ANDREWS
ENGINEERING, INC.

April 22, 2013

Joe Feldman P.E., L.S.
Franklin County Highway Department
400 East Locust
Room 003A
Union, MO 63084

Re: Proposed Coal Ash Waste Landfill
Ameren – Labadie Power Plant
Franklin County, Missouri

Dear Mr. Feldman:

Per your request, we have reviewed available records as relevant to the proposed Ameren-Labadie coal ash landfill referenced above in regards to the Groundwater Detection Monitoring System.

Documents reviewed are:

- Ameren Missouri Labadie Energy Center, Groundwater Detection Monitoring System for a Proposed Utility Waste Landfill, Franklin County, Missouri, January 2013
- Appendix Q Groundwater Sampling and Analysis Plan
- Appendix W Groundwater Hydraulic Data
- Appendix X Documentation of Groundwater Monitoring System Design
- Ameren Missouri Labadie Energy Center, Construction Permit Application for a Proposed Utility Waste Landfill, Franklin County, Missouri, January 2013

Based upon our review of the Groundwater Detection Monitoring System, Andrews Engineering, Inc. has generated a draft set of comments and have submitted them to Gredell Engineering Resources, Inc. (Ameren Engineering Consultant) for clarification. In addition, meetings were held on March 18, 2013 with Franklin County and Ameren and March 26, 2013 with Franklin County, Ameren and their consultants to discuss the review process and draft comments. Enclosed is a summary of the Groundwater Detection Monitoring System review.

If you have any questions or concerns, please do not hesitate to contact me.

Very truly yours,

Douglas W. Mauntel, P.E.
Andrews Engineering, Inc.

DWM:dwm:ldb

cc: Kenneth Liss, L.P.G. Vice President of Operations, Andrews Engineering, Inc.
Karl Finke, P.E., Andrews Engineering, Inc.

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Ameren Missouri
Labadie Energy Center
Franklin County, Missouri

Groundwater Monitoring Application Review

April 2013

Submitted to:
Franklin County Board of Commissioners
Franklin County, Missouri

Prepared for:
Franklin County Board of Commissioners
Franklin County, Missouri

Prepared by:
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FIGURES

ATTACHMENTS

1. INTRODUCTION

Appendix X of the Construction Permit Application is the Documentation of Groundwater Monitoring System Design prepared by Gredell Engineering Resources, Inc. (GREDELL) on behalf of Ameren Missouri (Ameren) for the proposed Utility Waste Landfill at the Ameren Labadie Power Plant.

The location and spacing of the wells are described in Appendix X of the Construction Permit Application and depicted on Figure 2 of Appendix Q (Proposed Utility Waste Landfill Monitoring Well Location Map). As described in the text and depicted on Figure 2,, the well spacing beginning at the northwestern corner of Cell 2 is approximately 450 feet (MW-1 through MW-4). Wells MW-1 through MW-4 are located approximately 180 feet north, along an azimuth of 32.6 degrees, of Cell 2. Wells MW-5, MW-6 and MW-7, are spaced wider since these wells are farther from the disposal limits of Cell 2 due to the location of Pond 2. Wells MW-5, MW-6 and MW-7 are located east of the pipeline and north and east of Pond 2. Wells MW-5 and MW-6 are located approximately 600 feet and 1400 feet downgradient, along an azimuth of 32.6 degrees, of Cells 2 and 1, respectively. The spacing of wells along the eastern perimeter of Cell 3 is specified as approximately 330 feet (MW-7 through MW-17). As depicted on Figure 2, wells MW-7 through MW-17 are located approximately 400 feet, along an azimuth of 66.6 degrees, of Cell 3. Along the southern edge of Cell 3, it is described that the well spacing has been increased to avoid placing a well in a jurisdictional area (MW-18). Along the eastern perimeter of Cell 4, the well spacing is specified as between approximately 330 and 500 feet (MW-19 through MW-21). Lastly, a sentry well (TMW-1) is to be installed immediately east downgradient of Cell 1 within the utility pipeline corridor. This sentry well is to be used during the initial operation within Cell 1.

Based upon the review of the proposed well spacing, Andrews Engineering, Inc. (Andrews) does not concur that the proposed well spacing sufficiently meets the requirements of 10 CSR 80-11.010 Section 11 or Franklin County Land Use Regulations Section 238(C)(3)(f). In discussions with GREDELL it was found that much of the information required by Section 11 has not been collected or has not been sufficiently characterized.

Specifically, this includes:

- Characterization of the extent or thickness of the uppermost aquifer;
- Characterization of the effective porosity of the uppermost aquifer;
- Characterization of the physical and hydrogeologic properties of the uppermost confining unit;
- Characterization of vertical hydraulic gradients within the uppermost aquifer;
- A demonstration that the proposed background well locations are representative of background groundwater quality not affected by the existing utility waste landfill;
- A demonstration that the proposed number, locations and depths of monitoring wells shall ensure the detection of any significant amount of fluids generated by the utility waste landfill that migrate from the utility waste landfill to the groundwater.

In an effort to provide a path forward, Andrews has prepared a sensitivity analysis and recommendations for well spacing, including the installation of nested groundwater monitoring

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wells to allow the collection and characterization of vertical hydraulic gradients and spatial variation in groundwater quality with depth.

2. WELL SPACING EVALUATION AND SENSITIVITY ANALYSIS

The well spacing demonstration presented in Appendix X uses the PLUME model. PLUME is a module of the Monitoring Analysis Package (MAP) software package distributed by the International Ground Water Modeling Center in Golden, Colorado and is based on a two-dimensional analytical transport model presented by Domenico and Robbins (1985) and modified in Domenico (1987). This model assumes that solute is released along a continuous line source in a uniform aquifer, and predicts the concentrations that would be observed at points downgradient of the source. The parameters of this model are outlined in Appendix X of the Construction Permit Application.

Based upon our review, the parameters used in the PLUME model were not well documented or characterized. To determine the relative importance of these parameters, a sensitivity analysis has been completed. The sensitivity analysis was only completed on the parameters used to characterize the well spacing for Cells 1 and 2. This sensitivity analysis evaluated the following parameters:

- Source width (Y),
- Effective porosity (n_e),
- Longitudinal and transverse dispersivity (a_x and a_y),
- Hydraulic gradient (i), and
- Source concentration (C_o).

2.1 Source Width (Y)

The PLUME model presented in Appendix X assumes a source width, Y, of 100 feet. The source width parameter represents the length of the source perpendicular to the groundwater flow path. A 100 foot source width represents a catastrophic failure of the 60 mil HDPE and the underlying 2 feet of engineered earthen liner. A failure of this magnitude is unlikely and with respect to well spacing, modeling cannot be considered remotely conservative. Given the current level of QA/QC and material, a more likely breach of the liner will occur as a rip, tear or puncture on the order of 5 feet or less.

The sensitivity analysis of the source width was completed for source widths of 5, 10 and 20 feet. In this analysis, the only value varied was Y. The results of the 100 foot source width modeled by Ameren, using all of Ameren's parameters, resulted in a plume length of 664 feet and a 0.001 concentration contour plume width of 273 feet. This can be considered the "baseline" scenario to which all sensitivities are compared. This baseline scenario represents the plume length and dimension for 44 years (528 months), which is the active life and post-closure care period for the proposed landfill.

