SUPPLEMENTAL TESTIMONY

OF

CHARLES H. NORRIS, P.G.

Case No. EA-2012-0281

Q. Please state your name and business address.

A. My name is Charles H. Norris and my business address is Geo-Hydro, Inc., 1928 East 14th Avenue, Denver, Colorado 80206.

Q. Are you the same Charles H. Norris who previously filed cross-surrebuttal testimony in this case?

A. Yes.

Q. What is the purpose of your supplemental testimony?

A. My supplemental testimony responds to the supplemental testimony provided by Ameren witnesses Craig Giesmann, Tyler Gass, and Steven Putrich, and the supplemental schedule filed with Mr. Giesmann's testimony.

Q. What documents have you reviewed in connection with your supplemental testimony?

A. In addition to the pre-filed testimony, schedules, and data request responses previously filed in this case, and the documents I reviewed in preparing my cross-surrebuttal testimony, I also reviewed the supplemental testimony and schedule referenced above. I also reviewed the comments prepared by Andrews Engineering (Andrews), Franklin County's Independent

Registered Professional Engineer, on Ameren's previous versions of its construction permit application (CPA), and Ameren's responses to the comments prepared by Andrews. The comments by Andrews and subsequent responses by Ameren were referenced in the supplemental testimony of Ameren's witnesses, and are submitted herewith as Norris Schedules S1-S5.

I also reviewed previously-filed testimony and schedules that are pertinent to supplemental testimony by Tyler Gass related to contamination of groundwater by the existing ash ponds, including Schedule LNJB-S13, filed with the pre-filed surrebuttal testimony by Lisa Bradley. I also reviewed three of the references cited in Schedule LNJB-S13 -- the April 2012 Golder Associates report regarding temporary piezometers in bedrock near and above the Labadie plant, and the laboratory analyses of the first two rounds of baseline sampling performed in the monitoring system wells by Reitz & Jens, Inc., and Gredell Engineering Resources, Inc, in April and August 2013, respectively. I also reviewed a summary of results of the third round of baseline sampling performed in November 2013. Tables prepared by Lisa Bradley summarizing the first three baseline sampling events are submitted herewith as Norris Schedule S6.

Q. Have the opinions you stated in your prior testimony changed?

A. No.

Q. Are the opinions expressed in this testimony and your prior testimony based on a reasonable degree of certainty based on your education, training, and experience as a professional geologist specializing in hydrogeology and geochemistry?

A. Yes.

Q. To the extent that you relied on any documents, including in forming your opinions, do you consider such documents reasonably reliable and are those documents of the type reasonably relied upon by experts in the area of hydrogeology?

A. Yes, With respect to the documents submitted or referenced by Ameren's witnesses, I relied on the data within those documents but not the discussions or conclusions.

Q. Did Andrews Engineering, Franklin County's designated Independent Registered Professional Engineer, raise concerns about Ameren's groundwater detection monitoring system?

A. Yes, among the concerns raised by Andrews were concerns about Ameren's groundwater detection monitoring system.

Q. What concerns did Andrews Engineering raise regarding Ameren's groundwater detection monitoring system?

A. Andrews' concerns were based in part on the lack of sufficient information to design a scientifically and technically sufficient monitoring system. Andrews identified two foundational concerns with the proposed groundwater detection monitoring system. The first is that Ameren based its groundwater monitoring system on data obtained during what Ameren perceived to be a hydrogeologically atypical period. The second foundational concern was that the characterization of the hydrogeology of the proposed site was insufficient for the design of an adequate groundwater monitoring system. Andrews noted that the hydrogeologic characterization of the site was limited to two dimensions (horizontal flow), but that an aquifer needs characterization of flow in three dimensions, i.e., characterization of vertical as well as horizontal flow. Part of the characterization for vertical flow requires geologic and hydrogeologic characterization of the aquifer from top to bottom and characterization of the rock layer at the base of the aquifer, across the entirety of the site.

These two foundational concerns generated a number of derivative concerns regarding the adequacy of the design for the groundwater monitoring system. Among those concerns were the following:

(1) A good design derived of data from a period of atypical conditions will be adequate for periods of comparable atypical conditions. Ameren did not demonstrate that the model it used would be adequate for other conditions.

(2) Andrews raised the concern that site characterization was performed only sufficiently to describe flow in a horizontal direction across the site Andrews recognized that for this aquifer in this setting, it is highly unlikely there is only two-dimensional, horizontal flow and recognized that potential impacts must be evaluated in all directions of flow. Andrews therefore proposed five deep borings surrounding the proposed waste disposal area, each to be drilled into the confining unit below the aquifer. The objective would be to characterize geologic and hydrogeologic conditions through the thickness of the aquifer and at its base at representative locations around the utility waste disposal area.

(3) Andrews was also concerned that the proposed monitoring system was collecting baseline water quality data only at the water table. Andrews recognized that for this aquifer at this setting, water quality would likely vary vertically and horizontally. Therefore, baseline water quality data must be collected throughout the aquifer, not just at the water table, to detect leakage from the landfill to the groundwater. Andrews therefore recommended that five deep characterization borings be completed as deep monitoring wells to establish baseline water

quality at the bottom of the aquifer, to collect head data to determine background local vertical gradients, and to serve as permanent wells in the monitoring system for head and water quality data.

(4) Andrews was also concerned that many of the input parameters to the computer program that was used in designing the monitoring system were generic or literature-based. Andrews established through sensitivity studies that these parameters substantially impact the geometry of any plume of utility waste leachate, and that using measurements taken specifically for this aquifer at this site or nearby sites would yield a more meaningful groundwater monitoring system. Where on-site or nearby hydrologic properties of the aquifer had not been measured, Andrews recommended that aquifer sediments be collected from the additional characterization borings. This would allow site-specific approximations of the properties to be calculated and would allow site-specific inputs to the computer program, designing a more effective monitoring system.

(5) Andrews was also concerned that the computer program PLUME, which cannot take into account vertical flow or vertical dispersion, was inappropriate for the design of an effective monitoring system. However, until the additional characterization and data collection were available to describe three-dimensional flow within the aquifer, Andrews could not recommend an alternative computer program to assist with additional design for the monitoring system.

Andrews was also concerned that the implementation of the computer program PLUME was flawed with respect to the use of hydrogeologic input parameters taken from literature; the input choices for the size, geometry, and orientation of hypothetical liner failures creating a plume; source term concentrations; and relevant plume boundary concentrations for determining an adequate number and placement of monitoring points for the monitoring system. To demonstrate the sensitivity of the design by PLUME to variations of these inputs, Andrews used PLUME to generate an alternative monitoring system, accepting hypothetically that flow and contaminant migration are strictly two-dimensional. Andrews then recommended that, to appropriately implement PLUME at this site, nine additional monitoring wells should be installed at the water table.

Q. Do you have an opinion regarding the validity of Andrews' concerns as summarized above?

A. Yes. In my professional opinion, the concerns raised by Andrews are valid and significant.

Q. **Ameren subsequently made some changes to the monitoring system, as reflected in the revised Construction Permit Application (CPA) submitted to DNR in December 2013. To what extent do the changes in the monitoring system address the concerns raised by Andrews Engineering?**

A. The changes Ameren made to the monitoring system do not completely address any of the concerns raised by Andrews, although they partially address some of the concerns.

Ameren eventually agreed to add three deep characterization wells, rather than the five requested by Andrews. Whereas Andrews sought characterization of the full thickness of the aquifer, its contact with the underlying bedrock, and the nature of the bedrock contact entirely around the proposed landfill, the changes made by Ameren will provide new data only around the north half of Cell 2 and west of Cell 4. The bulk of the proposed landfill site will remain uncharacterized.

Each of the three deep characterization wells will be completed with a screened interval directly above the bedrock interface at the bottom of the alluvial aquifer. Except for measurements of heads, no direct hydrologic data collection, such as hydraulic conductivity testing or tracer testing, is proposed. The reduction from five deep alluvial wells around the facility (as recommended by Andrews) to three at only one end (as agreed to by Ameren in its revised application) significantly reduces the usefulness of this new data from the deep aquifer. The five wells proposed by Andrews around the circumference of the site would have likely provided sufficient data for heads deep in the aquifer to be integrated with those from the shallow aquifer. That would have enabled an analysis of vertical groundwater flow patterns and variations under the entire facility. By limiting the deep well data to the northwest corner of the proposed facility, little more is likely possible than assigning a planar gradient pattern to the deep aquifer under that corner.

Water quality data will be collected from the three deep wells both for purposes of determining baseline water quality at those three locations, and for conducting detection monitoring once the utility waste landfill is built. This is an improvement over the previous monitoring system and partially addresses concerns expressed by Andrews. However, as discussed above, the changes accepted by Ameren are limited to only a corner of the facility, whereas Andrews appropriately recommended obtaining this data from the whole facility.

These three deep wells have very limited utility for detecting groundwater contamination due to their locations. There is likely no upgradient/downgradient relationship among the wells. The two "downgradient" wells are located north and northeast of Cell 2 of the proposed landfill, where the river-side flow regime is north 32.6 degrees east. Water passing these wells is not water that passed through the area monitored by the "upgradient" deep well. The "upgradient" deep well is located in the southern, bluff-side water regime, where the depicted flow direction averages north 66.6 degrees east. Water passing the "upgradient" well moves under Cells 3 and 4 of the proposed landfill, but is not monitored on the downgradient side.

The monitoring proposed by Andrews for the base of the aquifer would have monitored both upgradient and downgradient locations for both the river-side and bluff-side regimes of flow, thereby allowing common statistical techniques to be used to compare water qualities to determine impacts. In contrast, the limited additional monitoring in Ameren's revised application is not sufficient to support meaningful comparison between the "upgradient" and "downgradient" locations. As a result, the revised groundwater monitoring plan is unlikely to detect impacts of the proposed landfill on the deep aquifer.

Finally, as discussed by Andrews in its comments, the monitoring of the deep aquifer for baseline water quality may demonstrate that groundwater at the proposed landfill site is already contaminated by leachate from the existing ash ponds at the power plant site. That would significantly complicate the challenge of determining whether contaminants detected at the landfill site are coming from the landfill, the ash ponds, or both. If the plume from the ash ponds were of appropriate composition and sufficient concentration, identification of significant leakage from the utility waste landfill may be impossible. The revised monitoring system could identify an existing plume of contamination under only the northwest corner of the utility waste landfill, leaving the rest of the facility without this crucial information.

Q. To what extent do the changes in the monitoring system address the concerns you raised in your cross-surrebuttal testimony?

A. To almost no extent. The only concern it partially addresses is the need to identify an existing plume from the ash ponds. The addition of the three deep monitoring wells may allow one to identify such a plume in the northwest corner of the facility, but will do nothing to detect any such plume throughout the rest of the proposed landfill site.

Q. In your opinion, is the revised monitoring system contained in the December 2013 CPA adequate to detect groundwater contamination originating from the proposed landfill?

A. No.

Q. Why not?

A. The revised shallow monitoring system remains designed based upon the unrealistic assumption that that all migration from any liner failure will migrate at, and solely at, the water table and that the migration will occur in directions and rates determined without benefit of any water table measurements. Under pre-construction hydrologic conditions, water-table contamination will migrate downward, away from the water table. Under post-construction hydrologic conditions, that downward movement will be accentuated. Except under exceptional and unusual situations, contamination from the proposed facility will pass below – and undetected by – the water table monitoring system. The three deep wells that have been added do not form an upgradient/downgradient package and do not cover a significant portion of the facility.

Q. Did you review the opinion expressed by Tyler Gass in his supplemental testimony that the existing ash ponds "have never been found to have caused any groundwater contamination during the past 40 years of operation"?

A. Yes.

Q. Do you have a response to that opinion?

A. Yes. That statement is misleading. The failure to find contamination does not confirm that no such contamination exists. In this case, it likely reflects the failure to look for it.

Q. On what is your response based?

A. I found no evidence that Ameren has sought to determine any existence and extent of contamination from the ash ponds. I looked through all available sources I could find related to this proceeding or written by Ameren and publicly available that might indicate any effort to determine the existence and extent of groundwater contamination caused by the existing ash ponds. These sources included the 1992 construction permit application and associated specification form for the lined waste impoundment, the Detailed Site Investigation (DSI) for the proposed landfill, the first three rounds of baseline water sampling performed in the groundwater detection monitoring system for the proposed landfill, available NPDES permit applications for the Labadie plant, the CPA for the proposed landfill, and water quality and head data obtained from piezometers/wells installed and sampled by Golder Associates in the bluffs south of the Labadie plant.

Q. What did your review determine?

A. There has been no documentation of any attempt to look for potential contamination that could be attributed to the existing ash ponds. It is not the case that thorough investigations have established there is no contamination caused by the waste impoundments. To the contrary, there has been no attempt to investigate groundwater quality in the vicinity of the ash ponds. With respect to the documents I reviewed, I found the following:

1. The 1992 construction permit application and specification form for the lined ash pond discussed wells/piezometers that were located appropriately and at appropriate depths to have been used to obtain information regarding groundwater quality related to the pre-existing, unlined ash pond. However, there is no indication in those documents that the wells were ever sampled for that purpose.

2. The 100+ piezometers installed and monitored for the DSI investigation were located in an area apparently downgradient of the ash ponds. The piezometers were completed within the alluvial aquifer at some distance below the water table, where impoundment-related contamination might be found, were there a plume in the area. However, there is no indication in the DSI that any of these piezometers were sampled for water quality.

3. The 1992 and 2011 NPDES permit applications describe leakage of coal ash wastewater from the unlined ash pond. One of the leaks was estimated at up to 30 gallons per minute and was described as soaking into the ground. There is no indication that Ameren conducted any groundwater investigation to determine the impact of this leakage on groundwater quality. Ameren submitted its 2011 application in response to Staff Data Request 14.2. Attachment A of the 1992 application is submitted herewith as Norris Schedule S7.

4. The bedrock piezometers installed for Ameren by Golder Associates on the bluffs south of the Labadie plant sampled groundwater that was determined to be upgradient of both the plant and the ash ponds. Therefore, these groundwater sampling points shed no light on whether the ash ponds are causing groundwater contamination.

5. The baseline monitoring for the groundwater detection monitoring system for the proposed landfill, like the earlier DSI piezometers, is favorably located with respect to possible migration of contaminated groundwater from the waste impoundments. To date, the monitoring system has sampled only water table wells. Because these wells are completed at the water table, evidence of any underlying plume would be subtle.

Q. Is there any evidence that is suggestive of groundwater contamination that might be attributable to the existing ash ponds?

A. Yes. The first such evidence is the NPDES permit applications' discussion of leakage from the unlined ash pond. Ameren stated that "the location and chemical make up of the seeps indicate that their source is the ash pond." Ameren also stated that one of the seeps was soaking into the ground. Yet Ameren made no effort to test the groundwater for contamination.

Additional evidence is found in comparing the groundwater data collected from the wells drilled in the bluffs south of and upgradient from the plant with the groundwater data from the monitoring wells at the proposed landfill site, which are downgradient from the plant and the ash ponds. The first three sampling events to develop baseline water quality from the monitoring wells have been completed. If the ash ponds were not affecting groundwater quality, then the water quality immediately downgradient from the plant site should closely resemble the water quality immediately upgradient from the site. This is not the case; the downgradient groundwater at the proposed landfill site is substantially degraded relative to the upgradient water. At the proposed landfill site, averages of specific conductance (indicative of total dissolved solids) and sulfate are each 166% that of the upgradient groundwater. Boron concentrations at the proposed landfill site average more than 300% that of the upgradient groundwater. Arsenic concentrations at the proposed landfill site average more than 220% that of the upgradient groundwater. Barium at the monitoring systems averages 250% that at the upgradient piezometers. All of these constituents are associated with coal ash.

Q. In your opinion, if Ameren had conducted groundwater monitoring at the existing ash ponds at the plant site, would contamination likely have been detected?

A. Yes.

Q. Does this conclude your Supplemental Testimony?

A. Yes.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and a Certificate of Public Convenience and Necessity Authorizing it to Construct, Install, Own, Operate, Maintain and Otherwise Control and Manage A Utility Waste Landfill and Related Facilities at its Labadie Energy Center	)))))))	File No. EA-2012-0281

AFFIDAVIT OF CHARLES H. NORRIS, P.G.

STATE OF COLORADO)
) ss
CITY OF DENVER)

Charles H. Norris, being first duly sworn on his oath, states:

1. My name is Charles H. Norris. I work in Denver, Colorado and am employed by Geo-Hydro, Inc. as a professional geologist and a hydrogeologist.
2. Attached hereto and made a part hereof is my Supplemental Testimony on behalf of Intervenors Labadie Environmental Organization and Sierra Club. The testimony consists of 13 pages and has been prepared for introduction into evidence in the above-referenced matter.
3. I hereby swear and affirm that my answers contained in the attached testimony are true and correct to the best of my knowledge and belief.

Charles H. Norris

Subscribed and sworn to before me this 19 day of February, 2014.

Notary Public

My Commission expires:

Ryan Dravitz
NOTARY ID #20144002250
NOTARY PUBLIC
STATE OF COLORADO
My Commission expires Jan 15, 2018

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

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.

C:\Users\lbrown\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Outlook\M7NR5TWC\Cover Letter.doc

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:
ANDREWS
ENGINEERING, INC.
3300 Ginger Creek Drive
Springfield, Illinois 62711
Tel: (217) 787-2334; Fax: (217) 787-9495

TABLE OF CONTENTS

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 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.

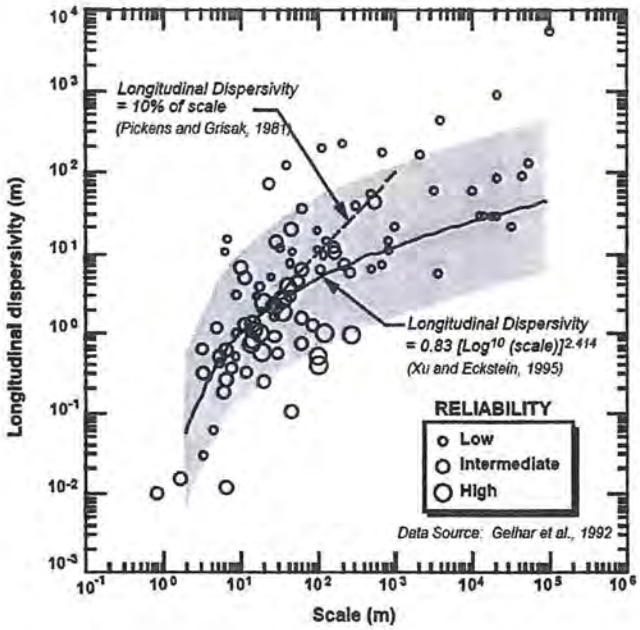


Figure A.3. Longitudinal dispersivity vs. scale data reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of circle represents general reliability of dispersivity estimates. Location of 10% of scale linear relation plotted as dashed line (Pickens and 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 $a_y = 0.1\ a_x$.

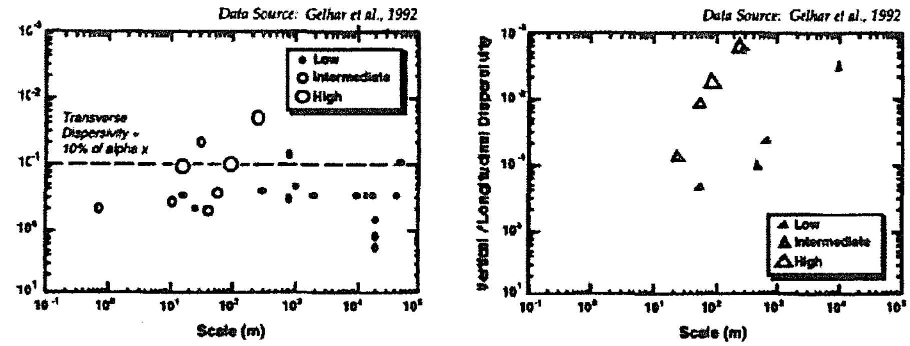


Figure A.4. Ratio of transverse dispersivity and vertical dispersivity to longitudinal dispersivity data vs. scale reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of symbol represents general reliability of dispersivity estimates. Location of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

Aziz, C.E., C.J. Newell, J.R. Gonzales, P. Haas, T.P. Clement, and Y. Sun. 2000. BIOCHLOR—Natural attenuation decision support system v1.0. User's Manual, U.S. EPA Report, EPA 600/R-00/008.

Cherry, D.S., R.J. Currie and D.J. Soucek. 2000. Review of the Global Adverse Environmental Impacts to Ground Water and Aquatic Ecosystems from Coal Combustion Wastes. http://www.citizenscoalcouncil.org/wp-content/uploads/2012/07/A-REVIEW-OF-THE-ADVERSE-ENVIRONMENTAL-IMPACTS-OF-COAL-COMBUS.htm

Domenico, P.A. and G.A. Robbins. 1985. A new method of contaminant plume analysis. Ground Water Vol. 23(4):476-485.

Domenico, P.A. 1987. An analytical model for multidimensional transport of decaying contaminant species. Journal of Hydrology 91:49-58.

Gelhar L.W., Welty C., and Rehfeldt K.R. (1992). A critical review of data on field-scale dispersion in aquifers. Water Resources Research Vol. 28(7):1955–1974.

Golder Associates, Inc. 1992. MAP (Monitoring Analysis Package). International Ground Water Modeling Center, Colorado School of Mines, Colorado. 39 p.

Golder Associates, Inc. 2012. Report on Piezometer Installation, Water Level Monitoring, and Groundwater Sampling – Labadie, Missouri. http://www.ameren.com/Environment/Documents/PiezometerInstallationReport.pdf

McWorter, D.B., and D.K. Sunada. 1977. Groundwater Hydrology and Hydraulics. Water Resources Publications, Ft. Collins, CO. 304 p.

Mugel, D.N. 1993. Geohydryologic Data for the St. Charles County Well Field and Public-Water Supply, 1985-91, and Projected Public-Water Supply, 1995 and 2000, for St. Charles County, Missouri. U.S. Geological Survey Open-File Report 93-455. 28 p.

Wiedmeier, T.H., M.A. Swanson, D.E. Montoux, E.K. Gordon, J.T. Wilson, B.H. Wilson, D.H. Kampbell, J.E. Hansen, P. Haas, and F.H. Chapelle. 1998. Technical protocol for evaluating natural attenuation of chlorinated solvents in groundwater. EPA/600/R-98/128. National Risk Management Research Laboratory Office of Research and Development. Cincinnati, Ohio: U.S. EPA.

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.

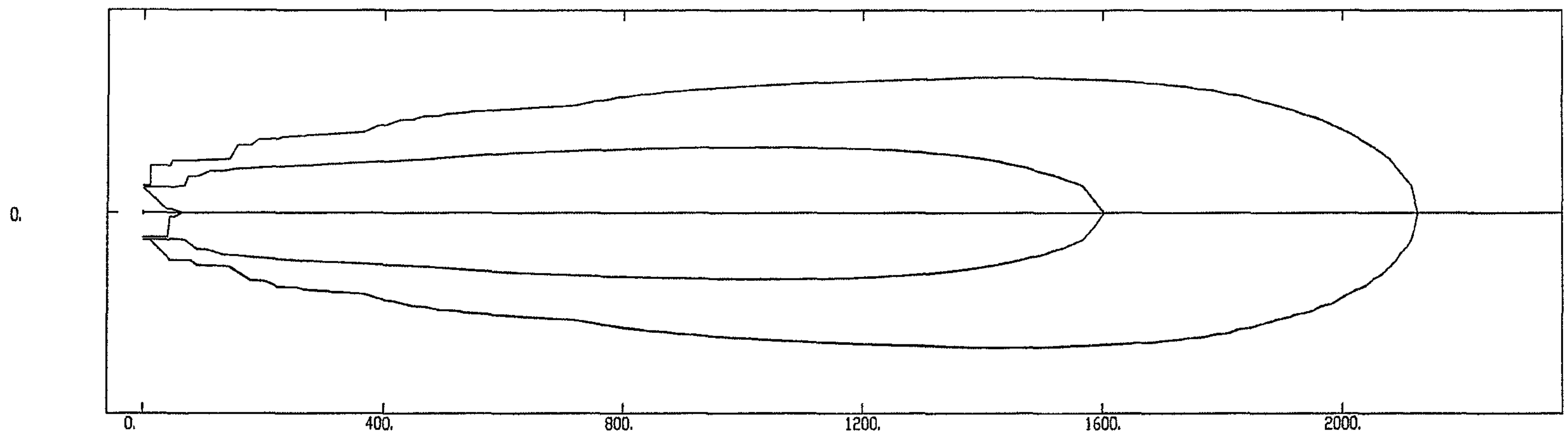
20. What is the site-specific effective porosity of the uppermost aquifer?

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

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495

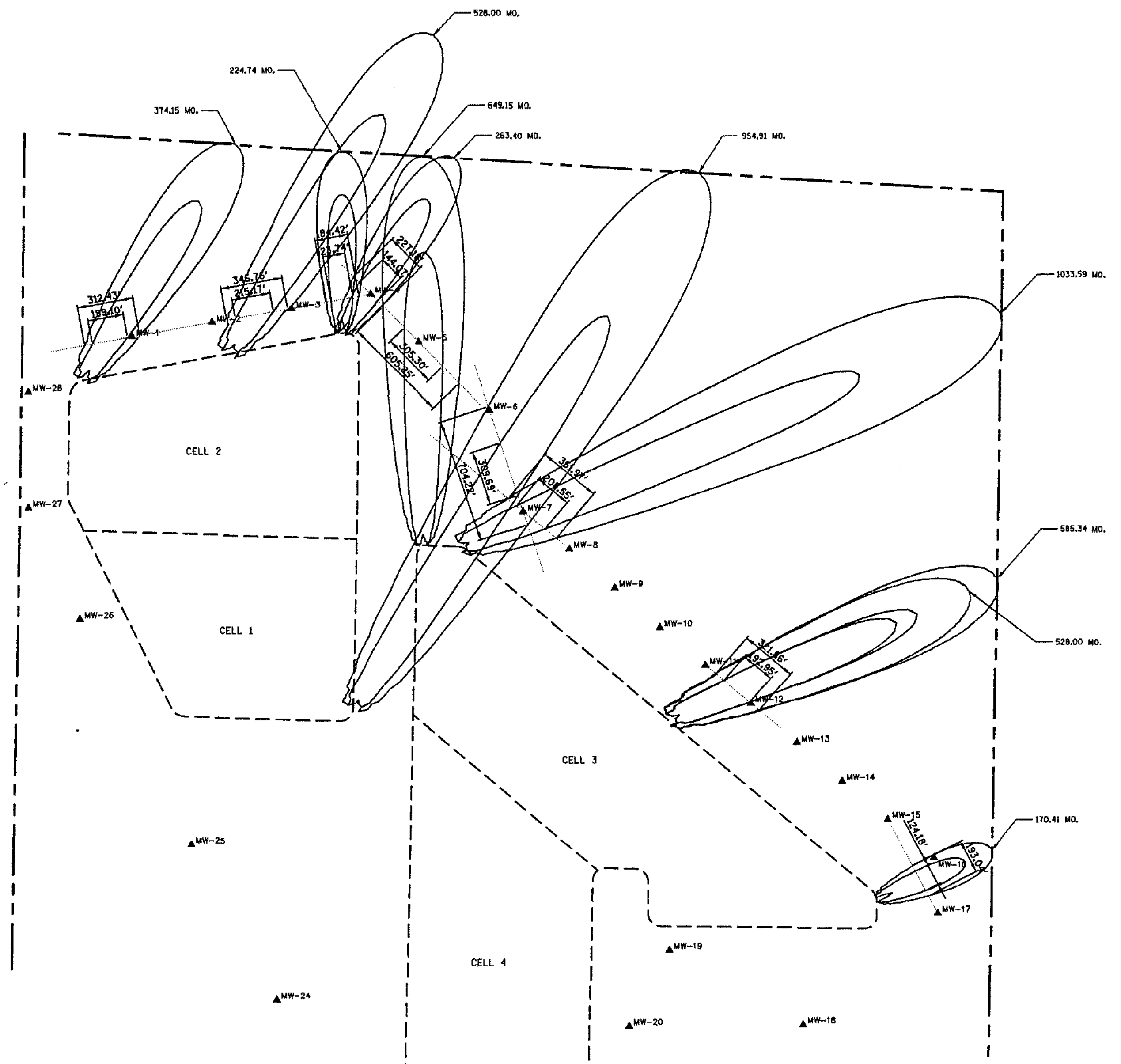
44 YEAR PLUME FOR CELLS 1 & 2

PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS

DATE: APRIL 2013
PROJECT ID: 2012-106
SHEET NUMBER: 1

Exhibit 301 p.34

Norris Sch. S1-20



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.

NO.	DATE	REVISIONS DESCRIPTION	BY

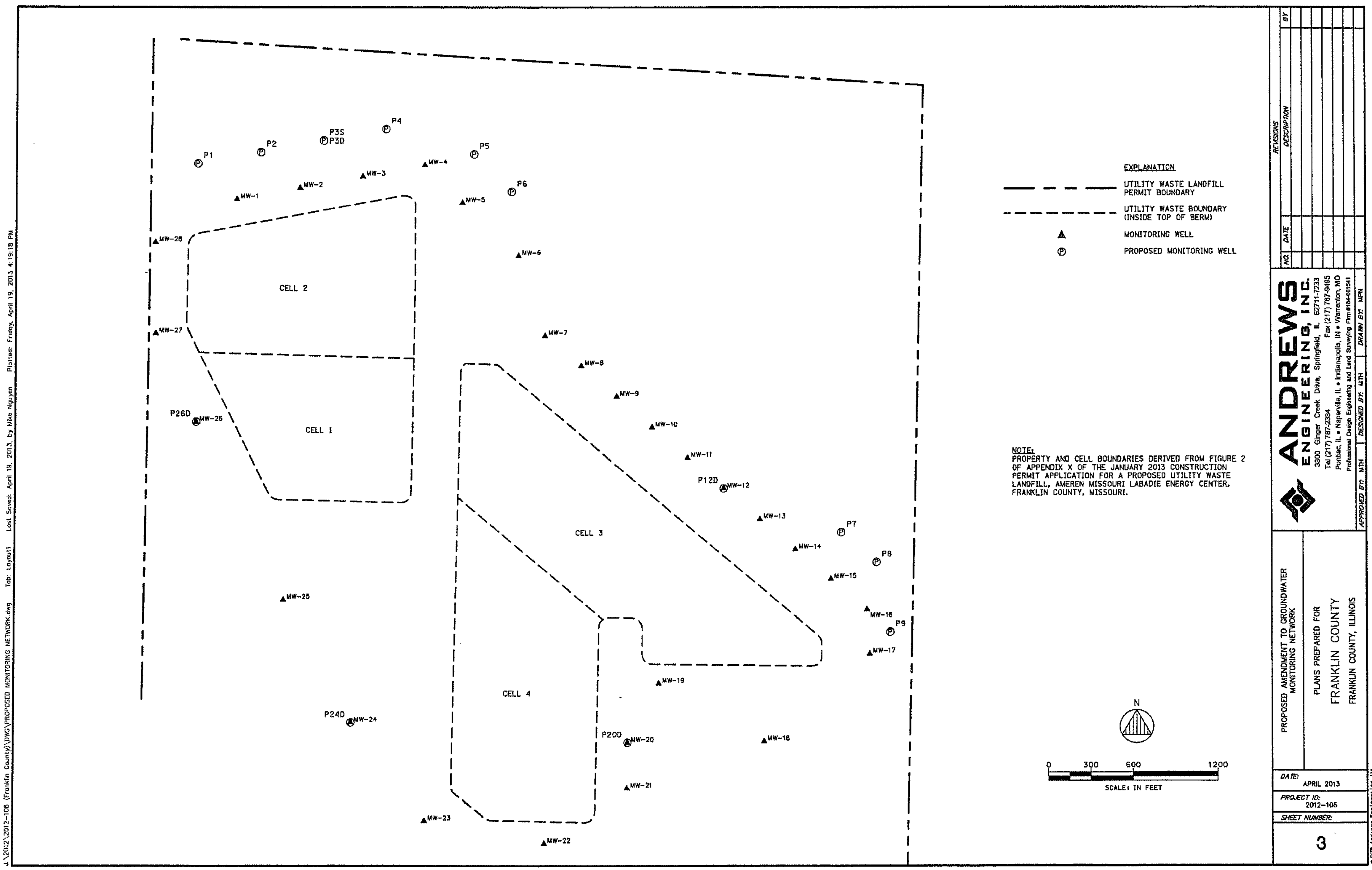
ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO
Professional Design Engineering and Land Surveying Firm #184-001541

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

PLUMES EVALUATION

PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS

DATE: APRIL 2013
PROJECT ID: 2012-106
SHEET NUMBER: 2


P1
P2
P3S
P3D
P4
P5
P6
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
P12D
MW-12
MW-13
P7
MW-14
P8
MW-15
MW-16
P9
MW-17
MW-18
MW-19
P20D
MW-20
MW-21
MW-22
MW-23
P24D
MW-24
MW-25
P26D
MW-26
MW-27
MW-28
CELL 1
CELL 2
CELL 3
CELL 4
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.
N
0
300
600
1200
SCALE: IN FEET
REVISIONS
NO.
DATE
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
PROPOSED AMENDMENT TO GROUNDWATER MONITORING NETWORK
PLANS PREPARED FOR
FRANKLIN COUNTY
FRANKLIN COUNTY, ILLINOIS
DATE: APRIL 2013
PROJECT ID: 2012-108
SHEET NUMBER:
3
© 2013 Andrews Engineering, Inc.

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

ANDREWS
ENGINEERING, INC.

June 6, 2013

Joe Feldmann 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 Engineering Design.

Documents reviewed are:

- Ameren Missouri Labadie Energy Center, Construction Permit Application and accompanying set of Permit Drawings for a Proposed Utility Waste Landfill, Franklin County, Missouri, January 2013

Based upon our review of the Engineering Design, Andrews Engineering, Inc. has generated a draft set of comments for Franklin County as its Independent Registered Professional Engineer. Enclosed is a summary of the Engineering Design review comments.

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:slm

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

Liner & Cover

The separation between the compacted soil component of the composite liner shall be two feet above the Natural Water Table in the site area. Provide a potentiometric surface map for the critical monitoring events from the DSI with the post-settlement base grades provided of the landfill footprint. In any area where the potentiometer surface map illustrates that the surface is above the existing topography, use the top of the existing topography (pre-land disturbance) for those areas.

On Sheets 22 and 23, show the bottom of the clay liner on the cross section drawings.

If soils from onsite are acceptable for clay liner, prior to use for such, a test pad for these materials would be necessary since the offsite borrow soils are different.

No demonstration was made to not use one foot (1') of $1x10^{-5}$ cm/sec soil in the final cover directly under the geomembrane. A demonstration is required and must be approved for the use of an alternate final cover. 10 CSR 80-11.010(14)(C)3. "As each phase of the utility waste landfill is completed, a final cover system shall be installed consisting of one foot (1') of compacted clay with a coefficient of permeability of $1 \text{ X } 10^{-5}$ cm/sec or less and overlaid with one foot (1') of soil capable of sustaining vegetative growth." 10 CSR 80-11.010(14)(C)5. "The department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate to the department that the alternative design will be at least equivalent to the final cover system described in paragraph (14)(C)3. of this rule." The proposed final cover in the permit application consists of "a textured 40-mil HDPE geomembrane liner placed directly on the CCRs, overlain by a 16-oz/yd^2 non-woven, needle-punched geotextile, and covered with two (2) feet of nominally compacted vegetative soil capable of supporting the final vegetation cover." The proposed final cover does not include all the minimum requirements, specifically the 1-foot low-permeability compacted clay layer, nor is it demonstrated that the proposed final cover would be equivalent to those requirements.

The plan sheets don't match the CQA Plan for the top crown HDPE. Please revise and provide the appropriate calculations as necessary.

Sheet 19 shows one anchor trench containing the liner geomembrane, the geocomposite drain, and the final cover geomembrane. A second anchor trench for the cover system is necessary to prevent damage to the previously installed geosynthetic components.

On Sheet 19, the Perimeter Ditch at Closure shows 12" of cover soils over the geomembrane with no clay liner beneath the geomembrane. A minimum of two feet of soil cover must be over the landfilled CCR. Additionally, erosion protection in the perimeter ditch is necessary to prevent exposure of the geomembrane.

Leachate Collection

The landfill liner and overlying leachate collection system must have a minimum slope of 1%, pre and post settlement. Revise the landfill grades to meet this requirement during all times within the landfill footprint. Provide plan sheets with the critical cross sections which show the pre and post settlement landfill base grades.

Specify the geotextiles for the cushion fabric and the filter fabric shown in the Bottom Liner and Leachate Collection System Detail. Provide the supporting documentation and any necessary calculations.

Provide detail drawings for the pipe perforation or slotting pattern for the leachate collection lines and sump riser pipe.

H.E.L.P. models include only fly ash layers. Section 3.1.4 of the report states that waste are predicted to include "approximately 70% fly ash and 30% bottom ash". This report also discusses the acceptance of Flue Gas Desulfurization (FGD) byproducts. Neither bottom ash nor FGD byproducts were included in any of the H.E.L.P. models. The H.E.L.P. models used default values for fly ash when some values, such as hydraulic conductivity, were tested for in Appendix J.

