Ameren MISSOURI

Power Operations Services

January 3, 2013

Ms. Charlene Fitch, P.E.
Engineering Section Chief
MDNR Solid Waste Management Program
P.O. Box 176
Jefferson City, MO 65102-0176

Re: Proposed Groundwater Monitoring Program - Utility Waste Landfill
Ameren Missouri Labadie Energy Center

Dear Ms. Fitch:

In support of the proposed new Utility Waste Landfill (UWL) at our Labadie Energy Center, we are enclosing information concerning the proposed Groundwater Monitoring Program for the UWL. The scope of this detection system was discussed in our December 13, 2012 meeting with your staff and staff from the Division of Geology and Land Survey (DGLS) at DGLS' office in Rolla, Missouri. We anticipate submitting the complete Construction Permit Application (CPA) for this UWL in the first quarter of 2013. However, to complete eight (8) rounds of background statistical groundwater sampling prior to operation of this UWL we are requesting your review and approval of this Groundwater Monitoring Program at your earliest convenience.

The following documents that are from the pending CPA, signed and sealed by both a Professional Engineer and a Registered Geologist, are enclosed and demonstrate that the proposed Labadie Energy Center UWL's Groundwater Monitoring Program is in compliance with 10 CSR 80-11.010(11):

- Appendix Q from the pending CPA providing details of the proposed Groundwater Sampling and Analysis Plan for the Labadie Energy Center UWL.
- Appendix W from the pending CPA summarizing the Groundwater Hydraulic Data for the Labadie Energy Center UWL.
- Appendix X from the pending CPA documenting the proposed Groundwater Monitoring Well Design for the Labadie Energy Center UWL.
- Five (5) copies of the 28"x36" drawing from Appendix Q showing the proposed UWL configuration and Monitoring Well locations for the Labadie Energy Center UWL.
- A DVD containing electronic PDF files of the above and the approved Detailed Site Investigation report for this facility.

We understand from our December 13 meeting that the SWMP and DGLS will review the enclosed information for approval prior to formal submittal of the complete CPA for the Labadie Energy Center UWL. We are planning for installation of the groundwater monitoring system in the first quarter of 2013. If you have any questions or require additional information prior to completing your review, please contact me at 314-957-3407 or CGiesmann@ameren.com.

Sincerely,

Craig J. Giesmann, P.E., P.M.P.
Managing Supervisor, Hydro Engineering
T 314.957.3407
F 314.957.3260

Enclosures

cc: P. T. Price (MDNR)
T. R. Gredell (GER)
P. H. Reitz (R&J)

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Union, MO 63084-1862

Mr. Doug Mauntel
c/o Andrews Engineering
3300 Ginger Creek Drive
Springfield, IL 62711

bcc: P. R. Pike
T. L. Hollenkamp
K. J. Gerhardt
S. B. Knowles
B. S. Skitt
D. L. Strubberg
S. C. Whitworth
M. J. Tomasovic

MAR 07 2013

Mr. Paul R. Pike
Environmental Science Executive
Ameren Missouri
1901 Chouteau Avenue
P.O. Box 66149, MC 602
St. Louis, MO 63166-6149

RE: Groundwater Detection Monitoring System for a Proposed Utility Waste Landfill, Ameren Missouri Labadie Energy Center, Franklin County

Dear Mr. Pike:

On January 4, 2013, the Missouri Department of Natural Resources' (Department) Solid Waste Management Program (SWMP) received the proposed groundwater detection monitoring system for the proposed utility waste landfill titled "Ameren Missouri Labadie Energy Center Groundwater Detection Monitoring System for a Proposed Utility Waste Landfill Franklin County, Missouri", dated January 3, 2013, and prepared on behalf of Ameren Missouri by Reitz & Jens, Inc. and Gredell Engineering Resources, Inc. The SWMP, Geological Survey Program (GSP), and the Water Protection Program (WPP) reviewed this document to ensure compliance with 10 CSR 80-11.010(11).

This document proposes the monitoring network to consist of the installation of 29 groundwater monitoring wells. Twenty-two (22) wells are designated as downgradient wells: MW-1 through MW-21, and TMW-1. These wells will be located generally on the north, east, and south sides of the site. The 7 wells designated as upgradient wells, MW-22 through MW-28, will be located on the west side of the site. The proposed well TMW-1 is a temporary well which will be located downgradient for Cells 1 and 2 until Cell 3 becomes operational, at which time TMW-1 will be removed.

The SWMP grants the facility approval to install the proposed monitoring network with the condition that the following comments will be fully addressed during the Construction Permit Application phase. The SWMP, GSP, and the WPP have the following comments that are based on the review of this document.

COMMENTS:

1. The submitted document indicates the prevailing groundwater flow direction during periods of high river elevations is generally eastward. Conversely, Appendix W, Groundwater Hydraulic Data Summary, states "During periods of relatively low river elevations (November-February) the prevailing direction of groundwater flow was north-northwest toward the river." The proposed locations of several wells designated as upgradient may potentially be in the groundwater flow path during periods of relatively low river elevations. In the event that the upgradient monitoring wells intercept downgradient groundwater, they may not provide sufficient data as initially intended.

2. As documented in the 2011 Detailed Site Investigation (DSI) of the site, groundwater flow direction in this alluvial setting fluctuates seasonally. As a result of the DSI, 22 proposed groundwater monitoring wells have been designated as downgradient and 7 wells have been designated as upgradient for the purpose of this groundwater monitoring program. In the event that data collected from a designated upgradient well has shown to be characteristic of a downgradient well, the well designation may need to be changed and the well spacing requirements for that monitoring area may need to be modified and justified.

3. Section 8.3 states that the facility will have two potential methods for purging of the groundwater monitoring wells prior to sampling. These purging methods consist of a purge/recover sampling method and the low-flow sampling method. It is encouraged that the facility implement a sampling procedure that will minimize the drawdown and agitation, and mixing of the stagnant casing waters. The use of bailers is not a prohibited sampling method, but the purging/recover method and sampling with a bailer may produce sample results that are biased and that are not representative to the groundwater. Therefore, it is strongly recommended that the facility implement a sampling method using the low-flow dedicated pumps.

4. In Appendix 2, titled "Missouri Solid Waste Management Rule Constituents for Detection Monitoring (10 CSR 80-11.010, Appendix I)", please include the constituent molybdenum to the sampling list. It is requested to sample for molybdenum because this constituent has been identified as a pollutant of concern by EPA's documents on coal ash. In addition, in the National Pollution Discharge Elimination System permit Ameren is required to have for water discharges, molybdenum was identified during the Technology Based Effluent Limit (TBEL) determination required for the coal ash pond. With molybdenum's presence in the ash pond discharge and EPA's identification of it as a pollutant of concern, the WPP requests that molybdenum monitoring be established and added to the sampling list.

If you have any questions concerning this letter, please contact Mr. Darrell Hartley of my staff at (573) 526-3940 or at P.O. Box 176, Jefferson City, Missouri, 65102-0176.

Sincerely,

SOLID WASTE MANAGEMENT PROGRAM

Charlene S Fitch

Charlene S. Fitch, P.E.
Chief, Engineering Section

CSF:crl

c: Mr. Kevin Gerhardt, Ameren Missouri
Tom Gredell, P.E., Gredell Engineering Resources, Inc.
Mr. Paul Reitz, Reitz & Jens, Inc.
Mr. Peter Price, Chief, Environmental Geology Section, DGLS
Mr. Chris Wieberg, Unit Chief, WPP
St. Louis Regional Office

Appendix W

Groundwater Hydraulic Data
Revised August 2013

Documents Included:

W(a) Groundwater Hydraulic Data

W(b) Agricultural Well Aquifer Drawdown Potential

Appendix W(a)

Groundwater Hydraulic Data
Revised August 2013

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

Appendix W(a)
Groundwater Hydraulic Data Summary

December 2012
Revised August 2013

INTRODUCTION

Appendix W(a) contains a summary description and graphical representations of surface water and groundwater data acquired from the Ameren Missouri Labadie Energy Center proposed Utility Waste Landfill site during completion of the Detailed Site Investigation (DSI) in 2009-2010. The surface water and groundwater data have been evaluated to identify and describe the factors that influence the direction and flow rate of the uppermost aquifer beneath the proposed Utility Waste Landfill. Additional details on the data used for this evaluation can be found in the DSI report for this site on file with the Missouri Department of Natural Resources, Division of Geology and Land Survey in Rolla, Missouri and referenced at the end of this report.

The Ameren Missouri Labadie Energy Center is located near Missouri River Mile 57. Missouri River elevations obtained from the Labadie Energy Center gauging station, which is at the same approximate river mile, are provided for comparison to the groundwater data due to the significant influence river levels have on the groundwater potentiometric surface across the site.

DISCUSSION OF DATA

Groundwater elevation readings were taken on a monthly basis for twelve consecutive months from all one hundred (100) piezometers installed at the site for the DSI. These readings were taken from December 2009 through November 2010. Seven additional sets of readings from select piezometers were obtained between late April and June 2010 to better evaluate what short term impacts rising Missouri River elevations have on the groundwater elevations and gradients beneath the proposed site. The DSI report also investigated what impact precipitation has on groundwater elevations. Following approval of the DSI report, 90 of the piezometers were properly plugged and abandoned in April 2011. The remaining 10 piezometers were properly plugged and abandoned in early September 2011.

During the year-long DSI monitoring period, it was determined that the direction of groundwater flow varied in response to Missouri River elevation. During periods of relatively low river elevations (November-February) the prevailing direction of groundwater flow was north-northwest toward the river. During periods of relatively high river elevations (March-October) the prevailing direction of groundwater flow shifted eastward. These changes in flow direction can be quite rapid. For example, from the “routine” monthly measurements made on May 11, 2010 to the supplemental measurements made on May 18, 2010, as the Missouri River rose 12 feet, groundwater flow shifted approximately 90 degrees from a northeasterly to a southeasterly direction. This shift was accompanied by site-wide increases in groundwater levels of between 1.5 and 7.25 feet and a corresponding increase in hydraulic gradient.

The behavior of groundwater elevations in response to changes in Missouri River stage as described in the DSI report indicated that at the beginning of the monitoring period (December 2009), river elevation was below the water table surface. It remained more or less below the local water table throughout the succeeding three months (January to March 2010) except for relatively short-term periods (4 to 9 days). Average water table elevation remained slightly above 459 feet during this period and overall groundwater flow direction was northward, toward the Missouri River. However, beginning in mid-March 2010, river level surged above 460 feet and generally remained above that elevation through late August 2010. During that same time period, average water table elevation also rose above 460 feet, where it remained throughout the five-month time span. Water table maps for this time period (March-August 2010) show overall groundwater flow direction with a strong easterly component. Northeasterly trends for the months of March and May 2010 coincided with relatively “low” average water table elevations (460.41 to 461.98 feet) and a southeasterly trend during July 2010 coincided with a relatively high and sustained water table exceeding 463 feet. By November 2010, as both the water table and river levels dropped below 460 feet, overall groundwater flow direction “reverted” to the northwest, essentially mirroring groundwater behavior observed during the first three months of monitoring.

Comparison of groundwater levels in the southeastern part of the site (farthest from the river) to groundwater levels in the northwestern part of the site (closest to the river) suggests that the reversal in groundwater flow occurs when the Missouri River level attains a more or less sustained elevation of between 461 and 463 feet.

As recorded in the DSI report, calculated groundwater velocities range from extremes of 0.1 to 584 feet per year (ft/yr). This wide range is chiefly attributable to both calculated hydraulic gradient and effective porosity values. Hydraulic conductivity values are relatively uniform across the site due to the homogeneous nature of the sandy soils comprising the alluvial aquifer. The DSI report indicated that the lower ranges in hydraulic gradient were believed more representative of prevailing groundwater movement at the site, which results in velocities ranging from 0.1 to 10 ft/yr. However, the report also noted the possibility of higher groundwater velocity values in the northwestern part of the site, where hydraulic gradient increases in response to changes in Missouri River elevation.

Figure 1 is a graphical representation of the relationship between groundwater and river elevations at the Ameren Missouri Labadie Energy Center proposed landfill site from the period December 2009 to November 2010. It is based on Figure 31 of the DSI Report. In addition,

Figure 2 provides a summary of groundwater movement for the twelve-month monitoring period (December 2009 to November 2010) during the DSI investigation. The figure is based on Figures 18-29 of the DSI Report.

SUMMARY AND CONCLUSIONS

The variable direction of groundwater movement at the Ameren Missouri Labadie Energy Center proposed landfill site appears intrinsically related to Missouri River elevation. When river elevations are relatively high, it acts as a recharge source to the alluvial aquifer and groundwater movement is generally toward the east and southeast. Conversely, when river elevations are relatively low, the local water table appears to "unwater" toward the river and groundwater movement is generally toward the north and northwest. Based on the data presented in the DSI report, this change in flow direction occurs when the Missouri River reaches an elevation of between 461 and 463 feet. Comparison of the river gauge data acquired during the 12-month monitoring period to gauge data for the preceding ten years suggests that river levels were unseasonably high in 2010, relative to the years 2000-2009. Thus, "unwatering" of the local water table toward the Missouri River may be more prevalent than what was suggested by the DSI data. Regardless, groundwater movement throughout much of the site is along a shallow hydraulic gradient. Calculated groundwater velocities believed to be representative of this shallow gradient range from 0.1 to 10 ft/yr, but could be as high as 584 ft/yr. Higher velocities to the northwest are suggested, where hydraulic gradient increases.

REFERENCES

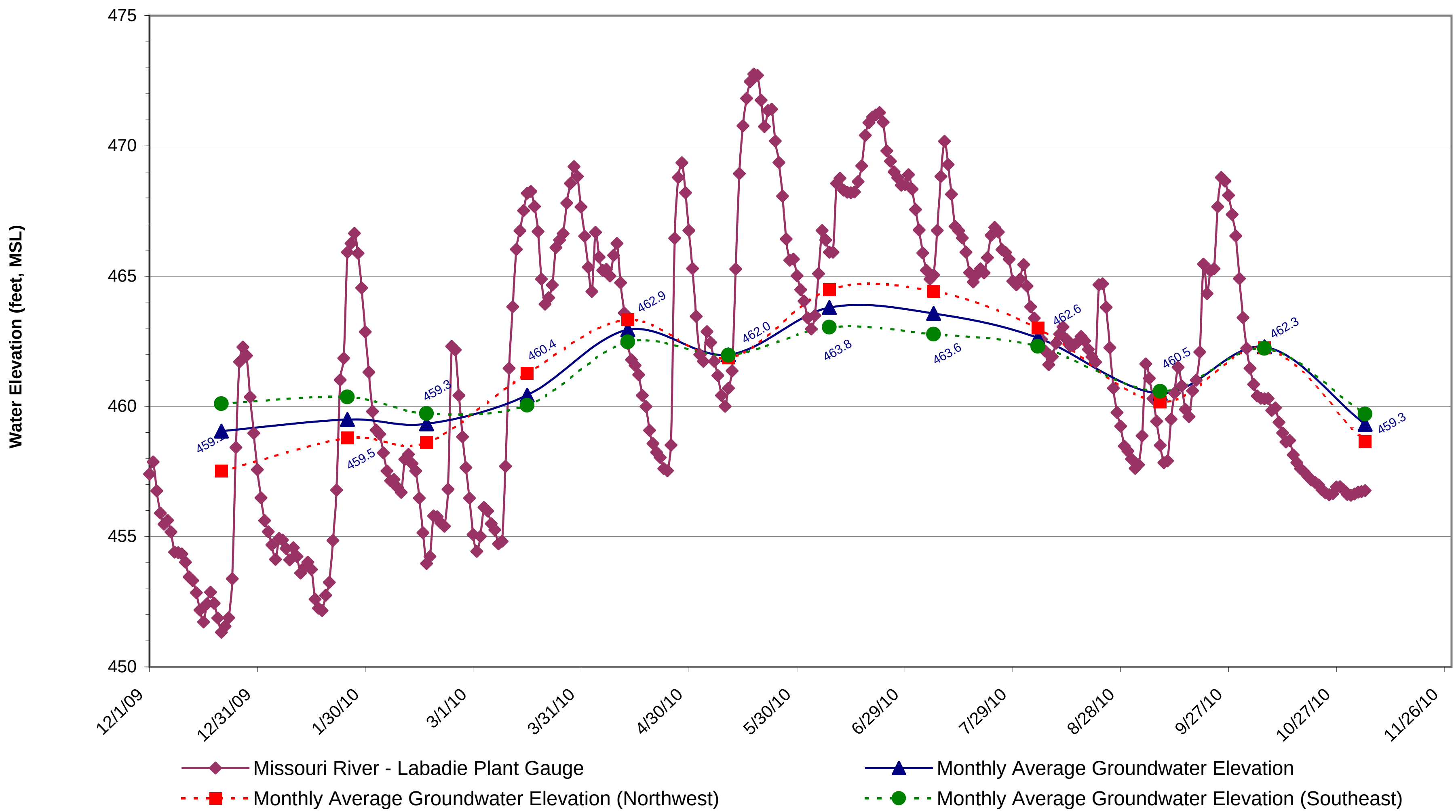
1. *Detailed Site Investigation Report For Ameren Missouri Labadie Power Plant Proposed Utility Waste Disposal Area, Franklin County, Missouri*, dated February 4, 2011, revised March 30, 2011 by GREDELL Engineering Resources, Inc. and Reitz & Jens, Inc.