Source Width, Y (feet)	Length of Plume (0.001 contour), x (feet)	Width of Plume at 180 feet (0.001 contour) (feet)
100 (Ameren)	664	273
5	620	158
10	632	170
20	643	184

As shown in the table above, the length and width of the plume are sensitive to the source width. However, it should be noted that the width of the plume is more sensitive to the source width than is the length. A source width of 5 feet resulted in only 6.6% reduction of the plume length while resulting in a 41% reduction in the plume width.

2.2 Effective Porosity (n_e)

The well spacing proposed by Ameren is based on an assumed effective porosity of the uppermost aquifer of 35% (n_e = 0.35). Based on site-specific data for the St. Charles well field (Mugel, 1993), located approximately 7 miles downstream of the Ameren Labadie facility, the effective porosity of the Missouri River alluvium ranges from 21% to 32%. These effective porosity values are based on a tracer test performed in the Missouri River alluvial aquifer. Based on this data, the uppermost aquifer exhibits a mean effective porosity of 26.5%.

As presented in the table below, the first outcome noted is for the Ameren baseline scenario where a literature derived value of 35% was used to represent the effective porosity of the uppermost aquifer. The second outcome listed presents the result of an effective porosity value of 26.5% for a 100 foot source width.

Effective Porosity, n_e (unitless)	Seepage Velocity (feet/month)	Source Width, Y (feet)	Length of Plume (0.001 contour), x (feet)	Width of Plume at 180 feet (0.001 contour) (feet)
0.35 (Ameren)	1.013	100 (Ameren)	664	273
0.265	1.34	100 (Ameren)	853	273
0.265	1.34	5	802	167

The PLUME model is somewhat sensitive to the effective porosity. The effect of lowering the effective porosity is to increase the seepage velocity. The seepage velocity, v is:

$$v_s = \frac{Ki}{n_e}$$

where: v_s = seepage velocity (feet/month)

K = hydraulic conductivity = 0.05002 feet/min (Ameren value for Cells 1 and 2) = 2191 feet/month

i = hydraulic gradient = 0.000162 feet/feet (Ameren resultant value reported on Table 2a)

n_e = 0.35 (Ameren literature derived value) = 0.265 (St. Charles Well Field value for Missouri River alluvium)

Using the Ameren derived hydraulic gradient, 0.000162 feet/feet, and the Ameren reported literature value for effective porosity of 0.35, the seepage velocity is 1.013 feet/month. Using the Ameren derived hydraulic gradient and the Missouri River alluvium effective porosity, the seepage velocity is 1.34 feet/month.

The effect of decreasing the effective porosity results in an increased seepage velocity that results in an increased plume length for the same time period 44 years (528 months). It should be noted that the seepage velocity used by Ameren is based on a hydraulic gradient that is a fraction of that reported in Attachment 1 Baseline Hydrologic Data Notes. The mean hydraulic gradient reported in Attachment 1 is 0.00037 feet/feet for Cells 1 and 2. However, back calculating the hydraulic gradient for the Ameren modeled effective porosity (0.35), hydraulic conductivity (2191 feet/month) and seepage velocity (1.013 feet/month) used in the PLUME demonstration, shows that a hydraulic gradient of 0.000162 feet/feet was assumed. This is similarly questioned for Cells 3 and 4. The seepage velocity Ameren used for the PLUME model for Cells 3 and 4 is 1.212 feet/month. This back calculates to a hydraulic gradient of 0.000194, whereas the reported hydraulic gradient for Cells 3 and 4 is 0.00028 feet/feet.

On Tables 2a and 2b, the unit of hydraulic conductivity is noted as feet/yr. However, it appears that this is a typo and according to Attachment 1 Baseline Hydrologic Data Notes and Table 6 of the March 2011 Detailed Site Investigation (DSI), the units should be feet/min. In addition, the hydraulic conductivity used in the calculations for dispersivity and seepage velocity presented on Table 2b for Cells 3 and 4 are based on the hydraulic conductivities reported for Cells 1 and 2 and not for Cells 3 and 4. The average hydraulic conductivity for Cells 3 and 4 is 0.05567 feet/min. However, Table 2b uses an average hydraulic conductivity calculated for Cells 1 and 2 as 0.05002 feet/min. The outcome of these errors is a misrepresentation of the seepage velocity which is expressed in incorrect plume lengths. The results of using these corrected values for Cells 1 and 2 are evaluated following the sensitivity analysis of longitudinal and transverse dispersivities below.

2.3 Longitudinal and Transverse Dispersivity (a_x and a_y)

The longitudinal (a_x) and transverse (a_y) dispersivities used in the Ameren PLUME models for Cells 1 and 2 and Cells 3 and 4 are derived from resultant vectors calculated on Tables 2a and 2b of Appendix X, respectively. Dispersivity represents the spreading of a contaminant over a given flow length. It is generally accepted that as the scale of the plume increases, the dispersivity will also increase.

The method of deriving longitudinal and transverse dispersivities presented in Tables 2a and 2b is unconventional and not consistent with the recommendations of the USEPA.

As a rule of thumb, the U.S. EPA suggests that longitudinal dispersivity can be initially estimated as 10 percent of the plume length (Wiedemeier, et al. 1998; Aziz et al. 2000). This assumes that dispersivity varies linearly with scale. However, based on a study by Xu and Eckstein (1995) of data collected by Gelhar et al. (1992), longitudinal dispersivity is best represented by the relationship:

$a_x = 0.83[\log_{10}(L_p)]^{2.414}$
a_x = longitudinal dispersivity estimate
L_p = Plume Length *(L_p is in meters)*

The relationship of Gelhar (1992) and Xu and Eckstein (1995) are illustrated in the figure below.

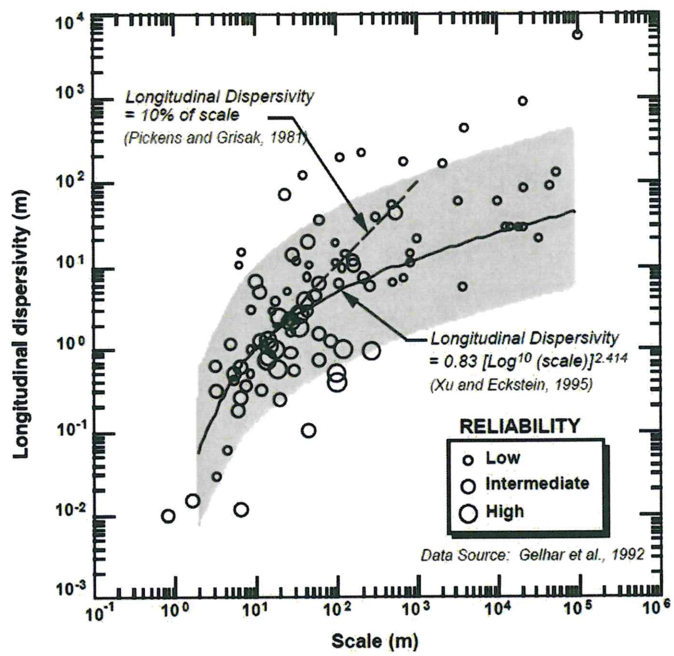

Figure A.3. Longitudinal dispersivity vs. scale data reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of circle represents general reliability of dispersivity estimates. Location of 10% of scale linear relation plotted as dashed line (Pickens and Grisak, 1981). Xu and Eckstein's regression shown as solid line. Shaded area defines ±1 order of magnitude from the Xu and Eckstein regression line and represents general range of acceptable values for dispersivity estimates.

