APPENDICIES

Detailed Site Investigation
Proposed Utility Waste Disposal Area
Ameren Labadie Power Plant

Prepared by: GREDELL Engineering Resources, Inc.

Appendix 1

Detailed Site Investigation
Work Plan and Approval

Detailed Site Investigation
Proposed Utility Waste Disposal Area
Ameren Labadie Power Plant

Prepared by: GREDELL Engineering Resources, Inc.

STATE OF MISSOURI
Jeremiah W. (Jay) Nixon, Governor • Mark N. Templeton, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

June 15, 2009

CERTIFIED MAIL #7008 0500 0001 0080 1978
RETURN RECEIPT REQUESTED

Mr. Paul Pike
Ameren Services
One Ameren Plaza
1901 Chouteau Avenue
St. Louis, MO 63166

Re: Detailed Site Investigation Workplan of the AmerenUE-Labadie Utility Waste Landfill, (Sections 17 and 20, Township 44 North, Range 2 East, Labadie 7.5 Minute Quadrangle, Franklin County)

Dear Mr. Pike:

The Geological Survey Program (GSP) has reviewed the document "AmerenUE Labadie Power Plant Utility Waste Landfill Detailed Site Investigation Work Plan" dated May 18, 2009. This plan details the workflow and requirements to characterize the 400 acre proposed utility waste landfill located adjacent to the existing AmerenUE Labadie power plant. It details how AmerenUE intends to characterize the alluvial aquifer in order to determine the hydrological conditions that exist below the site. This will include piezometer installation, geotechnical borings, cone penetrometer tests, in situ aquifer tests, bedrock characterization and piezometric surface characterization. The GSP concurs with investigation elements and methodology as proposed and hereby approves this work plan.

Questions regarding this review (Report ID F01709) may be directed to Blake Smotherman at 573-368-2132, P.O. Box 250, Rolla, MO 65402.

Sincerely,

DIVISION OF GEOLOGY AND LAND SURVEY

James W. Duley

James W. Duley, RG
Deputy Division Director
Geological Survey Program

cc: Mikel Carlson, GREDELL Engineering Resources, Inc.
Jeffrey L. Fouse, Reitz & Jens, Inc.

Missouri Department Of Natural Resources
Division of Geology and Land Survey
P.O. Box 250
Rolla, Missouri 65402
Phone - 573.368.2161 Fax - 573.368.2111
E-mail -gspgeol@dnr.mo.gov

DATE
6/15/2009
Identification Number
F01709

Landfill Report

TO **Paul Pike**
FROM **Blake Smotherman, Geologist**
SUBJECT ***AmerenUE Labadie, Utility Waste Landfill***

Location

Quadrangle **LABADIE**
Section **17** Township **44N** Range **2E**
County **FRANKLIN**

Latitude **0.000000** **38** Deg **34** Min **0** Sec North Longitude **0.000000** **90** Deg **49** Min **31** Sec West

Additional Location Information

Requested by **Paul Pike, One Ameren Plaza, 1901 Chouteau Ave., St. Louis, MO 63166-1419**

Previous Reports ☒ **Not applicable**

The Geological Survey Program (GSP) has reviewed the document "AmerenUE Labadie Power Plant Utility Waste Landfill Detailed Site Investigation Work Plan" dated May 18, 2009. This plan details the workflow and requirements to characterize the 400 acre proposed utility waste landfill located adjacent to the existing AmerenUE Labadie power plant. It details how AmerenUE intends to characterize the alluvial aquifer in order to determine the hydrological conditions that exist below the site. This will include piezometer installation, geotechnical borings, cone penetrometer tests, in situ aquifer tests, bedrock characterization and piezometric surface characterization.
The GSP concurs with investigation elements and methodology as proposed and hereby approves this work plan.

STATE OF MISSOURI
LARRY D. PIERCE
RG0179
REGISTERED GEOLOGIST

Ameren Services

Environmental Services
314.554.2388 (Phone)
314.554.4182 (Facsimile)
ppike@ameren.com

One Ameren Plaza
1901 Chouteau Avenue
PO Box 66149
St. Louis, MO 63166-6149

Ameren

May 14, 2009

COPY

Mr. Larry Pierce, R.G., Unit Chief
Division of Geology and Land Survey
Missouri Department of Natural Resources
P.O. Box 250
Rolla, MO 65402

Re: Detailed Site Investigation Work Plan, Proposed Ameren Labadie Power Plant Utility Waste Landfill, St. Charles County, MO

Dear Mr. Price:

Attached for your review and approval are two (2) copies of a detailed site investigation work plan for the Labadie Power Plant Utility Waste Landfill. This work plan has been prepared in general accordance with guidance criteria promulgated as Appendix 1 under 10 CSR 80-2.015, effective January 29, 2007. The guidance criteria were further clarified at our meeting with you and your staff on April 21, 2009.

If you have and questions or require clarification on any element of this work plan that might expedite the review process, please contact either myself (314-554-2388) or Mr. Mike Carlson of Gredell Engineering (573-659-9078). We look forward to working with you and your staff on this project.

Sincerely,

Paul R. Pike
Strategic Analyst

Attachment

REITZ & JENS, INC.
CONSULTING ENGINEERS

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

Project Engineering Team

AmerenUE Labadie Power Plant

Utility Waste Landfill
Detailed Site Investigation Work Plan

Prepared for:

Ameren

Ameren Services
New Generation & Environmental Projects
3700 South Lindbergh Blvd.
St. Louis, Missouri 63127

May 2009

AmerenUE Labadie Power Plant

Utility Waste Landfill
Detailed Site Investigation Work Plan

Prepared for:

Ameren Services
New Generation & Environmental Projects
3700 South Lindbergh Road
St. Louis, Missouri 63127

May 2009

Prepared By:

Reitz & Jens, Inc.
St. Louis, Missouri
and
GREDELL Engineering Resources, Inc.
Jefferson City, Missouri

AmerenUE Labadie Power Plant
Utility Waste Landfill
Detailed Site Investigation Work Plan

May 2009

Table of Contents

List of Figures

List of Appendices

1.0 INTRODUCTION

On behalf of AmerenUE, Labadie Power Plant, Reitz & Jens, Inc. of St. Louis, Missouri (R&J) and GREDELL Engineering Resources, Inc. of Jefferson City, Missouri (GER) herein presents for review and approval the following detailed site investigation (DSI) work plan for a proposed utility waste landfill (UWL) subject to the permitting requirements promulgated under 10 CSR 80-2 and 10 CSR 80-11. This work plan follows submittal of the preliminary site investigation (PSI) request dated December 3, 2008, which was subsequently approved by the Missouri Department of Natural Resources – Division of Geology and Land Survey (MDNR-DGLS) on February 2, 2009. Both documents are included for reference as Appendix 1.

Ameren Company is an electric power producer and distributor that operates a coal-fired power plant known as the Labadie Power Plant within the Missouri River alluvial plain in northeastern Franklin County, Missouri. Combustion wastes are currently placed in a wastewater treatment device (ash pond) located between the power plant and the proposed UWL site. Regulatory requirements to further reduce air pollutants from the power plant flue gases are anticipated to generate large quantities of flue gas scrubber by-products. A UWL will be required to manage these by-products and the proposed site location for the UWL is the focus of this DSI. Utility wastes generated at this site potentially include various combinations of fly ash, bottom ash, and other coal combustion by-products.

The proposed UWL site is located on properties owned and controlled by Ameren (Figure 1). The planned disposal area footprint measures approximately 400 acres in size, not including ancillary support features to be located outside the accepted limits of solid waste placement. The anticipated disposal area sub-base grade is on average ten (10) feet below existing ground surface based on assumed soil and groundwater conditions. Prospective borrow sources currently are assumed to lie within, or near, proposed investigative boundaries. Those sources will be better defined as both field investigations and the design process proceeds.

Coincident with this proposed DSI investigation will be a geotechnical evaluation of the site. Elements of the geotechnical investigation having application to this DSI work plan are described herein, with the expectation that the results of both field investigations will be utilized in the preparation of the final DSI report. A copy of the proposed geotechnical work plan is included as Appendix 2.

1.1 Purpose

The purpose of this work plan is to define the scope of work necessary to characterize the geologic and hydrologic conditions at the proposed UWL site. It has been prepared in general accordance with the criteria described in 10 CSR 80-2.015, Appendix 1, "*Guidance for Conducting and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid-Waste Disposal Area*", dated January 29, 2007. A copy of the *Guidance* document is included for reference as Appendix 3. Included herein are descriptions of proposed methods for drilling and sampling, data collection, record-keeping procedures, laboratory testing, piezometer construction and development, and reporting. Applicable aspects of the concurrent geotechnical investigation are also described.

2.0 PHYSICAL AND GEOLOGIC SETTING

The proposed UWL site is located approximately two and one-half (2-½) miles northeast of the town of Labadie and immediately southeast of the Missouri River in northeast Franklin County (Figure 1). The National Geodetic Survey indicates the site lies within the northwestern part of Township 44 North, Range 2 East. Portions of the proposed investigation 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. Reference to *cares.missouri.edu* or similar mapping programs shows that the approximate midpoint of the proposed UWL is located at Latitude 38.5621 and Longitude –90.8168.

2.1 Physical Setting

The proposed UWL site is located within an extensive area of Holocene-age alluvial deposits largely derived from the Missouri River, which bounds the site to the north and forms the most conspicuous natural feature in the area (Figure 1). At its closest approach, the normal flow line of the river lies within approximately 4,000 feet (1,200 m) of the northwest corner of the site. Rock bluffs showing approximately 100 feet (33 m) of topographic relief relative to the alluvial plain bound the area to the south and extend to within approximately 800 feet (240 m) of the southern limits of the proposed UWL site.

Due to the alluvial setting, the most striking aspect of the site is the low topographic relief, which varies less than ten feet (3 m). Based on the topography shown on Figure 1, existing ground surface elevations range from 460 to 471 feet above mean sea level (msl). Drainage through this very flat terrain is facilitated by the creation of small waterways and diversions. Within the northern part of the proposed site, surface runoff generally flows northeastward toward the Missouri River. Within the southern part of the site, surface runoff flows to the southeast through the constructed waterways toward Becker Creek situated near the base of the rock bluffs. From there, the runoff flows northeast and appears to ultimately enter the Missouri River approximately one mile north of the hamlet of St. Albans.

The proposed UWL site and surrounding areas to the north, south, and east are currently used primarily for agricultural (row-crop) production. The AmerenUE Labadie Power Plant facility is located immediately to the west (Figure 1). An agricultural levee along the Missouri River marks the approximate northern boundary of the investigative area, and a Laclede Gas pipeline and another agricultural levee mark the approximate southern boundary of the investigative area. Labadie Bottom Road marks the approximate western boundary of the site and Davis Road marks the eastern boundary of the site. The agricultural levees serve as partial flood protection for the proposed UWL site. Although the site currently lies within the 100-year floodplain of the Missouri River, proposed waste boundaries have been located so as to remain outside of applicable floodway boundaries. Further protection of the site from the 100-year flood event through construction of a perimeter berm around the UWL is currently anticipated.

2.2 Geologic and Hydrogeologic Setting

The proposed UWL site is situated within Holocene-age alluvium chiefly derived from the Missouri River. These alluvial deposits, which largely consist of sand and small gravel with lesser amounts of silt and clay, are approximately 100 feet thick, based on site-specific borings developed in March 2007. The results of that previous field effort were provided to MDNR-DGLS as part of the preliminary site investigation (PSI) request submitted in December 2008 and are included here for reference in Appendix 4. That site-specific information suggests that the upper 15 feet of alluvial material consists of varying proportions of interbedded clay, silt, and fine-grained sand. Relatively homogeneous, coarser grained sand predominates to a depth of approximately 50 feet. At deeper depths, gravelly sand becomes common, with reported clast size ranging upwards to cobbles and possible boulders. In Boring B-7, limestone bedrock was encountered at a depth of 104.5 feet. In Boring P-1, which was extended to a depth of 91.5 feet and therefore near to the bedrock contact, high-density gravel was encountered that precluded further advancement of the borehole.

Information concerning the local bedrock geology is derived from on-site inspection of the rock bluffs bordering the proposed site to the south, geologic well log data available from the MDNR-Water Resources Center website at www.dnr.mo.gov/env/wrc/logmain, as well as the Missouri Environmental Geology Atlas (MEGA) and other literature sources available from MDNR-DGLS (e.g. Brill, 1991; Thompson and Robertson, 1993; Thompson, 1995). Available well log data are provided in Appendix 5. They consist of three (3) records for wells drilled on the bluffs immediately south of the site (Figure 1). A bedrock map adapted from MEGA is included as Figure 2. A generalized stratigraphic column is also provided for reference as Figure 3.

These data show that the bluffs bordering the site immediately to the south consist of upper Ordovician (Mohawkian Series) St. Peter Sandstone, as well as the overlying Joachim Dolomite. Well log data suggest that the St. Peter Sandstone is between 55 and 110 feet thick, whereas the overlying Joachim Dolomite is less than 50 feet thick (Appendix 5). Below the St. Peter Sandstone are older geologic formations variously assigned to the middle Ordovician (Canadian Series) Powell, Cotter, and Jefferson City formations. These formations are lithologically very similar and for that reason are not readily differentiated from one another in this part of the state. Regardless, they have an aggregate thickness in excess of 200 feet and likely constitute the uppermost bedrock surface encountered in site-specific borings developed within the proposed UWL site.

Based on available well data, groundwater resources in the vicinity of the proposed site are primarily derived from the Holocene-age alluvium that overlies bedrock in this area. This alluvial aquifer is marked by a shallow water table surface (10 to 20 feet in depth) and is believed to retain predominantly unconfined hydraulic characteristics. Yields ranging from 1,000 to 2,000 gallons per minute are reported (Appendix 5).

Although the geologic and hydrologic settings are relatively straightforward, the proposed site and surrounding region are located along the northern margin of an area of potential seismic activity known as the New Madrid Seismic Zone. That seismic activity is embedded in deeply buried Paleozoic and Precambrian basement rocks beneath the Mississippi Embayment and reflects the vestiges of a failed rift system believed related to the early Pennsylvanian (Morrowan-Atokan Series) Oklahoma Aulocogen (Houseknecht and Kacena, 1983). Spasmodic earthquakes generally of low magnitude are a relatively common occurrence and it is for that reason that the region is considered part of a "seismic impact zone" as defined by regulation under 10 CSR 80-2.010(69) or as otherwise described under the criteria for Holocene age fault displacement found in 10 CSR 80-11.010(4)(B)3.

3.0 SITE INVESTIGATION

The site investigation for the proposed 400-acre UWL facility includes the development of unconsolidated materials borings, sample collection and description, field and laboratory testing, piezometer installation and development, surveying, aquifer testing, and water level monitoring. Bedrock investigation will be limited owing to the significant depth of burial of pre-Holocene geologic formations. Site activities will be performed by or under the direction of a qualified groundwater scientist as defined by 10 CSR 80-2.010(83). All subsequent geologic and hydrologic interpretation shall be under the direction of a geologist registered in the state of Missouri. All geotechnical interpretation shall be under the direction of an engineer registered in the state of Missouri. At a minimum, the qualified groundwater scientist or his firm shall also hold a restricted monitoring well installation contractor's permit. A company properly holding a non-restricted monitoring well installation contactor's permit will perform the drilling and piezometer installation. All drilling rigs shall have permit numbers prominently displayed.

Following completion of field activities, a detailed site investigation report shall be prepared and shall be submitted to the Division of Geology and Land Survey (DGLS) for review and approval as described under 10 CSR 80-2.015. Both field investigation techniques and reporting procedures as described below shall conform to the criteria described in 10 CSR 80-2.015, Appendix 1, "*Guidance for Conducting and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid-Waste Disposal Area*", dated 1/29/07 (subsequently referred to in this work plan as *Guidance*) (Appendix 3). The DSI report shall be signed and sealed by a geologist registered in the state of Missouri.

3.1 Field Investigation

The proposed field investigation will consist of the establishment of a minimum of 200 borings and cone penetrometer test (CPT) soundings, and the subsequent conversion of 100 of the borings into piezometers, in accordance with *Guidance* criteria specifying one boring per two acres and one piezometer per four acres for the proposed 400-acre disposal area. Proposed boring and CPT sounding locations are shown on Figure 4. They conform to a regular grid-like pattern. However, specific drilling locations may vary from a strictly linear pattern due to local field conditions or to better optimize site characterization. Certain piezometers will also be located outside proposed waste disposal boundaries to potentially serve as future groundwater detection monitoring wells for the UWL facility.

All piezometers and most temporary borings will be developed to an approximate depth of at least 35 feet. The proposed minimum depth is based on the *Guidance* requirement that all borings must extend at least 25 feet below the anticipated disposal area subgrade, which is approximately ten (10) feet. Some temporary borings and CPT soundings may be extended to deeper depths (e.g. 40 to 50 ft) to facilitate geotechnical considerations. All temporary borings not subsequently converted into piezometers shall be immediately backfilled following completion of borehole advancement using approved materials in accordance with 10 CSR 23-6 and the location marked for future survey reference. In addition, one (1) temporary boring is proposed to be extended to the top of bedrock (estimated depth 90 to 105 ft) to supplement the two existing site-specific "deep" boreholes (Borings B-7 and P-1, Appendix 4). The deeper depths of investigation will allow for the basic characterization of older unconsolidated layers, assist in the delineation of potentially confining layers to the overlying alluvial aquifer, and enable a more thorough assessment of geotechnical considerations to be made for future design purposes. Borings selected for deepening will be drilled to total depth in one continuous operation. The deeper borings shall also be promptly backfilled with approved materials in accordance with 10 CSR 23-6 and the location marked for future survey reference. Registration records shall be filed with the MDNR-Wellhead Protection Program within required timeframes.

Initially, borehole locations may be spotted in the field using global positioning system (GPS) techniques. Surveyed northings, eastings, and ground surface elevations performed by a registered land surveyor for the temporary borings will be obtained contemporaneously with piezometer survey data to the extent practicable using field marks as reference points. The previously acquired GPS data may also be necessary in the event field marks are obliterated between the time of backfilling of the temporary borings and mobilization of a survey crew, be it attributable to wind, water, or other climatic conditions, or through continued use of the site for agricultural production.

3.2 Drilling and Sampling

Proposed drilling methods include a combination of hollow-stem auger (HSA), solid-flight auger (SFA), and rotary-wash water techniques. Methods used will be predicated on borehole conditions and specific characterization objectives. Borings will be sampled using a combination of CME continuous samplers, split-spoons, or Shelby tubes at approximate 5-foot intervals (2.5-foot sample intervals will be implemented in the first 10 feet and if complex stratigraphic horizons are encountered). Shelby tubes will also be used if cohesive materials are encountered. Sampling equipment will be advanced within the open borehole, or within the interior of HSA's as needed to offset collapsible granular materials. The sampling in the temporary geotechnical borings deeper than 35 feet is described in Appendix 2. Sampling will be supplemented as required by means of "grab" samples taken at approximate 5-ft intervals or at obvious changes in lithology or texture. Borings planned for piezometer construction will have a nominal borehole diameter at least four inches larger than the outer diameter of the well screen and riser pipe used for construction.

Drilling and sampling activities will be logged and described by or under the direction of a qualified groundwater scientist, geologist or geotechnical engineer. Field notes will be recorded in clear, concise fashion in indelible ink for later reference and inclusion in the final report. Notes shall include drilling equipment, drilling personnel, date, start up and end times for drilling, weather conditions at the time of drilling, drill-rate data and observations, and sampling methods and data. Depth to groundwater shall be recorded. Field descriptions for the piezometer borings shall be entered using standard stratigraphic nomenclature and techniques. Note shall be made of color, texture, lithology, porosity, permeability, and significant characteristics of the geologic strata encountered. Sedimentary structures and possible subdivision of discrete lithologic units into depositional facies shall follow conventional terminology, such as described in Reineck and Singh (1980) or similar reference text. The field descriptions for the temporary geotechnical borings will follow ASTM standards.

All geologic and geohydrologic field work shall be completed under the direction of a geologist registered in the state of Missouri per RSMo 256.450 through 256.483 and the rules promulgated pursuant thereto. Applicable aspects of the concurrent geotechnical investigation will also be performed under the supervision of a professional engineer registered in the state of Missouri.

Analytical tests performed as a result of either the DSI or geotechnical investigation may include the following: Atterberg limits, hydraulic conductivity, unconfined compressive strength, unconsolidated-undrained strength (UU triaxial test), and consolidated-undrained strength (R triaxial test with pore pressure measurements). In addition, an estimated minimum of 50 granular samples collected during the investigation will be subjected to grain size analyses, including percent passing a #200 U.S. standard sieve (i.e. percent silt and clay). Selected representative samples will be cut from the continuous tube sample for index testing in the lab. Applicable standards to the geotechnical investigation and subsequent analytical procedures are described in Appendix 2.

3.3 Piezometer Installation

A total of 100 piezometers will be installed in an effort to characterize the behavior of the shallow alluvial aquifer beneath the proposed UWL facility. Proposed locations are presented on Figure 4. Piezometer depths will be dependent on the depth to the water table surface as determined while drilling. However, total depths should be sufficient to ensure submersion of the well screens to the extent practicable. Where the base of any boring extends deeper than what is required for piezometer construction, the lower part of the boring shall be backfilled using approved materials in accordance with 10 CSR 23-4.

Proposed construction methods will be in general accordance with 10 CSR 23-4.060. Proposed piezometer construction diagrams outlining the anticipated methods are presented as Figure 5 and Figure 6. Piezometers will be constructed using new, NSF-rated WC or PW, flush-threaded, nominal 2-inch and 4-inch Schedule 40 PVC well screen and riser pipe. The nominal 4-inch diameter piezometers may be required to facilitate aquifer testing. Proposed well-screen lengths will be ten feet. The well screens will be machine-slotted and will have a maximum aperture size of 0.010 inches (10-slot). Each well screen will be equipped with a sump of approximate four-inch length. The sump will also be flush-threaded. Well-screen depth data will take into account the sump at the base of the piezometers.

Once the well screen and riser pipe are installed, a primary filter pack will be tremied into the annular space, beginning at the base of the piezometer construction interval. The primary filter pack will consist of natural, rounded, well-sorted (poorly graded), quartz-rich sand. For 10-slot well screens, filter pack grain size will conform to the U.S. Standard sieve range of 20-40 (0.85 mm-0.425 mm). Filter pack volumes will be calculated beforehand. Once filter pack volumes are calculated, the sand will be emplaced in the annulus using approximate small diameter, clean PVC tremie pipe. Sand will be poured slowly to ensure that it drops through the water column to the base of the piezometer. Bridging will be corrected by "washing" the interior of the tremie pipe with potable water. The volume of introduced water will be tracked for later development purposes. As filter pack sand is poured, the tremie will be lifted in stages to a height of between two and five feet above the calculated top of the well screen. Measurements will be determined using a weighted tape. The amount of primary filter pack sand used will be recorded and compared to calculated values. Once the sand is placed, the interior of the well casing may be agitated with a surge block to promote additional settlement. The resulting change in depth will be recorded and sand added, if necessary, to ensure the 2-foot minimum standard is met. Surging will take place before any additional well construction materials are introduced into the annulus.

Because collapsible sands are anticipated and may be ubiquitous in this geologic setting, natural sand packs may be considered as an alternative to artificially emplaced filter packs, as allowed for under 10 CSR 23-4.060(8)(B). Piezometers where this alternative technique may be required will be discussed with DGLS prior to completion of the piezometer.

A secondary filter pack will be utilized in each piezometer where high-solids bentonite slurry is used as the bentonite seal. The secondary filter pack will also consist of natural, rounded, well-sorted (poorly graded), quartz-rich sand. Sand size will be selected based on the size of the underlying primary filter sand. If 20-40 primary sand is used, the secondary sand will correspond to the U.S. Standard sieve range of 60-120 (0.125-0.25 mm). Tremie methods identical to that described above will also be used to install the secondary filter pack. The volume of secondary sand required will be calculated beforehand. Secondary filter pack thickness will be between one and two feet. Measurements will be recorded using a weighted tape. The amount of secondary sand used will be recorded and compared to calculated volumes.

A bentonite seal will be installed immediately above the secondary filter pack, or the primary filter pack if a secondary filter pack is not used. The bentonite seal will consist either of bentonite chips or high-solids bentonite slurry grout. Bentonite chips may be used in those instances where the upper part of the borehole is unsaturated. The chips shall be placed in approximate one-foot layers and hydrated prior to installing the succeeding layers. The chips will be placed by gravity methods into the annulus to a thickness of between three and five feet. Measurements will be determined using a weighted tape. Volumes will be calculated beforehand and compared to quantities actually used. Prior to use, the chips will be screened to remove fine particulate matter so as to avoid flash swelling during emplacement. If bentonite slurry grout is used, the installation procedure is as follows.

The bentonite slurry grout will be between 20 and 30 percent by weight solids and will be tremied from bottom to top in one continual operation. Side-discharging tremie methods may be used to minimize damage to the underlying filter pack. The grout will be thoroughly mixed to a uniform consistency in an aboveground tank prior to use. Calculations will be made to ensure the 20-30 percent by weight solids standard is met. Annular volume calculations will also be made beforehand and compared to actual quantities of grout used. As grouting proceeds, the tremie pipe will be lifted in stages to ensure minimal displacement of the bentonite slurry once it is injected into the borehole.