FIGURES

AMEREN MISSOURI LABADIE POWER PLANT
GROUNDWATER HYDRAULIC DATA SUMMARY
APPENDIX W(a)

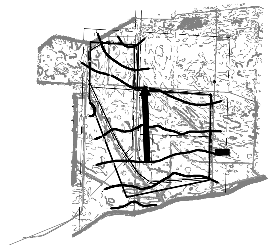
Monthly Average Water Table Elevation vs Missouri River Elevation

FIGURE 1*



*From Figure 31 of the Detailed Site Investigation Report

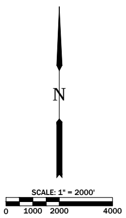
DECEMBER 21, 2009 GROUNDWATER MAP



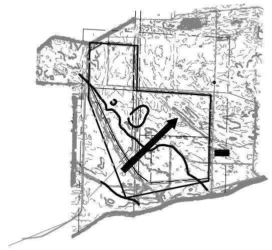
JANUARY 25, 2010 GROUNDWATER MAP

FEBRUARY 16, 2010 GROUNDWATER MAP

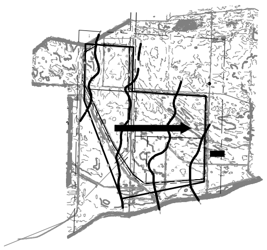
MARCH 16, 2010 GROUNDWATER MAP



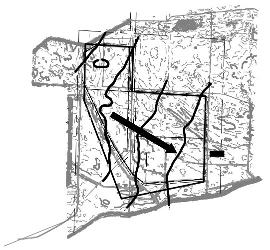
APRIL 13, 2010 GROUNDWATER MAP



MAY 11, 2010 GROUNDWATER MAP

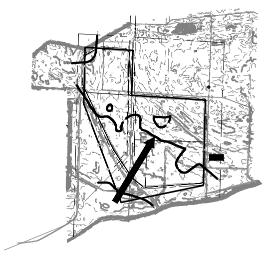


JUNE 08, 2010 GROUNDWATER MAP



JULY 07, 2010 GROUNDWATER MAP

AUGUST 5, 2010 GROUNDWATER MAP



SEPTEMBER 8, 2010 GROUNDWATER MAP

OCTOBER 7, 2010 GROUNDWATER MAP

NOVEMBER 4, 2010 GROUNDWATER MAP

LEGEND

- GROUNDWATER FLOW DIRECTION
- 464.00 — GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT.
- DETAILED SITE INVESTIGATION AREA

NOTES:

1. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY BORINGS.
2. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ & JENS, INC..

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REITZ & JENS, INC.
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GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1505 East High Street Jefferson City, Missouri 65101
Telephone: (573) 659-9078 Facsimile: (573) 659-9079

PREPARED FOR Ameren MISSOURI

DRAWN 020411 W.J.A. (GER)	FIGURE 2 APPENDIX W(a) GENERALIZED GROUNDWATER SUMMARY DECEMBER 2009 THROUGH NOVEMBER 2010
CHKD. M.C.C. (GER)	
SUPV. M.C.C. (GER)	
APPD. M.C.C. (GER)	LOCATION 001004 — LABADIE PLANT — CLASS 02010
Ameren MISSOURI ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG — REV.

Appendix W(b)

Agricultural Well Aquifer
Drawdown Potential
Revised August 2013

1505 E. High Street
Jefferson City, Missouri 65101
Telephone No. (573) 659-9078
Fax No. (573) 659-9079

GREDELL Engineering Resources, Inc.

Memo

To: Jeff Fouse, P.E., Reitz & Jens, Inc.

From: Travis Doll, R.G., R.E.H.S. TAD

CC: Tom Gredell, P.E. and Mike Carlson, R.G., Gredell Engineering MC

Date: July 31, 2013

Re: Ameren Missouri Labadie Energy Center – CPA Report Response to MDNR Comment No.25 Regarding Irrigation Well Aquifer Drawdown Potential

---

This hydrologic memorandum was prepared for the exclusive use of Reitz & Jens, Inc. and Ameren Missouri. Gredell Engineering completed the evaluation using information obtained from the *Detailed Site Investigation Report for Ameren Missouri Labadie Power Plant Proposed Utility Waste Disposal Area Franklin County, Missouri February 4, 2011 (Revised March 30, 2011)*; hereinafter referred to as DSI, and customary practices for determining aquifer drawdown in an unconfined aquifer.

Reitz & Jens, Inc. requested that GREDELL Engineering Resources, Inc. (Gredell Engineering) provide a detailed evaluation and response to the Missouri Department of Natural Resources (MDNR) Comment No. 25 that was included in a May 7, 2013 letter from MDNR to Ameren Missouri, regarding Review and Comments on Construction Permit Application for a Proposed Utility Waste Landfill, Ameren Missouri Labadie Energy Center, Franklin County, Missouri. Comment No. 25 states the following:

> *During our April 4, 2013, site visit, the SWMP observed relocation of two groundwater monitoring wells to accommodate operation of a traveling irrigation boom supplied by water from a nearby irrigation well. A recent review of the DSI approval reveals, the Geological Survey Program expressly required information regarding the status and analysis of the influence of an operational well be provided during the permitting stage of the project. This information was not provided in the application as required. This evaluation and analysis shall be provided or the well shall be permanently decommissioned prior to the second quarter of background sampling.*

Gredell Engineering evaluated the aquifer drawdown potential of the irrigation well pumping on the monitoring wells at the Ameren Missouri Labadie Energy Center Proposed Utility Waste Landfill site when the irrigation well pumping is activated for the operation of the center pivot irrigation system. Of all monitoring wells on site, MW-11 is the closest monitoring well to the irrigation well, and therefore, it was selected in this evaluation (Figure 1). Based on Gredell Engineering's evaluation, we conclude that the closest monitoring well to the agricultural well will have an unmeasurable drawdown for the agricultural pumping rates described below.

Gredell Engineering referenced Freeze and Cherry, 1979, pp. 314-327 to determine the effects of pumping/aquifer drawdown in an unconfined aquifer. The user (Brunjes) of the irrigation well has reported pumping rates of 1,000 to 1,200 gallons per minute (gpm) from the well. This well will only operate periodically during periods of dry weather, typically for durations of up to four days. The periodic operation of this well will have unmeasurable impacts on the groundwater levels in the adjacent groundwater monitoring wells. Due to the unknown details of the irrigation well construction (e.g., depth of well, length of well screen, etc.), additional references that are mentioned later in this memorandum, were used to obtain practical values to include in the aquifer drawdown calculations.

Gredell Engineering chose the following well function equations, as referenced in Freeze and Cherry, 1979, p. 317, equations 8.6 and 8.7, to calculate the aquifer drawdown potential from the operation of the irrigation well.

Equation 8.7

$$h_o - h = \frac{Q}{4\pi T} W(u)$$

Where:

$h_o - h$ = drawdown, feet
Q = Pumping rate of irrigation well, gallons per minute (gpm)
π = 3.14, unitless
T = Transmissivity = *K* x *b*, gallons per day per foot (gpd/ft)
K = Hydraulic Conductivity, gallons per day per square foot (gpd/ft^2)
b = Unconfined Aquifer Initial Saturated Thickness, feet
$W(u)$ = Well function, unitless

Equation 8.6

$$u = \frac{r^2 S_y}{4Tt}$$

Where:

u = Related to the Well Function *W (u),* unitless, reference (Freeze and Cherry, 1979, pp. 317)
r = Radius from irrigation well to MW-11, feet
S_y = Specific yield ≈ effective porosity in an unconfined aquifer (Sutch and Dirth, 2006, Ch. 8, p. 10), whereas (S_y) ≈ Storativity (*S*) in an unconfined aquifer, unitless (Freeze and Cherry, 1979, pp. 317, 324-325)
T = Transmissivity, gallons per day per foot
t = Time, days

According to Freeze and Cherry, 1979, pp. 317, 324-325, the following is stated: *"If the aquifer properties,* ***T*** *and* ***S****, and the pumping rate,* ***Q****, are known, it is possible to predict the drawdown in any hydraulic head in a confined aquifer at any distance* ***r*** *from a well at any time* ***t*** *after the start of pumping. It is simply necessary to calculate* ***u*** *from Equation 8.6, look up the value of* ***W(u)*** *on Table 8.1, and calculate* $\mathbf{h_o - h}$ *from Equation 8.7." For unconfined aquifers, "…use the same equation as for a confined aquifer (Equation 8.7) but with the argument of the well function (Equation 8.6) defined in terms of the specific yield* $\mathbf{S_y}$ *rather than storativity* ***S****. The transmissivity* ***T*** *must be defined as* ***T = kb****, where* ***b*** *is the initial saturated thickness."*

The following values (constants) where obtained from the DSI (Tables 7 and 8) for performing the calculations of potential aquifer drawdown in reference to the monitoring well MW-11:

K_{avg} = 4.905 x 10^{-2} feet per minute or 528.32736 gpd/ft^2
b = 90 feet
n = 0.35 = Effective porosity, unitless. As discussed above, specific yield (S_y) ≈ effective porosity (n) in an unconfined aquifer, whereas (S_y) ≈ Storativity (*S*) in an unconfined aquifer

Additional references were utilized to obtain estimated values of Q in the Missouri River Alluvium Aquifer in the lower Missouri River valley. "*Data from an U.S. Geological Survey test drilling program along this reach of the river indicates that in most places the alluvium is capable of yielding 1,000 to 3,000 gpm. Yields of from 2,500 gpm to 3,000 gpm, with transmissivities of 200,000 gpd/ft to 250,000 gpd/ft (26,700 ft^2/day to 33,400 ft^2/day), are not unusual…For example, a well producing 2,000 gpm from an aquifer with a transmissivity of 250,000 gpd/ft and a specific yield of 0.15 will create only about 5.7 ft of drawdown in the aquifer a distance of 100 ft from the pumped well after 10 days of continuous pumping. Drawdown in the aquifer adjacent to the well will be only about 15 ft, and 10 ft from the well it will be about 10 ft.*" (Miller and Vandike, 1997, p. 150).

The following values were used in the above equations for:

r = 1,525 feet (approximate distance from the irrigation well to closest monitoring well MW-11).
Q = 1,000 gpm, 1,500 gpm, and 2,000 gpm.

Attached to this memo are sample computations for MW-11 when the irrigation well is pumping at 1,000 gpm, 1,500 gpm and 2,000 gpm for durations of 24 hours (1 day) and 96 hours (4 days) of continuous pumping. At 1,000 gpm for 1 day of continuous irrigation well pumping, the drawdown in MW-11 is calculated to be less than 1.1 x E-05 feet. Additionally, at 2,000 gpm for 4 days of continuous irrigation well pumping, the drawdown in MW-11 is calculated to be less than 1.8 x E-04 feet. Hand calculations using the *W(u)* values in Table 5 *Values of W(u) for values of u between* 10^{-15} *and 9.9* (Lohman, 1972, p. 16) are included as Attachment 1.

Conclusions

Because the calculated drawdown is unmeasurable additional computations have not been pursued.
It is recommended that groundwater sampling occur a minimum of 24 hours after the agricultural well was last operated to mitigate any potential impacts on the adjacent groundwater monitoring wells.

REFERENCES

Freeze, R.A. and Cherry, John. A, *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1979, pp. 315-327.

GREDELL Engineering Resources, Inc. and Reitz & Jens, Inc., *Detailed Site Investigation Report for Ameren Missouri Labadie Power Plant Proposed Utility Waste Disposal Area Franklin County, Missouri February 4, 2011 (Revised March 30, 2011).*

Lohman, S.W., *Ground-Water Hydraulics*, Geological Survey Professional Paper 708, United States Government Printing Office, Washington: 1972, p. 16.

Miller, Don E. and Vandike, James E., *Water Resources Report Number 46, Missouri State Water Plan Series Volume II, Groundwater Resources of Missouri*, Missouri Department of Natural Resources, Division of Geology and Land Survey,1997, pp. 147-151.

Sutch, Patti and Dirth, Lisa, *Geology Study Manual: 2006 Review for the National (ASBOG) Geology Licensing Exam*, Reg Review, Inc., 2006, Chapter 8, p. 10.

###

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REVISIONS		
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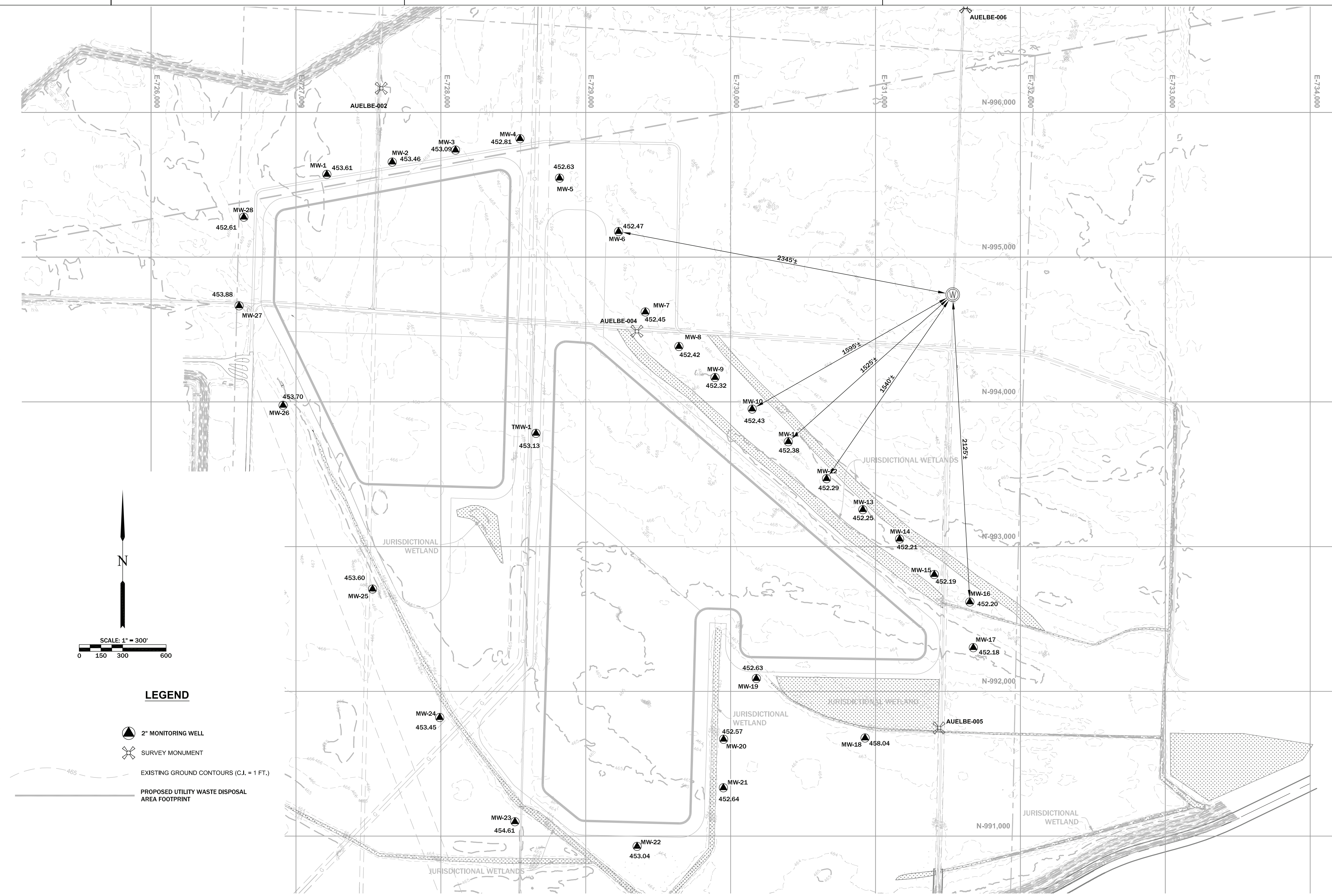

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	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

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PREPARED FOR Ameren MISSOURI

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FIGURE 1
DISTANCES BETWEEN IRRIGATION WELL AND SELECT MONITORING WELLS PROPOSED UTILITY WASTE LANDFILL

LOCATION 001009 | LABADIE ENERGY CENTER | CLASS 02010

Ameren MISSOURI | ST. LOUIS, MISSOURI | JUNE 2013 | REV. 0

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Date: 07/29/13		Page No: 1 of 3
Client: Reitz & Jens		
Prepared By: TAO	Checked By: TG	Project: Ameren MO Labadie UWL - CPA
Subject: Irrigation Well Influence Calcs.		

$$h_0 - h = \frac{Q}{4\pi T} W(u) \quad \text{where } u = \frac{r^2 S}{4Tt} = \frac{r^2 S_y}{4Tt}$$

$W(u)$ = well function

Q = pumping rate (gpm)

r = radius from well MW11

S = Storativity, which is = Specific Yield (S_y) in Unconfined Aquifer
$S_y \approx n_e$ (effective Porosity)

T = Transmissivity, which is
$T = Kb$ (gpd/ft or ft²/day)

K = Hydraulic Conductivity (gpd/ft²)

b = Saturated Thickness of Aquifer

t = time

$h_0 - h$ = drawdown

ATTACHMENT 1

EXAMPLE 1. – 1 Day @ 1,000 gpm pump rate

$$h_o - h = \frac{Q}{4\pi T} W(u) \quad \text{where } u = \frac{r^2 S_y}{4Tt}$$

$Q = 1{,}000$ gpm $r = 1{,}525$ ft $S_y = 0.35$ $t = 1$ day

$K_{avg} = 4.905 \times 10^{-2}$ ft/min $\times$ 1,440 min/day $\times$ 7.48 gal/ft^3 = 528.32736 gpd/ft^2

$b = 90$ ft.

