K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

CCR COMPLIANCE
STATISTICAL APPROACH FOR GROUNDWATER DATA EVALUATION

Midwest Generation, LLC
Joliet #9 Station
1601 S. Patterson Road
Joliet, Illinois

PREPARED BY: KPRG and Associates, Inc.
14665 West Lisbon Road, Suite 2B
Brookfield, WI 53005

October 10, 2017

TABLE OF CONTENTS

SECTION/DESCRIPTION **PAGE**

FIGURE

TABLE

1.0 INTRODUCTION

The Midwest Generation Joliet #9 Generating Station is located at 1601 South Patterson Road, Joliet, Will County, Illinois. The facility was a coal-fired electric power generating station, recently converted to gas, situated on approximately 170 acres and also includes the associated Lincoln Stone Quarry (LSQ) occupying approximately 120 acres both of which are located on the south side of the Des Plaines River. Electrical power is transmitted from the site to the area grid through overhead transmission power lines. The LSQ, located southeast of the station, is used for disposal of bottom ash from both Joliet #9 and Joliet #29 stations. The LSQ property, which is owned by Lincoln Stone Quarry, Inc. and leased and operated by Midwest Generation, is located at the southwest corner of the intersection of Patterson Road and Brandon Road in Joliet, Illinois. The LSQ facility is permitted as an ash landfill (Permit No. 1994-241-LFM) by the Illinois Environmental Protection Agency (IEPA) Bureau of Land. It has operated as a disposal facility for coal ash from the two generating stations since circa 1962 (prior to regulations). The overall disposal facility consists of an inactive portion referred to as the West Filled Area (WFA), which has a vegetated soil cover over the historically disposed ash, which included fly ash, and the active bottom ash disposal area referred to as the Main Quarry. Historically, there had been some fly ash and bottom ash from the Joliet #9 site disposed of within the WFA. Since the late 1970s fly ash has been dry-handled and properly disposed of or beneficially reused off-site. No ash has been disposed of within the WFA since prior to 1994. The Main Quarry is an unlined former dolomite quarry which has reportedly received only bottom ash (i.e., no fly ash was reportedly disposed of within the Main Quarry). Within the Main Quarry, the ash settles out and the sluice water is subsequently drained via gravity through two pipes to a secondary settling pond north of Patterson Road within what is referred to as the North Quarry. The water is then discharged back to the Des Plaines River through Outfall 005 under National Pollutant Discharge Elimination System (NPDES) Permit No. IL0002216.

It is noted that natural groundwater flow in the vicinity of the Main Quarry is from the south and east to the north and west. Approximately 16 years ago, the Vulcan Laraway Quarry (an open-pit dolomite quarry which is located approximately 1,000 feet to the southeast of the Main Quarry) initiated dewatering operations to facilitate quarrying. The dewatering activities have resulted in a reversal of groundwater flow direction in a portion of the Silurian dolomite. Due to this localized groundwater flow reversal, some leachate from the Main Quarry has migrated to the southeast and past what used to be upgradient site boundaries. In accordance with permit requirements, Midwest Generation completed a Groundwater Impact Assessment (GIA) and has implemented Interim Remedial Measures (IRMs) to address this issue. The IRMs include a groundwater extraction system along the south perimeter of the LSQ to establish a hydraulic trough along the southern border to preclude continued migration of leachate in that direction. The captured water is discharged back into the Main Quarry. Impacts that have migrated past site boundaries are being managed under an IEPA-approved Groundwater Management Zone (GMZ). All work was performed under IEPA plan approvals. The IEPA has considered the interim remedial measures implemented to be adequately addressing the issue and formally re-issued the facility permit on August 14, 2015.

On April 17, 2015, the United States Environmental Protection Agency published a final rule regulating coal combustion residuals (CCR) as part of 40 CFR 257 (the CCR Rule) that includes a groundwater detection monitoring program. In support of this requirement, the CCR Rule specifically requires that "the owner or operator of a CCR unit must develop a sampling and analysis program that includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain of custody (COC) control, and quality assurance and quality control." As a result, each regulated facility must develop a program that meets the CCR Rule. Midwest Generation determined that the LSQ meets the CCR Rule requirements for groundwater monitoring which are different than the groundwater monitoring being performed under the landfill's operational permit. Midwest Generation has identified 10 monitoring wells (R08S, G20S, G30S, R32S, G44S, G45S, G46S, G47S, G48S and T03S) to meet the CCR Rule monitoring requirements. The locations of these wells are shown on Figure 1. Well T03S is an upgradient/side gradient monitoring well. It is noted that Figure 1 also includes twelve extraction wells (X101 through X112) along the south side of the LSQ which are part of an interim corrective action which intercepts southward migration of groundwater from the LSQ.