An annular seal will be placed immediately above the bentonite seal. It will also consist of 20-30 percent by weight solids, bentonite slurry grout. In those piezometers where both the bentonite seal and annular seal consist of bentonite slurry grout, they will be installed in one continual operation. The methods used to install the annular seal will be as described above. Once the seal is installed, the grout will be allowed to cure and checked for settlement. It will be topped off as necessary with additional bentonite slurry grout to a minimum of within two feet of ground surface.

Each completed piezometer will be flush-cut approximately 2.5 feet above ground surface, equipped with a vented cap, labeled, and marked with a survey reference point by notching the top of the casing. Each piezometer will subsequently be surveyed by a registered land surveyor in the State of Missouri to establish x, y, and z coordinate information. Both ground surface and top-of-casing elevations accurate to within 0.01-ft will be obtained.

Aboveground completions shall be consistent with the requirements of 10 CSR 23-4.060(12). They will consist of properly sized steel protective casing set in concrete. The protective casing will extend at least two inches higher than the interior PVC casing. The base of the casing will extend down into the borehole a minimum of two feet. The borehole will be enlarged to ensure it is at least eight (8) inches in diameter larger than the size of the protective casing. At a minimum, concrete pads will be used for piezometers having utility as future groundwater monitoring wells. They will have a minimum dimension of 2 feet x 2 feet and will extend below finish grade to a depth sufficient to prevent frost heaving, which for eastern Missouri is between 15 and 20 inches. The top of the concrete pad will be shaped to facilitate drainage away from the protective casing. A small diameter (<1/8 inch) weep hole will be placed near the base of the protective casing. The interior of the casing will be partially filled with either coarse sand or gravel. The riser pipe will be equipped with a vented cap and the exterior protective casing provided with a locking cap and lock. For those piezometers located along high-traffic areas, three large-diameter (>4 inch), steel bollards may be installed around the concrete pad. The bollards will be set in concrete at least two feet below finish grade and will extend at least three feet above finish grade. The bollards will be painted to promote easy visibility.

Following completion of the piezometers, including survey data, well certification records will be prepared and submitted to the DGLS-Wellhead Protection Program within required timeframes.

3.4 Piezometer Development

Each piezometer shall be developed in accordance with 10 CSR 23-4.070. Proposed methods include the use of either disposal bailers or a non-dedicated, submersible pump. In no event will the method used introduce any contaminants into the piezometers. A minimum of three well volumes of water will be removed or until the piezometer 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 piezometer, if any, will be removed.

Field measurements of groundwater temperature, pH, and specific conductivity may be recorded in some piezometers during the development process, particularly those having potential utility for long-term groundwater detection monitoring. If performed, and provided sufficient recharge is realized, 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.

3.5 Aquifer Testing

Aquifer testing will be performed in one out of every four of the piezometer borings (25 percent of the piezometer borings drilled on-site) as described by *Guidance*. Consequently, if a total of 100 piezometers are constructed as proposed elsewhere in this work plan, a minimum of 25 percent or 25 piezometers will be selected for aquifer testing. Piezometers selected for analysis will be based on a combination of location and screen interval lithology in order to provide a representative depiction of hydraulic behavior throughout the limits of investigation. Piezometer locations currently under consideration for testing are noted on Figure 4.

Aquifer testing will be conducted after piezometer development is complete. The appropriate test for each piezometer will be dependent on site-specific conditions, including screen interval lithology, water column height, and apparent recharge as determined during development. However, based on prior experience in alluvial settings, piezometers screened across medium- to coarse-grained (or larger) sand will recharge very quickly and for that reason rising head (recovery) test methods are anticipated using 4-inch diameter piezometers. This larger diameter will permit the use of 3-inch or 4-inch submersible pumps (e.g. Grundfos Redi-Flo3 or Redi-Flo4) capable of sustaining 20-30 gpm pump rates believed necessary to achieve adequate suppression of the water table surface. Continuous recording of water level will be maintained until 90 percent of the drawdown is recovered, relative to initial water level measurements.

Falling head (slug) test methods may be considered if fine-grained (i.e. silt and very fine sand) materials predominate at the level of the screen interval. This method can likely be successfully accomplished in 2-inch diameter piezometers due to the relatively low recharge rate of the formation materials. If used, falling head tests will be continued until the water level has stabilized or until 70 percent of the excess head has dissipated.

Laboratory testing of hydraulic conductivity for aquifer characterization purposes is not proposed.

3.6 Monthly Water Level Monitoring

Monthly water level monitoring will be performed for a period of 12 consecutive months following piezometer installation as required by *Guidance* in an effort to characterize flow direction and seasonal variation in water table elevation. Measurements will be made to an accuracy of 0.01-ft using the surveyed "top-of casing" as a reference point. An effort will be made to ensure that all measurements are made within an approximate 48-hr time period. Accumulated data will be evaluated to determine the effects of precipitation-derived recharge on the alluvial aquifer. Possible influences from the Missouri River will also be examined. River flow data will be obtained from the nearest available gauging stations. The U.S. Army Corps of Engineers (USACE) maintains a gauging station upstream at Washington, MO (MOWA, found on the USACE website at *http://mvs-wc.mvs.usace.army.mil/trans/gages.html*) The United States Geological Survey (USGS) maintains a gauging station upstream at Washington, MO (USGS #06935450, found on the USGS website at *http://waterdata.usgs.gov/nwis/uv?06935450)*.

Precipitation data will be gathered throughout the twelve-month monitoring period. These data will be gathered either from a continuously recording device located at or near the investigative site or from the nearest local weather center in the event of equipment malfunction.

4.0 EVALUATION AND REPORT

Following completion of field activities, a detailed site investigation report will be prepared for review and approval by DGLS. The DSI report will detail the results of the field investigation and interpret the geologic and hydrogeologic conditions of the site based on data collected in accordance with this work plan. The content and format of the report shall be in general conformance with *Guidance* criteria. All DSI report work shall be prepared under the direction of a qualified groundwater scientist who is a geologist registered in the state of Missouri per RSMo 256.450 through 256.483 and the rules promulgated pursuant thereto. This person shall also sign and seal the report. The concurrent geotechnical investigation results will be described in a separate document appended to the DSI report and signed and sealed by a professional engineer registered in the state of Missouri.

Major narrative elements of the report will include an introductory section, a description of field data collection methodology, a description of field data collection results, and an interpretative summary describing conclusions reached about the hydrogeologic character of the site. The introductory section will provide general information about the proposed UWL site, including the regional geographic and geologic setting and historical land use(s). Siting restrictions for utility waste landfills as described under 10 CSR 80-11.010(4)(B) may also be discussed, although not specifically required by *Guidance* criteria. Field methods will include discussion of drilling, sampling, and logging procedures, as well as an accurate description of analytical testing. Standard procedures will be appropriately referenced. Field results will be presented in a clear and concise fashion and will include discussion of any anomalous data. The conclusion section of the report will describe how the site-specific hydrogeology may affect the design of the UWL. A conceptual groundwater detection monitoring system will also be described.

Data collected during the field investigation, and as described in the detailed site investigation report, shall be supported by figures, tables, maps, and cross-sections. Drilling logs, piezometer construction diagrams, and development records will be provided as appendices to the report. Appendix information will also include well certification and registration records, raw analytical data, and copies of field notes, including photographic documentation as applicable. An aerial photograph of the proposed site and surrounding area will also be provided. *Guidance* criteria require the aerial photograph to be taken between November 1st and March 30th within two years of report submittal. However, because the proposed UWL facility is located in a region of minimal tree cover or other limiting obstructions, it is herein proposed that the monthly timeframes be waived in this instance.

Tabular data presented in the report will consist of borehole and piezometer construction summaries, including identification, location, total depth, surface elevation, well-screen interval, and hydrogeologic information. Monthly groundwater elevation summaries will also be provided. Laboratory analytical data shall be summarized in similar fashion. Other tabular data will include a summation of any hydrologic testing, as well as precipitation data recorded during the investigative and monitoring period.

All maps displaying site-specific data acquired during the investigation will be at a scale of one-inch equals 400 feet or less. Initial site topography will be shown using a maximum contour interval of five feet. Each map will contain a scale, north arrow, and concise legend describing all of the symbols used on the map. Proposed facility boundaries will be shown. Maps shall provide information as required by *Guidance*, or as otherwise applicable.

Geologic cross-sections will be provided both parallel and perpendicular to the facility baseline utilizing borehole information to illustrate the geologic and hydrologic character of the site. At least one cross-section will be constructed parallel to groundwater flow. Cross-sections will clearly depict relevant lithostratigraphic boundaries with appropriate designations defined in the accompanying legend. Applicable boring log and piezometer construction data will be portrayed. Both the anticipated sub-base and final grades for the proposed UWL disposal area will be shown.

5.0 REFERENCES

Brill, K.G., Jr., 1991, *Geologic Map St. Louis City and County, Missouri*, Missouri Department of Natural Resources, Division of Geology and Land Survey Open File Map OFM-91-259-GI.

Held, R.J., 1989, *Soil Survey of Franklin County, Missouri:* United States Department of Agriculture, Soil Conservation Service, 160p.

Houseknecht, D.W., and Kacena, J.A., 1983, *Tectonic and Sedimentary Evolution of the Arkoma Foreland Basin*: in Houseknecht, D.W., ed., Tectonic-Sedimentary Evolution of the Arkoma Basin, Society of Economic Paleontologists and Mineralogists Mid-Continent Section, v.1, p.1-34.

Imes, J.L., and Emmett, L.F., 1994, *Geohydrology of the Ozark Plateaus Aquifer System in Parts of Missouri, Arkansas, Oklahoma, and Kansas;* U.S. Geological Survey Professional Paper 1414-D., 127p.

McKee, E.D., and Weir, G.W., 1953, *Terminology for Stratification and Cross-Stratification*: Geological Society of America Bulletin, v.64, p.381-390.

Missouri Department of Natural Resources Technical Bulletin, 2007, *Guidance For Conducting and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid-Waste Disposal Area*: 10 CSR 80-2 Appendix 1.

Missouri Department of Natural Resources, Division of Geology and Land Survey, 2009, Preliminary Site Investigation Report dated February 2, 2009.

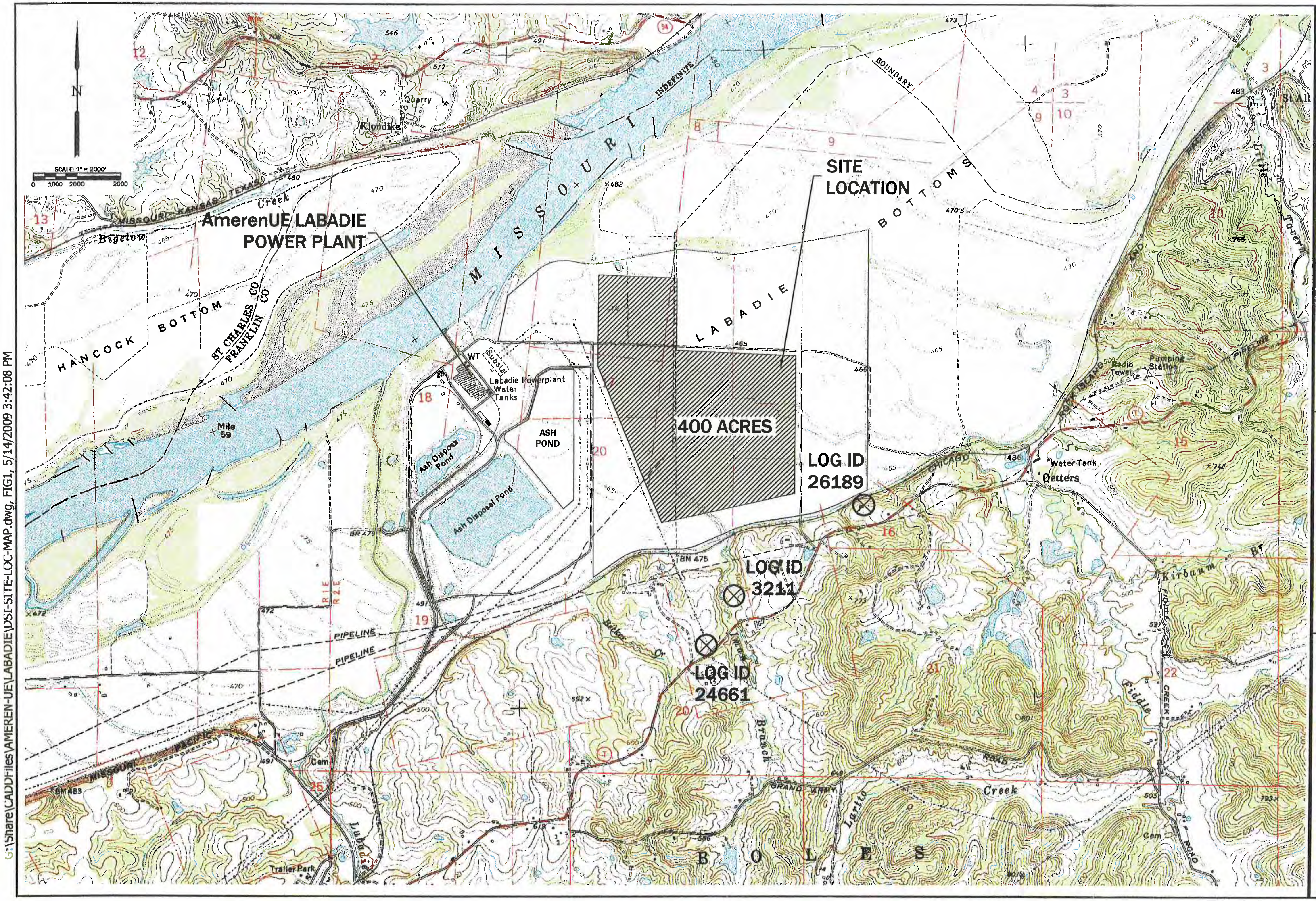
Smith, D.C., and Beste, R.C., 2001, *Selected Industrial Mineral Producers Along Interstate 70 and Missouri Highway 94, St. Charles County, Missouri*: Guidebook for the 48th Association of Missouri Geologists Annual Meeting and Field Trip, September 28 and 29, 2001, 32p.

Reineck, H.E, and Singh, I.B., 1980, *Depositional Sedimentary Environments*, 2nd Edition, Springer-Verlag, Berlin, Heidelberg, New York, p.257-312.

Thompson, T.L., 1995, *The Stratigraphic Succession in Missouri (Revised - 1995)*: Missouri Department of Natural Resources, Division of Geology and Land Survey, Volume 40 (revised), 190p.

Thompson, T.L., and Robertson, C.E., 1993, *Guidebook to the Geology Along Interstate Highway 44 (I-44) in Missouri*: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigation No. 71, Guidebook No. 23, 185p.

FIGURES



G:\Share\CADDFiles\AMEREN-UE\LABADIE\DSI-SITE-LOC-MAP.dwg, FIG1, 5/14/2009 3:42:08 PM

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

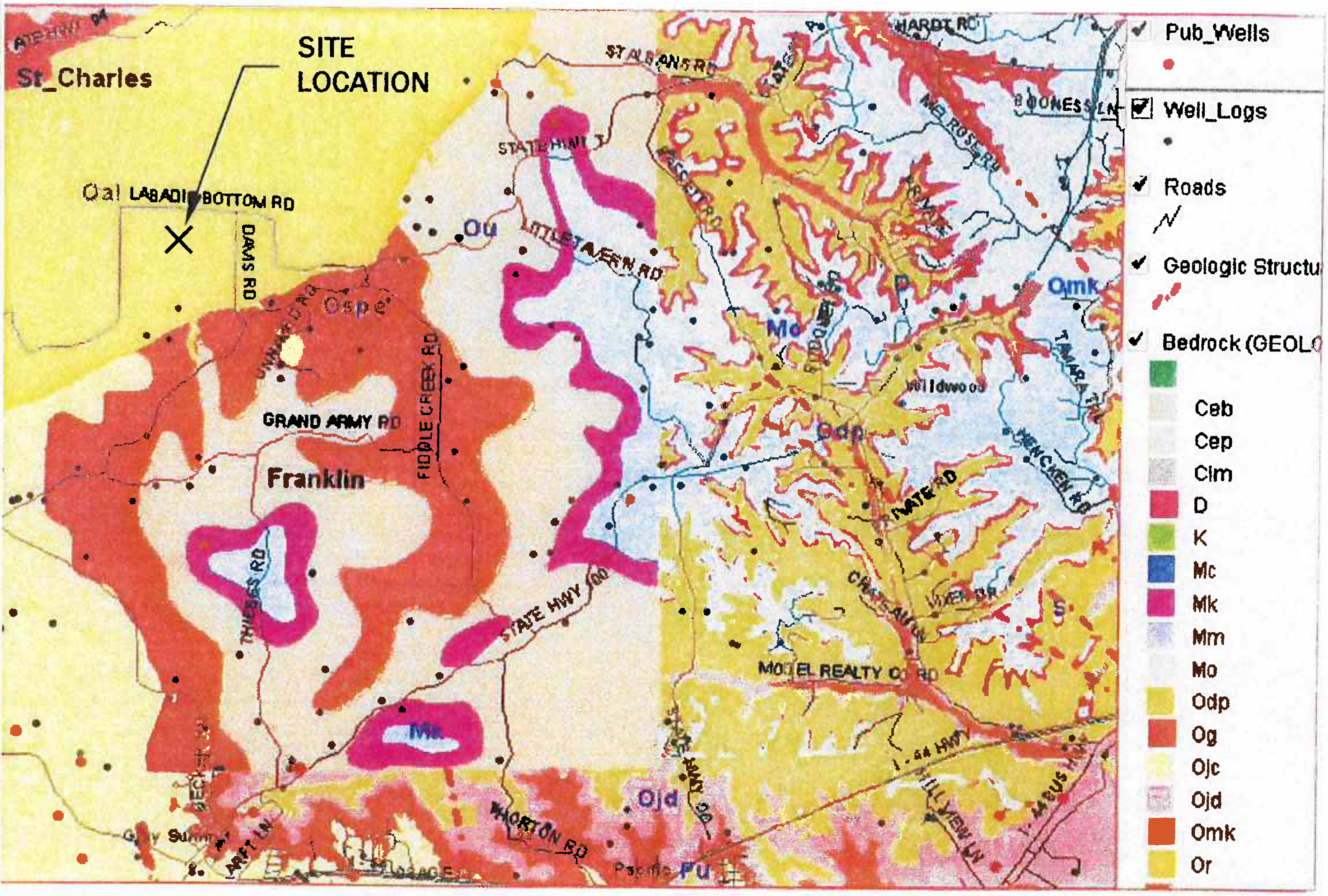
DETAILED SITE INVESTIGATION
WORK PLAN
SITE LOCATION MAP
FIGURE 1

AmerenUE LABADIE POWER PLANT
FRANKLIN COUNTY
MISSOURI

SURVEYED	DESIGNED	DRAWN	CHECKED	APPROVED	DATE	SCALE	FILE NO.	PROJECT NO.	SHEET NO.
NA	M.C.C.	W.J.A.	M.C.C.	M.C.C.	3/2009	AS SHOWN	DSI-SITE-LOC-MAP	LABADIE	

NO.	DATE	REVISION DESCRIPTION	BY

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



GENERALIZED
BEDROCK MAP
(MEGA, 2007)

AmerenUE LABADIE
POWER PLANT

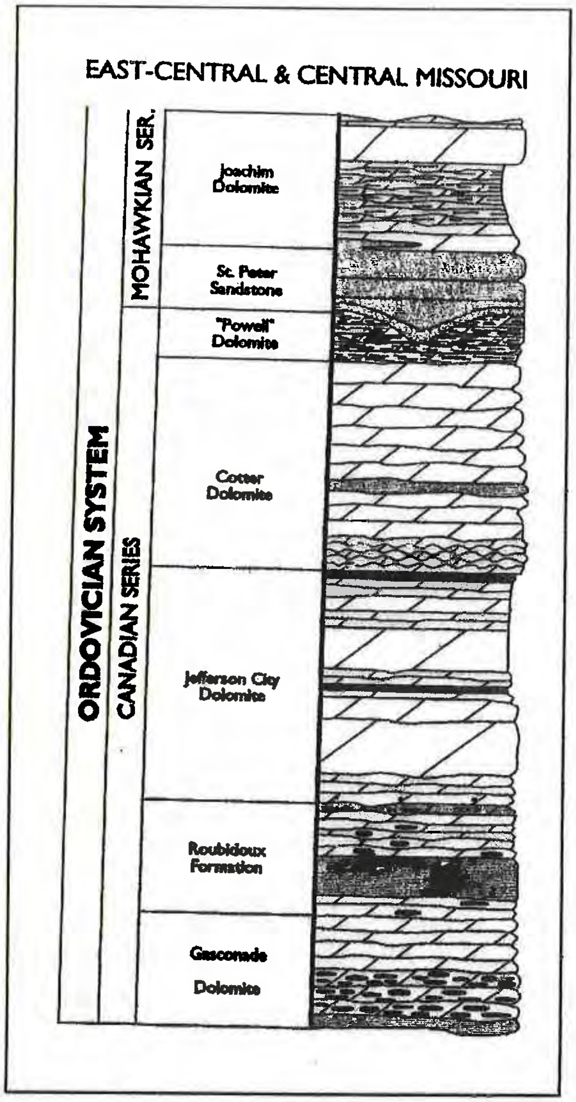
DETAILED SITE INVESTIGATION
WORK PLAN

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

DATE	SCALE	FIGURE		REV
3/2009	N.T.S.	FIGURE 2		

DRAWN BY: W.J.A. APPROVED BY: M.C.C. PROJECT NO.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



GENERALIZED STRATIGRAPHIC COLUMN (THOMPSON AND ROBERTSON, 1993)

AmerenUE LABADIE POWER PLANT

DETAILED SITE INVESTIGATION WORK PLAN

GREDELL Engineering Resources, Inc.

ENVIRONMENTAL ENGINEERING

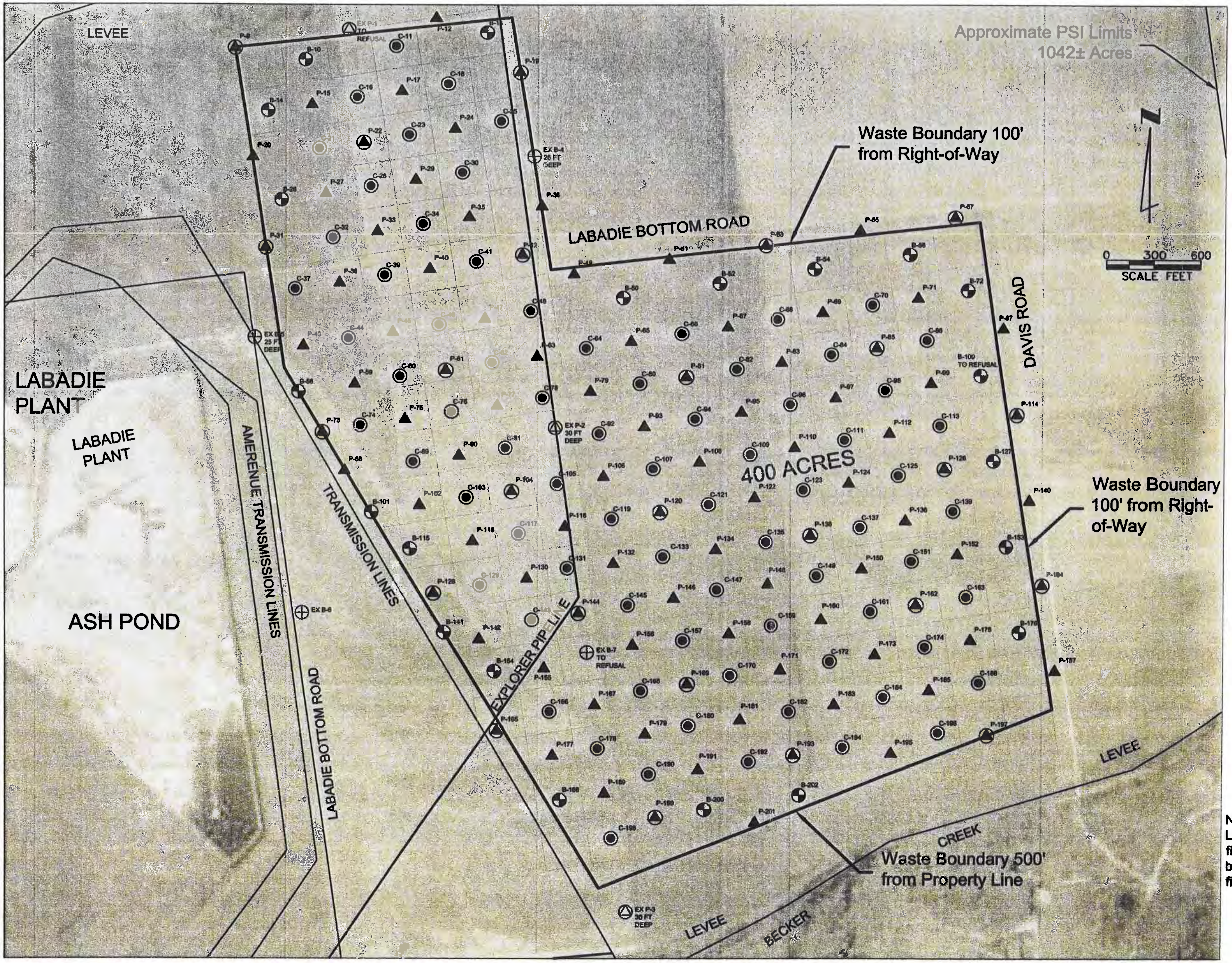
LAND AIR WATER

1505 East High Street
Jefferson City, Missouri 65101

Telephone: (573) 659-9078
Facsimile: (573) 659-9079

DATE	SCALE	FIGURE		REV
3/2009	N.T.S.	FIGURE 3		

DRAWN BY:	W.J.A.	APPROVED BY:	M.C.C.	PROJECT NO.