$T = Kb = 528.32736$ gpd/ft^2 $\times$ 90 ft = 47,549.4624 gpd/ft

$$u = \frac{(1{,}525\text{ ft})^2 \times 0.35}{4(47{,}549.4624\text{ gpd/ft})(1\text{ Day})}$$

$$u = \frac{813{,}968.75\text{ ft}^2}{4\left(47{,}549.4624\text{ gpd/ft} \times 1\text{ Day} \times \frac{1\text{ ft}^3}{7.48\text{ gal}}\right)} = 32.01$$

32.01 >> 9.9 ∴ $W(u) < 0.000004637$ from Ground-Water Hydraulics Table 5

$$h_o - h = \frac{1{,}000\text{ gpm}}{4\pi(47{,}549.4624\text{ gpd/ft}^2)} \times 0.000004637$$

$$" = \frac{1{,}000\text{ gpm} \times 1{,}440\text{ min/day}}{597{,}524.167032\text{ gpd/ft}} \times 0.000004637$$

$$" = 1.117 \times 10^{-5}\text{ ft}$$

EXAMPLE 2. – 1 Day @ 1,500 gpm = Q

$$h_o - h = \frac{1{,}500\text{ gpm} \times 1{,}440\text{ min/day}}{597{,}524.167032\text{ gpd/ft}} \times 0.000004637$$

$$" = 1.676 \times 10^{-5}\text{ ft}$$

Example 3. – 1 Day @ 2,000 gpm = Q

$$h_o - h = \frac{2{,}000\text{ gpm} \times 1{,}440\text{ min/day}}{597{,}524.167032\text{ gpd/ft}} \times 0.000004637$$

$$" = 2.235 \times 10^{-5}\text{ ft}$$

EXAMPLE 4. - 4 days @ 1,000 gpm

$$u = \frac{(1{,}525\,ft)^2 \times 0.35}{4(47{,}549.4624\,gpd/ft)(4\,days)}$$

$$u = \frac{813{,}968.75\,ft^2}{4(47{,}549.4624\,gpd/ft \times 4\,days \times \frac{1\,ft^3}{7.48\,gal}}$$

$$u = \frac{813{,}968.75\,ft^2}{101{,}710.08\,ft^2} = 8.00$$

$W(u) = 0.00003767$ from Table 5

$$h_0 - h = \frac{1{,}000\,gpm}{4\pi(47{,}549.4624\,gpd/ft^2)} \times 0.00003767$$

$$'' = \frac{1{,}000\,gpm \times 1{,}440\,min/day}{597{,}524.167032\,gpd/ft} \times 0.00003767$$

$$'' = 9.078 \times 10^{-5}\,ft.$$

EXAMPLE 5. - 4 days @ 1,500 gpm

$$h_0 - h = \frac{1{,}500\,gpm \times 1{,}440\,min/day}{597{,}524.167032\,gpd/ft} \times 0.00003767$$

$$'' = 1.362 \times 10^{-4}\,ft.$$

EXAMPLE 6. - 4 days @ 2,000 gpm

$$h_0 - h = \frac{2{,}000\,gpm \times 1{,}440\,min/day}{597{,}524.167032\,gpd/ft} \times 0.00003767$$

$$'' = 1.816 \times 10^{-4}\,ft.$$

Appendix Q

Groundwater Sampling and Analysis Plan
Revised August 2013

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

Groundwater Sampling and Analysis Plan

Ameren Missouri
Power Operation Services
3700 South Lindbergh Blvd.
St. Louis, Missouri 63127

December 2012
Revised August 2013

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Ameren Missouri Labadie Energy Center
Groundwater Sampling and Analysis Plan
Proposed Utility Waste Landfill
Franklin County, Missouri

December 2012
Revised August 2013

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1.0 INTRODUCTION

This sampling and analysis plan (SAP) has been prepared by GREDELL Engineering Resources, Inc. for the proposed Ameren Missouri Labadie Utility Waste Landfill, located adjacent to the Labadie Energy Center and approximately two and one-half miles northeast of the town of Labadie and immediately southeast of the Missouri River in northeast Franklin County, Missouri. The proposed utility waste disposal area and surrounding areas to the north, south, and east are currently used primarily for agricultural (row-crop) production. The Labadie Energy Center is located immediately to the west. Labadie Bottom Road marks the approximate western boundary of the site and Davis Road marks the eastern boundary of the site. The general location is shown on Figure 1.

The SAP has been prepared consistent with the rules and regulations promulgated by the Missouri Department of Natural Resources Solid Waste Management Program (SWMP) and the Division of Geology and Land Survey (DGLS), found under 10 CSR 80-11.010(11)(C)2. through 10 CSR 80-11.010(11)(C)6. and 10 CSR 23-4, respectively. This SAP includes the following information: QA/QC procedures to be followed during both field sampling and laboratory analyses; groundwater sample preservation and shipment procedures; a chain-of-custody procedure; and discussion of statistical methods to be followed in the evaluation of groundwater samples gathered in accordance with this plan. Site-specific technical reports were also consulted during development of this plan. They include:

> *Detailed Site Investigation Report for Ameren Missouri Labadie Power Plant Proposed Utility Waste Disposal Area, Franklin County, Missouri*, dated February 4, 2011, revised March 30, 2011 by GREDELL Engineering Resources, Inc. and Reitz & Jens, Inc.
>
> *Construction Permit Application for Utility Waste Landfill, Ameren Missouri Labadie Energy Center,* prepared by Reitz & Jens, Inc. and GREDELL Engineering Resources, Inc.

This SAP is being submitted as an appendix to the solid waste disposal area construction permit application referenced above. The SAP focuses on the implementation of appropriate sampling and analysis procedures for the establishment of a groundwater detection monitoring system at the proposed utility waste landfill. This SAP will help ensure that the landfill development proceeds in an environmentally sound fashion, consistent with Solid Waste Management Law and Rules.

2.0 FACILITY LOCATION

The proposed Labadie UWL is located within the alluvial floodplain of the Missouri River in northeastern Franklin County approximately two and one-half miles northeast of the town of Labadie and six miles north of intersection of State Hwy 100 and Interstate 44 (Figure 1). The National Geodetic Survey indicates the site lies within the northwestern part of Township 44 North, Range 2 East. Portions of the area are part of the "historic" Spanish Land Grant survey system identified as "SUR". The site is located within sections 17 and 20, SUR 384, and SUR 1735. The site has had a historical land use of agriculture.

Groundwater levels are largely influenced by fluctuations in Missouri River level. Depth to groundwater is relatively shallow and varies from two to 13 feet, but levels were noted in some instances to rise up to, and during infrequent high-river stages, may slightly exceed ground surface elevation. Hydraulic gradients are also shallow. Minimum values range from 1.990×10^{-6} ft/ft to 6.161×10^{-5} ft/ft (0.015 to 0.33 ft/mi). Maximum values range from 3.517×10^{-3} ft/ft to 5.534×10^{-4} ft/ft (3 to 18 ft/mi). Calculated hydraulic conductivity values range from 9.47×10^{-2} to 2.15×10^{-2} feet per minute (ft/min), and average 4.91×10^{-2} ft/min. These values fall within the range of hydraulic conductivity values typically ascribed to coarse and medium sand deposits.

3.0 FACILITY BACKGROUND

The Ameren Missouri Labadie Utility Waste Landfill is being proposed as a landfill site to accommodate the waste generated from the flue gas desulfurization units, fly ash, and bottom ash.

The proposed UWL covers a waste boundary area of approximately 166.5 acres of the 813-acre landfill permit boundary within the Ameren Missouri Labadie Energy Center Property. The entire site is zoned by Franklin County as Agricultural Non-Urban (ANU). Improvements within the Labadie UWL permit boundary include the 166.5-acre waste disposal area, stormwater management ponds permitted separately as no discharge wastewater facilities under Missouri Clean Water Law, soil stockpile areas, flood protection berms, perimeter stormwater control structures, site access roads, perimeter security fencing, buffer zones, and groundwater monitoring.

In order to ensure that groundwater is protected a series of groundwater monitoring wells are proposed for installation both upgradient and downgradient of the UWL. Periodic sampling of the groundwater monitoring well system is required under Missouri's Solid Waste Management Regulations, 10 CSR 80-11.010(11).

4.0 PROPOSED GROUNDWATER MONITORING SYSTEM

The proposed groundwater monitoring system consists of 28 permanent wells and one temporary well (Figure 2). Each well will monitor shallow groundwater contained within the unconfined alluvial aquifer that underlies the site as recommended in the Detailed Site Investigation. The wells that generally are downgradient from waste disposal boundaries are designated MW-1 through MW-21. The wells that generally are upgradient from waste disposal boundaries are designated MW-22 through MW-28. Individual well location and depth information is summarized in Table 1. The table also lists a temporary monitoring well (TMW-1) that will serve as a “sentry” for the initial operations within Cell 1. It will be used to supplement water quality data derived from the permanent downgradient wells located along the eastern perimeter of Cell 3.

Justification for the location of the proposed permanent well system is presented in Appendix X of the Construction Permit application. The proposed wells will be installed prior to acceptance of waste. TMW-1 will be removed when Cell 3 becomes operational.

4.1 Well Construction

All monitoring well drilling and construction will be completed in accordance with the Missouri Monitoring Well Construction Code of regulations found in 10 CSR 23-4. A typical monitoring well construction detail for the proposed well installation is provided as Figure 3. Well depths will be in general accordance with Table 1 to ensure full submersion of each 10-ft screen interval. Some allowances may have to be made in actual well location to ensure they do not conflict with planned landfill development, terrain or subsurface irregularities, overhead power lines, or similar encumbrances. This in turn will affect actual well depths, which are based on ground surface elevations.

Drilling and well construction will be completed by a properly permitted monitoring well installation contractor. Drilling logs and monitoring well construction details will be completed subsequent to installation activities and inserted into Appendix 1 of this SAP at a later date.

Proposed monitoring wells will be located such that reasonable access can be gained for the purpose of maintenance and repairs. The surrounding natural drainage will not be impaired. Each well will be placed so as to facilitate surface water drainage surrounding the well.

4.2 Well Development or Redevelopment

Each well will be developed with the use of either disposal bailers or a non-dedicated, submersible pump. In no event will the method used introduce any contaminants into the wells. A minimum of three well volumes of water will be removed or until the well is effectively “dry”. A “well volume” includes both the filter pack and casing, as measured from the base of the well to the initial static water level. In addition, the volume of potable water introduced into the well bore while drilling and/or constructing the well, if any, will be removed.

Field measurements of groundwater temperature, pH, and specific conductivity will be recorded during the development process. Field measurements will continue until both temperature and specific conductivity have stabilized to within ten percent between three successive readings. Similarly, pH readings should stabilize within 0.2 pH units.

In addition to the above, development records will include documentation of both pre- and post-development water levels. Final clarity of the water will also be noted.

Redevelopment will be undertaken when 20 percent of the well screen is occluded by sediments, as determined during routine measurements of the depth of the well taken during field sampling events.

5.0 SAMPLING FREQUENCY - DETECTION MONITORING

Detection monitoring is required at all monitoring wells. The sampling frequency required by 10 CSR 80-11.010(11)(C) is twice yearly during the months of May and November, except for initial background water quality monitoring following well installation and prior to operation. The rule requires a minimum of four independent samples to be collected from each well. This requirement allows identification of background concentrations contained in the shallow alluvial aquifer using a statistically valid number of sampling events. Background water quality data are critical to identify in order to allow comparison with subsequent sample analysis to determine if statistically significant increases in target contaminants are present within the groundwater.

The proposed schedule for background water quality sampling at the Ameren Missouri Labadie Utility Waste Landfill is presented in Table 2. The intent of the schedule is to provide eight independent rounds of background data prior to the start of operations. The eight sets of data (from the four minimum sampling events required by the rule plus four additional sampling events) will better define the spatial variability of groundwater quality across the footprint of the disposal area. The degree of spatial variability will ultimately determine the statistical approach to be used in the evaluation of detection monitoring results. Sampling events will also be scheduled such that they occur no sooner than twenty-four (24) hours after cessation of pumping from the irrigation well located approximately 1,800 feet northeast of proposed waste boundaries (see Plan Sheet 4 of CPA drawings).

Detection Monitoring will include analysis of the parameters listed in Appendix I of 10 CSR 80-11.010. Those parameters are listed for reference in Appendix 2.

6.0 FIELD SAMPLING EQUIPMENT - QA/QC PROCEDURES

All field personnel must read and familiarize themselves with the protocol established in this section. All personnel involved in the sampling process must wear Level D Protective clothing as defined by OSHA. This includes, but is not limited to, safety boots/shoes, safety glasses, and disposable gloves. No smoking is allowed during sampling. A first aid kit must be accessible to field personnel during each well sampling event.

The following equipment, at a minimum, will be available in the field during each sampling event: purging and sampling equipment, both dedicated and non-dedicated; an electronic water level measurement device; pH, temperature, specific conductivity, oxidation-reduction potential (ORP), and turbidity meters; sample containers, and coolers.

The probes and attachments of each pH, temperature, specific conductivity, oxidation-reduction potential (ORP), and turbidity meter will be hand washed in a laboratory grade, non-phosphate detergent, followed by a triple rinse in distilled water. The meters will then be calibrated in accordance with manufacturer's recommendations or as otherwise specified in the *Field Equipment Calibration Forms and Procedures* included in Appendix 3. Any malfunction will be corrected or the meter will be replaced.

Sample containers will be pre-cleaned by the contract laboratory by washing in a laboratory grade, non-phosphate detergent, triple rinsed in distilled water, and sufficiently dried to remove all moisture. The sample containers will be checked/inventoried for proper container volume, material, preservatives, labels and any observed defects (e.g., preservative leakage) at the time of receipt from the laboratory and documented on the *Groundwater Sampling Bottle Inventory* form (Appendix 4).

Prior to collecting a sample, the following decontamination procedures will be implemented.

1. Purging and Sampling Equipment will be handled and decontaminated as necessary to prevent contamination of the wells.

    a. If non-dedicated purging and sampling equipment is used, it will be thoroughly decontaminated and tested by collecting an equipment blank prior to use (see Section 7.4 Equipment Blank).
    b. If disposable bailers are used in the purging and sampling of the wells, they will be new, single-use bailers for each well and purging/sampling event. Used disposable bailers, even if decontaminated, are not acceptable.
    c. If dedicated pumps or bailers are used, care will be taken to prevent cross contamination.

2. Water level measuring device, including sensor probe and the entire length of graduated tape will be washed in laboratory grade, non-phosphate detergent followed by a triple rinse in distilled water.

    a. As the tape is reeled back onto the carrying spool, it will be wiped and dried using clean, dry paper towels.

3. During sampling, carefully lower the purging and sampling equipment into the well, handling it only with clean, disposable gloves. Do not drop any equipment into the well. The intake of the sampling equipment should be suspended above the base of the well to avoid churning of particulate matter within the sump.

4. After each well is sampled or during sampling events, as necessary, disposable gloves should be discarded, hands washed with soap and water, and fresh disposable gloves applied before the next sampling.

5. After use, the purging and sampling equipment will be washed in laboratory grade, non-phosphate detergent followed by a triple rinse with distilled water, prior to any further use.

6. Should purging and sampling equipment malfunction or not be available for use during the sampling event, substitute equipment or a bailer may be used.

7. All handling of the bailer will be with clean disposable gloves. Gloves must be changed as often as necessary, particularly if contact is made with other substances during the bailing process. The bailer must not be allowed to contact any foreign substance, in which case the bailer will be promptly replaced, regardless of condition.

8. Lightweight, high tensile strength line or a similar product used in conjunction with the disposable bailers or reel systems will be discarded and replaced each time a well is sampled.