Source: Aziz et al 2000.

In addition to longitudinal dispersivity it is necessary to estimate transverse dispersivity. Based on the high reliability points from Gelhar et al. (1992) the transverse dispersivity may be calculated as 1/10th the longitudinal dispersivity or $a_y = 0.1\ a_x$.

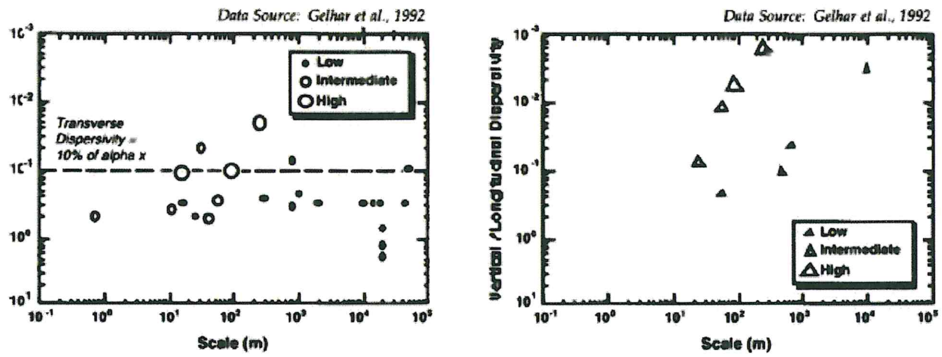

Figure A.4. Ratio of transverse dispersivity and vertical dispersivity to longitudinal dispersivity data vs. scale reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of symbol represents general reliability of dispersivity estimates. Location of transverse dispersivity relation used in BIOCHLOR is plotted as dashed line.

Source: Aziz et al 2000.

The first outcome is for the baseline scenario where Ameren's dispersivity and a 100 foot source width is used. The second outcome is for a longitudinal dispersivity (24.5) based on the plume length (1004 feet) and transverse dispersivity (2.45) based on 1/10th the longitudinal dispersivity for a 100 foot source width. The third outcome is for dispersivities based on the estimation methods of Xu and Eckstein (1995) and Gelhar (1992) for a 5 foot source width.

Longitudinal and Transverse Dispersivity, a_x / a_y (feet)	Source Width, Y (feet)	Length of Plume (0.001 contour), x (feet)	Width of Plume at 180 feet (0.001 contour) (feet)
1.744 / 2.032 (Ameren)	100 (Ameren)	664	273
24.5 / 2.45	100 (Ameren)	1004	291
22.6 / 2.26	5	826	169

The sensitivity of the PLUME model to dispersivity is characterized by an increase in both the length and width of the plume with an increase in both longitudinal and transverse dispersivities.

2.4 Source Concentration (C_o)

The following table compares the plume lengths and plume widths for Cells 1 and 2 for the Ameren proposed well spacing model and for a well spacing model that incorporates all of the changes to the parameter values discussed above. The first outcome is for the baseline scenario proposed by Ameren. The second outcome is for a reduced source width (Y = 5 foot), longitudinal (a_x = 33 feet) and transverse (a_y = 3.3 feet) dispersivities based on U.S. EPA approved methods, site-specific hydraulic gradient (i = 0.00037), and an effective porosity from an in situ test of the Missouri River alluvium (n_e = 26.5). The compounding effect of changing all of these parameters is outlined in the table below.

Source Width, Y (feet)	Longitudinal and Transverse Dispersivity, a_x / a_y (feet)	Hydraulic Gradient (feet/feet)	Effective Porosity, n_e (unitless)	Length of Plume (0.001 contour), x (feet)	Width of Plume at 180 feet (0.001 contour) (feet)
100 (Ameren)	1.744 / 2.032 (Ameren)	0.000162 (Ameren)	0.35 (Ameren)	664	273
5	33/ 3.3	0.00037	0.265	2125	231

As shown in the table above, using a 5 foot source width with the conservative parameters outlined above, result in a plume length of 2,125 feet for a time period of 44 years (528 months). The distance from the northeast corner of the waste boundary of the proposed Cell 2 to the property boundary is 1022 at its shortest and 1168 feet along the proposed flow azimuth of 32.6 degrees. For parameters with source concentration to groundwater standard ratios of 0.001, this would result in migration beyond the property boundary along the north side of Cell 2.

The importance of identifying the concentration contours at which the plume length and width are presented above can be expressed by explaining the significance of the ratio between the source concentration and the calculated groundwater protection standard. The PLUME model presented by Ameren assumes a constant source concentration for chloride (total) of 3000 mg/L and an assumed groundwater protection standard of 3 mg/L. However, since PLUME does not allow the entry of a source concentration, the concentrations must be expressed as normalized values. The normalized concentration for the Ameren scenario would result in a chloride (total) source concentration of 1 mg/L and a groundwater protection standard of 0.001 mg/L. At this time, given the lack of site-specific data, this cannot be considered a conservative concentration contour for determining well spacing.

In lieu of site-specific data, an independent report prepared by Cherry et al. (2000) was consulted for leachate concentration data for the detection parameter chloride. The data compiled in the March 28, 2000 report entitled "Review of the Global Adverse Environmental Impacts to Ground Water and Aquatic Ecosystems from Coal Combustion Wastes," reports chloride leachate concentrations from coal ash disposal facilities ranging from 470 mg/L to 4,600 mg/L. Based on this information, source concentrations were evaluated for the mean (2,525 mg/L), the minimum (470 mg/L) and maximum (4,600 mg/L) values.

A groundwater protection standard for chloride was estimated from Ameren's groundwater sampling and analysis effort provided in the May 9, 2012 report prepared by Golder and Associates, Inc. entitled "Report on Piezometer Installation, Water Level Monitoring, and Groundwater Sampling - Labadie, Missouri." Based on the analytical results presented in the report, chloride concentrations in groundwater samples collected from piezometers TGP-A, TGP-B, and TGP-C were 5.8 mg/L, 29 mg/L, and 43 mg/L, respectively. The mean of these values is 25.9 mg/L and the standard deviation is 18.8 mg/L. Using the mean plus three standard deviations, a groundwater protection standard for chloride (total) is estimated as 82.3 mg/L.

Assuming a minimum chloride source concentration of 470 mg/L and a groundwater protection standard of 82.3 mg/L, the concentration contour that would represent the groundwater protection standard is the normalized concentration contour of 0.175. If the concentration is 4600 mg/L, the normalized concentration contour would be 0.0179. For our estimations, given that we do not know what the actual chloride source concentration or the groundwater protection standard will be, Andrews Engineering, Inc. will associate these concentrations with the 0.01 and 0.1 contours.