Section 257.93(f) of the CCR Rule requires the selection of the statistical approach that will be used for assessing the data and determining whether a statistically significant increase over background concentrations in groundwater has occurred at identified downgradient monitoring points. Potential statistical methods that can be applied to the data are listed in Section 257.93(f)(1-5) and performance standards are provided in 257.93(h).

This narrative of the statistical approach that will be used for the Joliet #9 LSQ facility's groundwater monitoring data is intended to fulfill certification requirements under Section 257.93(f)(6). The professional engineer's certification is provided in Section 4.0. The certification will be placed into the facility's operating record, noticed to the State Director and posted to the publically accessible internet site.

2.0 STATISTICAL METHOD SELECTION and BACKGROUND DATA EVALUATION

Section 257.93(f) identifies five statistical data evaluation methods that can be used for assessing site groundwater data. Relative to the subject site, the prediction interval procedure identified in 257.93(f)(3) will be used. This approach is robust and conforms to varying data distributions and facilitates various non-detect frequencies. U.S. EPA identifies this method as preferred over establishment of tolerance intervals (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009 [Unified Guidance]).

Groundwater data collected over eight rounds of sampling at the established background well location will be used to develop prediction limits for the regulated unit for each constituent listed in Part 257 Appendix III and Appendix IV (see Table 1).

Statistical evaluations will be performed with the assistance of the Sanitas™ software package.

2.1 Outlier Testing

The background dataset(s) will be first checked for potential outliers for each constituent. Potential causes of outliers can be, but are not limited to:

- Changes in sampling technique;
- Changes in analytical methods;
- Data transcription errors;
- Unnatural localized event such as a spill; or
- Natural but extreme variations in constituent concentration.

The Unified Guidance does not recommend removing an outlier from the data set unless it can be shown that the outlier is not caused by extreme natural variation. If the outlier can be traced to other than natural causes, the data set will be adjusted appropriately.

2.2 Spatial Variability

If more than one background well is being used for the monitored unit, an evaluation of spatial variability will be performed to determine whether the mean concentration of a constituent varies statistically between the background points. This is generally accomplished by performing an Analysis of Variance (ANOVA). If spatial variation is determined to be present, the background points will be evaluated for potential impacts from the regulated unit. If a background well is determined to be impacted by the unit, it will be discarded from use as a representative background well. If the spatial variability is determined to be natural, an intrawell data evaluation approach may be considered for both upgradient and downgradient wells.

2.3 Temporal Variability

Temporal variability in groundwater data from a specific monitoring point occurs when a consistent fluctuation of constituent concentrations occurs over time. The most common example is seasonal variation. If such a variation is noted in the data, the dataset should be corrected to account for the trend, however, any such corrections must be applied judiciously and would be completed in accordance with the Unified Guidance recommended procedures.

2.4 Test of Normality

The main underlying assumption in parametric data evaluations, such as establishing prediction limits, is that the underlying data distribution is normal. A quick approximation can be made by calculating the Coefficient of Variance (CV) which is the quotient of the standard deviation divided by the sample mean. In general, if this quotient is greater than 1, the underlying data distribution is probably not normal. The new Unified Guidance is more conservative and suggests that if this quotient is greater than 0.5, the dataset may not be normal and a more robust distribution evaluation should be performed. Therefore, for any CV value greater than 0.5 for a specific dataset, normality will be evaluated using the Shapiro-Wilk Test with an alpha (α) value of 0.05 (or 95%).

If the dataset does not pass this initial test, the data will undergo a log transformation and the test will be repeated for the natural log values of the dataset. If it is determined that this dataset is log-normal, statistical evaluations will be completed on those values and the result converted back to the standard value. If the underlying distribution is also determined not to be log-normal, the Unified Guidance provides for a number of other data transformations that can be performed to evaluate whether those underlying distributions may be normal at which point the entire dataset would be transformed for subsequent calculations.

If a normal underlying distribution can not be determined, non-parametric statistical evaluations will need to be considered which do not rely on a specific underlying distribution.

2.5 Non-Detects

It is not uncommon in environmental datasets to have parameters being detected at low concentrations during one sampling event and being not detected in other sampling events. Having a consistent approach to the handling of non-detect values is an important part of the statistical evaluation process. The handling of non-detect values will be accomplished as follows:

- 100 Percent Non-Detects – Assumed that the constituent is not present and no statistical evaluations will be performed. The upper prediction limit will be set at the practical quantitation limit (PQL) established by the analytical laboratory.

- 90 Percent or Greater Non-Detects – A non-parametric evaluation will be performed where the confidence interval will be constructed using the highest detected concentration as the upper prediction limit.