If dedicated pumps are used, care should be taken to prevent any foreign objects from being part of the sample. The outside of the sample discharge tubing should be cleaned to prevent introduction of foreign objects into the sample container.

7.0 GROUNDWATER SAMPLES - QA/QC PROCEDURES

7.1 General

Precautions must be taken during both sampling and shipping procedures to ensure representative groundwater is obtained. Sample blanks and sample duplicates are therefore required to guard against and/or identify accidental, "induced" contamination from these sources. Sample blanks include trip blanks, field blanks, and equipment blanks. Sample duplicates are self-explanatory, but can include both matrix spike and matrix spike duplicates. Each of these quality control features is explained more fully as follows.

7.2 Trip Blanks

Trip blanks are prepared in the laboratory. They are designed to detect contamination resulting from improper or inadequately cleaned containers, sample coolers used for transport, or from chemical preservatives. A trip blank is prepared by filling an appropriately sized container with distilled water and any applicable chemical preservative. It is then shipped to the sample site and subsequently accompanies groundwater samples on the "trip" back to the laboratory. Trip blanks must be clearly identified as such along with the analyses to be performed on them. At a minimum, one trip blank per sampling event will be provided.

7.3 Field Blanks

Field blanks are prepared in the field. A field blank is prepared by directly filling an appropriately sized container with laboratory-supplied deionized water. Field blanks are used to detect contamination resulting from changed ambient air conditions. They also serve as a check against trip blanks. Field blanks should be clearly identified in the sampler's field notes and appropriately labeled to ensure its later identification in laboratory analytical results. One field blank will be collected per sampling event.

7.4 Equipment Blanks

Equipment blanks are prepared in the field when non-dedicated sampling equipment is used. They are used to ensure that non-dedicated equipment is properly decontaminated. This is accomplished by collecting a sample of distilled water passed through non-dedicated equipment after they have been decontaminated. Equipment blanks should also be collected anytime new, dedicated equipment is introduced into the water sampling process. Equipment blanks should be clearly identified in the sampler's field notes and appropriately labeled to ensure its later identification in laboratory analytical results. At a minimum, one equipment blank per sampling event will be collected.

7.5 Sample Duplicates

Sample duplicates are independent samples collected as close in time as possible as the original sample from any given well. They are stored and analyzed separately from the original sample and are a check on the precision of the sampling and analytical process.

Sample duplicates must immediately follow original sample collection of any given chemical parameter. Because they serve as a check on the reproducibility of data generated by the analytical laboratory, labeling should follow a format that does not overtly divulge the true identity of the sample on the sample labels or on the chain-of-custody sheet. It should be clearly identified in the sampler's field notes and appropriately labeled to ensure its later identification in laboratory analytical results. One sample duplicate will be collected for every 20 samples. At a minimum, one sample duplicate per day per sampling event will be collected.

7.6 Matrix Spikes

Matrix spikes are prepared in the laboratory by adding a known amount of target analyte to a sample prior to preparation and analysis. They are used to determine the bias of a method in a given sample matrix.

7.7 Matrix Spike Duplicates

Matrix spike duplicates are intra-laboratory split samples containing identical concentrations of target analytes. They are used to substantiate matrix spike samples.

8.0 FIELD SAMPLING PROCEDURES

8.1 General

Upon arrival at each monitoring well, its physical condition must be documented. Appendix 5 contains a *Monitoring Well Field Inspection* form that must be filled out for each well each time it is sampled. Any irregularities in the condition of the well must be immediately reported and corrective action implemented prior to the next sampling event.

8.2 Water Level Measurements

The next procedure is to obtain water level measurements. They must be obtained immediately prior to any attempt to purge the well. All water levels measuring equipment will be thoroughly decontaminated as previously described and checked for wear and abrasion prior to use. Clean, disposable gloves will be worn. All measurements must be recorded to $\pm$0.01 foot and should be based on a permanent reference point located at the top of the well, the elevation of which is established by a licensed surveyor.

Once the sample is collected, it is also necessary to measure the depth of the well. This is required to determine if the well screen is partially blocked by sediment, thus inhibiting recharge. If accumulated sediment obstructs more than twenty percent of the well screen height, it will be reported and arrangements made to redevelop the well prior to the next sampling event. Record all data gathered during water level measurements on the *Field Sampling Log* form provided in Appendix 6.

Ensure the well cap is clean prior to replacing after measurements are complete. Do not leave the well cap off for any reason, even for brief periods, unless purging immediately commences.

8.3 Purging

The next procedure is to purge the wells. There are two potential methods for purging the wells: Purge/Recover Sampling method; and Low-Flow Sampling method. Each method is acceptable, if the procedures are diligently followed. Each method is described separately below. All purge volumes must be documented on the *Volume Tracking Log* form provided in Appendix 6.

Purge/Recover Sampling: If using dedicated purge and sampling equipment, the following paragraph does not apply. If non-dedicated purge and sampling equipment is used, the wells should be purged in an order that precludes any potential cross-contamination. Typically, the upgradient wells are purged prior to the downgradient wells.

Purging must occur prior to any sampling, because water standing in the well may be unrepresentative due to physical and/or chemical alteration. Each well will be purged by removing at least three well volumes of water or until purge parameters stabilize. A well volume is considered the sum of the saturated portion of the well casing plus the saturated portion of the filter pack, which is roughly equivalent to an effective pore volume of 30 percent. The calculated volumes are based on the height of the water column above the established base of the well as measured immediately prior to purging. Filter pack heights must also be known. Well construction information for this facility will be placed in Appendix 1 following construction of the wells.

Wells will be purged using either dedicated bailers or other suitable purging and sampling equipment. All handling of purging equipment will be done wearing clean disposable gloves. Purge water will be poured into a graduated container sufficient to allow accurate measurement of the volume of water obtained. Once a well volume is obtained, temperature, specific conductivity, pH, oxidation-reduction potential (ORP) and turbidity will be recorded. Temperature must be measured first, followed by specific conductance ORP, pH, and lastly by turbidity. It is important to measure specific conductance and ORP prior to pH due to the potential presence of salts on the pH probe unit. All meters will be calibrated and checked for proper operation following manufacturer's recommendations or as otherwise outlined in Appendix 3. The clarity (turbidity) of the water will be noted. Cloudy, turbid water must be minimized.

Low–Flow Sampling Method: When using dedicated low flow pumps and automatic purge parameter sensors, such as the YSI 5083 Flow Cell, the following procedures will be followed to assess the stability of a water sample. At a minimum, all water will be purged from the line between the low-flow pump and the automatic sensors. This will be done by allowing a minimum of one volume within the connecting sampling tubing to flow from the well before assessing the stability of the water sample.

To be considered stable, the reading from each respective purge parameter sensor will be compared to the previous two values (collected at least one minute apart), and will be within the following limits:

- pH +/- 0.2 S.U.
- Specific Conductance +/- 20 umhos/cm
- Temperature +/- 1 C
- Oxidation-Reduction Potential +/- 20 millivolts
- Turbidity +/- 1 NTU (optional)

or

- 10 percent for SC, temperature, ORP and turbidity and +/- 0.2 S.U. for pH

If one-quarter inch (¼") tubing is used to connect the low flow pump to the automatic sensor, it takes one minute to purge 26 feet of tubing at 250 ml/minute.

Once sampling is complete, properly dispose of all purge water. Record all purge data on the *Field Sampling Log* form provided in Appendix 6.

8.4 Sampling

The next procedure is the actual sampling of the well. As much as practical, sampling should take place within two hours of the final purge event. In some instances, the recharge characteristics of the screened interval may be such that the two-hour stipulation is not feasible. In that event, sampling should be performed no later than 24 hours after final purging. Wells should be sampled in the order that precludes as much, to the extent practical, any potential cross-contamination. Typically, the upgradient wells are purged prior to the downgradient wells. Samples from each well will be collected in the following order, based on their sensitivity to volatilization:

- TOX
- TOC
- TDS
- Metals
- Non-metals
- COD

Samples must be <u>carefully</u> decanted into the appropriate sample container. Agitation must be minimized to avoid altering the chemical makeup of the sample. If well pumps are being used, care should be taken to prevent any contaminant from the exterior of the sample tubing from contaminating the water sample. Field filtration of samples is not allowed under 10 CSR 80-11.010(11)(C)2.B. Consequently, sample clarity must be documented and efforts made to minimize increasing turbidity beyond what naturally occurs in the well environment. Once a sample is retrieved, it will be preserved according to the guideline provided in Appendix 4. Samples requiring storage at low temperature will be immediately placed in coolers packed with ice. The temperature of the storage coolers will be monitored to ensure appropriate temperatures are maintained. All sampling data will be documented on the *Field Sampling Log* form provided in Appendix 6.

9.0 SAMPLE TRANSPORT AND DELIVERY, CHAIN-OF-CUSTODY

A chain-of-custody procedure is necessary to ensure the integrity of samples from the time of collection through delivery and final analysis. A sample is considered in someone's custody if:

1. It is in that person's physical possession;
2. In view of that person once he/she has taken possession;
3. Has been secured by that person so as to prevent tampering, or;
4. Has been placed by that person in an area restricted to authorized personnel.

Any person with custody as defined above must comply with the procedures established herein.

Prior to transport, the person collecting the samples must properly label each sample container and complete a *Chain-of-Custody Field Record* form. An example chain-of-custody field record form is provided in Appendix 7. Each label must be secured to the container and the following information clearly described on the label in indelible marker or pen:

- Collector's name
- Date and time of sampling
- Monitoring Well ID
- Sample ID
- Preservative(s) used, if any
- Required analytical test(s)

If the sample cooler(s) used for transport is not tamper proof, each sample container must also have a tamper proof seal affixed by the collector across the lid. A chain-of-custody summarizing the samples to be transported is also required. This form should be prepared by the collector and completed upon final sampling. A copy of the form(s) should accompany the person responsible for transporting the samples so that it can be included with the final analytical report as support documentation. The sample collector also initializes the chain-of-custody record process. It is his/her responsibility to ensure that the record is maintained upon relinquishment of the samples for transport to the laboratory.

When samples are transported, the carrier assumes responsibility for the chain-of-custody record and for ensuring safe transport of the samples to the laboratory. The carrier must recognize the contents of the shipment, the potential hazards they entail, and demonstrate an understanding of the proper handling precautions to be used during transport. The carrier is responsible for ensuring that all samples are properly stored to avoid leakage or breakage. Sample coolers should be checked to ensure required temperatures are maintained and any additional ice is added as necessary. Do not use dry ice during transport. The carrier must also ensure that all relevant shipping manifests are properly and fully completed. Other individuals who might accompany the carrier must be advised of the nature of the shipment and must not be allowed direct contact with any of the samples.

Any transfer of samples from one carrier to another must be accompanied by the chain-of-custody record and the above process repeated prior to relinquishment of the samples. The carrier must deliver the samples to the laboratory as soon as practicable after sampling, generally no later than 48 hours. The carrier should ensure that the samples are delivered to the person in the laboratory qualified to receive samples prior to relinquishment of the chain-of-custody record to that individual.

The laboratory should assign a specific individual to be responsible for the samples. This individual should first inspect the condition of the sample containers and any seals, and then reconcile the information on sample labels with that listed on the chain-of-custody record prior to signing the record. This individual should then assign laboratory numbers to each sample, enter these numbers on the laboratory logbook and on each sample container label, and should store the samples in a secured storage area until ready for analysis. This individual is ultimately responsible for completion of the chain-of-custody record and for ensuring that it forms part of the final analytical report.

10.0 ANALYTICAL LABORATORY - REPORTING AND QA/QC PROCEDURES

The contract laboratory must have the ability to produce reliable quantitative results in accordance with established protocol. At a minimum, the laboratory must use analytical methods that will achieve the nominal target reporting limits for the MDNR Appendix I groundwater monitoring parameters listed in Appendix 2. Adequate levels of accuracy, precision, and completeness must be maintained.

10.1 Accuracy

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. To achieve an adequate appraisal of accuracy, spikes and/or control samples should be made for one of every twenty samples analyzed. Minimum levels for accuracy should be listed in specific laboratory quality assurance plans.

10.2 Precision

Precision is a measure of the reproducibility of analytical results, generally expressed as a *Relative Percent Difference*. To achieve an adequate appraisal of precision, duplicate analyses should be performed for every one in twenty samples. Minimum levels for precision should be listed in specific laboratory quality assurance plans.

The relative standard deviation is a measure of the variability of the results from an analytical procedure. The relative standard deviation is calculated by taking the difference between a sample result, x, and the average of sample results from numerous laboratories, x_{bar}, for each analyte divided by x_{bar} [$(x-x_{bar})/x_{bar}$ expressed as a percentage].

The relative percent difference is the difference, by analyte, between the results of duplicate sample divided by the average value for those samples [$(x_1-x_2)/((x_1+x_2)/2)$ expressed as a percentage]. It is a measure of the variation in the results of an analyte for duplicate samples.

If the results for duplicate samples of an analyte for relative percent difference are within 2.5 times the percent relative standard deviation, the analytical data for the parameter may be accepted as being comparable results. If the results of an analyte for duplicate samples for relative percent difference are not within 2.5 times the percent relative standard deviation, the results of the analyte should be checked for comparability.

10.3 Completeness

Completeness is a comparison of the amount of valid data acquired to the amount of valid data planned to be obtained, expressed as a percentage. Should the percentage of completeness fall below 90 percent for the analytical results of any given sampling event, the laboratory should be prepared to present a corrective action narrative prior to receiving further groundwater samples.

10.4 Reporting Requirements

Minimum reporting requirements for the laboratory responsible for analytical results of groundwater monitoring well samples are as follows:

1. A table summary of all analytical test methods used in the analysis, including references for each to the method manual and test method number.

2. A summary of all analytical results. This must include use of appropriate units, reporting Practical Quantitation Limit (PQL), and appropriate signature on all data sheets. Units must be shown for each analyte. Data cannot be method blank corrected. Data must be appropriately flagged.

3. A complete chain-of-custody form(s). A complete form includes name and affiliation of sample collector, time and date of sampling, and all appropriate signatures denoting custody changes. The chain-of-custody form should be an original or a highly legible copy.

4. A completed copy of the field sampling log(s) contained in Appendix 6 of this Sampling and Analysis Plan.

5. Method detection limits must be established for all metals analysis. Method blank results are required.

6. All inorganic results will be accompanied by a Quality Assurance data form that includes minimum detection limits, method blanks, field or trip blanks, and lab replicate. If spiked samples are used, these data will also be included.

Supplemental laboratory data will include a summary that chronicles laboratory procedures, including date of sampling, sample receipt, preservation, preparation, analysis, and approval signature of the results.

Once laboratory analytical data are received, facility personnel must in turn submit the data to MDNR-SWMP in report form for review and comment within 90 days of the date of sampling. Information to be contained in the report should include the following:

1. Clearly state the purpose of the submittal (i.e. either detection or assessment monitoring).

2. Supply a copy of field notes, including all field data sheets.

3. Provide unaltered copies of the “raw” analytical data. A summary table is also recommended, but cannot take the place of the “raw” data.

4. Include the completed chain-of-custody form(s).

5. Summarize the data validation procedures.

6. Summarize groundwater flow direction and hydraulic gradient. Compare and contrast with previous data. Supply an updated water table (potentiometric) map prepared by a properly qualified individual.

7. Provide a statistical analysis summary using approved methods, including discussion of any statistically significant increase over established background values.

8. Note any deviations from the Sampling and Analysis Plan that may have taken place during the sampling event.

9. Provide electronic submission of groundwater data in a format and method prescribed by the MDNR-SWMP.

11.0 STATISTICAL ANALYSIS

The statistical analysis procedure(s) used for the Ameren Missouri Labadie Utility Waste Landfill (UWL) were selected to be consistent with the requirements of 10 CSR 80-11.010(11)(C)5. The statistical analysis plan below was developed for this facility and is submitted for review and approval.

This section contains a general discussion of the type of statistics chosen for the facility. The type of statistics chosen reflects the understanding that the site is located in a flood plain, and the shallow alluvial groundwater will be monitored.

11.1 Characterization of Well Network and Selection of Statistics

Upon installation of permanent groundwater monitoring wells, the Labadie Energy Center will follow the schedule for sampling shown in Table 2. After eight rounds of background sampling, a report will be prepared comparing the distribution of data for each parameter in both the upgradient and downgradient wells. Comparisons may include Box Plots for median, quartile and extreme values and Kruskal Wallis tests for comparison of populations at a 0.05 level of significance or other tests as appropriate. If downgradient well data are not comparable to upgradient well data, intra-well statistics will be considered for future comparisons. If data from one or more upgradient wells are comparable to the downgradient well(s) data, inter-well statistics will be considered for future comparisons.

11.2 Prediction Intervals or Other Statistical Tools

Parametric and non-parametric prediction intervals will be used as discussed below. The types of statistics to be used include parametric and non-parametric prediction intervals. For intra-well comparisons, the parametric and non-parametric prediction intervals will be defined by the data from previous samples collected at the well being reviewed. For inter-well comparisons, the parametric and non-parametric prediction intervals will be defined by the data from previous samples collected at the upgradient well(s).