Leachate Storage and Conveyance

The leachate storage tanks have no capacities or sizes listed or illustrated in the drawings. The leachate storage tanks must be sized based upon the pumping rates of the sumps within the landfill, and the maintenance and inspection schedule or control systems for each.

Leachate storage tank appears misplaced on Sheet 6.

The Leachate and Stormwater Forcemains are shown in the Exterior Berm without the depths noted. The forcemains must be installed at a depth to prevent freezing during cold weather conditions. Additionally, account for these forcemains being located in a berm above grade and the landfill will not have exothermic reactions.

Due to the size of the cells, provide calculations to show the removal rate of leachate generated from a storm event during the first couple of weeks of filling. Justify the storm event, calculate the removal rate and describe disposal method utilized.

Stormwater

The stormwater management plan for the site allows most stormwater to become contact waters and thus leachate. Based upon the stormwater management plan, no waters onsite will be allowed to discharge from the site and must be contained and treated as leachate. Additionally, a one-way valve rather than a gate valve alone would be required in the Stormwater Ponds (Leachate Ponds) to prevent leachate out of the ponds during the equalization. These ponds will additionally need to be designed with a liner system which meets the requirements of MDNR's Solid Waste Management and Water Protection Programs for storing leachate (waste waters). The use of these waters will be limited to within the composite lined landfill area or for use as makeup waters within the power plant's future scrubber systems.

The 25-year, 24-hour rainfall event is greater than 5.6 inches based upon the NOAA Atlas 14 Volume 8, Version 2 Point Precipitation Frequency Estimates. Increase the 25-year, 24-hour rainfall event to the recently revised amount.

Section 4.1.2 Sequence of Phase Construction describes the construction sequence of each phase. The Phase 1 Construction Sequence doesn't discuss the timing of constructing the stormwater pond, but Phases 3 and 4 Construction Sequence discuss constructing the stormwater ponds after placing CCR in the phase area. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond.

In 4.2.1 UWL Disposal Operational Description section, the perimeter ditches around each phase must not provide storage of stormwater but must be designed to rapidly convey stormwater to the stormwater ponds for storage.

The perimeter ditches are designed with flat slopes. This may lead to standing water retained in these ditches which does not minimize infiltration. This design also may not empty expeditiously after storms. Additionally, this doesn't take into account the anticipated differential settlement. 10 CSR 80-11.010(8)(B)1.F.: "Provisions for surface water runoff control to minimize infiltration and erosion of cover. All Water Pollution Control Program permits and approvals necessary to comply with requirements of the Missouri Clean Water Law and corresponding rules shall be obtained from the department." 10 CSR 80-11.010(8)(B)1.F.(IV): "On-site drainage and channels shall be designed to empty expeditiously after storms to maintain the design capacity of the system."

Since the perimeter ditches are designed with flat slopes, it would be difficult to estimate the amount of watershed area that would collect into the two separate ponds that serve Cells 3 and 4. The notes for Tables N-2 to N-5 state that "flows are split generally at half the distance between the entrances to the pond along the perimeter ditch." While this would seem like a reasonable assumption in theory, actual field conditions, subject to settlement and weathering, will probably not result in a perfectly flat ditch slope. Additionally, no consideration is given to the differences in times of concentration that would be present along the perimeter ditches due to the varying flow lengths down the final cover slopes.

On Sheets 5 and 7, show how the stormwater from Cell 2 will flow into the Stormwater Pond 1.

After closure, all stormwater should be routed through the stormwater ponds to reduce sediment loading rather than allowing the letdown structures to discharge over the exterior berms.

Berms

Interior berms filled with CCR must be constructed immediately after receiving the Operating Permit or Authorization to Operate due to placing waste within the landfill footprint. Additional CQA reporting will then be required for the construction of the interior berm and requires approval prior to placing CCR material onto it.

The design of the landfill has the interior berms exposed the same as the exterior berms during the filling of Cells 1 and 3, thus it is required to have the same protection as the exterior berms since they would be considered exterior berms during the filling of cells 1 and 3, prior to the construction of cells 2 and 4.

In the interior berms, the geomembrane needs to wrap back over the leachate collection and protection layers at the point of future tie in to prevent backup leachate from seeping through the exterior slope.

Section 3.3.2.3 Franklin County Requirement – Erosion Protection in the Landfill Design discusses 2.2-inch thick fabric-formed concrete mats and Appendix K states that the exterior berm slopes will be lined with a 6-inch thick, fabric-formed articulated concrete mat. Section 9.0

Erosion Protection From Levee Overtopping of Failure in Appendix J provides a 56mm (2.2-inches) thick fabric-formed concrete mat such as Hydrotex FP220. The drawings include no dimensions. Revise all section and have the same dimensions listed for each. Additionally, add details to the drawings for the fabric-formed concrete mats.

Operations

The procedure for the placement of the first lift of CCR to prevent damage to the underlying layers needs to be developed and included in the operations section.

Flooding of the phase due to not having adequate CCR in place would need a contingency plan developed and included in the construction permit application. The inundation of the phase area would need to be equalized to prevent significant differential head on the liner. Additionally, the pumping down would need to occur relative to the floodwaters surrounding the phase as they recede to prevent a high differential head.

The Solid Waste Excluded lists Major Appliances and Whole Waste Tires. Modify these to list as Any Appliances and Waste Tires.

Dust suppression must be employed to prevent the migration of CCR offsite during all phases of construction, including mining activities, if and when allowed.

Backup equipment or additional equipment is necessary more quickly than within 3 days due to the volume of waste generated. If a piece of equipment goes down, backup or replacement equipment should be in use within 24 hours.

Seeding to establish vegetation on the intermediate side slope cover needs to occur within a much shorter period than annually as provided in the Phases 1, 2, 3 and 4 Aesthetic Cover section.

General Comments

The waste boundary should be reduced to allow the groundwater monitoring wells to be installed in the area of the DSI. If the wells are installed outside the area of the DSI, the data from the wells must be complied and correlated to existing DSI data and provided as an addendum to the DSI.

Provide the approved design and drawings of the proposed underpass for Labadie Bottom Road and all approvals from the controlling authorities.

Sheet 8 appears to be missing leaders and detailed descriptions. Please update for further review.

Appendix D

Appendix D should be renamed "Violation History Disclosure Form" rather than the older language which has a negative connotation.

Appendix H

The only document contained in Appendix H Floodplain Documentation is a review letter for the "Floodplain Analysis of the Missouri River for the Ameren Missouri Labadie Energy Center" by the Independent Registered Professional Engineer (IRPE). Please provide the additional documentation that was submit to receive this letter from the IRPE.

Appendix J

The Table of Contents for Appendix J lists that Files on Enclosed CD. AEI was not provided the CD which includes the Files of the Printed Outputs from Computer Runs to review. We will need a copy of the computer runs of the revised report based upon the comment letters.

Friction angles for the geomembrane/clay interface appear to be too high. The direct shear testing performed on the interface did not adequately displace the interface and the normal loads were low. The displacement testing should be on the order of inches and the normal stresses need to meet the full capacity of the landfill design. Additionally, at lower normal stresses, the critical interface may occur between the geomembrane and geotextile or geocomposite. All of the designs need to be analyzed to have the proper inputs for stability analysis. The bottom liner illustrated as detail 3/17 Bottom Liner and Leachate Collection Detail shows a smooth geomembrane, not a textured HDPE geomembrane as was tested and provided in Appendix A-1 of Appendix J. The interface friction angle (15 degrees) utilized in the Analysis and Design of Veneer Cover Soils, Figure E-42, is a more representative value for textured HDPE geomembranes/clay interface.

Friction angles in the stability analyses don't correspond to the testing on the CH clay liner material from the offsite borrow. Triaxial shear testing (CU) on the CH clay resulted in phi of 14.6 effective stress shear angle with cohesion near 0.21 tons per square foot. The effective friction angle used in the stability analysis for the compacted clay liner was listed as 25 degrees. Verify each input providing references for their values.

The stability analysis failed to meet the required and recommended factor of safeties. Cross-section E-E' failed to meet the factor of safety of 1.5 for the static drained global circular failure surface both with the initial and full fill of CCP.

The minimum factor of safety recommended by the draft technical guidance document from MDNR-SWMP and Stark is 1.2 to 1.3, not 1.1 as listed in Table E-2 Results of Slope Stability Analyses.

Liquefaction has been determined to occur in multiple layers. When reviewing the post-liquefied shear strengths provided in the table for the stability analysis, they don't match the shear strengths from correlation charts based upon the SPT blow counts. The chart referenced in the Reitz & Jens report was H. Bolton Seed's 1987 chart. Seed and Harder updated this chart with additional information in 1990 and this chart is available with a 3rd Order Best-Fit curve to simplify the correlation. Please provide the graphed correlations providing the residual shear strengths based upon the SPT blowcount corrected for the percentage of fines.

Liquefaction analysis is typically performed in the upper 50' of unconsolidated materials. Almost every boring was stopped at 35' in depth. Due to the lack of information from the 35' to 50' interval of the unconsolidated materials, provide a narrative justifying why liquefaction would not be anticipated at depths below 35'.

The draft technical guidance document from MDNR-SWMP and Stark wasn't intended for designing landfills within a very young geologic age and active floodplain. Stability analysis for varying phases of filling is necessary due to the proposed location of the landfill.

Protective/drainage layers are missing from the stability analysis. Both designs need analyzed in the stability models if both are considered for permitting and construction.

The boring B-100 is no longer centralized or even under a cell of the landfill. Other soil profiles should be analyzed to provide the critical Shake analysis. This will require additional borings to bedrock within the footprint of the landfill.

The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration = 0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling.

Provide the actual stability analysis for the deformation analysis and provide with a narrative rather than a table listing the yield accelerations and deformations for the short and long-duration events.

The Table of Contents for Appendix C Seismic Analyses appears to have C-18 & C-19 swapped with C-20 & C-21. Please revise and verify the information.

Settlement analysis demonstrates some differential settlement which could cause ponding in the flat stormwater channels, a reduction in the overall height of the berms and settlement of the base grades of the landfill. Each of these must be discussed including how Franklin County's regulations will be satisfied during all phases of construction, filling and closure. Additionally, the settlement analysis typically has a range of settlement that may occur due to variability in the underlying subgrade and must be conservatively considered in the analysis to prevent overtopping of the exterior and interior berms due to a 500-year flood event.

Provide the calculations correlating the CPT test data to the elastic modulus utilized in the Settlement Analysis. The CPT logs which were provided in the DSI don't provide enough detail to verify the elastic moduli provided in the settlement analyses. Additionally, heavily loaded conditions decrease the modulus, so these factors need to be accounted for relative to their location within the footprint of the fill. The Bowles 1997 reference appears to be dated and newer, more precise correlations are widely available which utilize the normalized cone resistance and normalized friction ration.

Calculate the bearing capacity of the subgrade in varying locations throughout the footprint. Additionally, calculate the bearing capacity during a maximum credible seismic event which induces liquefaction during each phase of construction and filling of the landfill.

The protection of liner from hydrostatic uplift discusses the flooding with the gravel drainage layer and sand protective layer. The alternate design with the geocomposite drain and protective sand layer must also be discussed in the flooding scenarios.

In Appendix G – Design of Fabric-Formed Concrete Mat (FCM), the factor of safety calculation has a missing value, t (= 0.183 ft) in the numerator after substitution:

$$F.S. = \left[\frac{\mu(t)(\gamma_c - \gamma_w)cos\theta cos \propto - \tau_{DES}}{\sqrt{[t(\gamma_c - \gamma_w)sin\theta]^2 + \tau_{DES}{}^2}}\right]$$

$$F.S. = \left[\frac{0.637(130\,PCF - 62.4\,PCF)\cos(18.435°)cos(0°) - \tau_{DES}}{\sqrt{[(0.183')(130 - 62.4)sin18.435]^2 + \tau_{DES}{}^2}}\right]$$

This reduces the value of the maximum design velocity significantly. Update the calculations with the thickness of the fabric-formed concrete included.

Appendix O

The filter design basis in the Memo from Bruce Dawson, PE to Gredell Engineering Resources, Inc, included in Appendix O-1, requires a tighter gradation for the sand protective layer based upon the R15 provided. The D15 for the sand should range from 0.24 mm to 0.8 mm based upon the D15 of the Fly Ash and the R15 provided from the Peck Hanson Thornburn filter criteria.

Appendix P

The Construction Quality Assurance Plan inadequately addresses the requirements in 10 CSR 80-11.010(6)(B)1.A. "A detailed description of the QA/QC testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;" Specifically, this section should include tables showing the frequency and acceptable test result values for each testing procedure. The Air Pressure Testing of seams cannot allow a drop of 4 psi during the 5 minute test. It must not drop more than 10% of the equalized pressure of at least 25 psi.

Appendix P Construction Quality Assurance Plan section 3.2 Test Pad references the Demolition Landfill regulations. Please revise to reference the appropriate regulations.

In section 3.5 Quality Assurance Monitoring and Testing, the following statement must be omitted since there is no justification of the reduced testing frequency. "If liner quality soils are stockpiled on site prior to the beginning of placement, a reduced frequency of verification testing will be requested."

A log of soils should be maintained for soils brought in from offsite. The log should provide the testing performed and the intended use on site. This will assist in construction planning for each cell construction.

Appendix V

Need a full size Survey Plat for review of Appendix V.

Appendix Y

In Appendix Y(a) Leachate Pipe and Pump Calculations, the leachate storage tank is listed as a 12-ft diameter horizontal tank. The drawings provided for the site have a vertical storage tank shown without any detail drawings for the storage tanks. Provide a detailed drawing for the storage tanks and the anticipated operations of the tanks to prevent them from exceeding capacity. Provide the pump details for the pumps within the leachate storage tanks. This should be included in the leachate management plan.

In Appendix Y(a) Pipe Capacities, the flow capacity calculation in this section was miscalculated by a factor of 10:

$$Q = \frac{1.49}{.009} \times 0.156 \times 0.111^{2/3} \times 0.005^{1/2} \neq 4.2\, cfs$$
$$= 0.42\, cfs$$

In Appendix Y(a), the Leachate Pipe Crushing and Buckling Scenarios, Scenario 1 provides an H20 truck in the analysis. This size of truck is normal for highway use but it is anticipated based upon the amount of CCR being deposited that the size of the equipment and tire loads could be greater. Scenario 3 uses a live load of a 3 ton skid steer on the sump riser trench with one foot of CCR placed over the top of the sump riser trench. In all likelihood, this loading would occur prior to the placement of the CCR and the geotextile, and would be used to place the clean gravel. Additionally, Scenarios 1 and 3 drawings appears to be in error that CCR would be placed as the protective cover over the geocomposite drainage. Please revise these drawings and recalculate with the proper loading. It also appears that the pipe values were not reduced due to the perforations in Scenarios 1 and 2. Density of waste is listed as 75 pcf. Testing results in Appendix J report higher densities for CCPs. A density of 93 pcf is assumed in calculations in Appendix Y(d).

In Appendix Y(c) – Water Management Calculations, the second paragraph of the concluding statements reads "Backup leachate management will be at an offsite POTW." The permit should specify which POTW will manage the leachate as backup and a signed agreement pertaining to this management should be included.

In Appendix Y(d) – Flood Mitigation Calculations, Pumping Rates for Flood Water Protection – Cell 3, the concluding statement reads, "A pumping rate of 13,194 gpm, pumping 24 hours per day, is required to fill Cell 3 in 10 days for 100-year flood protection." The source and location of the required water supply, as well as the necessary equipment for pumping should be specified.

Included in Appendix Y(e), the clay/geomembrane interface for the side slope cover material stability calculates with a factor of safety of 1.46, below the 1.5 as stated. The interface friction angles used for the clay and geomembrane are stated to be taken from Table 5.6 and Table 5.7. Analysis and Design of Veneer Cover Soils is included in Appendix J with an interface friction angle of 15 degrees. In hand written calculations provided in Appendix Y(e), the factor of safety for CCR to geomembrane is calculated as 1.2 in static conditions. Provide a detailed narrative with additional calculations to support the provided calculations and how they relate to each other. If the fly ash were to be utilized as being in intimate contact with the geomembrane with moistures approximately five percent over optimum, this interface would need laboratory testing as part of the demonstration for an alternative final cover system and included in the stability analysis.

In Appendix Y(e), the attached printout for the 60 mil Geomembrane has 23.00 kN/m provided as the Allowable Force in Geosynthetic, TDESIGN. The valve for the Strength at Yield in the GSE Product Data Sheets has 22 n/mm. Update the value in the printout.

Liner & Cover

1. The separation between the compacted soil component of the composite liner shall be two feet above the Natural Water Table in the site area. Provide a potentiometric surface map for the critical monitoring events from the DSI with the post-settlement base grades provided of the landfill footprint. In any area where the potentiometer surface map illustrates that the surface is above the existing topography, use the top of the existing topography (pre-land disturbance) for those areas. (Article 10, Section 238 C.3.c.)

2. On Sheets 22 and 23, show the bottom of the clay liner on the cross section drawings. (Article 10, Section 238 C.3.c., Article 10, Section 238 C.3. 10 CSR 80-11.010(4)(B)6.)

3. If soils from onsite are acceptable for clay liner, prior to use for such, a test pad for these materials would be necessary since the offsite borrow soils are different. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(10)(C)1.)

4. No demonstration was made to not use one foot (1') of 1×10^{-5} cm/sec soil in the final cover directly under the geomembrane. A demonstration is required and must be approved for the use of an alternate final cover. 10 CSR 80-11.010(14)(C)3. "As each phase of the utility waste landfill is completed, a final cover system shall be installed consisting of one foot (1') of compacted clay with a coefficient of permeability of 1×10^{-5} cm/sec or less and overlaid with one foot (1') of soil capable of sustaining vegetative growth." 10 CSR 80-11.010(14)(C)5. "The department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate to the department that the alternative design will be at least equivalent to the final cover system described in paragraph (14)(C)3. of this rule." The proposed final cover in the permit application consists of "a textured 40-mil HDPE geomembrane liner placed directly on the CCRs, overlain by a 16-oz/yd^2 non-woven, needle-punched geotextile, and covered with two (2) feet of nominally compacted vegetative soil capable of supporting the final vegetation cover." The proposed final cover does not include all the minimum requirements, specifically the 1-foot low-permeability compacted clay layer, nor is it demonstrated that the proposed final cover would be equivalent to those requirements. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

5. The plan sheets don't match the CQA Plan for the top crown HDPE. Please revise and provide the appropriate calculations as necessary. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(B)8.)

6. Sheet 19 shows one anchor trench containing the liner geomembrane, the geocomposite drain, and the final cover geomembrane. A second anchor trench for the cover system is necessary to prevent damage to the previously installed geosynthetic components. (General Engineering Comment)

7. On Sheet 19, the Perimeter Ditch at Closure shows 12" of cover soils over the geomembrane with no clay liner beneath the geomembrane. A minimum of two feet of soil cover must be over the landfilled CCR. Additionally, erosion protection in the perimeter ditch is necessary to prevent exposure of the geomembrane. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

Leachate Collection

8. The landfill liner and overlying leachate collection system must have a minimum slope of 1%, pre and post settlement. Revise the landfill grades to meet this requirement during all times within the landfill footprint. Provide plan sheets with the critical cross sections which show the pre and post settlement landfill base grades. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(10)(B)4.)

9. Specify the geotextiles for the cushion fabric and the filter fabric shown in the Bottom Liner and Leachate Collection System Detail. Provide the supporting documentation and any necessary calculations. (General Engineering Comment)

10. Provide detail drawings for the pipe perforation or slotting pattern for the leachate collection lines and sump riser pipe. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

11. H.E.L.P. models include only fly ash layers. Section 3.1.4 of the report states that waste are predicted to include "approximately 70% fly ash and 30% bottom ash". This report also discusses the acceptance of Flue Gas Desulfurization (FGD) byproducts. Neither bottom ash nor FGD byproducts were included in any of the H.E.L.P. models. The H.E.L.P. models used default values for fly ash when some values, such as hydraulic conductivity, were tested for in Appendix J. Use the anticipated waste composition for modeling purposes. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

Leachate Storage and Conveyance

12. The leachate storage tanks have no capacities or sizes listed or illustrated in the drawings. The leachate storage tanks must be sized based upon the pumping rates of the sumps within the landfill, and the maintenance and inspection schedule or control systems for each. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

13. Leachate storage tank appears misplaced on Sheet 6. (General Engineering Comment)

14. The Leachate and Stormwater Forcemains are shown in the Exterior Berm without the depths noted. The forcemains must be installed at a depth to prevent freezing during cold weather conditions. Additionally, account for these forcemains being located in a berm above grade and the landfill will not have exothermic reactions. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.D.)

15. Due to the size of the cells, provide calculations to show the removal rate of leachate generated from a storm event during the first couple of weeks of filling. Justify the storm event, calculate the removal rate and describe disposal method utilized. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

Stormwater

16. The stormwater management plan for the site allows most stormwater to become contact waters and thus leachate. Based upon the stormwater management plan, no waters onsite will be allowed to discharge from the site and must be contained and treated as leachate. Additionally, a one-way valve rather than a gate valve alone would be required in the Stormwater Ponds (Leachate Ponds) to prevent leachate out of the ponds during the

equalization. These ponds will additionally need to be designed with a liner system which meets the requirements of MDNR's Solid Waste Management and Water Protection Programs for storing leachate (waste waters). The use of these waters will be limited to within the composite lined landfill area or for use as makeup waters within the power plant's future scrubber systems. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e.; 10 CSR 80-11.010(8)(B)1.F.(V); 10 CSR 80-11.010(8)(C)2. & 10 CSR 80-11.010(9)(C)2.)

17. The 25-year, 24-hour rainfall event is greater than 5.6 inches based upon the NOAA Atlas 14 Volume 8, Version 2 Point Precipitation Frequency Estimates. Increase the 25-year, 24-hour rainfall event to the recently revised amount. (Article 10, Section 238 C.3.; 10 CSR 80-11.010(8)(B)1.F.(III) & 10 CSR 80-11.010(9)(B)3.)

18. Section 4.1.2 Sequence of Phase Construction describes the construction sequence of each phase. The Phase 1 Construction Sequence doesn't discuss the timing of constructing the stormwater pond, but Phases 3 and 4 Construction Sequence discusses constructing the stormwater ponds after placing CCR in the phase area. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. (General Engineering Comment)

19. In 4.2.1 UWL Disposal Operational Description section, the perimeter ditches around each phase must not provide storage of stormwater but must be designed to rapidly convey stormwater to the stormwater ponds for storage. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(8)(B)1.F.(IV))

20. The perimeter ditches are designed with flat slopes. This may lead to standing water retained in these ditches which does not minimize infiltration. This design also may not empty expeditiously after storms. Additionally, this doesn't take into account the anticipated differential settlement. 10 CSR 80-11.010(8)(B)1.F.: "Provisions for surface water runoff control to minimize infiltration and erosion of cover. All Water Pollution Control Program permits and approvals necessary to comply with requirements of the Missouri Clean Water Law and corresponding rules shall be obtained from the department." 10 CSR 80-11.010(8)(B)1.F.(IV): "On-site drainage and channels shall be designed to empty expeditiously after storms to maintain the design capacity of the system." (Article 10, Section 238 C.3.; 10 CSR 80-11.010(8)(B)1.F. & 10 CSR 80-11.010(8)(B)1.F.(IV))

21. Since the perimeter ditches are designed with flat slopes, it would be difficult to estimate the amount of watershed area that would collect into the two separate ponds that serve Cells 3 and 4. The notes for Tables N-2 to N-5 state that "flows are split generally at half the distance between the entrances to the pond along the perimeter ditch." While this would seem like a reasonable assumption in theory, actual field conditions, subject to settlement and weathering, will probably not result in a perfectly flat ditch slope. Additionally, no consideration is given to the differences in times of concentration that would be present along the perimeter ditches due to the varying flow lengths down the final cover slopes. (General Engineering Comment)

22. On Sheets 5 and 7, show how the stormwater from Cell 2 will flow into the Stormwater Pond 1. (General Engineering Comment)

23. After closure, all stormwater should be routed through the stormwater ponds to reduce sediment loading rather than allowing the letdown structures to discharge over the exterior berms. (General Engineering Comment)

Berms

24. Interior berms filled with CCR must be constructed immediately after receiving the Operating Permit or Authorization to Operate due to placing waste within the landfill footprint. Additional CQA reporting will then be required for the construction of the interior berm and requires approval prior to placing CCR material onto it. (Article 10, Section 238 C.3.d.)

25. The design of the landfill has the interior berms exposed the same as the exterior berms during the filling of Cells 1 and 3, thus it is required to have the same protection as the exterior berms since they would be considered exterior berms during the filling of cells 1 and 3, prior to the construction of cells 2 and 4. (Article 10, Section 238 C.3.d.)

26. In the interior berms, the geomembrane needs to wrap back over the leachate collection and protection layers at the point of future tie in to prevent backed-up leachate from seeping through the exterior slope. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(C)2.)

27. Section 3.3.2.3 Franklin County Requirement – Erosion Protection in the Landfill Design discusses 2.2-inch thick fabric-formed concrete mats and Appendix K states that the exterior berm slopes will be lined with a 6-inch thick, fabric-formed articulated concrete mat. Section 9.0 Erosion Protection From Levee Overtopping of Failure in Appendix J provides a 56mm (2.2-inches) thick fabric-formed concrete mat such as Hydrotex FP220. The drawings include no dimensions. Revise all section and have the same dimensions listed for each. Additionally, add details to the drawings for the fabric-formed concrete mats. (Article 10, Section 238 C.3.d.)

Operations

28. The procedure for the placement of the first lift of CCR to prevent damage to the underlying layers needs to be developed and included in the operations section. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(2)(C)1.)

29. Flooding of the phase due to not having adequate CCR in place would need a contingency plan developed and included in the construction permit application. The inundation of the phase area would need to be equalized to prevent significant differential head on the liner. Additionally, the pumping down would need to occur relative to the floodwaters surrounding the phase as they recede to prevent a high differential head. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

30. The Solid Waste Excluded lists Major Appliances and Whole Waste Tires. Modify these to list as Any Appliances and Waste Tires. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(3)(A))

31. Dust suppression must be employed to prevent the migration of CCR offsite during all phases of construction, including mining activities, if and when allowed. (Article 10, Section 238 C.3; 10 CSR 80-11.010(12)(A) & 10 CSR 80-11.010(13)(C)1.)

32. Backup equipment or additional equipment is necessary more quickly than within 3 days due to the volume of waste generated. If a piece of equipment goes down, backup or replacement equipment should be in use within 24 hours. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(15)(B)1.)

33. Seeding to establish vegetation on the intermediate side slope cover needs to occur within a much shorter period than annually as provided in the Phases 1, 2, 3 and 4 Aesthetic Cover section. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(13)(B))

General Comments

34. The waste boundary should be reduced to allow the groundwater monitoring wells to be installed in the area of the DSI. If the wells are installed outside the area of the DSI, the data from the wells must be complied and correlated to existing DSI data and provided as an addendum to the DSI. (Article 10, Section 238 C.3; 10 CSR 80-2.015(1)(D) & 10 CSR 80-2.015 Appendix I)

35. Provide the approved design and drawings of the proposed underpass for Labadie Bottom Road and all approvals from the controlling authorities. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(4)(C)1.)

36. Sheet 8 appears to be missing leaders and detailed descriptions. Please update for further review. (General Engineering Comment)

Appendix D

37. Appendix D should be renamed "Violation History Disclosure Form" rather than the older language which has a negative connotation. (Article 10, Section 238 C.3 & 10 CSR 80-2.020(2)(A)2.I.)

Appendix H

38. The only document contained in Appendix H Floodplain Documentation is a review letter for the "Floodplain Analysis of the Missouri River for the Ameren Missouri Labadie Energy Center" by the Independent Registered Professional Engineer (IRPE). Please provide the additional documentation that was submitted to receive this letter from the IRPE. (Article 10, Section 238 C.3; 10 CSR 80-11.010(4)(B)1.)

Appendix J

39. The Table of Contents for Appendix J lists the Files on Enclosed CD. AEI was not provided the CD which includes the Files of the Printed Outputs from Computer Runs to review. We will need a copy of the computer runs of the revised report based upon the comment letters. (Article 10, Section 238 C.3 & 10 CSR 80-2.020(2)(A)2.B.)

40. Friction angles for the geomembrane/clay interface appear to be too high. The direct shear testing performed on the interface did not adequately displace the interface and the normal loads were low. The displacement testing should be on the order of inches and the normal stresses need to meet the full capacity of the landfill design. Additionally, at lower normal stresses, the critical interface may occur between the geomembrane and geotextile or geocomposite. All of the designs need to be analyzed to have the proper inputs for stability analysis. The bottom liner illustrated as detail 3/17 Bottom Liner and Leachate Collection Detail shows a smooth geomembrane, not a textured HDPE geomembrane as was tested and provided in Appendix A-1 of Appendix J. The interface friction angle (15 degrees) utilized in the Analysis and Design of Veneer Cover Soils, Figure E-42, is a more representative value for

textured HDPE geomembranes/clay interface. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

41. Friction angles in the stability analyses don't correspond to the testing on the CH clay liner material from the offsite borrow. Triaxial shear testing (CU) on the CH clay resulted in phi of 14.6 effective stress shear angle with cohesion near 0.21 tons per square foot. The effective friction angle used in the stability analysis for the compacted clay liner was listed as 25 degrees. Verify each input providing references for their values. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

42. The stability analysis failed to meet the required and recommended factor of safeties. Cross-section E-E' failed to meet the factor of safety of 1.5 for the static drained global circular failure surface both with the initial and full fill of CCP. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

43. The minimum factor of safety recommended by the draft technical guidance document from MDNR-SWMP and Stark is 1.2 to 1.3, not 1.1 as listed in Table E-2 Results of Slope Stability Analyses. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

44. Liquefaction has been determined to occur in multiple layers. When reviewing the post-liquefied shear strengths provided in the table for the stability analysis, they don't match the shear strengths from correlation charts based upon the SPT blow counts. The chart referenced in the Reitz & Jens report was H. Bolton Seed's 1987 chart. Seed and Harder updated this chart with additional information in 1990 and this chart is available with a 3rd Order Best-Fit curve to simplify the correlation. Please provide the graphed correlations providing the residual shear strengths based upon the SPT blowcount corrected for the percentage of fines. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

45. Liquefaction analysis is typically performed in the upper 50' of unconsolidated materials. Almost every boring was stopped at 35' in depth. Due to the lack of information from the 35' to 50' interval of the unconsolidated materials, provide a narrative justifying why liquefaction would not be anticipated at depths below 35'. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and

Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

46. The draft technical guidance document from MDNR-SWMP and Stark wasn't intended for designing landfills within a very young geologic age and active floodplain. Stability analysis for varying phases of filling is necessary due to the proposed location of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

47. Protective/drainage layers are missing from the stability analysis. Both designs need analyzed in the stability models if both are considered for permitting and construction. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

48. The boring B-100 is no longer centralized or even under a cell of the landfill. Other soil profiles should be analyzed to provide the critical Shake analysis. This will require additional borings to bedrock within the footprint of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

49. The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration = 0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

50. Provide the actual stability analysis for the deformation analysis and provide with a narrative rather than a table listing the yield accelerations and deformations for the short and long-duration events. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

51. The Table of Contents for Appendix C Seismic Analyses appears to have C-18 & C-19 swapped with C-20 & C-21. Please revise and verify the information. (General Engineering Comment)

52. Settlement analysis demonstrates some differential settlement which could cause ponding in the flat stormwater channels, a reduction in the overall height of the berms and settlement of the base grades of the landfill. Each of these must be discussed including how Franklin County's regulations will be satisfied during all phases of construction, filling and closure. Additionally, the settlement analysis typically has a range of settlement that may occur due to variability in the underlying subgrade and must be conservatively considered in the analysis to prevent overtopping of the exterior and interior berms due to a 500-year flood event. (Article 10, Section 238 C.3; Article 10, Section 238 C.3d.i.; 10 CSR 80-11.010(5)(A)4.A & 10 CSR 80-11.010(8)(B)1.F.(IV))

53. Provide the calculations correlating the CPT test data to the elastic modulus utilized in the Settlement Analysis. The CPT logs which were provided in the DSI don't provide enough detail to verify the elastic moduli provided in the settlement analyses. Additionally, heavily loaded conditions decrease the modulus, so these factors need to be accounted for relative to their location within the footprint of the fill. The Bowles 1997 reference appears to be dated and newer, more precise correlations are widely available which utilize the normalized cone resistance and normalized friction ration. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

54. Calculate the bearing capacity of the subgrade in varying locations throughout the footprint. Additionally, calculate the bearing capacity during a maximum credible seismic event which induces liquefaction during each phase of construction and filling of the landfill. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

55. The protection of liner from hydrostatic uplift discusses the flooding with the gravel drainage layer and sand protective layer. The alternate design with the geocomposite drain and protective sand layer must also be discussed in the flooding scenarios. (General Engineering Comment)

56. In Appendix G – Design of Fabric-Formed Concrete Mat (FCM), the factor of safety calculation has a missing value, t (= 0.183 ft) in the numerator after substitution:

$$F.S. = \left[\frac{\mu(t)(\gamma_c - \gamma_w)cos\theta cos \propto - \tau_{DES}}{\sqrt{[t(\gamma_c - \gamma_w)sin\theta]^2 + \tau_{DES}{}^2}}\right]$$

$$F.S. = \left[\frac{0.637(130\, PCF - 62.4\, PCF)\cos(18.435°)cos(0°) - \tau_{DES}}{\sqrt{[(0.183')(130 - 62.4)sin18.435]^2 + \tau_{DES}{}^2}}\right]$$

This reduces the value of the maximum design velocity significantly. Update the calculations with the thickness of the fabric-formed concrete included. (General Engineering Comment)

Appendix O

57. The filter design basis in the Memo from Bruce Dawson, PE to Gredell Engineering Resources, Inc, included in Appendix O-1, requires a tighter gradation for the sand protective layer based upon the R15 provided. The D15 for the sand should range from 0.24 mm to 0.8

mm based upon the D15 of the Fly Ash and the R15 provided from the Peck Hanson Thornburn filter criteria. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(9)(B)1.D.)

Appendix P

58. The Construction Quality Assurance Plan inadequately addresses the requirements in 10 CSR 80-11.010(6)(B)1.A. "A detailed description of the QA/QC testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;" Specifically, this section should include tables showing the frequency and acceptable test result values for each testing procedure. The Air Pressure Testing of seams cannot allow a drop of 4 psi during the 5 minute test. It must not drop more than 10% of the equalized pressure of at least 25 psi. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(B)1.A.)

59. Appendix P Construction Quality Assurance Plan section 3.2 Test Pad references the Demolition Landfill regulations. Please revise to reference the appropriate regulations. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(10)(C)1.)

60. In section 3.5 Quality Assurance Monitoring and Testing, the following statement must be omitted since there is no justification of the reduced testing frequency. "If liner quality soils are stockpiled on site prior to the beginning of placement, a reduced frequency of verification testing will be requested." (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(C)1.)

61. A log of soils should be maintained for soils brought in from offsite. The log should provide the testing performed and the intended use on site. This will assist in construction planning for each cell construction. (General Engineering Comment)

Appendix V

62. Need a full size Survey Plat for review of Appendix V. (General Engineering Comment)

Appendix Y

63. In Appendix Y(a) Leachate Pipe and Pump Calculations, the leachate storage tank is listed as a 12-ft diameter horizontal tank. The drawings provided for the site have a vertical storage tank shown without any detail drawings for the storage tanks. Provide a detailed drawing for the storage tanks and the anticipated operations of the tanks to prevent them from exceeding capacity. Provide the pump details for the pumps within the leachate storage tanks. This should be included in the leachate management plan. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

64. In Appendix Y(a) Pipe Capacities, the flow capacity calculation in this section was miscalculated by a factor of 10:

$$Q = \frac{1.49}{.009} \times 0.156 \times 0.111^{2/3} \times 0.005^{1/2} \neq 4.2\, cfs$$
$$= 0.42\, cfs$$

(Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B))

65. In Appendix Y(a), the Leachate Pipe Crushing and Buckling Scenarios, Scenario 1 provides an H20 truck in the analysis. This size of truck is normal for highway use but it is anticipated based upon the amount of CCR being deposited that the size of the equipment and tire loads could be greater. Scenario 3 uses a live load of a 3 ton skid steer on the sump riser trench with one foot of CCR placed over the top of the sump riser trench. In all likelihood, this loading would occur prior to the placement of the CCR and the geotextile, and would be used to place the clean gravel. Additionally, Scenarios 1 and 3 drawings appears to be in error that CCR would be placed as the protective cover over the geocomposite drainage. Please revise these drawings and recalculate with the proper loading. It also appears that the pipe values were not reduced due to the perforations in Scenarios 1 and 2. Density of waste is listed as 75 pcf. Testing results in Appendix J report higher densities for CCPs. A density of 93 pcf is assumed in calculations in Appendix Y(d). (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

66. In Appendix Y(c) – Water Management Calculations, the second paragraph of the concluding statements reads "Backup leachate management will be at an offsite POTW." The permit should specify which POTW will manage the leachate as backup and a signed agreement pertaining to this management should be included. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)4.)