- 50 to 90 Percent Non-Detects – The non-detect values will be replaced with one-half of the reporting limit concentration (RL/2) and a non-parametric evaluation will be performed where the confidence interval will be constructed using the highest detected concentration as the upper prediction limit.

- 0 to 50 Percent Non-Detects - The non-detect values will be replaced with RL/2 and the dataset will be evaluated for distribution normality. If the distribution is normal or log-normal, the sample mean and standard deviation will be adjusted in accordance with Unified Guidance (e.g., Aitchison's Adjustment) and a parametric prediction limit will be established/calculated. If the distribution is not normal or log-normal, non-parametric statistics will be used in accordance with Unified Guidance.

2.6 Prediction Limit Calculation for Normally Distributed Data

For datasets where the distribution or underlying transformed distribution is normal, a parametric statistical approach will be used for establishing the prediction limit at the required 95% statistical confidence. In accordance with Unified Guidance, the following equation will be used:

$$95\%\ Prediction\ Limit\ = \bar{x} + t_{1-0.05/m,n-1} s \sqrt{1 + \frac{1}{n}}$$

Where:

$\bar{x}$ = the sample mean of the detected or adjusted results
S = sample standard deviation of the detected or adjusted results
$t_{1-0.05/m,n-1}$ = the students t-coefficient for degrees of freedom (n-1) and confidence level (1-0.05/m)
n = the number of samples
m = the number of future samples

The number of future sampling events (*m*) will be set at 2 which will account for one sampling event and a confirmation resampling. This will assist in limiting the potential number of false positives. An acceptable site-wide false positive (SWFP) rate of 10% or less is acceptable under the Unified Guidance.

2.7 Prediction Limit Calculation for Non-Normally Distributed Data

If the dataset distribution or underlying distribution is determined not to be normal, a non-parametric approach will need to be used for the establishment of the prediction limit. The non-parametric evaluation will use the highest detected concentration as the upper prediction limit for the specific constituent.

3.0 GROUNDWATER MONITORING – DETECTION and ASSESSMENT

To meet the requirements set forth in Section 257.94(b), a minimum of eight rounds of groundwater data need to be collected by no later than October 17, 2017 for all identified monitoring wells (upgradient and down gradient) and analyzed for Appendix III and IV parameters. At that point, statistical evaluation of the background dataset will be performed to establish the upper prediction limits for each Appendix III constituent. It is noted that in the case of pH, a lower prediction limit will also be established since this parameter has an established upper and lower value range for compliance.

Upon completion of this initial sample dataset generation, “detection monitoring” will be initiated with all wells being sampled on a semi-annual basis for Appendix III parameters. If the results indicate a statistically significant increase (or decrease in the case of pH), a determination will be made whether there may be a source of the increase other than the regulated unit. If this determination can not be made, the regulated unit will transition to “assessment monitoring” within 90 days of the determination of a statistically significant increase. This transition will be placed into the facility record, notified to the State Director and posted on the publically accessible internet site.

Assessment monitoring will conform to Section 257.95. All wells will be sampled for Appendix IV parameters and at least semi-annually thereafter, and all wells will be analyzed for both Appendix III and Appendix IV parameters. In accordance with Section 257.95(d)(1), within 90 days of obtaining the results from the initial and subsequent sampling events required in Section 257.95(b), all wells will be resampled for all parameters in Appendix III and for those detected constituents in Appendix IV.

The initial eight rounds of sampling data generated for the background well will undergo the statistical evaluation discussed above for the Appendix IV parameters and groundwater protection standards (GPSs) will be established in accordance with Section 257.95(h) as follows:

- If the constituent has an established federal Maximum Contaminant Level (MCL) and the MCL is greater than the calculated background upper prediction limit, then the MCL will serve as the GPS. If the background upper prediction limit is greater than the MCL, the upper prediction limit will serve as the GPS.

- If the constituent does not have an established MCL then the calculated upper prediction limit will serve as the GPS.

If continued assessment monitoring shows that there are no statistical exceedances for Appendix III or IV parameters in two consecutive rounds of sampling, detection monitoring will resume and the appropriate notifications will be made of the transition.

If assessment monitoring indicates that one or more Appendix IV constituents exceed the established GPS at one or more downgradient monitoring wells, appropriate notifications will be made and an assessment of corrective measures as required by Section 257.96 will be initiated or a demonstration will be made that a source other than the regulated unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or a natural variation in the groundwater quality.

4.0 CERTIFICATION

In accordance with Section 257.93(f)(6) of the CCR Rule, I hereby certify based on a review of the information contained within this CCR Compliance Statistical Approach for Groundwater Data Evaluation dated October 10, 2017, the statistical method selected for evaluation of groundwater data associated with the Midwest Generation Joliet #9 Station CCR Units is adequate and appropriate relative to both detection and assessment monitoring.