The contours depicted on the output files for Cells 1 and 2 and for Cells 3 and 4 provided in Attachment 3 "PLUME Model Outputs" of the Construction Permit Application represent the 0.001, 0.01 and 0.1 concentration contours with the outer concentration contour representing the 0.001 contour and the inner contour representing the 0.1 concentration contour. It can be seen on these output files that the widths of the plumes depicted by the 0.01 and 0.1 contours are significantly smaller than the 0.001 contour.

Concentration Contour (unitless)	Length of Plume (feet)	Width of Plume at 180 feet (feet)
0.1	581	170
0.01	630	228
0.001	664	273

Sheet 1 in Attachment 1, (Draft Comments to Gredell) depicts the 0.001, 0.01 and 0.1 concentration contours for Cells 1 and 2 using the parameter values suggested herein. Sheet 1 is for a time period of 44 years (528 months). As depicted in Sheet 1, the 0.001 concentration contour extends to a distance of 2125 feet.

Concentration Contour (unitless)	Length of Plume (feet)	Width of Plume at 180 feet (feet)
0.1	581	-
0.01	630	148
0.001	664	231

As indicated in the preceding tables, it can be seen that the plume width is critically dependent upon the ratio of the source concentration to the groundwater protection standard. For a greater ratio, the plume widths decrease, and similarly, for a low ratio the plume widths increase.

Another factor that has not been characterized in the presented monitoring well spacing evaluation is the time for the contaminant to migrate through the constructed clay liner. Should only a tear occur in the flexible membrane liner, there will be a delay in the contaminant to reach the uppermost aquifer, the "contaminant breakthrough time." The contaminant breakthrough time is characterized below.

The major contaminant migration processes through a liner system is advection, diffusion and adsorption. Advection of a pollutant is associated with the seepage velocity of the leachate and calculated using the Darcy's law given in equation:

$$v_s = \frac{Ki}{n_e}$$

The contaminant breakthrough time if only advection is considered can be calculated using the equation:

$$t = \frac{H}{v_s}$$

where: t = contaminant breakthrough time
K = hydraulic conductivity = 1x10-7 cm/sec = 0.000238 feet/day
i = hydraulic gradient = (1 feet head + 2 feet liner) / 2 feet liner = 1.5 feet/feet
n_e = McWorter and Sunada (1977) report effective porosity of clay ranging from 0.01 to 0.18 with a mean of 0.06 (unitless) = 0.05 to 0.1
H = liner thickness = 2 feet
v_s = seepage velocity

$$v_s = \frac{Ki}{n_e} = \frac{0.000283 ft / day \bullet 1.5 ft / ft}{0.06} = 0.00425 ft / day$$

$$t = \frac{H}{v_s} = \frac{2 ft}{0.00425} = 283\, days$$

Assuming a mean effective porosity ranging from 0.01 to 0.18, migration through the liner to the top of the vadose zone could range from as little as 47 days to as much as 848 days. While the effective porosity takes more effort to characterize, as shown above, the rate of migration is very sensitive to this parameter. This additional time for migration has not been addressed in the PLUME model.

3. PROPOSED WELL SPACING

Using conservative parameters described in Section 2 above, PLUME was used to determine well spacing for Cells 1 and 2 and Cells 3 and 4. The plumes are depicted on Sheet 2 of Attachment 1 (Draft Comments to Gredell). Based on Ameren's data, the plume azimuth for Cells 1 and 2 is 32.6 degrees and for Cells 3 and 4 the flow azimuth is 66.6 degrees. As depicted on Sheet 2, the predicted plume widths are considerably smaller for the 0.01 and 0.1 concentration contours than proposed by Ameren. Given the proximity to the property boundary along the north edge of Cell 2 and along the southeast edge of Cell 3, additional wells are being recommended. The locations and depths of the additional wells are discussed below.

Based on the evaluation and sensitivity presented above, Andrews Engineering, Inc. proposes the following amendments to the Ameren proposed monitoring well network.

3.1 Cells 1 and 2

Monitoring wells MW-1 through MW-4 along the north side of Cells 1 and 2 are located approximately 180 feet from the waste boundary and have an approximate spacing of 450 feet. Along the described flow azimuth of 32.6 degrees, the wells are approximately 261 feet from the waste boundary. Using this flow distance, a well spacing for the 0.01 concentration contour would be approximately 200 feet at the northwest corner and decreasing to approximately 145 feet along the northeast corner.

Based on the depicted plume widths, it is recommended that seven additional wells be installed along the north and northeast edges of Cell 2. As depicted on Sheet 3, wells P1, P2, P3S and P4 are proposed at locations 492 feet from the waste boundary, offset from wells MW-1, MW-2, MW-3 and MW-4. Wells P5 and P6 are located northeast of Cell 2 and are located 303 feet from the line of wells MW-4, MW-5 and MW-6. Wells P1, P2, P3S and P4 are spaced 450 feet apart and are offset from wells MW-1, MW-2, MW-3 and MW-4. Wells P5 and P6 are spaced 450 feet apart and are offset from wells MW-4, MW-5 and MW-6.

Wells P1 through P6 must be screened consistent with the screened elevations of wells MW-1 through MW-6. In addition to the shallow wells, it is proposed that a deep well be installed within 10 feet of well P3S. The proposed well, P3D, should be constructed with a 10 foot long screen and be located across the overburden/bedrock interface. This well will be used to characterize vertical gradient and groundwater quality at the bottom of the overburden/top of bedrock.

3.2 Cells 3 and 4

Cells 3 and 4 are monitored by wells MW-7 through MW-17. These wells are located approximately 370 feet from the waste boundary and have an approximate spacing of 330 feet. Along the described flow azimuth of 66.6 degrees, the wells are approximately 412 feet from the waste boundary. Using this flow distance, a well spacing for the 0.01 concentration contour would be approximately 210 feet at the northwest corner and decreasing to approximately 125 feet along the southeast corner.

Four wells are proposed for Cells 3 and 4. As depicted on Sheet 3, wells P7 and P8 are proposed at locations 303 feet from the line of wells inscribed by MW-7 through MW-16. Wells P7 and P08 are located approximately 330 feet apart and are offset from wells MW-14, MW-15 and MW-16. Proposed well P9 is located approximately mid-distance between the line inscribed by wells MW-16 and MW-17 and the property boundary. This places well P9 along a line approximately 150 feet from the line of wells MW-16 and MW-17. The screened zones for wells P7, P8 and P9 must be screened consistent with the screened elevations of wells MW-14 through MW-17.

Proposed well P12D is a deep well to be installed within 10 feet of well MW12. The proposed well, P12D should be constructed with a 10 foot long screen and be located across the overburden/bedrock. This well will be used to characterize vertical gradient and groundwater quality at the bottom of the overburden/top of bedrock.

3.3 Upgradient Wells

In addition to the proposed downgradient wells, three upgradient deep wells are proposed. As depicted on Sheet 3, the proposed deep wells are located near proposed groundwater monitoring wells MW-20, MW-24 and MW-26. The proposed wells are identified as P20D, P24D and P26D, respectively.