67. In Appendix Y(d) – Flood Mitigation Calculations, Pumping Rates for Flood Water Protection – Cell 3, the concluding statement reads, "A pumping rate of 13,194 gpm, pumping 24 hours per day, is required to fill Cell 3 in 10 days for 100-year flood protection." The source and location of the required water supply, as well as the necessary equipment for pumping should be specified. (General Engineering Comment)

68. Included in Appendix Y(e), the clay/geomembrane interface for the side slope cover material stability calculates with a factor of safety of 1.46, below the 1.5 as stated. The interface friction angles used for the clay and geomembrane are stated to be taken from Table 5.6 and Table 5.7. Analysis and Design of Veneer Cover Soils is included in Appendix J with an interface friction angle of 15 degrees. In hand written calculations provided in Appendix Y(e), the factor of safety for CCR to geomembrane is calculated as 1.2 in static conditions. Provide a detailed narrative with additional calculations to support the provided calculations and how they relate to each other. If the fly ash were to be utilized as being in intimate contact with the geomembrane with moistures approximately five percent over optimum, this interface would need laboratory testing as part of the demonstration for an alternative final cover system and included in the stability analysis. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.D.)

69. In Appendix Y(e), the attached printout for the 60 mil Geomembrane has 23.00 kN/m provided as the Allowable Force in Geosynthetic, TDESIGN. The valve for the Strength at Yield in the GSE Product Data Sheets has 22 N/mm. Update the value in the printout. (General Engineering Comment)

Ameren
MISSOURI

July 8, 2013

By Electronic Mail and Regular Mail

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

Re: IRPE Comments

Dear Mr. Feldman,

Ameren Missouri has completed its detailed review of the June 6, 2013 comments of Andrews Engineering, the County's Independent Registered Professional Engineer ("IRPE"), under the County's new Landfill Ordinance 2011-307 (the "Ordinance"), together with the IRPE's revised draft of that review received on June 27, 2013, as well as their comments on the Groundwater Monitoring System dated April 22, 2013. This will confirm that these three sets of IRPE comments on the Application are complete for purposes of the Application and Ordinance.

Enclosed are our responses to those comments, subject to the following.

As you probably know, the Missouri Department of Natural Resources ("MDNR") has already reviewed the same Ameren Missouri Construction Permit Application that is the subject of our application to the County, by its letter dated May 7, 2013, a copy of which you have already received, so that we have the benefit of knowing exactly where MDNR stands. MDNR's letter is conclusive as to what the MDNR statute and regulations require as to the Application with the County, and therefore covers and pre-empts the great majority of the IRPE's comments.

The Ordinance does not (and cannot, legally) authorize the IRPE to state what MDNR regulations and statutes require in contradiction to what MDNR has interpreted them to mean, or to make new regulatory or environmental policy for either MDNR or the County. In addition, the Ordinance also does not (and cannot, legally) authorize the IRPE to read MDNR regulations to require items or orders of magnitude of construction of agreed upon items that MDNR does not require (e.g., the sheer number of monitoring wells).

The Ordinance does, subject to Ameren Missouri's rights under the pending zoning jurisdiction litigation now in the Missouri Court of Appeals, authorize the IRPE or the County's other officials to "verify" compliance with the MDNR regulations and enforce the specific, technical provisions of the Ordinance, which, as noted above, has been mooted as to the MDNR component, to the extent of the MDNR May 7, 2013 comment letter.

As we have discussed, Ameren Missouri does agree to comply with specific stated objective requirements of the Ordinance, for example the 500 year flood level requirement in Section 238C(3)(d)(i) on page 11 and the concrete material berm provision, and we agree that the Ordinance, in its objective, technical requirements can be "more strict" than the MDNR Regulations (again, subject to and without waiving all of our legal arguments raised in the pending lawsuit by LEO and others).

Notwithstanding the foregoing, as noted in the attached comments from our engineering team, there are a number of comments from the IPRE, outside of its authority of the Ordinance, which Ameren Missouri does present a response to, in the spirit of cooperation and simply to expedite the MDNR application, but subject, in all cases, to the IRPE and the County being overruled by MDNR.

Our legal counsel has corresponded with the County's counsel on other jurisdictional aspects of the Ordinance, and we understand that the County is in agreement with us on those issues.

Please call me at any time to discuss and we assure the County that we give you these points in a spirit of cooperation.

Sincerely,

Craig J. Giesmann

Craig J. Giesmann, P.E., P.M.P.
Union Electric Company, d/b/a Ameren Missouri

Labadie Energy Center – Utility Waste Landfill
Construction Permit Application
Response to Franklin County IRPE Review Comments

July 8, 2013

Prepared For:

Ameren
MISSOURI

Prepared by:

REITZ & JENS, INC.
CONSULTING ENGINEERS
50 YEARS

and

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND-AIR-WATER

The following responds to the comments made by Franklin County's Independent Registered Professional Engineer (IRPE) concerning their review of the Construction Permit Application (CPA) for Ameren Missouri's proposed Utility Waste Landfill (UWL) at the Labadie Energy Center. The CPA was submitted to Franklin County on January 29, 2013. The IRPE's review comments were transmitted to Franklin County under cover of a letter dated June 6, 2013. A copy of the IPE's cover letter and comments are attached.

Certain of the IRPE's comments refer to items which the IRPE concludes are required by Franklin County's new Landfill Ordinance 2011-307, and Missouri Solid Waste Management Rules 10 CSR 80-2 and 10 CSR 80-11 for UWL permitting, design and operation of UWLs administered by the Missouri Department of Natural Resources-Solid Waste Management Program (MDNR-SWMP). The landfill design and operating procedures have been prepared by the undersigned in accordance with the UWL requirements of the Missouri Solid Waste Management Law and Rules and Franklin County ordinances, and accepted engineering practice.

The following technical responses address those review comments that relate to the additional UWL design requirements we understand to be required by the Franklin County ordinance. Many of the IRPE's review comments relate to UWL design requirements that are MDNR-SWMP's review responsibility in accordance with 10 CSR 80-2 and 10 CSR 80-11. MDNR-SWMP provided their CPA review comments in a May 7, 2013 letter, a copy of which was sent to Franklin County. We defer to the MDNR-SWMP's review letter for interpretation of the regulatory requirements for UWL design in the State of Missouri which we believe pre-empts many of the IRPE's comments as to what the MDNR-SWMP statutes and regulations require. As a result, the following responses acknowledge, but may not directly respond to certain IRPE comments that we understand to be under MDNR-SWMP's review.

Where the IRPE's comments identified clerical corrections that need to be made to the CPA, such as typographical errors, we will revise the CPA appropriately. We are revising the Construction Permit Application and preparing a separate response to MDNR-SWMP as required by their May 7, 2013 review letter. We will also address other minor, but non-clerical comments, but only in the interest of expediting the review process, and in the event that MDNR-SWMP decides otherwise, we reserve the right to comply with MDNR-SWMP comments.

A copy of the revised Construction Permit Application and response to MDNR-SWMP will also be sent to Franklin County.

<u>COMMENT RESPONSES:</u>

Liner & Cover

The UWL liner system will include a composite bottom liner consisting of 24-inches of compacted clay with a permeability not exceeding 1×10^{-7} cm/sec overlain by a 60-mil thick HDPE geomembrane installed before placement of CCPs, and a final cover consisting of 40-mil

HDPE liner overlain by 24-inches of soil cover to support a hardy stand of vegetation once all CCPs are placed. The design, construction, and operation of the liner and cover meet or exceed the design requirements of 10 CSR 80-11.010(10) and 10 CSR 80-11.010(14).

IRPE 1 This comment will also be addressed in response to MDNR-SWMP's review comment 27. Historical flood data on the Missouri River and available historical groundwater level data were analyzed to establish the Natural Water Table at the Labadie UWL site at elevation 464. This analysis was presented in our April 9, 2012 "Design Basis for Groundwater Level". A separate November 2012 "Demonstration: Base of Utility Waste Liner in Intermittent Contact with Groundwater" showed that intermittent contact with the water table does not impact the liner performance. Both of these documents, included in Appendix Z of the CPA, were conceptually approved by the IRPE in their January 7, 2013, letter to Ameren. The bottom liner grades were designed in anticipation of the predicted settlement so that the bottom of the soil component remains at least 2 feet above the Natural Water Table, except at the sumps. The sumps will be filled with clean gravel to a minimum elevation of 468 resulting in all CCPs disposed of in the UWL being at least four (4) feet above the Natural Water Table.

IRPE 2 The requested information will be added to Sheets 22 and 23 of the revised CPA.

IRPE 5 The top crown of the HDPE will be revised to be consistent on the plan sheets and CQA Plan.

Section 238 Article 10(C)(3)c of Franklin County's Landfill Ordinance 2011-307 requires that the composite liner system meet the standards established by applicable portions of MDNR regulations. The IPRE's comments 3, 4, 6 and 7 regarding the liner and cover's compliance with 10 CSR 80-11.010 were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Leachate Collection

The UWL will use a conventional area disposal method for dry landfill disposal of CCPs. The CCPs will be dewatered or conditioned as necessary to pass the paint filter test prior to being transported to the UWL for disposal. In addition to intermediate and final cover, the UWL will include a leachate collection system constructed immediately on top of the composite liner. Leachate (water that has infiltrated into the CCPs) will be collected by the leachate collection system that covers the entire bottom and side slopes of each disposal cell that drains to leachate collection sumps. Each leachate collection sump will be equipped with a submersible pump automated to control and maintain less than 12 inches of leachate on the bottom composite liner during all phases of UWL operation. The design, construction, and operation of the leachate collection system meets or exceeds the requirements of 10 CSR 80-11.010(9).

Section 238 Article 10(C)(3)e of Franklin County's Landfill Ordinance 2011-307 requires that the leachate collection system be designed and constructed as required by MDNR-SWMP. The

IPRE's comments 8 through 11 regarding the leachate collection system's compliance with 10 CSR 80-11.010 were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Leachate Storage and Conveyance

Section 238 Article 10(C)(3)e of Franklin County's Landfill Ordinance 2011-307 requires that the leachate collection system be designed and constructed as required by MDNR-SWMP. The design, construction, and operation of the leachate storage and conveyance system meet or exceed the requirements of 10 CSR 80-11.010(9). The IPRE's comments 12 through 15 regarding the leachate collection system's storage and conveyance were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Stormwater

The UWL's stormwater management system is designed to manage the 25-year, 24-hour storm event without discharge to Waters of the State during the active operations. The system will temporarily retain and reuse leachate and contaminated stormwater to the extent practical on-site for dust control, to condition CCPs prior to placement, and/or as makeup water for future scrubber operations at the plant. Excess water will be managed through the plant's NPDES permit. The design, construction, and operation of the stormwater management system meet or exceed the requirements of 10 CSR 80-11.010(8)(B)1.F. The IPRE's comments 16 through 23 regarding the stormwater management system's compliance with 10 CSR 80-11.010 were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Berms

Each UWL cell will be fully enclosed with a perimeter berm prior to beginning active disposal operations. The perimeter berm will include both permanent exterior and temporary interior berms constructed to elevation 488, at least 0.4 feet above the highest 500-year flood elevation at the site and more than 3 feet above the regulatory 100-year flood elevation. The exterior berm will remain throughout the life of the UWL while the temporary interior berm will be enclosed as future cells are developed. The core of the exterior berms will be compacted earthen material and the core of the interior berms will be compacted CCPs, both of which will be covered on the exterior slope by fabric-formed concrete mats (FCM). The interior slope of each berm will be lined with a composite liner and leachate drainage layer. The design, construction, and operation of the berms meet or exceed the requirements of 10 CSR 80-11.010(4)(B)1, as well as Section 238 Article 10(C)(3)(d)i and ii of Franklin County's Landfill Ordinance 2011-307.

IRPE 24 The IPRE's comment regarding this aspect of the berm sequencing was addressed by MDNR-SWMP in their review of the CPA. This comment is noted, however no additional response or revision will be provided.

IRPE 25 This comment has also been addressed in response to MDNR-SWMP's review comment 9 and 28. The engineering report and the applicable plan sheets have been revised to include fabric-formed concrete mat on both the interior and exterior berms.

IRPE 26 It is our opinion that a design modification is not required to prevent 'backed-up' leachate from seeping through the exterior slope. The elevation difference between the top of the leachate sumps and the edge of the interior berms is more than 4 feet, while the maximum allowable leachate ponding depth on the bottom liner is 12-inches, making the back-up of leachate to the liner elevation in the interior berm highly unlikely. Furthermore, if the leachate elevation did reach the edge of the liner at this location, the current design in the CPA will prevent leachate from seeping past the berm toe. This comment is noted, however no additional response or revision will be provided.

IRPE 27 This comment has also been addressed in response to MDNR-SWMP's review comment 5. Appendix K will be revised to state the correct thickness of the concrete Fabric-Formed mat, 2.2 inches, as indicated in Section 3.3.2.3. Sheet 19 of the plans will be revised to identify the mat thickness at 2.2 inches.

Operations

The UWL will use a conventional area disposal method for dry landfill disposal of CCPs in accordance with 10 CSR 80-11.010(10) and 10 CSR 80-11.010(14) , as well as Section 238 Article 10(C) 7 of Franklin County's Landfill Ordinance 2011-307.

IRPE 28 The IPRE's comment regarding this operational aspect was addressed by MDNR-SWMP in their review of the CPA. This comment is noted, however no additional response or revision will be provided.

IRPE 29 A flood mitigation plan is provided in Section 3.3.2.2 of the engineering report. A provision of this plan is to flood a phase with non-potable water by pumping floodwaters from the outside the exterior berm over the berm into the cell to counterbalance uplift pressure due to flooding. Appendix Y contains calculations of the pumping rates needed to flood the largest cell.

IRPE 30 The requested revision will be added to Section 4.4 of the revised CPA.

IRPE 31 Section 4.6.1 of the engineering report will be modified to specify that dust control and mitigation will be employed during all phases of UWL construction and operation, including mining activities. Section 4.6.1 currently states that future mining of CCPs will not occur without MDNR-SWMP approval of a specific operating plan for this activity.

IRPE 32 The requested revision will be added to Section 4.8.3 of the revised CPA.

IRPE 50 The perimeter berms will be constructed to a minimum elevation of 488. As part of ongoing UWL operation and maintenance, both during operation and post closure, the top of berm elevation will be periodically determined by level survey. If the top elevation of the exterior berms settles below the 500-year elevation of 487.6, suitable fill will be added to the perimeter roads on the top of the berm to raise the minimum berm elevation to 488. Section 2.8.3 will be revised to reflect this operational procedure to maintain the perimeter berms to the 500-year flood elevations.

IRPE 56 The corrected formula yields a τ_{DES} of 1.29 PSF, and a resulting maximum allowable V_{DES} of 11.4 feet/second, which is still an order of magnitude greater than the maximum anticipated floodwater velocity of 1.4 feet/second. This correction will be included in the revised CPA but does not require any change to the design of the fabric-formed concrete erosion protection mat.

Appendix O

IRPE 57 This IPRE general comment was addressed by MDNR-SWMP in their review of the CPA. This comment is noted, however no additional response or revision will be provided.

Appendix P

The Construction Quality Assurance Plan included in Appendix P will be followed to assure that UWL construction is in accordance with the approved design and the requirements of 10 CSR 80-11.010. The IPRE's comments 58 through 61 regarding the Construction Quality Assurance Plan's compliance with 10 CSR 80-11.010 were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Appendix V

IRPE 62 This IPRE request was not required by MDNR-SWMP to complete their review of the CPA. This comment is noted, however no additional response or revision will be provided.

Appendix Y

IRPE 63 The miscellaneous calculations included in Appendix Y of the CPA will be revised to clarify items requested in MDNR-SWMP comments and Franklin County comments 64 and 67. The remaining IPRE comments regarding these calculations were addressed by MDNR-SWMP in their review of the CPA. These comments are noted, however no additional response or revision will be provided.

Liner & Cover

1. The separation between the compacted soil component of the composite liner shall be two feet above the Natural Water Table in the site area. Provide a potentiometric surface map for the critical monitoring events from the DSI with the post-settlement base grades provided of the landfill footprint. In any area where the potentiometer surface map illustrates that the surface is above the existing topography, use the top of the existing topography (pre-land disturbance) for those areas. (Article 10, Section 238 C.3.c.)

2. On Sheets 22 and 23, show the bottom of the clay liner on the cross section drawings. (Article 10, Section 238 C.3.c., Article 10, Section 238 C.3. 10 CSR 80-11.010(4)(B)6.)

3. If soils from onsite are acceptable for clay liner, prior to use for such, a test pad for these materials would be necessary since the offsite borrow soils are different. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(10)(C)1.)

4. No demonstration was made to not use one foot (1') of $1x10^{-5}$ cm/sec soil in the final cover directly under the geomembrane. A demonstration is required and must be approved for the use of an alternate final cover. 10 CSR 80-11.010(14)(C)3. "As each phase of the utility waste landfill is completed, a final cover system shall be installed consisting of one foot (1') of compacted clay with a coefficient of permeability of 1 X 10^{-5} cm/sec or less and overlaid with one foot (1') of soil capable of sustaining vegetative growth." 10 CSR 80-11.010(14)(C)5. "The department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate to the department that the alternative design will be at least equivalent to the final cover system described in paragraph (14)(C)3. of this rule." The proposed final cover in the permit application consists of "a textured 40-mil HDPE geomembrane liner placed directly on the CCRs, overlain by a 16-oz/yd^2 non-woven, needle-punched geotextile, and covered with two (2) feet of nominally compacted vegetative soil capable of supporting the final vegetation cover." The proposed final cover does not include all the minimum requirements, specifically the 1-foot low-permeability compacted clay layer, nor is it demonstrated that the proposed final cover would be equivalent to those requirements. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

5. The plan sheets don't match the CQA Plan for the top crown HDPE. Please revise and provide the appropriate calculations as necessary. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(B)8.)

6. Sheet 19 shows one anchor trench containing the liner geomembrane, the geocomposite drain, and the final cover geomembrane. A second anchor trench for the cover system is necessary to prevent damage to the previously installed geosynthetic components. (General Engineering Comment)

7. On Sheet 19, the Perimeter Ditch at Closure shows 12" of cover soils over the geomembrane with no clay liner beneath the geomembrane. A minimum of two feet of soil cover must be over the landfilled CCR. Additionally, erosion protection in the perimeter ditch is necessary to prevent exposure of the geomembrane. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

Leachate Collection

8. The landfill liner and overlying leachate collection system must have a minimum slope of 1%, pre and post settlement. Revise the landfill grades to meet this requirement during all times within the landfill footprint. Provide plan sheets with the critical cross sections which show the pre and post settlement landfill base grades. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(10)(B)4.)

9. Specify the geotextiles for the cushion fabric and the filter fabric shown in the Bottom Liner and Leachate Collection System Detail. Provide the supporting documentation and any necessary calculations. (General Engineering Comment)

10. Provide detail drawings for the pipe perforation or slotting pattern for the leachate collection lines and sump riser pipe. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

11. H.E.L.P. models include only fly ash layers. Section 3.1.4 of the report states that waste are predicted to include "approximately 70% fly ash and 30% bottom ash". This report also discusses the acceptance of Flue Gas Desulfurization (FGD) byproducts. Neither bottom ash nor FGD byproducts were included in any of the H.E.L.P. models. The H.E.L.P. models used default values for fly ash when some values, such as hydraulic conductivity, were tested for in Appendix J. Use the anticipated waste composition for modeling purposes. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

Leachate Storage and Conveyance

12. The leachate storage tanks have no capacities or sizes listed or illustrated in the drawings. The leachate storage tanks must be sized based upon the pumping rates of the sumps within the landfill, and the maintenance and inspection schedule or control systems for each. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

13. Leachate storage tank appears misplaced on Sheet 6. (General Engineering Comment)

14. The Leachate and Stormwater Forcemains are shown in the Exterior Berm without the depths noted. The forcemains must be installed at a depth to prevent freezing during cold weather conditions. Additionally, account for these forcemains being located in a berm above grade and the landfill will not have exothermic reactions. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.D.)

15. Due to the size of the cells, provide calculations to show the removal rate of leachate generated from a storm event during the first couple of weeks of filling. Justify the storm event, calculate the removal rate and describe disposal method utilized. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

Stormwater

16. The stormwater management plan for the site allows most stormwater to become contact waters and thus leachate. Based upon the stormwater management plan, no waters onsite will be allowed to discharge from the site and must be contained and treated as leachate. Additionally, a one-way valve rather than a gate valve alone would be required in the Stormwater Ponds (Leachate Ponds) to prevent leachate out of the ponds during the

equalization. These ponds will additionally need to be designed with a liner system which meets the requirements of MDNR's Solid Waste Management and Water Protection Programs for storing leachate (waste waters). The use of these waters will be limited to within the composite lined landfill area or for use as makeup waters within the power plant's future scrubber systems. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e.; 10 CSR 80-11.010(8)(B)1.F.(V); 10 CSR 80-11.010(8)(C)2. & 10 CSR 80-11.010(9)(C)2.)

17. The 25-year, 24-hour rainfall event is greater than 5.6 inches based upon the NOAA Atlas 14 Volume 8, Version 2 Point Precipitation Frequency Estimates. Increase the 25-year, 24-hour rainfall event to the recently revised amount. (Article 10, Section 238 C.3.; 10 CSR 80-11.010(8)(B)1.F.(III) & 10 CSR 80-11.010(9)(B)3.)

18. Section 4.1.2 Sequence of Phase Construction describes the construction sequence of each phase. The Phase 1 Construction Sequence doesn't discuss the timing of constructing the stormwater pond, but Phases 3 and 4 Construction Sequence discusses constructing the stormwater ponds after placing CCR in the phase area. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. (General Engineering Comment)

19. In 4.2.1 UWL Disposal Operational Description section, the perimeter ditches around each phase must not provide storage of stormwater but must be designed to rapidly convey stormwater to the stormwater ponds for storage. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(8)(B)1.F.(IV))

20. The perimeter ditches are designed with flat slopes. This may lead to standing water retained in these ditches which does not minimize infiltration. This design also may not empty expeditiously after storms. Additionally, this doesn't take into account the anticipated differential settlement. 10 CSR 80-11.010(8)(B)1.F.: "Provisions for surface water runoff control to minimize infiltration and erosion of cover. All Water Pollution Control Program permits and approvals necessary to comply with requirements of the Missouri Clean Water Law and corresponding rules shall be obtained from the department." 10 CSR 80-11.010(8)(B)1.F.(IV): "On-site drainage and channels shall be designed to empty expeditiously after storms to maintain the design capacity of the system." (Article 10, Section 238 C.3.; 10 CSR 80-11.010(8)(B)1.F. & 10 CSR 80-11.010(8)(B)1.F.(IV))

21. Since the perimeter ditches are designed with flat slopes, it would be difficult to estimate the amount of watershed area that would collect into the two separate ponds that serve Cells 3 and 4. The notes for Tables N-2 to N-5 state that "flows are split generally at half the distance between the entrances to the pond along the perimeter ditch." While this would seem like a reasonable assumption in theory, actual field conditions, subject to settlement and weathering, will probably not result in a perfectly flat ditch slope. Additionally, no consideration is given to the differences in times of concentration that would be present along the perimeter ditches due to the varying flow lengths down the final cover slopes. (General Engineering Comment)

22. On Sheets 5 and 7, show how the stormwater from Cell 2 will flow into the Stormwater Pond 1. (General Engineering Comment)

23. After closure, all stormwater should be routed through the stormwater ponds to reduce sediment loading rather than allowing the letdown structures to discharge over the exterior berms. (General Engineering Comment)

Berms

24. Interior berms filled with CCR must be constructed immediately after receiving the Operating Permit or Authorization to Operate due to placing waste within the landfill footprint. Additional CQA reporting will then be required for the construction of the interior berm and requires approval prior to placing CCR material onto it. (Article 10, Section 238 C.3.d.)

25. The design of the landfill has the interior berms exposed the same as the exterior berms during the filling of Cells 1 and 3, thus it is required to have the same protection as the exterior berms since they would be considered exterior berms during the filling of cells 1 and 3, prior to the construction of cells 2 and 4. (Article 10, Section 238 C.3.d.)

26. In the interior berms, the geomembrane needs to wrap back over the leachate collection and protection layers at the point of future tie in to prevent backed-up leachate from seeping through the exterior slope. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(C)2.)

27. Section 3.3.2.3 Franklin County Requirement – Erosion Protection in the Landfill Design discusses 2.2-inch thick fabric-formed concrete mats and Appendix K states that the exterior berm slopes will be lined with a 6-inch thick, fabric-formed articulated concrete mat. Section 9.0 Erosion Protection From Levee Overtopping of Failure in Appendix J provides a 56mm (2.2-inches) thick fabric-formed concrete mat such as Hydrotex FP220. The drawings include no dimensions. Revise all section and have the same dimensions listed for each. Additionally, add details to the drawings for the fabric-formed concrete mats. (Article 10, Section 238 C.3.d.)

Operations

28. The procedure for the placement of the first lift of CCR to prevent damage to the underlying layers needs to be developed and included in the operations section. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(2)(C)1.)

29. Flooding of the phase due to not having adequate CCR in place would need a contingency plan developed and included in the construction permit application. The inundation of the phase area would need to be equalized to prevent significant differential head on the liner. Additionally, the pumping down would need to occur relative to the floodwaters surrounding the phase as they recede to prevent a high differential head. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

30. The Solid Waste Excluded lists Major Appliances and Whole Waste Tires. Modify these to list as Any Appliances and Waste Tires. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(3)(A))

31. Dust suppression must be employed to prevent the migration of CCR offsite during all phases of construction, including mining activities, if and when allowed. (Article 10, Section 238 C.3; 10 CSR 80-11.010(12)(A) & 10 CSR 80-11.010(13)(C)1.)

32. Backup equipment or additional equipment is necessary more quickly than within 3 days due to the volume of waste generated. If a piece of equipment goes down, backup or replacement equipment should be in use within 24 hours. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(15)(B)1.)

33. Seeding to establish vegetation on the intermediate side slope cover needs to occur within a much shorter period than annually as provided in the Phases 1, 2, 3 and 4 Aesthetic Cover section. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(13)(B))

General Comments

34. The waste boundary should be reduced to allow the groundwater monitoring wells to be installed in the area of the DSI. If the wells are installed outside the area of the DSI, the data from the wells must be complied and correlated to existing DSI data and provided as an addendum to the DSI. (Article 10, Section 238 C.3; 10 CSR 80-2.015(1)(D) & 10 CSR 80-2.015 Appendix I)

35. Provide the approved design and drawings of the proposed underpass for Labadie Bottom Road and all approvals from the controlling authorities. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(4)(C)1.)

36. Sheet 8 appears to be missing leaders and detailed descriptions. Please update for further review. (General Engineering Comment)

Appendix D

37. Appendix D should be renamed "Violation History Disclosure Form" rather than the older language which has a negative connotation. (Article 10, Section 238 C.3 & 10 CSR 80-2.020(2)(A)2.I.)

Appendix H

38. The only document contained in Appendix H Floodplain Documentation is a review letter for the "Floodplain Analysis of the Missouri River for the Ameren Missouri Labadie Energy Center" by the Independent Registered Professional Engineer (IRPE). Please provide the additional documentation that was submitted to receive this letter from the IRPE. (Article 10, Section 238 C.3; 10 CSR 80-11.010(4)(B)1.)

Appendix J

39. The Table of Contents for Appendix J lists the Files on Enclosed CD. AEI was not provided the CD which includes the Files of the Printed Outputs from Computer Runs to review. We will need a copy of the computer runs of the revised report based upon the comment letters. (Article 10, Section 238 C.3 & 10 CSR 80-2.020(2)(A)2.B.)

40. Friction angles for the geomembrane/clay interface appear to be too high. The direct shear testing performed on the interface did not adequately displace the interface and the normal loads were low. The displacement testing should be on the order of inches and the normal stresses need to meet the full capacity of the landfill design. Additionally, at lower normal stresses, the critical interface may occur between the geomembrane and geotextile or geocomposite. All of the designs need to be analyzed to have the proper inputs for stability analysis. The bottom liner illustrated as detail 3/17 Bottom Liner and Leachate Collection Detail shows a smooth geomembrane, not a textured HDPE geomembrane as was tested and provided in Appendix A-1 of Appendix J. The interface friction angle (15 degrees) utilized in the Analysis and Design of Veneer Cover Soils, Figure E-42, is a more representative value for

textured HDPE geomembranes/clay interface. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

41. Friction angles in the stability analyses don't correspond to the testing on the CH clay liner material from the offsite borrow. Triaxial shear testing (CU) on the CH clay resulted in phi of 14.6 effective stress shear angle with cohesion near 0.21 tons per square foot. The effective friction angle used in the stability analysis for the compacted clay liner was listed as 25 degrees. Verify each input providing references for their values. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

42. The stability analysis failed to meet the required and recommended factor of safeties. Cross-section E-E' failed to meet the factor of safety of 1.5 for the static drained global circular failure surface both with the initial and full fill of CCP. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

43. The minimum factor of safety recommended by the draft technical guidance document from MDNR-SWMP and Stark is 1.2 to 1.3, not 1.1 as listed in Table E-2 Results of Slope Stability Analyses. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

44. Liquefaction has been determined to occur in multiple layers. When reviewing the post-liquefied shear strengths provided in the table for the stability analysis, they don't match the shear strengths from correlation charts based upon the SPT blow counts. The chart referenced in the Reitz & Jens report was H. Bolton Seed's 1987 chart. Seed and Harder updated this chart with additional information in 1990 and this chart is available with a 3rd Order Best-Fit curve to simplify the correlation. Please provide the graphed correlations providing the residual shear strengths based upon the SPT blowcount corrected for the percentage of fines. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

45. Liquefaction analysis is typically performed in the upper 50' of unconsolidated materials. Almost every boring was stopped at 35' in depth. Due to the lack of information from the 35' to 50' interval of the unconsolidated materials, provide a narrative justifying why liquefaction would not be anticipated at depths below 35'. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and

Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

46. The draft technical guidance document from MDNR-SWMP and Stark wasn't intended for designing landfills within a very young geologic age and active floodplain. Stability analysis for varying phases of filling is necessary due to the proposed location of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

47. Protective/drainage layers are missing from the stability analysis. Both designs need analyzed in the stability models if both are considered for permitting and construction. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

48. The boring B-100 is no longer centralized or even under a cell of the landfill. Other soil profiles should be analyzed to provide the critical Shake analysis. This will require additional borings to bedrock within the footprint of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

49. The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration = 0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

50. Provide the actual stability analysis for the deformation analysis and provide with a narrative rather than a table listing the yield accelerations and deformations for the short and long-duration events. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

46. The draft technical guidance document from MDNR-SWMP and Stark wasn't intended for designing landfills within a very young geologic age and active floodplain. Stability analysis for varying phases of filling is necessary due to the proposed location of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

47. Protective/drainage layers are missing from the stability analysis. Both designs need analyzed in the stability models if both are considered for permitting and construction. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

48. The boring B-100 is no longer centralized or even under a cell of the landfill. Other soil profiles should be analyzed to provide the critical Shake analysis. This will require additional borings to bedrock within the footprint of the landfill. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

49. The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration = 0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

50. Provide the actual stability analysis for the deformation analysis and provide with a narrative rather than a table listing the yield accelerations and deformations for the short and long-duration events. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

51. The Table of Contents for Appendix C Seismic Analyses appears to have C-18 & C-19 swapped with C-20 & C-21. Please revise and verify the information. (General Engineering Comment)

52. Settlement analysis demonstrates some differential settlement which could cause ponding in the flat stormwater channels, a reduction in the overall height of the berms and settlement of the base grades of the landfill. Each of these must be discussed including how Franklin County's regulations will be satisfied during all phases of construction, filling and closure. Additionally, the settlement analysis typically has a range of settlement that may occur due to variability in the underlying subgrade and must be conservatively considered in the analysis to prevent overtopping of the exterior and interior berms due to a 500-year flood event. (Article 10, Section 238 C.3; Article 10, Section 238 C.3d.i.; 10 CSR 80-11.010(5)(A)4.A & 10 CSR 80-11.010(8)(B)1.F.(IV))

53. Provide the calculations correlating the CPT test data to the elastic modulus utilized in the Settlement Analysis. The CPT logs which were provided in the DSI don't provide enough detail to verify the elastic moduli provided in the settlement analyses. Additionally, heavily loaded conditions decrease the modulus, so these factors need to be accounted for relative to their location within the footprint of the fill. The Bowles 1997 reference appears to be dated and newer, more precise correlations are widely available which utilize the normalized cone resistance and normalized friction ration. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

54. Calculate the bearing capacity of the subgrade in varying locations throughout the footprint. Additionally, calculate the bearing capacity during a maximum credible seismic event which induces liquefaction during each phase of construction and filling of the landfill. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

55. The protection of liner from hydrostatic uplift discusses the flooding with the gravel drainage layer and sand protective layer. The alternate design with the geocomposite drain and protective sand layer must also be discussed in the flooding scenarios. (General Engineering Comment)

56. In Appendix G – Design of Fabric-Formed Concrete Mat (FCM), the factor of safety calculation has a missing value, t (= 0.183 ft) in the numerator after substitution:

$$F.S. = \left[\frac{\mu(t)(\gamma_c - \gamma_w)\cos\theta\cos\propto - \tau_{DES}}{\sqrt{[t(\gamma_c - \gamma_w)\sin\theta]^2 + \tau_{DES}^2}}\right]$$

$$F.S. = \left[\frac{0.637(130\,PCF - 62.4\,PCF)\cos(18.435°)\cos(0°) - \tau_{DES}}{\sqrt{[(0.183')(130 - 62.4)\sin 18.435]^2 + \tau_{DES}^2}}\right]$$

This reduces the value of the maximum design velocity significantly. Update the calculations with the thickness of the fabric-formed concrete included. (General Engineering Comment)

Appendix O

57. The filter design basis in the Memo from Bruce Dawson, PE to Gredell Engineering Resources, Inc, included in Appendix O-1, requires a tighter gradation for the sand protective layer based upon the R15 provided. The D15 for the sand should range from 0.24 mm to 0.8

mm based upon the D15 of the Fly Ash and the R15 provided from the Peck Hanson Thornburn filter criteria. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(9)(B)1.D.)

Appendix P

58. The Construction Quality Assurance Plan inadequately addresses the requirements in 10 CSR 80-11.010(6)(B)1.A. "A detailed description of the QA/QC testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;" Specifically, this section should include tables showing the frequency and acceptable test result values for each testing procedure. The Air Pressure Testing of seams cannot allow a drop of 4 psi during the 5 minute test. It must not drop more than 10% of the equalized pressure of at least 25 psi. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(B)1.A.)

59. Appendix P Construction Quality Assurance Plan section 3.2 Test Pad references the Demolition Landfill regulations. Please revise to reference the appropriate regulations. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(10)(C)1.)

60. In section 3.5 Quality Assurance Monitoring and Testing, the following statement must be omitted since there is no justification of the reduced testing frequency. "If liner quality soils are stockpiled on site prior to the beginning of placement, a reduced frequency of verification testing will be requested." (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(C)1.)

61. A log of soils should be maintained for soils brought in from offsite. The log should provide the testing performed and the intended use on site. This will assist in construction planning for each cell construction. (General Engineering Comment)

Appendix V

62. Need a full size Survey Plat for review of Appendix V. (General Engineering Comment)

Appendix Y

63. In Appendix Y(a) Leachate Pipe and Pump Calculations, the leachate storage tank is listed as a 12-ft diameter horizontal tank. The drawings provided for the site have a vertical storage tank shown without any detail drawings for the storage tanks. Provide a detailed drawing for the storage tanks and the anticipated operations of the tanks to prevent them from exceeding capacity. Provide the pump details for the pumps within the leachate storage tanks. This should be included in the leachate management plan. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

64. In Appendix Y(a) Pipe Capacities, the flow capacity calculation in this section was miscalculated by a factor of 10:

$$Q = \frac{1.49}{.009} \times 0.156 \times 0.111^{2/3} \times 0.005^{1/2} \neq 4.2\, cfs$$
$$= 0.42\, cfs$$

(Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B))

65. In Appendix Y(a), the Leachate Pipe Crushing and Buckling Scenarios, Scenario 1 provides an H20 truck in the analysis. This size of truck is normal for highway use but it is anticipated based upon the amount of CCR being deposited that the size of the equipment and tire loads could be greater. Scenario 3 uses a live load of a 3 ton skid steer on the sump riser trench with one foot of CCR placed over the top of the sump riser trench. In all likelihood, this loading would occur prior to the placement of the CCR and the geotextile, and would be used to place the clean gravel. Additionally, Scenarios 1 and 3 drawings appears to be in error that CCR would be placed as the protective cover over the geocomposite drainage. Please revise these drawings and recalculate with the proper loading. It also appears that the pipe values were not reduced due to the perforations in Scenarios 1 and 2. Density of waste is listed as 75 pcf. Testing results in Appendix J report higher densities for CCPs. A density of 93 pcf is assumed in calculations in Appendix Y(d). (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

66. In Appendix Y(c) – Water Management Calculations, the second paragraph of the concluding statements reads "Backup leachate management will be at an offsite POTW." The permit should specify which POTW will manage the leachate as backup and a signed agreement pertaining to this management should be included. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)4.)