Below is a specific discussion on the implementation for the statistics listed above. Prediction intervals for parametric and non-parametric distributions are recommended. Most computer statistical software programs include distribution testing with the appropriate selection of normal, log normal or non-parametric distribution. Some statistical software programs use the Ladder of Powers concept in an attempt to normalize data. Prediction intervals may include samples with results below detection limits by using either the Cohen or Aitchison approximations for a limited number of non-detects.

11.3 Choice of Statistical Test for Limited Data

The following restrictions apply to these statistical methods recommended in Section 11.2 depending on the number of samples that have been collected:

- Sample size < 4 – do not run statistics

- Sample size ≥ 4 but ≤ 8 – may use Poisson Prediction Limit Test or similar tests as a cursory review of parameter concentrations. Elevated parameters from this test are not Statistically Significant Increases (SSIs), but are parameters that will need to be looked at more closely when the sample size is greater than 12
- Sample size > 8 – use recommended Statistical methods

11.4 Non-Detects

There are limitations on the use of statistical procedures if analytical results do not detect a parameter. Examples are as follows:

- For non-detects ≥ 76 percent and < 100 percent, use a non-parametric inter-well prediction interval testing with the Upper Prediction Limit (UPL) = to the largest non-outlier value.
- For non-detects equal to 100 percent, use a non-parametric prediction interval testing with the Upper Prediction Limit (UPL) = the Practical Quantitation Limit (PQL). The analytical laboratory will maintain the lowest PQL practicable. Significant changes in PQL (± 25 percent) will be avoided as much as practicable.
- For non-detects < 25 percent, use PQL divided by two, or Cohen's Adjustment, and check for normality. The SWMP may approve use of a median PQL.
- For non-detects ≥ 25 percent and < 75 percent, use Cohen's Adjustment or a modified Aitchison's Adjustment (also known as the modified delta method), and check for normality.

11.5 Normality Testing

The purpose of normality testing is to determine whether the background data is normally distributed or if it can be normalized through transformation. Data that is normally distributed or that can be normalized will be evaluated using a parametric statistical tool. Data that is not normal will be evaluated using a non-parametric statistical tool. Examples of normality testing include:

- For sample population ≤ 50 – Shapiro-Wilk Test or equivalent
- For sample population > 50 – Shapiro-Francia Test or equivalent

Show normality testing on at least the original data, data residuals, and natural logarithmically transformed data or data transformed by the Ladder of Powers concept.

11.6 Outlier Testing

Since most of the software packages available use either the t-test or Dixon's method for determining outliers and neither of these methods can determine multiple outliers the SWMP has developed the following procedure to be used in determining outliers.

Screen data first by using Probability Plots and Time Series Plots. The Time Series Plot and the Probability Plots will aid in determining whether there are multiple possible outliers or a single possible outlier. The time Series Plot is used along with the Probability Plots to screen for possible outliers, a screening tool. The possible outliers are the points on the Probability Plots that appear out of alignment with the rest of the data. Care should be taken when using Probability Plots because non-normal data will also have points out of alignment as compared to the rest of the data. In addition, the Probability Plots will help determine if the numerical tests should be evaluated using log-transformations or transformed by the Ladder of Powers concept.

Determine the Median value for the Data to be processed. The median was chosen because the median value is not changed by either high or low values. This value is the *screening tool* to be used in the steps listed below:

- Use the screening tool to determine what values are possible outliers. The Time Series Plots could aid in the identification. If the number of possible outliers is equal to one, run the outlier test on that one value. If there are no possible outliers identified, do not screen for outliers. If there is more than one possible outlier proceed to the next step.

- Determine if one or more of the possible outliers could mask the other outliers. For example, for possible outlier values of 194, 290, 332, 838 and 1630, 1630 could mask 838 as an outlier. When masking can occur, each possible outlier should be tested with the other possible outliers not used in the calculations. In the example given, tag the value of 1630 and then run the outlier test on the value of 838. If the value 838 is an outlier then the value 1630 would also be an outlier and removed from the data set as confirmed outlier.

- If the outlier test would be run on the complete data set of 194, 290, 332, 838 and 1630, to determine if 1630 was an outlier, the value of 838 would not be an outlier if the value 1630 were not an outlier.

Also, when looking at the initial sample values, use the time series plots to determine if these initial values are within reasonable limits as compared to the other early samples. Some parameters have high readings the first few times a well is tested and these higher readings could mask a trend if they are not removed early in the monitoring program. Simply relying on a computer program to determine outliers without looking at the data through a visual means can give erroneous results.

There are different outlier tests depending on the number of samples:

- Use only Dixon's Test if the sample size is $\leq$ 25.

- Use Rosner's Test, if available, only if the sample size is ≥ 20. Rosner's Test is able to test for either single or for multiple outliers. Although Rosner's test avoids the problem of masking when multiple outliers are present in the same data set, it is not immune to the related problem of *swamping*. Swamping refers to a block of measurements all being labeled as outliers even though only some of the observations are actually outliers. This potential pitfall seems to be in properly identifying the total number of possible outliers. Following the screening procedure above should minimize the problem of *swamping*:

    - Outliers can only be excluded for the analytical event in which they are determined.

    - Previously determined outlier results will be re-checked when background is updated to confirm that these results are still outliers and not included in the background database.

    - Last date outliers of compliance well comparisons must not be excluded from current analysis.

    - Outlier screening will never be applied to the current (future values) monitoring data of control charts.

Other types of outlier test, besides those mentioned previously, may be used.

11.7 Prediction Interval Testing

When inter-well comparisons are being used, compare inter-well Upper Prediction Limit (UPL) to each downgradient well's last date value. Inter-well UPL is calculated from all dates of upgradient well background data.

When using intra-well comparisons, compare the UPL from previous sampling to the results by constituent of the current round of sampling results by constituent.

11.8 Procedures for Response to Future SSI's

This section contains a general discussion on the re-sampling strategy for any parametric or non-parametric inter-well prediction interval methods, re-sampling used to verify SSI's. An SSI is not proven:

- If the pooled background sample size (n) is ≤ 10, there is one resample out of two samples that does not show an SSI for the parameter; or

- If the pooled background sample size (n) is > 10, the single resample does not show an SSI for the parameter

This sampling strategy is identified in flow charts provided in Appendix 8.

If an SSI is confirmed, current (1997) Missouri Solid Waste Management Rules require the following procedures [Reference 10 CSR 80-11.010(11)(C)6].

"6. Response to statistical analysis.

A. *If the comparison for the upgradient wells shows a statistically significant increase (or pH change) over background, the owner/operator shall submit this information to the department.*

B. *If the comparisons for downgradient wells show a statistically significant increase (or pH change), resulting from the landfill, over background, the owner/operator shall within ninety (90) days of the last sampling event obtain additional groundwater samples from those downgradient wells where a statistically significant difference was detected, split the samples in two (2), and obtain analyses of all additional samples to determine whether the significant statistical difference was a result of laboratory error.*

C. *If the additional samples show a statistically significant increase (or pH change) over background, the owner/operator must demonstrate to the department within ninety (90) days that a source other than the utility waste landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation or natural variation. If the owner/operator cannot make this demonstration to the department, the owner/operator shall submit a plan to the department for a groundwater assessment monitoring program and implement the program as described in subparagraphs (11)(C)6.D. through H. of this rule. The plan shall specify the following:*

   (I) The number, location and depth of wells;

   (II) Sampling and analytical methods for the monitoring parameters listed in Appendix I of this rule on a quarterly basis;

   (III) Evaluation procedures, including any use of previously gathered groundwater quality information;

   (IV) The rate and extent of migration of the contaminant plume in the groundwater; and

   (V) The concentrations of the contaminant plume in the groundwater.

D. *After obtaining the results from the initial or subsequent sampling events required in subparagraph (11)(C)6.B. the owner/operator shall -*

   (I) Within fourteen (14) days, notify the department and place a notice in the operating record identifying the constituents that have been detected;

   (II) Within ninety (90) days, and on a quarterly basis after that, resample all wells and conduct analysis for all constituents listed in Appendix I to this rule and notify the department of the constituent concentrations. A minimum of one (1) sample

from each well sampled (background and downgradient) shall be collected and analyzed during these sampling events;

(III) Establish background concentrations for any new constituents detected during subsequent monitoring events; and

(IV) Establish groundwater protection standards for all new constituents detected during subsequent monitoring events.

E. *If the concentration of all constituents listed in Appendix I to this rule are shown to be at or below background levels as established in paragraph (11)(C)3. of this rule for two (2) consecutive sampling periods, the owner/operator may reinstate detection monitoring at the utility waste landfill as specified under subparagraph (11)(C)3.C. of this rule.*

F. *If the concentrations of any constituents listed in Appendix I of this rule are above background values, but all concentrations are below the groundwater protection standard established under subparagraph (11)(C)6.D. of this rule using the statistical procedures in paragraph (11)(C)5. of this rule, the owner/operator shall notify the department and the department may require the owner/operator to--*

(I) Continue assessment monitoring; or

(II) Develop a corrective measures assessment, or both.

G. *If one (1) or more constituents listed in Appendix I of this rule are detected at levels above the groundwater protection standard as established under subparagraph (11)(C)6.D., the owner/operator shall--*

(I) Provide the department with a report assessing potential corrective measures;

(II) Characterize the nature and extent of the release by installing additional monitoring wells as necessary; install at least one (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with paragraph (11)(C)6. of this rule and, if required by the department, notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells; and

(III) Continue assessment monitoring as per the groundwater quality assessment plan, and implement the approved corrective action program specified in part (11)(C)6.G.(I) of this rule.

H. *The results of implementation of the assessment monitoring program shall be submitted to the department at the end of each year or an alternate time period approved by the department."*

Prior to implementing a response to a future SSI, it is recommended that the Missouri Code of State Regulations be reviewed to determine if the Solid Waste Management Rules regarding Response to Statistical Analysis have been revised.

11.9 Current MDNR Protocols

The following protocols are currently used by MDNR's Solid Waste Management Program in managing groundwater monitoring data for solid waste disposal areas and in evaluating that data for statistically significant increases (SSI's)

The SWMP has previously not allowed a verified SSI or its verification resample value(s) to be excluded as outliers from the database for control charts if the previously specified resample strategy shows that only the "future measurements" plot, including resample(s) measurement(s), does not exceed the "SCL - limit" line.

- Re-sampling SSI's must be conducted a minimum of one quarter later from the previous sampling event. MDNR's in-house laboratory or subcontractor will be given the option to split samples for each re-sampling event.

- If a subset of background data is to be excluded, or if a previous excluded subset of background data is to be re-included for statistical analysis, a request for modification to the approved statistical analysis plan must be submitted to and approved by the SWMP before implementation. This requirement does not include the data that would be temporarily excluded because of outlier testing during a single statistical analysis event.

- See Appendix 8, Attachment 1 for a flow diagram for implementing Prediction Intervals.

- See Appendix 8, Attachment 2 for a flow diagram for Non-Parametric Prediction Intervals for data that is non-normal or for data that cannot be normalized.

Prior to utilizing various MDNR protocols for statistical analysis of groundwater monitoring data, it is recommended that the SWMP be contacted to obtain updated recommendations on current protocols and/or policies.

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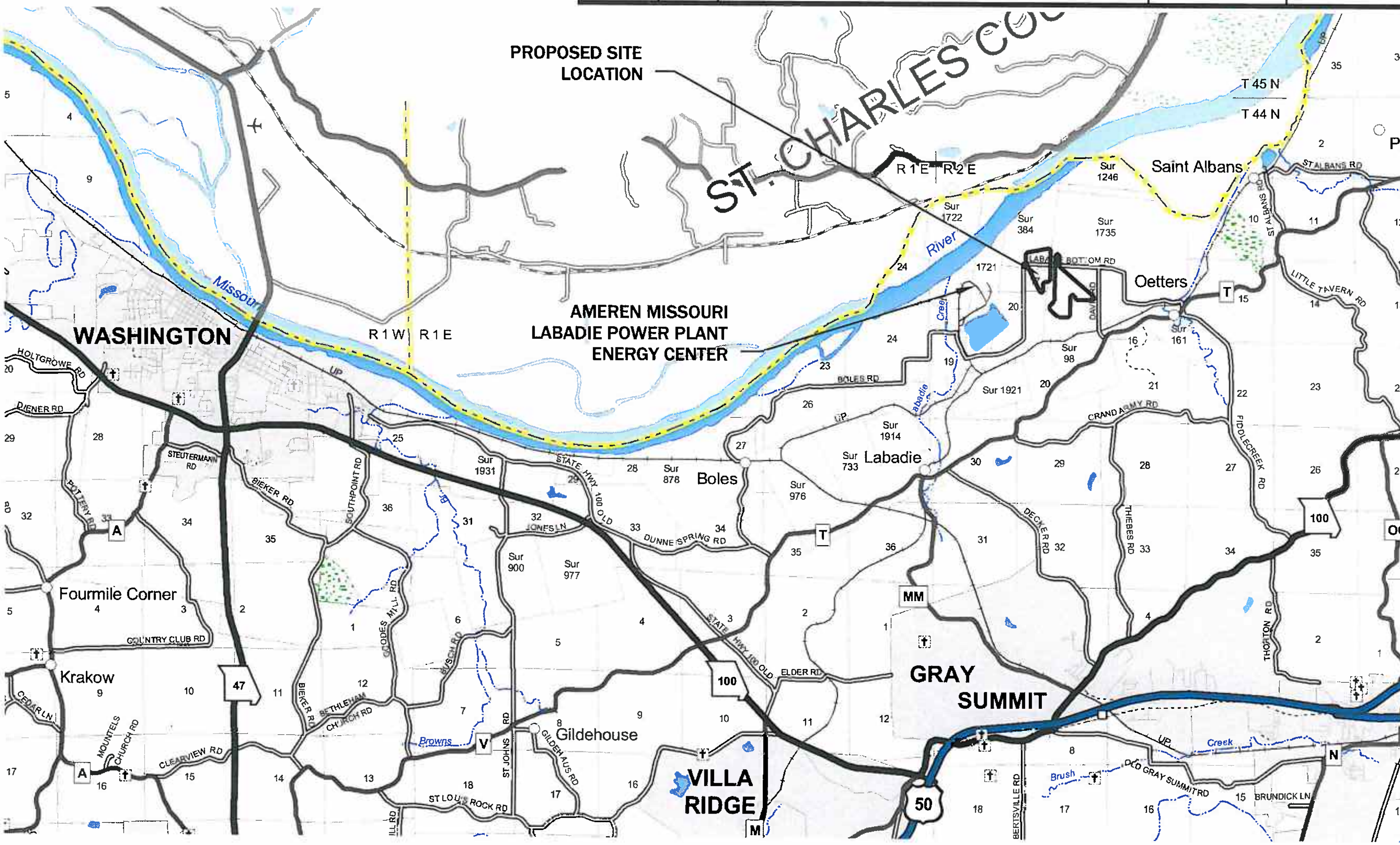
Figures

ZONE	REV	DESCRIPTION	DATE	APPROVED

REVISIONS



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APPD. T.R.G. (G.E.R.)

FIGURE 1, APPENDIX Q
LABADIE ENERGY CENTER
PROPOSED UTILITY WASTE LANDFILL
SITE LOCATION MAP

LOCATION		CLASS
001009	LABADIE ENERGY CENTER	02010

Ameren MISSOURI ST. LOUIS, MISSOURI

REV.