LEGEND

⊕ Existing 2007 Boring
△ Existing 2007 Piezometer
▲ New Piezometer
▲ New Piez. w/Aquifer Test
◑ New Boring
◉ New CPT Location

72	New Piezometers
25	New Piez. w/Aquifer Test
3	Existing Piezometers
21	New Borings
3	Old Borings
76	Cone Penetrometer Tests
200	Total Test Locations

NOTE: Piezometer and boring Locations may be adjusted based on field conditions. All piezometer and boring locations will be located by field survey.

Figure 4

REITZ & JENS, INC.
CONSULTING ENGINEERS
1055 CORPORATE SQUARE DRIVE
ST. LOUIS, MISSOURI 63132
(314) 993-4132
PROFESSIONAL ENGINEERING CORP., LICENSE #000215

Designed J.L.F.
Checked M.C.C-GER
Drawn P.H.R.
Issued 04/29/2009

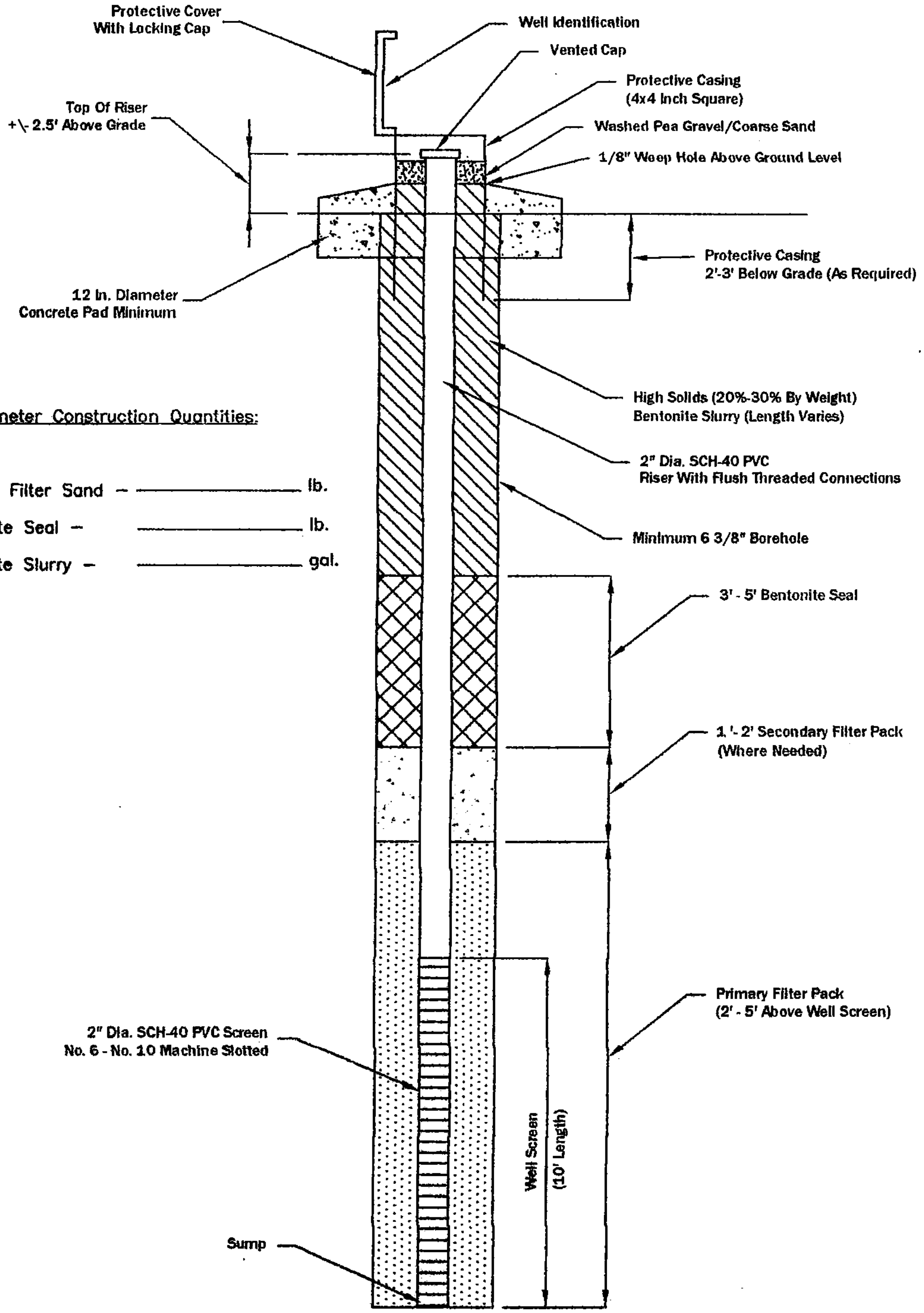
AmerenUE

Labadie UWL
DSI Boring Layout
2008012455

SHEET
1 OF 1

MDNR Permits\Detailed Site Investigation\Work Plan\DSI Boring Layout-April 28/2009

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Piezometer Construction Quantities:

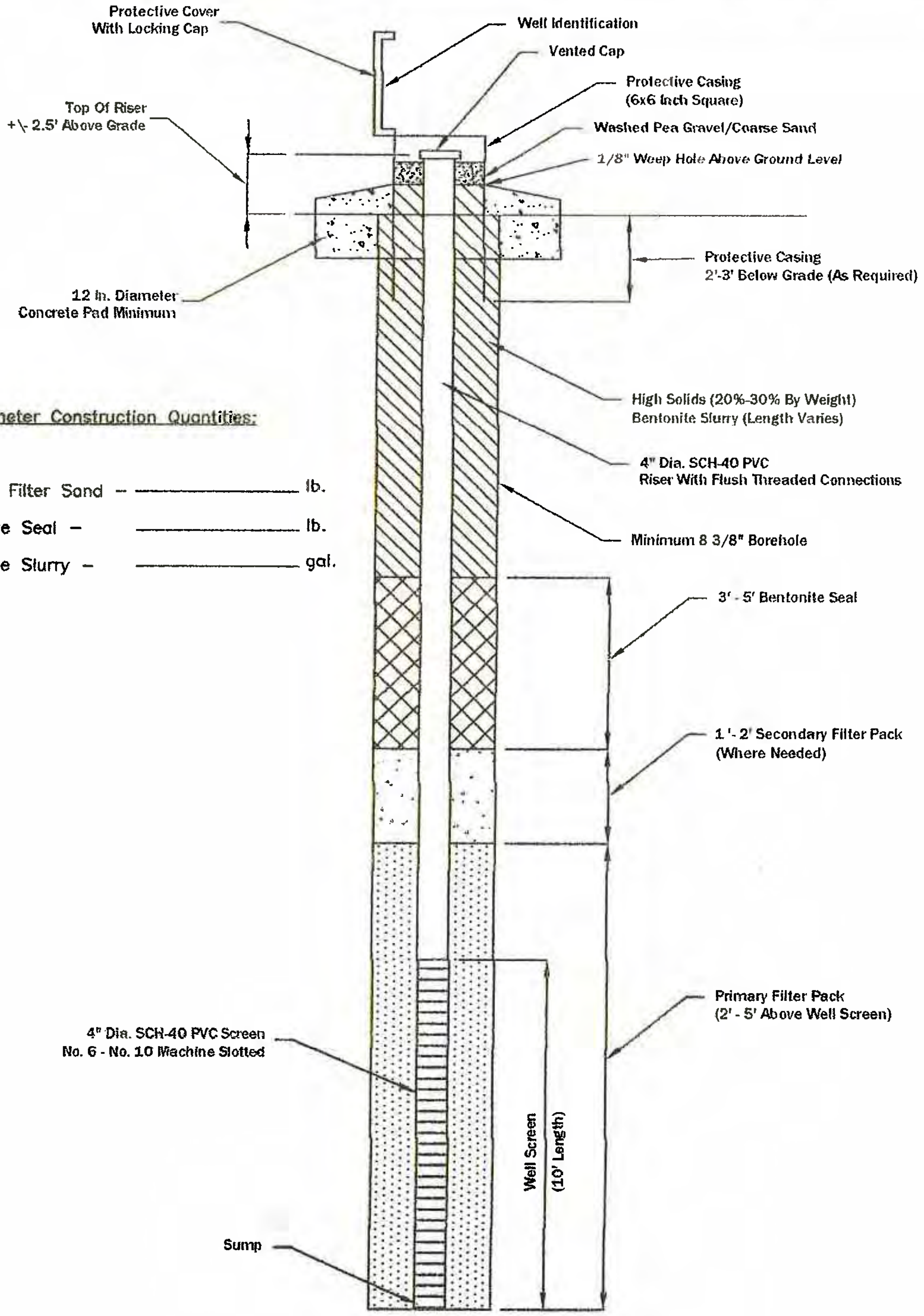
1. Primary Filter Sand – ______ lb.
2. Bentonite Seal – ______ lb.
3. Bentonite Slurry – ______ gal.

Remarks:

PROPOSED 2" PIEZOMETER CONSTRUCTION DIAGRAM	**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			
AmerenUE LABADIE POWER PLANT	DATE 3/2009	SCALE N.T.S.	FIGURE FIGURE 5	REV
DETAILED SITE INVESTIGATION WORK PLAN	DRAWN BY: W.J.A.	APPROVED BY: M.C.C.	PROJECT NO.	

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



Piezometer Construction Quantities:

1. Primary Filter Sand – ________________ lb.
2. Bentonite Seal – ________________ lb.
3. Bentonite Slurry – ________________ gal.

Remarks:

PROPOSED 4" PIEZOMETER
CONSTRUCTION
DIAGRAM

AmerenUE LABADIE
POWER PLANT

DETAILED SITE INVESTIGATION
WORK PLAN

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

DATE	SCALE	FIGURE		REV
3/2009	N.T.S.	FIGURE 6		

DRAWN BY: W.J.A. APPROVED BY: M.C.C. PROJECT NO.

APPENDICES

APPENDIX 1

Preliminary Site Investigation (PSI) Correspondence

Electronic copy
of letterhead

STATE OF MISSOURI Jeremiah W. (Jay) Nixon, Governor Joseph P. Bindbeutel, Acting Director
DEPARTMENT OF NATURAL RESOURCES

www.dnr.mo.gov

February 2, 2009

COPY

CERTIFIED MAIL 7005 3110 0004 3988 9017
RETURN RECEIPT REQUESTED

Mr. Paul Pike
Ameren
One Ameren Plaza
1901 Chouteau Avenue
St. Louis, MO 63166

Re: Preliminary investigation of the proposed expansion of the AmerenUE-Labadie Utility Waste Landfill, (Section 17 and 20, Township 44 North, Range 2 East, Labadie 7.5 Minute Quadrangle, Franklin County)

Dear Mr. Pike:

The Geological Survey Program (GSP) has completed the Preliminary Site Investigation (PSI) for the proposed expansion to the AmerenUE-Labadie Utility Waste Landfill. The proposed landfill is approximately 1042 acres.

The site is approved to proceed to the next phase of the permitting process. Please find enclosed the PSI report (ID# F00409) that summarizes the geologic and hydrologic evaluation of the proposed expansion area.

Also enclosed is a copy of Appendix 1, Guidelines for Planning, Conducting, and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid Waste Disposal Area. This document summarizes the elements and format that should be used to develop a detailed site investigation workplan. We encourage you and your consultant to meet with the GSP staff prior to finalizing a workplan for the detailed site investigation to discuss the elements to be included within the report. Please contact Mr. Larry Pierce, telephone 573-368-2191, or email larry.pierce@dnr.mo.gov, to schedule this workplan meeting.

Current procedures call for an applicant receiving approval at the preliminary site investigation stage to participate in public involvement activities as part of the solid waste disposal area permit application process. Within 30 days of the approval, the applicant must notify both the governing body of the county or city, and the solid waste management district in which the proposed disposal area is to be located. This notification is to be by certified mail.

Within 90 days of the Preliminary Site Investigation approval, the department will conduct a public awareness session in the county in which the proposed disposal area is to be located. For further information concerning these public involvement requirements, please contact the Solid Waste Management Program at (573) 751-5401.

If you have any questions, please feel free to contact Larry "Boot" Pierce at P.O. Box 250, Rolla, Missouri 65402, telephone (573) 368-2191, or email at larry.pierce@dnr.mo.gov. Thank you for your interest.

Sincerely,

DIVISION OF GEOLOGY AND LAND SURVEY

James W. Duley

James W. Duley, RG
Deputy Division Director

cc: Charlene Fitch, Waste Management Program, w/enclosure
Paul Reitz, P.E., Reitz & Jens, Inc., w/enclosure
Mike Carlson, R.G., Gredell Engineering Resources, Inc., w/enclosure ✓
Region I – East Central SWMD

Missouri Department Of Natural Resources
Division of Geology and Land Survey
P.O. Box 250
Rolla, Missouri 65402-0250
Phone - 573.368.2161 Fax - 573.368.2111
E-mail - gspgeol@dnr.mo.gov

Project ID Number
F00409

County
Franklin

Solid Waste Disposal Site - Geologic Evaluation

Project Name AmerenUE Labadie, Utility Waste Landfill **Quadrangle** LABADIE

Location **Section** 17 **Township** 44N **Range** 2E

Additional Location Inforamtion Also Section 20, includes SUR 354 and 735

Latitude 38 Deg 34 Min 0 Sec North **Longitude** 90 Deg 49 Min 31 Sec West

---

Owner: Ameren

One Ameren Plaza, 1901 Chouteau Ave., St. Louis, MO 63166-1419 (314) 342-1000

Requestor: Ameren Services

Paul Pike, One Ameren Plaza, 1901 Chouteau Ave., St. Louis, MO 63166-1419 (314) 554-2388

Date of Field Visit

Slope

● < 4%
○ 4% to 8%
○ 8% to 15%
○ >15

Landscape position

○ Broad uplands
○ Ridgetop
○ Hillslope
○ Narrow ravine
● Floodplain
○ Alluvial plain
○ Terrace
○ Other

Groundwater of concern

○ Perched
● Local
○ Regional

Groundwater located in

● Overburden
○ Bedrock

Bedrock

The uppermost bedrock is the Ordovician-age Everton Formation or the Jefferson City-Cotter Dolomite, which both exhibit low permeability in this area. These formations are typically composed of an undulating dolomite overlying a thicker, massive sandstone, and a light-gray to light brown, medium- to finely crystalline, cherty dolomite, respectively.

Overburden

The surficial materials are best described as ranging from brown to tan, silty-sand alluvium with some clay (SM/SC) to brown to gray, highly plastic, inorganic clay (CH) in the upper 20-30 feet. Two soil borings (P-1 and B-7) indicate cobble and boulder-size limestone and dolomite debris below 50 feet. Bedrock is contacted at approximately 100 feet. These materials typically exhibit moderate to high permeability in this environment.

Site Hydrology

The Missouri River alluvial aquifer is the uppermost continuous water-bearing unit. Groundwater in the alluvial aquifer largely flows in the same direction but is variable depending on the river stage. Surface water and groundwater also flow due north from the Franklin Low Hills of the Ozark Uplands south of the site and contribute to the overall water balance at the site. Overland flow on the site tends to travel north-northeast.

Underlying the Quaternary alluvium of the proposed site, the uppermost continuous bedrock water-bearing unit is within the Ordovician dolomites. Though no confining unit separating the alluvial aquifer from the underlying Ozark Aquifer has been identified, the thickness of saturated alluvium and the groundwater direction and gradient makes it highly unlikely that this lower aquifer could become contaminated by the proposed site.

Remarks

The proposed AmerenUE utility-waste landfill was visited to conduct preliminary site investigations and determine the general suitability for use as a utility waste disposal area. The site is located in the east halves of Sections 17 and 20, Township 44 North, Range 2 East, in the Lower Missouri River Alluvial Plain. The elevation of the proposed site is approximately 465 msl. The area of the proposed site is an alluvial bottomland bounded by the Missouri River on the north, east and west; and the Ozark Uplands to the south. The proposed utility landfill is tentatively sited in the alluvial bottoms, approximately one-third of a mile to the east of the existing Ameren Labadie power plant.

Examination of the well logs of on-site boreholes indicates the presence of alluvial materials ranging from silts and clays to fine to coarse grained sand, to gravel, cobble and boulder-size clasts of limestone, dolomite and insoluble clasts at depth. Some organic materials, such as decaying trees were observed at depth in the logs. There is no evidence of a lower confining unit within the alluvium. However, the thickness of the alluvium (over 100 feet thick) and the shallow depth to groundwater (ranging from eight to 20 feet) and the existing groundwater gradients indicate a low probability of groundwater contamination from this facility into the lower Missouri River alluvial aquifer or the Ozark Aquifer.

During the site visit for the preliminary site investigation, fault displacement was observed in the bed cut of a railroad bordering the southern edge of the proposed utility landfill. This fault appeared to transect the Ordovician-age Everton Formation and the overlying Ordovician-age St. Peter Sandstone. Inactive bedrock faults are not uncommon, however, further exploration may be warranted during the detailed site investigation.

Results of Preliminary Investigation ☑ Approval ☐ Disapproval

Further exploration not recommended due to unstable or unsuitable conditions in the following areas

○ Hydrological ○ Collapse Potential ○ Bedrock ○ Soil

Report By Blake Smotherman for Blake Smotherman **Report Date** 02/03/2009

CC Charlene Fitch, Paul Reitz (Reitz & Jens, Inc.), Mike Carlson (Gredell Engineering), Region I - East Central SWMD

LARRY D. PIERCE
RG0179

Ameren Services

Environmental Services
314.554.2388 (Phone)
314.554.4182 (Facsimile)
ppike@ameren.com

One Ameren Plaza
1901 Chouteau Avenue
PO Box 66149
St. Louis, MO 63166-6149
314.621.3222

December 3, 2008

COPY

Mr. Larry Pierce, R.G.
Unit Chief - Geological Survey Program
Division of Geology and Land Survey
Department of Natural Resources
P.O. Box 250
Rolla, MO 65402-0250

Ameren

RE: Preliminary Site Investigation Request - Proposed Utility Waste Landfill
AmerenUE Labadie Power Plant, Franklin County, Missouri

Dear Mr. Pierce,

As discussed in our November 12 meeting in your office, enclosed is a Preliminary Site Investigation (PSI) request for a proposed Utility Waste Landfill at AmerenUE's Labadie Power Plant in Franklin County, Missouri. This PSI request is being made in accordance with 10 CSR 80-2.015(1)(A). The PSI request encompasses approximately 1,042 acres, however only a portion of the area will be permitted as a solid waste disposal area. Following the Department's PSI findings, AmerenUE will identify and delineate a smaller footprint for the Detailed Site Investigation (DSI), design and permitting of the actual solid waste disposal area.

Ameren either currently owns, or has a verbal agreement to purchase all of the land within the PSI limits by February 27, 2009. The purchase agreement includes the rights to access the site for the purpose of completing the DSI.

A USGS map at 1" = 2000' scale is attached to the PSI request form. The limits of the PSI area are shown on this map. Generally the PSI area extends from Labadie Bottom Road on the west to a property line approximately 1500 feet east of Davis Road on the east, and from the existing agricultural levee on the south to the existing levee on the north. Additional site information, including site maps, boring logs, piezometer locations, and piezometric water level data were provided to you on November 12th. This additional information is referenced but not submitted with this PSI request. Additional copies of this information can be provided at your request.

We understand that 10 CSR 80-2.015(1)(A) requires review and approval/disapproval of the PSI within sixty (60) days of receipt. It is also our understanding that Department staff will make a site visit during this 60 day time period to observe site conditions. AmerenUE requests notification of this site visit so that the necessary and appropriate representatives can be present during that visit. Please coordinate the date of your site visit with either myself or Paul H. Reitz, P.E. with Reitz & Jens, Inc. I can be reached at prpike@ameren.com or 314-554-2388. Mr. Reitz can be reached at preitz@reitzjens.com or 314-993-4132, ext. 224. Once contacted, we will subsequently notify other appropriate AmerenUE representatives of the planned date and time of your staff's site visit.

If you have any questions or would like additional information regarding this PSI request, please contact me at 314-554-2388 or prpike@ameren.com.

Sincerely,

Paul R. Pike
Strategic Analyst
Environmental Services

Enclosures

cc: Bill Duley, R.G., Geological Survey Program w/enclosure
Charlene Fitch, Waste Management Program, w/enclosure
Paul Reitz, P.E., Reitz & Jens, Inc., w/enclosure
Mikel Carlson, R.G., GREDELL Engineering Resources, Inc., w/enclosure

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY, GEOLOGICAL SURVEY PROGRAM

REQUEST FOR PRELIMINARY INVESTIGATION OF PROPOSED SOLID-WASTE DISPOSAL SITE

FOR OFFICE USE ONLY
PROJECT CODE
DATE RECEIVED

FACILITY OR PROJECT LOCATION

FACILITY OR PROJECT NAME
AmerenUE Labadie Plant Utility Waste Landfill

¼ ¼ ¼ SECTION	¼ ¼ SECTION	¼ SECTION	SECTION	TOWNSHIP	RANGE	QUADRANGLE NAME
			*	44 North	2 ☒ East ☐ West	Labadie

WRITTEN LOCATION IF LEGAL DESCRIPTION IS UNAVAILABLE	COUNTY
*Section 17/20 also includes SUR 354 and 735	Franklin

OWNER INFORMATION

OWNER'S NAME		TELEPHONE	
Ameren		(314) 342-1000	
ADDRESS	**CITY**	**STATE**	**ZIP CODE**
One Ameren Plaza, 1901 Chouteau Ave	St. Louis	MO	63166-1419

EVALUATION REQUESTED BY

NAME AND COMPANY OF REQUESTOR		TELEPHONE	
Paul Pike, Ameren Services		(314) 554-2388	
ADDRESS	**CITY**	**STATE**	**ZIP CODE**
One Ameren Plaza, 1901 Chouteau Ave	St. Louis	MO	63166-1419

FACILITY INFORMATION

TYPE OF DISPOSAL AREA PROPOSED

☐ SANITARY LANDFILL ☐ DEMOLITION LANDFILL
☒ UTILITY WASTE LANDFILL ☐ **SPECIAL WASTE LANDFILL*
* Please specify type of special waste ______

ESTIMATED SIZE OF DISPOSAL AREA IN ACRES
+/- 1042**

ESTIMATED ELEVATION OF THE SUB-BASE GRADE IN FEET ABOVE MEAN SEA LEVEL
455 ft.

** A special waste is defined as "solid-waste requiring handling other than normally used for municipal waste."

SKETCH OR MAP MUST BE SUBMITTED WITH REQUEST !

A topographic map must be provided with this request that contains the following information: all known wells, springs, sinkholes, caves, mines, roads, and dwellings within ¼ mile of the facility. Show the estimated boundaries of the disposal facility and any existing borings, test pits, or excavations which expose soil or bedrock. Include a scale and north arrow on the map.