Certified by: ______________________

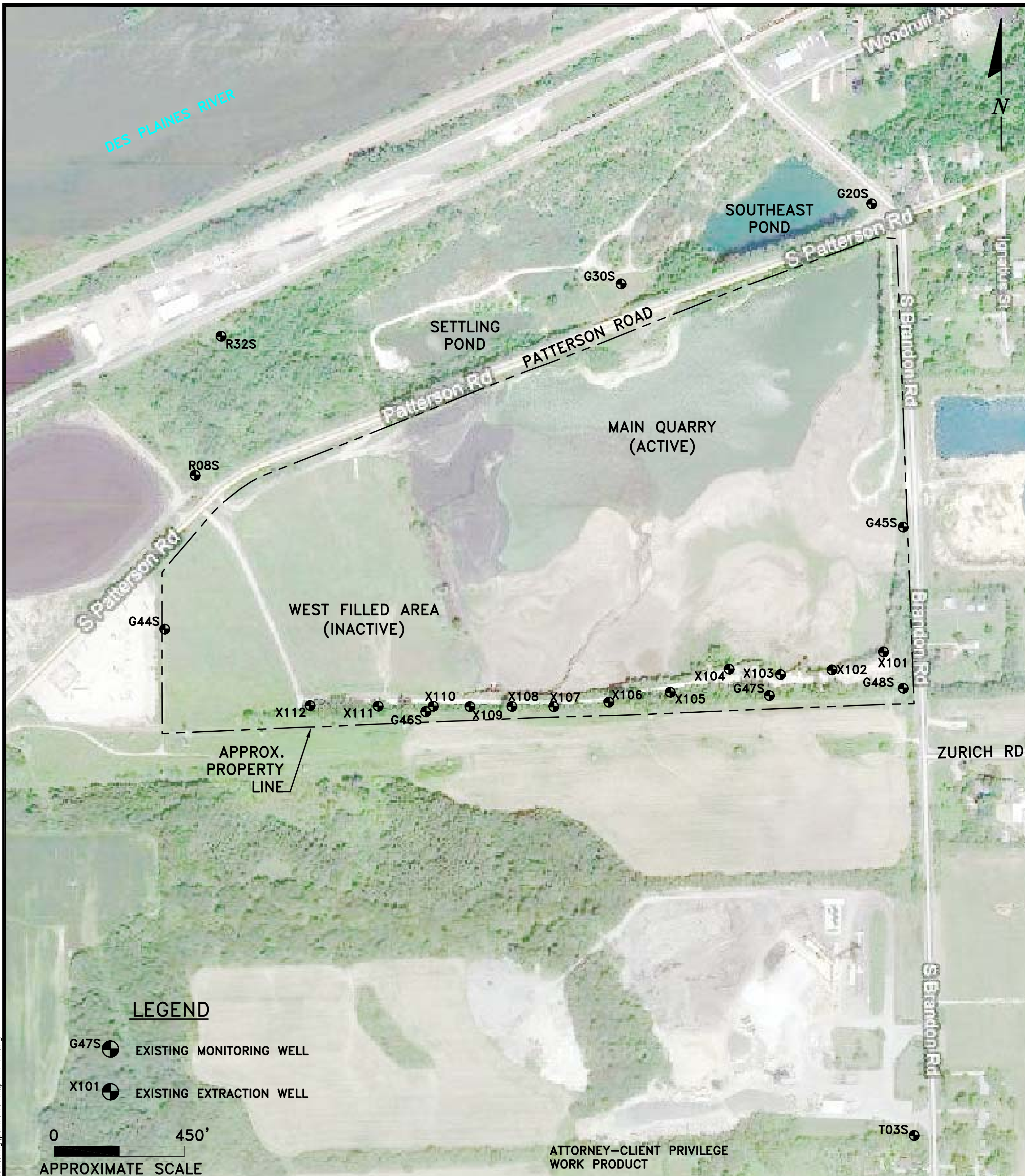
Date: 10-13-17

Joshua Davenport, P.E.

Professional Engineer Registration No. 062.061945

KPRG and Associates, Inc.

FIGURE



W:\c\projects\midwest generation\lincoln quarry gw monitoring\permit well map 4-4-14.dwg

E N V I R O N M E N T A L C O N S U L T A T I O N & R E M E D I A T I O N

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 2B Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

CCR MONITORING WELL SITE MAP

LINCOLN STONE QUARRY
JOLIET, ILLINOIS

Scale: 1" = 450' | Date: February 11, 2016

KPRG Project No. 12313 | FIGURE 1

TABLE

Table 1. Part 257 Appendix III and IV Parameters

APPENDIX III PARAMETERS
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)
APPENDIX IV PARAMETERS
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercíry
Molybdenum
Selenium
Thallium
Radium 226/228 combined