 Summary statistics for the influent (FGD Purge) concentrations for plants from which the data were used as the basis for calculating the limits for vapor-compression evaporation treatment technology option for FGD wastewater

Pollutant (daily limits)	Plant Name	Summary Statistics for influent by Pollutant and Plant Name				
		N	Minimum	Median	Mean	Maximum
Arsenic (Daily Limit = 4 µg/L)	Brindisi	2	53.0	54.0	54.0	55.0
Mercury (Daily Limit = 39 ng/L)	Brindisi	2	21,100.0	24,000.0	24,000.0	26,900.0
Selenium (Daily Limit = 5 µg/L)	Brindisi	2	220.0	255.0	255.0	290.0
Total Dissolved Solids (Daily Limit = 50 mg/L)	Brindisi	2	13,000.0	14,000.0	14,000.0	15,000.0

Limits for Gasification Wastewater Based on Vapor-Compression Evaporation (Arsenic, Mercury, Selenium, and TDS)

Table A7.9 presents the influent summary statistics for all pollutants at Polk and Wabash River. Also provided in the table is the daily limit for each pollutant. As mentioned above, the data for arsenic and mercury at Wabash River failed the data editing criteria, thus the data for these two pollutants at Wabash River were excluded from developing the limits for this technology option. However, for completeness, the summary statistics for arsenic and mercury are provided in the table below.

Table A7.9 Summary statistics for the influent (vapor compression evaporator influent) concentrations from plants for which the data were used as the basis for calculating the limits for vapor-compression evaporation treatment technology option for gasification wastewater

Pollutant (daily limits)	Plant Name	Summary Statistics for influent by Pollutant and Plant Name				
		N	Minimum	Median	Mean	Maximum
Arsenic (Daily Limit = 4 µg/L)	Polk	4	220.0	280.0	280.0	340.0
	Wabash River[1]	*4*	*4.0*	*4.5*	*4.5*	*5.0*
Mercury (Daily Limit = 1.8 ng/L)	Polk	4	17.0	85.9	70.4	92.7
	Wabash River[1]	*4*	*5.0*	*9.9*	*8.7*	*9.9*
Selenium (Daily Limit = 453 µg/L)	Polk	4	720.0	1,295.0	1,277.5	1,800.0
	Wabash River	4	800.0	890.0	920.0	1,100.0
Total Dissolved Solids (Daily Limit = 38 mg/L)	Polk	4	4,500.0	4,600.0	4,575.0	4,600.0
	Wabash River	4	3,600.0	4,400.0	4,225.0	4,500.0

[1] Arsenic and Mercury data from Wabash River were not used to calculate the limits.