COMMENTS

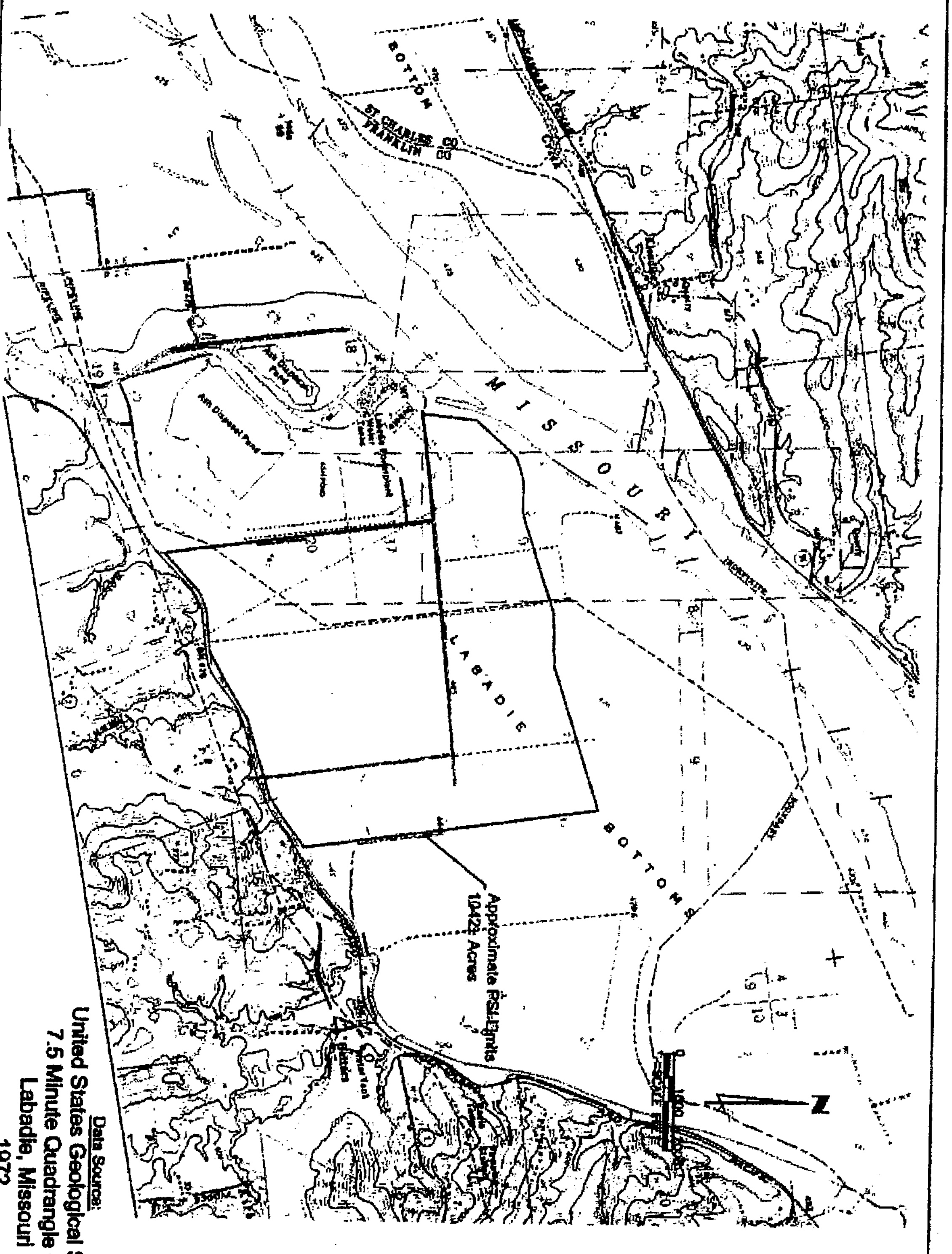
**A USGS topographic map is attached, which outlines the approximate boundaries of the requested PSI investigation area. The area delineated includew qncillary and support features of the future solid waste disposal area. Following receipt of DGLS's PSI report, AmerenUE intends to delineate a final, smaller disposal area footprint for evaluation during the DSI process.

Additional site information, including site maps, soil borings, and groundwater data, was provided to DGLS at our November 12, 2008 meeting in Rolla.

Please contact Paul Pike at 314-554-2388 or Paul Reitz (Reitz & Jens, Inc.) at 314-993-4132 to coordinate the PSI site visit.

REQUESTOR'S SIGNATURE	DATE
	12/3/2008
OWNER'S SIGNATURE (INDICATES PERMISSION TO ACCESS PROPERTY)	**DATE**
	12/3/2008

MO 780-1689 (5-07) MAIL COMPLETED COPY TO: DEPARTMENT OFNATURAL RESOURCES, ENVIRONMENTAL GEOLOGY SECTION, PO BOX 250, ROLLA, MO 65402-0250
PHONE: (573) 368-2161 FAX: (573) 368-2111 E-MAIL ADDRESS: gspgeol@dnr.mo.gov



Data Source:
United States Geological Survey
7.5 Minute Quadrangle Map
Labadie, Missouri
1972

SHEET 1 OF 1	Labadie UWL PSI Site Layout 2008012455	Ameren UE	Designed Drawn Checked Issued	REITZ & JENS, INC. CONSULTING ENGINEERS

2008 Site Layouts/PSI-USGS 11/26/2008

SHEET

1 OF 1

Labadie UWL
PSI Site Layout
2008012455

Designed p.h.r. Checked p.h.r.
Drawn p.h.r. Issued 11/26/2008

REITZ & JENS, INC.
CONSULTING ENGINEERS
1055 CORPORATE SQUARE DRIVE
ST. LOUIS MISSOURI 63132
(314) 993-4132

Bcc: J. Thee, w/enclosure
K.D. Stumpe w/enclosure
M. J. Tomasovic w/enclosure
D. V. Fox, w/o enclosure
E. J. Kammerer w/o enclosure
S. B. Knowles, w/o enclosure
T. J. Fox w/o enclosure
B. S. Skitt, w/o enclosure
C. R. Henderson w/o enclosure
W.E. Kahl w/o enclosure
M. L. Menne, w/o enclosure
S. C. Whitworth, w/o enclosure
J. C. Pozzo, w/o enclosure
File WM 3.5.8 w/enclosure

APPENDIX 2

Geotechnical Work Plan for AmerenUE Labadie Plant UWL

Appendix 2

AMEREN LABADIE PLANT UWL
DETAILED SITE INVESTIGATION – GEOTECHNICAL WORKPLAN

1.0 SCOPE OF GEOTECHNICAL INVESTIGATION

1.1 This geotechnical investigation is a component of a Detailed Site Investigation (DSI) for the proposed Utility Waste Landfill (UWL) for the Ameren U.E. Labadie Power Plant in Franklin County, Missouri. The purpose of this geotechnical investigation is to provide data of subsurface conditions for: 1) the geologic and hydrogeologic characterization of the site for the DSI to be submitted to MDNR-DGLS, and 2) the geotechnical analyses and design of the UWL.

1.2 The geotechnical component of the DSI will consist of 100 temporary borings or cone penetrometer test (CPT) soundings. Three borings from the 2007 investigation by Reitz & Jens will be included. We anticipate a minimum of 21 new temporary borings, to supplement the geological borings, and 76 CPT soundings. The geotechnical component will be done after the geological borings and piezometers are completed. These borings and CPT soundings will be distributed evenly across the proposed site, unless the geological borings indicate portions of the site that need further investigation.

1.3 If CPT soundings indicate an unexpected soil stratigraphy in an area that was not found in the geological or geotechnical borings, then additional geotechnical borings will be made to verify the soil stratigraphy and to obtain soil samples.

2.0 DEPTH CRITERION FOR GEOTECHNICAL BORINGS

2.1 The geotechnical borings will be made to a minimum depth of 35 feet, which is a minimum of 25 feet below the proposed depth of the UWL. The borings will extend beyond the minimum depth of 30 feet to a depth where the following two criteria are met: 1) the uncorrected N-value from the Standard Penetration Test (SPT) with an automatic hammer is a minimum of 12 blows/foot, AND 2) the last 15 feet of soil is classified as sand or gravel (Unified Soil Classifications of SW, SP, SM, GW, GP, GP-SP).

2.2 One of the geotechnical borings will extend to drilling or sampler refusal on bedrock or boulders. Drilling refusal is defined as a penetration rate with a fishtail or similar drill bit of less than 0.2-inches per minute for 5 minutes and with a downward pressure of at least 500 psi. Sampler refusal is defined as less than 6 inches of penetration after 50 blows with an automatic SPT hammer. The deep boring will be located to supplement the two deep borings completed by Reitz & Jens in 2007.

2.3 Borings may be advanced from the ground surface to the depth of the ground water table using 4.25-inch I.D. hollow-stem augers. The depth of the water inside the hollow-stem augers shall be maintained at the same depth as the surrounding ground water. The water levels shall equalize before a SPT is performed. After the underlying sand strata has been reached below the prevailing ground water table, the borings shall be advanced using rotary drilling techniques with Bentonite or drilling revert to stabilize the hole. The drilling fluid and cuttings shall be re-circulated using a metal drilling-mud pit.

3.0 CONE PENETROMETER (CPT) SOUNDINGS

3.1 CPT soundings will be made with a dedicated cone penetrometer truck or drill rig, and in general accordance with ASTM D 5778-07, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils." A copy of the standard is included in Appendix 6. A piezocone penetrometer will be used, capable of measuring end bearing of the cone, side friction on the sleeve behind the cone, and pore water pressure. A hydraulic ram will be used to push the rod string and cone into the ground at a constant rate of 4 feet per minute. The penetration of the cone may be paused at selected intervals in fine-grain soils to measure pore water pressure dissipation, which will be used to estimate hydraulic conductivity and consolidation properties.

3.2 The depths of the CPT soundings will be a minimum of 30 feet, or to the depth of the dense coarse sand and gravel stratum found in the previous borings by R&J at about 30 to 40 feet deep.

3.3 As the penetrometer is advanced, Bentonite grout will be pumped into the annular space formed between the smaller diameter sounding rods and the larger diameter cone penetrometer. After retrieval of the rod string, grout levels will be checked and more grout will be added if necessary.

3.4 In addition to the planned CPT soundings, a minimum of two piezometer borings will be selected and a CPT sounding will be made adjacent to each of the piezometer borings, to correlate the readings from the CPT with a continuously-sampled boring. The borings will be selected to provide a range of different subsurface conditions, if possible.

3.5 A separate report of the CPT soundings will be generated. The report will contain the data from the CPT in 6-inch increments, both in tables and plotted. The data will be analyzed to estimate: soil classification, undrained shear strength (s_u) or drained friction angle (ϕ'), relative density, and normalized Standard Penetration Test N-value.

4.0 SAMPLING CRITERION FOR GEOTECHNICAL BORINGS

4.1 <u>From the ground surface (GS) to a depth of 10 feet</u>: The thickness of the ploughed zone with organics and root balls, etc., shall be noted on the boring log based upon initial auger cuttings or a shallow test pit adjacent to the boring. Samples of the subsurface soils will be taken at depths of: 1.0 feet, 4.0 feet, 7.0 feet, and at 10.0 feet. Samples will be taken using either: 1) a hydraulically pushed, 3-in. O.D., thin-wall "Shelby tube" sampler (ASTM D-1587); or 2) a 2-in. O.D., split-spoon sampler driven by an automatic hammer in conjunction with a Standard Penetration Test (ASTM D-1586). One Shelby tube sample of fine-grain soils will be taken in the first 10 feet of each boring. The depth of the Shelby tube sample will be rotated between the above depths except that if the uncorrected N-value from a SPT is less than 5 blows/foot AND is a fine-grain soil, then the following sample will be a Shelby tube regardless of whether a Shelby tube sample has already been taken at a shallower depth.

4.2 <u>From a depth of 10 feet to a depth of 50 feet</u>: Samples will be taken at intervals of 5.0 feet. Samples will be obtained using a 2-in. O.D., split-spoon sampler driven by an automatic hammer in conjunction with a Standard Penetration Test (ASTM D-1586). However, if the uncorrected N-value from a SPT is less than 5 blows/foot AND is a fine-grain soil, then the boring will be cleaned out to the depth of the SPT sample and a 3-in. O.D., thin-walled "Shelby tube" sample (ASTM D-1587) will be taken.

4.3 From a depth of 50 feet to refusal: Samples will be taken at intervals of 10.0 feet. Samples will be obtained using a 2-in. O.D., split-spoon sampler driven by an automatic hammer in conjunction with a Standard Penetration Test (ASTM D-1586).

5.0 FIELD PROCEDURES

5.1 A qualified geologist or geotechnical engineer will supervise and maintain quality control of the drilling and sampling program, and will log the borings, determine the completion depths, collect and prepare samples for transport, and obtain water level readings. Borings will be backfilled after the 24-hour groundwater level readings. Backfilling of borings will be in accordance with 10 CSR 23-6.

5.2 A continuous field log of the boring shall be recorded in general accordance with ASTM D-5434 "Field Logging of Subsurface Explorations of Soil and Rock," and shall include the following information at a minimum:

1. All of the information at the top of the field boring log form.
2. An accurate description of any deviation from the planned boring location.
3. Drilling method(s) used, including diameter of augers.
4. Depths of generalized soil and rock boundaries encountered, based upon drilling characteristics, samples, cuttings, color of drilling fluid, etc.
5. Depths of samples, including: type, length sampled, length recovered, hammer blows for each 6-in. interval for Standard Penetration Tests (SPT=s).
6. Loss of drilling fluid, if applicable.
7. Water level readings (to 0.1 foot) when free water is first encountered, at the conclusion of drilling and 24 hours after drilling.
8. Type of drilling fluid used to stabilize the hole, if applicable.
9. Identification of the soil as specified below.
10. Pocket penetrometer readings on firm to stiff cohesive soil samples, or torvane reading on soft soil samples (Shelby-tube samples only).
11. Note the length and cause of significant delays in field operations.
12. If the boring does not stand open, record the depth of material sloughed into the hole or the depth to collapse of the hole.
13. Note how the boring is backfilled, including installation of piezometer if applicable.

5.3 Soils will be classified in general accordance with ASTM D-2487 AStandard Classification of Soils for Engineering Purposes (Unified Soil Classification System)@ and ASTM D-2488 AStandard Practice for Description and Identification of Soils (Visual-Manual Procedure),@ except that the descriptions will be in the following sequence:

a) Modifying Major Component (ex. AClayey@ or ASilty@)
b) Major Component (ex. ACLAY,@ ASAND,@ ASILT,@ etc.)

c) USCS abbreviation in parentheses [ex. A(CL)@ or A(SM)@]
d) Color
e) Secondary Components or Inclusions (ex. Awith sand@ or Atrace gravel@)
f) Structure (ex. Ahomogeneous,@ Alaminated,@ A slickensided,@ etc.)
g) Consistency (ex. Asoft@ or Amedium stiff@ for cohesive soils; or Aloose@ or Amedium-dense@ for cohesionless soils)
h) Moisture (ex. Amoist@ or Awet@)

5.4 If a clay or silt is high plastic, put AHigh Plastic@ as the Modifying Major Component (ex. AHigh Plastic CLAY@). Similarly, if silt is non-plastic, put ANon-Plastic SILT.@ If a material is primarily man-made, put AMiscellaneous FILL@ for the Modifying Major Component and Major Component. If the material is primarily a specific soil type but was placed as a fill, then list the Origin as A(fill).@

5.5 All personnel in the vicinity of the drill rig shall wear hard hat, steel-toed safety boots, and long pants or coveralls. All personnel operating the drill rig or handling drilling equipment and tools shall wear eye protection and gloves, or as otherwise specified in the Project's approved health & safety plan.

5.6 If unknown or unexpected contamination of the soil and ground water is encountered, then field work shall stop immediately and Reitz & Jens shall be contacted. Secure the area to prevent the spread of the contamination and to prevent anyone from approaching the boring.

5.7 Soil cuttings and material sloughed from the side of the boring shall be removed prior to sampling. The field technician shall note the length of drilling rod in the hole before it is extracted and after the sampler is set on the bottom of the boring. If the change in depth is more than 3 inches, then the sampler shall be removed and the hole cleaned out.

5.8 Hollow-stem augers shall be advanced with the center plug attached to the drill rods, to prevent soil from entering the augers.

5.9 The procedures for drilling a test hole and obtaining split-spoon samples are described in ASTM D-1586. The following major points shall be followed and noted on the field boring log:

1. Drag, chopping, fishtail and roller-cone bits between 2.2 in. and 6.5 in. diameter are permitted. Bottom discharge bits are not permitted in rotary wash borings. The inside diameter of hollow-stem augers, and the outside diameter of continuous-flight augers, must also be between 2.2 in. and 6.5 in.

2. Flush-joint steel AA@ drill rods (1-5/8" O.D. and 1-1/8" I.D.) shall be used. The rods must be tight so that there is no movement at the joints.

3. Count and record the number of blows for each 6 inches of penetration.

4. THE SPLIT-SPOON SAMPLER SHALL NOT BE DRIVEN MORE THAN 18 INCHES.

5. A representative soil sample shall be taken from each split-spoon. If there is a change in soil type, two samples shall be taken. Each sample shall be placed in a glass jar and immediately sealed to prevent loss of moisture. The jar should be filled as much as possible. Label each jar (not the lid) with the boring number, sample number, sample depth, and the blow count for each 6-in. increment. Protect the samples against extreme temperature changes.

5.10 The procedures for obtaining thin-walled tube samples are described in ASTM D-1587. The following major points shall be followed and noted on the boring log:

1. Jetting or bottom discharge bits are not permitted.
2. Loose material from the bottom of the hole shall be removed without disturbing the interval to be sampled.
3. The bottom of the hollow-stem auger or casing shall not be below the interval to be sampled.
4. Only clean, new, galvanized Shelby tubes, 30 or 36 inches long, shall be used. The tubes shall be round, and the cutting edge shall be sharp and free of burrs or nicks.
5. The tube shall be hydraulically pushed in one continuous, rapid motion without rotation.
6. THE SAMPLER SHALL NOT BE PUSHED MORE THAN 24 INCHES.
7. Trim the bottom end of the sampler and obtain a pocket-penetrometer or torvane reading, and then seal the bottom end of the tube with a tight-fitting plastic cap and duct tape.
8. Remove the excess fluid and loose material from the upper end of the tube and measure the length of the sample recovered.
9. Seal the top end of the tube with a tight-fitting plastic cap and duct tape.
10. Clean and dry the outside of the tube and write with a permanent marker on the tube (not the cap) the boring number, sample number, sample depth, and recovered length.
11. Tube samples shall be maintained in a vertical position with the bottom end down at all times. Protect the sample from extreme changes in temperature or disturbance.

5.11 ASTM D 4220-95 AStandard Practice for Preserving and Transporting Soil Samples@ will be used as a guide. The following shall be the minimum requirements:

1. Relatively undisturbed, thin-walled samples shall be transported vertically in a rack to prevent disturbance.
2. All samples shall be protected from freezing or extreme temperatures at all times.

3. All samples shall be transported to Reitz & Jens' laboratory daily, or more frequently if necessary to prevent damage due to temperature extremes.

4. Bulk samples shall be transported in clean plastic 5-gallon buckets with a sealed lid. (A sealed lid is not required if the moisture content of the sample will be determined from other samples.)

5. Jar samples shall be transported in the cardboard box with dividers that come with the jars.

6. Reitz & Jens shall be responsible for the transporting of all geotechnical samples, and for maintaining records of chain of custody.

6.0 LABORATORY PROCEDURES

6.1 All samples will be transported to Reitz & Jens' AMRL-approved laboratory. Shelby tube samples will be stored in the vertical position.

6.2 All testing will be done in general accordance with the latest applicable ASTM procedures. The following minimum guidelines will be followed:

1. All samples shall be classified in the lab by a different technician, geotechnical engineer or geologist than the one who performed the field classifications.

2. Moisture contents will be determined on all fine-grained soil samples.

6.3 All split-spoon jar samples shall be retained until the final boring logs are completed, or for a period of 90 days, whichever is longer. Relatively-undisturbed tube soil samples, either un-tested or unused portions of tested samples, shall be discarded after the final boring logs are completed or after 45 days, whichever is longer. Selected representative specimens from tube samples may be sealed in paraffin in plastic tubes for long-term storage.

6.4 The procedures contained in Reitz & Jens' AAP-approved Quality Manual shall be followed.

6.5 Once all laboratory testing for given boring is complete, it will be combined with the information in the field boring log using GEOSYS. The draft log will be reviewed both for accuracy (i.e. correct blow counts, sample types, sample depths, recovery percentages and laboratory test results) and consistency of the information provided. The final boring log=s consistency will be reviewed by an experienced registered geotechnical engineer. In this review the engineer will look at the sample description on the field log, the sample description from the laboratory, and the laboratory test results to make verify they are consistent in representing the sample. In certain instances, a judgment call will need to be made to reconcile these three aspects of each sample. Unless there is strong evidence to the contrary, the stratification lines identified in the field boring log will be shown on the final boring log.

6.6 The final test results will include the following:

1. Index Properties B unless other testing is requested, moisture contents and liquid and plastic limits will be transmitted only on the final boring logs.

2. Grain Size Distribution and Hydrometer Tests B graph of grain size distribution and USCS designation (CL, ML, SM, SP, etc.).

3. Unconfined Compressive Strength Tests B the sample description from the laboratory classification, USCS designation (CL, CH, ML, etc.), moisture content, dry density, liquid limit and plasticity index (if requested), unconfined compressive strength, mode of failure, strain at failure, and a graph of the stress-strain curve.

4. Unconsolidated-Undrained Triaxial Shear Strength Tests B the sample description from the laboratory classification, USCS designation (CL, CH, ML, etc.), moisture content, dry density, liquid limit and plasticity index (if requested), unconfined compressive strength, mode of failure, strain at failure, the stress and strain readings, and graphs of the stress-strain curve and the total stress Mohr=s circle.

5. Consolidated-Undrained Triaxial Shear Strength Tests B the sample description from the laboratory classification, USCS designation (CL, CH, ML, etc.), moisture content, dry density, liquid limit and plasticity index (if requested), unconfined compressive strength, mode of failure, strain at failure, the stress and strain readings, and graphs of the stress-strain curve, the total and effective stress paths, and the total and effective stress Mohr=s circles.

6. Consolidation and Swell Tests B the sample description from the laboratory classification, USCS designation (CL, CH, ML, etc.), moisture content, dry density, liquid limit and plasticity index (if requested), the graph of consolidation curve (strain vs. pressure), tables of c_v and c_α for each load increment, and the graphs of the time-deflection curve for each load increment.

7. Moisture-Density Relationship (standard or modified Proctor compaction tests) B graph of the dry unit weight versus moisture content, the sample description from the laboratory classification, USCS designation (CL, CH, ML, etc.), natural moisture content, maximum dry unit weight, optimum moisture content, and the liquid limit and plasticity index.

7.0 LABORATORY TESTING PROGRAM

7.1 The laboratory testing program will be determined based upon the types of subsurface soils encountered. The following general guidelines will be followed in developing the laboratory testing program.

7.2 Grain-size analyses will be performed on cohesionless samples (Unified Soil Classifications of SW, SP, SM, GW, GP, GP-SP). If the percentage of fines (passing #200 U.S. sieve) is greater than 25%, then a hydrometer analysis will be performed on the fine-grain portion of the sample. Samples that appear to be from the same stratum may be combined.

7.3 Moisture and dry unit weight shall be measured on all undisturbed Shelby tube samples if possible.

7.4 Two series of unconsolidated-undrained triaxial shear strength tests will be performed on each major cohesive soil stratum. Each series will have a minimum of three points.

7.5 Two series of consolidated-undrained triaxial shear strength tests will be performed on each major cohesive soil stratum that will be below the berm. Each series will have a minimum of three points.

7.6 The following tests will be performed on samples of prospective construction materials:

a) natural moisture content,
b) Atterberg liquid and plastic limits,
c) grain-size analyses,
d) moist-density relationship (standard or modified Proctor),
e) unconsolidated-undrained triaxial shear strength tests on compacted samples, and
f) flexible-wall permeability tests on compacted samples.

Samples will be compacted to the appropriate compaction criterion (95% of standard Proctor or 90% of modified Proctor) and at moisture contents approximately 3% higher than the optimum moisture content determined by the corresponding test.

7.7 One-dimensional consolidation test on each major cohesive soil stratum beneath the UWL.

APPENDIX 3

Guidance for Conducting and Reporting Detailed Geologic and Hydrologic Investigations at a Proposed Solid - Waste Disposal Area

(January 2007)

(copy of 10 CSR 80-2.015 Appendix 1)

APPENDIX 1

GUIDANCE FOR CONDUCTING AND REPORTING DETAILED GEOLOGIC AND HYDROLOGIC INVESTIGATIONS AT A PROPOSED SOLID-WASTE DISPOSAL AREA

Missouri Department of Natural Resources
Division of Environmental Quality
Division of Geology and Land Survey

This appendix contains the following:

- Elements and format of a workplan for conducting the Detailed Site Investigation.
- Guidance for conducting an acceptable detailed geologic and hydrologic investigation of a proposed solid-waste disposal area.
- Guidance for the acceptable presentation of site characterization data.
- Form for requesting a preliminary investigation for a proposed solid-waste disposal area.

ELEMENTS AND FORMAT OF A DETAILED SITE INVESTIGATION WORKPLAN

The detailed site investigation workplan must contain the following elements plus any additional site-specific elements which may be requested by the Geological Survey Program (GSP).

1. Topographic map at a scale of 1:24,000 showing the pertinent property boundaries, as well as the location of the proposed solid-waste disposal area, and potential borrow areas
2. Site map at a suitable scale to display proposed locations for pits, borings, and piezometers
3. A general description of the proposed facility to include:
    a. Maximum depth of excavation
    b. Total acreage to be developed as a solid-waste disposal area
4. Description of proposed methods for site exploration to include:
    a. Drilling methods
    b. Sampling methods
    c. Piezometer and monitoring well construction methods (must comply with 10CSR23-4):
        (1) Approximate depth intervals to be screened
        (2) Specific grout mixtures and emplacement methods to be used
    d. Aquifer test methods
    e. Alternative exploration methods (such as geophysical methods)
5. Record keeping procedures for:
    a. Well logs, boring logs, drilling logs, pit logs
    b. On-site precipitation data
    c. Periodic water-level measurement data from piezometers
    d. Aquifer test data

DETAILED SITE INVESTIGATION

General Procedures for Detailed Site Investigations

The potential disposal area construction permit applicant is responsible for retaining a qualified groundwater scientist to provide the GSP with a complete and accurate evaluation of the geologic and hydrologic conditions of the proposed solid-waste disposal area. All geologic and geohydrologic work must be completed under the direction of a geologist registered in the State of Missouri per RSMo 256.450 through 256.483 and the rules promulgated pursuant thereto. A consultant who subcontracts the drilling of piezometers or monitoring wells must hold a restricted or a nonrestricted monitoring well installation contractor's permit. Drilling must be done by a driller holding a nonrestricted monitoring well installation contractor's permit and appropriate permit numbers must be prominently displayed on all drill rigs used for site characterization, as required by 10 CSR 23 Chapters 1,2 and 4. The detailed site investigation is intended to provide the GSP with sufficient geohydrologic data to determine if the site is suitable for the development of a solid waste disposal area.