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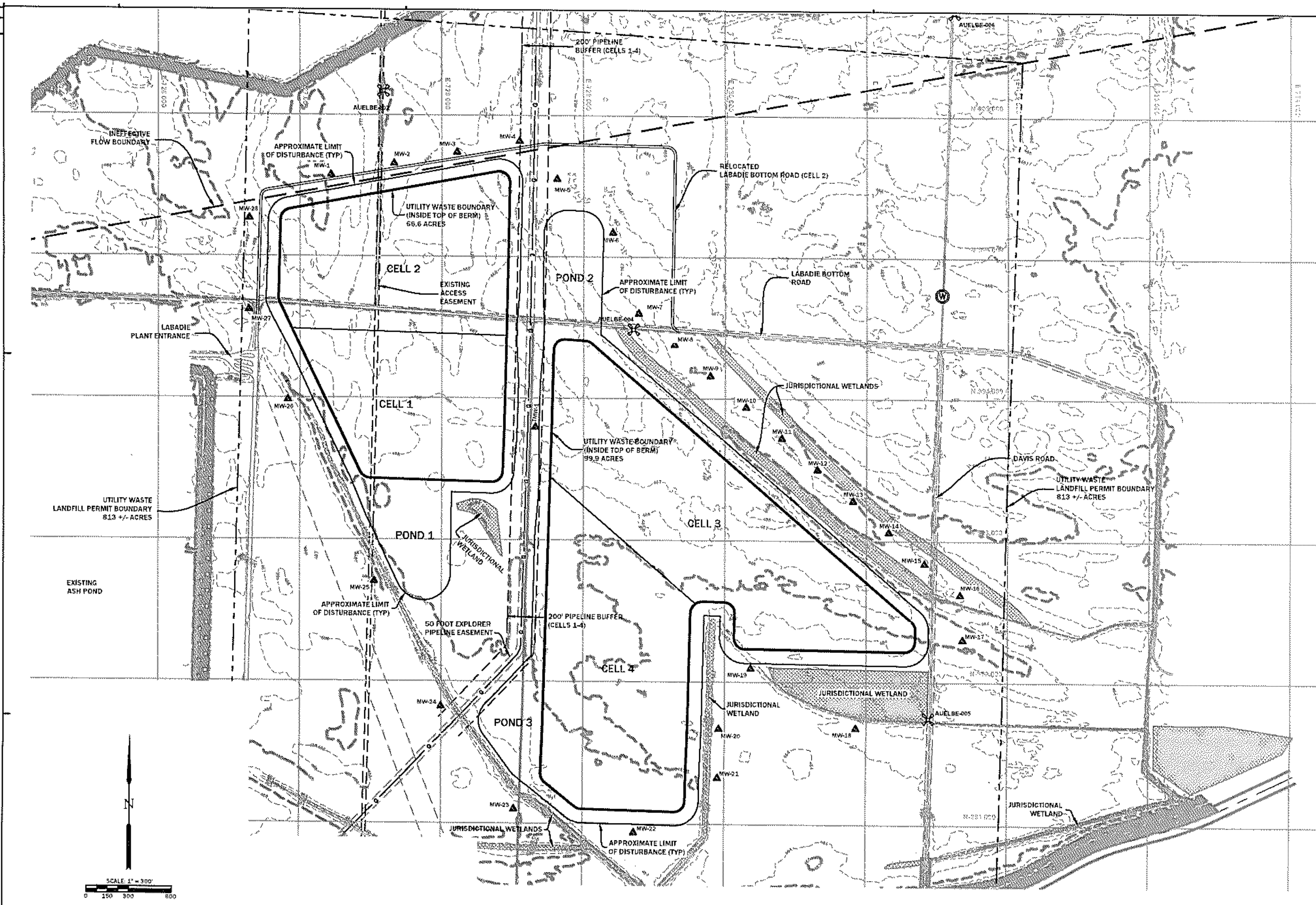

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	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 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.

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GREDELL Engineering Resources, Inc.

PREPARED FOR Ameren

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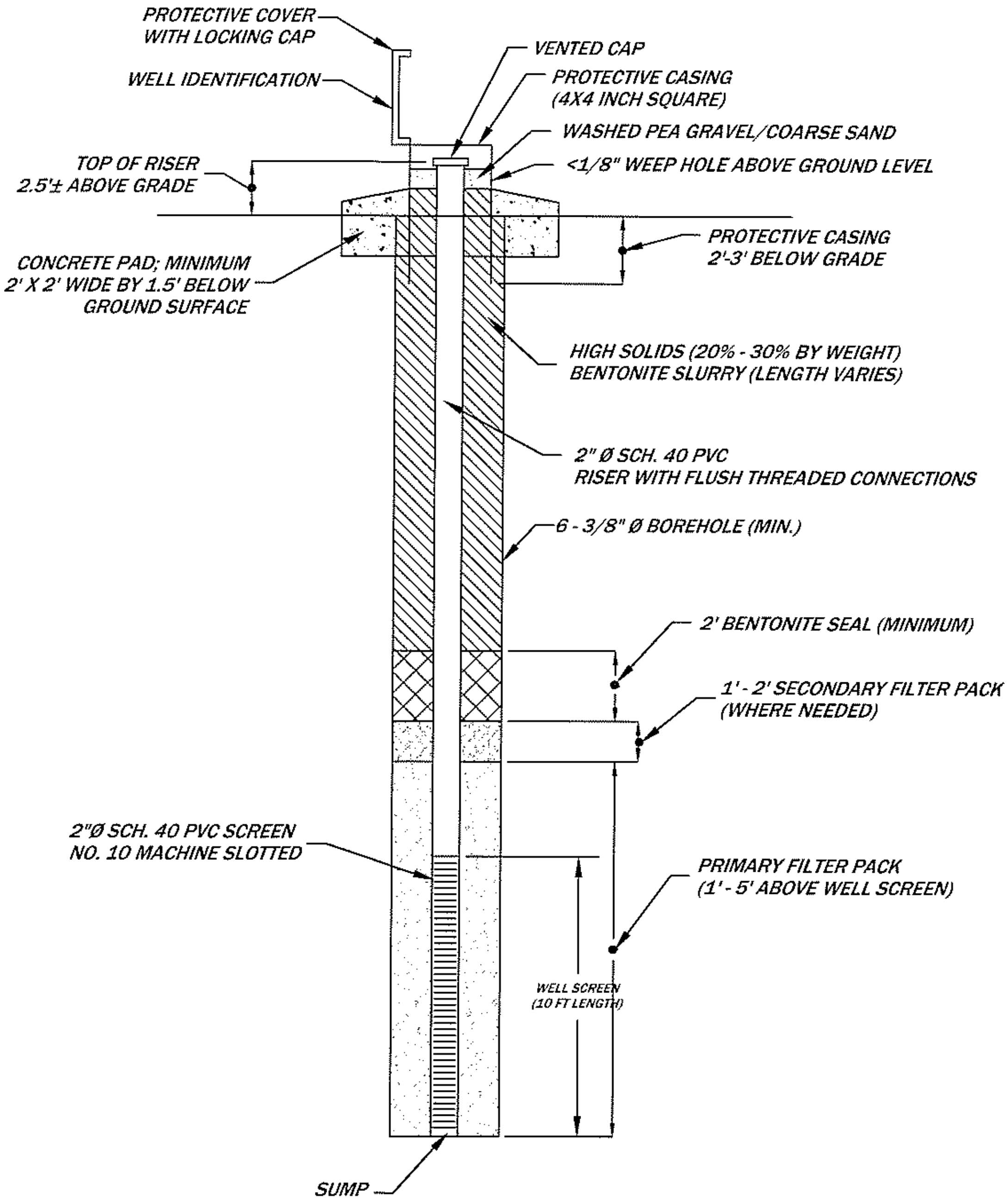
CHKD.	R.L.R. (G.E.R.)
SUPV.	T.R.G. (G.E.R.)
APPD.	T.R.G. (G.E.R.)

FIGURE 2, APPENDIX Q
PROPOSED UTILITY WASTE LANDFILL
MONITORING WELL LOCATION MAP

LOCATION		CLASS
001009	LABADIE ENERGY CENTER	02010

Ameren MISSOURI — ST. LOUIS, MISSOURI

DECEMBER 18, 2012 — REV 0



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DRAWN A.J.K. (G.E.R.)	FIGURE 3, APPENDIX Q PROPOSED UTILITY WASTE LANDFILL TYPICAL GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL
CHKD. M.C.C. (G.E.R.)	
SUPV. M.C.C. (G.E.R.)	
APPD. T.R.G. (G.E.R.)	LOCATION 001009 — LABADIE ENERGY CENTER — CLASS 02010
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APPENDIX Q - SAMPLING & ANALYSIS PLAN

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Tables

Construction Permit Application
Proposed Utility Waste Landill
Ameren Missouri Labadie Energy Center
Franklin County, Missouri

Groundwater Sampling and Analysis Plan
Groundwater Monitoring Well Summary
Table 1

Monitoring Well Designation	Upgradient or Downgradient	Northing	Easting	Ground Surface Elevation (approx.)	Well Depth (feet, bgs)	Screen Length (feet)	Top of Screen Interval Elevation (approx.)
MW-1	DG	995574	727216	470	25	10	455
MW-2	DG	995656	727662	469	23	10	456
MW-3	DG	995738	728106	468	22	10	456
MW-4	DG	995819	728547	468	21	10	457
MW-5	DG	995548	728812	468	21	10	457
MW-6	DG	995171	729206	467	20	10	457
MW-7	DG	994600	729389	467	19	10	458
MW-8	DG	994380	729642	466	18	10	458
MW-9	DG	994160	729895	465	17	10	458
MW-10	DG	993940	730147	466	18	10	458
MW-11	DG	993720	730400	466	18	10	458
MW-12	DG	993500	730653	465	17	10	458
MW-13	DG	993280	730905	465	17	10	458
MW-14	DG	993060	731158	464	16	10	458
MW-15	DG	992840	731410	464	15	10	459
MW-16	DG	992620	731663	464	15	10	459
MW-17	DG	992302	731681	465	16	10	459
MW-18	DG	991674	730925	462	13	10	459
MW-19	DG	992096	730184	463	15	10	458
MW-20	DG	991668	729958	463	14	10	459
MW-21	DG	991332	729953	463	14	10	459
MW-22	UG	990940	729361	464	15	10	459
MW-23	UG	991102	728514	465	17	10	458
MW-24	UG	991822	727995	465	17	10	458
MW-25	UG	992708	727524	466	18	10	458
MW-26	UG	993986	726913	467	20	10	457
MW-27	UG	994619	726637	468	22	10	456
MW-28	UG	995267	726640	469	24	10	455
TMW-1	DG	993795	728659	467	19	10	458

NOTES:

1. Refer to Figure 2 for proposed monitoring well locations.
2. TMW-1 is a temporary ("sentry") well located immediately east of initial cell construction area (Cell 1).
3. Basis for permanent well locations described in "Documentation of Groundwater Monitoring Well Design"; see Appendix X of Construction Permit Application.
4. Refer to Figure 3 for typical well construction details.
5. MW-1 through MW-21, and TMW-1, denote generally downgradient well positions. MW-22 through MW-28 denote generally upgradient well positions.

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

Groundwater Sampling and Analysis Plan
Groundwater Monitoring Schedule
Table 2

Time	Item to Be Completed	Reports to MDNR
27 or 28 months before initial UWL operation	Install and develop groundwater monitoring wells.	Monitoring well installation records to Wellhead Protection Program
26 months before initial UWL operation	Initial sampling event	Initial groundwater field sampling and laboratory data to Solid Waste Management Program (SWMP)
23 months before initial UWL operation	Second sampling event	Groundwater field sampling and laboratory data to SWMP
20 months before initial UWL operation	Third sampling event	Groundwater field sampling and laboratory data to SWMP
17 months before initial UWL operation	Fourth sampling event	Groundwater field sampling and laboratory data to SWMP
14 months before initial UWL operation	Fifth round of sampling	Groundwater field sampling and laboratory data to SWMP
11 months before initial UWL operation	Sixth round of sampling	Groundwater field sampling and laboratory data to SWMP
8 months before initial UWL operation	Seventh round of sampling	Groundwater field sampling and laboratory data to SWMP
5 months before initial UWL operation	Eighth round of sampling	Report on field sampling and analytical data distributions and choice of intra-well or inter-well statistics to SWMP. Includes groundwater sampling data.
2 months before initial UWL operation	Submit Request for Operating Permit to MDNR	MDNR-SWMP has 60 days to review the submittal and make a decision on the Operating Permit.
Initial UWL operations begin.	N/A	N/A
Continue monitoring once per six months during May and November	Semi-annual sampling for routine detection monitoring	Groundwater field sampling, laboratory data and statistical report within 90 days of each subsequent sampling event to SWMP

Appendices

Appendix 1

Driller's Logs and Monitoring Well Construction Details

This Appendix Intentionally Left Blank.
Information to be included following installation
of groundwater monitoring wells.

Appendix 2

Missouri Solid Waste Management Rule
Constituents for Detention Monitoring
(10 CSR 80-11.010, Appendix I)
Revised August 2013

Ameren Missouri Labadie Energy Center
Groundwater Sampling and Analysis Plan

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

Chemical Constituent	Units	Method[1]	PQL[2]
Aluminum (Al)	ug/l	6010B	50
Antimony (Sb)	ug/l	7010	5
Arsenic (As)	ug/l	7010	3
Barium (Ba)	ug/l	6010B	5
Beryllium (Be)	mg/l	6010B	0.001
Boron (B)	ug/l	6010B	20
Cadmium (Cd)	ug/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)	ug/l	6010B	10
Cobalt (Co)	ug/l	6010B	10
Copper (Cu)	ug/l	6010B	10
Fluoride	mg/l	9214	0.10
Hardness	mg/l	2340B	NA
Iron (Fe)	ug/l	6010B	20
Lead (Pb)	ug/l	7010	2
Magnesium (Mg)	mg/l	6010B	0.01
Manganese (Mn)	ug/l	6010B	5
Mercury (Hg)	ug/l	7470A	0.2
Molybdenum (Mo)[3]	ug/l	6010B	10
Nickel (Ni)	mg/l	6010B	0.01
pH (Field)	S.U.	NA	NA
Selenium (Se)	ug/l	6010B	30
Silver (Ag)	ug/l	6010B	10
Sodium (Na)	mg/l	6010B	0.05
Specific Conductance (Field)	umhos/cm	NA	NA
Sulfate	mg/l	9036	10
Thallium (Tl)	ug/l	7010	2
Total Dissolved Solids (TDS)	mg/l	2540C	20
Total Organic Carbon (TOC)	mg/l	9060	1
Total Organic Halogens (TOX)	mg/l	9020B	0.02
Zinc (Zn)	ug/l	6010B	10
Ground Water Elevation (Field)	feet	NA	NA

1. 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.
2. Practical Quantitation Limits as established by the contract laboratory.
3. Molybdenum added per the request of MDNR-SWMP in correspondence dated March 7, 2013 and May 7, 2013.

Appendix 3

Field Equipment Calibration Forms and Procedures

Field Instrumentation Calibration Log

Calibrated by: ______________________________

Field Instrument ____________ ____________

S/N # ____________ ____________ ____________ ____________

	Date	Time	pH Standards		pH Measurements	Specific Conductivity Standard (µs/cm)		Specific Conductivity Measurement (µs/cm)	Oxidation Reduction Potential Standard (mV)				Oxidation Reduction Potential Measurement (mV)	Turbidity Standards (NTU)		Turbidity Measurements (NTU)
Beginning of Day Calibration			4.00	=		1413	=		Temperature (°C)	=		=		0.02	=	
			7.00	=					Standard (mV)	=				10.0	=	
			10.00	=										1000	=	
End of Day Check			4.00	=		1413	=		Temperature (°C)	=		=		0.02	=	
			7.00	=					Standard (mV)	=				10.0	=	
			10.00	=										1000	=	

Notes: ______________________________

I certify that the aforementioned meters were calibrated within the manufactures specifications.

Date: ________ By: ______________________________

Prepared by GREDELL Engineering Resources, Inc.