67. In Appendix Y(d) – Flood Mitigation Calculations, Pumping Rates for Flood Water Protection – Cell 3, the concluding statement reads, "A pumping rate of 13,194 gpm, pumping 24 hours per day, is required to fill Cell 3 in 10 days for 100-year flood protection." The source and location of the required water supply, as well as the necessary equipment for pumping should be specified. (General Engineering Comment)

68. Included in Appendix Y(e), the clay/geomembrane interface for the side slope cover material stability calculates with a factor of safety of 1.46, below the 1.5 as stated. The interface friction angles used for the clay and geomembrane are stated to be taken from Table 5.6 and Table 5.7. Analysis and Design of Veneer Cover Soils is included in Appendix J with an interface friction angle of 15 degrees. In hand written calculations provided in Appendix Y(e), the factor of safety for CCR to geomembrane is calculated as 1.2 in static conditions. Provide a detailed narrative with additional calculations to support the provided calculations and how they relate to each other. If the fly ash were to be utilized as being in intimate contact with the geomembrane with moistures approximately five percent over optimum, this interface would need laboratory testing as part of the demonstration for an alternative final cover system and included in the stability analysis. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.D.)

69. In Appendix Y(e), the attached printout for the 60 mil Geomembrane has 23.00 kN/m provided as the Allowable Force in Geosynthetic, TDESIGN. The valve for the Strength at Yield in the GSE Product Data Sheets has 22 N/mm. Update the value in the printout. (General Engineering Comment)

Ameren Missouri
Labadie Energy Center
Response to April 22, 2013
Franklin County IRPE Comments

July 8, 2013

Prepared By:

Reitz & Jens, Inc.
1055 Corporate Square Drive
St. Louis, Missouri 63132
(314) 993-4132

and

GREDELL Engineering Resources, Inc.
1505 East High Street
Jefferson City, Missouri 65101
(573) 659-9078

Ameren Missouri
Labadie Energy Center
Response to April 22, 2013
Franklin County IRPE Comments

July 8, 2013

Table of Contents

Ameren Missouri
Labadie Energy Center
Response to April 22, 2013
Franklin County IRPE Comments

July 8, 2013

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

This report has been prepared in response to comments developed by the County's Independent Registered Professional Engineer (IRPE) in a report entitled, "*Groundwater Monitoring Application Review, April 2013*". The IPRE report constituted a review and critique of the basis for the detection groundwater monitoring system as presented in a document entitled, "*Documentation of Groundwater Monitoring System Design*". That document, written by GREDELL Engineering Resources, Inc. (Gredell Engineering), is included as Appendix X to the Construction Permit Application (CPA) for the Ameren Missouri Labadie Energy Center Proposed Utility Waste Landfill, which is under review by the County as of the date of this report. Appendix X along with supporting information contained elsewhere in the CPA (Appendix Q - Groundwater Sampling and Analysis Plan and Appendix W – Groundwater Hydraulic Data) was part of a January 3, 2013 submittal to both the Missouri Department of Natural Resources Solid Waste Management Program (MDNR-SWMP) and the County that predated submittal of the entire CPA document on January 29, 2013. The information included in Appendix X was presented at a level of detail sufficient to allow review and evaluation by MDNR personnel, including elements of the SWMP, Geological Survey Program (GSP), and Water Protection Program (WPP). Appendix X and the proposed detection groundwater monitoring system were approved by MDNR on March 7, 2013. Subsequently, the detection groundwater monitoring system was installed as approved around the perimeter of the proposed UWL facility from mid-March through mid-April 2013.

Comments made in the IRPE report suggest both a technical and philosophical disagreement with several elements of the detection groundwater monitoring system accepted by MDNR. Some of the technical concerns appear to be the result of what the IRPE considered incomplete documentation of the modeling approach used to develop the groundwater system design as presented in Appendix X, which limited their ability to conduct a comprehensive evaluation of the data presented. Other technical aspects are more fundamental and derive from what is best characterized as professional differences of opinion concerning the choice of basic model parameters used in the development of the current system. Philosophically, differences in opinion also exist concerning the adequacy of the site-specific investigative process (i.e. Detailed Site Investigation, or DSI) on which the system was based, the intent of the system as designed (a Detection Monitoring System), and the consideration of existing ash impoundments, which are outside the regulatory requirements of the current UWL solid waste permit process.

The responses presented below are intended to address key points raised in the IRPE report. Philosophical comments are addressed in the following subsections. Relevant technical comments are addressed in the remainder of this document.

1.1 Basis for Groundwater Monitoring Design

A fundamental difference of opinion exists concerning the adequacy of the site-specific geologic and hydrologic data on which the current detection monitoring system is based. The IRPE identifies apparent deficiencies in the data collected as contrary to regulations cited under 10 CSR 80-11.010(11) and makes the representation that such omissions result in non compliance with MDNR's regulatory process as described under Missouri Solid Waste Management Law and Rules and as implemented by MDNR-SWMP and MDNR-GSP .

The groundwater monitoring system developed for the Labadie UWL is a direct outgrowth of the geologic and hydrologic data gathered during the Detailed Site Investigation (DSI) conducted at the site in 2009-2010. The requirements for completing the DSI process are described in 10 CSR 80-2.015(1)(B), (C), and (D). This process is generally as follows:

1. Initially, a work plan development meeting must be held with the MDNR-GSP. MDNR-SWMP representatives also are in attendance. Discussion must focus on the geology and hydrology of the proposed site, specific elements to be included in the DSI work plan, time frames for completion of the work, and review of the regulatory process.

2. Following that meeting, a detailed work plan is developed for review and approval by the MDNR-GSP with input from MDNR-SWMP. It must be based on the requirements 10 CSR 80-2.015 Appendix 1, "*Guidance for Conducting and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid-Waste Disposal Area*" (commonly referred to simply as the "Guidance").

3. After the work plan is approved, a field investigation must be completed in accordance with the approved work plan, applicable rules, and department guidance. The "Guidance" document also details the specific elements to be included in the DSI report, which is then submitted to the MDNR-GSP and MDNR-SWMP for review and approval.

Approval of a DSI report by both the MDNR-GSP and MDNR-SWMP indicates that a site is found to have suitable geologic and hydrologic characteristics for the development of an environmentally sound solid waste disposal area. Approval also indicates that the DSI report adequately addresses geologic or hydrologic conditions that can be overcome by engineering pursuant to 10 CSR 80-11.010(5)(A)3 for the development of an environmentally sound solid waste disposal area. This is a rigorous and thorough regulatory process and is accompanied by two separate public participation events as required by Solid Waste Management Law.

The Ameren Missouri Labadie Energy Center Proposed Utility Waste Landfill was subject to the DSI process described above. All elements of the DSI work plan, field investigation, final report, and public participation requirements were conducted and completed to the satisfaction of both the MDNR-GSP and MDNR-SWMP, as evidenced by their approval of the final DSI report on April 8, 2011. To suggest that relevant parts of this process were overlooked or ignored without due consideration of their applicability is simply not an accurate portrayal of the regulatory process.

1.2 Detection versus Compliance Monitoring Systems

A second recurrent theme in the IRPE report is a reliance on various water quality standards and waste-specific chemical parameters and concentrations to make representations concerning the effectiveness of the current system at a point of compliance (e.g. property line). Understanding the intent of the required detection monitoring system as described in 10 CSR 80-11.010(11)(C)4. and as presented in Appendix X is essential to understanding the groundwater monitoring system developed at the Labadie UWL. The approved system at Labadie is not a compliance-based system. Rather, as described in 10 CSR 80-11.010(11)(B)4.B., the number, locations, and depths of the groundwater wells were designed to, "*...ensure that they detect any significant amounts of fluids generated by the UWL that migrate from the UWL to the groundwater*". Detection of "*any significant amounts of fluids*" is accomplished through statistical comparisons of groundwater analytical data to determine if statistically significant increases (SSIs) through time are occurring for any of the 32 required monitoring parameters listed in 10 CSR 80-11.010 Appendix I.

Compliance monitoring systems assume a specific standard (e.g. Federal MCL's, State Groundwater Protection Standards) must be met, generally at a property boundary. Detection monitoring is a precursor to compliance monitoring because it examines SSIs in water chemistry through time irrespective of absolute chemical concentration or compliance with specific standards. If statistical evaluations reveal an increasing concentration over time for one or more of the required analytical parameters, then a demonstration must be made to MDNR in accordance with 10 CSR 80-11.010(11)(C)6 that a source other than the UWL caused the SSI or that the SSI is the result of an error in sampling, analysis, statistical evaluation, or natural geospatial variation.

If a demonstration cannot be made that the statistical increase is not due to the UWL, then Assessment Monitoring is required by regulation. Assessment monitoring includes the installation of additional wells, an increased frequency in sample collection and analysis, and an evaluation of the rate and extent of migration of the contaminant plume, including documentation of contaminant concentrations. It is during the assessment monitoring process that comparisons to groundwater protection standards are required and in that sense the additional wells installed essentially create a compliance-based system. Most of the comments presented in the IRPE report would be addressed during the assessment phase, which is a separate and distinct process from the development and implementation of the detection groundwater monitoring system required by MDNR regulation.

The detection monitoring system presented in Appendix X of the CPA is better understood by reference to Figure 1 of this report. This figure was not included in Appendix X. It visually illustrates the derivation and selection of the spacing criteria for the down gradient wells, as described on pages 5 and 6 of Appendix X, by showing the dispersion plumes in relationship to one another and to solid waste disposal boundaries. The dimensions of the dispersion plumes, which are the same as those presented in Attachment 3 of Appendix X, are based on a 44-year (528 months) time period. These plumes demonstrate a high degree of probability for detecting contaminant plumes along the eastern and northern (i.e. down gradient) perimeters of the proposed UWL using the baseline model parameters described in Appendix X.

1.3 Existing Ash Impoundments

The third philosophical difference is related to the compliance aspects mentioned above and is the consideration of regulatory issues outside the requirements of 10 CSR 80-11. Specifically, the IRPE has included comments specific to the existing ash impoundments at the Labadie Energy Center and the impact of the impoundments on current groundwater quality based on an assumption of leakage since 1992 (e.g. refer to comments 11 and 12 of IRPE's Attachment 1). These comments also appear to form the primary basis for the IRPE's conclusion that deeper monitoring wells are required at the UWL facility that has not yet been constructed. These IRPE comments apply to a regulatory process subject to Missouri Clean Water Commission jurisdiction and consequently are not a matter specific to the solid waste permit process involving the proposed UWL. Existing groundwater quality in the recently installed detection monitoring well system has and will continue to be documented throughout the background monitoring period (eight rounds of quarterly data). Possible impacts on up gradient groundwater quality, if any, that could be attributable to other existing sources, will be evaluated at the end of the background monitoring period, which is scheduled for completion in early 2015.

Ameren has noted that they are currently in the process of renewing their NPDES permit for the Labadie Energy Center. This regulatory process will require the installation of ground water monitoring wells to evaluate the existing impoundments.

2.0 SOURCE WIDTH

Section 2.1 of the IRPE report describes the use of a 100-foot source width as representative of a catastrophic failure in the liner system and further suggests that a failure of this magnitude is unlikely. The IRPE considered that minor "tears" in the liner system of five feet or less were more likely to occur. Data is presented showing the effect a smaller source width has on dispersion plume dimensions. The data presented by the IRPE indicate that for a smaller source width (i.e. 5-ft, 10-ft, and 20-ft "tears") both the length and width of the dispersion plume is less than that for a 100-foot "tear". The width of the plume generated using a five-foot "tear" is noted as 41 percent narrower than the width of the plume generated using a 100-foot "tear" (using a 180-ft measure of dimension that presumably reflects the distance between the proposed well placements north of Cell 2 and the assumed edge of the waste placement boundary).

We have re-evaluated the dispersion plumes using the original model parameters presented in Appendix X of the CPA except for source width. Source widths (initial liner "tears") of five feet and 25 feet were assumed. PLUME model outputs showing the resultant dimensions for each modeling scenario, including the original 100-foot source width, are presented as Figures 2 through 7. The PLUME model outputs shown in Figures 2, 3, and 4 pertain to Cell 1 and 2. The PLUME Model outputs shown in Figures 5, 6, and 7 pertain to Cell 3 and 4. The dimensions for each modeling scenario are summarized in Table 1. Resultant plume widths are based on the average distance between proposed wells and the edge of waste, which is defined as the inside toe of the containment berm around the waste disposal cells.

The results of this re-evaluation also concluded that a smaller initial source width results in a slightly shorter dispersion plume and a more pronounced narrowing of the dispersion plume width. For comparison, the difference in plume length between the 100-foot and five-foot "tears" is between 5 and 6 percent. The difference in plume width is between 38 and 39 percent.

The effect a narrower plume from a five-foot "tear" has on the MDNR-approved groundwater monitoring system is graphically illustrated on Figure 8. For each well location, the dispersion plumes generated for the five-foot "tears" (Figures 4 and 7) have been superimposed (in green) on the dispersion plumes for the 100-foot "tears". Lines drawn tangentially from the widest part of each "five-foot" dispersion plume are shown extending into the solid waste area until they either intersect or the inside toe of slope is reached. These triangular shapes provide an estimate of the area where a failure in the liner system could escape detection by the approved and installed groundwater monitoring system. The sum of these areas is approximately ten percent of the total proposed disposal area of 166.5 acres.

3.0 LONGITUDINAL & TRANSVERSE DISPERSIVITY

The groundwater model approach used to determine longitudinal and transverse dispersivity values was developed in response to the data obtained during the 12-month DSI time period (December 2009 to November 2010). During that period, groundwater flow direction fluctuated widely in response to changes in Missouri River elevation. Groundwater movement generally was north-northwestward toward the Missouri River during periods of low river stage and generally shifted eastward away from the river during periods of high river stage. These changes in flow direction commonly occurred from month-to-month during the DSI time period with a 90 degree shift in groundwater flow documented over the span of one week in May 2010. The overall effect imposed by the Missouri River on groundwater movement is not unlike the ebb and flow of water in the tidal zone of an ocean beach. This "swash" effect is not uncommon in alluvial aquifers and conventional modeling literature emphasizes the need to acquire as much site-specific data as possible because of the "profound influence" such variations can have on contaminant transport (Wiedemeier et al., 1998). However, conventional modeling techniques do not account for the degree of variation observed during the 12-month DSI time period and for that reason the method of analysis used a multidirectional aspect of groundwater flow to develop an overall detection groundwater monitoring system.

An expanded discussion of the approach used to derive longitudinal and transverse dispersivity values is provided in Appendix 1. It is based on the concepts and techniques cited in Freeze and Cherry (1979), Gelahar et al., (1992), Wang and Anderson (1982), and Wilson et al., (1992).

4.0 OTHER MODEL CONSIDERATIONS

As stated in Section 1.0 of this response, the IRPE report references several concepts or opinions having relatively minor impact on the final model results or the IRPE makes recommendations that are not well supported by detailed calculations or documentation. Section 2.0, Source Width, and Section 3.0, Longitudinal & Transverse Dispersivity, address two topics described in the IRPE report that have a minor impact on the final model results. This section addresses other specific topics or recommendations made by IRPE that do not warrant individual detailed response.

4.1 Source Concentrations

We recognize the need for reasonable, site-specific source concentrations in modeling the impact from a known, contaminated site (e.g. a leaking underground petroleum storage tank) to forecast the potential time of travel, concentration, and impact of contaminant plumes on adjacent properties and/or existing groundwater uses. However, the intent of the PLUME model used for the Labadie UWL is to develop hypothetical plume shapes and sizes for the purpose of designing and evaluating a DETECTION GROUNDWATER MONITORING SYSTEM. The IRPE acknowledged that the PLUME model does not require or allow the entry of a source concentration – therefore the choice of an initial source concentration does not impact the PLUME model and does not impact the overall shape, length, or width of the resultant plume developed by the model.

The IRPE agreed with the use of the PLUME model, which develops a plume shape represented by "concentration contours" that are a percentage of the initial source concentration. In this case, "concentration contours" of one-tenth (0.1), one-one hundredth (0.01) and one-one thousandth (0.001) of an initial source concentration were modeled. Primarily for illustrative purposes, we chose to use an initial source concentration of 3,000 mg/l for the contaminant, Chloride, in the original model. Chloride was chosen as a contaminant that can be expected to be present in the UWL at some concentration, is recognized by the scientific community as mobile in groundwater flow regimes, and is commonly used as a conservative "tracer" contaminant. The following excerpt supports the use of Chloride (Wiedemeier et al, 1998):

> *Chloride (Cl-) forms ion pairs or complex ions with some of the cations present in natural waters, but these complexes are not strong enough to be of significance in the chemistry of fresh water. Chloride ions generally do not enter into oxidation-reduction reactions, form no important solute complexes with other ions unless the chloride concentration is extremely high, do not form salts of low solubility, are not significantly adsorbed on mineral surfaces, and play few biochemical roles. Thus, physical processes control the migration of chloride ions in the subsurface. Because of the neutral chemical behavior of chloride, it can be used as a conservative tracer to estimate biodegradation rates (in chlorinated solvents).*

The plume shape defined by the outermost 0.001 concentration contour was used as the basis for the number and location of groundwater monitoring wells that would result in a highly efficient detection monitoring system. The initial source concentration (in this case, 3,000 mg/l Chloride) was used to provide a numerical value for the 0.001 concentration contour (3 mg/l) that generally approximates the Practical Quantitation Limit (PQL) of Chloride.

Modeling is a hypothetical exercise, albeit a scientific one. Modeling using scientific parameters is the best available predictor of future performance of landfills. However, an actual source concentration from a POTENTIAL FUTURE LEAK from a UWL with a composite liner and leachate collection system cannot be predicted. The "leak" may be very small (the HELP model uses 2 centimeter diameter holes in the geomembrane liner, not a 5-foot tear) or it may be very minor volumes (the HELP model predicts that the maximum head on the Labadie UWL composite liner will be less than 1 inch). Therefore, despite the actual contaminant concentrations in the "leak", the contaminant will be diluted once it reaches the large volumes of groundwater within the alluvial aquifer of the Missouri River valley. As a result, an estimated source concentration was used for illustrative purposes that may represent a "worst case" scenario, while the source concentration of an actual event could be higher or lower than the concentration modeled.

It is our professional opinion that initial source concentration is a minor factor in the design of a DETECTION GROUNDWATER MONITORING SYSTEM and its value is primarily used to model only one of many possible scenarios. Regardless of the source concentration, the PLUME model predicts the size and shape of a future contaminant plume as defined by the 0.001 concentration contour. Depending on the source concentration and analytical limitations, a specific contaminant may not be detected at one-one thousandth of the initial concentration. Under the current Missouri regulatory framework for detection monitoring of landfills, the use of "indicator" or "tracer" parameters and the regular statistical evaluation of groundwater data for SSIs seeks to identify potential containment system failures at small quantities and concentrations as soon as they can be practically detected, but before they exceed a compliance concentration (typically at the property boundary).

4.2 Deep Wells

The IRPE report recommendation to install five "deep" wells (i.e. to the top of bedrock) is unsupported by the data presented. As previously noted, this recommendation appears to come from concerns with potential contamination from existing ash impoundments at Labadie. However, the recommendation also appears to be based on the potential for vertical migration of a contaminant plume emanating from the proposed UWL prior to detection by the groundwater monitoring system approved by MDNR. Vertical migration of contaminants is a concept most often associated with immiscible organic chemical compounds, some with specific gravities greater than water ("sinkers") and some with specific gravities less than water ("floaters"). The chemical constituents of CCPs are primarily metals and inorganic chemical compounds that naturally occur in the coal used in the combustion process. The list of detection monitoring parameters required by MDNR (10 CSR 80-11.010, Appendix I) focus on these inorganic parameters, which generally are in a dissolved phase and do not sink through the water column.

The groundwater transport model presented in Appendix X of the CPA considered the vertical component of dispersion insignificant "*because contaminant concentrations are assumed to be preferentially moving parallel with groundwater flow direction*" (p. 5). This assumption is confirmed by previous studies, particularly the work by Gelhar et al. (1992), who after review of multiple field studies determined that, "*In all of these cases, vertical transverse dispersivity is 1-2 orders of magnitude smaller than the horizontal transverse dispersivity*".

The data presented by Gelhar for what was considered high reliability field studies show vertical-to-horizontal dispersivity ratios greater than two orders of magnitude (see Gelhar's Table 1, data for the Garabedian et al. (1988) and Rajaram & Gelhar (1991) field studies). These data suggest that for every foot of vertical movement, the horizontal movement is in excess of 100 feet and possibly in excess of 600 feet. Thus, modeling a maximum width for the Labadie UWL of approximately 3,000 feet (Cell 3 as measured southeast to northwest) and an alluvial aquifer thickness of approximately 100 feet, the horizontal movement of groundwater will transport potential contaminants toward the approved detection monitoring system well in advance of contaminant conveyance and detection in deep wells. If assessment monitoring is needed at the site in the future, the concept of deep wells should be considered.

On these bases, we believe the recommendation for deep wells is without justification and do not agree that they are needed as part of the detection groundwater monitoring system.

4.3 Effective Porosity

The IRPE report demonstrates that use of a lower effective porosity value (0.265) results in a slight increase in plume length and virtually no change in plume width with respect to the effective porosity value (0.35) used in Appendix X. The same holds true when comparing the results for the five-foot source width shown in the two tables on page 3 of the IRPE report. We concur with IRPE's conclusion that effective porosity values have a minor impact on plume width, but that source width considerations have a much greater impact on the dispersion plume width. The range of effective porosity values presented in Table 1 of Appendix X (0.30, 0.35, and 0.40) are the same values as used in Table 8 of the DSI Report and are based on the data of Peck (1953) for mixed-grain sands. Our model uses the middle value. The grain sizes, and therefore the geometry of the pore apertures and the degree of interconnectivity of pore throats that define effective porosity found in an alluvial aquifer can vary considerably across the site. For purposes of designing a detection monitoring system, there is little apparent benefit to further refining the effective porosity value.

4.4 Contaminant Breakthrough Time

The IRPE estimated the time it would take contaminants to migrate through a compacted clay liner should a rupture occur in the overlying flexible membrane liner system. Their calculations suggest a contaminant breakthrough time of between 47 and 848 days assuming an effective porosity value of 0.06 for the compacted clay. Given that the IRPE agrees with the use of a 44-year time period (16,060 days) in the PLUME model, the breakthrough times are comparatively insignificant and were not considered in our model approach.

4.5 Southeastern Shallow Wells

The IRPE recommends the installation of three wells (P7, P8 and P9) near the southeast corner of Cell 3 without detailed explanation. Based on the information presented in their report, we conclude this recommendation is primarily based on the IRPE's misconception that the 813-acre permit boundary is also Ameren Missouri's property boundary (see Figure 3 of the IRPE report). This coupled with the IRPE's opinion that the groundwater monitoring system should be a compliance system, instead of a detection system has led to their recommendation for additional wells at the southeast corner of the UWL. In reality, the actual property boundary is over 1,200 feet east of the easternmost edge of Cell 3.

Furthermore, the locations of proposed wells P7 and P8 appear to "shadow" the current locations of MW-15 and MW-16 for the resultant predicted northeasterly direction of flow. Using a more northerly direction of flow as preferred by the IRPE (reference Section 5.0 of this report), the additional wells provide no apparent improvement to the current detection monitoring system.

The location of proposed well P9 appears to fill a perceived "gap" between MW-16 and MW-17 using the resultant predicted northeasterly direction of flow and is located very close to the permit boundary. Again, using the northerly direction of flow preferred by the IRPE, the addition of P9 provides no apparent improvement to the current detection monitoring system.

For these reasons, it is our professional opinion that adding P7, P8, and P9 does not improve the performance of the groundwater detection system at the Labadie UWL and consequently they do not need to be added.

5.0 EVALUATION OF ALTERNATIVE FLOW DIRECTION

Subsection 2.4 of the IRPE report summarizes the sensitivity analyses described in subsections 2.1, 2.2, and 2.3. These analyses are summarized at the top of page 7. This data suggests that using a 5-ft source width in combination with alternative values for effective porosity and longitudinal/transverse dispersivity, a plume length of 2,125 feet is generated over the proposed 44-year (528 months) time period. This result is graphically illustrated in Figure 1 of the IRPE report. Although not specifically stated by IRPE, a plume length of this magnitude appears to be based on an assumption that groundwater flow direction is constant throughout the 44-year time period. Plume length is also magnified by use of an average contaminant velocity of 3.060, more than triple the value (1.013) used in our model (see Figures 2, 3, and 4). Assuming the plume generated by IRPE is based on a higher velocity and a continuous direction of flow for 44 years, the result is not an accurate representation of the behavior of the alluvial aquifer and its response to changes in Missouri River elevation. Our dispersion plumes are modeled based on the back-and-forth motion of groundwater as determined during the 12-month DSI time period, which has been viewed by IRPE as "atypical" and not representative of normal site conditions (e.g. refer to comments 9 and 10 of IRPE's Attachment 1). The IRPE's opinion is not supported by review of historical Missouri River elevations for the past 13 years.

Our modeling approach presented in Appendix X of the CPA was based on the results of the 12-month DSI time period. Those data show that groundwater exhibits considerable variation in flow direction in response to changes in Missouri River elevation. During periods of low river stage, groundwater generally flows north-northwest toward the river. During periods of high river stage, groundwater flow shifts eastward away from the river. This "swash" effect on groundwater movement and resultant velocities was accounted for in our modeling approach (reference Section 3.0). This explains why plume lengths are considerably shorter than the plume lengths predicted on the summary table presented on page 7 of the IRPE report. This also explains why plumes are wider than the plume widths predicted on the IRPE's summary table.

The representativeness of Missouri River levels and their consequent impacts on groundwater flow behavior during the 12-month DSI time period in relationship to the preceding ten-year time period (2000-2009) is described on page 40 of the DSI report. The DSI recognized that Missouri River levels generally were higher during the DSI than in preceding years and is the reason why one of the conclusions stated in the DSI report (p. 52) was, "*..."unwatering" of the local water table toward the Missouri River may be more prevalent than what is suggested by the current data*". Thus, the DSI acknowledged that the 12-month DSI timeframe (2009-2010) on which our modeling effort was based coincided with a period of unseasonably high river levels and consequently, the DSI data do not positively predict groundwater behavior under "normal" river stage conditions. However, the DSI data does provide a basis for understanding how groundwater movement behaves under more seasonal river stage conditions.

In the absence of piezometric data during periods of "normal" river stage conditions, it is not possible to accurately model or predict the resultant impacts on groundwater movement. However, general conclusions can be made by extrapolating piezometric readings during the 12-month DSI investigation to the historical river elevation readings as recorded at the Labadie Power Plant gauging station.

Figure 9 is a hydrograph depicting the daily Missouri River elevations as obtained from Ameren personnel for the Labadie gauging station. The figure is identical to the hydrograph presented as Figure 32 of the DSI report except for the addition of data from 2011-2013. As noted on page 40 of the DSI report, a reversal in groundwater flow direction appears to occur when Missouri River levels attain a more or less sustained elevation of between 461 and 463 feet. Groundwater flow direction generally is toward the river below this range in elevation and generally moves away from the river above this range in elevation. As can be seen from the hydrograph, using a midpoint elevation of 462 feet, groundwater movement toward the river is predicted to occur more frequently in the timeframes both before and after the 12-month DSI time period. The hydrograph also indicates that the longest sustained period of time river elevations remained below 462 feet is approximately 678 days. Conversely, the hydrograph indicates that the longest sustained period of time river elevations remain above 462 feet is approximately 166 days. This suggests that groundwater movement typically has a more northerly component than evidenced by the data acquired during the DSI timeframe and that the maximum length of time before a shift from this northerly flow occurs is slightly less than two years. Sustained periods of high river flow are of shorter duration (<6 months), which supports the modeled impact the "swash" effect has on groundwater velocity values.

An evaluation of what constitutes more typical river flow conditions can be approximated by considering the average or mean value of the daily river elevations as measured over the 2000-2013 period at Labadie. This is shown in the frequency histogram presented as Figure 10 that indicates the mean river elevation over the 13-year (4,817 days) time period is 454.9 feet. This is approximately seven feet lower than the estimated elevation (462 feet) at which groundwater begins moving toward the Missouri River and is further evidence that a northerly flow component is more frequent than shown by the data acquired during the DSI. The longest time period the river remains below this typical flow condition is approximately 309 days (Figure 9).

A similar analysis of the Labadie gauging station data was made in Appendix Z of the CPA. However, the purpose of that analysis was to determine a "natural water table" elevation for the liner design and the focus was on the relationship between elevated groundwater levels and gauge data rather than an assessment of typical river flow conditions.

Based on a more northerly component of groundwater flow (toward the Missouri River) as suggested by the 13-year historical time period of river stage analysis, we graphically re-evaluated the northern tier of wells in the approved detection monitoring system, located immediately north of Cell 2. The results of this re-evaluation are presented in Figure 11. For the purposes of demonstration, a northerly orientation perpendicular to the solid waste boundary was selected for the axis of the dispersion plumes (a plume axis perpendicular to the solid waste boundary requires the narrowest well spacing). The dispersion plumes used are based on the five-foot source width as shown in Figures 4 and 8. All other model parameters were unchanged. Proposed well locations depicted in Figure 3 of the IRPE report are also superimposed for reference.

As diagramed in Figure 11, as many as seven well locations would be required to achieve full efficiency of the detection monitoring system using the noted plume dimensions for this more northerly flow direction. However, existing wells MW-1, MW-2, and MW-3 are within the boundaries of three of the dispersion plumes. Using the more northerly direction of groundwater flow, our evaluation is in general agreement with adding the western four of six wells suggested by the IRPE report (except the IRPE wells are further away from the edge of waste).

The remaining down gradient wells in the approved detection monitoring system (MW-5 through MW-22) were not graphically re-evaluated using a more northerly direction of groundwater flow. The northwest to southeast orientation of MW-5 through MW-15 along the eastern boundary of Cell 3 predetermines that they will provide a high efficiency detection monitoring system for a more northerly groundwater flow direction because of the relatively close well spacing in the east-west direction. Wells MW-16 through MW-22 are east or south of the solid waste boundary of Cells 3 and 4. Therefore, during a more northerly direction of groundwater flow, these wells will either be "up gradient" of the solid waste disposal area or east of a potential contaminant plume.

6.0 SUMMARY AND CONCLUSIONS

The groundwater model design presented in Appendix X of the CPA for the Labadie Energy Center Proposed Utility Waste Landfill is based on the results of the DSI investigation conducted for the facility in 2009-2010. The DSI included an evaluation of groundwater flow based on measurements taken from 100 piezometers over a period of 12 consecutive months (December 2009 to November 2010). These site-specific data are considered appropriate for the development of a rational, scientifically based groundwater well design intended specifically as a detection monitoring system as required by Missouri State Solid Waste Management Law and Rules. The detection monitoring system has been approved by MDNR-SWMP, in conjunction with joint review by MDNR-GSP and MDNR-WPP.

Modeling is a subjective process and is used as a tool to evaluate the potential efficiency of a detection groundwater monitoring system. Model parameters can be adjusted based on various assumptions and the desired degree of conservatism, with the end result being a monitoring system design that is not expected nor required to be 100 percent efficient. Rather, the intent of the modeling process is to support the development of a detection monitoring system that is considered "highly efficient" (no regulatory definition for "highly efficient" exists in Missouri State Solid Waste Management Law and Rules).

In response to the IRPE review report, Gredell Engineering and Reitz & Jens recommend the following:

1. No additional field exploration to further identify and define aquifer parameters used in the PLUME model is recommended at this time. This is supported by MDNR's review and approval of the DSI and current detection groundwater monitoring system.

2. Based on the past 13 years of historical Missouri River elevations, groundwater movement trends more northerly than what was indicated by the 12-month DSI investigative time period. In combination with the narrower plume widths generated assuming a five-foot "tear" width in the liner system, additional wells in the area north of Cell 2 warrant consideration. Recommended locations for as many as seven (7) new wells are depicted on Figure 11 of this response. Wells installed in this area should be of the same approximate depth as the existing wells and integrated into the current detection groundwater monitoring system. Alternatively, the four (4) existing wells in this location (MW-1 through MW-4) could be supplemented with four (4) additional wells.

3. The two easternmost wells proposed by the IRPE north of Cell 2 (P5 and P6) are unnecessary because they provide no additional benefit and do not increase the effectiveness of the current detection monitoring system.

4. Additional shallow wells for the purposes of detection groundwater monitoring are unnecessary southeast of the Cell 3 area of the proposed UWL, as they provide no additional benefit and do not increase the effectiveness of the current detection monitoring system.

5. The IRPE did not provide a compelling basis for the installation of deeper wells as it relates to detection groundwater monitoring for the proposed UWL. Literature sources confirm that the horizontal component of contaminant migration is much greater than the vertical component of contaminant migration. MDNR's review and approval of the DSI and their acceptance of the current detection groundwater monitoring system confirm this position.

6. No additional evaluation of PLUME model input parameters or additional iterations of model scenarios is recommended at this time.

Our interpretation of MDNR's current approach to groundwater detection monitoring at landfills is that groundwater monitoring is a dynamic process, subject to ongoing re-evaluation and conclusion based on data from each background or semi-annual sampling event. As such, future data collected during routine detection monitoring events will provide additional information that will be evaluated by Ameren Missouri, MDNR and/or Franklin County in order to consider the need for modifications to the currently approved groundwater monitoring system. Until such time, the current detection groundwater monitoring system meets the requirements and intent of 10 CSR 80-11.010. However, the addition of wells north of Cell 2 could enhance the current detection groundwater monitoring system during periods of a more northerly direction of groundwater flow.

7.0 REFERENCES

Freeze, R.A. and Cherry, J.A., 1979, "*Groundwater, Chapter 9 Groundwater Contamination*"; Department of Earth Sciences, University of Waterloo, Waterloo, Ontario.

Gelahar, L.W., Welty, C., and Rehfeldt, K.R., 1992, "*A Critical Review of Data on Field-Scale Dispersion in Aquifers*", Water Resources Research, Vol. 28, No.7, pp. 1955-1074.

Peck, R.B., Hanson, W.E., and Thornburn, T.H., 1953, Foundation Engineering, John Wiley & Sons, New York, London, Sydney, Second Edition, p.13, Table 1.4.

Prickett, T.A., Naymik, T.G., and Lonnquist, C.G., 1981, "*A "Random-Walk" Solute Transport Model for Selected Groundwater Quality Evaluations*", Illinois State Water Survey Bulletin 65/81 (found at http://www.isws.illinois.edu/pubdoc/b/iswsb-65.pdf).

Wang, H.F. and Anderson, M.P., 1982, "*Introduction to Groundwater Modeling: Finite Difference and Finite Element Methods, Chapter 8 Advective-Dispersive Transport*"; W. H. Freeman and Company, San Francisco.

Weidemeier, T.H., Swanson, M.A., Montoux, D.E., Gordon, E.K., Wilson, J.T., Wilson, B.H., Kampbell, D.H., Hansen, J.E., Haas, P., and Chapelle, F.H., 1998, "*Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*", EPA/600/R-98/128, National Risk Management Research Laboratory Office of Research and Development, Cincinnati, Ohio, U.S. EPA.

Wilson, C.R., Einberger, C.M., Jackson, R.L., and Mercer, R.B., 1992, "*Design of Ground-Water Monitoring Networks Using Monitoring Efficiency Model (MEMO)*", GROUND WATER, Vol. 30 No. 6, pp. 965–970.

ANDREWS
ENGINEERING, INC.

October 08, 2013

Mark S. Vincent
Franklin County Counselor
203 East Main Street
Suite C
Union, MO 63084

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

Dear Mr. Vincent:

We have completed a review of the Ameren Missouri ("Ameren") letter dated July 8, 2013 in response to "IRPE Comments" and the August 7, 2013 additional information submitted for the Construction Permit Application. Andrews Engineering, Inc. ("Andrews") is under contract to Franklin County ("County") to perform duties as the Independent Registered Professional Engineer ("IRPE") pursuant to the Franklin County Unified Land Use Regulations and landfill ordinances that pertain to Utility Waste Landfills, Section 238, ("Ordinance"). Ameren references three sets of IRPE comments in their letter concerning the permitting and review process for the proposed Labadie Ash Disposal Facility.

The last sentence of the opening paragraph of the Ameren letter states, "This will confirm that these three sets of IRPE comments on the Application are complete for purposes of the Application and Ordinance." This statement requires clarification. I can confirm that to date the body of work prepared by our firm (Andrews) is complete, but only to the extent where information was provided by Ameren and no further comments are necessary. However, as you are aware, for approximately half of the technical comments prepared, Ameren has either not provided a response or their response does not address the technical issue. Therefore, the review process has not been completed.