The proposed deep wells, P20D, P24D and P26D should be constructed with a 10 foot long screen and be located across the overburden/bedrock interface. These wells will be used to characterize vertical gradient and groundwater quality at the bottom of the overburden/top of bedrock.

4. REFERENCES

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Attachment 1

Draft Comments to Gredell

Please forgive the informality of these comments. However, please consider them a starting point for further discussion and resolution of this project. Please let me know if you have any questions.

Comments regarding the sampling and analysis plan:

1. Appendix Q Groundwater Sampling and Analysis Plan, Section 4.1 Well Construction, page 6 and Table 2 – the narrative and table should include the requirement for submittal of monitoring well construction reports to MODNR within 60 days of completion of the well.

   10 CSR 23-4.020(1) requires monitoring well construction reports be submitted to MODNR within 60 days of completion of the well.

2. Appendix Q Groundwater Sampling and Analysis Plan, Section 5.0 Sampling Frequency, page 8 and Appendix 2 – the reportable concentrations for Beryllium and TOX are presented as ug/L, but should be mg/L, Iron is presented as mg/L, but should be ug/L.

   10 CSR 80-11.010, Appendix I Reporting units should be consistent with the units specified on the electronic submission form required by Missouri DNR. http://www.dnr.mo.gov/env/swmp/docs/ashdown.csv

3. Appendix Q Groundwater Sampling and Analysis Plan, Section 7.2 Trip Blanks, page 11 – a trip blank should also be collected at a minimum rate of one trip blank for each day of sampling of each sampling event. No proposal for the collection of trip blanks is provided.

4. Appendix Q Groundwater Sampling and Analysis Plan, Section 7.4 Equipment Blanks, page 11 – equipment blanks should be collected at a frequency of one per day or one for every five downgradient wells sampled if more than 5 wells are sampled. Also, equipment blanks should be collected each time a known contaminated well is sampled. This is outlined in Collection Handling and Reporting Procedure for Groundwater Samples PUB000181 C.3.

5. Appendix Q Groundwater Sampling and Analysis Plan, Section 8.3 Purging, page 13 – Clean container or plastic sheeting must be placed around or next to the monitoring well prior to commencement of purging and sampling activities to prevent contamination. This is outlined in Collection Handling and Reporting Procedure for Groundwater Samples PUB000181 C.2.

Comments regarding the DSI:

The DSI does not appear to meet the requirements of:

1. One boring for every 4 acres advanced to a depth sufficient to characterize the underlying confining unit;

2. The hydraulic conductivity of the uppermost confining bed must be determined by in situ test in a least one out of every two, but a minimum of five borings that penetrate the confining unit;

3. Wells are proposed outside of the limits of the DSI;

4. Piezometers and borings must be located within 500 feet of the limits of the existing filled area such that there is a minimum of one piezometer per 400 lineal feet extending along the periphery of the existing filled area;

Comments regarding the Groundwater Monitoring Program and Well Spacing:

1. What is the hydraulic conductivity and porosity of the upper weathered bedrock?

2. What portion of the weathered bedrock, if any, is considered part of the uppermost aquifer?

3. What is the total thickness of the uppermost aquifer, to include that portion of the weathered bedrock, if present, that is in direct hydraulic communication with the overlying alluvial valley fill?

4. What is the underlying confining unit? What field work has been done to characterize the confining unit as such?

5. What is the topography of the upper surface of the underlying confining unit? Are there bedrock highs or valleys that may influence flow?

6. What is the vertical hydraulic gradient of the uppermost aquifer? Does it vary with the monthly changes in flow direction or does it vary with depth? If so, what are the gradients in the upper portion, the middle portion and the deep portion of the uppermost aquifer?

7. Are all proposed/installed groundwater monitoring wells located within the footprint of the DSI? If not, what wells are located outside the area of the DSI?

8. Where cross-sections A-A' and B-B' intersect, the geology does not match. Which one is correct? How does this impact the conclusions of the DSI?

9. The year in which the groundwater elevations were collected is described as atypical. What is the groundwater flow direction under normal river stage and precipitation conditions? How does this affect the proposed background and downgradient groundwater monitoring well locations?

10. Since the groundwater conditions are described as atypical during the period in which data was collected, are the hydraulic gradients still applicable (i.e., consistent with typical groundwater conditions)?

11. Will background groundwater quality collected from the proposed background wells be representative of background conditions of the Missouri River alluvium that has not been impacted by the existing fly ash impoundments? What data will be used to determine whether a statistically significant change in groundwater quality in the downgradient wells is attributable to the past ash management areas or the new cells?

12. How will the existing 154 acre "Original Pond" that was put into service in 1970 and leaking since 1992 influence background groundwater quality and determination of an appropriate background for the newly proposed lined facility?

13. Considering contaminant transport and groundwater flow within the entirety of the uppermost aquifer, what additional wells may be necessary to ensure that a release is detected before the end of the monitoring period?

14. Are there any site-specific groundwater flow conditions within the uppermost aquifer that will limit the extent of the release to only the upper portion of the uppermost aquifer as assumed? If so, please describe these conditions and provide supporting documentation for such conditions.

15. Using a representative source concentration (leachate data for a like facility or laboratory determined results) and source width (provide rational for source width chosen), for a conservative parameter (i.e., a high Compliance Limit/Source Concentration ratio) and the assumptions of no retardation and no degradation, how long will it take for the Compliance Limit to be exceeded at the property boundary, from the most downgradient edge of the proposed waste unit and the groundwater flow direction under normal river stage and precipitation conditions?

16. Is your well spacing representative of the most and least conservative parameters, leachate concentrations and background limits?

17. Is the time for contaminant travel within the period of active, closure and/or post-closure care?

18. Using the conditions above, what well spacing will allow the detection of a release from the proposed unit before the end of the monitoring period?

19. What method was used to calculate dispersivity (i.e., longitudinal and transverse)? Explain how the method chosen is representative of the flow distance.