ORP Interpolation Reference Table

Temperture °C	ORP mV	Temperture °C	ORP mV	Temperture °C	ORP mV	Temperture °C	ORP mV	Temperture °C	ORP mV	Temperture °C	ORP mV	Temperture °C	ORP mV
0.0	237.0	6.6	231.4	13.2	228.1	19.7	223.2	26.3	219.0	32.7	214.4	39.3	209.6
0.1	236.9	6.7	231.3	13.3	228.0	19.8	223.2	26.4	218.9	32.8	214.3	39.4	209.5
0.2	236.8	6.8	231.3	13.4	228.0	19.9	223.1	26.5	218.8	32.9	214.3	39.5	209.4
0.3	236.7	6.9	231.2	13.4	228.0	20.0	223.0	26.6	218.7	33.0	214.2	39.6	209.3
0.4	236.6	7.0	231.2	13.5	227.9	20.1	222.9	26.7	218.6	33.1	214.1	39.7	209.2
0.5	236.5	7.1	231.2	13.6	227.8	20.2	222.9	26.8	218.6	33.2	214.1	39.8	209.2
0.6	236.4	7.2	231.1	13.7	227.8	20.3	222.8	26.9	218.5	33.3	214.0	39.9	209.1
0.7	236.3	7.3	231.1	13.8	227.7	20.4	222.8	27.0	218.4	33.4	214.0	40.0	209.0
0.8	236.2	7.4	231.0	13.9	227.7	20.5	222.7	27.1	218.3	33.5	213.9	40.1	208.9
0.9	236.1	7.5	231.0	14.0	227.6	20.6	222.6	27.2	218.2	33.6	213.8	40.2	208.8
1.0	236.0	7.6	231.0	14.1	227.5	20.7	222.6	27.3	218.2	33.7	213.8	40.3	208.8
1.1	235.9	7.7	230.9	14.2	227.5	20.8	222.5	27.4	218.1	33.8	213.7	40.4	208.7
1.2	235.8	7.8	230.9	14.3	227.4	20.9	222.5	27.5	218.0	33.9	213.7	40.5	208.6
1.3	235.7	7.9	230.8	14.4	227.4	21.0	222.4	27.6	217.9	34.0	213.6	40.6	208.5
1.4	235.6	8.0	230.8	14.5	227.3	21.1	222.3	27.7	217.8	34.1	213.5	40.7	208.4
1.5	235.5	8.1	230.8	14.6	227.2	21.2	222.3	27.8	217.8	34.2	213.5	40.8	208.4
1.6	235.4	8.2	230.7	14.7	227.2	21.3	222.2	27.9	217.7	34.3	213.4	40.9	208.3
1.7	235.3	8.3	230.7	14.8	227.1	21.4	222.2	28.0	217.6	34.4	213.4	41.0	208.2
1.8	235.2	8.4	230.6	14.9	227.1	21.5	222.1	28.1	217.5	34.5	213.3	41.1	208.1
1.9	235.1	8.5	230.6	15.0	227.0	21.6	222.0	28.2	217.4	34.6	213.2	41.2	208.0
2.0	235.0	8.6	230.6	15.1	226.9	21.7	222.0	28.3	217.4	34.7	213.2	41.3	208.0
2.1	234.9	8.7	230.5	15.2	226.8	21.8	221.9	28.4	217.3	34.8	213.1	41.4	207.9
2.2	234.8	8.8	230.5	15.3	226.8	21.9	221.9	28.5	217.2	34.9	213.1	41.5	207.8
2.3	234.7	8.9	230.4	15.4	226.7	22.0	221.8	28.6	217.1	35.0	213.0	41.6	207.7
2.4	234.6	9.0	230.4	15.5	226.6	22.1	221.7	28.7	217.0	35.1	212.9	41.7	207.6
2.5	234.5	9.1	230.4	15.6	226.5	22.2	221.7	28.8	217.0	35.2	212.8	41.8	207.6
2.6	234.4	9.2	230.3	15.7	226.4	22.3	221.6	28.9	216.9	35.3	212.8	41.9	207.5
2.7	234.3	9.3	230.3	15.8	226.4	22.4	221.6	29.0	216.8	35.4	212.7	42.0	207.4
2.8	234.2	9.4	230.2	15.9	226.3	22.5	221.5	29.1	216.7	35.5	212.6	42.1	207.3
2.9	234.1	9.5	230.2	16.0	226.2	22.6	221.4	29.2	216.6	35.6	212.5	42.2	207.2
3.0	234.0	9.6	230.2	16.1	226.1	22.7	221.4	29.3	216.6	35.7	212.4	42.3	207.2
3.1	233.9	9.7	230.1	16.2	226.0	22.8	221.3	29.4	216.5	35.8	212.4	42.4	207.1
3.2	233.8	9.8	230.1	16.3	226.0	22.9	221.3	29.3	216.6	35.9	212.3	42.5	207.0
3.3	233.7	9.9	230.0	16.4	225.9	23.0	221.2	29.4	216.5	36.0	212.2	42.6	206.9
3.4	233.6	10.0	230.0	16.5	225.8	23.1	221.1	29.5	216.4	36.1	212.1	42.7	206.8
3.5	233.5	10.1	229.9	16.6	225.7	23.2	221.1	29.6	216.3	36.2	212.0	42.8	206.8
3.6	233.4	10.2	229.9	16.7	225.6	23.3	221.0	29.7	216.2	36.3	212.0	42.9	206.7
3.7	233.3	10.3	229.8	16.8	225.6	23.4	221.0	29.8	216.2	36.4	211.9	43.0	206.6
3.8	233.2	10.4	229.8	16.9	225.5	23.5	220.9	29.9	216.1	36.5	211.8	43.1	206.5
3.9	233.1	10.5	229.7	17.0	225.4	23.6	220.8	30.0	216.0	36.6	211.7	43.2	206.4
4.0	233.0	10.6	229.6	17.1	225.3	23.7	220.8	30.1	215.9	36.7	211.6	43.3	206.4
4.1	232.9	10.7	229.6	17.2	225.2	23.8	220.7	30.2	215.9	36.8	211.6	43.4	206.3
4.2	232.8	10.8	229.5	17.3	225.2	23.9	220.7	30.3	215.8	36.9	211.5	43.5	206.2
4.3	232.7	10.9	229.5	17.4	225.1	24.0	220.6	30.4	215.8	37.0	211.4	43.6	206.1
4.4	232.6	11.0	229.4	17.5	225.0	24.1	220.5	30.5	215.7	37.1	211.3	43.7	206.0
4.5	232.5	11.1	229.3	17.6	224.9	24.2	220.5	30.6	215.6	37.2	211.2	43.8	206.0
4.6	232.4	11.2	229.3	17.7	224.8	24.3	220.4	30.7	215.6	37.3	211.2	43.9	205.9
4.7	232.3	11.3	229.2	17.8	224.8	24.4	220.4	30.8	215.5	37.4	211.1	44.0	205.8
4.8	232.2	11.4	229.2	17.9	224.7	24.5	220.3	30.9	215.5	37.5	211.0	44.1	205.7
4.9	232.1	11.5	229.1	18.0	224.6	24.6	220.2	31.0	215.4	37.6	210.9	44.2	205.6
5.0	232.0	11.6	229.0	18.1	224.5	24.7	220.2	31.1	215.3	37.7	210.8	44.3	205.6
5.1	232.0	11.7	229.0	18.2	224.4	24.8	220.1	31.2	215.3	37.8	210.8	44.4	205.5
5.2	231.9	11.8	228.9	18.3	224.4	24.9	220.1	31.3	215.2	37.9	210.7	44.5	205.4
5.3	231.9	11.9	228.9	18.4	224.3	25.0	220.0	31.4	215.2	38.0	210.6	44.6	205.3
5.4	231.8	12.0	228.8	18.5	224.2	25.1	219.9	31.5	215.1	38.1	210.5	44.7	205.2
5.5	231.8	12.1	228.7	18.6	224.1	25.2	219.8	31.6	215.0	38.2	210.4	44.8	205.2
5.6	231.8	12.2	228.7	18.7	224.0	25.3	219.8	31.7	215.0	38.3	210.4	44.9	205.1
5.7	231.7	12.3	228.6	18.8	224.0	25.4	219.7	31.8	214.9	38.4	210.3	45.0	205.0
5.8	231.7	12.4	228.6	18.9	223.9	25.5	219.6	31.9	214.9	38.5	210.2		
5.9	231.6	12.5	228.5	19.0	223.8	25.6	219.5	32.0	214.8	38.6	210.1		
6.0	231.6	12.6	228.4	19.1	223.7	25.7	219.4	32.1	214.7	38.7	210.0		
6.1	231.6	12.7	228.4	19.2	223.6	25.8	219.4	32.2	214.7	38.8	210.0		
6.2	231.5	12.8	228.3	19.3	223.6	25.9	219.3	32.3	214.6	38.9	209.9		
6.3	231.5	12.9	228.3	19.4	223.5	26.0	219.2	32.4	214.6	39.0	209.8		
6.4	231.4	13.0	228.2	19.5	223.4	26.1	219.1	32.5	214.5	39.1	209.7		
6.5	231.4	13.1	228.1	19.6	223.3	26.2	219.0	32.6	214.4	39.2	209.6		

Note: Standard ORP measurements 0, 5, 10, 15, 20, 25, 30, 35, and 40 were provided by Geotech Environmental Equipment, Inc.
The rest of the standard ORP measurements were interpolated from Geotech Standard ORP measurements.

FIELD EQUIPMENT CALIBRATION PROCEDURES

Multi-meter pH, Temperature, Conductivity, Oxidation Reduction Potential (ORP)

pH Calibration/Operation Procedures

(Reference EPA Method 9040)

The field pH meter will be calibrated each day water samples are collected. Calibration results will be recorded on the Field Instrumentation Calibration Log in Appendix 3 of the Sampling and Analysis Plan.

pH Three-Buffer Calibration

This procedure is recommended for precise measurements.

1. Select three buffers which bracket the expected sample pH. The first should be near the electrode isopotential point (pH 7) and the second and third should bracket the expected sample pH (e.g. pH 4 and pH 10).
2. Rinse electrode first with distilled water and then with pH 7 buffer. Place the electrode in pH 7 buffer.
3. Wait for stable display. Set the meter to the pH value of the buffer at its measured temperature. (ATC @ 25°C = 7.00).
4. Rinse electrode first with distilled water and then with the second buffer. Place the electrode in the second buffer.
5. When the display is table, set the meter to the actual pH value of the buffer as described in the meter instruction manual.
6. Rinse electrode first with distilled water and then with the third buffer. Place the electrode in the third buffer.
7. When the display is table, set the meter to the actual pH value of the buffer as described in the meter instruction manual.
8. If all steps are performed correctly, and the slope is between 92 and 102%, proceed to pH Measurement.

For detailed calibration and temperature compensation procedures, consult meter instruction manual.

pH Measurement

1. Obtain a neat sample from collection device and place electrode directly into sample.
2. Allow reading to stabilize.
3. Record pH reading directly from meter and record on the Field Sampling Log.
4. Probes are to be decontaminated by multiple rinses with distilled water.

If the above procedures do not work, refer to Troubleshooting section of instrument instruction manual.

Measuring Hints

1. Always use fresh buffers for calibration. Choose buffers that are no more than 3 pH units apart.
2. Check electrode slope daily by performing a three-buffer calibration. Slope should be 92 to 102%.
3. Between measurements, rinse electrodes with distilled water and then with the next solution to be measured.
4. Stir all buffers and samples.
5. Avoid rubbing or wiping electrode bulb, to reduce chance of error due to polarization.

Interferences

Oil samples and salty samples may leave residues on the electrodes. The probe has to be rinsed thoroughly between all measurements using distilled water to remove salt residues. If oily residues need to be removed, rinse with acetone then distilled water. The electrodes need to be kept wet to ensure proper response.

FIELD EQUIPMENT CALIBRATION PROCEDURES

Conductivity/Temperature Calibration/ Operation Procedures

(Reference EPA Method 9050)

Calibration Procedures

Conductivity will be checked at a minimum of once per day using commercial traceable standards in the 1000 and 10,000 mmhos/cm range and recorded on the Field Instrumentation Calibration Log. Calibration checks outside of a ± 10% range are not acceptable and will require the sensor replacement and/or re-check of the standards. If calibration check standards are still outside ± 10% range, use alternate meter. Do not proceed with sample collection without acceptable calibration checks.

Temperature measurement is factory calibrated. Temperature will be checked for calibration by comparison with a laboratory thermometer within a ± 10% range prior to the sample event.

Temperature Measurement

Report all values on the Field Sampling Log in degrees Celsius (°C).

1. Immerse the temperature/conductivity sensor into the sample.
2. Record temperature reading directly from meter and record on the Field Sampling Log.

Conductivity Measurement

Report all values on the Field Sampling Log in umhos/cm (uS/cm).

1. Immerse the temperature/conductivity sensor into the sample.
2. Record conductivity reading directly from meter and record on the Field Sampling Log.
3. Sensors are to be decontaminated by multiple rinses with distilled water.

Most meters have a fixed temperature coefficient (TC) of 2.1% per °C and a fixed reference temperature of 25°C. These parameters are sufficient for the majority of "natural water" samples.

FIELD EQUIPMENT CALIBRATION PROCEDURES

Oxidation Reduction Potential (ORP) Calibration/ Operation Procedures

(Reference YSI Environmental)

ORP Calibration

Report all values on the Field Instrumentation Calibration Log in millivolts (mV).

1. Select ORP.
2. Immerse the sensor into the calibration solution.
3. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature (Refer to the Appendix 3 ORP Interpolation Reference Table in the Sampling and Analysis Plan).
4. Record ORP reading directly from meter and record on the Field Instrumentation Calibration Log.
5. Sensors are to be decontaminated by multiple rinses with distilled water.

ORP Measurement

Report all values on the Field Sampling Log in millivolts (mV).

1. Select ORP.
2. Immerse the sensor into the sample.
3. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature (Refer to the Appendix 3 ORP Interpolation Reference Table in the Sampling and Analysis Plan).
4. Record ORP reading directly from meter and record on the Field Sampling Log.
5. Sensors are to be decontaminated by multiple rinses with distilled water.

Low-Flow cell calibration

The manufacturer's recommended procedures shall be followed for low-flow cell calibration. A copy of these procedures is to be made a part of this sampling and analysis plan.

FIELD EQUIPMENT CALIBRATION PROCEDURES

Turbidimeter Calibration/ Operation Procedures

(Reference HF Scientific)

The Turbidimeter allows for the measurement of turbidity in the field. The instrument measures and reports the turbidity of a sample in nephelometric turbidity units (NTU's).

Turbidimeter Calibration

The instrument was calibrated and tested prior to leaving the factory. The instrument requires three (3) standards to be calibrated.

1. Select the calibration function of the instrument by pressing the CAL button once. The "CAL" block will be illuminated on the display with "1" indicating the standard required for this step of the calibration. This is the first standard that should be used in a full calibration.
2. Insert the 1000 NTU standard (CAL 1 in the figure above) into the sample well and press down until the cuvette snaps fully into the instrument. Align the indexing ring with the arrow on the instrument.
3. Wait for the reading to stabilize. Once the reading has stabilized press the enter button to indicate to the instrument that it should calibrate on this point.
4. When the instrument has completed calibration on this point, it prompts you to insert the next calibration standard into the sample well (CAL 2).
5. Repeat steps 2-4 for each calibration standard. When you calibrate on CAL 3 (turbidity free water), the instrument will automatically exit out of calibration returning back to the normal operating mode.

Turbidimeter Measurement

Turn on the instrument by pressing the ON/OFF button continuously for 1 second. Allow 75-second warm-up period while preparing for the turbidity measurement as described in the following steps:

1. Sample approximately 100 ml of your process, as you would normally do for turbidity measurement.
2. Obtain a clean and dry sample cuvette.
3. Rinse the cuvette with approximately 10 ml of the sample water (2/3 of cuvette volume), capping the cuvette with the black light shield (cuvette top) and inverting several times. Discard the used sample and repeat the rinsing procedure two more times.
4. Completely fill the rinsed cuvette (from step 3) with the remaining portion (approximately 15 ml) of the grab sample and then cap the cuvette with the supplied cap. Ensure that the outside of the cuvette is dry, clean and free from smudges.

5. Place the cuvette into the instrument and press it down until it snaps fully into the sample well. Index the cuvette by pressing and holding down the enter button while rotating the cuvette to identify the lowest reading (the displayed turbidity is continuously updated on the display). Once the cuvette is indexed, release the enter button to display the measured turbidity.

Appendix 4

Sample Container and Preservation Guidelines and Groundwater Sampling Bottle Inventory Form

Ameren Missouri LABADIE ENERGY CENTER
Groundwater Sampling and Analysis Plan

Sample Container and Preservation Guidelines

Measurement	Volume Req., (ml)	Container[a]	Preservative	Max. Holding Times	Reference
Specific Cond. (Field)	100	P, G	None	Det. on Site	1
pH (Field)	50	P, G	None	Det. on Site	1, 2
Temperature (Field)	1000	P,G	None	Det. on Site	1
Oxidation Reduction Potential	1000	P,G	None	Det. on Site	
Turbidity	1000	P,G	None	Det. on Site	
Inorganics, Non-Metallics					
Fluoride	300	P, G	HNO_3 to pH <2	28	1, 2
Total Organic Carbon	100	G_b	Cool, 4°C; HCl or H_2SO_4 to pH <2	28	1
Total Dissolved Solids	500	P, G	Cool, 4°C	7 Days	1,4
Chloride	500	P, G	Cool,4°C	28 Days	1, 2
Sulfate	200	P, G	Cool, 4°C	28 Days	1, 2,4
Total Organic Halides (TOX)	2000	G	Cool, 4°C; HCl or H_2SO_4 to pH <2	7 Days	4
COD	50	P, G	H_2SO_4 to pH <2	28 Days	1
Metals					
Total Recoverable	500	P, G	HNO_3 to pH <2	6 Mos	1, 2
Mercury	500	P, G	HNO_3 to pH <2	28 Days	1, 2

NOTES:

a. Plastic (P) or Glass (G). For metals, polyethylene with an all polypropylene cap is preferred.
b. Use Teflon© lined cap.
c. Silver requires an amber bottle

REFERENCES:

1. Methods for Chemical Analysis of Water and Wastes, March, 1983, USEPA, 600/4-79-020 and additions thereto.
2. Test Methods for Evaluating Solid Waste, Physical/Chemical Method, November, 1986, Third Edition, USEPA, SW-846 and additions thereto.
3. Guidelines Establishing Test Procedures for the Analysis of Pollutant Under the Clean Water Act", Environmental Protection Agency, Code of Federal Regulations (CFR), Title 40, Part 136.
4. MDNR-FSS-001, Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations, Randy Crawford, Trish Rielly, Water Quality Monitoring Section, MDNR ESP September 17, 2003

Groundwater Sampling Bottle Inventory

Well ID	Date Received	Bottles Received					
		Chloride, Sulfate, Fluoride, Hardness, and TDS 1,000 mL - 1 Total (pl - none)	Metals 500 mL (pl - HNO_3)	TOX 500 mL (gl - H_2SO_4)	TOC 125 mL Amber (gl - H_2SO_4)	COD 125 mL (pl - H_2SO_4)	Broken or Damaged Bottles
Extra # 1							
Extra # 2							
Duplicate # 1							
Duplicate # 2							
Field Blank							
Trip Blank							