Attached to this letter are two memorandums. One includes comments concerning the groundwater and the other the engineering. At your request we have identified certain comments as critical. The remaining comments and concerns include additional information relating to the critical comments or reference discrepancies within the document that should be clarified prior to issuing a permit. In order for Andrews to complete our review we request that Ameren address these comments.

The statements made by Ameren in their July 8, 2013 letter bring to light the difficulty we have had trying to complete our review. That being Ameren has declared the Missouri Department of Natural Resources ("MDNR") the final authority, which "pre-empts the great majority of the IRPE's comments." The letter goes on to question the validity of the County Ordinance with respect to a technical review process independent of MDNR.

Section 238(C)(3)(a) states in part that:

> *Under no circumstances shall any construction of any component of a Utility Waste Landfill be commenced prior to the approval of all designs, plans, addendums, construction documents by the Independent Registered Professional Engineer.*

We have proceeded with the interpretation that the County rules and ordinances do not conflict or reinterpret the MDNR regulations but allow the County to conduct its own review and the County has the authority to require additional documentation beyond that found acceptable by MDNR. Therefore the potential exists that the County, under their authority, can impose additional safeguards for design, permitting, construction, and compliance determinations.

If you have any questions or concerns, please contact me at (217) 787-2334.

Sincerely,

Kenneth W. Liss
Vice President of Operations
Andrews Engineering, Inc.

KWL:dwm:sjb

Attachment(s)

cc:

J:\2012\2012-106 (Franklin County)\DOC\2013\comment cover letter to vincent 08oct13 rev.docx
Correspondence
!Unexpected End of Formula

ATTACHMENTS

Groundwater Comments

This document summarizes comments prepared from a review of Ameren's July 11, 2013 response letter.

Franklin County Commission Precedence

Gredell asserts that the approval of the Detailed Site Investigation Report and Groundwater Monitoring Program by Missouri DNR supersedes the technical review and comments prepared by Franklin County's IRPE.

It is understood that Missouri DNR has reviewed and approved the separate site investigation and monitoring well installation work plans and reports. However, as specifically stated in Section 238(C)(3)(a) of Article 10, "Supplementary Use Regulations" of the Franklin County Planning and Zoning Unified Land-Use Regulations:

> "Under no circumstances shall any construction of any component of a Utility Waste Landfill be commenced prior to the approval of all designs, plans, addendums, construction documents by the Independent Registered Professional Engineer."

It would seem that installation of the proposed groundwater monitoring well network prior to the approval of Franklin County's IRPE, shows indifference to this requirement.

Characterization of the Uppermost Aquifer and Confining Unit

Gredell has neglected to address the characterization of the uppermost aquifer and the confining unit to the satisfaction of the Franklin County IRPE.

The guidance in Appendix 1 of 10 CSR 80-2.015 and 10 CSR 80-11.010(11) are clear on the requirements for characterization of the physical and hydrogeologic properties of the uppermost aquifer and upper confining unit. Pursuant to 10 CSR 80-11.010(11)(C)(1)(A) groundwater monitoring wells shall be installed so that the number, spacing and depths of monitoring systems shall be determined based upon site-specific technical information that shall include thorough characterization of:

(I) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and

(II) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities and porosities.

It is understood that the level of effort to characterize the uppermost aquifer and upper confining unit may be lessened by the Missouri Department of Natural Resources Geological Survey Program (see Appendix 1 of 10 CSR 80-2.015). However, it seems that the Franklin County's IRPE should have been involved in the process of determining the extent of the characterization effort as this information is critical to the understanding of groundwater flow, both shallow and deep and for evaluation of the adequacy of the proposed groundwater monitoring well network to monitor the uppermost aquifer.

The information presented does not address the thickness of the uppermost aquifer, does not identify the uppermost confining unit, does not characterize variations in vertical or horizontal hydraulic gradients or hydraulic conductivity throughout the uppermost aquifer nor does the information address the hydraulic conductivity of the upper confining unit.

Well Spacing Evaluation

Gredell asserts that the proposed and already installed groundwater monitoring well network is based on a representative evaluation and characterization of groundwater flow and the uppermost aquifer. It is Franklin County IRPE's conclusion that Gredell's well spacing evaluation is based on atypical groundwater elevations from an atypical year of precipitation (see Comment No. 2 in Section 6.0 Summary and Conclusions of the July 11, 2013 Response to April 22, 2013 Franklin County IRPE Comments), an incomplete evaluation of the properties and thickness of the uppermost aquifer and confining unit, and unconservative source width assumption and arbitrary concentration contour.

As such, Franklin County's IRPE cannot comment on the PLUME modeling effort other than to say that the information provided is incomplete and does not warrant further evaluation given the limited data provided and Gredell's refusal to collect additional data.

Critical Comments

1. Page 1, last line of paragraph 1. Gredell Engineering Resources, Inc. (Gredell) indicates that the groundwater monitoring network has only to meet the approval of MDNR. Andrews Engineering, Inc. (Andrews) is under contract to Franklin County (County) to perform duties as outlined in the Franklin County Unified Land Use Regulations and landfill ordinances that pertain to Utility Waste Landfills, Section 238 (Ordinance). Contrary to the Ordinance, the investigation of the site and construction of components of the proposed Utility Waste Landfill have commenced without the approval of the County's IRPE. (Article 10, Section 238, C.3.a.)

2. Page 4, paragraph 1. The assertion here is that the proposed and already installed groundwater monitoring well network is based on a representative evaluation and characterization of the uppermost aquifer and confining unit. However, as admitted by Gredell, the groundwater flow direction and the hydraulic gradients are not representative of typical surface water and groundwater elevations. As a result, the plumes are based on hydrodynamic dispersion values calculated from atypical groundwater velocities; furthermore, the value used to characterize the effective porosity of the uppermost aquifer is: (1) based on a literature value and (2) for total porosity. The effective porosity (n) directly impacts the dispersion value which affects the groundwater velocity and ultimately the plume width. (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

   The dispersion coefficients are functions of the average contaminant velocity, the dispersivities, and the molecular diffusion coefficient for the chemical of interest in water:

$$D_x = a_x v + D_m$$
$$D_y = a_y v + D_m$$

Where:a_x and a_y are the longitudinal and transverse dispersivities, respectively; and D_m is the effective molecular diffusion coefficient for the chemical of interest through the porous medium.

The average contaminant velocity, v, is computed as:

$$v = Ki/Rn$$

Where: K is the hydraulic conductivity
i is the groundwater gradient
R is the retardation factor
n is the effective porosity

The dispersivities and velocity are used in the PLUME equation; calculation for the PLUME model is provided below:

$$C_{(x,y,t)} = (C_0/4)exp\{(xv/2D_x)[1-(1+4kD_x/v^2)^{1/2})]\}$$
$$erfc\{[x-vt(1+4kD_x/v^2)^{1/2}\}/2(D_xt)^{1/2}\}$$
$$\{erf[(y+Y/2)/2(D_yx/v)^{1/2}]-erf[(y-Y/2)/2(D_yx/v)^{1/2}]\}$$

Where: $C_{(x,y,t)}$ is the concentration at x,y,t
C_0 is the source concentration
x is the distance downstream from the source
y is the transverse distance from the source
k is the first-order radioactive decay constant
Y is the width of the source
v is the average contaminant velocity
D_x is the longitudinal dispersion coefficient
D_y is the transverse dispersion coefficient
t is time

3. Page 4, paragraph 2. The assumption by Gredell is that all groundwater flow within the uppermost aquifer is shallow. However, the uppermost aquifer is comprised of at least 100 feet of alluvial valley sediments overlying an undetermined thickness of permeable bedrock. The bottom of the uppermost aquifer, the confining unit, has not been characterized. The possibility of the vertical movement of water is wholly ignored. The issue regarding deeper wells has nothing to do with the existing landfill unit. Deeper wells are for monitoring the entirety of the UMA. As it is, contamination that migrates deeper than 20 to 25 feet, the depth of the proposed groundwater monitoring well system, will be missed. Also, groundwater quality resulting from the existing unit should be characterized to determine effects on upgradient/background groundwater quality of the proposed unit. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

4. Page 5, paragraph 4. If Gredell is trying to establish efficiency, then MEMO should be used. While there are no requirements regarding monitoring efficiency, it would seem that the minimum appropriate efficiency that should be strived for is 95%. This is often the USEPA benchmark for compliance issues. What they have done by turning the plumes around and making the wells the source location is confusing and I don't believe is representative of the

modeling effort. The source should be located at the waste boundary. (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

5. Page 6, general comment. The assumption by Gredell that the groundwater data collected are representative of the following typical years is not appropriate. The water levels were abnormally high resulting in widely varying flow direction, more so than in most past years. This widely varying flow direction used as part of the dispersivity has shortened the plume lengths and widened the plumes. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

6. Page 8, paragraph 4. The proposal for deep wells is not directed toward the groundwater quality of the existing impoundments. The deep wells are proposed as part of the uppermost aquifer characterization and monitoring. Vertical gradients have not been characterized, as such, the adequacy of the currently installed groundwater monitoring system is unknown. Our argument regarding vertical migration is not aimed at evaluating contaminant transport due to density differences. Vertical gradients due to variations in river stage and groundwater elevation in the uplands and the river terrace sediments are not unknown phenomena. Gredell has ignored the issue of vertical groundwater flow. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

7. Page 10, general comment. Gredell assumes that groundwater compliance is only an issue at the property boundary. Pursuant to discussion with Mo DNR, the permit boundary is where compliance must be demonstrated. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

Additional Comments & Concerns

8. Page 2, general comment. The uppermost aquifer and confining unit have not been characterized. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B); Article 10, Section 238 C.3.f.)

9. Page 3, paragraph 1. The concentration contour used for well spacing should be applicable to the anticipated source concentration and compliance concentration ratio. An assumption of a 1000:1 (0.001 concentration contour) source to compliance ratio is unfounded. Also, note that the ratio of 1000:1 provides for a larger plume width than a ratio of 100:1 or even 10:1 (i.e., 0.01 and 0.1). (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

10. Page 3, paragraph 2. Gredell identifies the property boundary as the limit for compliance. Per conversation with MNDR staff, groundwater compliance must be within the permitted boundary. If compliance is only an issue at the limits of the property boundary, then it would seem the entire property boundary should be identified as the permit boundary. (Appendix 1 of 10 CSR 80-2.015; Article 10, Section 238 C.3.f.)

11. Page 5, paragraph 2. Gredell uses a porosity value that is not site-specific and dispersion values are based on atypical groundwater levels. The contention that the PLUME modeling effort is based on representative data is incorrect. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.) The wording used to describe the

development of well spacing from the locations of the wells with respect to the waste boundary is confusing. I'm not sure what the point is here.

12. Page 7, paragraph 1. The statements by Gredell regarding porosity and dispersivity are not true. The porosity affects the length and width of the plume since the velocity is indirectly proportional to the effective porosity. The velocity is a factor in calculation of the dispersivity. The assumption of a higher porosity shortens the plume.

13. Page 7, paragraph 2. The size of the plume is greatly influenced by the concentration contour selected. The concentration contour is representative of the ratio of the source concentration to the compliance concentration. No explanation was provided by Gredell of how the 0.001 concentration contour is applicable to the contaminant concentrations and compliance concentrations for this facility and wastes. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

14. Page 8, paragraph 2. Gredell should have approximate value of chloride concentrations within the coal ash waste. (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

15. Page 8, paragraph 3. If conservatism is the goal, then Gredell should be using a concentration contour of 0.01 for the PLUME evaluation. (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

16. Page 8, paragraph 3. Gredell is incorrect. Groundwater compliance within the permitted boundary needs to be shown. (10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

17. Page 9, paragraph 4. Gredell uses total porosities values based on literature as related to grain size. The effective porosity characterized by near-by in situ testing has a mean value of 26.5%. Much less than the 30, 35 and 40 proposed. This should be addressed at it directly impacts contaminant transport calculation. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

18. Page 11, paragraph 1. As indicated above, the velocity is directly affected by the effective porosity. The velocity is indirectly proportional. The total porosity value of 35% is much higher than nearby determined average effective porosity of 26.5%. Andrews used the effective porosity from tracer test studies conducted in the same Missouri alluvium sediments in the nearby St. Charles well field. This is the best data available given the lack of site specific porosity data. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

19. Page 12, paragraph 1. Gredell comments that the groundwater elevation data they collected is not typical of yearly precipitation events and river stages. However, this is what their PLUME evaluation is based upon. It would seem that the PLUME modeling effort completed by Gredell is compromised. (Appendix 1 of 10 CSR 80-2.015; 10 CSR 80-11.010(11)(B)(4)(B)); Article 10, Section 238 C.3.f.)

Engineering Comments

Please find below Andrews Engineering's response to the Ameren Construction Permit Application for Proposed Utility Waste Landfill originally submitted on January 29, 2013 with additional information submitted on August 7, 2013.

1. Calculate the bearing capacity of the subgrade in varying locations throughout the footprint. Additionally, calculate the bearing capacity during a maximum credible seismic event which induces liquefaction during each phase of construction and filling of the landfill. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

   Bearing capacity analysis has been performed on static conditions. The factor of safety slightly exceeded 1.0. The model analysis had multiple error codes which are typically indicative of improper input parameters. No explanation of the error codes was provided other than the stability software's output.

2. On Sheet 19, the Perimeter Ditch at Closure shows 12" of cover soils over the geomembrane with no clay liner beneath the geomembrane. A minimum of two feet of soil cover must be over the landfilled CCR. Additionally, erosion protection in the perimeter ditch is necessary to prevent exposure of the geomembrane. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

   This has not been revised and still remains an outstanding issue. This issue can be handled in a permit condition that requires two feet soil required in the final cover and the stormwater perimeter ditches are part of the cover system due to the fact that they are directly over waste. No erosion protection exists in the design and will need to be addressed during construction.

3. Liquefaction has been determined to occur in multiple layers. When reviewing the post-liquefied shear strengths provided in the table for the stability analysis, they don't match the shear strengths from correlation charts based upon the SPT blow counts. The chart referenced in the Reitz & Jens report was H. Bolton Seed's 1987 chart. Seed and Harder updated this chart with additional information in 1990 and this chart is available with a 3rd Order Best-Fit curve to simplify the correlation. Please provide the graphed correlations providing the residual shear strengths based upon the SPT blowcount corrected for the percentage of fines. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign).

   The model runs have been revised with some new values but the Table E-1 has not been revised so the values don't correlate between the model runs and the table. Additionally, the model runs have the revised inputs with the reduced cohesive values but resulted in higher FOS. Please explain how the model was revised to obtain a higher FOS when using reduced cohesive values.

4. The waste boundary should be reduced to allow the groundwater monitoring wells to be installed in the area of the DSI. If the wells are installed outside the area of the DSI, the data from the wells must be complied and correlated to existing DSI data and provided as

an addendum to the DSI. (Article 10, Section 238 C.3; 10 CSR 80-2.015(1)(D) & 10 CSR 80-2.015 Appendix I)

No revisions were made pertaining to this comment. The geologic data from the new groundwater monitoring wells that were installed needs to be used to update the DSI.

5. Section 4.1.2 Sequence of Phase Construction describes the construction sequence of each phase. The Phase 1 Construction Sequence doesn't discuss the timing of constructing the stormwater pond, but Phases 3 and 4 Construction Sequence discusses constructing the stormwater ponds after placing CCR in the phase area. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. (40 CFR Part 122.26; 10 CSR 20-6.200)

   No revisions were made. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. A condition could be added to the construction permit to require that the stormwater ponds are constructed and permitted prior to the operating permit for each associated cell.

6. The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration = 0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

   This has not been revised. This section needs further justification.

7. Friction angles for the geomembrane/clay interface appear to be too high. The direct shear testing performed on the interface did not adequately displace the interface and the normal loads were low. The displacement testing should be on the order of inches and the normal stresses need to meet the full capacity of the landfill design. Additionally, at lower normal stresses, the critical interface may occur between the geomembrane and geotextile or geocomposite. All of the designs need to be analyzed to have the proper inputs for stability analysis. The bottom liner illustrated as detail 3/17 Bottom Liner and Leachate Collection Detail shows a smooth geomembrane, not a textured HDPE geomembrane as was tested and provided in Appendix A-1 of Appendix J. The interface friction angle (15 degrees) utilized in the Analysis and Design of Veneer Cover Soils, Figure E-42, is a more representative value for textured HDPE geomembranes/clay interface. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor

of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

This comment was not addressed. Direct shear analysis of the clay liner borrow material and the textured HDPE for the composite liner will need to be properly tested and analyzed during preparation of the construction specifications to verify the permanent cumulative deformation analysis.

8. The Construction Quality Assurance Plan inadequately addresses the requirements in 10 CSR 80-11.010(6)(B)1.A. "A detailed description of the QA/QC testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;" Specifically, this section should include tables showing the frequency and acceptable test result values for each testing procedure. The Air Pressure Testing of seams cannot allow a drop of 4 psi during the 5 minute test. It must not drop more than 10% of the equalized pressure of at least 25 psi. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(B)1.A.)

   This comment was not addressed. The air pressure testing still needs to be revised as it does not meet the industry standard.

Additional Comments & Concerns

9. Interior berms filled with CCR must be constructed immediately after receiving the Operating Permit or Authorization to Operate due to placing waste within the landfill footprint. Additional CQA reporting will then be required for the construction of the interior berm and requires approval prior to placing CCR material onto it. (Article 10, Section 238 C.3.d.)

   No revisions were found within the revised CPA. This can be made a condition of the construction permit.

10. The minimum factor of safety recommended by the draft technical guidance document from MDNR-SWMP and Stark is 1.2 to 1.3, not 1.1 as listed in Table E-2 Results of Slope Stability Analyses. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

    Revisions to the narrative of Appendix J with regards to the minimum factor of safety have been further discussed and now agrees with the above draft technical guidance document but Table E-2 has not been updated.

11. After closure, all stormwater should be routed through the stormwater ponds to reduce sediment loading rather than allowing the letdown structures to discharge over the exterior berms. (General Engineering Comment)

This comment was not addressed. This is something that can be dealt with in the future as part of the construction specifications for the final cover of the landfill.

12. The separation between the compacted soil component of the composite liner shall be two feet above the Natural Water Table in the site area. Provide a potentiometric surface map for the critical monitoring events from the DSI with the post-settlement base grades provided of the landfill footprint. In any area where the potentiometer surface map illustrates that the surface is above the existing topography, use the top of the existing topography (pre-land disturbance) for those areas. (Article 10, Section 238 C.3.c..)

    On January 7, 2013, Andrews provided a letter as requested by Ameren for inclusion in their permit application. In that letter, it states that we agree with the concept but we couldn't provide an approval until we received an application to review. Franklin County's Article 10, Section 238 C.3.c. sets the limit for separation between the compacted soil component of the composite liner and the Natural Water Table. Franklin County's regulation does not have an allowance for a demonstration specifically stated.

13. Settlement analysis demonstrates some differential settlement which could cause ponding in the flat stormwater channels, a reduction in the overall height of the berms and settlement of the base grades of the landfill. Each of these must be discussed including how Franklin County's regulations will be satisfied during all phases of construction, filling and closure. Additionally, the settlement analysis typically has a range of settlement that may occur due to variability in the underlying subgrade and must be conservatively considered in the analysis to prevent overtopping of the exterior and interior berms due to a 500-year flood event. (Article 10, Section 238 C.3; Article 10, Section 238 C.3d.i.; 10 CSR 80-11.010(5)(A)4.A & 10 CSR 80-11.010(8)(B)1.F.(IV))

    This comment was not addressed. No changes or discussion on the stormwater channels. Operationally, it is added to maintain the berm height during operations of the facility.

14. Due to the size of the cells, provide calculations to show the removal rate of leachate generated from a storm event during the first couple of weeks of filling. Justify the storm event, calculate the removal rate and describe disposal method utilized. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

    This comment was not addressed. This will need to be specified in the construction specifications and approved prior to construction.

15. On Sheets 5 and 7, show how the stormwater from Cell 2 will flow into the Stormwater Pond 1. (General Engineering Comment)

    This comment was not addressed. At some point in time, they appear to regrade the stormwater ditches to connect from Cell 2 to Cell 1 with no discussion. This is an operational issue that would need to be addresses prior to issuing the operating permit for Cell 2.

16. The stormwater management plan for the site allows most stormwater to become contact waters and thus leachate. Based upon the stormwater management plan, no waters onsite will be allowed to discharge from the site and must be contained and treated as leachate. Additionally, a one-way valve rather than a gate valve alone would be required in the Stormwater Ponds (Leachate Ponds) to prevent leachate out of the ponds during the

equalization. These ponds will additionally need to be designed with a liner system which meets the requirements of MDNR's Solid Waste Management and Water Protection Programs for storing leachate (waste waters). The use of these waters will be limited to within the composite lined landfill area or for use as makeup waters within the power plant's future scrubber systems. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e.; 10 CSR 80-11.010(8)(B)1.F.(V); 10 CSR 80-11.010(8)(C)2. & 10 CSR 80-11.010(9)(C)2.)

In the response to MDNR Comment #7, it is stated that "Leachate and stormwater that cannot be utilized within the UWL limits for dust control or for conditioning of the ash prior to disposal in the UWL will be pumped back to ash ponds at the plant for discharge through NPDES Outfall 002." Based upon this response, it appears they intend to manage their leachate via dilution with the stormwater. No revisions made to the plan.

17. Seeding to establish vegetation on the intermediate side slope cover needs to occur within a much shorter period than annually as provided in the Phases 1, 2, 3 and 4 Aesthetic Cover section. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(13)(B))

    This comment has not been incorporated into the CPA. On page 4-4, Section 4.1.2 Sequence of Phase Construction; Phases 1, 2, 3 and 4 Aesthetic Cover states "Seed to establish vegetation on the intermediate side slope cover annually." This is still unacceptable.

18. The Leachate and Stormwater Forcemains are shown in the Exterior Berm without the depths noted. The forcemains must be installed at a depth to prevent freezing during cold weather conditions. Additionally, account for these forcemains being located in a berm above grade and the landfill will not have exothermic reactions. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.D.)

    This comment was not addressed. This will need to be specified in the construction specifications and approved prior to construction.

19. If soils from onsite are acceptable for clay liner, prior to use for such, a test pad for these materials would be necessary since the offsite borrow soils are different. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(10)(C)1.)

    This comment was not addressed.

20. The landfill liner and overlying leachate collection system must have a minimum slope of 1%, pre and post settlement. Revise the landfill grades to meet this requirement during all times within the landfill footprint. Provide plan sheets with the critical cross sections which show the pre and post settlement landfill base grades. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(10)(B)4.)

    This comment was not addressed.

21. Specify the geotextiles for the cushion fabric and the filter fabric shown in the Bottom Liner and Leachate Collection System Detail. Provide the supporting documentation and any necessary calculations. (General Engineering Comment)

    This comment was not addressed. Will need to be specified in the construction specifications and approved prior to construction.

22. Provide detail drawings for the pipe perforation or slotting pattern for the leachate collection lines and sump riser pipe. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

    This comment was not addressed. Will need to be specified in the construction specifications and approved prior to construction.

23. In Appendix Y(a) Leachate Pipe and Pump Calculations, the leachate storage tank is listed as a 12-ft diameter horizontal tank. The drawings provided for the site have a vertical storage tank shown without any detail drawings for the storage tanks. Provide a detailed drawing for the storage tanks and the anticipated operations of the tanks to prevent them from exceeding capacity. Provide the pump details for the pumps within the leachate storage tanks. This should be included in the leachate management plan. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

    This comment was not addressed. This should be provided in the construction specifications prior to construction.

24. The leachate storage tanks have no capacities or sizes listed or illustrated in the drawings. The leachate storage tanks must be sized based upon the pumping rates of the sumps within the landfill, and the maintenance and inspection schedule or control systems for each. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

    This comment was not addressed. This will need to be specified in the construction specifications and approved prior to construction.

25. The stability analysis failed to meet the required and recommended factor of safeties. Cross-section E-E' failed to meet the factor of safety of 1.5 for the static drained global circular failure surface both with the initial and full fill of CCP. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

    The CPA stated the required factor of safety as 1.5 for the static drained global circular failure. Our review concurred with this statement and further implemented it during the review.

26. Liquefaction analysis is typically performed in the upper 50' of unconsolidated materials. Almost every boring was stopped at 35' in depth. Due to the lack of information from the 35' to 50' interval of the unconsolidated materials, provide a narrative justifying why liquefaction would not be anticipated at depths below 35'. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

    This comment was not addressed.

27. Provide the actual stability analysis for the deformation analysis and provide with a narrative rather than a table listing the yield accelerations and deformations for the short and long-duration events. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & *Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities* produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

    This comment was not addressed and needs to include appropriate narrative explaining the interface shear values used for deformation analysis.

28. Provide the calculations correlating the CPT test data to the elastic modulus utilized in the Settlement Analysis. The CPT logs which were provided in the DSI don't provide enough detail to verify the elastic moduli provided in the settlement analyses. Additionally, heavily loaded conditions decrease the modulus, so these factors need to be accounted for relative to their location within the footprint of the fill. The Bowles 1997 reference appears to be dated and newer, more precise correlations are widely available which utilize the normalized cone resistance and normalized friction ration. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

    This comment was not addressed.

29. In Appendix Y(a), the Leachate Pipe Crushing and Buckling Scenarios, Scenario 1 provides an H20 truck in the analysis. This size of truck is normal for highway use but it is anticipated based upon the amount of CCR being deposited that the size of the equipment and tire loads could be greater. Scenario 3 uses a live load of a 3 ton skid steer on the sump riser trench with one foot of CCR placed over the top of the sump riser trench. In all likelihood, this loading would occur prior to the placement of the CCR and the geotextile, and would be used to place the clean gravel. Additionally, Scenarios 1 and 3 drawings appears to be in error that CCR would be placed as the protective cover over the geocomposite drainage. Please revise these drawings and recalculate with the proper loading. It also appears that the pipe values were not reduced due to the perforations in Scenarios 1 and 2. Density of waste is listed as 75 pcf. Testing results in Appendix J report higher densities for CCPs. A density of 93 pcf is assumed in calculations in Appendix Y(d). (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

    This comment was not addressed.

30. Provide the approved design and drawings of the proposed underpass for Labadie Bottom Road and all approvals from the controlling authorities. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(4)(C)1.)

    This comment was not addressed, but will be required by the county.

Ameren Missouri November 18, 2013 Response to Andrews Engineering's Comments Re: Labadie Landfill

Ameren Missouri's responses to comments appended to Andrews Engineering's *October 8, 2013* correspondence to Franklin County are set forth below:

Groundwater Comments

Background

On April 8, 2011, the Missouri Department of Natural Resources ("MDNR") issued its approval of the Detailed Site Investigation ("DSI") conducted by Ameren Missouri and its consultants regarding property located in Franklin County ("the County") and adjacent to the Labadie Energy Center. As regulatory pre-requisite to submitting a Construction Permit Application (CPA), an applicant must perform a Preliminary Site Investigation ("PSI") and a DSI. Those evaluations which consider a variety of hydrogeologic and geologic conditions were included along with the use of a model (from Monitoring Network Design Package ("MAP"), by Golder Associates, Inc. (1992) to define the locations of a groundwater monitoring well network associated with the proposed Labadie UWL. All such assessments (groundwater modeling, DSI, groundwater monitoring plan) have undergone extensive agency review pursuant to MDNR's Solid Waste Management Program, the Geologic Survey Program and, as appropriate, the Water Pollution Program. Such submittals were prepared in accordance with Missouri regulations and MDNR requirements. On March 7, 2013, MDNR approved the Groundwater Detection Monitoring System for a Proposed Utility Waste Landfill in Franklin County. Accordingly the site evaluation phase of the project has concluded and once MDNR approves the revised CPA, Ameren Missouri's focus is on landfill design and construction.

The County has engaged Andrew's Engineering, Inc. as its Independent Registered Professional Engineer ("IRPE") under the County's Landfill Ordinance to review the DSI and CPA. Andrews Engineering has provided written comments as a result of their reviews. Subsequent to a November 12, 2013 meeting with the County and the IRPE, Ameren Missouri agreed to install seven (7) additional groundwater monitoring wells to monitor UWL Phase 1. This includes four (4) shallow and two (2) deep wells downgradient of UWL Phase 1 and one (1) deep well immediately upgradient of UWL Phase 1.

All of the wells will be monitored in accordance with the routine groundwater monitoring requirements. The downgradient deep wells will be statistically compared to the background concentrations established by sampling the upgradient deep well. In addition the deep wells will be used to calculate the vertical gradients using data collected contemporaneously at the adjacent shallow well.

The proposed groundwater monitoring network is now comprised of a total of 35 monitoring wells all located approximately 70 to 460 feet from the landfill base (outside toe). Thirty-two (32) of the wells are finished at depths of approximately 16 to 25 feet within the shallow portion of the aquifer and three (3) wells will be screened in the deeper portion of the aquifer. Attached is a figure that depicts the landfill layout and accompanying groundwater monitoring network including the locations of the seven (7) newly proposed wells. Monitoring wells MW-29 through MW-32 are located north of Cell 2 and will monitor the shallow portion of the aquifer.

As indicated above, the deep wells will be used to determine groundwater quality a nd gradient data. In order to determine vertical gradients the deep wells need to be installed within approximately ten (10) feet of a shallow well location. Therefore the proposed locations are within approximately ten (10) feet of wells MW-30 and MW-05 for hydraulically downgradient locations and MW-25 for the upgradient location. The three deep wells will be screened over a ten (10) feet interval approximately seventy-five (75) to eighty-five (85) feet below the existing ground surface.

Ameren Missouri will collect data during the installation of the deep wells to determine the textural and geologic classification of the aquifer. Such data will consist of disturbed soil samples collected in a Standard Penetration Test (ASTM D1586) at about 5-foot intervals and continuous logging by a qualified geologist. Laboratory testing of the soil samples will consist of grain-size analyses. The grain-size analyses and the N-values from the SPT testing will be used to estimate the bulk porosity and horizontal coefficient of permeability at the depth of each sample. Following installation of the wells, Ameren Missouri will obtain water level and water quality data on a routine schedule to obtain 8 representative background data sets. These data will be evaluated to determine the apparent direction of horizontal flow and gradient. Vertical flow and gradients will be determined using similar data from the shallow groundwater monitoring wells.

Engineering Comments

1. **(Bearing Capacity of the Subgrade and Impact on Liner and Leachate Collection)**

Calculate the bearing capacity of the subgrade in varying locations throughout the footprint. Additionally, calculate the bearing capacity during a maximum credible seismic event which induces liquefaction during each phase of construction and filling of the landfill. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

Bearing capacity analysis has been performed on static conditions. The factor of safety slightly exceeded 1.0. The model analysis had multiple error codes which are typically indicative of improper input parameters. No explanation of the error codes was provided other than the stability software's output.

RESPONSE: Missouri regulations require a settlement and bearing analysis be performed for all stages of construction on the "in place foundational material beneath the disposal area." *10 CSR 80-11-010 (5) (A) 4A.* Contrary to the comment and citation to the regulation, the regulation does not require the plan to "calculate the bearing capacity during a maximum credible seismic event which includes liquefaction during each phase of construction and filling of the landfill." Rather, the regulation states: "*Settlement and bearing capacity shall be performed on the in-place foundation material beneath the disposal area. The effect of the foundation material settlement on the liner and leachate collection system shall be evaluated." 10 CSR 80-11-010 (5) (A) 4A.* (In any event, a liquefaction stability analysis (as depicted in Figure E-2 and similar Figures) does in fact show the bearing capacity of the UWL foundation soils with liquefaction at multiple locations and for various phases of construction. Those analyses contemplate a seismic event of magnitude (Mw) 7.5 and a peak horizontal ground acceleration (PHGA) of 0.179g and assesses the impact of potential liquefaction at various locations within the UWL where liquefaction might occur. See also Response to Comment 26).

Ameren Missouri has performed the bearing capacity analysis required by *10 CSR 80-11-010 (5) (A) 4A* which confirmed that the weight of the expected landfill mass will be protective of the liner and leachate collection system. Specifically, the bearing capacity analysis included in Appendix J, Section 6.4 of the August 2013 CPA demonstrates that UWL's factor of safety against bearing capacity failure is 2.0, which conforms to generally accepted engineering practice. The error codes in the output from the SLIDE software program are not the result of input errors, but boundary conditions. Boundary conditions will be properly established in all future modeling runs to eliminate error codes where feasible. The software analyzes tens of thousands of potential failure surfaces within the parameters requested, some of which are not feasible; the error codes merely notify the user that those trial surfaces were considered.

2. **(Final Cover System)**

On Sheet 19, the Perimeter Ditch at Closure shows 12" of cover soils over the geomembrane with no clay liner beneath the geomembrane. A minimum of two feet of soil cover must be over the landfilled CCR. Additionally, erosion protection in the perimeter ditch is necessary to prevent exposure of the geomembrane. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(14)(C)3.)

This has not been revised and still remains an outstanding issue. This issue can be handled in a permit condition that requires two feet soil required in the final cover and the stormwater perimeter ditches are part of the cover system due to the fact that they are directly over waste. No erosion protection exists in the design and will need to be addressed during construction.

RESPONSE: Missouri regulations permit MDNR to authorize the use of alternative landfill cover systems. Specifically, *10 CSR 80-11-010 (14)(C)5* provides "*[t]he department may approve the use of an alternative final cover system provided that the owner/operator can demonstrate that the alternative design will be at least equivalent to the final cover system described in paragraph (14)(C)3 of this rule.*" Ameren Missouri has elected to use a synthetic geomembrane system similar to that approved by MDNR at the Sioux Energy Center UWL. Ameren Missouri has proposed to MDNR an alternative final cover system comprised of geomembrane component overlain by at least 1 foot of soil to support vegetative growth. Missouri regulations require a minimum final cover to include 1 foot of compacted clay with a permeability of 1x10-5 cm/sec or less, overlain by 1 foot of soil capable of sustaining vegetative growth. The final cover in Labadie UWL perimeter ditch will include a 40-mil HDPE liner overlain with 1 feet of vegetative soil, while the final cover for the remainder of the UWL will include a 40-mil HDPE liner overlain with 2 feet of vegetative soil as indicated in Section 3.12 of the August 2013 CPA. . The adequacy of this alternative landfill cover system was demonstrated in the Modification to Construction Permit Number 0918301 for the Sioux Energy Center UWL that was approved by MDNR on February 8, 2013. Ameren will comply with future modifications to UWL regulations that may necessitate revisions to final cover system requirements.

10 CSR 80-11-010 (14)(C)3 states *"As each phase of the utility waste landfill is completed, a final cover system shall be installed of* ***one foot (1')*** *of compacted clay ... and overlaid with one foot of soil capable of sustaining vegetative growth."* 10 CSR 80-11.010(1) states *"...If techniques other than those listed as satisfactory compliance in design or operation are used, it is the obligation of the utility waste landfill owner/operator to demonstrate to the department in advance that the techniques to be employed will satisfy the requirement..."* The use of a much less permeable HDPE liner in lieu of 1 foot of compacted clay is a more conservative cover system than required by 10 CSR 80-11.010(14)(C)3 and is consistent with other landfill cover systems approved by MDNR. Nevertheless, Ameren intends to employ two feet of soil over the majority of the UWL surface area and one foot of soil in the stormwater channels (over a geomembrane) as outlined above with erosion protection within the stormwater channels where flow velocities exceed 3 ft/sec.

(3) **(Modeling to Assess Liquefaction)**

Liquefaction has been determined to occur in multiple layers. When reviewing the post-liquefied shear strengths provided in the table for the stability analysis, they don't match the shear strengths from correlation charts based upon the SPT blow counts. The chart referenced in the Reitz & Jens report was H. Bolton Seed's 1987 chart. Seed and Harder updated this chart with additional information in 1990 and this chart is available with a 3rd Order Best-Fit curve to simplify the correlation. Please provide the graphed correlations providing the residual shear strengths based upon the SPT blowcount corrected for the percentage of fines. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign).

The model runs have been revised with some new values but the Table E-1 has not been revised so the values don't correlate between the model runs and the table. Additionally, the model runs have the revised inputs with the reduced cohesive values but resulted in higher FOS. Please explain how the model was revised to obtain a higher FOS when using reduced cohesive values.

RESPONSE: Pursuant to *10 CSR 80-11.010(5)(A)4,* the applicant must perform stability analyses for all stages of construction as follows: settlement and bearing capacity, *11.010(5)(A)4A*; stability analysis on all liner and leachate system components, *11.010(5)(A)4B*; structural strength to support maximum loads imposed by overlying materials and equipment, *11.010(5)(A)4C*; waste mass stability and intermediate and final slope grade conditions, *11.010(5)(A)4D*. Ameren Missouri has performed each of these assessments and the results can be found in Appendix J, Section 6.1.3 of the August 2013 CPA.