The minimum elements of a detailed site investigation are partially dependent on site-specific geologic conditions. As a result of data gathered during the preliminary or detailed site investigation, the GSP may require additional investigations to adequately define the geology and hydrology of the site. The GSP may require less detailed investigation based upon site geohydrologic conditions.

Geophysical methods may be used to help characterize the site; however borings or pits must be located and drilled to verify the results of the geophysical survey(s). Where geologic structures or solution features are present or suspected, additional borings or pits will be required to adequately define the extent and distribution of these features across the site, and to determine the relationships between these features and hydrostratigraphic units.

Sinkholes, solution-enlarged fractures and caves may have very small, near-surface expressions that a boring program would not be expected to detect. Sites will be rejected during preliminary or detailed site investigations where the site is characterized by karst terrane features which may affect the structural integrity or effective monitoring of the site.

Field Direction

A qualified groundwater scientist must direct the excavation of all pits, the drilling of all borings, the performance of any geophysical surveys, and the installation, development and abandonment of all exploratory wells or piezometers. Interpretations of geological data must be conducted under the direction of a geologist registered in the State of Missouri per RSMo 256.450 through 256.483.

A qualified groundwater scientist must supervise all field testing to determine the geologic and hydrologic characteristics of the material encountered or intended for use at the proposed site. A qualified groundwater scientist must maintain accurate and complete field notes of the investigation activities.

A land surveyor registered in the State of Missouri must determine the location and elevation of all wells and piezometers. Borings, excavation pits and all transects performed as part of a geophysical exploration will be located to the nearest one-tenth (0.1) foot by a land surveyor registered in the State of Missouri. All elevation measurements, grid patterns, and coordinates must be established and used consistently throughout the investigation and referenced to North American Datum (NAD) 1983 and National Geodetic Vertical Datum (NGVD) 1929 or North American Vertical Datum (NAVD) 1988. Monitoring well and piezometer measuring-point elevations must be accurate to the nearest one-hundredth (0.01) foot.

Field Investigations

The minimum requirements for conducting a detailed subsurface investigation are listed below. Alternative investigation techniques and procedures may be approved at the discretion of the GSP. Additional borings or pits may be required, subject to site-specific conditions, to fully characterize the geology of the area. The number of borings, pits, and piezometers required is dependent upon the anticipated size of the proposed disposal area and the site geohydrology. Borings that are not used as monitoring wells or piezometers must be permanently abandoned and reported as per 10 CSR 23-4. Exploration pits must be backfilled using native material, compacted to natural density condition, and their locations clearly marked on site maps.

1. Surficial Materials

A qualified groundwater scientist must determine the thickness, and geotechnical characteristics of significant hydrostratigraphic units, where they exist at the site, above competent bedrock. At least one boring must be drilled per two acres of the proposed disposal area. All borings must be extended to at least 25 feet below the anticipated disposal area sub-base grade or to competent bedrock, whichever is less. All borings must be continuously sampled. Exploration pits may be substituted for borings in areas where the surficial materials can be fully penetrated by the pits. For sites that meet the conditions pursuant to 10 CSR 80-2.015(1)(A)3 the GSP shall require only one boring per four acres of the site.

If geologic structures or solution features are suspected, at least one boring must be completed per acre of the proposed disposal area. All of these borings will be drilled to competent bedrock. Exploration pits may be substituted if approved by GSP.

The borings or pits must be distributed in a grid pattern across the site or located in a manner that will optimize characterization of the site. Deviations from a regular grid pattern must be approved by the GSP. The locations and elevations of borings or pits must be surveyed by a land surveyor.

2. Aquifers

A qualified groundwater scientist must determine the depth, thickness and lateral extent of the uppermost aquifer(s) beneath the proposed site and additional aquifers which are potentially at risk (as determined by the GSP).

Piezometers are required to adequately characterize the groundwater at the proposed site. There must be at least five piezometers, or one piezometer per four acres of the site, whichever is greater, installed in each aquifer to be characterized. For sites that meet the conditions pursuant to 10 CSR 80-2.015(1)(A)3 there must be at least five piezometers, or one piezometer per eight acres of the site, whichever is greater. Piezometer construction and development standards must be in accordance with 10 CSR 23-4.

All piezometers must be distributed in a grid pattern across the proposed site or located in a manner that will optimize characterization of the site. Deviations from a regular grid pattern must be approved by the GSP. An adequate number of piezometers must be located outside the anticipated fill area to sufficiently characterize each aquifer investigated. The measuring-point elevation of the piezometers must be determined by a land surveyor. Additional piezometers may be required to demonstrate the effectiveness of confining units and extent of aquifers. If geophysical methods are used, piezometers must be installed to verify the results of the geophysical survey(s).

A continuously recording precipitation gauge, capable of measuring precipitation events greater than one-tenth (0.1) inch, must be installed at the site concurrent with, or prior to, installation of piezometers. Data from the gauge will be used to interpret any fluctuations in potentiometric level(s) throughout the site characterization period and may be used for other purposes later, at the discretion of the department.

The hydraulic conductivity of the uppermost aquifer(s) beneath the proposed disposal area must be determined. The hydraulic conductivity must be determined in one out of every four piezometers installed for each aquifer tested. The hydraulic conductivity must be determined in the field. Accepted field tests are ***in situ*** slug and/or pump tests, as determined through the workplan process, which isolate the geologic unit of interest.

3. Other Hydrostratigraphic Units

At least one boring per four acres of the proposed disposal area or five borings, whichever is greater, must be drilled to characterize hydrostratigraphic units, including the uppermost confining unit, below the anticipated sub-base grade of the site. The depth of these borings will be determined based on geohydrologic conditions at the site. At least five of these borings must be continuously sampled, unless otherwise approved by the GSP. For sites that meet the conditions pursuant to 10 CSR 80-2.015(1)(A)3 there must be at least five of these borings or one boring per eight acres of the site, whichever is greater.

A qualified groundwater scientist must determine the occurrence, thickness, depth and lateral extent of the uppermost confining unit beneath the proposed solid-waste disposal area. If the uppermost confining unit is more than 150 feet below the lowest anticipated sub-base grade, the GSP will determine the need for characterization of the unit. If the thickness of the confining unit is greater than 50 feet, the depth of drilling required will be determined by GSP. The hydraulic conductivity of the uppermost confining bed must be determined by *in situ* tests in at least one out of every two, but a minimum of five, borings that penetrate the confining unit.

For investigation of horizontal expansions and investigations near previously existing disposal areas, piezometers and borings must be located within 500 feet of the limits of the existing filled area such that there is a minimum of one piezometer per 400 lineal feet extending along the periphery of the existing filled area. As determined by the GSP, if geologic structures or features are present or suspected, one piezometer/boring must be installed per 200 lineal feet along the periphery of the existing filled area. Piezometers will not be installed within the boundary of the pre-existing waste.

Records (Field Notes)

The geologic materials in each boring, exploration pit, piezometer or well must be logged in detail during drilling or excavation by a qualified groundwater scientist. The qualified groundwater scientist must describe and record the physical and lithologic characteristics of each geologic material encountered as well as other information pertaining to drilling or excavation. Field logs and notes pertaining to the field investigation shall be retained by the applicant or owner/operator of a permitted solid waste disposal area until closure.

At a minimum, a qualified groundwater scientist must, in the field, note on a descriptive log the following:

1. Texture of geologic material
2. Color (qualitative descriptions - include mottling) of geologic material
3. Relative degree of saturation (description)
4. Voids
5. Geologic origin
6. Secondary permeability features
7. Zones of incomplete sample recovery
8. Depth at which water is encountered
9. Depth and rate of drilling fluid gain or loss
10. Type and size of drilling/excavation equipment
11. Drilling rate and penetration rate (blow counts), as appropriate
12. Packer tests (intervals tested and results), as appropriate
13. Start and stop times for drilling/excavation
14. Names of field personnel
15. Date, time, weather conditions
16. Depth to water upon completion

All borings or pits must be observed until the water level has stabilized for at least 24 hours following completion. This observation must determine if groundwater has entered the hole, the depth to water, and, if possible, the water bearing hydrostratigraphic units. During observation all borings and pits must be protected from rainfall and runoff.

Laboratory Analysis

All samples collected for laboratory analyses must be clearly labeled (sampling location - boring/pit number, depth, date of sample) and preserved. Soil samples not destroyed by testing and rock core must be stored, protected from the weather, and available for the GSP's inspection in Missouri until closure.

Laboratory Testing

A laboratory must be retained to conduct geotechnical analyses for each unconsolidated material encountered to verify field observations. The following must be recorded for each sample tested.

1. Texture
2. Color (based on a Munsell color chart - include mottling)
3. Grain size distribution (reported in percent)
4. Soil classification (reported in Unified Soil Classification System)
5. Moisture content (reported in percent)
6. Liquid Limit
7. Plasticity Index
8. Standard Proctor density
9. Names of lab personnel
10. Date

Monitoring Wells

While monitoring wells are not normally required as part of the detailed site investigation, background water quality data will be required prior to operation of a solid-waste disposal facility. The number of monitoring wells required will be dependent upon the presence and number of aquifers monitored and the presence and number of confining beds Well construction standards and development must be in accordance with 10 CSR 23-4.

A minimum of one monitoring well must be located hydraulically upgradient and three monitoring wells located hydraulically downgradient for each aquifer monitored. These wells must be located outside of but not greater than 500 feet from the anticipated limit of the area. The screen and/or filter-pack must not extend through confining units.

Water Level Data Collection

Measurements of water level, to the nearest hundredth (0.01) of a foot, must be made every month for one year for all wells and piezometers. For sites that meet the conditions pursuant to 10 CSR 80-2.015(1)(A)3 the GSP may allow termination of water-level measurements after six (6) months. Water-level measurements in all wells and piezometers should be made within a 48-hour period, if possible. Additional measurements may be necessary as determined by the GSP.

PRESENTATION OF DATA AND INTERPRETATIONS

The following information must be provided in the order specified below. The report must be prepared under the direction of a qualified groundwater scientist who is a geologist registered in the State of Missouri per RSMo 256.450 through 256.483 and the rules promulgated pursuant thereto. This person must sign and seal the report.

1. Table of Contents

2. Introduction (general information about the site vicinity and the investigation)

   A. Location:
   A written narrative of the geographic setting with legal description (section, township, and range)

   B. Regional Geology:
   A written narrative describing the regional lithologic, stratigraphic, structural and hydrologic settings of the area

   C. Historic Land Uses:
   A written narrative describing previous land use such as mining or mineral exploration

The sections above must address geologic conditions that relate to the siting restrictions pertaining to sites adjacent to or in the vicinity of unstable areas, faults and seismic impact zones. Other siting restrictions listed in 10 CSR 80-3.010(4)(B), including proximity to airports, floodplains and wetlands, must be addressed in the permit application.

3. Method of Study

A written narrative must be provided which describes field and laboratory procedures used to characterize geologic and hydrologic conditions of the site. Standardized laboratory and field procedures may be referenced. All other procedures must be described in detail. Deviations from and amendments to the approved workplan during the detailed site investigation should be described.

4. Results of Investigation

A written detailed narrative must be provided that describes the site-specific geology and hydrology based on data collected. The narrative must include explanations of any anomalous data. Interpretations of results must be presented in a clear and concise manner.

5. Conclusions

A written narrative must be provided that details how the site-specific geology and hydrology will impact the design of the disposal area and groundwater monitoring system. The narrative must assess the inadequacies of the investigation and propose future investigations if needed. The narrative must describe the proposed monitoring system design.

6. References

All published information sources used in the compilation or research of the hydrogeologic investigation must be listed.

7. Appendices

The appendices of the site characterization report must include:

- Compiled logs of all borings, excavations, wells and piezometers.
- The raw data for any and all tests (e.g., pumping tests)
- All additional information that may facilitate the GSP's assessment of the acceptability of the proposed site.

A. Logs
Lithologic logs of all borings and excavations, including well construction diagrams, must be provided. Each log must include borehole identification, borehole grid location, soil and rock description, sample depths, methods of sampling, sampling date, land surface elevation, borehole total depth, moisture content, and test results such as: blow counts, vane shear, or pocket penetrometer measurements.

B. Tables
Presentations of tabular data that must be supplied include the following:
(1) All borehole, well and piezometer construction data. Such data should include the borehole, well or piezometer identification, grid location, total depth, surface elevation and, if applicable, screened interval and hydrogeologic unit monitored.
(2) Monthly groundwater elevation measurements for each piezometer or well. The table(s) should indicate the well or the piezometer identification, depth to water from measuring-point, groundwater elevation and date of measurement.
(3) The results of all unconsolidated-material testing. The table(s) must include the sample location, depth, sampling date, and test results.
(4) The results of all hydrologic testing. The table(s) must include the well or piezometer identification, method and date of test, depths of interval tested, hydrologic unit tested and results.
(5) The daily precipitation data collected at the site.

C. Maps

All detailed site maps for the report must be drawn on a scale where one inch equals 400 feet or less. As appropriate, maps should be drawn on a consistent scale. All maps must include a scale, north arrow, and a clear and concise legend describing all of the symbols used on the map. More than one map will be required to include the following information:

(1) A base map showing initial topography (on 5 foot contour intervals unless otherwise specified by the GSP), borrow area(s), and proposed disposal area boundary.
(2) Map(s) showing land use, ownership, residences, septic systems, lateral lines, buildings, wells, cisterns, mined or quarried areas, mine shafts, spoil piles, and all other man-made features within 1/4 mile of the proposed disposal area boundary.
(3) Map(s) showing springs, water courses, streams, lakes, caves, sinkholes, rock outcrops, and other significant geologic features within 1/4 mile of the proposed disposal area boundary.
(4) Map(s) showing all borings, excavations, piezometers, and wells constructed for the study.
(5) Monthly piezometric maps per aquifer to be monitored. The maps must include labels showing water elevations next to each well or piezometer and must indicate the date when the water elevation was measured.
(6) Map(s) showing inferred results of geophysical explorations with survey tracks (if applicable).
(7) Map(s) locating cross-sections showing borings used in cross-section representation.
(8) Map(s) locating floodplains, wetlands and fault(s).
(9) Map delineating seismic impact zones.
(10) Bedrock contour map (where applicable).

D. Cross-sections

Geologic cross-sections must be constructed through all appropriate borings both perpendicular and parallel to the facility baseline as well as along and across all transects which include major geologic features such as faults, sinkholes, and buried valleys. At least one cross-section must be constructed parallel to groundwater flow. The subsurface conditions of the site must be illustrated in these cross-sections. Where more than one interpretation may be reasonably made, conservative assumptions must be used.

The following information must be included on the cross-sections:

(1) A dashed line or question mark for inferred lithostratigraphic boundaries, a number or symbol to label major soil units (instead of extensive shading) and legend containing a description of the soil units.
(2) The anticipated sub-base, and final grades for the proposed disposal area.
(3) All boring logs, the Unified Soil Classification System soil classifications and the geologic origin for each soil unit. The results of all lab and field tests, and all well construction details including screen and seal length along with the stabilized water elevations should be shown on the logs beside the descriptions of the materials encountered.

E. Aerial Photographs

One or more vertical aerial photographs, representing the entire area of the proposed site plus the area within 1/4 mile of the site must be included in the report. The photos must be taken between November 1 and March 30, within two years of the submittal of the report unless significant excavation has occurred at the site. If significant excavation has occurred at the site during the previous two years, the photos must be taken between November 1 and March 30, within one year of the submittal of the report. The extent of the proposed disposal area, the anticipated limits of the proposed fill area and a north arrow must be added to the photos. Photocopies of the photographs will not be accepted.

APPENDIX 4

Preliminary Report of Feasibility Study, Reitz & Jens, Inc., May 1, 2007

REITZ & JENS, INC.
CONSULTING ENGINEERS

1055 corporate square drive
st. louis, missouri 63132
phone: 314.993.4132
fax: 314.993.4177
www.reitzjens.com

MEMORANDUM

TO: Mr. Carl Rezsonya, PE, PMP
New Generation & Environmental Projects
Ameren Services

FROM: Jeffrey Fouse, PE

SUBJECT: Preliminary Report of Feasibility Study
Labadie Power Plant Utility Waste Landfill
ESA No. E223, Task No. GEN-56

DATE: May 1, 2007

This preliminary report presents the results of the field exploration that has been completed for the feasibility investigation for the development of a Utility Waste Landfill (UWL) on property adjacent to AmerenUE's Labadie Power Plant. This UWL would accept gypsum from the future Wet Flue Gas Desulphurization (WFGD) scrubbers to be constructed at the Plant, and potentially other ash by-products. This investigation was done in general accordance with Task No. GEN-56, dated February 5, 2007, of Reitz & Jens' Engineering Services Agreement E223 with Ameren Services.

Site Description

The proposed site of the UWL is located east of the Labadie Power Plant as shown in Figure 1. The site is composed of three parcels belonging to Heisel, Drewel and Newman. The site is bounded on the west by Labadie Bottom Road, on the south by the Laclede Gas pipeline, and on the north by a Missouri River levee. The ground surface is relatively flat, ranging between el. 465 and 471. The site is protected from flooding by levees.

An AmerenUE transmission line runs diagonally across the Heisel and Drewel parcels. The east-west portion of Labadie Bottom Road also divides the Heisel and Drewel parcels. Our field investigation located an Explorer pipeline which crosses diagonally the southern half of the Heisel and Drewel parcels, and then runs north along a field road between the Drewel and Newman parcels (see Figure 2).

Field Investigation

Our field investigation consisted of 8 borings, located as shown in Figure 2. Temporary standpipe piezometers were installed in three borings, designated P-1, P-2 and P-3. Borings P-1 and B-7 were drilled to refusal in cobbles or limestone bedrock. The completed depths of these borings were 91.5 feet and 104.5 feet, respectively. The other borings were 20 to 30 feet deep, and were terminated in the underlying medium-dense sand.

Below the surface topsoil and disturbed zone (due to farming), the 8 borings encountered 0 to 8.5 feet of high plastic clay which should have a permeability of $1x10^{-7}$ cm/sec or less when compacted, and thus would be suitable for a composite liner for the UWL. Boring P-1 on the north end and Boring B-8 on the south end had no clay stratum. The thickness of the high plastic clay in the remaining 6 borings ranged from 2.5 feet to 8.5 feet, and averaged about 6 feet. The remainder of the soils in the upper 13.5 feet consisted of sandy silts, silty clay, silt, and silty sand.

Below about 13.5 feet, the borings encountered strata of medium-dense to very dense sand and gravelly sand. Cobbles and boulders were encountered below about 50 feet in the two deep borings.

Geology

The site is located on the floodplain adjacent to the Missouri River between River Mile 57 and 58. The nearest river gage is located in Washington, Missouri at river mile 67.0. The site is contained within the floodplain, approximately 0.5 miles south of the Missouri River. Alluvium, or sediment deposited by flowing water, covers the entire site. To the south, the site is bordered by loess covered uplands or the River Hills landform.

Geologic structural features closest to the proposed site are the Eureka-House Springs anticline, Moselle normal fault and the Jeffreisburg fault. These features were formed as a result of periods of uplift in the Ozarks and seismic activity from the New Madrid fault system. The Eureka-House Springs anticline is located approximately 7 miles to the northeast. The Moselle normal fault is approximately 10 miles to the southwest. The Jeffreisburg fault is approximately 14 miles to the southwest. There is no literature indicating that these faults are currently active or have been active in the recent geologic past.

There do not appear to be any geologic issues that would preclude the construction of a UWL, such as recent fault, unstable ground or karst topography.

Preliminary Findings

The borings reveal alluvial deposits that are typical of the Missouri River floodplain. The general soil stratigraphy will support a gypsum stack that is 100 feet high, or higher. The upper (0 to 13.5 feet) strata contain suitable materials for construction of the perimeter berms, but may not have sufficient clays to construct the 2-foot composite liner and final cover. Other borrow areas probably will need to be identified.

The existing Explorer pipeline is a controlling factor in the plan of the UWL. We contacted Pat Nwakoby with Explorer Pipeline (918-493-5172) to discuss the possibility of relocating the pipeline. He said that Explorer would be willing to relocate a portion of the pipeline, if AmerenUE provides a new easement and pays the construction costs. He estimated that the cost to relocate the pipeline would be on the order of $250 per lineal foot.

The UWL would store WFGD gypsum utilizing the wet gypsum stack method similar to the UWL proposed for the Sioux Power Plant. The UWL would consist of a perimeter berm constructed using on-site soils or ash from the Labadie Power Plant. For this study, the berm was assumed to be 25 feet high and have a width at the crest of 12 feet. The exterior slope would be 3 horizontal to 1 vertical (3:1) and the interior slope would be about 2.4:1. The boundary of the wet gypsum stack would be coincident with the inside edge of the crest of the berm. The wet gypsum stack would extend to a total height of 100 feet above the existing ground surface. The side slopes of the wet gypsum stack would be 3:1. A recycle pond would be required to store all of the potential water discharge: decanted water from the top of the wet gypsum stack, seepage water from the interior consolidation of the stack, and all storm water. The recycle pond was assumed to be 25 feet deep, formed by the construction of a perimeter berm with the same geometry of the berm for the wet gypsum stack.

State regulations require that the boundary of the solid waste (i.e. the wet gypsum stack) shall be a minimum of 100 feet from an exterior property boundary or right-of-way. Also, the minimum distance from the outside edge of the perimeter berm to any utility (AmerenUE transmission lines or buried gas pipeline) was assumed to be 60 feet.

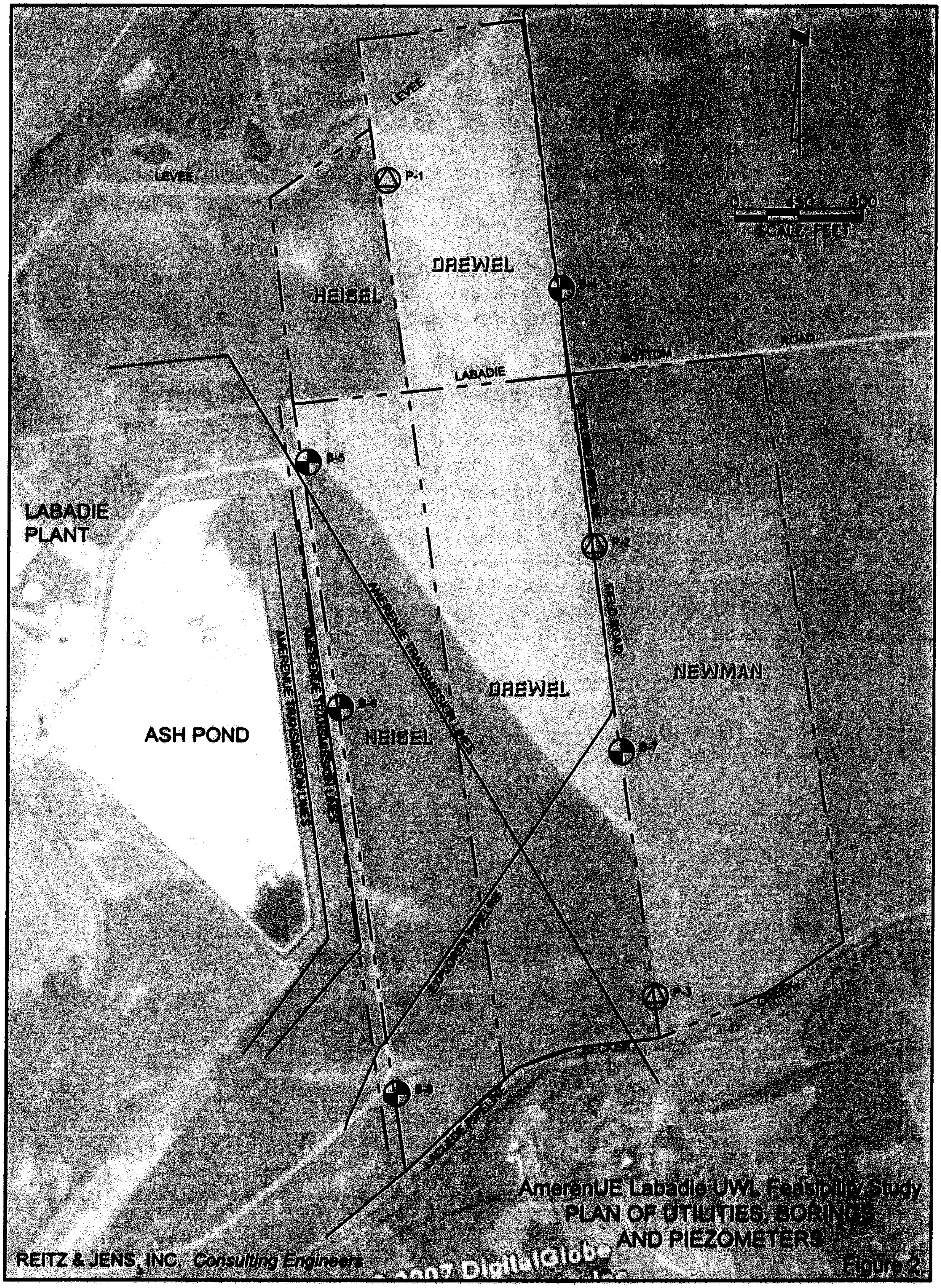
We computed the volume of the wet gypsum stack on the basis of three possible scenarios:

1. Assuming that the Explorer pipeline was not relocated, and that the Newman property was not acquired, then a single wet gypsum stack could be constructed as shown in Figure 3 (Stack 1). The recycle pond could be located west of the transmission line and north of the Explorer pipeline. The pond could have a footprint of 35 acres, and a volume of 472 acre-feet (to the top of the berm). The wet gypsum stack could have a footprint of 178 acres and a volume of 21.4 million cubic yards (CY). The land west of the transmission line and south of the Explorer pipeline is too small to contain a wet gypsum stack operation; however, a dry stack could be constructed with a volume of 1.7 million CY. The quantities of fill required for construction of the perimeter berms are approximately: 1) 900,000 CY for the Wet Gypsum Stack 1, 2) 500,000 CY for the recycle pond, and 3) 300,000 CY for the dry stack.