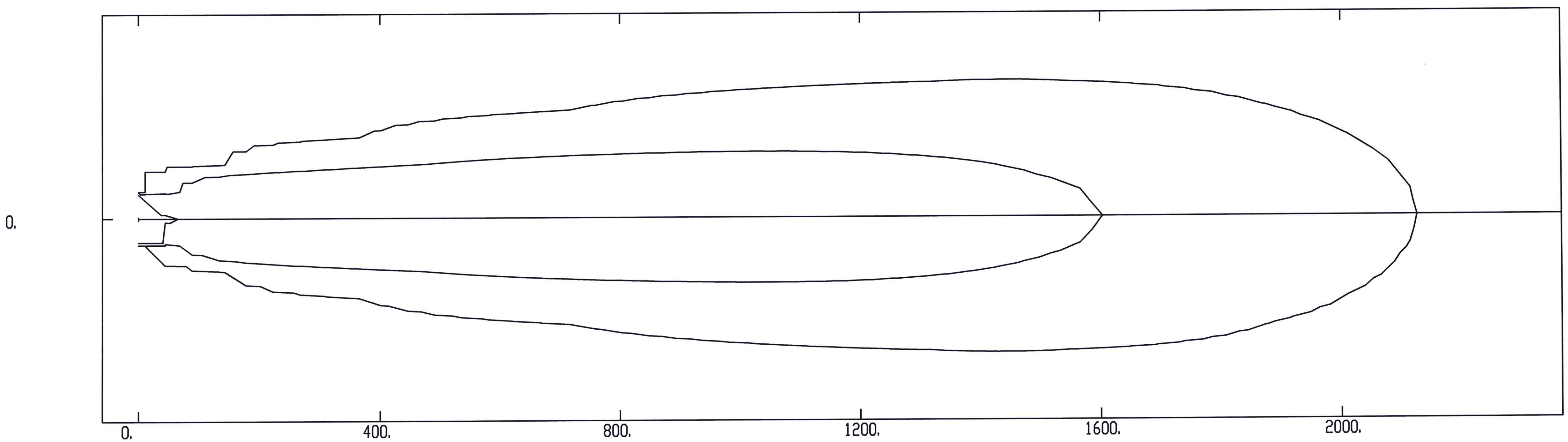
20. What is the site-specific effective porosity of the uppermost aquifer?

21. What source width is consistent with the level of QA/QC and current liner installation practices.

Attachment 2

Correspondence with Gredell

MAP ver 1.1 PLUME Simulation Golder Associates Inc.



Contours at: .00100, .01000, .10000

Advection time = 528.00

Average contaminant velocity = 3.0600

Width of line source = 5.00

Longitudinal dispersivity = 33.00

Transverse dispersivity = 3.30

First-order decay constant = .000E+00

Diffusion coefficient = .000E+00

0 100 200 400

SCALE: IN FEET

NO.	DATE	REVISIONS DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO
Professional Design Engineering and Land Surveying Firm #184-001541

APPROVED BY: MTH DESIGNED BY: MTH DRAWN BY: MPN

44 YEAR PLUME FOR CELLS 1 & 2

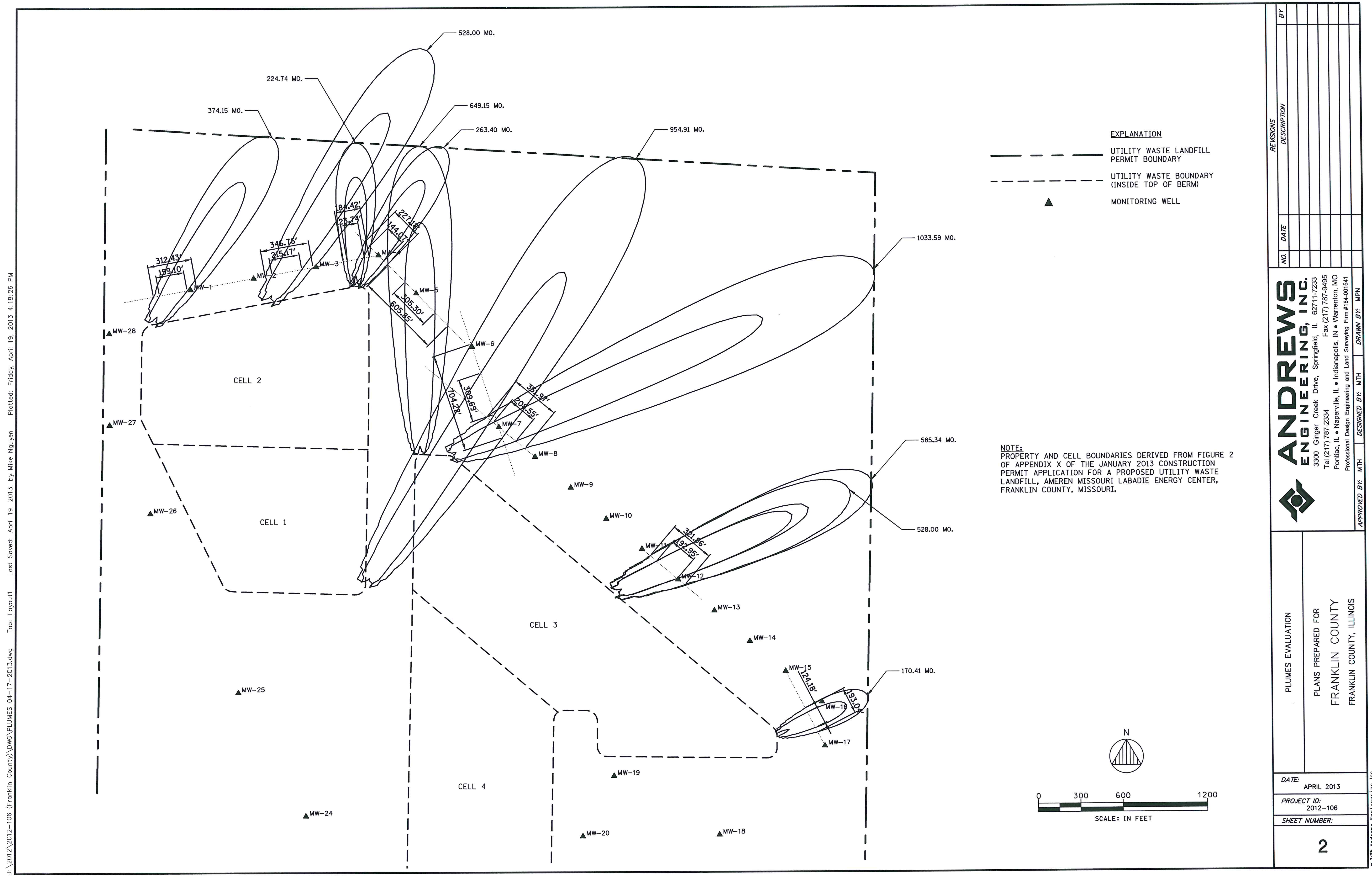
PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS

DATE: APRIL 2013

PROJECT ID: 2012-106

SHEET NUMBER: 1

J:\2012\2012-106 (Franklin County)\DWG\CELLS12-44YR.dwg Tab: Model Last Saved: April 19, 2013, by Mike Nguyen Plotted: Friday, April 19, 2013 3:57:30 PM