The Seed and Harder, 1990 empirical relationship was compared with 8 other published criteria. The criteria for estimating the shear resistance of liquefied soils used in the initial analyses are consistent with Seed and Harder (1990) for N-values up to about 10 blows per foot (for weak or loose soils). The stability analyses were rerun using the residual strengths of the liquefied soils per the recent criterion by Idriss and Boulanger (2008), corrected for fine soil content. The factors of safety (FS) decreased by 0.068 or less, which is less than the accuracy of the analyses (which MDNR-SWMP and Stark states is about ±5%). Also, the original stability analyses were run assuming that liquefaction could occur under the completed UWL where other analyses showed that liquefaction would not occur. If the liquefiable soil strata were limited to those areas where it may still occur within the completed UWL, then the FS shown in Table E-2 increased to between 1.50 and 1.81. However, since the original liquefaction analysis was more conservative, and thus adequately protective, the original results were reported in Table E-1 and E-2. The additional modeling runs using justified appropriate values to demonstrate that the FS exceeds the minimums provided in MDNR-SWMP and Stark's Guidance Document will be included in Appendix J of the CPA.

(4) **(Ground Water Monitoring Wells)**

The waste boundary should be reduced to allow the groundwater monitoring wells to be installed in the area of the DSI. If the wells are installed outside the area of the DSI, the data from the wells must be compiled and correlated to existing DSI data and provided as an addendum to the DSI. (Article 10, Section 238 C.3; 10 CSR 80-2.015(1)(D) & 10 CSR80-2.015 Appendix I) No revisions were made pertaining to this comment. The geologic data from the new groundwater monitoring wells that were installed needs to be used to update the DSI.

RESPONSE: The subsurface information obtained during groundwater monitoring well installation was compiled and submitted to MDNR and DGLS in the "Groundwater Detection Monitoring Wells Installation Report" dated May 9, 2013. This data has been correlated with the existing DSI data to verify the consistency of the geology. The proposed landfill is located within the area defined and evaluated by the DSI and monitoring wells have been located approximately 70 to 460 feet from the base (outside toe) of the landfill. MDNR's published guidance provides that wells be "*located outside but not greater than 500 feet from the anticipated limit of the area". 10 CSR 80-2.015; Appendix I, Monitoring Wells.* The monitoring well network is intended to "evaluate the potential for migration of fluids generated by the utility waste landfill." *11 CSR 80- 011 8 (B)3.* The monitoring well network serves that purpose. Further, as noted above, at the request of the County, Ameren Missouri will install seven (7) additional monitoring wells (4 shallow and 3 deep) to augment the monitoring network.

(5) **(Construction of Stormwater Ponds)**

Section 4.1.2 Sequence of Phase Construction describes the construction sequence of each phase. The Phase 1 Construction Sequence doesn't discuss the timing of constructing the stormwater pond, but Phases 3 and 4 Construction Sequence discusses constructing the stormwater ponds after placing CCR in the phase area. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. (40 CFR Part 122.26; 10 CSR 20-6.200)

No revisions were made. The construction of each stormwater pond and the CQA report for each must be approved prior to placing CCR into the phase area associated with the stormwater pond. A condition could be added to the construction permit to require that the stormwater ponds are constructed and permitted prior to the operating permit for each associated cell.

RESPONSE: Construction of stormwater ponds will occur in conjunction with construction of the landfill so that stormwater can be properly managed at the site. Accordingly, permits for the construction of stormwater ponds will be obtained from MDNR as appropriate prior to the operation of the pond associated with a specific phase of the landfill. In Section 4.1.2 of the CPA to be re-submitted, Ameren will clarify that Pond 1 will be constructed concurrently with Phase 1; Pond 2 will be constructed concurrently with Phase 3; and Pond 3 will be constructed concurrently with Phase 4. CQA reports will be completed for each pond and submitted concurrently with the CQA report for the applicable cell prior to issuance of the MDNR operating permit and Franklin County operating license.[1]

(6) **(Seismic Risk Analysis)**

The information provided in Section 5.3 Estimate of Yield Acceleration and Lateral Spreading for the short-duration time history appears to be incorrect and/or not the most critical based upon the provided charts. The data provided for the short-duration time history came from chart #10 (page C-9) when chart #2 (page C-10) provide a higher peak rock acceleration =0.25 and PHGA = 0.24 based upon the output provided from SHAKE2000 analysis using the same soil profile. The values provided are for the unfilled conditions. Additional model runs were completed for the filled conditions for use in the final cover but not discussed in this section. Provide a narrative with the Appendix C

[1] In this comment, the IRPE also suggests that a "condition could be added to the construction permit..." Because the County does not require or issue a UWL construction permit, we assume that this comment may suggest a condition under the County's Operating License should the County so chose.

Results of Seismic Risk Analyses to detail the assumptions and correlate the model analysis from the inputs to the generated results. Update this information and use it in your modeling. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

RESPONSE: The comment notes that additional modeling runs have been performed as reflected in Sub-Appendix C of Appendix J in the August 2013 CPA and requests a narrative description of the assumptions and correlations be provided. The description was in Section 6.1.2 of Appendix J in the August 2013 CPA. The additional computer runs will be added to Sub-Appendix C of Appendix J in the CPA.

(7) **(Geomembrane Liner and Clay Interface)**

Friction angles for the geomembrane/clay interface appear to be too high. The direct shear testing performed on the interface did not adequately displace the interface and the normal loads were low. The displacement testing should be on the order of inches and the normal stresses need to meet the full capacity of the landfill design. Additionally, at lower normal stresses, the critical interface may occur between the geomembrane and geotextile or geocomposite. All of the designs need to be analyzed to have the proper inputs for stability analysis. The bottom liner illustrated as detail 3/17 Bottom Liner and Leachate Collection Detail shows a smooth geomembrane, not a textured HDPE geomembrane as was tested and provided in Appendix A-1 of Appendix J. The interface friction angle (15 degrees) utilized in the Analysis and Design of Veneer Cover Soils, Figure E-42, is a more representative value for textured HDPE geomembranes/clay interface. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4.B. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

This comment was not addressed. Direct shear analysis of the clay liner borrow material and the textured HDPE for the composite liner will need to be properly tested and analyzed during preparation of the construction specifications to verify the permanent cumulative deformation analysis.

RESPONSE: This comment addresses the level of friction between the clay and the HPDE liner. Circular sliding surfaces were used for the global stability analyses in accordance with standard practice. A plane with lower shear strength properties would be "invisible" to a circular sliding surface because only the tangent point at the interface would have the lower shear strength (see discussion by MDNR-SWMP and Stark). Therefore, the shear strength properties of the clay liner, and the gravel leachate collection layer if used, were reduced to account for the probable lower shear strength at the interface. This is conservative because it assigns a reduced shear strength to all of the increments of the trail sliding surface that are in the clay liner. Minimum shear strength properties of the interface were used for the stability analyses that assumed trial sliding surfaces consisting of multiple planes because the critical sliding surface would be along the interface. Section 10.1 in Appendix J of the August 2013 CPA states that all of the engineering properties of the clay and associated interfaces will be tested to verify that the proposed clay liner material meets or exceeds all of the design assumptions. Ameren Missouri agrees with the comment and a testing and analysis requirement using Spencer's Method will be included as part of the procurement and construction bid process. The testing and analysis will be provided to Franklin County's IRPE for review and approval.

(8) **(Air Pressure Tests of Liner)**

The Construction Quality Assurance Plan inadequately addresses the requirements in 10 CSR 80- 11.010(6)(B)1.A. "A detailed description of the QA/QC testing procedures that will be used for every major phase of construction. The description must include at a minimum, the frequency of inspections, field testing, laboratory testing, equipment to be utilized, the limits for test failure, and a description of the procedures to be used upon test failure;" Specifically, this section should include tables showing the frequency and acceptable test result values for each testing procedure. The Air Pressure Testing of seams cannot allow a drop of 4 psi during the 5 minute test. It must not drop more than 10% of the equalized pressure of at least 25 psi. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(6)(B)1.A.)

RESPONSE: Ameren Missouri agrees that the liner system should be properly air tested during construction and will employ industry standard air pressure tests to assess liner seams during construction. The CQA Plan (Appendix P) will be modified in the CPA to reflect the industry standards, including that the pressure cannot drop more than 2 psi during the 5 minute test or more than 10% of the equalized pressure of at least 25 psi.

(9) **(Construction of Interior CCR Berms)**

Interior berms filled with CCR must be constructed immediately after receiving the Operating Permit or Authorization to Operate due to placing waste within the landfill footprint. Additional CQA reporting will then be required for the construction of the interior berm and requires approval prior to placing CCR material onto it. (Article 10, Section 238 C.3.d.)

RESPONSE: The interior CCP berm is an integral component of the exterior berm system required by Article 10, Section 238 C.3.d of the Franklin County regulations. With respect to timing of construction, both the interior and exterior berms must be constructed under the MDNR Construction Permit, and prior to issuance of the MDNR operating permit and Franklin County operating license. CCP material used as part of the berm construction is an authorized use by MDNR and CCP waste material cannot be placed in the UWL until MDNR issues an operating permit. This same construction sequencing of berms (interior and exterior berms constructed in conjunction but prior to placement of CCP waste) has been approved by MDNR on February 8, 2013 as part of their approval of the Modification to Construction Permit Number 0918301 for the Sioux Energy Center UWL. Upon completion of Phase 1 and Phase 3 construction of the composite lined area, including the CCP berms, a CQA Report will be submitted to Franklin County's IRPE to review the report for the internal CCP berms and areas beneath the internal berms.

(10) **(Safety Factor Analysis – Slope Stability Analysis)**

The minimum factor of safety recommended by the draft technical guidance document from MDNR-SWMP and Stark is 1.2 to 1.3, not 1.1 as listed in Table E-2 Results of Slope Stability Analyses. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

Revisions to the narrative of Appendix J with regards to the minimum factor of safety have been further discussed and now agrees with the above draft technical guidance document but Table E-2 has not been updated.

RESPONSE: As described in Appendix J, Section 6.1.3 of the August 2013 CPA, to confirm the conservative nature of our assumptions, Ameren Missouri performed stability analyses of five UWL cross sections and assumed the presence of fully liquefied soil strata (loose sandy soils) *without* consideration of the impact of soil consolidation resulting from construction of the berms and CCP fill . (As soil consolidation occurs, loose, sandy soil pockets become compressed and the potential for liquefaction diminishes.) The FS_{liq} for this conservative assumption ranged from 1.13 to 1.72, slightly less than the above guidance criterion (1.2 to 1.3). As standard engineering practice, a factor of safety above 1.0 is acceptable when assessing seismic conditions. Table E-2 will be modified to show Recommended Minimum FS' of 1.2 for global circular failure with liquefaction analyses with a footnote explaining the reduced FS for the full height UWL.

(11) **(Routing of Stormwater Following Closure of the Landfill)**

After closure, all stormwater should be routed through the stormwater ponds to reduce sediment loading rather than allowing the letdown structures to discharge over the exterior berms. (General Engineering Comment)

RESPONSE: Ameren Missouri intends for the UWL to operate for approximately 30 years and it is premature at this time to delineate the precise manner in which stormwater occurring post-closure will be managed. The current UWL design that discharges stormwater from the closed landfill directly to the surrounding property via letdowns is consistent with 10 CSR 80-11.010(8)(F) and other landfill drainage systems approved by MDNR throughout the State. The letdowns have been designed to control erosion so that the stormwater discharges meet water quality requirements. Ameren Missouri will comply with all MDNR requirements and appropriate stormwater management measures developed and included within the Labadie UWL operating procedures. Upon closure of the UWL, such Plan will be updated to describe the appropriate stormwater management methods applicable at that time.

(12) **(Separation between Compacted Soils and Natural Groundwater Table)**

The separation between the compacted soil component of the composite liner shall be two feet above the Natural Water Table in the site area. Provide a potentiometric surface map for the critical monitoring events from the DSI with the post-settlement base grades provided of the landfill footprint. In any area where the potentiometer surface map illustrates that the surface is above the existing topography, use the top of the existing topography (pre-land disturbance) for those areas. (Article 10, Section 238 C.3.c.)

RESPONSE: Franklin County's Ordinance requires "the clay or composite soil component at the base of the Utility Waste Landfill shall be at least two (2) feet above the Natural Water table in the site area." The Natural Water Table at the Labadie Energy Center was defined in Appendix Z of the August 2013 CPA at elevation 464 and is the basis for design of the composite liner system. The site will be graded to a minimum subgrade elevation of 466 prior to installation of the clay liner. Drainage sumps must be located at a lower level so that gravity will allow the leachate to drain into them. The separation between the composite liner and Natural Water Table proposed in the August 2013 CPA is consistent with other landfill liner systems approved by MDNR and has been preliminarily approved by MDNR. 10 CSR 80-11.010 (4) (B) 6.

(13) **Potential for Differential Settlement in Stormwater Channels and Berm Heights**

Settlement analysis demonstrates some differential settlement which could cause ponding in the flat stormwater channels, a reduction in the overall height of the berms and settlement of the base grades of the landfill. Each of these must be discussed including how Franklin County's regulations will be satisfied during all phases of construction, filling and closure. Additionally, the settlement analysis typically has a range of settlement that may occur due to variability in the underlying subgrade and must be conservatively considered in the analysis to prevent overtopping of the exterior and interior berms due to a 500-year flood event. (Article 10, Section 238 C.3; Article 10, Section 238 C.3d.i.; 10 CSR 80-11.010(5)(A)4.A & 10 CSR 80-11.010(8)(B)1.F.(IV))

RESPONSE: In accordance with 10 CSR 80-11.010(5)A.4.A.&B., and 10 CSR 80-11.010(8)(B)1.F.(IV), Ameren Missouri has performed an analysis that contemplates the manner in which various feature of the landfill (e.g. berms, stormwater channels, etc.) may settle based upon a variety of future operating scenarios and weather conditions. As with any structure, settlement may occur over time. The integrity of the landfill will be operated, maintained, and monitored, however, so that stormwater is properly managed and that, in the event of a 500-year flood event, the exterior berms are not overtopped. Temporary ponding due to minor settlement in the perimeter ditches is not an issue since all stormwater falling within the UWL waste boundary will be managed as either leachate or stormwater in this no-discharge system. As part of the operating procedures of the Labadie UWL, stormwater management practices and procedures that will be developed and periodically updated as project and external conditions warrant. Section 2.8.3 of the CPA states "...as part of the UWL ongoing operation and maintenance, both during operation and post-closure, the top of berm elevation will be periodically determined by level survey. If the elevation of the exterior berms settles below the 500-year elevation of 487.6, suitable fill will be added to the perimeter roads on top of the berm to raise the minimum berm elevation to 488.0"

(14) **(Removal Rate of Leachate Generated during a Storm Event Occurring) during First 2 weeks Of Filling)**

Due to the size of the cells, provide calculations to show the removal rate of leachate generated from a storm event during the first couple of weeks of filling. Justify the storm event, calculate the removal rate and describe disposal method utilized. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.E.)

RESPONSE: Pursuant to *10 CSR 80-11.010(9(A) and (B),* the applicant must design and construct a leachate collection system. A leachate collection system open to the atmosphere must be designed to prevent discharge during a 25 year, 24 hour storm event. In addition, ponds and/or tanks must have sufficient capacity to store and equalize flow to the disposal system. The leachate collection system has been designed with these requirements.

Section 3.9.2 of the August 2013 CPA summarizes the approach to leachate collection, storage, and disposal. Leachate will be routed to sumps and then pumped to a storage vessel adjacent to the landfill. Preliminary analysis using the average annual leachate generation rates indicate that 50,000 to 70,000 gallons of temporary storage capacity will be provided by multiple 10,000 gallon movable tanks interconnected in a "tank farm" during the initial operations of Phase 1. Additional temporary leachate storage capacity is available in Pond 1 for Phase 1 during start-up, Pond 2 for Phase 3 start-up, and Pond 3 for Phase 4 start-up. The ultimate purpose of these ponds is to manage stormwater runoff from the active disposal cell, however during initial operations stormwater runoff will be contained within the cell until the cell has been sufficiently filled with CCPs to allow gravity flow of excess stormwater into the ponds. Until that time, the entire capacity of the ponds is available for temporary leachate storage. The design capacity of the stormwater ponds are adequate to store and manage this water until it can be reused or disposed off-site. Using the leachate generation history from the operation of Phase 1, the water (leachate and stormwater) management plan will be re-evaluated and revised as the project proceeds. Due to the nature of the materials, CCP tends to consolidate quickly thereby reducing the amount of leachate generated. See also Response to Comment 23.

(15) **(Flow of Stormwater from Cell 2 into Stormwater Pond)**

On Sheets 5 and 7, show how the stormwater from Cell 2 will flow into the Stormwater

Pond 1. (General Engineering Comment)

This comment was not addressed. At some point in time, they appear to regrade the stormwater ditches to connect from Cell 2 to Cell 1 with no discussion. This is an operational issue that would need to be addresses prior to issuing the operating permit for Cell 2.

RESPONSE: Sections 3.7.1 and 4.5.1 of the August 2013 CPA describes how stormwater runoff will be routed from the UWL disposal cells (referred to as Phase 1, Phase 2, etc.) into designated stormwater ponds via properly sized perimeter ditches inside the perimeter berms and how the UWL will manage stormwater as a no discharge facility. Phase 2 is constructed adjacent to Phase 1 and the perimeter ditch around Phase 1 that conveys stormwater runoff from Phase 1 to Pond 1. The Phase 2 perimeter ditch will be connected to the Phase 1 perimeter ditch once Phase 2 is constructed and filled to a minimum elevation of 483. Ameren Missouri recognizes this operational issue and, as the various cells are constructed, stormwater will need to be conveyed away from the UWL and into a stormwater pond. As stated in Section 3.7.1 of the CPA,

> "During the initial, active operation of disposal cells, stormwater runoff may temporarily pond on the CCPs within the UWL. Temporary collection basins will be located within the active disposal cell and temporary pumps used to pump accumulated runoff to the perimeter ditch or directly to adjacent stormwater holding ponds to minimize the amount of stormwater that infiltrates into the waste. After the elevation of in place CCPs exceeds the height of the perimeter ditch, the CCPs will be graded to maintain slopes on active landfill areas to avoid ponding, except in temporary collection basins. Ultimately, the perimeter ditch will convey stormwater from the side slopes, letdown structures, and side slope benches to the on-site stormwater holding ponds."

At the point in operations when CCP fill exceeds the height of the perimeter berm, plans detailing the connection of the perimeter ditch from Phase 2 to Phase 1 will be determined and submitted to the IRPE before construction of Phase 2.

(16) **(Stormwater Management)**

The stormwater management plan for the site allows most stormwater to become contact waters and thus leachate. Based upon the stormwater management plan, no waters onsite will be allowed to discharge from the site and must be contained and treated as leachate. Additionally, a one-way valve rather than a gate valve alone would be required in the Stormwater Ponds (Leachate Ponds) to prevent leachate out of the ponds during the equalization. These ponds will additionally need to be designed with a liner system which meets the requirements of MDNR's Solid Waste Management and Water Protection Programs for storing leachate (waste waters). The use of these waters will be limited to within the composite lined landfill area or for use as makeup waters within the power plant's future scrubber systems. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e.; 10 CSR 80-11.010(8)(B)1.F.(V); 10 CSR 80-11.010(8)(C)2. & 10 CSR 80-11.010(9)(C)2.)

In the response to MDNR Comment #7, it is stated that "Leachate and stormwater that cannot be utilized within the UWL limits for dust control or for conditioning of the ash prior to disposal in the UWL will be pumped back to ash ponds at the plant for discharge through NPDES Outfall 002." Based upon this response, it appears they intend to manage their leachate via dilution with the stormwater. No revisions made to the plan.

RESPONSE: Sections 3.7, 3.9 and 4.5 of the August 2013 CPA describe how stormwater runoff and leachate from the UWL will be managed and disposed of in accordance with applicable water quality standards and requirements. A gate valve and check (one-way) valve will be installed on the flood mitigation pipe as shown on drawing 4/16 of the CPA. A separate NPDES construction permit will be obtained from MDNR prior to construction of the ponds as in indicated in Note 1 on drawing 16. Stormwater and leachate will be managed as explained in the second of section 3.7.1 of the CPA. All on-site stormwater ponds will be fully lined and comply with MDNR permitting requirements.

(17) **(Seeding to Establish Vegetation)**

Seeding to establish vegetation on the intermediate side slope cover needs to occur within a much shorter period than annually as provided in the Phases 1, 2, 3 and 4 Aesthetic Cover section. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(13)(B)) This comment has not been incorporated into the CPA. On page 4-4, Section 4.1.2 Sequence of Phase Construction; Phases 1, 2, 3 and 4 Aesthetic Cover states "Seed to establish vegetation on the intermediate side slope cover annually." This is still unacceptable.

RESPONSE: As part of its ongoing maintenance and inspection procedures, Ameren Missouri will inspect the landfill slopes and perform seeding activities at appropriate intervals so as to establish a vegetative cover. Section 3.11 states that cover will be vegetated by seeding immediately after placement. Section 4.1.2 will be updated to state that vegetation on the intermediate side slope cover will be inspected and maintained as necessary to provide adequate erosion protection as indicated in specification Section 3.11. Section 4.9 states that seeding will be completed as soon as practical after placement of cover as required by *10 CSR 80-11.010(14)(B)7.* Furthermore, all stormwater within the UWL waste boundary is captured and controlled during operations to prevent sediment discharge from the area.

(18) **(Depths of Leachate and Stormwater Piping)**

The Leachate and Stormwater Forcemains are shown in the Exterior Berm without the depths noted. The forcemains must be installed at a depth to prevent freezing during cold weather conditions. Additionally, account for these forcemains being located in a berm above grade and the landfill will not have exothermic reactions. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.D.)

RESPONSE: Ameren Missouri agrees that such piping will be installed below the frost depth established by existing Franklin County building code or local practice, whichever is more conservative. Typically this depth is no more than 30-inches below finished grade.

(19) **(Test Pad – Borrow Material)**

If soils from onsite are acceptable for clay liner, prior to use for such, a test pad for these materials would be necessary since the offsite borrow soils are different. (Article 10, Section 238 C.3. & 10 CSR 80-11.010(10)(C)1.)

RESPONSE: Ameren Missouri intends to use off-site soils in constructing the compacted clay liner and will use a test pad to confirm performance and suitability for such materials prior to construction as indicated in Section 3.0 Appendix P of the August 2013 CPA.

(20) **(Slope Between Landfill Liner and Leachate Collection System)**

The landfill liner and overlying leachate collection system must have a minimum slope of 1%, pre and post settlement. Revise the landfill grades to meet this requirement during all times within the landfill footprint. Provide plan sheets with the critical cross sections which show the pre and post settlement landfill base grades. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(10)(B)4.)

RESPONSE: This comment suggests that a minimum slope of 1% between the liner and leachate collection system should be maintained at all times. However, due to the size and configuration of the UWL, the CPA includes a 1% liner and 0.5% leachate collection system slope. 10 CSR 80-11.010(1) states "...If techniques other than those listed as satisfactory compliance in design or operation are used, it is the obligation of the utility waste landfill owner/operator to demonstrate to the department in advance that the techniques to be employed will satisfy the requirement..." The effectiveness of using of a 0.5% slope for the leachate collection pipe was demonstrated in the CPA to the satisfaction of MDNR. In addition, the HELP modeling results show that the depth of leachate on the liner in this collection system will never be greater than 2 inches, much lower than the 1 foot maximum allowed by 10 CSR 80-11.010(B)1.E. This is consistent with 10 CSR 80-11.010(10)(B)4 and other landfills approved by MDNR.

(21) **(Material Specifications of Liner Cushion and Filter Fabric)**

Specify the geotextiles for the cushion fabric and the filter fabric shown in the Bottom Liner and Leachate Collection System Detail. Provide the supporting documentation and any necessary calculations. (General Engineering Comment)

RESPONSE: The detailed material specifications for the various liner elements will be determined as part of the construction procurement specification and bid process.

(22) **(Drawing Details – Slotting Pattern For Leachate Lines)**

Provide detail drawings for the pipe perforation or slotting pattern for the leachate collection lines and sump riser pipe. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)

RESPONSE: The detailed material specifications and configuration or the various leachate collection lines will be determined as part of the construction procurement specification and bid process. At that point, construction drawings detailing such elements will be developed.

(23) **(Detailed Drawings Leachate Storage Tanks)**

In Appendix Y(a) Leachate Pipe and Pump Calculations, the leachate storage tank is listed as a 12-ft diameter horizontal tank. The drawings provided for the site have a vertical storage tank shown without any detail drawings for the storage tanks. Provide a detailed drawing for the storage tanks and the anticipated operations of the tanks to prevent them from exceeding capacity. Provide the pump details for the pumps within the leachate storage tanks. This should be included in the leachate management plan. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

RESPONSE: Section 3.9.2, of the August 2013 CPA summarizes the approach to leachate storage. The number and location of tanks will require ongoing evaluation as a part of the UWL operations. Plan sheets 6, 7, 8 and 9 show the general location of a leachate storage tank for each cell, although there is sufficient room for several tanks at each location. If necessary, additional area for setting temporary leachate tanks will be developed within the active disposal cell on top of the CCPs. Appendix O summarizes the Peak Daily Leachate Volume and the Average Annual Leachate Volume predicted by the HELP model which was used to predict leachate generation rates. Ameren's experience with utility waste active dry cell CCP landfills reflects that very little leachate is generated, particularly when compared to the volumes predicted by the HELP model.[2] Therefore, the leachate quantities predicted by the HELP model are considered to represent conservatively high, or 'worst case' scenarios. The water management calculations found in Appendix Y(c) conservatively estimate that reusing the on-site stormwater and leachate for moisture conditioning and dust control on interior haul roads can annually consume approximately 1.5 times the quantity of water that will be generated by the UWL under the worst case scenarios modeled. Appendix Y(c) also assumes that prefabricated 10,000 gallon storage tanks, which are readily available, will be used to temporarily store the leachate on-site until it can be beneficially reused within the UWL, or transported to an off-site location for disposal. These tanks will be interconnected and located in a "tank farm" at the approximate locations shown on the

[2] For example, at landfills owned and operated by an Ameren Energy Resources, an affiliate, less than 1,000 gallons of leachate is generated annually. Ameren Missouri would anticipate less than 10,000 gallons ***annually*** of leachate generated from the Labadie UWL, far less than the 6,000 gallons ***daily*** default levels predicted by the HELP model. (Such model was developed for municipal landfills whose waste materials decay and generated significant quantities of leachate).

drawings. Using the leachate generation history from the operation of Phase 1, the number of tanks required to manage leachate generated from Phases 2, 3 and 4 can be more accurately predicted using actual peak and annual data. The long-term leachate storage requirements will depend on the actual amount of leachate generated and amount reused within the UWL, which will require ongoing adaptive management based on historical data during the UWL operation.

(24) **(Capacity Size: Leachate Storage Tanks)**

The leachate storage tanks have no capacities or sizes listed or illustrated in the drawings. The leachate storage tanks must be sized based upon the pumping rates of the sumps within the landfill, and the maintenance and inspection schedule or control systems for each. (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.A.)

RESPONSE: The CPA has been modified to include additional discussion regarding the leachate storage tanks as outlined in response to comments 14 and 23. The precise location of such tanks cannot be determined at this time but will be included on final construction drawings. A maintenance and inspection schedules for such tanks will also be developed as part of Ameren Missouri's internal operating plan.

(25) **(Stability Analysis and Safety Factors)**

The stability analysis failed to meet the required and recommended factor of safeties. Cross-section E-E' failed to meet the factor of safety of 1.5 for the static drained global circular failure surface both with the initial and full fill of CCP. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

The CPA stated the required factor of safety as 1.5 for the static drained global circular failure. Our review concurred with this statement and further implemented it during the review.

RESPONSE: Appendix J, Section 6.1.1 of the August 2013 CPA states that the initial configuration was also analyzed using long-term (i.e. "drained") shear strength properties. The minimum FS ranged from 1.45 to 2.70, which are essentially 1.5 or greater. The actual FS in the long-term will be greater than the values depicted in Table E-2 because the "initial" configuration is temporary and the fully drained shear strength properties are greater. The global stability of the completed UWL was also analyzed using drained strength properties. The FS of the global stability of the CCP and berm varied from 1.46 to 2.27. The actual FS would be greater than these values because these analyses did not incorporate the compressive strength of the CCP due to cementation, nor the gain in shear strength of the foundation soils due to consolidation. While Missouri regulations do not specify a minimum factor of safety, guidance documents (MDNR-SWMP and Stark, 1998) recommend a minimum factor of safety of 1.5 for static stability analyses. Modeling runs using justified appropriate values to demonstrate that the FS exceeds the minimums provided in MDNR-SWMP and Stark's Guidance Document will be included in Appendix J of the CPA.

(26) **(Liquefaction Analysis – Narrative Description Pertaining to Depths below 35 Feet)**

Liquefaction analysis is typically performed in the upper 50' of unconsolidated materials. Almost every boring was stopped at 35' in depth. Due to the lack of information from the 35' to 50' interval of the unconsolidated materials, provide a narrative justifying why liquefaction would not be anticipated at depths below 35'. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)

RESPONSE: As part of its liquefaction analysis, in addition to 93 CPT soundings, Ameren Missouri drilled 119 borings at the UWL site at depths ranging from 19 to 108 feet. Sixty-five (65) CPT soundings were more than 35 feet deep. Twelve (12) borings and seven (7) CPT soundings in the DSI were more than 40 feet deep. As explained in Appendix J, Section 6.1.3 of the August 2013 CPA, the risk of liquefaction diminishes as CCP is placed in the UWL and the soil consolidates. The CPT data was analyzed in discrete 6-inch increments (a "location") for the full depth of each sounding where empirical analysis suggested an anomaly or potential liquefaction existed. After 20 feet of CCP has been placed, less than 13% of the 78 locations analyzed between 35 and 50 feet in the 65 CPT soundings had a factor of safety less than 1.0 against liquefaction. All of these locations were only 6 inches thick. After 80 feet of CCP has been placed, less than 4% of the locations had a factor of safety less than 1.0 against liquefaction. Such limited strata are both too deep to impact the stability of the UWL, and too thin to significantly impact settlement. Accordingly, the analyses focused on the potential for near-surface liquefiable strata which could theoretically impact the UWL in the event of a seismic event. The analyses of the risk of liquefaction for various heights of CCP are included in Appendix D of Appendix J of the CPA. Such analysis reflects that liquefaction conditions would be localized to thin sand zones exterior to the UWL (not the landfill interior) near the surface which would drain quickly. As noted in the guidance document by MDNR-SWMP and Stark and in the IRPE's comment, liquefaction does not appear to occur below depths of 50. Therefore, after 20 to 30 feet of CCP has been placed, all of these potentially liquefiable thin strata are effectively located more than 50 feet deep and it is reasonable to expect the liquefaction potential to disappear.

(27) **(Stability Analysis – Deformation of UWL Side Slopes)**

Provide the actual stability analysis for the deformation analysis and provide with a *narrative rather than a table listing the yield accelerations and deformations for the short and long- duration events. (Article 10, Section 238 C.3; 10 CSR 80-11.010(5)(A)4. & Draft Technical Guidance Document on Static and Seismic Slope Stability for Solid Waste Containment Facilities produced by The Solid Waste Management Program/DEQ/MDNR and Timothy D. Stark, Ph.D., P.E. Associate Professor of Civil Engineering, Department of Civil Engineering, University of Illinois at Urbana-Champaign)*

RESPONSE: The slope stability analyses that determined the yield acceleration for each section for initial and full conditions are in Appendix E of Appendix J of the August 2013 CPA. The SHAKE2000 deformation analyses were run for a range of yield accelerations. The minimum yield acceleration caused a maximum cumulative deformation of 0.05 inch, two orders of magnitude smaller than the allowable deformation of 6 inches. This method of analysis was thorough and complete, and there is nothing to be learned or gained from additional calculations. Section 5.3 of Appendix J currently reflects that the analyses estimated the probable horizontal deformation due to a seismic event for a range of yield accelerations (K), and that the analyses demonstrate that the estimated probable horizontal deformations of the UWL are much less than the maximum deformation of 6 inches allowed by MDNR for a sanitary landfill.

(28) **Calculations Regarding Settlement Analysis and CPT Test Data**

Provide the calculations correlating the CPT test data to the elastic modulus utilized in the Settlement Analysis. The CPT logs which were provided in the DSI don't provide enough detail to verify the elastic moduli provided in the settlement analyses. Additionally, heavily loaded conditions decrease the modulus, so these factors need to be accounted for relative to their location within the footprint of the fill. The Bowles 1997 reference appears to be dated and newer, more precise correlations are widely available which utilize the normalized cone resistance and normalized friction ration. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(5)(A)4.A)

RESPONSE: The CPT test data were correlated to the elastic modulus in Appendix 2, Sub-Appendix D of the DSI. This analysis was completed using CPT-Pro, a commercially available CPT analysis software from GeoSoft. References were provided in the Appendix D of the DSI. The description of the methods used to correlate CPT test data to the elastic modulus that was included in Appendix 2, Sub-Appendix D of the DSI will be added to Appendix J of the CPA.

(29) **(Pipe Crushing and Buckling Scenarios)**

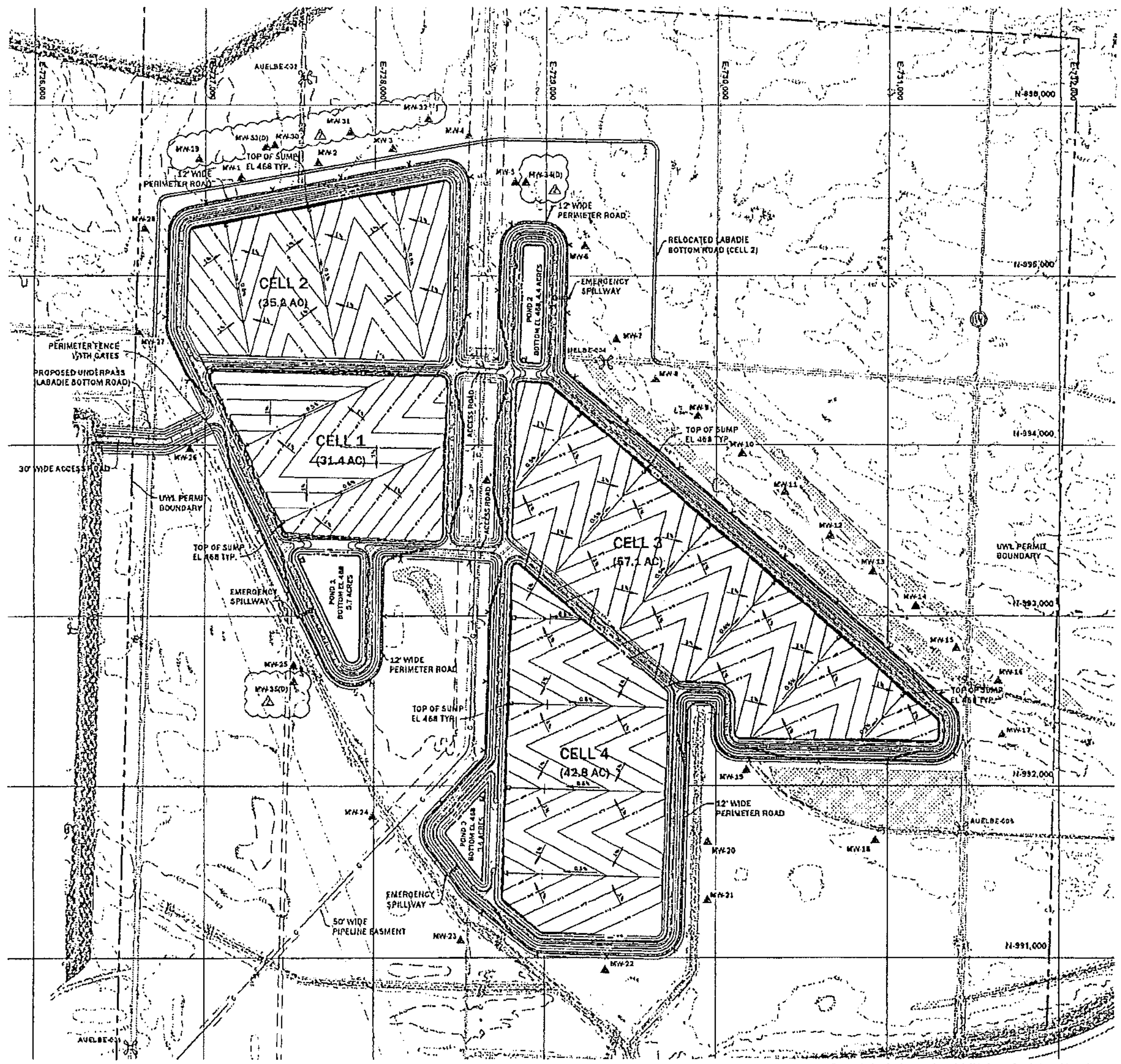
In Appendix Y(a), the Leachate Pipe Crushing and Buckling Scenarios, Scenario 1 provides an H20 truck in the analysis. This size of truck is normal for highway use but it is anticipated based upon the amount of CCR being deposited that the size of the equipment and tire loads could be greater. Scenario 3 uses a live load of a 3 ton skid steer on the sump riser trench with one foot of CCR placed over the top of the sump riser *trench. In all likelihood, this loading would occur prior to the placement of the CCR and the geotextile, and would be used to place the clean gravel. Additionally, Scenarios 1 and 3 drawings appears to be in error that CCR would be placed as the protective cover over the geocomposite drainage. Please revise these drawings and recalculate with the proper loading. It also appears that the pipe values were not reduced due to the perforations in Scenarios 1 and 2. Density of waste is listed as 75 pcf. Testing results in Appendix J report higher densities for CCPs. A density of 93 pcf is assumed in calculations in Appendix Y(d). (Article 10, Section 238 C.3.; Article 10, Section 238 C.3.e. & 10 CSR 80-11.010(9)(B)1.C.)*

RESPONSE: The pipe crushing and buckling calculations and scenarios in Appendix Y(a) and Y (d) of the August 2013 CPA depict typical worst case loadings and substantiate the pipe strength is more than adequate. Those assessments reflect that the leachate pipes can withstand wheel weights of 16,000. The scenarios evaluated are typical of those completed and accepted for compliance with 10 CSR 80-11.010(9)(B)1.C and the probability that the worst case loading would occur prior to the pipes having additional cover and protection is remote. Ameren Missouri agrees that as part of the prudent construction design and operation of the landfill, vehicles used in either the construction or operation of the landfill must be evaluated to ensure that the weight of such vehicle does not damage the underlying leachate piping system, as well as other components. A variety of standard construction practices can be employed to further protect existing underground piping or piping being installed during the ongoing construction. The specific vehicles to be used in either the construction or operation of the UWL must be evaluated and appropriate care will be taken to ensure the integrity of the leachate system is maintained.