Bottles delivered by: ______________________

H_2SO_4 = Sulfuric Acid

HNO_3 = Nitric Acid

Appendix 5

Monitoring Well Field Inspection Form

Monitoring Well Field Inspection

Facility: Ameren Missouri Labadie Energy Center Utility Waste Landfill

Monitoring Well ID: ____________________

Name (Field Sampler): ____________________________

Date: ____________

Access:

Accessibility: Good ____ Fair ____ Poor_____

Well clear of weeds and/or debris?: Yes ____ No ______

Well identification clearly visible?: Yes ____ No ______

Remarks:

Concrete Pad:

Condition of Concrete Pad: Good ____ Inadequate _____

Depressions or standing water around well?: Yes ____ No_____

Remarks:

Protective Outer Casing: Material =

Condition of Protective Casing: Good ____ Damaged_____

Condition of Locking Cap: Good ____ Damaged_____

Condition of Lock: Good ____ Damaged_____

Condition of Weep Hole: Good ____ Damaged_____

Remarks:

Well Riser: Material =

Condition of Riser: Good ____ Damaged_____

Condition of Riser Cap: Good ____ Damaged_____

Measurement Reference Point: Yes ____ No_____

Remarks:

Dedicated Purging/Sampling Device: Type -

Condition: Good ____ Damaged ____ Missing_____

Remarks:

Field Certification

____

Signed Title Date

Appendix 6

Field Sampling Log and Volume Tracking Log Forms

Field Sampling Log

Facility: Ameren Missouri Labadie Energy Center UWL

Date: ____________ Monitoring Well ID: ____________

Name (Field Sampler): ____________

Gas Detected Y / N

PURGE INFORMATION:

Method of Well Purge: ____________

Dedicated? Y / N

Date/Time Initiated: ____________

One (1) Well Volume (ml): ____________

Initial Water Level (feet): ____________

Total Volume Purged (ml): ____________

GroundWater Elevation (NGVD): ____________

Well Purged To Dryness? Y / N

Well Total Depth (feet): ____________

Water Level after Purge (feet): ____________

Casing Diameter (feet): ____________

Date/Time Completed: ____________

PURGE DATA:

Time	Purge Rate (ml/min)	Cumulative Volume (ml)	Temp (°C)	pH	Specific Conductivity (µS)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Water Level	Notes

Field Sampling Log

Sampling Information: Date:__________ Monitoring Well ID: __________

Method of Sampling: low flow, peristaltic pump Dedicated: (Y) / N

Water Level @ Sampling, Feet: __________

Monitoring Event: Annual ( ) Semi-Annual ( ) Quarterly (x) Monthly ( ) Other ( )

Sampling Data:

Date/Time	Sample Rate ml/min	Temp (°C)	pH	Specific Conductivity (µS)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)

Instrument Check Data:

pH Meter Serial #: 1* 4.0 std. = 1* 7.0 std. = 1* 10.0 std. 1*

Conduct. Meter Serial #: 1* standard = 1* µS reading = 1* µS

Turbidity Meter Serial #: 1* standard = 1* NTU reading = 1* NTU

* See instrument calibration log for daily calibration data.

General Information:

Weather Conditions @ time of sampling: __________

Sample Characteristics: __________

Sample Collection Order: Per SOP

Comments and Observations:

I certify that sampling procedures were in accordance with applicable EPA and State protocols.

Date: __________ By: __________ Title: __________

Volume Tracking Log

Facility Name: Ameren Missouri Labadie Energy Center UWL		
Well ID	**Tally notes**	**Total Volume (mL)**

Note: Each Tick mark is equal to 1000 mL or 1L.
Total volume based on a 1L graduated cylinder.

Appendix 7

Example Chain-of-Custody Field Record Form

Chain of Custody Record

Date: ____________ Page: _____ of _____

Plant Manager	314-992-8201	314-992-8204
Contact Name	Phone Number	Fax Number
Ameren Missouri Labadie Energy Center UWL		
Company Name		
Labadie Bottom Road		
Street Address		
Labadie, MO 63055		
City, State, Zip		
Labadie Power Plant	Utility Waste Landfill	
Project Name	Site Location	

Preservation Code

1 = 4°C
2 = HNO_3
3 = HCl
4 = H_2SO_4
5 = NaOH
6 = Other

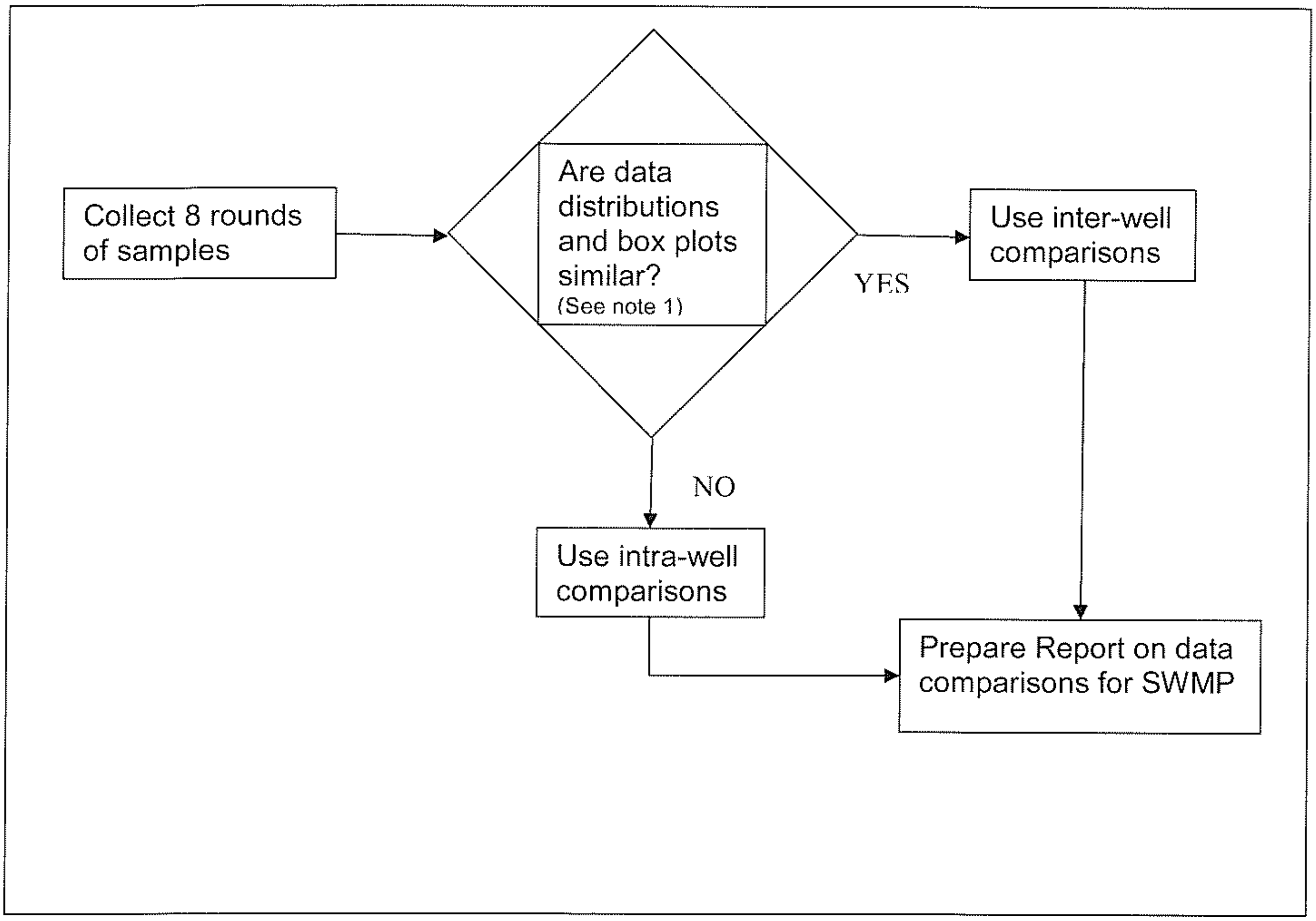
Sample ID	Date Collected	Time	Matrix	Lab ID	Preservation Code	Number of Containers	Rush	Container Size	Analysis Request							Comments

Special Instructions / Comments	(1) Relinquished By	(2) Relinquished By	Sampler Initials:
	(1) Date / Time	(2) Date / Time	Method of Shipment
	(1) Company	(2) Company	HAND CARRY USPS FEDX UPS
	(1) Received By	(2) Received By	CoC
Route Results Through: Circle: Fax Email	(1) Date / Time	(2) Date / Time	Seal Intact?
Email address:	(1) Company	(2) Company	Yes No

Appendix 8

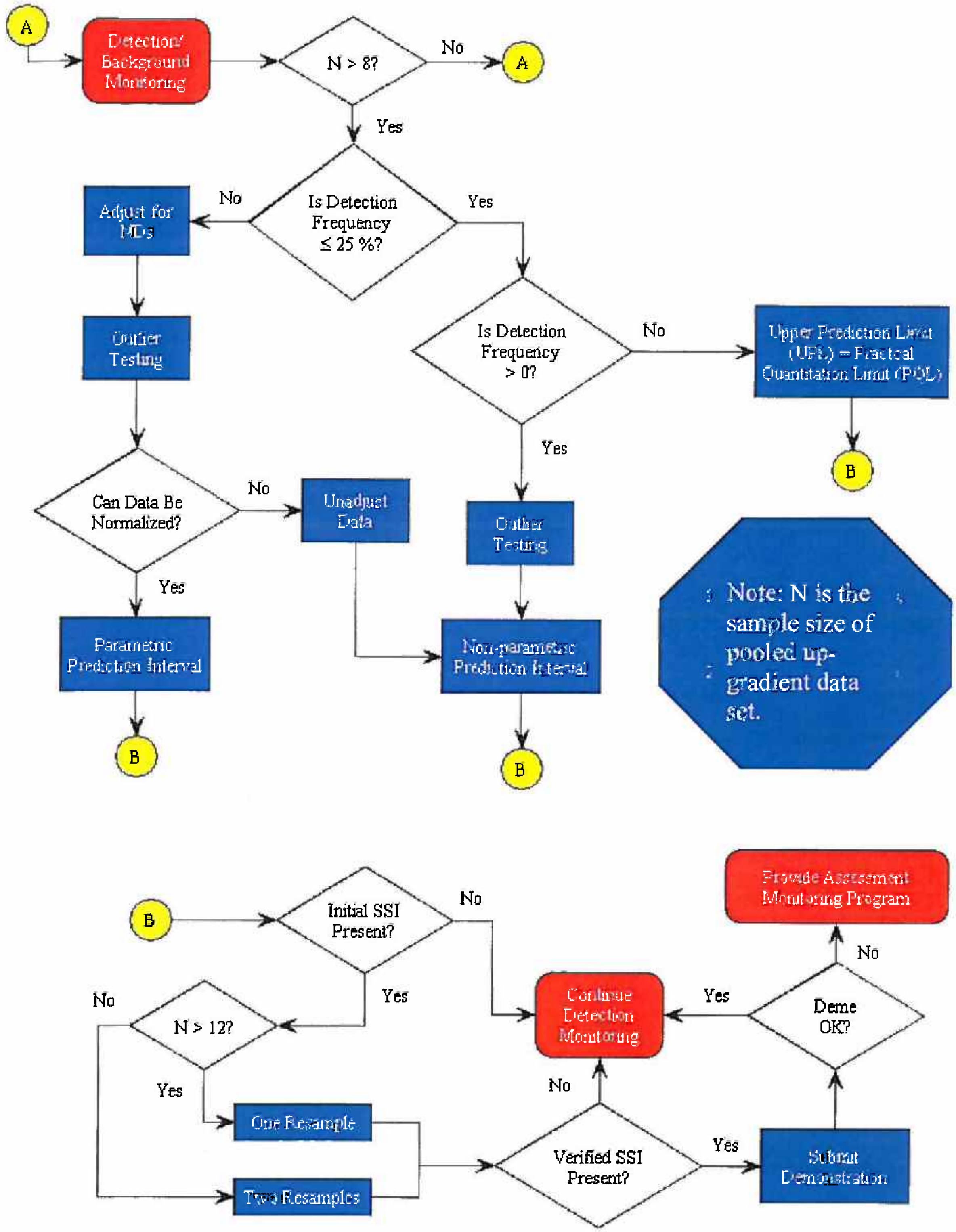
Decision Flow Charts

Selection of Statistical Procedure Based on Groundwater Background Data



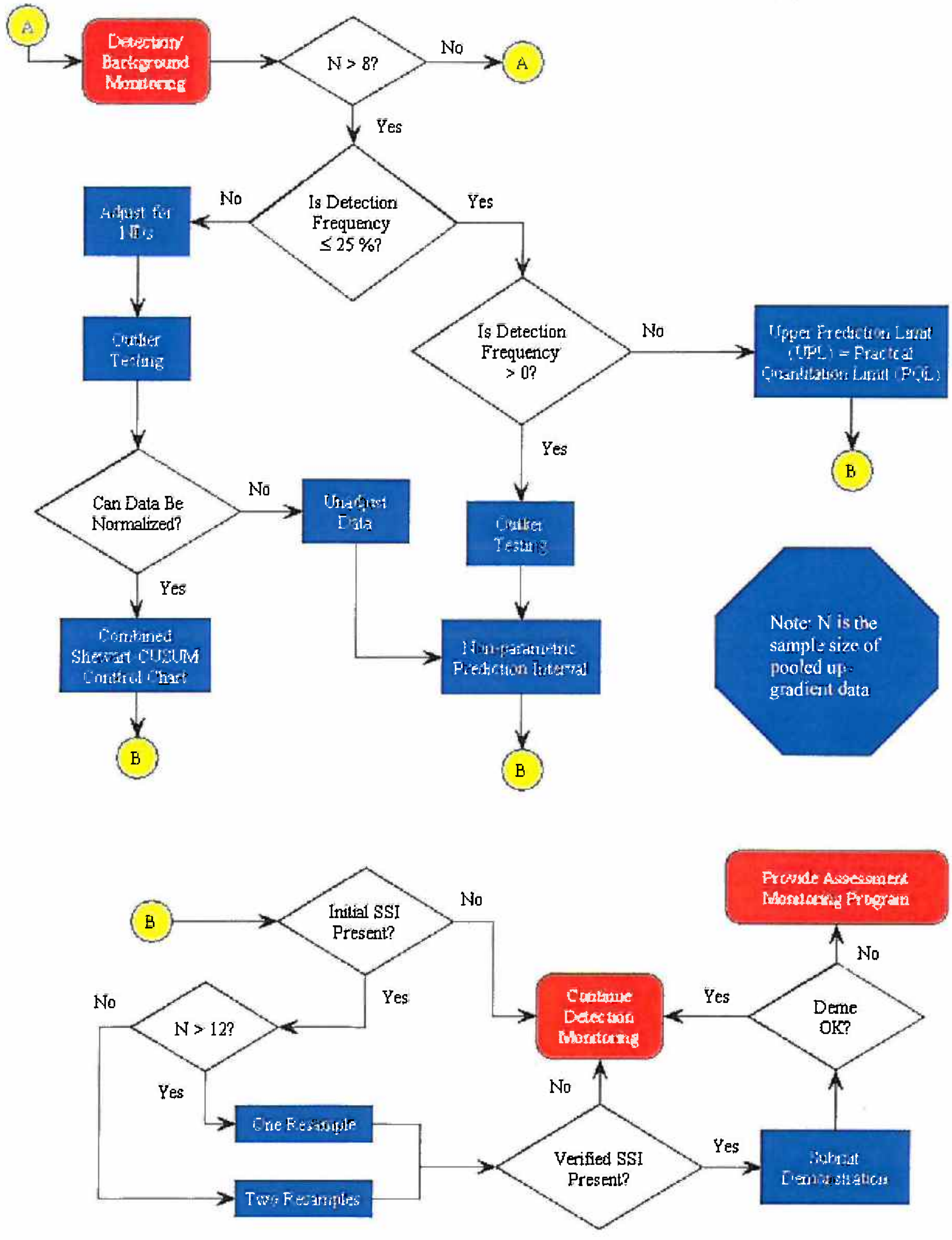
Note 1: This logic step is complex and will consist of various other steps. Exact steps are to be determined after data is available.

Attachment 1: Prediction Interval Test Strategy



Source: Missouri Department of Natural Resources Solid Waste Management Program DRAFT Technical Bulletin:"Statistical Analysis Plan Guidance", 4/26/01.

Attachment 2: Control Chart & Non-Parametric Prediction Interval Test Strategy



Source: Missouri Department of Natural Resources Solid Waste Management Program DRAFT Technical Bulletin:"Statistical Analysis Plan Guidance", 4/26/01.