EXPLANATION
UTILITY WASTE LANDFILL PERMIT BOUNDARY
UTILITY WASTE BOUNDARY (INSIDE TOP OF BERM)
MONITORING WELL
NOTE:
PROPERTY AND CELL BOUNDARIES DERIVED FROM FIGURE 2 OF APPENDIX X OF THE JANUARY 2013 CONSTRUCTION PERMIT APPLICATION FOR A PROPOSED UTILITY WASTE LANDFILL, AMEREN MISSOURI LABADIE ENERGY CENTER, FRANKLIN COUNTY, MISSOURI.
528.00 MO.
224.74 MO.
374.15 MO.
649.15 MO.
263.40 MO.
954.91 MO.
1033.59 MO.
585.34 MO.
528.00 MO.
170.41 MO.
312.43'
199.10'
346.76'
215.17'
184.42'
23.74'
227.18'
144.07'
305.30'
605.85'
309.69'
704.28'
351.91'
208.55'
321.86'
192.95'
124.18'
193.04'
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
MW-18
MW-19
MW-20
MW-24
MW-25
MW-26
MW-27
MW-28
CELL 1
CELL 2
CELL 3
CELL 4
N
0 300 600 1200
SCALE: IN FEET
REVISIONS
NO. DATE DESCRIPTION BY
ANDREWS ENGINEERING, INC.
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Professional Design Engineering and Land Surveying Firm #184-001541
APPROVED BY: MTH DESIGNED BY: MTH DRAWN BY: MPN
PLUMES EVALUATION
PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS
DATE: APRIL 2013
PROJECT ID: 2012-106
SHEET NUMBER:
2
© 2013 Andrews Engineering, Inc.
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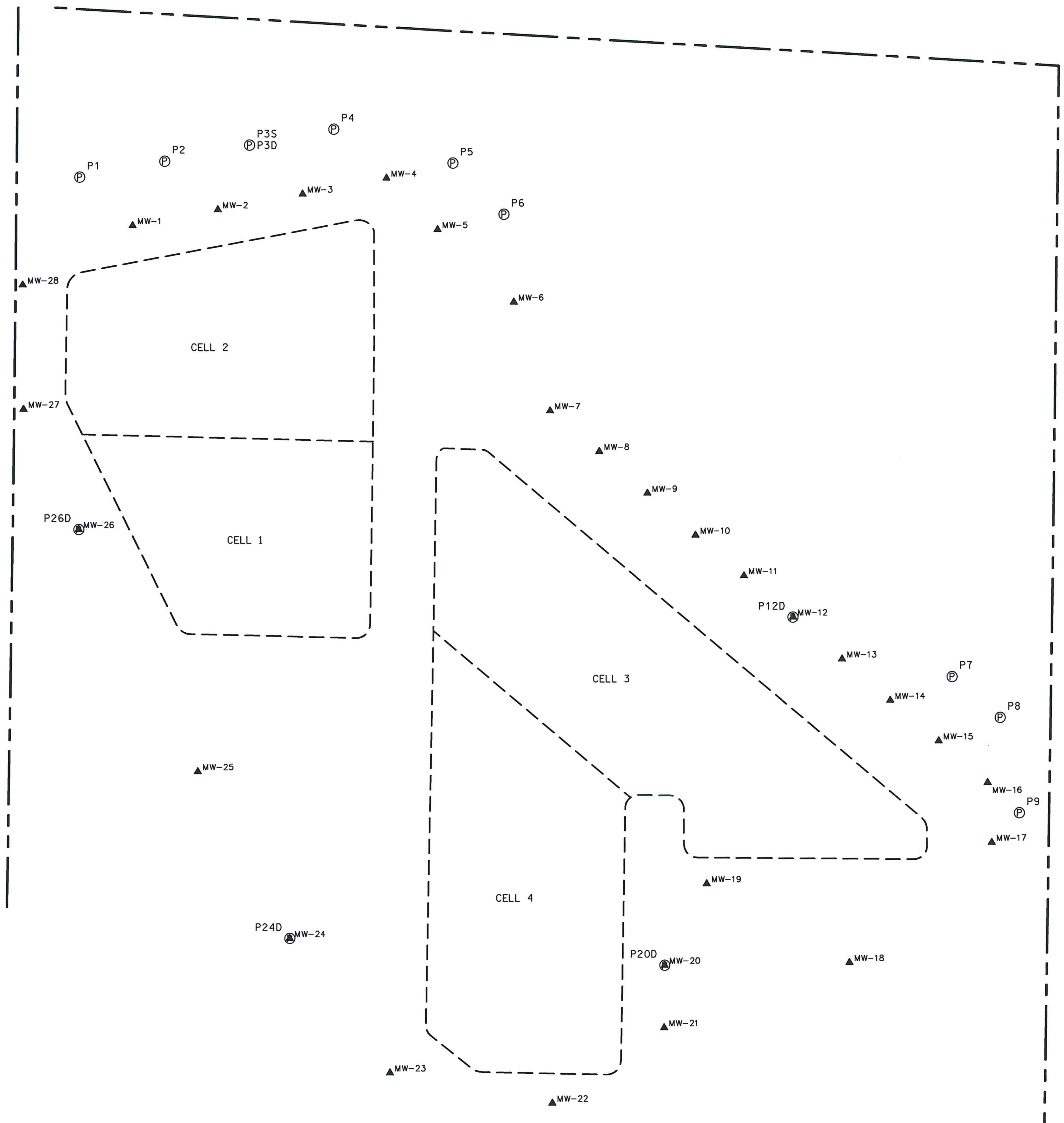

EXPLANATION

UTILITY WASTE LANDFILL PERMIT BOUNDARY

UTILITY WASTE BOUNDARY (INSIDE TOP OF BERM)

MONITORING WELL

PROPOSED MONITORING WELL

NOTE:
PROPERTY AND CELL BOUNDARIES DERIVED FROM FIGURE 2 OF APPENDIX X OF THE JANUARY 2013 CONSTRUCTION PERMIT APPLICATION FOR A PROPOSED UTILITY WASTE LANDFILL, AMEREN MISSOURI LABADIE ENERGY CENTER, FRANKLIN COUNTY, MISSOURI.

NO.	DATE	REVISIONS DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
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Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO
Professional Design Engineering and Land Surveying Firm #184-001541

APPROVED BY: MTH DESIGNED BY: MTH DRAWN BY: MPN

PROPOSED AMENDMENT TO GROUNDWATER MONITORING NETWORK

PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS

DATE: APRIL 2013

PROJECT ID: 2012-106

SHEET NUMBER: 3

J:\2012\2012-106 (Franklin County)\DWG\PROPOSED MONITORING NETWORK.dwg Tab: Layout1 Last Saved: April 19, 2013, by Mike Nguyen Plotted: Friday, April 19, 2013 4:19:18 PM

Attachment 2

Correspondence with Gredell

Mahlon Hewitt

From:	Mike Carlson <mikec@ger-inc.biz>
Sent:	Thursday, March 28, 2013 10:41 AM
To:	Mahlon Hewitt
Subject:	RE: Ameren - Labadie Draft Comments

Ron:

Will Monday afternoon @ 2 p.m. work for a conference call? Please let me know.

Also, turns out Thursday will not work for a meeting as we have a company-wide function I forgot about. Is Friday a possibility?

Mikel C. Carlson, R.G.
Senior Geologist
GREDELL Engineering Resources, Inc.
1505 E. High Street
Jefferson City, MO 65101
573-659-9078 (office)
573-659-9079 (fax)
573-694-0624 (cell)
866-892-0727 (office - toll free)
mikec@ger-inc.biz (email)

From: Mahlon Hewitt [mailto:mhewitt@andrews-eng.com]
Sent: Thursday, March 28, 2013 8:49 AM
To: Mike Carlson
Subject: RE: Ameren - Labadie Draft Comments

Mike,

You are correct, Ameren asked that we meet ASAP to resolve the outstanding issues. Thursday works for me. It looks like at least a 3.5 hour drive to Jefferson City from here. Prior to coming to your office though, I think it would be worthwhile to teleconference and work through as many of the issues as possible so that we can focus on the hard issues on Thursday. Can we teleconference Monday or Wednesday regarding the draft comments?