(30) <u>**Labadie Bottom Road Underpass**</u>

Provide the approved design and drawings of the proposed underpass for Labadie Bottom Road and all approvals from the controlling authorities. (Article 10, Section 238 C.3 & 10 CSR 80-11.010(4)(C)1.)

RESPONSE: See attached correspondence from Franklin County.



N

SCALE 1" = 300'

0 150 300 600

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.60	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.87	731438.29	462.78
AUELBE-006	996729.00	731621.70	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983,
Vertical Datum NAVD 1988

NOTES:

1. CELLS 1 & 2 AREAS WERE MEASURED TO INSIDE TOP OF EXTERIOR BERMS AND OUTSIDE TOP OF INTERIOR BERMS
2. CELLS 3 & 4 AREAS WERE MEASURED TO INSIDE TOP OF EXTERIOR BERMS AND INSIDE TOP OF INTERIOR BERMS
3. POND AREAS WERE MEASURED FROM THE INSIDE TOP OF BERM
4. FABRIC-FORMED FILTER POINT CONCRETE MAT (OVER NON WOVEN GEOTEXTILE) LATER TO BE PLACED ON THE OUTSIDE FACE OF ALL EXTERIOR BERMS
5. ALL LAND DISTURBANCE ACTIVITIES WILL HAVE A 35' MINIMUM SETBACK FROM JURISDICTIONAL WETLANDS WITH A STORMWATER BMP INSTALLED BETWEEN THE DISTURBANCE AND THE WETLAND DURING CONSTRUCTION. SEE DETAIL 4 ON SHEET 19

NOTES TO THE CONTRACTOR:

UNDERGROUND FACILITIES, STRUCTURES, AND UTILITIES HAVE BEEN PLOTTED FROM AVAILABLE SURVEYS AND RECORDS AND THEREFORE, THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHERS, THE EXISTENCE OF WHICH IS AT PRESENT NOT KNOWN. VERIFICATION OF THE LOCATIONS OF UNDERGROUND UTILITIES, SHOWN OR NOT SHOWN, WILL BE THE RESPONSIBILITY OF THE CONSTRUCTION CONTRACTOR.

THE CONTRACTOR SHALL MAKE SUITABLE AND TIMELY REQUESTS TO ALL UTILITY OWNERS, PIPELINE OWNERS, OR OTHER PARTIES AFFECTED TO HAVE ALL NECESSARY ADJUSTMENTS OF PUBLIC OR PRIVATE UTILITIES, PIPE LINES, OR OTHER APPURTENANCES WITHIN, OR ADJACENT TO THE LIMITS OF CONSTRUCTION, AS SOON AS PRACTICAL OR POSSIBLE.

MISSOURI ONE CALL SYSTEM (DIG-RITE) 1-800-344-7483

CALL BEFORE YOU
DIG • DRILL • BLAST
1-800-344-7483
(TOLL FREE)
MISSOURI ONE CALL SYSTEM, INC

PERMIT DRAWINGS NOT FOR CONSTRUCTION

THE ENGINEER WHOSE SIGNATURE AND PERSONAL SEAL APPEAR HEREON ASSUMES RESPONSIBILITY ONLY FOR WHAT APPEARS ON THIS PAGE AND DISCLAIMS PURSUANT TO SECTION 327.411 RSMO ANY RESPONSIBILITY FOR ALL OTHER PLANS, SPECIFICATIONS, ESTIMATES, REPORTS OR OTHER DOCUMENTS OR INSTRUMENTS NOT SEALED BY THE UNDERSIGNED ENGINEER RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE PROJECT TO WHICH THIS PAGE REFERS.

Reitz & Jens, Inc.

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING

PREPARED FOR Ameren

DRAFT
11/21/13

DRAWN W.J.A.(GER)	SHEET 5 PROPOSED UTILITY WASTE LANDFILL OVERALL BOTTOM GRADING PLAN (TOP OF LINER)	
CHKD K.L.R.(GER)		
SUPV T.R.G.(GER)		
APPD T.R.G.(GER)	LOCATION 001009 LABADIE ENERGY CENTER	CLASS 02010
Ameren ST. LOUIS, MISSOURI	JANUARY 2013	REV 0

REVISIONS: REV. 1 — REV. 2

Exhibit 301 p.136

Norris Sch. S5-20

Table 9
Comparison of Proposed Landfill Groundwater Monitoring Results to Screening Levels – April 2013 Sampling Event (a)
Labadie Energy Center, Franklin County, MO
Ameren Missouri

Monitoring Well ID	Well Depth	pH	Chloride	Fluoride	Sulfate	TDS	Aluminum	Antimony	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Mercury	Molybdenum	Nickel	Lead	Selenium	Silver	Thallium	Zinc
	(feet, btor)	S.U.	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MCL/SMCL (b)	6.5-8.5	250	4	250	500	50	6	10	NA	2000	0.004	5	NA	100	1300	300	50	2	NA	NA	15	50	100	2	5000
	RSL (c)	NA	NA	0.62	NA	NA	16000	6	0.045	3100	2900	0.016	6.9	4.7	16000	620	11000	320	4.3	78	0.3	NA	78	71	0.16	4700
MW-1	27.76	6.83	10	0.11	26	536			[illegible]	79.4	402			3.3			[illegible]	[illegible]			0.0058					
MW-2	26.35	6.85	17	0.21	31	696			[illegible]	121	416			2.9			[illegible]	[illegible]								2.5
MW-3	25.15	6.99	9	0.12	54	516			[illegible]	63.6	415					3.3	[illegible]	[illegible]								2.2
MW-4	25.54	6.94	6	0.18	25	532				72.8	274						115	[illegible]			0.0091					
MW-5	24.68	6.86	2	0.16	16	482				52.9	293						210	[illegible]			0.0116					2.1
MW-6	23.1	6.82	3	0.14	19	566	37			62.2	227						53	106			0.0101					4.3
MW-7	21.94	7.07	15	0.2	26	568	246		[illegible]	72.6	480						[illegible]	[illegible]								2.9
MW-8	21.82	6.83	8	0.16	10	460			[illegible]	45.3	285						[illegible]	[illegible]								2.7
MW-9	20.18	7.16	5	0.18	20	414			[illegible]	53.6	265						[illegible]	[illegible]								
MW-10	21.45	6.99	6	0.17	54	430	27		8.8	56.7	462						[illegible]	[illegible]				0.4				
MW-11	20.95	6.89	2	0.12	64	460			0.8	54.8	301			3.1			436	[illegible]			0.0068	0.5				
MW-12	20.48	6.93	2	0.1	42	448	18		1.4	52.9	253			3			419	[illegible]			0.0052					4
MW-13	20.4	6.87	2	0.12	64	498	33			53.5	295						59.2	117								5.1
MW-14	19.79	6.95	3	0.14	42	490	30		7.1	48.2	268			3.3			3590	[illegible]			0.0039					5.5
MW-15	17.91	6.84	2	0.16	27	404				58.1	206						16	18.1			0.0058					4.1
MW-16	18.5	6.85	6	0.22	30	554	31		[illegible]	102	102			4.4			8580	[illegible]			0.0041					5
MW-17	19.72	6.79	2	0.13	59	580	119		5.3	64.9	275			3.4			1620	[illegible]			0.0037	0.7				3.5
MW-18	18.24	7	1	0.18	34	476				45.8	147						22.3	89.5				0.4	38.5			4
MW-19	18.19	6.83	2	0.15	72	500				72.1	228						136	98.9			0.0057					4.2
MW-20	17.62	6.99	2	0.19	21	356				48.7	182						30.9	154			0.0074	0.5				4
MW-21	17.71	6.92	3	0.16	30	262			[illegible]	57.7	237						1080	[illegible]			0.0036					3.8
MW-22	17.92	6.88	6	0.25	30	560			[illegible]	156	238						[illegible]	[illegible]				0.5				4.1
MW-23	19.65	6.84	4	0.18	21	508	153		3.4	94	210						3600	180			0.0039					3.5
MW-24	19.99	6.94	3	0.18	36	426	154			47.1	190					3	277	4.1			0.0048	0.6	45.5			4.1
MW-25	20.84	7.18	4	0.14	17	406	38		0.5	124	511						4850	[illegible]			0.0036	0.7				3.8
MW-26	23	7.02	4	0.16	45	504	55.5			82.7	286						630	[illegible]			0.0043	0.7				
MW-27	25.91	6.83	11	0.18	29	576	31		8.3	98.6	268			4.1			3220	[illegible]			0.0058	0.5				5.2
MW-28	27.06	6.78	6	0.16	31	556	16		1.5	86.7	269						2020	[illegible]			0.0082	1				4.5
TMW-1	21.58	7.01	6	0.26	128	674			[illegible]	100	355						[illegible]	[illegible]			0.0036					5.5

Notes:
Blank data cells indicate a non-detect value.
btor - below top of riser.
MCL - Maximum Contaminant Level.
mg/L - Milligrams per liter.
NA - Not available.
RSL - Regional Screening Level.
SMCL - Secondary Maximum Contaminant Level. Value used if no MCL available.
S.U. - Standard Units.
ug/L - Micrograms per liter.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.
(a) - Numerical values were obtained from the Ameren Missouri Labadie Energy Center Utility Waste Landfill, Solid Waste Disposal Area, Franklin County, Missouri, Groundwater Detection Monitoring Wells Installation Report prepared by Reitz & Jens, Inc., May 2013. Samples collected on 4/16/2013.
(b) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. http://water.epa.gov/drink/contaminants/index.cfm; adopted as Missouri state values at 10 CSR 60-4.
(c) - USEPA Regional Screening Levels (November 2013). Values for tapwater.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

greater than MCL
greater than MCL and RSL
greater than RSL

Table 10
Comparison of Proposed Landfill Groundwater Monitoring Results to Screening Levels – August 2013 Sampling Event (a)
Labadie Energy Center, Franklin County, MO
Ameren Missouri

Monitoring Well ID	Well Depth (feet, btor)	pH	Chloride	Fluoride	Sulfate	TDS	Aluminum	Antimony	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Mercury	Molybdenum	Nickel	Lead	Selenium	Silver	Thallium	Zinc
		S.U.	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MCL/SMCL (b)	6.5-8.5	250	4	250	500	50	6	10	NA	2000	0.004	5	NA	100	1300	300	50	2	NA	NA	15	50	100	2	5000
	RSL (c)	NA	NA	0.62	NA	NA	16000	6	0.045	3100	2900	0.016	6.9	4.7	16000	620	11000	320	4.3	78	0.3	NA	78	71	0.16	4700
MW-1	27.76	6.76	7	0.16	27	600				82.6	298						178	539			0.0066					
MW-2	26.35	6.74	6	0.18	38	738			1	109	233			4.1			707	1300			0.005					
MW-3	25.15	6.88	5	0.18	66	606			2.4	67.2	266						3110	1580			0.0053					
MW-4	25.54	6.93	5	0.17	33	600				71.8	240		0.3				8.5	155								
MW-5	24.68	6.83	2	0.18	21	562				55	260							3.8								
MW-6	23.1	6.79	3	0.17	23	608				58.5	211															
MW-7	21.94	6.96	5	0.23	39	598			18.9	67.7	347			2.4			5900	1600			0.0036					
MW-8	21.82	6.85	3	0.21	23	514			2.1	48.5	252						3440	987			0.0039					
MW-9	20.18	7.05	4	0.26	18	370			1.2	43	196						255	584			0.0082					17.6
MW-10	21.45	6.86	3	0.21	30	516				55.6	252						768	52								2.1
MW-11	20.95	6.79	3	0.16	48	596				60.9	179						22.1	4.3								
MW-12	20.48	6.8	3	0.16	37	540				53.5	186						19	2.3					24			
MW-13	20.4	6.77	3	0.17	49	590				62.9	178						12				0.004		70.9			3.8
MW-14	19.79	6.77	2	0.2	36	528			1.9	61.4	223			4.1			347	252			0.0044					
MW-15	17.91	6.75	3	0.22	29	538				66.8	243						111	41.1			0.0044					2.8
MW-16	18.5	6.83	3	0.26	34	636			1.6	106	392			7.2			1060	3610			0.0062					2.3
MW-17	19.72	6.85	4	0.25	21	532	21			64.4	236						17	17.4								3.4
MW-18	18.24	6.96	2	0.24	37	536				86	172							219								2.2
MW-19	18.19	6.73	2	0.27	39	506				69.1	195						83.8	249			0.0043					
MW-20	17.62	6.92	3	0.27	36	466				60.2	176						9.2	8.3								
MW-21	17.71	7.03	3	0.3	22	396			2.5	81.7	169						12	60.3								2.9
MW-22	17.92	6.86	3	0.25	30	572	20		16.1	140	230						8410	1510								3.1
MW-23	19.65	6.9	5	0.24	24	624	284		8.8	146	260						5600	510			0.0034					3.1
MW-24	19.99	6.88	4	0.22	35	486				60.1	184						15	7.1			0.0036		42.7			
MW-25	20.84	7.04	3	0.18	39	506			1.4	144	464						294	1160			0.0048					
MW-26	23	7.01	5	0.21	38	556				69.8	236						37.5	141								
MW-27	25.91	6.73	20	0.2	37	690			2	86.1	264			5.4			1190	667			0.0083					3.4
MW-28	27.06	6.78	8	0.19	32	600	203		1.5	91.2	261						800	147			0.0081		44.3			2.8
TMW-1	21.58	6.93	5	0.28	83	658			8.5	91.7	348			3.9			1010	4800	0.06		0.0042					

Notes:
Blank data cells indicate a non-detect value.
btor - below top of riser.
MCL - Maximum Contaminant Level.
mg/L - Milligrams per liter.
NA - Not available.
RSL - Regional Screening Level.
SMCL - Secondary Maximum Contaminant Level. Value used if no MCL available.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
ug/L - Micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) - Numerical values were obtained from the Ameren Missouri Labadie Energy Center Utility Waste Landfill, Solid Waste Disposal Area, Franklin County, Missouri, Groundwater Detection Monitoring Wells Installation Report prepared by Reitz & Jens, Inc., Samples collected on 8/21/2013.
(b) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. http://water.epa.gov/drink/contaminants/index.cfm; adopted as Missouri state values at 10 CSR 60-4.
(c) - USEPA Regional Screening Levels (November 2013). Values for tapwater.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
greater than MCL
greater than MCL and RSL
greater than RSL

Table 11
Comparison of Proposed Landfill Groundwater Monitoring Results to Screening Levels – November 2013 Sampling Event (a)
Labadie Energy Center, Franklin County, MO
Ameren Missouri

Monitoring Well ID	Well Depth	pH	Chloride	Fluoride	Sulfate	TDS	Aluminum	Antimony	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Mercury	Molybdenum	Nickel	Lead	Selenium	Silver	Thallium	Zinc
	(feet, btor)	S.U.	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MCL/SMCL (b)	6.5-8.5	250	4	250	500	50	6	10	NA	2000	0.004	5	NA	100	1300	300	50	2	NA	NA	15	50	100	2	5000
	RSL (c)	NA	NA	0.62	NA	NA	16000	6	0.045	3100	2900	0.016	6.9	4.7	16000	620	11000	320	4.3	78	0.3	NA	78	71	0.16	4700
MW-1	27.76	6.63	6	0.2	24	602				103.0	349			2.8			192	[illegible]			0.0076		62.5			
MW-2	26.35	6.66	5	0.17	44	616			1.8	116.0	196						1090	32			0.0042		35.1			
MW-3	25.15	6.77	5	0.14	75	558			1.0	81.3	313			3.1			1020	1940			0.0071					3.2
MW-4	25.54	6.87	6	0.15	25	506			0.9	83.5	213						21.1	33.1			0.0039		36			4.5
MW-5	24.68	6.82	3	0.18	18	476			0.8	65.4	240						8.6	6.7					27			
MW-6	23.1	6.78	3	0.16	20	536			0.8	69.1	221						7.1	1.6			0.0047					
MW-7	21.94	6.83	3	0.17	40	568			2.2	60.6	296			3.9			855	[illegible]			0.0046		76.9			
MW-8	21.82	6.76	3	0.24	22	434			1.1	53.7	276						389	550			0.0055		33.8			
MW-9	20.18	7.00	3	0.22	21	382			1.5	49.9	225						447	712					50.4			
MW-10	21.45	6.82	3	0.16	33	502			0.9	63.6	255						640						53.1			
MW-11	20.95	6.76	3	0.14	51	542				69.0	191						18	35.7			0.0062		39.1			
MW-12	20.48	6.79	3	0.14	43	516			1.3	63.4	194						20.4	8.1			0.0042		44.6			
MW-13	20.4	6.79	3	0.15	61	538			1.2	76.8	173						9	1.6			0.0064		[illegible]			2.5
MW-14	19.79	6.74	3	0.17	41	496			1.1	64.2	202			3.2			460	156			0.0070		66.5			
MW-15	17.91	6.74	3	0.17	23	464			1.0	59.2	229							26.7			0.0050					2.2
MW-16	18.5	6.69	3	0.16	49	580			1.0	88.0	270						103	[illegible]			0.0122		32.5			
MW-17	19.72	6.77	3	0.19	33	502			0.8	68.2	218						17	4.9			0.0036					
MW-18	18.24	6.87	3	0.25	32	470			1.3	142.0	210						99.8	1110			0.0033					
MW-19	18.19	6.82	3	0.2	55	470			1.3	76.6	230						407	806			0.0063					
MW-20	17.62	6.87	3	0.25	36	404			1.1	61.2	174						7.1	3.3			0.0039		33.8			
MW-21	17.71	6.96	4	0.29	25	330			4.4	86.0	155		0.7				1930	536		3.4	0.0033					8.3
MW-22	17.92	6.89	4	0.25	37	528			[illegible]	169.0	315						23500	1720				0.5				
MW-23	19.65	6.82	6	0.23	9	620	62.4		20.2	209.0	274						18300	467								
MW-24	19.99	6.87	4	0.2	36	438				58.7	193						21.1	4.6			0.0034		40.4			3
MW-25	20.84	6.97	4	0.14	32	464				148.0	481						174	[illegible]			0.0043					
MW-26	23	6.93	4	0.18	30	446				59.7	212						15	131								
MW-27	25.91	6.65	16	0.18	43	606				104.0	242						129	149			0.0092	0.4	37.6			2.2
MW-28	27.06	6.64	9	0.18	24	542				92.1	249						29.9	12.7			0.0069		41.9			4.8
TMW-1	21.58	6.89	5	0.25	85	576			6.1	99.5	283			3.2			784	3620			0.0043					

Notes:
Blank data cells indicate a non-detect value.
btor - below top of riser.
MCL - Maximum Contaminant Level.
mg/L - Milligrams per liter.
NA - Not available.
RSL - Regional Screening Level.
SMCL - Secondary Maximum Contaminant Level. Value used if no MCL available.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
ug/L - Micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) - Numerical values were obtained from the Ameren Missouri Labadie Energy Center Utility Waste Landfill, Solid Waste Disposal Area, Franklin County, Missouri, Groundwater Detection Monitoring Wells Installation Report prepared by Reitz & Jens, Inc., Samples collected on 11/19/2013.
(b) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012. http://water.epa.gov/drink/contaminants/index.cfm; adopted as Missouri state values at 10 CSR 60-4.
(c) - USEPA Regional Screening Levels (November 2013). Values for tapwater. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

greater than MCL
greater than MCL and RSL
greater than RSL

ATTACHMENT A
Description of Designated Outfalls

Our existing permit contains two designated outfalls as described below:

No. 001 Non-Contact Cooling Water - Outfall for once-through cooling water system. Water is withdrawn from the river, passed through condensers and other heat exchangers, and returned to the river. The outfall is considered a non-process waste stream. A portion of this discharge may be treated as described in Attachment H, Macroinvertebrate Control.

Note that treated river water from the water treatment plant is used to lubricate the circulating water and screen wash pump bearings in the intake structure. This lube water mixes with the normal pump flow and is normally discharged via the circulating water system, Outfall 001 or from the screen wash system. When both circulating pumps in one intake bay are not operating, this lube water could be slowly discharged from the bay at the face of the intake structure. The total flow of treated water to the intake structure for bearing lubrication is about 100 gpm. Although treated water pH is typically above 9 due to the lime treatment process, it would not affect the outfall pH, due to the insignificant flow (relative to the circulating water system).

No. 002 Ash Pond - Outfall for plant wastewater treatment pond. The pond provides treatment for fly ash, bottom ash and low volume waste and treated sanitary waste streams. The ash pond discharge is treated to control pH. The outfall is considered a process waste stream.

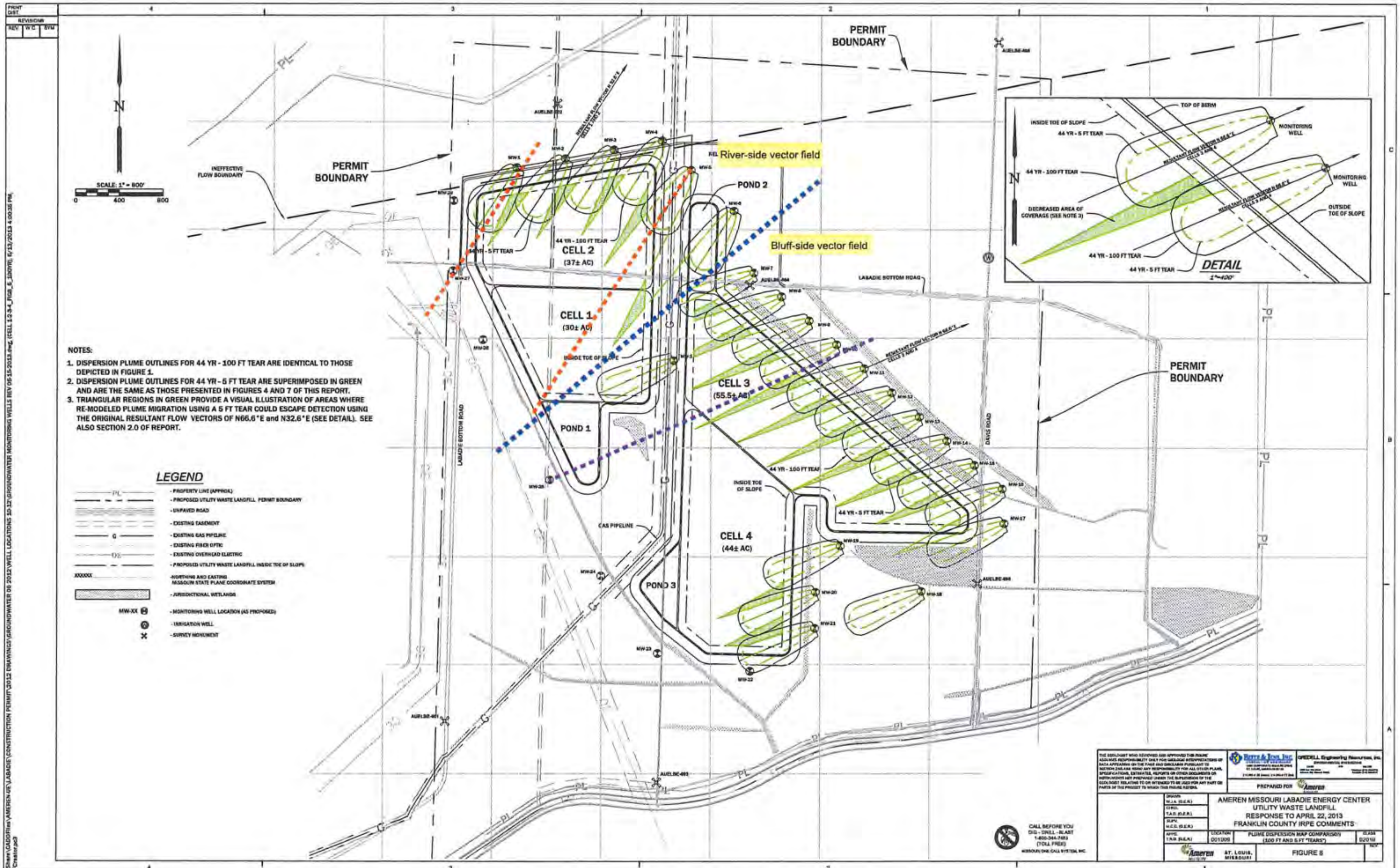
The sanitary waste that is routed to the ash pond is treated by aerobic digestion in a package plant prior to being routed to the ash pond. This Sewage Treatment Plant (STP) consists of clarifier and aeration basin set in an inground concrete tank. The plant employs the extended aeration activated sludge process. Periodically to optimize treatment, sludge is wasted from the unit to an installed holding tank. As necessary, this holding tank is pumped by a licensed waste hauler for disposal. The STP is operated in accordance with plant procedures and adjustments are made as necessary. Recent effluent monitoring shows that the discharge easily meets normal secondary treatment limits. As it does not discharge directly, but discharges to the ash pond, we request that no monitoring requirements or limits be placed upon the discharge from the STP.

The water in the ash pond is normally above a pH of 9. As such, the discharge is treated with CO_2 to reduce the pH. The CO_2 is injected into the gravity discharge line which results in the formation of carbonic acid that reacts with some of the alkalinity in the water. The discharge usually cycles on and off approximately five times per day to maintain ash pond level. The CO_2 system automatically cycles on whenever the discharge valves open. The feed rate is adjusted manually to give an acceptable effluent pH. This system works well and no changes are planned in the near future for the discharge structure.

There are currently two seeps at the plant that are believed to be originating from the ash pond. Although dye studies have not confirmed their origin, the location and chemical make up of the seeps indicate that their source is the ash pond. As described below, we do not believe these seeps constitute separate discharges, but are only alternate routes for Outfall 002 within the authorization under our existing permit.

The first seep is located at the effluent end of the ash pond gravity discharge structure. The seep consists of a flow of approximately 2-5 gpm that comes from the fill material around the ash pond discharge pipe. This flows into the discharge canal which carries the Outfall 002 effluent to the Missouri River. We believe this discharge is authorized as a component of Outfall 002. This position is supported by seep's close proximity to the outfall, and its insignificant contribution to the discharge flow.

The second seep flows into an area of several acres at the southwest corner of the ash pond. The seep emanates from coarse fill material and appears to have a flow of up to 30 gpm. The area that this water flows into is bounded on all sides by elevated road bed with no outlets. Thus, the seep is not directly discharged to waters of the state. We believe that there is no need to regulate this seep since it is confined on site.



PERMIT BOUNDARY
PERMIT BOUNDARY
PERMIT BOUNDARY
N
SCALE: 1" = 800'
0
400
800
INEFFECTIVE FLOW BOUNDARY
River-side vector field
Bluff-side vector field
POND 2
CELL 2
(37± AC)
CELL 1
(30± AC)
POND 1
CELL 3
(55.5± AC)
CELL 4
(44± AC)
POND 3
44 YR - 100 FT TEAR
44 YR - 5 FT TEAR
INSIDE TOE OF SLOPE
GAS PIPELINE
LABADIE BOTTOM ROAD
DAVIS ROAD
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
MW-24
MW-25
MW-26
MW-27
MW-28
NOTES:
1. DISPERSION PLUME OUTLINES FOR 44 YR - 100 FT TEAR ARE IDENTICAL TO THOSE DEPICTED IN FIGURE 1.
2. DISPERSION PLUME OUTLINES FOR 44 YR - 5 FT TEAR ARE SUPERIMPOSED IN GREEN AND ARE THE SAME AS THOSE PRESENTED IN FIGURES 4 AND 7 OF THIS REPORT.
3. TRIANGULAR REGIONS IN GREEN PROVIDE A VISUAL ILLUSTRATION OF AREAS WHERE RE-MODELED PLUME MIGRATION USING A 5 FT TEAR COULD ESCAPE DETECTION USING THE ORIGINAL RESULTANT FLOW VECTORS OF N66.6°E and N32.6°E (SEE DETAIL). SEE ALSO SECTION 2.0 OF REPORT.
LEGEND
- PROPERTY LINE (APPROX.)
- PROPOSED UTILITY WASTE LANDFILL PERMIT BOUNDARY
- UNPAVED ROAD
- EXISTING EASEMENT
- EXISTING GAS PIPELINE
- EXISTING FIBER OPTIC
- EXISTING OVERHEAD ELECTRIC
- PROPOSED UTILITY WASTE LANDFILL INSIDE TOE OF SLOPE
- NORTHING AND EASTING MISSOURI STATE PLANE COORDINATE SYSTEM
- JURISDICTIONAL WETLANDS
- MONITORING WELL LOCATION (AS PROPOSED)
- IRRIGATION WELL
- SURVEY MONUMENT
TOP OF BERM
INSIDE TOE OF SLOPE
44 YR - 5 FT TEAR
MONITORING WELL
44 YR - 100 FT TEAR
DECREASED AREA OF COVERAGE (SEE NOTE 3)
OUTSIDE TOE OF SLOPE
DETAIL
1"=400'
LABADIE BOTTOM ROAD
CALL BEFORE YOU DIG - DRILL - BLAST
PREPARED FOR Ameren
DRAWN W.J.A. (G.E.R.)
CHKD. T.A.G. (G.E.R.)
SUPV. M.C.C. (G.E.R.)
APPD. T.A.G. (G.E.R.)
AMEREN MISSOURI LABADIE ENERGY CENTER
UTILITY WASTE LANDFILL
RESPONSE TO APRIL 22, 2013
FRANKLIN COUNTY IRPE COMMENTS
LOCATION 001309
PLUME DISPERSION MAP COMPARISON (100 FT AND 5 FT "TEARS")
CLASS 02010
ST. LOUIS, MISSOURI
FIGURE 8

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Groundwater Monitoring Well Network Summary
Table 1

Monitoring Well ID[1]	Northing Location[2]	Easting Location[2]	Ground Surface Elevation[2] (feet)	Top of Riser Elevation[2] (feet)	Well Depth[3] (feet, btor[4])	Base of Well Elevation[3] (feet, btor[4])	Screen Length[3,5] (feet)	Top of Screen Elevation[3] (feet)
MW-1	995572	727213	469.45	472.05	27.76	444.29	9.7	454.49
MW-2	995657	727664	469.30	471.86	26.35	445.51	9.7	455.71
MW-3	995740	728101	468.49	471.01	25.15	445.86	9.7	456.06
MW-4	995818	728546	468.34	470.96	25.54	445.42	9.7	456.62
MW-5	995546	728819	467.42	470.06	24.68	445.38	9.7	455.58
MW-6	995177	729227	467.09	469.68	23.10	446.58	9.7	456.78
MW-7	994621	729411	466.65	469.15	21.94	447.21	9.7	457.41
MW-8	994383	729643	465.57	468.25	21.82	446.43	9.7	456.63
MW-9	994168	729893	465.14	467.81	20.18	447.63	9.7	457.83
MW-10	993950	730149	465.84	468.56	21.45	447.11	9.7	457.31
MW-11	993725	730398	466.11	468.55	20.95	447.60	9.7	457.80
MW-12	993470	730662	465.74	468.11	20.48	447.63	9.7	457.83
MW-13	993256	730913	465.61	468.10	20.40	447.70	9.7	457.90
MW-14	993052	731166	464.15	466.83	19.79	447.04	9.7	457.24
MW-15	992807	731406	465.03	467.30	17.91	449.39	9.7	459.59
MW-16	992618	731651	463.97	466.57	18.50	448.07	9.7	458.27
MW-17	992302	731675	465.29	467.89	19.72	448.17	9.7	458.37
MW-18	991678	730928	462.76	465.27	18.24	447.03	9.7	457.23
MW-19	992089	730178	463.51	466.16	18.19	447.97	9.7	458.17
MW-20	991669	729952	463.61	465.97	17.62	448.35	9.7	458.55
MW-21	991334	729950	463.40	465.90	17.71	448.19	9.7	458.39
MW-22	990929	729355	464.20	466.80	17.92	448.88	9.7	459.08
MW-23	991099	728511	464.90	467.54	19.65	447.89	9.7	458.09
MW-24	991819	727992	464.59	467.10	19.99	447.11	9.7	457.31
MW-25	992707	727529	465.95	468.61	20.84	447.77	9.7	457.97
MW-26	993976	726911	466.66	469.20	23.00	446.20	9.7	456.40
MW-27	994664	726608	467.41	470.05	25.91	444.14	9.7	454.34
MW-28	995276	726640	468.60	471.18	27.06	444.12	9.7	454.32
TMW-1*	993783	728657	466.91	469.34	21.58	447.76	9.7	457.96

NOTES:

1. Refer to Figure 1 for monitoring well locations.
2. Monitoring well survey data provided by KdG, Inc. Ground Elevation at Monitoring Well is a Cut + on the Concrete Pad
   Horizontal Datum: Missouri State Plane Coordinates - NAD 83 (Feet), Vertical Datum: NAVD 88 (Feet)
3. Numerical values were obtained from the *Ameren Missouri Labadie Energy Center Utility Waste Landfill, Solid Waste Disposal Area, Franklin County, Missouri, Groundwater Detection Monitoring Wells Installation Report prepared by Reitz & Jens, Inc., May 2013.*
4. btor = below top of riser.
5. Actual screen length (9.7 feet) is the machine-slotted section of the 10-foot length of Schedule 40 PVC pipe.

* - TMW-1 is a temporary ("sentry") well located immediately east of initial cell construction area (Cell 1).

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Groundwater Elevation Summary
Table 2

Monitoring Well ID	Top of Riser Elev. (ft)	April 2013[1] Groundwater Depth[2] (ft)	April 2013[1] Groundwater Elev. (ft)
MW-1	472.05	18.44	453.61
MW-2	471.86	18.40	453.46
MW-3	471.01	17.92	453.09
MW-4	470.96	18.15	452.81
MW-5	470.06	17.43	452.63
MW-6	469.68	17.21	452.47
MW-7	469.15	16.70	452.45
MW-8	468.25	15.83	452.42
MW-9	467.81	15.49	452.32
MW-10	468.56	16.13	452.43
MW-11	468.55	16.17	452.38
MW-12	468.11	15.82	452.29
MW-13	468.10	15.85	452.25
MW-14	466.83	14.62	452.21
MW-15	467.30	15.11	452.19
MW-16	466.57	14.37	452.20
MW-17	467.89	15.71	452.18
MW-18	465.27	7.23	458.04
MW-19	466.16	13.53	452.63
MW-20	465.97	13.40	452.57
MW-21	465.90	13.26	452.64
MW-22	466.80	13.76	453.04
MW-23	467.54	12.93	454.61
MW-24	467.10	13.65	453.45
MW-25	468.61	15.01	453.60
MW-26	469.20	15.50	453.70
MW-27	470.05	16.17	453.88
MW-28	471.18	18.57	452.61
TMW-1	469.34	16.21	453.13
		Monthly Variability (ft)	5.86
		Maximum Water Elevation (ft)	458.04
		Minimum Water Elevation (ft)	452.18

NOTES:

1 - Groundwater level measurements collected on April 16-17, 2013.

2 - Depth measured from top of riser.

2.0 GROUNDWATER MONITORING SYSTEM

The accepted groundwater monitoring system consists of 28 permanent wells and one temporary well. Each well was designed and installed to monitor uppermost groundwater within the alluvial aquifer underlying the UWL to an approximate maximum depth of 25 feet. A summary of monitoring well information is presented in Table 1. Additional information can be found in the groundwater monitoring well installation report.

An initial round of water level measurements from the 29 wells were collected within a six-hour period on April 15, 2013. A second round of water level measurements were collected during the groundwater sampling activities on April 16 and 17, 2013, which occurred over a 32-hour period. Groundwater levels recorded during the second round of water level measurements are summarized in Table 2. A groundwater contour map based on the second round of water level measurements is included in Figure 1.

A summary of the monitoring well analytical data results are presented in Table 3.