2. If the Newman property was acquired, then a second wet gypsum stack could be constructed, as shown in Figure 3 (Stack 2). The second stack could have a footprint of 138 acres, and a storage volume of 15.3 million CY. The total volume of gypsum storage of Stacks 1 & 2 would be 36.7 million CY. The quantity of fill required for the perimeter berm of Stack 2 is 800,000 CY.

3. If the Explorer pipeline was relocated to AmerenUE's right-of-way on the west side of Labadie Bottom Road as shown in Figure 4 and the Newman property was acquired, then a wet gypsum stack with a footprint of 328 acres could be constructed. The calculated volume of gypsum storage is 41.9 million CY, or 5.2 million CY greater than the volume of the two stacks shown in Figure 3. The quantity of fill required for the construction of the perimeter berm is 1,300,000 CY, or about 400,000 CY less than the fill required for the two stacks. About 8800 feet of pipeline would have to be relocated for the scheme shown in Figure 4, for an estimated cost of $2.2 million.

We are completing our feasibility study, which will include zoning requirements, floodplain, wetlands, and ground water issues. All of our data and findings, including the information in this preliminary report, will be summarized in our forthcoming report. Please contact us if you have any comments or questions which should be addressed in that report.



AmerenUE Labadie UWL Feasibility Study
PLAN OF UTILITIES, BORINGS
AND PIEZOMETERS

REITZ & JENS, INC. *Consulting Engineers*

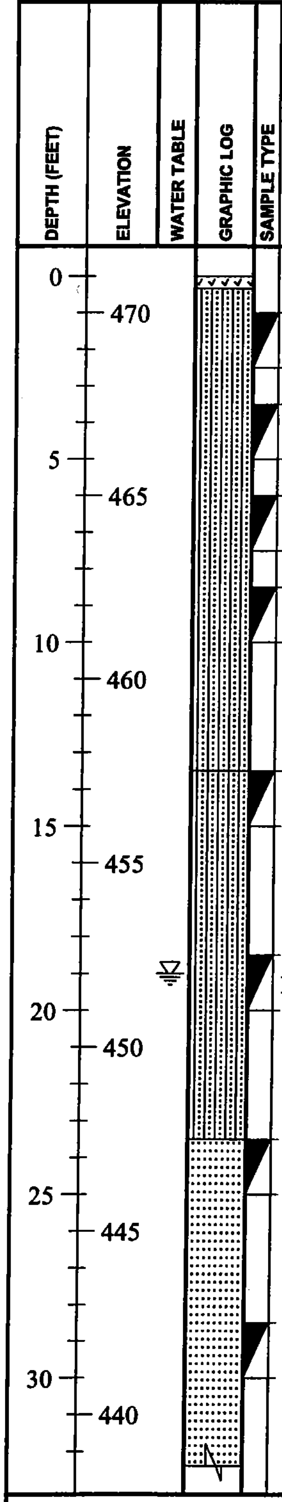
Figure 2

REITZ & JENS, INC.
CONSULTING ENGINEERS

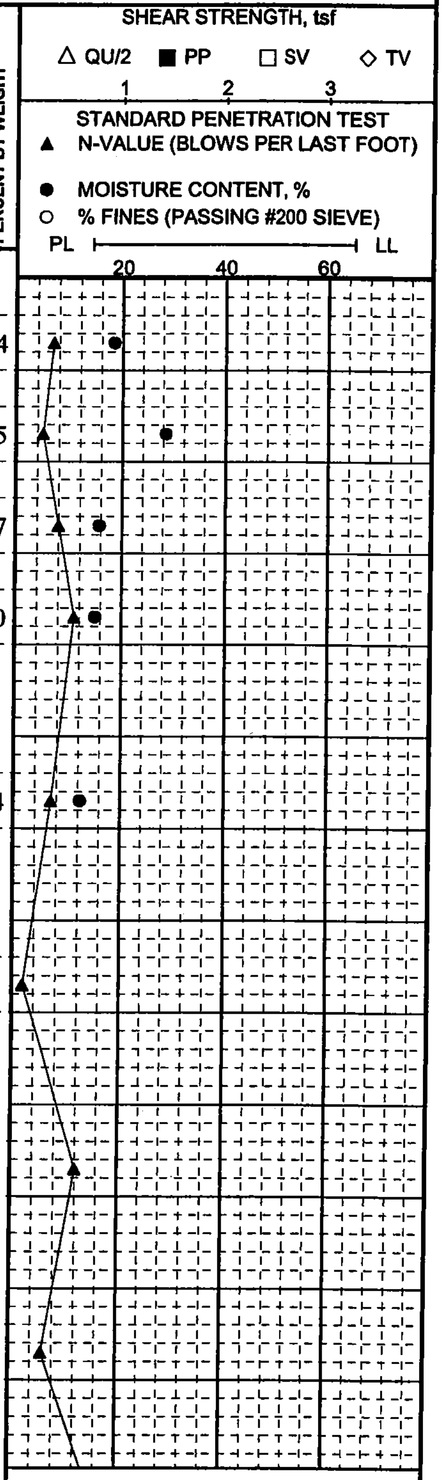
BORING LOG P-1

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 471 DATUM: U.S.G.S.
DATE DRILLED: 3-14-2007



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	TOPSOIL (4")		
83	Sandy SILT (ML), brown, loose, dry	3-4-3	18.4
78	Becoming grayish brown, less sandy, with clay laminations, moist	2-2-3	28.5
67	Becoming more sandy, medium-dense, dry	2-3-5	15.7
72	Becoming tan	3-5-6	15.0
89	Silty SAND (SP-SM), tan, fine, loose	3-3-4	12.4
100	Becoming gray, slightly silty, very loose, with clay balls, free water	1-1-1	
94	SAND (SP), tan, fine, medium-dense	3-5-7	
89	Becoming gray, fine- to medium-grain, with decaying wood, loose	3-2-4	



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 19 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT 30 FEET

File: 2007012401

BORING LOG P-1

AmerenUE Labadie Power Plant UWL

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
35	435				83	Becoming tan, fine- to coarse, medium- dense	6-8-10	
40	430				72	Becoming gray, fine- to medium-grain, dense, with decaying wood	10-15-10	
45	425				72	Without decaying wood	13-21-15	
50	420				39	SAND and GRAVEL (SP-GP), gray, dense, with clay balls and fragments of dolomite (up to 1.5") Very stiff drilling at 51' (heavy gravels and cobbles)	9-16-7	
55	415							
60	410				78	Becoming medium-dense, without clay and fragments of dolomite Very stiff drilling from 60.5' to 61.5' possible limestone cobbles or boulders	12-10-8	
65	405							
70	400				72		2-8-9	

SHEAR STRENGTH, tsf

△ QU/2 ■ PP ☐ SV ◇ TV

1 2 3

▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ├──┤ LL

20 40 60

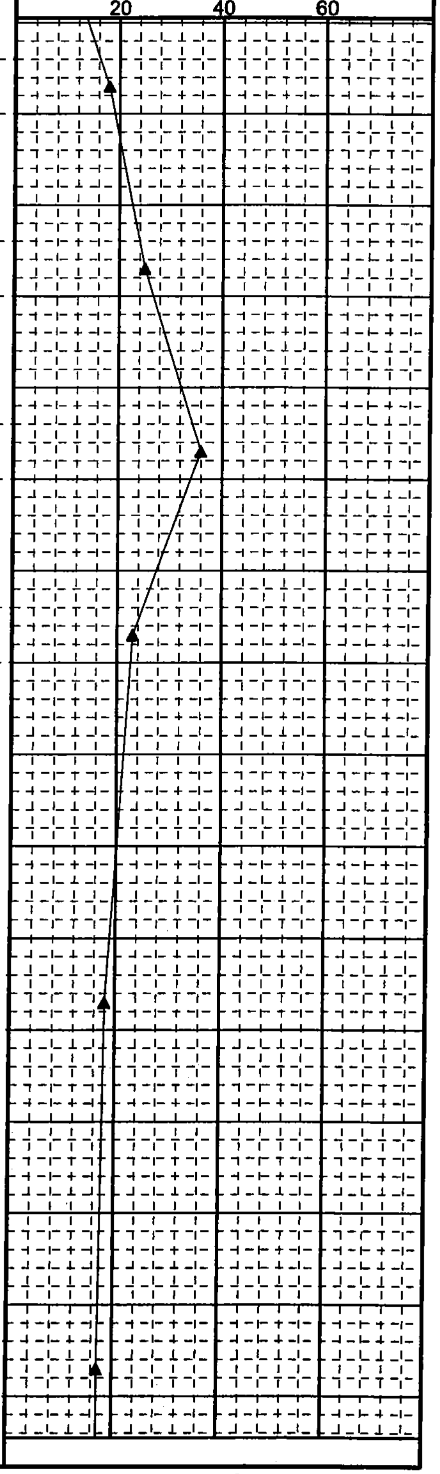


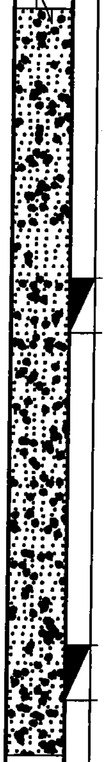
Figure A-1 Sheet 2 of 3

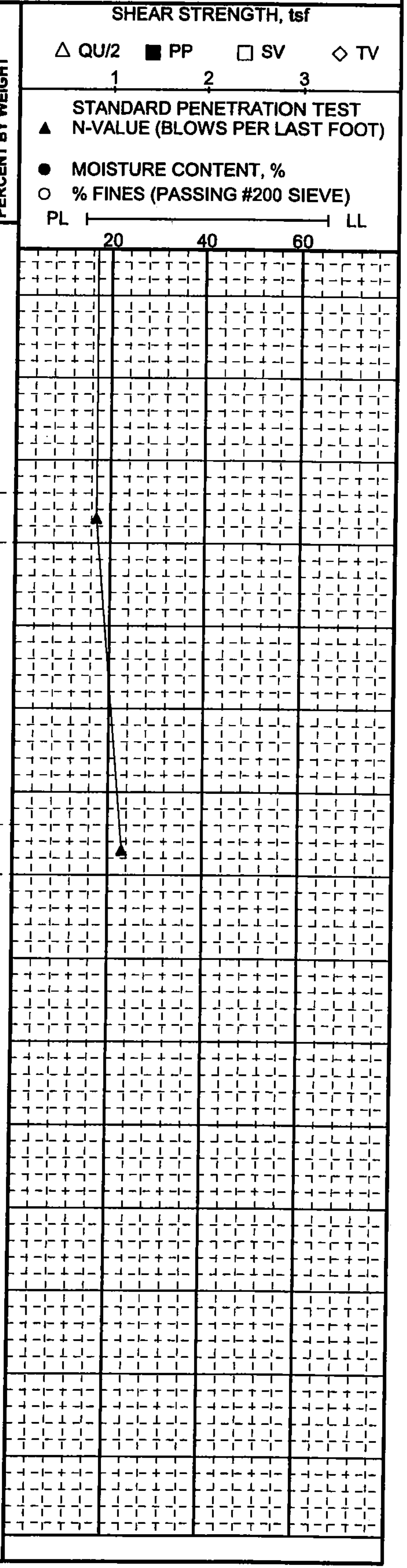
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-1

AmerenUE Labadie Power Plant UWL

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
						Very stiff drilling at 71', 73', and 77' to 78', possible cobbles or boulders		
75	395							
					44		7-8-9	
80	390					Very stiff drilling from 80' to 91.5' possible cobbles		
85	385							
					33	Becoming dense	10-11-12	
90	380							
						Boring terminated at 91'-6" in cobbles. Note: terminated boring due to very difficult drilling; rods were binding during advancement, near breaking point.		
95	375							
100	370							
105	365							





File: 2007012401

Figure A-1 Sheet 3 of 3

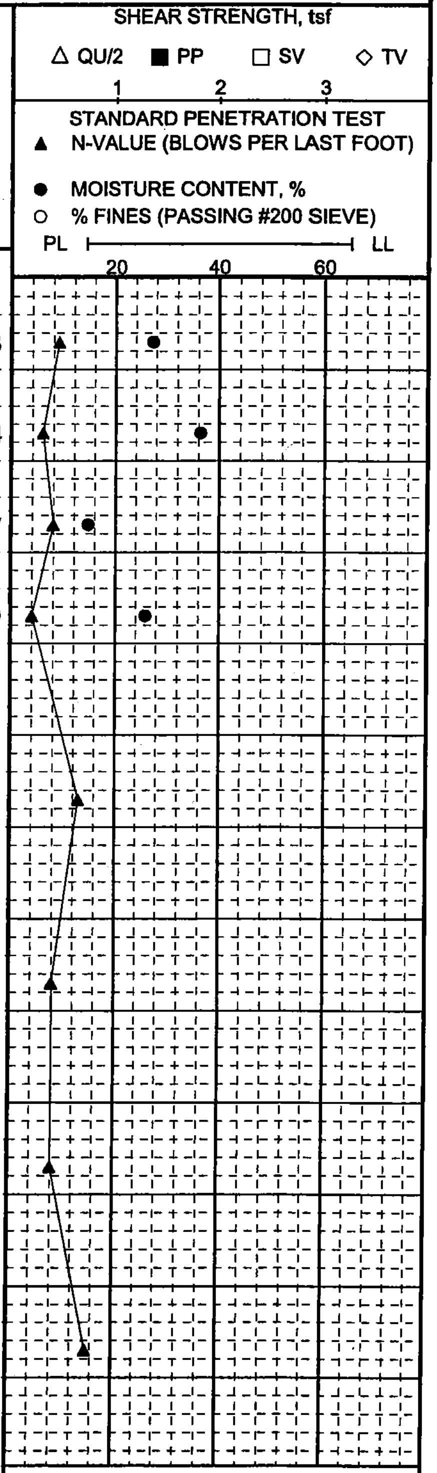
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-2

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 467 DATUM: U.S.G.S.
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0			TOPSOIL (5")		
	465	100	CLAY (CH), dark grayish brown, high plastic, moist, stiff	3-3-6	27.3
5		94	Becoming firm, with seams of grayish brown silt	3-3-3	36.4
	460	100	SILT (ML), tan, medium-dense, with fine sand, dry	3-4-4	14.7
10		89	Becoming loose, with traces of iron stains	2-1-3	25.9
	455				
15		100	SAND (SP), grayish tan, fine, medium- dense	4-6-7	
	450				
20		78	Becoming dark gray	1-3-5	
	445				
25		100	Becoming fine- to medium-grain	2-3-5	
	440				
30		100	Becoming fine to coarse	7-7-8	
	435		Boring terminated at 30'-0"		



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 14 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT 30 FEET

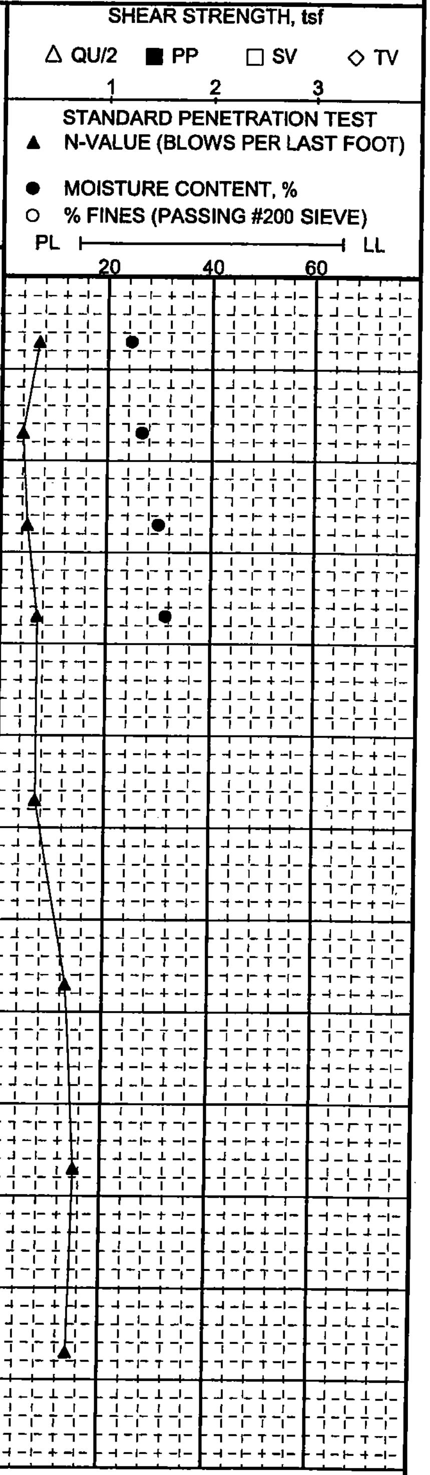
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-3

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 467 DATUM: U.S.G.S.
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						TOPSOIL (5")		
	465				78	CLAY (CH), dark gray, high plastic, with silt seams, moist, stiff	2-3-4	24.5
						SILT (ML), grayish tan, with fine sand		
5					94	Silty SAND (SP-SM), grayish tan, fine, loose	1-3-1	26.6
	460				100	With lenses of gray high plastic clay	1-1-4	29.9
10					100	With alternating layers of fine silty sand and high plastic clay	2-3-4	31.4
	455	▽						
15					83	SAND (SP), gray, fine, loose	2-4-3	
	450							
20					100	Becoming medium-dense	2-5-8	
	445							
25					100		5-7-8	
	440							
30					100		6-7-7	
						Boring terminated at 30'-0"		
	435							



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): ______
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 13.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT 30 FEET

File: 200701240l

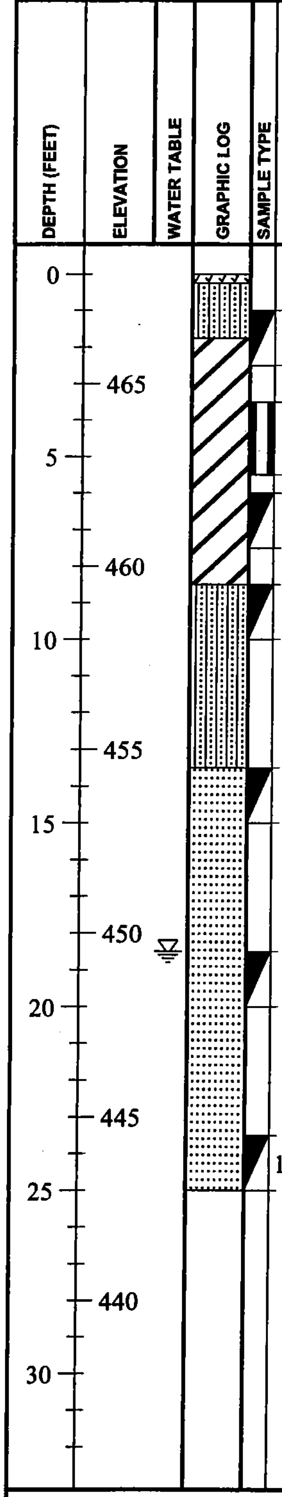
Figure A-3 Sheet 1 of 1

REITZ & JENS, INC.
CONSULTING ENGINEERS

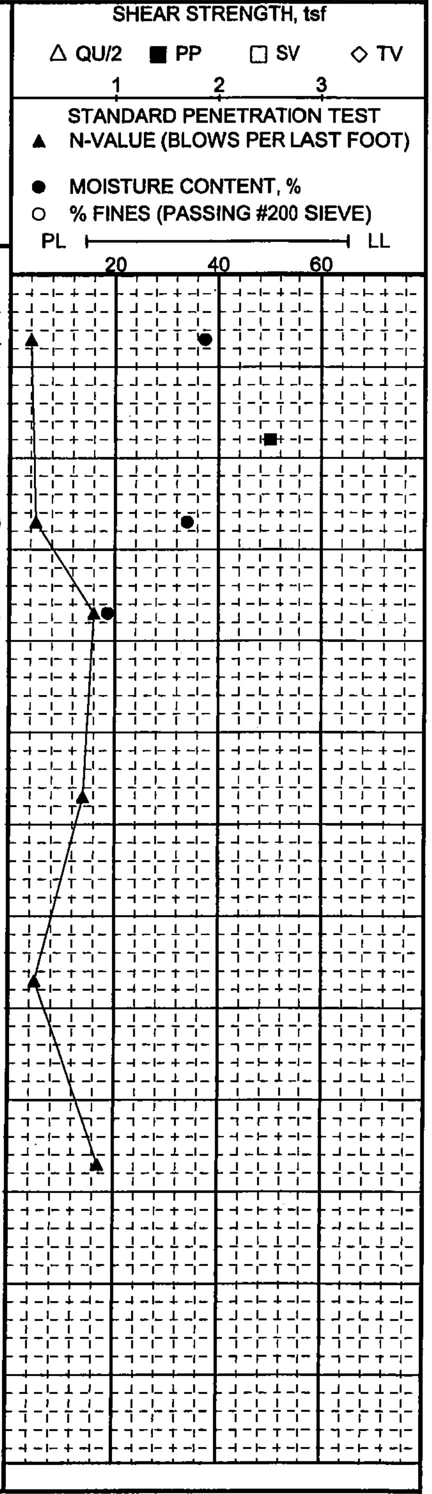
BORING LOG B-4

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 468 DATUM: U.S.G.S.
DATE DRILLED: 3-9-2007



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	TOPSOIL (3")		
78	Sandy SILT (ML-SM), tan, loose, wet	3-3-1	37.4
	CLAY (CH), grayish brown, high plastic, moist, soft		
100			
89	Becoming dry and firm	1-2-3	34.0
72	Sandy SILT (ML-SM), tan, medium-dense, moist	5-9-7	18.6
67	SAND (SP), tan, fine, medium-dense with organic clay balls	4-4-10	
89	Becoming tan and gray, fine- to medium-grain, loose	1-2-3	
100	Becoming medium-dense	4-7-10	
	Boring terminated at 25'-0"		



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 18.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

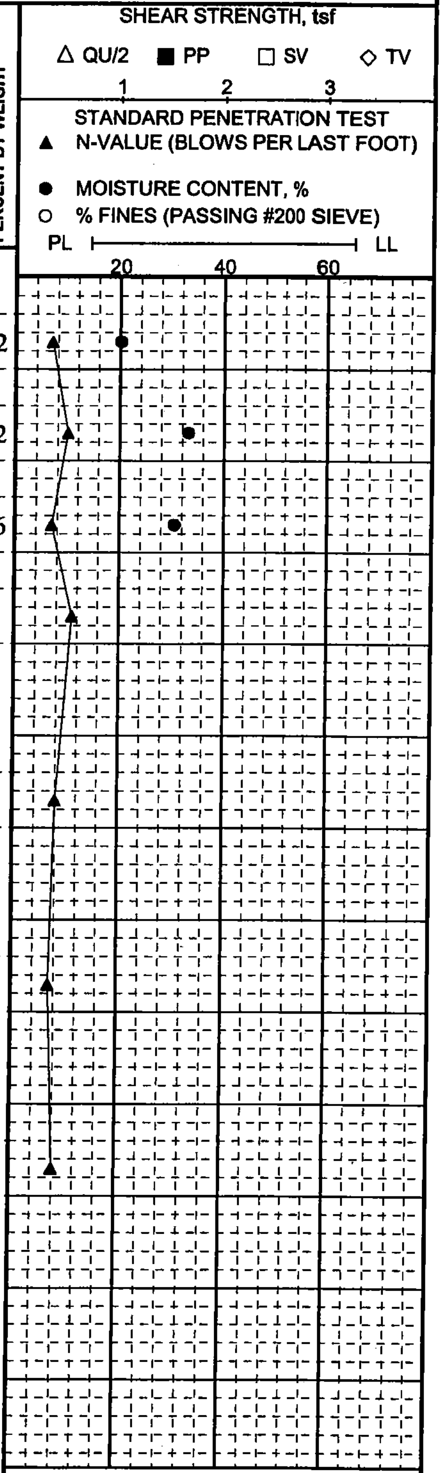
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-5

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 467 DATUM: U.S.G.S.
DATE DRILLED: 3-12-2007

PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	TOPSOIL (4")		
100	Silty CLAY (CL-CH), brown, moderately plastic, stiff, dry	2-3-4	20.2
78	CLAY (CH), grayish brown, high plastic, stiff, moist	2-4-6	33.2
94	With tan silty fine sand laminations	2-3-4	30.6
83	SAND (SP), tan, fine, medium-dense with sporatic clay balls	4-5-6	
72	Becoming grayish tan, without clay balls	3-4-4	
89		1-3-4	
100		1-4-4	
	Boring terminated at 25'-0"		