From: Mike Carlson [mailto:mikec@ger-inc.biz]
Sent: Wednesday, March 27, 2013 4:38 PM
To: Mahlon Hewitt
Subject: RE: Ameren - Labadie Draft Comments

Thank you, Ron. I echo your sentiment. I will obviously look at this as quickly as possible, probably tonight. Do you have a day and time in mind to meet next week? What I heard at the conclusion of our meeting was that Andrews was asked by Ameren to meet at Gredell's office in Jefferson City next week. Let me know if that was not your understanding. Our current schedule is such that Wednesday is out as an option and Monday may be too soon to have a productive meeting. Tuesday, Thursday, or Friday are open at this point in time. Obviously, I would like to have as many responses as possible to your comments prepared in advance of that meeting for your review to facilitate discussion and hopefully resolution to significant issues.

Regards,

Mikel C. Carlson, R.G.
Senior Geologist
GREDELL Engineering Resources, Inc.

1505 E. High Street
Jefferson City, MO 65101
573-659-9078 (office)
573-659-9079 (fax)
573-694-0624 (cell)
866-892-0727 (office - toll free)
mikec@ger-inc.biz (email)

From: Mahlon Hewitt [mailto:mhewitt@andrews-eng.com]
Sent: Wednesday, March 27, 2013 4:21 PM
To: Mike Carlson
Cc: Kenn Liss; Doug Mauntel; Karl Finke
Subject: Ameren - Labadie Draft Comments

Mike,

It was a pleasure to meet with you guys yesterday. Attached are draft comments as promised. Please let us know if you have any questions.

Cheers,

Mahlon Hewitt, LPG
Andrews Engineering, Inc.
3300 Ginger Creek Drive
Springfield, IL 62711
Office: (217)862-2511 or (217)787-2334
Fax: (217)787-9495

Mahlon Hewitt

From:	Tom Gredell <tomg@ger-inc.biz>
Sent:	Thursday, April 04, 2013 5:24 PM
To:	Kenn Liss
Cc:	Giesmann, Craig J; Joe Feldmann; Doug Mauntel; Mahlon Hewitt; Tom Gredell; Mike Carlson
Subject:	RE: Conference call follow up

Ken, I concur that we were not planning on meeting with Andrews representatives tomorrow, Friday, April 5, 2013, in Jefferson City. Mike Carlson and I will review your email in the morning.

Thomas R. Gredell, P.E.
GREDELL Engineering Resources, Inc.
573-659-9078 (office)
866-892-0727 (office - toll free)
573-659-9079 (fax)
573-645-9078 (cell phone)
tomg@ger-inc.biz (e-mail)

From: Kenn Liss [mailto:kliss@andrews-eng.com]
Sent: Thursday, April 04, 2013 4:43 PM
To: Tom Gredell
Cc: Giesmann, Craig J; Joe Feldmann; Doug Mauntel; Mahlon Hewitt
Subject: Conference call follow up

Tom:

I am sending this as a follow up to our telephone call.

As we left it, you and your staff will provide a written response to our draft comments in order to narrow down the remaining issues. For a majority of the comments, you indicated that certain information we are requesting is either not available or not necessary. In order to clearly understand Ameren's position, if the information is not available, please respond to the comment accordingly. If you feel the information is not necessary to support your work, please indicate that it is your professional opinion that it is not necessary and it will not be provided as you stated during our call. Providing a reply to each comment in this manner will enable us to continue moving forward. For Ameren, time is of the essence and we are committed to completing this review process as soon as practical. Having a clear response to each comment will allow us to finalize our review.

In the meantime, Ron (Mahlon) and I are revisiting the draft comments sent out prior to our call with consideration to the points you raised. After receiving your response, we will promptly update our comments and reply. Without the technical information to support your input values or a clear response to our comments, there is no need to travel the approximately a 7 hour roundtrip from Springfield to your office for a meeting tomorrow.

Before our meeting at Ameren's office, I spoke with Craig Giesmann about the upcoming field work. We discussed the potential for installing additional wells and using that opportunity to obtain field data. As we also discussed during our call, Ron and I are recommending that you install nested monitoring wells or piezometers between the new area and the existing disposal units. Much of the information we are requesting can be obtained using the core samples and then conducting the appropriate testing using those monitoring points. This includes site specific porosity, vertical gradients, hydraulic conductivity testing and groundwater quality information to support the assumptions in your model. In addition, we are still in need of the expected leachate concentrations and the manner in which you calculated input values for dispersivity. We understand the values listed in your table 2a and 2b were derived from your groundwater flow direction evaluation. However the manner in which the calculation was made is unconventional and we are not able to reproduce your results.

Groundwater modeling, like any other analytical representation, is only as reliable as the input data. Our comments largely concern the lack of documentation or suitability of your input values. This needs to be corrected. When completed, we are confident that using your model, within the performance standards of the MDNR and ordinances of Franklin County, that we will agree on a monitoring program for the site that is defendable.

We will continue to work on this end and look forward to your prompt reply.

Kenneth W. Liss LPG
Vice-President of Operations
Andrews Engineering, Inc.
3300 Ginger Creek Drive
Springfield, Illinois 62711

(217) 787-2334

Mahlon Hewitt

From: Mike Carlson <mikec@ger-inc.biz>
Sent: Wednesday, April 10, 2013 12:04 PM
To: Mahlon Hewitt
Subject: RE: Ameren Labadie Comments

No

Mikel C. Carlson, R.G.
Senior Geologist
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573-659-9079 (fax)
573-694-0624 (cell)
866-892-0727 (office - toll free)
mikec@ger-inc.biz (email)
-----Original Message-----
From: Mahlon Hewitt [mailto:mhewitt@andrews-eng.com]
Sent: Wednesday, April 10, 2013 11:16 AM
To: Mike Carlson
Subject: Re: Ameren Labadie Comments

Do you have a projected time that you can provide comments?

On Apr 10, 2013, at 10:53, "Mike Carlson"
<mikec@ger-inc.biz<mailto:mikec@ger-inc.biz>> wrote:

Mahlon:

Gredell Engineering will not be able to respond to Andrews' draft comments before your stated deadline.

Regards,

Mikel C. Carlson, R.G.
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573-659-9079 (fax)
573-694-0624 (cell)
866-892-0727 (office - toll free)
mikec@ger-inc.biz<mailto:mikec@ger-inc.biz> (email) ________________________________
From: Mahlon Hewitt
[mailto:mhewitt@andrews-eng.com<http://andrews-eng.com>]
Sent: Tuesday, April 09, 2013 5:21 PM
To: Mike Carlson

Subject: Ameren Labadie Comments

Mikel,

We are to provide comments to the county by the end of this week. Should we expect comments from Gredell in response to our draft comment letter?

Thank you,

Mahlon Hewitt, LPG
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Office: (217)862-2511 or (217)787-2334
Fax: (217)787-9495