Table 4 lists the required constituents for detection monitoring, as shown in 10 CSR 80-11.010 - Appendix I, including Molybdenum which was added per MDNR-SWMP request on March 7, 2013. Table 4 also specifies the analytical method used during laboratory analysis for each constituent, units of measurement, and Practical Quantitation Limits. Generally, analytical methods are defined by the U.S. Environmental Protection Agency (EPA) in their *Test Methods for Evaluating Solid Wastes* and are presented in EPA Publication SW-846 available on-line at http://www.epa.gov.

2.1 Monitoring Well Dedicated Tubing Installation

Dedicated tubing used for low-flow purging and sampling activities was installed to each monitoring well prior to sampling. The intake of the dedicated polyethelene tubing (semi-rigid 1/4" ID x 3/8" OD) intersects each monitoring well screened interval approximately two feet above the bottom of the well. Additionally, dedicated silicone tubing (flexible 0.170" ID x 3/8" OD) is slip-connected to the semi-rigid tubing at the top of each well casing. The flexible tubing is then connected to a non-dedicated peristaltic pump during the low-flow purging and sampling activities. It is approximately 30-inches in length to prevent contact with the ground when removed from within the interior of the monitoring well riser. The open end of the flexible tubing represents the point of sample collection. A clean, braided nylon string secures the semi-rigid tubing just below the connection with the flexible tubing, and is further secured with a plastic zip tie around the slip-connection. The nylon string is connected to the well cap to maintain the intake elevation of the semi-rigid tubing within the lower part of the well screen. Once purging and sampling activities are completed, the silicone tubing is returned to the interior of each monitoring well's PVC riser.

REITZ & JENS, INC.
CONSULTING ENGINEERS

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND - AIR - WATER

Project Engineering Team

Ameren Missouri
Labadie Energy Center
Groundwater Monitoring Report
1st Background Sampling Event – April 16-17, 2013

Prepared for:

Ameren
MISSOURI

May 2013

Ameren Missouri
Labadie Energy Center
Groundwater Monitoring Report
1st Background Sampling Event – April 16-17, 2013

May 2013

Prepared By:

Reitz & Jens, Inc.
1055 Corporate Square Drive
St. Louis, Missouri 63132
(314) 993-4132

and

GREDELL Engineering Resources, Inc.
1505 East High Street
Jefferson City, Missouri 65101
(573) 659-9078

Ameren Missouri
Labadie Energy Center
Groundwater Monitoring Report
1st Background Sampling Event – April 16-17, 2013
Franklin County, Missouri

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

The following discusses the methods used to sample and analyze groundwater samples from 29 monitoring wells surrounding Ameren Missouri's proposed Utility Waste Landfill (UWL) at their Labadie Energy Center in Franklin County Missouri. The results of the sample analysis are also provided. The 29 monitoring wells sampled were installed mid-March through mid-April 2013. A groundwater monitoring well installation report has been prepared under separate cover

This groundwater monitoring report represents the first round of background sampling and analytical data collection required prior to operation of the proposed UWL. An additional seven rounds of background sampling is planned prior to evaluating the groundwater quality data and recommending an appropriate statistical analysis plan. Subsequent rounds of sampling are currently scheduled at approximate 90 day intervals. Therefore, background sampling and reporting is projected to continue through early 2015. All field sampling activities, sample transport, laboratory analytical testing, and reporting are to be consistent with the accepted Groundwater Sampling and Analysis Plan found in Appendix Q of the CPA currently under review by MDNR-SWMP.

2.0 GROUNDWATER MONITORING SYSTEM

The accepted groundwater monitoring system consists of 28 permanent wells and one temporary well. Each well was designed and installed to monitor uppermost groundwater within the alluvial aquifer underlying the UWL to an approximate maximum depth of 25 feet. A summary of monitoring well information is presented in Table 1. Additional information can be found in the groundwater monitoring well installation report.

An initial round of water level measurements from the 29 wells were collected within a six-hour period on April 15, 2013. A second round of water level measurements were collected during the groundwater sampling activities on April 16 and 17, 2013, which occurred over a 32-hour period. Groundwater levels recorded during the second round of water level measurements are summarized in Table 2. A groundwater contour map based on the second round of water level measurements is included in Figure 1.

A summary of the monitoring well analytical data results are presented in Table 3.

Table 4 lists the required constituents for detection monitoring, as shown in 10 CSR 80-11.010 - Appendix I, including Molybdenum which was added per MDNR-SWMP request on March 7, 2013. Table 4 also specifies the analytical method used during laboratory analysis for each constituent, units of measurement, and Practical Quantitation Limits. Generally, analytical methods are defined by the U.S. Environmental Protection Agency (EPA) in their *Test Methods for Evaluating Solid Wastes* and are presented in EPA Publication SW-846 available on-line at http://www.epa.gov.

2.1 Monitoring Well Dedicated Tubing Installation

Dedicated tubing used for low-flow purging and sampling activities was installed to each monitoring well prior to sampling. The intake of the dedicated polyethelene tubing (semi-rigid 1/4" ID x 3/8" OD) intersects each monitoring well screened interval approximately two feet above the bottom of the well. Additionally, dedicated silicone tubing (flexible 0.170" ID x 3/8" OD) is slip-connected to the semi-rigid tubing at the top of each well casing. The flexible tubing is then connected to a non-dedicated peristaltic pump during the low-flow purging and sampling activities. It is approximately 30-inches in length to prevent contact with the ground when removed from within the interior of the monitoring well riser. The open end of the flexible tubing represents the point of sample collection. A clean, braided nylon string secures the semi-rigid tubing just below the connection with the flexible tubing, and is further secured with a plastic zip tie around the slip-connection. The nylon string is connected to the well cap to maintain the intake elevation of the semi-rigid tubing within the lower part of the well screen. Once purging and sampling activities are completed, the silicone tubing is returned to the interior of each monitoring well's PVC riser.

3.0 FIELD SAMPLING SUMMARY

The first background groundwater sampling event was performed by qualified Gredell Engineering field personnel on April 16 and 17, 2013. Groundwater samples were collected from all 29 monitoring wells using low-flow sampling techniques and dedicated sampling equipment per the accepted Groundwater Sampling and Analysis Plan. Field tests for indicator parameters, as specified under 10 CSR 80-11.010(11)(C) 4.B, were performed and each sample was analyzed for the suite of chemical constituents listed on Table 4.

All sample bottles were prepared (i.e., pre-labeled and appropriate preservatives added) prior to shipment by the analytical contractor Teklab, Inc. (Teklab) of Collinsville, Illinois and delivered to the offices of Gredell Engineering in Jefferson City, Missouri.

Field environmental staff inspected the condition of each monitoring well prior to sampling and completed a checklist during that inspection using the forms provided in the accepted Groundwater Sampling and Analysis Plan. Copies of field notes and the completed Monitoring Well Field Inspection forms are included in Appendix 1. Water levels in each monitoring well were initially determined using a Geotech ET electronic water level meter graduated in 0.01 foot increments. A non-dedicated Geotech Geopump Series II peristaltic pump was then connected to the dedicated tubing in each well and then purged at a rate no greater than 400 milliliters per minute (mL/min). During purging, a YSI 556MPS multi-function meter fitted with a flow-through cell was used to measure field pH, specific conductance, temperature, oxidation reduction potential and dissolved oxygen. Turbidity was determined at periodic intervals using a MicroTPI HF Scientific Turbidimeter. When field indicator parameters stabilized, samples were collected at the specified purge rate. Collected samples were stored in coolers on wet ice until delivered to Teklab using standard chain-of-custody procedures. Stabilization information for each sample was recorded on a Field Sampling Log and copies of each log are included in Appendix 1.

Subsequent to the sampling event, a list of required field parameters (i.e., groundwater elevation, specific conductivity and pH) was compiled and transmitted to Teklab to be added to the laboratory analytical report as field determined values.

3.1 Field Quality Assurance/Quality Control

Field Quality Assurance/Quality Control performed during the sampling event included the collection of two field replicate samples (presented to the laboratory as unspecified duplicate samples), a field blank, and a trip blank. Duplicate 1 is a replicate of MW-27 and was collected immediately after the initial sample. Duplicate 2 is a replicate of MW-10 and was collected immediately after the initial sample. Additionally, one field blank sample was collected following the completion of sampling of MW-21. Field staff prepared the trip blank with deionized water (provided by Teklab) prior to the beginning of sampling activities. Rinsate (equipment) blanks were not collected due to the use of dedicated sampling equipment. Samples were preserved in the manner required for the parameter being analyzed, placed in a cooler containing water-ice, and picked up by a Teklab courier and transported to the laboratory facility for analysis. Standard chain-of-custody procedures were followed and copies of the completed chain-of-custody records received from Teklab are included in Appendix 3. The completed chain-of-custody records indicate that, upon receipt by the laboratory, additional nitric acid was needed in the containers for the TMW-01 metals and Duplicate 2 metals samples. Field staff had previously noted minor amounts of suspected nitric acid leakage (i.e., label discoloration) on these sample containers when originally received from Teklab.

3.2 Water Table Surface

The water level measurements taken April 16-17, 2013 are summarized in Table 2. The measurements show minor fluctuations relative to one another (+/- 2-3 ft) except for MW-18 (Table 2). This well had a water level several feet higher in elevation than the other wells. This is reflected on the water table surface map included as Figure 1. Otherwise, the movement of groundwater is generally from west-to-east across the site. Apparent hydraulic gradients as determined by the groundwater mapping software Surfer® Version 10.7.972 range from a minimum of 9.65×10^{-6} ft/ft to a maximum of 7.56×10^{-3} ft/ft in the vicinity of MW-18.

4.0 ANALYTICAL SUMMARY

Analytical data provided by Teklab for each well sampled during the background sampling event is provided in Appendix 2. These data are summarized on Table 3. Appendix 2 also contains the analytical data for the sample duplicates, field blank, and trip blank. Laboratory quality assurance/quality control documentation, including data for inorganic parameters, metals, and organic (TOX) parameters are provided in Appendix 3.

The analytical data sheets note that Beryllium, Nickel, and Total Organic Halogens (Halides) (TOX) were reported in micrograms per liter (µg/L). These units were converted to milligrams per liter (mg/L) on the data summary presented on Table 3 to maintain consistency with the reporting requirements of 10 CSR 80-11.010 - Appendix I.

4.1 Precision and Accuracy

Precision is a measure of the reproducibility of analytical results, generally expressed as a *Relative Percent Difference*. Laboratory quality control procedures to measure precision consist of laboratory control sample (LCS) analysis and analysis of matrix spike/matrix spike duplicates (MS/MSD). These analyses are used to define analytical variability. Accuracy is defined as the degree of agreement between the measured amount of a species and the amount actually known to be present, expressed as a percentage. It is generally determined by calculating the percent recoveries for analyses of surrogate compounds, laboratory control samples, continuing calibration check standards and matrix spike samples. Acceptable percent recoveries are established for SW-846 and EPA methods. Field and laboratory blank analyses are also used to address measurement bias.

The Analytical Report received from Teklab states that *"All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and in accordance with NELAP except where noted"* (Appendix 3). Quality control comments noted within the analytical report are described below:

- The matrix spike (MS) QC limits for Calcium and Magnesium in MW-2, MW-17 and TMW-1 are not applicable due to the high sample/spike ratio. These results are shown with an "S" flag.
- The MS QC limit for Iron in MW-2 and TMW-1 is not applicable due to the high sample/spike ratio. These results are shown with an "S" flag.
- Matrix interference for Antimony was present in the sample for MW-3 and was confirmed by bench spike. This result is shown with an "S" flag.
- MS and/or matrix spike duplicate (MSD) for Sulfate in MW-5, MW-6, MW-11 and MW-13 did not recover within control limits due to matrix interference. These results are shown with an "S" flag.

- Results of MS and/or MSD for Sulfate in MW-12 have less certainty because value(s) exceed upper quantitation limits. A flagged value is not associated with this comment.

- In addition, a significant number of data results are shown with a "J" flag (Table 3). According to the laboratory, a "J" flag denotes an analyte was detected below quantitation limits (PQL). Review of these results confirms that reported values all fall below applicable PQL's. It was also noted that "J" flags are used to report some parameters, but not others and no one parameter is consistently reported using "J" flag values.

- In some instances, dilution factors (DF) were required during analysis, specifically for Sulfate and Arsenic. A DF of two was used to obtain the analytical result for Sulfate in MW-10, whereas a DF of five was required for the analysis of Sulfate in MW-11, MW-13, MW-17, MW-19, MW-22, and TMW-1. Similarly, a DF of two was used to obtain the analytical result for Arsenic in MW-9, whereas a DF of five was required for the analysis of Arsenic in MW-7 and TMW-1. The analytical report defines DF as, "*The dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilution factors.*"

Additional Quality Assurance and Quality Control comments include the following:

- *Field Replicates*: Analyses of replicate samples are used to define the total variability of the sampling/analytical system as a whole. Two field replicates, Duplicate 1 and Duplicate 2, were collected during this sampling event (Duplicate 1 was a replicate sample of MW-27 and Duplicate 2 was a replicate sample of MW-10). The Relative Percent Difference (RPD) was calculated for detected chemical parameters, which consisted of Chloride, Fluoride, Hardness, Sulfate, TDS, TOC, Arsenic, Boron, Barium, Calcium, Iron, Magnesium, Manganese, and Nickel. Using a tolerance level of +/-20 percent, calculated RPDs were within acceptable ranges except for Fluoride (35%) and Sulfate (25%) in MW-27/Duplicate 1. The MW-10/Duplicate 2 sample comparisons were within acceptable ranges for each detected parameter.

- *Field and Trip Blanks*: One field blank and one trip blank were incorporated into the data set for this sampling event. The field blank contained reportable concentrations of Boron (36.7 µg/L), Calcium (0.091 µg/L), Copper (30.4 µg/L), Magnesium (0.012 µg/L), Sodium (0.464 µg/L) and Zinc (24.7 µg/L). The trip blank did not contain a reportable concentration of Total Organic Halogens (TOX), which is the only required test parameter for this sample.

- *Laboratory Blanks*: Method blanks, artificial, and matrix-less samples are analyzed to monitor the laboratory system for interferences and contamination from glassware, reagents, etc. Method blanks are taken throughout the entire sample preparation process. They are included with each batch of extractions or digestions prepared, or with each 20 samples, whichever was more frequent. Reference to Appendix 3 should be made for additional information related to these and other laboratory control samples.

4.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely reflect site conditions. Representativeness of the data is determined by comparing actual sampling procedures to those delineated in the field sampling and analysis plan, comparing results from field replicate samples and reviewing the results of field blanks.

4.3 Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured by using established and approved sample collection techniques and analytical methods, consistent basis of analysis, consistent reporting units, and analyzing standard reference materials.

4.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected under controlled laboratory conditions. Completeness is defined as the valid data percentage of the total tests requested. Valid data are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed chain-of-custody form. Furthermore, the sample must have been analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria are met.

5.0 RESULTS SUMMARY

As shown on Table 3, fourteen of the required analytical parameters were not detected in any of the 29 monitoring wells above established PQL concentrations. These "non-detect" parameters include Antimony, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Mercury, Molybdenum, Silver, Thallium, Zinc, Chemical Oxygen Demand (COD) and Total Organic Halogens (TOX). In some instances, "J" flag values, which imply a concentration below PQL but above Method Detection Limits (MDL), are used for reporting purposes for these fourteen parameters. This includes Cobalt (eight samples), Copper (two samples), Lead (eleven samples), Zinc (23 samples), COD (two samples), and TOX (five samples).

Seven of the required analytical parameters were detected above established PQL concentrations in all 29 monitoring wells (Hardness concentrations are also reported for all wells, but it is not associated with an established PQL). These "detected" parameters include Boron, Barium, Calcium, Magnesium, Sodium, Total Dissolved Solids (TDS), and Total Organic Carbon (TOC) (Table 3). In some instances, "S" flag qualifiers were used to denote that the reported result is associated with a matrix spike (MS) outside of QC limits. An "S" flag was used for three of the results for Calcium, Magnesium, and Sulfate. It was also used to denote two of the results for Iron and one of the results for Antimony.

The nine remaining required analytical parameters (Aluminum, Arsenic, Iron, Manganese, Nickel, Selenium, Chloride, Fluoride, and Sulfate) were reported as "detectable" in some wells and "non-detect" in other wells (Table 3). Iron, Manganese, Fluoride, and Sulfate were detected above the established PQL in 28 of the 29 wells. Arsenic was detected in 14 wells and Chloride was detected in 12 wells. Fewer wells contained detectable concentrations of Aluminum (five samples), Nickel (2 samples), and Selenium (2 samples). The usage of "J" flag qualifiers are also found in the results for Aluminum (nine samples), Arsenic (five samples), Nickel (18 samples), Chloride (17 samples), and Sulfate, Iron and Manganese (one sample each).

TABLES

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Groundwater Monitoring Well Network Summary
Table 1

Monitoring Well ID[1]	Northing Location[2]	Easting Location[2]	Ground Surface Elevation[2] (feet)	Top of Riser Elevation[2] (feet)	Well Depth[3] (feet, btor[4])	Base of Well Elevation[3] (feet, btor[4])	Screen Length[3,5] (feet)	Top of Screen Elevation[3] (feet)
MW-1	995572	727213	469.45	472.05	27.76	444.29	9.7	454.49
MW-2	995657	727664	469.30	471.86	26.35	445.51	9.7	455.71
MW-3	995740	728101	468.49	471.01	25.15	445.86	9.7	456.06
MW-4	995818	728546	468.34	470.96	25.54	445.42	9.7	456.62
MW-5	995546	728819	467.42	470.06	24.68	445.38	9.7	455.58
MW-6	995177	729227	467.09	469.68	23.10	446.58	9.7	456.78
MW-7	994621	729411	466.65	469.15	21.94	447.21	9.7	457.41
MW-8	994383	729643	465.57	468.25	21.82	446.43	9.7	456.63
MW-9	994168	729893	465.14	467.81	20.18	447.63	9.7	457.83
MW-10	993950	730149	465.84	468.56	21.45	447.11	9.7	457.31
MW-11	993725	730398	466.11	468.55	20.95	447.60	9.7	457.80
MW-12	993470	730662	465.74	468.11	20.48	447.63	9.7	457.83
MW-13	993256	730913	465.61	468.10	20.40	447.70	9.7	457.90
MW-14	993052	731166	464.15	466.83	19.79	447.04	9.7	457.24
MW-15	992807	731406	465.03	467.30	17.91	449.39	9.7	459.59
MW-16	992618	731651	463.97	466.57	18.50	448.07	9.7	458.27
MW-17	992302	731675	465.29	467.89	19.72	448.17	9.7	458.37
MW-18	991678	730928	462.76	465.27	18.24	447.03	9.7	457.23
MW-19	992089	730178	463.51	466.16	18.19	447.97	9.7	458.17
MW-20	991669	729952	463.61	465.97	17.62	448.35	9.7	458.55
MW-21	991334	729950	463.40	465.90	17.71	448.19	9.7	458.39
MW-22	990929	729355	464.20	466.80	17.92	448.88	9.7	459.08
MW-23	991099	728511	464.90	467.54	19.65	447.89	9.7	458.09
MW-24	991819	727992	464.59	467.10	19.99	447.11	9.7	457.31
MW-25	992707	727529	465.95	468.61	20.84	447.77	9.7	457.97
MW-26	993976	726911	466.66	469.20	23.00	446.20	9.7	456.40
MW-27	994664	726608	467.41	470.05	25.91	444.14	9.7	454.34
MW-28	995276	726640	468.60	471.18	27.06	444.12	9.7	454.32
TMW-1*	993783	728657	466.91	469.34	21.58	447.76	9.7	457.96

NOTES:

1. Refer to Figure 1 for monitoring well locations.
2. Monitoring well survey data provided by KdG, Inc. Ground Elevation at Monitoring Well is a Cut + on the Concrete Pad
   Horizontal Datum: Missouri State Plane Coordinates - NAD 83 (Feet), Vertical Datum: NAVD 88 (Feet)
3. Numerical values were obtained from the *Ameren Missouri Labadie Energy Center Utility Waste Landfill, Solid Waste Disposal Area, Franklin County, Missouri, Groundwater Detection Monitoring Wells Installation Report prepared by Reitz & Jens, Inc., May 2013.*
4. btor = below top of riser.
5. Actual screen length (9.7 feet) is the machine-slotted section of the 10-foot length of Schedule 40 PVC pipe.

* - TMW-1 is a temporary ("sentry") well located immediately east of initial cell construction area (Cell 1).

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Groundwater Elevation Summary
Table 2

Monitoring Well ID	Top of Riser Elev. (ft)	April 2013[1] Groundwater Depth[2] (ft)	April 2013[1] Groundwater Elev. (ft)
MW-1	472.05	18.44	453.61
MW-2	471.86	18.40	453.46
MW-3	471.01	17.92	453.09
MW-4	470.96	18.15	452.81
MW-5	470.06	17.43	452.63
MW-6	469.68	17.21	452.47
MW-7	469.15	16.70	452.45
MW-8	468.25	15.83	452.42
MW-9	467.81	15.49	452.32
MW-10	468.56	16.13	452.43
MW-11	468.55	16.17	452.38
MW-12	468.11	15.82	452.29
MW-13	468.10	15.85	452.25
MW-14	466.83	14.62	452.21
MW-15	467.30	15.11	452.19
MW-16	466.57	14.37	452.20
MW-17	467.89	15.71	452.18
MW-18	465.27	7.23	458.04
MW-19	466.16	13.53	452.63
MW-20	465.97	13.40	452.57
MW-21	465.90	13.26	452.64
MW-22	466.80	13.76	453.04
MW-23	467.54	12.93	454.61
MW-24	467.10	13.65	453.45
MW-25	468.61	15.01	453.60
MW-26	469.20	15.50	453.70
MW-27	470.05	16.17	453.88
MW-28	471.18	18.57	452.61
TMW-1	469.34	16.21	453.13
		Monthly Variability (ft)	5.86
		Maximum Water Elevation (ft)	458.04
		Minimum Water Elevation (ft)	452.18

NOTES:

1 - Groundwater level measurements collected on April 16-17, 2013.

2 - Depth measured from top of riser.

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Background Water Quality Summary
Table 3

Well ID	Constituent[1] Units[2] Date	Spec.Cond. µmhos/cm	pH S.U.	Chloride mg/L	COD mg/L	Fluoride mg/L	Hardness mg/L	SO_4 mg/L	TDS mg/L	TOC mg/L	TOX mg/L	Ag µg/L	Al µg/L	As µg/L	B µg/L	Ba µg/L	Be mg/L
MW-1	4/16/2013	991	6.83	10	<10	0.11	512	26	536	2.2	<0.02	<10.0	<50.0	22.1	79.4	402	<0.001
MW-2	4/16/2013	1305	6.85	17	<10	0.21	673	31	696	3.0	<0.02	<10.0	<50.0	29.5	121	416	<0.001
MW-3	4/16/2013	987	6.99	9	<10	0.12	501	54	516	2.4	<0.02	<10.0	<50.0	1.2 "J"	63.6	415	<0.001
MW-4	4/16/2013	973	6.94	6	<10	0.18	527	25	532	1.5	<0.02	<10.0	<50.0	<3.0	72.8	274	<0.001
MW-5	4/16/2013	899	6.86	2 "J"	<10	0.16	486	16 "S"	482	1.4	<0.02	<10.0	<50.0	<3.0	52.9	293	<0.001
MW-6	4/16/2013	992	6.82	3 "J"	<10	0.14	539	19 "S"	566	1.8	<0.02	<10.0	37 "J"	<3.0	62.2	227	<0.001
MW-7	4/16/2013	1087	7.07	15	9 "J"	0.20	536	26	568	3.4	<0.02	<10.0	246	66.6	72.6	480	<0.001
MW-8	4/16/2013	856	6.83	8	7 "J"	0.16	431	10 "J"	460	2.6	<0.02	<10.0	<50.0	13.6	45.3	265	<0.001
MW-9	4/16/2013	811	7.16	5 "J"	<10	0.18	415	20	414	1.7	<0.02	<10.0	<50.0	26.4	53.6	265	<0.001
MW-10[3]	4/16/2013	947	6.99	6	<10	0.17	502	54	430	1.9	<0.02	<10.0	27 "J"	8.8	56.7	462	<0.001
MW-11	4/16/2013	887	6.89	2 "J"	<10	0.12	493	64 "S"	460	1.8	<0.02	<10.0	<50.0	0.8 "J"	54.8	301	<0.001
MW-12	4/16/2013	829	6.93	2 "J"	<10	0.10 "J"	445	42	448	1.6	0.0151 "J"	<10.0	18 "J"	1.4 "J"	52.9	253	<0.001
MW-13	4/16/2013	901	6.87	2 "J"	<10	0.12	488	64 "S"	498	2.5	<0.02	<10.0	33 "J"	<3.0	53.5	295	<0.001
MW-14	4/16/2013	843	6.95	3 "J"	<10	0.14	465	42	490	1.8	<0.02	<10.0	30 "J"	7.1	48.2	268	<0.001
MW-15	4/16/2013	791	6.84	2 "J"	<10	0.16	436	27	404	1.7	<0.02	<10.0	<50.0	<3.0	58.1	206	<0.001
MW-16	4/16/2013	1038	6.85	6	<10	0.22	559	30	554	2.7	<0.02	<10.0	31 "J"	12.5	102	102	<0.001
MW-17	4/16/2013	1035	6.79	2 "J"	<10	0.13	564	59	580	4.2	<0.02	<10.0	119	5.3	64.9	275	<0.001
MW-18	4/16/2013	861	7.00	1 "J"	<10	0.18	450	34	476	1.7	0.0132 "J"	<10.0	<50.0	<3.0	45.8	147	<0.001
MW-19	4/16/2013	891	6.83	2 "J"	<10	0.15	478	72	500	2.0	<0.02	<10.0	<50.0	<3.0	72.1	228	<0.001
MW-20	4/16/2013	663	6.99	2 "J"	<10	0.19	355	21	356	2.3	<0.02	<10.0	<50.0	<3.0	48.7	182	<0.001
MW-21	4/16/2013	675	6.92	3 "J"	<10	0.16	350	30	262	1.6	0.0158 "J"	<10.0	<50.0	1.0 "J"	57.7	237	<0.001
MW-22	4/16/2013	1034	6.88	6	<10	0.25	537	30	560	2.8	<0.02	<10.0	<50.0	45.7	156	238	<0.001
MW-23	4/16/2013	1010	6.84	4 "J"	<10	0.18	543	21	508	2.2	<0.02	<10.0	153	3.4	94.0	210	<0.001
MW-24	4/16/2013	792	6.94	3 "J"	<10	0.18	427	36	426	1.3	<0.02	<10.0	154	<3.0	47.1	190	<0.001
MW-25	4/16/2013	834	7.18	4 "J"	<10	0.14	443	17	406	1.6	<0.02	<10.0	38 "J"	6.5	124	511	<0.001
MW-26	4/16/2013	899	7.02	4 "J"	<10	0.16	487	45	504	1.6	0.0175 "J"	<10.0	55.5	<3.0	82.7	286	<0.001
MW-27[3]	4/16/2013	1004	6.83	11	<10	0.18	549	29	576	1.8	0.0154 "J"	<10.0	31 "J"	3.3	98.6	268	<0.001
MW-28	4/16/2013	960	6.78	5	<10	0.16	530	31	556	1.7	<0.02	<10.0	16 "J"	1.5 "J"	86.7	269	<0.001
TMW-1	4/16/2013	1139	7.01	6	<10	0.26	593	128	674	2.6	<0.02	<10.0	<50.0	29.5	100	355	<0.001

Well ID	Ca mg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe µg/L	Mg mg/L	Mn µg/L	Mo µg/L	Na mg/L	Ni mg/L	Pb µg/L	Sb µg/L	Se µg/L	Zn µg/L	Hg µg/L	Tl µg/L
MW-1	158	<2.0	3.3 "J"	<10.0	<10.0	17000	28.7	1470	<10.0	5.05	0.0058 "J"	<2.0	<5.0	<30.0	<10.0	<0.20	<2.0
MW-2	185 "S"	<2.0	2.9 "J"	<10.0	<10.0	28400 "S"	51.2 "S"	2960	<10.0	8.98	<0.0100	<2.0	<5.0	<30.0	2.5 "J"	<0.20	<2.0
MW-3	141	<2.0	<10.0	<10.0	3.3 "J"	16200	36.1	2760	<10.0	8.58	<0.0100	<2.0	<5.0 "S"	<30.0	2.2 "J"	<0.20	<2.0
MW-4	162	<2.0	<10.0	<10.0	<10.0	115	29.4	1240	<10.0	6.02	0.0091 "J"	<2.0	<5.0	<30.0	<10.0	<0.20	<2.0
MW-5	157	<2.0	<10.0	<10.0	<10.0	210	22.8	458	<10.0	5.33	0.0116	<2.0	<5.0	<30.0	2.1 "J"	<0.20	<2.0
MW-6	163	<2.0	<10.0	<10.0	<10.0	53.0	32.2	106	<10.0	6.78	0.0101	<2.0	<5.0	<30.0	4.3 "J"	<0.20	<2.0
MW-7	150	<2.0	<10.0	<10.0	<10.0	30300	39.6	1670	<10.0	9.99	<0.0100	<2.0	<5.0	<30.0	2.9 "J"	<0.20	<2.0
MW-8	136	<2.0	<10.0	<10.0	<10.0	23600	22.0	896	<10.0	4.95	<0.0100	<2.0	<5.0	<30.0	2.7 "J"	<0.20	<2.0
MW-9	121	<2.0	<10.0	<10.0	<10.0	16700	27.5	1450	<10.0	5.44	<0.0100	<2.0	<5.0	<30.0	<10.0	<0.20	<2.0
MW-10[3]	144	<2.0	<10.0	<10.0	<10.0	16900	34.6	1350	<10.0	7.79	<0.0100	0.4 "J"	<5.0	<30.0	<10.0	<0.20	<2.0
MW-11	145	<2.0	3.1 "J"	<10.0	<10.0	436	32.0	523	<10.0	8.32	0.0068 "J"	0.5 "J"	<5.0	<30.0	<10.0	<0.20	<2.0
MW-12	128	<2.0	3.0 "J"	<10.0	<10.0	419	30.6	483	<10.0	6.96	0.0052 "J"	<2.0	<5.0	<30.0	4.0 "J"	<0.20	<2.0
MW-13	143	<2.0	<10.0	<10.0	<10.0	59.2	32.0	117	<10.0	6.42	<0.0100	<2.0	<5.0	<30.0	5.1 "J"	<0.20	<2.0
MW-14	140	<2.0	3.3 "J"	<10.0	<10.0	3590	27.8	979	<10.0	5.82	0.0039 "J"	<2.0	<5.0	<30.0	5.5 "J"	<0.20	<2.0
MW-15	136	<2.0	<10.0	<10.0	<10.0	16 "J"	23.5	18.1	<10.0	5.64	0.0058 "J"	<2.0	<5.0	<30.0	4.1 "J"	<0.20	<2.0
MW-16	157	<2.0	4.4 "J"	<10.0	<10.0	8580	40.4	3740	<10.0	9.50	0.0041 "J"	<2.0	<5.0	<30.0	5.0 "J"	<0.20	<2.0
MW-17	165 "S"	<2.0	3.4 "J"	<10.0	<10.0	1620	36.7 "S"	1270	<10.0	8.58	0.0037 "J"	0.7 "J"	<5.0	<30.0	3.5 "J"	<0.20	<2.0
MW-18	135	<2.0	<10.0	<10.0	<10.0	22.3	27.3	89.5	<10.0	6.93	<0.0100	0.4 "J"	<5.0	38.5	4.0 "J"	<0.20	<2.0
MW-19	143	<2.0	<10.0	<10.0	<10.0	136	29.4	98.9	<10.0	9.86	0.0057 "J"	<2.0	<5.0	<30.0	4.2 "J"	<0.20	<2.0
MW-20	106	<2.0	<10.0	<10.0	<10.0	30.9	21.7	154	<10.0	5.21	0.0074 "J"	0.5 "J"	<5.0	<30.0	4.0 "J"	<0.20	<2.0
MW-21	107	<2.0	<10.0	<10.0	<10.0	1080	19.9	412	<10.0	9.05	0.0036 "J"	<2.0	<5.0	<30.0	3.8 "J"	<0.20	<2.0
MW-22	145	<2.0	<10.0	<10.0	<10.0	19900	42.6	1900	<10.0	14.1	<0.0100	0.5 "J"	<5.0	<30.0	4.1 "J"	<0.20	<2.0
MW-23	144	<2.0	<10.0	<10.0	<10.0	3600	44.6	180	<10.0	17.0	0.0039 "J"	<2.0	<5.0	<30.0	3.5 "J"	<0.20	<2.0
MW-24	128	<2.0	<10.0	<10.0	3.0 "J"	277	25.9	4.1 "J"	<10.0	7.71	0.0048 "J"	0.6 "J"	<5.0	45.5	4.1 "J"	<0.20	<2.0
MW-25	132	<2.0	<10.0	<10.0	<10.0	4850	27.4	2730	<10.0	7.04	0.0036 "J"	0.7 "J"	<5.0	<30.0	3.8 "J"	<0.20	<2.0
MW-26	146	<2.0	<10.0	<10.0	<10.0	630	29.9	3000	<10.0	7.84	0.0043 "J"	0.7 "J"	<5.0	<30.0	<10.0	<0.20	<2.0
MW-27[3]	169	<2.0	4.1 "J"	<10.0	<10.0	3220	30.8	1280	<10.0	6.74	0.0058 "J"	0.5 "J"	<5.0	<30.0	5.2 "J"	<0.20	<2.0
MW-28	162	<2.0	<10.0	<10.0	<10.0	2020	30.2	402	<10.0	5.84	0.0082 "J"	1.0 "J"	<5.0	<30.0	4.5 "J"	<0.20	<2.0
TMW-1	163 "S"	<2.0	<10.0	<10.0	<10.0	12100 "S"	45.4 "S"	4690	<10.0	11.0	0.0036 "J"	<2.0	<5.0	<30.0	5.5 "J"	<0.20	<2.0

NOTES:
1. Abbreviated chemical constituent names are defined in Table 4.
2. Abbreviated units for chemical constituents are defined in Table 4.
3. Duplicate 1 is a duplicate sample of MW-27. Duplicate 2 is a duplicate sample of MW-10. Analytical results for the duplicate samples are provided in Appendix 2.
"J" Flag - Analyte detected below quantitation limits
"S" Flag - Spike Recovery outside recovery limits
Sequence of sample collection for April 16 and 17, 2013 event is MW-22 through MW-28, MW-1 through MW-15, MW-21, MW-20, MW-19, MW-18, MW-17, MW-16 and TMW-1

Ameren Missouri Labadie Energy Center
Proposed Utility Waste Landfill
Franklin County, Missouri

Constituents for Detection Monitoring
(10 CSR 80-11.010 – Appendix I)
Table 4

Chemical Constituent	Units[1]	Method[2]	PQL[3]
Aluminum (Al)	µg/L	6010B	50
Antimony (Sb)	µg/L	7041	5
Arsenic (As)	µg/L	7060A	3
Barium (Ba)	µg/L	6010B	5
Beryllium (Be)	mg/L	6010B	0.001
Boron (B)	µg/L	6010B	20
Cadmium (Cd)	µg/L	6010B	2
Calcium (Ca)	mg/L	6010B	0.05
Chemical Oxygen Demand (COD)	mg/L	410.4	10
Chloride	mg/L	9251	5
Chromium (Cr)	µg/L	6010B	10
Cobalt (Co)	µg/L	6010B	10
Copper (Cu)	µg/L	6010B	10
Fluoride	mg/L	9214	0.10
Hardness	mg/L	2340B	NA
Iron (Fe)	µg/L	6010B	20
Lead (Pb)	µg/L	7421	2
Magnesium (Mg)	mg/L	6010B	0.010
Manganese (Mn)	µg/L	6010B	5
Mercury (Hg)	µg/L	7470A	0.2
Molybdenum (Mo)[4]	µg/L	6010B	10
Nickel (Ni)	mg/L	6010B	0.01
pH (Field)	S.U.	9040B	NA
Selenium (Se)	µg/L	6010B	50
Silver (Ag)	µg/L	6010B	10
Sodium (Na)	mg/L	6010B	0.05
Specific Conductance (Field)	µmhos/cm	9050A	NA
Sulfate (SO_4)	mg/L	9036	10
Thallium (Tl)	µg/L	7841	2
Total Dissolved Solids (TDS)	mg/L	2540C	20
Total Organic Carbon (TOC)	mg/L	9060	1
Total Organic Halogens (TOX)	mg/L	9020B	20
Zinc (Zn)	µg/L	6010B	10
Ground Water Elevation	feet	NA	NA

NOTES:

1. µg/L = micrograms per liter
   mg/L = milligrams per liter
   S.U. = Standard Unit
   µmhos/cm = micromhos per centimeter
2. Suggested Methods refer to analytical procedure numbers used in EPA Report SW-846 "Test Methods for Evaluating Solid Waste", third edition, November 1986, as revised, December 1987, or applicable updates.
3. Practical Quantitation Limits as established by the contract laboratory.
4. Molybdenum added per the request of the MDNR-SWMP in correspondence dated March 7, 2013.

FIGURES