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 16.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2007012401

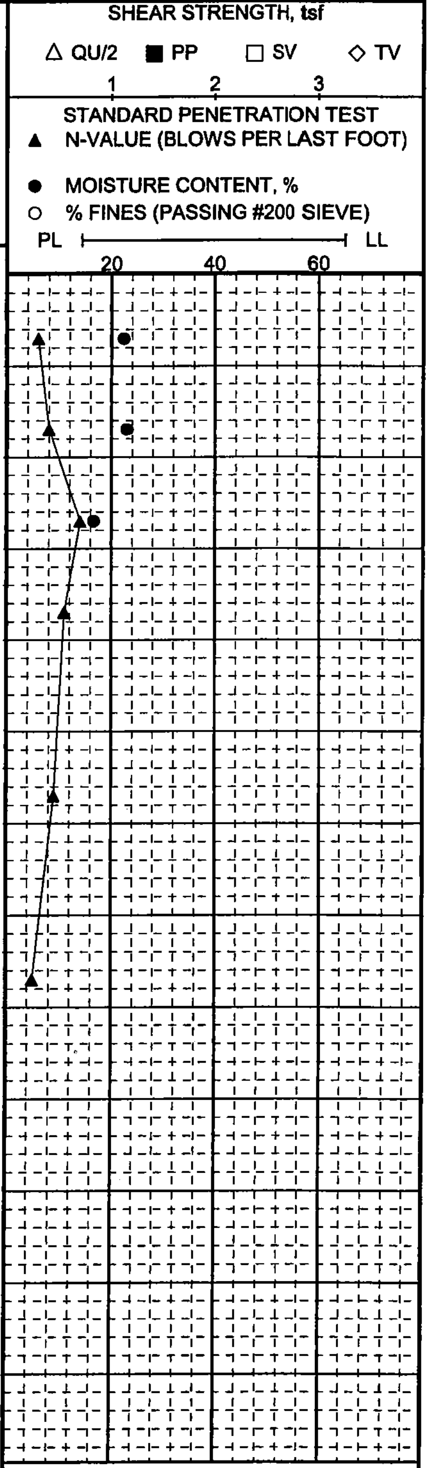
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-6

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 467 DATUM: U.S.G.S.
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						TOPSOIL (4")		
	465				61	CLAY (CH), grayish brown, high plastic, slightly silty, firm, dry	2-3-3	22.4
5					78	Sandy SILT (ML-SM), tan, medium-dense, becoming more sandy with depth	3-4-4	23.0
	460				94	With seams of dark grayish brown, stiff, high plastic clay	3-5-9	16.6
10					100	SAND (SP), tan, fine, medium-dense	6-6-5	
	455							
15					72	Becoming brown	3-4-5	
		▽						
	450							
20					78	Becoming loose	1-2-3	
						Boring terminated at 20'-0"		
	445							
25								
	440							
30								
	435							



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 16 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT __ FEET

File: 2007012401

Figure A-6 Sheet 1 of 1

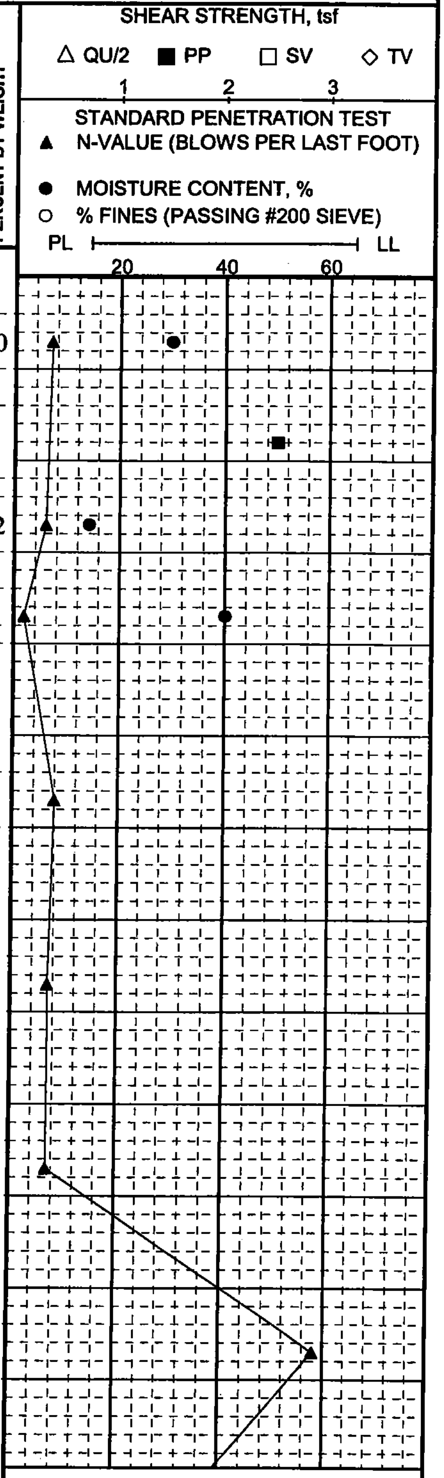
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-7

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 465 DATUM: U.S.G.S.
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465			TOPSOIL (4")		
			100	CLAY (CH), grayish brown, high plastic, with silty fine sand laminations, firm, moist	2-3-4	30.0
5	460		83			
			94	Becoming dry	1-2-4	14.2
10	455		100	Silty CLAY (CL), gray and tan, very soft, becoming more silty with depth, wet	1-1-1	40.1
15	450	▽	100	SAND (SP), gray, fine, slightly silty, medium-dense	1-4-4	
20	445		100	Becoming grayish tan and gray	2-2-5	
25	440		100	SAND and GRAVEL (GP-SP), grayish tan, fine sand to coarse gravel, medium-dense	3-2-5	
30	435		28	Becoming very dense, with less coarse gravel	23-30-28	



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): ____
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 14 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ____ FEET AFTER ____ HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT __ FEET

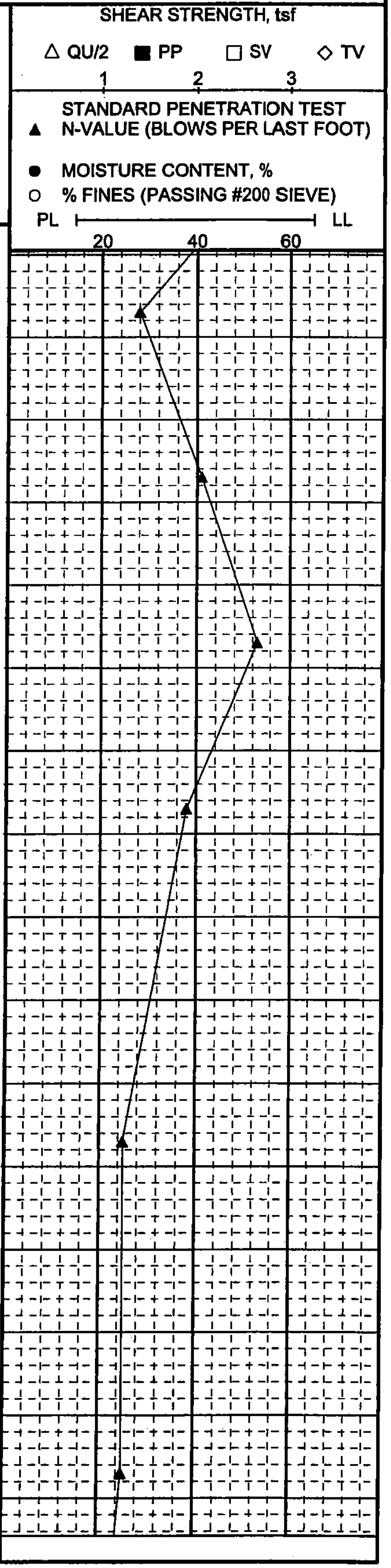
File: 2007012401

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-7

AmerenUE Labadie Power Plant UWL

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
35	430				78	Becoming dense with coarse gravel (up to 1")	17-15-13	
40	425				100	SAND (SP), gray, fine, very dense	10-17-24	
45	420				100		15-23-30	
50	415				89		14-19-19	
55	410							
60	405				94	SAND & GRAVEL (SP-GP), gray, coarse sand and fine gravel, dense	9-13-12	
65	400							
70	395				100	With medium gravel (to 3/8")	11-11-14	

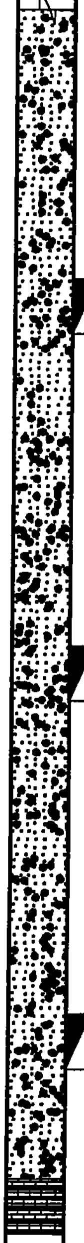


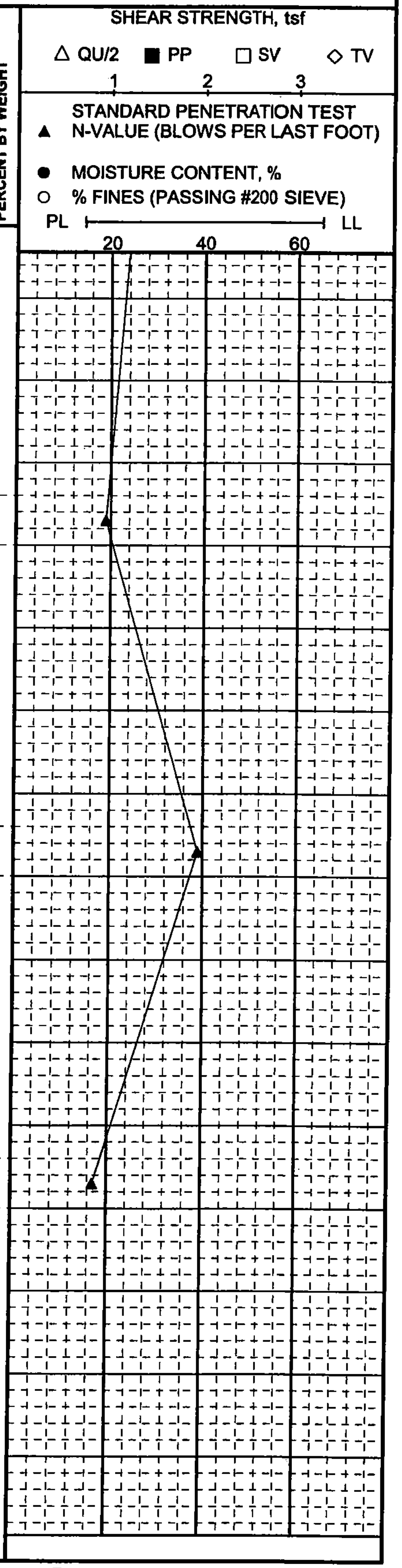
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-7

AmerenUE Labadie Power Plant UWL

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
75	390							
					100	Becoming medium-dense	9-9-10	
80	385							
85	380							
					89	Becoming very dense, with black shale fragments	11-19-20	
90	375							
95	370							
					78	Becoming medium-dense	8-9-8	
100	365							
						LIMESTONE, very weathered, soft		
105	360					Auger Refusal at 104'-6"		





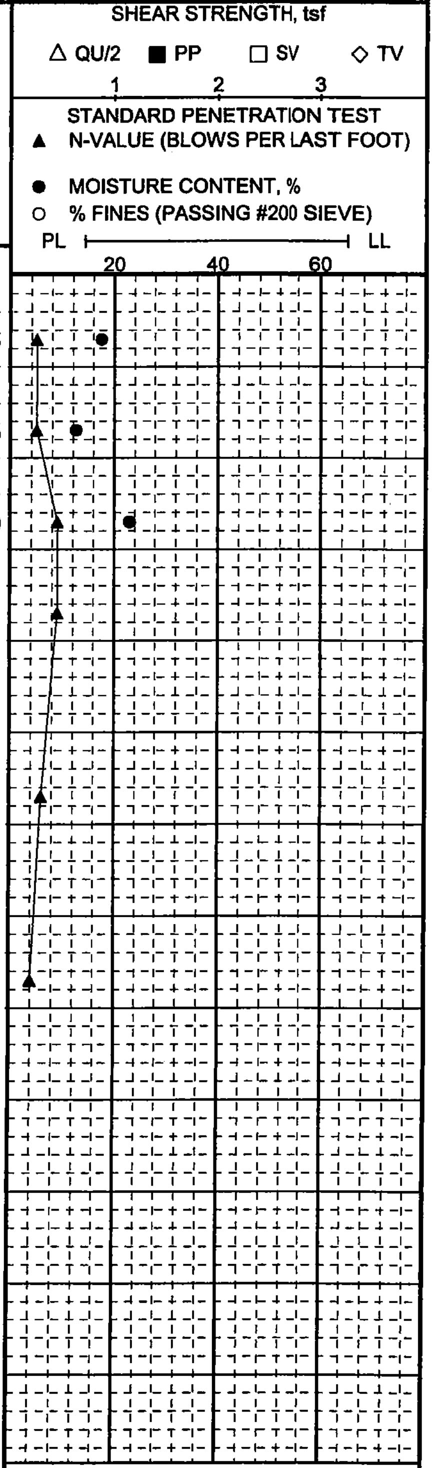
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-8

AmerenUE Labadie Power Plant UWL
Franklin County, Missouri
CLIENT: **Ameren Services**

LOCATION: N E
ELEVATION: 468 DATUM: U.S.G.S.
DATE DRILLED: 3-9-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				TOPSOIL (4")		
			83	Sandy SILT (ML-SM), gray and tan, loose, with seams of grayish brown high plastic clay, dry	2-2-3	17.5
	465					
			67		2-2-3	12.6
5						
			89	Becoming medium-dense, without clay seams, with fine sand laminations	3-5-4	23.0
	460					
			94	SAND (SP), tan, fine, medium-dense, with sporatic clay balls	3-5-4	
10						
	455					
			78	Becoming grayish brown, loose	2-3-3	
15						
		▽				
	450					
			94	Becoming very loose	1-1-3	
20				Boring terminated at 20'-0"		
	445					
25						
	440					
30						



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): ______
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 17.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

KEY TO BORING LOGS

KEY TO SOIL SYMBOLS

Symbol	Description
▒	Topsoil
▥	Silty SAND or Sandy SILT (SM)
░	Poorly-graded SAND (SP)
▓	Poorly-graded SAND & GRAVEL (GP)
▨	High plastic CLAY (CH)
▥	Inorganic, non-plastic SILT (ML)
▨	Medium to high plastic CLAY
▧	Low plastic Silty CLAY (CL)
▤	Very Weathered LIMESTONE

MISCELLANEOUS SYMBOLS

▽	Water table during drilling
—∿—	Boring continues

Symbol	Description
●	Moisture content (%)
▲	N-value from Standard Penetration Test (blows/ft)
■	Shear strength from Pocket Penetrometer (tsf)

SOIL SAMPLERS

◪	2-in. O.D. Split-Spoon
▯	3-in. O.D. Shelby Tube

Notes:

1. Borings were drilled March 9 - 14, 2007, by Midwest Drilling, Inc. The borings were advanced using continuous flight augers (CFA) to below the water table, and then with mud rotary drilling techniques using Bentonite slurry.

2. Boring locations were selected and located by Reitz and Jens, Inc.

3. Borings were logged in the field by a Reitz & Jens' soils technician based upon the recovered samples, cuttings and drilling characteristics. Samples were transported to Reitz & Jens' lab for testing. Field logs were revised, if needed, based upon laboratory classification and testing.

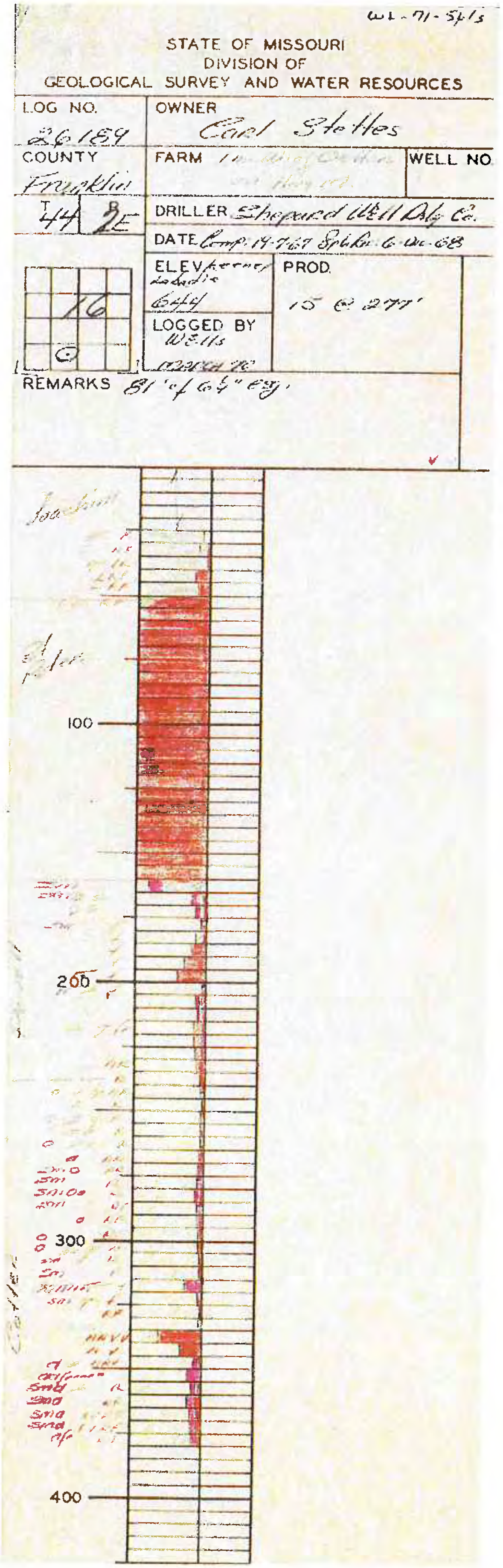
4. Stratification lines shown on the log represent approximate soil boundaries; actual changes in strata may be gradual or occur between samples.

5. Piezometers were installed in Borings labeled P-1, P-2, and P-3.

Figure A-0

APPENDIX 5

Well Log Record Data



WL-71-54/s

STATE OF MISSOURI
DIVISION OF
GEOLOGICAL SURVEY AND WATER RESOURCES

LOG NO. 26189

OWNER Carl Stettes

COUNTY Franklin

FARM [illegible]

WELL NO.

T 44 R 2E

DRILLER Shepard Well Drlg Co.

DATE Comp. 14-7-67 Spl. Rec. 6-Dec-68

ELEV Aneroid 644

PROD. 15 @ 277'

LOGGED BY Wells

16

REMARKS 81' of 6¼" csg.

Wr-4r-3/13

STATE OF MISSOURI
DIVISION OF
GEOLOGICAL SURVEY AND WATER RECOURCES

LOG NO. 24661

OWNER J. Kopsky

COUNTY Franklin

FARM

WELL NO

T 44 N

R 2 E

DRILLER Shepard

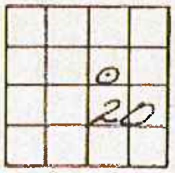
DATE 6-9-66

ELEV. Land 591

PROD. 22 gpm @ 196'
44 gpm @ bottom

LOGGED BY K. Anderson

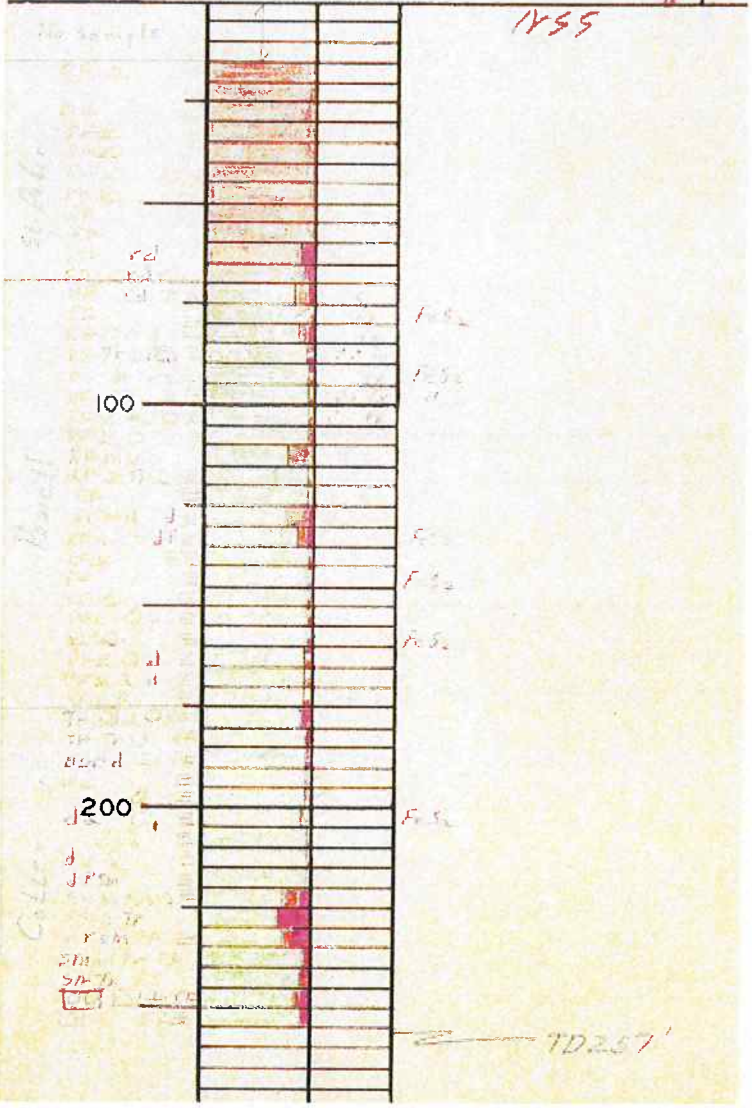
INDEX SHEET NO.



REMARKS 97' of 6¼" csg.

2 mi E of Labadie

1NSS



WL

MISSOURI BUREAU OF GEOLOGY & MINES, ROLLA, MO.

MO SURVEY Nº 3211	OWNER Franklin County Distillery	
COUNTY Franklin	FARM Fee	WELL Nº 1
T 44N R 2E	DRILLER C. W. Haverstick	
20	DATE March 1934	
	ELEVATION 534 PA (NH)	PRODUCTION Acidized in July 1948
	SAMPLES STUDIED Charles D. Gleason. Farrar	

REMARKS Samples stored for long period after drilling. Numbers obliterated on many of the sacks, hence only a part of the well was made up.

original [illegible] 80'
[illegible] 125'
after acidizing 60'
[illegible] 75'

100 gpm, 15' dd

specific capacity 6.7 gpm/ft

SAMPLES SAVED

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
(573) 368-2165

HIGH YIELD AND PUBLIC WELL RECORD AND PUMP INFORMATION DATA

REF NO 00066803
CR NO
DATE RECEIVED 11/14/1991
STATE CERT NO APPROVED DATE A023115
CHECK NO. 26228
DATE ENTERED PHASE 1 PHASE 2 PHASE 3 11/21/1991 01/01/1000 12/28/2005
ROUTE PLT / PCD
REVENUE NO. 661637

INFORMATION SUPPLIED BY WELL OR PUMP INSTALLATION CONTRACTOR

DNR VARIANCE NUMBER ____________
CASING DEPTH NUMBER ____________
Applicable only if casing depth or variance were obtained from DNR

OWNER NAME ST ALBANS COUNTRY CLUB
TELEPHONE (OPTIONAL) 000-742-4654

OWNER ADDRESS ST ALBANS RD
CITY ST ALBANS
STATE MO
ZIP 63073

ADDRESS OF WELL (IF DIFFERENT THAN ABOVE)
CITY
STATE MO
ZIP

PROPOSED USE OF WELL **SEE BACK OF FORM FOR WELL CLASSIFICATIONS**

☒ Water Supply for Irrigation (capable of producing more than 70 gpm to surface)
Unconsolidated Material Well ☐ Bedrock Well ☐
☐ Water Supply for a High-Capacity Well capable of producing more than 70 gpm to surface - get casing depth from GSRAD before start
☐ Open Loop Heat Pump
Supply Well ☐ Return Well ☐
☐ Water Supply to a Public Facility (convenience store, restaurant, church, business, condo, mobile home park, rural or urban water supply)
CONTACT THE DNR REGIONAL OFFICE to get instructions for water supply to a PUBLIC FACILITY

CASING DETAILS

CASING LENGTH 55 FT.
O.D. OF CASING 18.0 IN.
DIAMETER OF DRILL HOLE 42.0 IN.
CASING MATERIAL ☒ STEEL ☐ PLASTIC ☐ CONCRETE
POSITION OF GROUT SEAL ☐ BOTTOM ☒ FULL LENGTH ☐ TOP

COPY

CASING GROUT MATERIAL
CEMENT ☐ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS
☐ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☐ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
PRESSURE GROUT ☐ THROUGH CASING ☐ THROUGH TREMIE
DRILLING SUSPENDED ☒ NO ☐ YES 0 HRS
NO. OF SACKS USED 0.0
POUNDS PER SACK ____________

LINER DETAILS

LENGTH 0 FT.
O.D. OF LINER 0.0 IN.
LINER MATERIAL ☐ STEEL ☐ PLASTIC
POSITION OF SEAL ☐ FULL LENGTH ☐ BOTTOM ☐ TOP

LINER GROUT MATERIAL
CEMENT ☐ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS
☐ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☐ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
LINER USED TO: ☐ HOLD BACK FORMATION ☐ SEAL OUT UNDESIREABLE AQUIFER CONDITIONS ☐ PREVENT RUST
NO. OF SACKS USED 0.0
POUNDS PER SACK ____________
ABANDONED WELL ON SITE? ☒ YES
PLUGGED? ☒ YES

LOCATION OF WELL

LAT. 38 ° 35' 28.2"
LONG. 90 ° 46' 54.6"
COUNTY FRANKLIN

Please be aware that we do not guarantee the accuracy of the data. It is submitted to us by a third party and has not been field verified.

DEPTH TO FIRST GROUNDWATER 0.0 FEET
WELL YIELD 1150.0 GPM
STATIC WATER LEVEL 13.0 FEET
WELL COMPLETION DATE 09/19/1991

PUMP RATE 1000.0 GPM
PUMP SET DEPTH 61.0 FEET
PUMP INSTALLATION DATE
pump info required this record or on pump card

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION

DEPTH TO BEDROCK 0.0 FEET
TOTAL DEPTH 95.0 FEET

(OPTIONAL) ELEVATION 456 FT.
LEGAL LOCATION (OPTIONAL) SW 1/4 NE 1/4 SE 1/4
SEC. 3 TWN. 44 RNG. 2 E
AREA A1
C DATA REQ'D ☐

OTHER INFORMATION OR LOCATION DATA (OPTIONAL)

I HEREBY CERTIFY THE WELL/PUMP INFORMATION DESCRIBED HEREIN IS TRUE AND ACCURATE

PRIMARY CONTRACTOR SIGNATURE DANIEL FLYNN	PERMIT NUMBER 001120	DATE
WELL DRILLER SIGNATURE DANIEL FLYNN	PERMIT NUMBER 001120	DATE
PUMP INSTALLER SIGNATURE DANIEL FLYNN	PERMIT NUMBER 001120	DATE
APPRENTICE DRILLER SIGNATURE	PERMIT NUMBER	DATE
APPRENTICE PUMP SIGNATURE	PERMIT NUMBER	DATE

MISSOURI DEPARTMENT OF
NATURAL RESOURCES
DIVISION OF
ENVIRONMENTAL QUALITY
(573) 368-2165

HIGH YIELD AND PUBLIC WELL RECORD AND PUMP INFORMATION DATA

REF NO 00309286
CR NO
DATE RECEIVED 04/19/2004
STATE CERT NO APPROVED DATE A123149 05/04/2004
CHECK NO. 35610
DATE ENTERED PHASE 1 PHASE 2 PHASE 3 04/19/2004 04/23/2004 04/23/2004
ROUTE PCD
REVENUE NO. 041904

INFORMATION SUPPLIED BY WELL OR PUMP INSTALLATION CONTRACTOR

DNR VARIANCE NUMBER ____________
CASING DEPTH NUMBER ____________
Applicable only if casing depth or variance were obtained from DNR

OWNER NAME
CAPITOL SAND

TELEPHONE (OPTIONAL)
573-634-3020

OWNER ADDRESS 700 MOKANE RD BOX 104990
CITY JEFFERSON CITY
STATE MO
ZIP 69110

ADDRESS OF WELL (IF DIFFERENT THAN ABOVE) WASHINGTON MO
CITY
STATE MO
ZIP

PROPOSED USE OF WELL **SEE BACK OF FORM FOR WELL CLASSIFICATIONS**

☒ Water Supply for Irrigation (capable of producing more than 70 gpm to surface)
Unconsolidated Material Well ☐ Bedrock Well ☐
☐ Water Supply for a High-Capacity Well capable of producing more than 70 gpm to surface - get casing depth from GSRAD before start
☐ Open Loop Heat Pump
Supply Well ☐ Return Well ☐
☐ Water Supply to a Public Facility (convenience store, restaurant, church, business, condo, mobile home park, rural or urban water supply)
CONTACT THE DNR REGIONAL OFFICE to get instructions for water supply to a PUBLIC FACILITY

CASING DETAILS

CASING LENGTH 70 FT. O.D. OF CASING 16.0 IN. DIAMETER OF DRILL HOLE 30.0 IN.
CASING MATERIAL ☐ STEEL ☒ PLASTIC ☐ CONCRETE
POSITION OF GROUT SEAL ☐ BOTTOM ☐ FULL LENGTH ☒ TOP

COPY

CASING GROUT MATERIAL
CEMENT ☒ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS ☐ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☒ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
PRESSURE GROUT ☐ THROUGH CASING ☐ THROUGH TREMIE
DRILLING SUSPENDED ☒ NO ☐ YES 0 HRS
NO. OF SACKS USED 0.0 POUNDS PER SACK 94

LINER DETAILS

LENGTH 0 FT. O.D. OF LINER 0.0 IN.
LINER MATERIAL ☐ STEEL ☐ PLASTIC
POSITION OF SEAL ☐ FULL LENGTH ☐ BOTTOM ☐ TOP

LINER GROUT MATERIAL
CEMENT ☐ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS ☐ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☐ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
LINER USED TO: ☐ HOLD BACK FORMATION ☐ SEAL OUT UNDESIREABLE AQUIFER CONDITIONS ☐ PREVENT RUST
NO. OF SACKS USED 0.0 POUNDS PER SACK ______
ABANDONED WELL ON SITE? ☐ YES PLUGGED? ☐ YES

LOCATION OF WELL

LAT. 0 ° 0' 0.0"
LONG. 0 ° 0' 0.0"
COUNTY FRANKLIN

Please be aware that we do not guarantee the accuracy of the data. It is submitted to us by a third party and has not been field verified.

DEPTH TO FIRST GROUNDWATER 0.0 FEET
WELL YIELD 2000.0 GPM
STATIC WATER LEVEL 10.0 FEET
WELL COMPLETION DATE 03/20/2004

PUMP RATE 1800.0 GPM
PUMP SET DEPTH 65.0 FEET
PUMP INSTALLATION DATE
pump info required this record or on pump card

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0	3	FILL
3	7	SILT
7	70	CRSE SND;SH @70

DEPTH TO BEDROCK 0.0 FEET
TOTAL DEPTH 70.0 FEET

(OPTIONAL) ELEVATION 0 FT.
LEGAL LOCATION (OPTIONAL) ____ 1/4 ____ 1/4 ____ 1/4
SEC. 0 TWN. 44 RNG. 1 E
AREA A1
C DATA REQ'D ☐

OTHER INFORMATION OR LOCATION DATA (OPTIONAL)

I HEREBY CERTIFY THE WELL/PUMP INFORMATION DESCRIBED HEREIN IS TRUE AND ACCURATE

PRIMARY CONTRACTOR SIGNATURE GARY SISK	PERMIT NUMBER 002032	DATE
WELL DRILLER SIGNATURE GARY SISK	PERMIT NUMBER 002032	DATE
PUMP INSTALLER SIGNATURE GARY SISK	PERMIT NUMBER 002032	DATE
APPRENTICE DRILLER SIGNATURE	PERMIT NUMBER	DATE
APPRENTICE PUMP SIGNATURE	PERMIT NUMBER	DATE

MISSOURI DEPARTMENT OF
NATURAL RESOURCES
DIVISION OF
ENVIRONMENTAL QUALITY
(573) 368-2165

HIGH YIELD AND PUBLIC WELL RECORD AND PUMP INFORMATION DATA

REF NO 00236293
CR NO
DATE RECEIVED 05/23/2000
STATE CERT NO A088661 APPROVED DATE 07/25/2000
CHECK NO. 39457
DATE ENTERED PHASE 1 PHASE 2 PHASE 3
05/31/2000 01/01/1000 07/25/2000
ROUTE PCD
REVENUE NO. 052400

INFORMATION SUPPLIED BY WELL OR PUMP INSTALLATION CONTRACTOR

DNR VARIANCE NUMBER ____________
CASING DEPTH NUMBER ____________
Applicable only if casing depth or variance were obtained from DNR

OWNER NAME
CHARLES WEDEMIER
TELEPHONE (OPTIONAL)

OWNER ADDRESS 1566 FIDDLE RD
CITY LABADIE
STATE MO
ZIP 63055

ADDRESS OF WELL (IF DIFFERENT THAN ABOVE)
CITY
STATE MO
ZIP

PROPOSED USE OF WELL **SEE BACK OF FORM FOR WELL CLASSIFICATIONS**

☒ Water Supply for Irrigation (capable of producing more than 70 gpm to surface)
Unconsolidated Material Well ☐ Bedrock Well ☐
☐ Water Supply for a High-Capacity Well capable of producing more than 70 gpm to surface - get casing depth from GSRAD before start
☐ Open Loop Heat Pump
Supply Well ☐ Return Well ☐
☐ Water Supply to a Public Facility (convenience store, restaurant, church, business, condo, mobile home park, rural or urban water supply)
CONTACT THE DNR REGIONAL OFFICE to get instructions for water supply to a PUBLIC FACILITY

CASING DETAILS

CASING LENGTH 62 FT.
O.D. OF CASING 6.6 IN.
DIAMETER OF DRILL HOLE 10.63IN.
CASING MATERIAL ☒ STEEL ☐ PLASTIC ☐ CONCRETE
POSITION OF GROUT SEAL ☐ BOTTOM ☐ FULL LENGTH ☒ TOP

CASING GROUT MATERIAL
CEMENT ☐ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS ☒ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☒ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
PRESSURE GROUT ☐ THROUGH CASING ☐ THROUGH TREMIE
DRILLING SUSPENDED ☒ NO ☐ YES 0 HRS
NO. OF SACKS USED 11.0
POUNDS PER SACK 50

COPY

LINER DETAILS

LENGTH 0 FT.
O.D. OF LINER 0.0 IN.
LINER MATERIAL ☐ STEEL ☐ PLASTIC
POSITION OF SEAL ☐ FULL LENGTH ☐ BOTTOM ☐ TOP

LINER GROUT MATERIAL
CEMENT ☐ TYPE 1 ☐ HI-EARLY
BENTONITE ☐ SLURRY ☐ CHIPS ☐ GRANULAR ☐ PELLETS
METHOD OF GROUT INSTALLATION ☐ GRAVITY ☐ OPEN HOLE ☐ POS. DISPLACEMENT ☐ TREMIE
LINER USED TO: ☐ HOLD BACK FORMATION ☐ SEAL OUT UNDESIREABLE AQUIFER CONDITIONS ☐ PREVENT RUST
NO. OF SACKS USED 0.0
POUNDS PER SACK ____________
ABANDONED WELL ON SITE? ☐ YES
PLUGGED? ☐ YES

LOCATION OF WELL

LAT. 38° 32' 12.8"
LONG. 90° 46' 49.9"
COUNTY FRANKLIN

Please be aware that we do not guarantee the accuracy of the data. It is submitted to us by a third party and has not been field verified.

DEPTH TO FIRST GROUNDWATER 0.0 FEET
WELL YIELD 75.0 GPM
STATIC WATER LEVEL 24.0 FEET
WELL COMPLETION DATE 05/18/2000
PUMP RATE 20.0 GPM
PUMP SET DEPTH 43.0 FEET
PUMP INSTALLATION DATE
pump info required this record or on pump card

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0	32	CLY
32	48	SLTY CLY
48	62	SND/GRVL

DEPTH TO BEDROCK 0.0 FEET
TOTAL DEPTH 62.0 FEET

(OPTIONAL) ELEVATION 520 FT.
LEGAL LOCATION (OPTIONAL) SW 1/4 SW 1/4 SE 1/4
SEC. 22 TWN. 44 RNG. 2 E
AREA A1
C DATA REQ'D ☐

OTHER INFORMATION OR LOCATION DATA (OPTIONAL)

I HEREBY CERTIFY THE WELL/PUMP INFORMATION DESCRIBED HEREIN IS TRUE AND ACCURATE

PRIMARY CONTRACTOR SIGNATURE	PERMIT NUMBER	DATE
WELL DRILLER SIGNATURE RON HEATH	PERMIT NUMBER 001597	DATE
PUMP INSTALLER SIGNATURE JAMES WEBER	PERMIT NUMBER 001049	DATE
APPRENTICE DRILLER SIGNATURE	PERMIT NUMBER	DATE
APPRENTICE PUMP SIGNATURE	PERMIT NUMBER	DATE

APPENDIX 6

Standard for Piezocone Penetration Testing of Soils

ASTM D 5778-07

Designation: D 5778 – 07

Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils[1]

This standard is issued under the fixed designation D 5778; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers the procedure for determining the point resistance during penetration of a conical-shaped penetrometer as it is advanced into subsurface soils at a steady rate.

1.2 This test method is also used to determine the frictional resistance of a cylindrical sleeve located behind the conical point as it is advanced through subsurface soils at a steady rate.

1.3 This test method applies to friction-cone penetrometers of the electric and electronic type. Field tests using mechanical-type penetrometers are covered elsewhere by Test Method D 3441.

1.4 This test method can be used to determine porewater pressures developed during the penetration, thus termed piezocone. Porewater pressure dissipation, after a push, can also be monitored for correlation to time rate of consolidation and permeability.

1.5 Additional sensors, such as inclinometer, seismic geophones, resistivity, electrical conductivity, dielectric, and temperature sensors, may be included in the penetrometer to provide useful information. The use of an inclinometer is highly recommended since it will provide information on potentially damaging situations during the sounding process.

1.6 Cone penetration test data can be used to interpret subsurface stratigraphy, and through use of site specific correlations, they can provide data on engineering properties of soils intended for use in design and construction of earthworks and foundations for structures.

1.7 The values stated in SI units are to be regarded as standard. Within Section 13 on Calculations, SI units are considered the standard. Other commonly used units such as the inch-pound system are shown in brackets. The various data reported should be displayed in mutually compatible units as agreed to by the client or user. Cone tip projected area is commonly referred to in square centimetres for convenience. The values stated in each system are not equivalents; therefore, each system must be used independently of the other.

NOTE 1—This test method does not include hydraulic or pneumatic penetrometers. However, many of the procedural requirements herein could apply to those penetrometers. Also, offshore/marine CPT systems may have procedural differences because of the difficulties of testing in those environments (for example, tidal variations, salt water, waves). Mechanical CPT systems are covered under Test Method D 3441.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 3441 Test Method for Mechanical Cone Penetration Tests of Soil

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

E 4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology Convention (D 653).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent load transfer*—apparent resistance measured on either the cone or friction sleeve of an electronic cone penetrometer while that element is in a no-load condition but the other element is loaded. Apparent load transfer is the sum of cross talk, subtraction error, and mechanical load transfer.

3.2.2 *baseline*—a set of zero load readings, expressed in terms of apparent resistance, that are used as reference values during performance of testing and calibration.

3.2.3 *cone tip*—the conical point of a cone penetrometer on which the end bearing component of penetration resistance is developed. The cone has a 60° apex angle, a diameter of 35.7

---

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Nov. 1, 2007. Published December 2007. Originally approved in 1995. Last previous edition approved in 2000 as D 5778 – 95 (2000).

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

mm, and a corresponding projected (horizontal plane) surface area or cone base area of 10 cm^2. Also, enlarged cones of 43.7 mm diameter (base area = 15 cm^2) are utilized.

3.2.4 *cone penetration test*—a series of penetration readings performed at one location over the entire vertical depth when using a cone penetrometer. Also referred to as a cone sounding.

3.2.5 *cone penetrometer*—a penetrometer in which the leading end of the penetrometer tip is a conical point designed for penetrating soil and for measuring the end-bearing component of penetration resistance.

3.2.6 *cone resistance,* q_c—the measured end-bearing component of penetration resistance. The resistance to penetration developed on the cone is equal to the vertical force applied to the cone divided by the cone base area.

3.2.7 *corrected total cone resistance,* q_t—tip resistance corrected for water pressure acting behind the tip (see 13.2.1). Correction for water pressure requires measuring water pressures with a piezocone element positioned behind the tip at location u_2 (See section 3.2.26). The correction results in estimated total tip resistance, q_t.

3.2.8 *cross talk*—an apparent load transfer between the cone and the friction sleeve caused by interference between the separate signal channels.

3.2.9 *electronic cone penetrometer*—a friction cone penetrometer that uses force transducers, such as strain gauge load cells, built into a non-telescoping penetrometer tip for measuring, within the penetrometer tip, the components of penetration resistance.

3.2.10 *electronic piezocone penetrometer*—an electronic cone penetrometer equipped with a low volume fluid chamber, porous element, and pressure transducer for determination of porewater pressure at the porous element soil interface.

3.2.11 *end bearing resistance*—same as cone resistance or tip resistance, q_c.

3.2.12 *equilibrium pore water pressure,* u_0—at rest water pressure at depth of interest. Same as hydrostatic pressure (see Terminology D 653).

3.2.13 *excess pore water pressure,* Δu—the difference between porewater pressure measured as the penetration occurs (u), and estimated equilibrium porewater pressure (u_0), or: $\Delta u = (u - u_0)$. Excess porewater pressure can either be positive or negative for shoulder position filters.

3.2.14 *friction cone penetrometer*—a cone penetrometer with the capability of measuring the friction component of penetration resistance.

3.2.15 *friction ratio,* R_f—the ratio of friction sleeve resistance, f_s, to cone resistance, q_c, measured at where the middle of the friction sleeve and cone point are at the same depth, expressed as a percentage.

3.2.16 *friction reducer*—a narrow local protuberance on the outside of the push rod surface, placed at a certain distance above the penetrometer tip, that is provided to reduce the total side friction on the push rods and allow for greater penetration depths for a given push capacity.

3.2.17 *friction sleeve*—an isolated cylindrical sleeve section on a penetrometer tip upon which the friction component of penetration resistance develops. The friction sleeve has a surface area of 150 cm^2 for 10-cm^2 cone tips or 225 cm^2 for 15-cm^2 tips.

3.2.18 *friction sleeve resistance,* f_s—the friction component of penetration resistance developed on a friction sleeve, equal to the shear force applied to the friction sleeve divided by its surface area.

3.2.19 *FSO*—abbreviation for full-scale output. The output of an electronic force transducer when loaded to 100 % rated capacity.

3.2.20 *local side friction*—same as friction sleeve resistance, f_s (see 3.2.18).

3.2.21 *penetration resistance measuring system*—a measuring system that provides the means for transmitting information from the penetrometer tip and displaying the data at the surface where it can be seen or recorded.

3.2.22 *penetrometer*—an apparatus consisting of a series of cylindrical push rods with a terminal body (end section), called the penetrometer tip, and measuring devices for determination of the components of penetration resistance.

3.2.23 *penetrometer tip*—the terminal body (end section) of the penetrometer which contains the active elements that sense the components of penetration resistance. The penetrometer tip may include additional electronic instrumentation for signal conditioning and amplification.

3.2.24 *piezocone*—same as *electronic piezocone penetrometer* (see 3.2.10).

3.2.25 *piezocone porewater pressure,* u—fluid pressure measured using the piezocone penetration test.

3.2.26 *piezocone porewater pressure measurement location:* u_1, u_2, u_3—fluid pressure measured by the piezocone penetrometer at specific locations on the penetrometer as follows (**1**):[3] u_1—porous filter location on the midface or tip of the cone, u_2—porous filter location at the shoulder position behind the cone tip (standard location) and, u_3—porous filter location behind the friction sleeve.

3.2.27 *porewater pressure*—total porewater pressure magnitude measured during penetration (same as 3.2.25 above).

3.2.28 *porewater pressure ratio parameter,* B_q—the ratio of excess porewater pressure at the standard measurement location Δu_2, to corrected total cone resistance q_t, minus the total vertical overburden stress, σ_{vo} (see Eq 10).

3.2.29 *push rods*—the thick-walled tubes or rods used to advance the penetrometer tip.

3.2.30 *sleeve friction, sleeve, and friction resistance*—same as friction sleeve resistance.

3.2.31 *subtraction error*—an apparent load transfer from the cone to the friction sleeve of a subtraction type electronic cone penetrometer caused by minor voltage differences in response to load between the two strain element cells.

3.3 *Abbreviations:*

3.3.1 *CPT*—abbreviation for the cone penetration test.

---

[3] The boldface numbers given in parentheses refer to a list of references at the end of the text.

3.3.2 *PCPT or CPTu*—abbreviation for piezocone penetration test (note: symbol "u" added for porewater pressure measurements).

3.3.3 *CPTù*—abbreviation for the piezocone penetration test with dissipation phases of porewater pressures (ù).

3.3.4 *SCPTu*—abbreviation for seismic piezocone test (includes one or more geophones to allow downhole geophysical wave velocity measurements).

3.3.5 *RCPTu*—abbreviation for resistivity piezocone (includes electrical conductivity or resistivity module).

4. Summary of Test Method

4.1 A penetrometer tip with a conical point having a 60° apex angle and a cone base area of 10 or 15 cm^2 is advanced through the soil at a constant rate of 20 mm/s. The force on the conical point (cone) required to penetrate the soil is measured by electrical methods, at a minimum of every 50 mm of penetration. Improved resolution may often be obtained at 20- or 10-mm interval readings. Stress is calculated by dividing the measured force (total cone force) by the cone base area to obtain cone resistance, q_c.

4.2 A friction sleeve is present on the penetrometer immediately behind the cone tip, and the force exerted on the friction sleeve is measured by electrical methods at a minimum of every 50 mm of penetration. Stress is calculated by dividing the measured axial force by the surface area of the friction sleeve to determine sleeve resistance, f_s.

4.3 Most modern penetrometers are capable of registering pore water pressure induced during advancement of the penetrometer tip using an electronic pressure transducer. These penetrometers are called "piezocones." The piezocone is advanced at a rate of 20 mm/s, and readings are taken at a minimum of every 50 mm of penetration. The dissipation of either positive or negative excess porewater pressure can be monitored by stopping penetration, unloading the push rod, and recording porewater pressure as a function of time. When porewater pressure becomes constant it is measuring the equilibrium value (designated u_0) or piezometric level at that depth.

5. Significance and Use

5.1 Tests performed using this test method provide a detailed record of cone resistance which is useful for evaluation of site stratigraphy, homogeneity and depth to firm layers, voids or cavities, and other discontinuities. The use of a friction sleeve and porewater pressure element can provide an estimate of soil classification, and correlations with engineering properties of soils. When properly performed at suitable sites, the test provides a rapid means for determining subsurface conditions.

5.2 This test method provides data used for estimating engineering properties of soil intended to help with the design and construction of earthworks, the foundations for structures, and the behavior of soils under static and dynamic loads.

5.3 This method tests the soil in-situ and soil samples are not obtained. The interpretation of the results from this test method provides estimates of the types of soil penetrated. Engineers may obtain soil samples from parallel borings for correlation purposes but prior information or experience may preclude the need for borings.

6. Interferences

6.1 Refusal, deflection, or damage to the penetrometer may occur in coarse grained soil deposits with maximum particle sizes that approach or exceed the diameter of the cone.

6.2 Partially lithified and lithified deposits may cause refusal, deflection, or damage to the penetrometer.

6.3 Standard push rods can be damaged or broken under extreme loadings. The amount of force that push rods are able to sustain is a function of the unrestrained length of the rods and the weak links in the push rod-penetrometer tip string such as push rod joints and push rod-penetrometer tip connections. The force at which rods may break is a function of the equipment configuration and ground conditions during penetration. Excessive rod deflection is the most common cause for rod breakage.

7. Apparatus

7.1 *Friction Cone Penetrometer*—The penetrometer tip should meet requirements as given below and in 10.1. In a conventional friction-type cone penetrometer, the forces at the cone tip and friction sleeve are measured by two load cells within the penetrometer. Either independent load cells or subtraction-type penetrometers are acceptable for use (Fig. 1).

7.1.1 In the subtraction-type penetrometer, the cone and sleeve both produce compressive forces on the load cells. The load cells are joined together in such a manner that the cell nearest the cone (the "C" cell in Fig. 1*b*) measures the compressive force on the cone while the second cell (the "C + S" cell in Fig. 1*b*) measures the sum of the compressive forces on both the cone and friction sleeve. The compressive force from the friction sleeve portion is computed then by subtraction. This cone design is common in industry because of its rugged design. This design forms the basis for minimum performance requirements for electronic penetrometers.

7.1.1.1 Alternative designs have separate and non-dependent load cells separate for tip and sleeve. For instance, in Fig. 1*a*, the cone penetrometer tip produces a compression force on the cone load cell (the "C" cell in Fig. 1*a*) while the friction sleeve produces a tensile force on the independent friction sleeve load cell (the "S" cell). Designs are also available where both the tip and sleeve load cells are independent and operate in compression (2). These penetrometer designs result in a higher degree of accuracy in friction sleeve measurement, however, may be more susceptible to damage under extreme loading conditions.

7.1.1.2 Typical general purpose cone penetrometers are manufactured to full scale outputs (FSO) equivalent to net loads of 10 to 20 tons. Often, weak soils are the most critical in an investigation program, and in some cases, very accurate friction sleeve data may be required. To gain better resolution, the FSO can be lowered or the independent type penetrometer design can be selected. A low FSO subtraction cone may provide more accurate data than a standard FSO independent type cone depending on such factors as system design and thermal compensation. If the FSO is lowered, this may place electrical components at risk if overloaded in stronger soils.

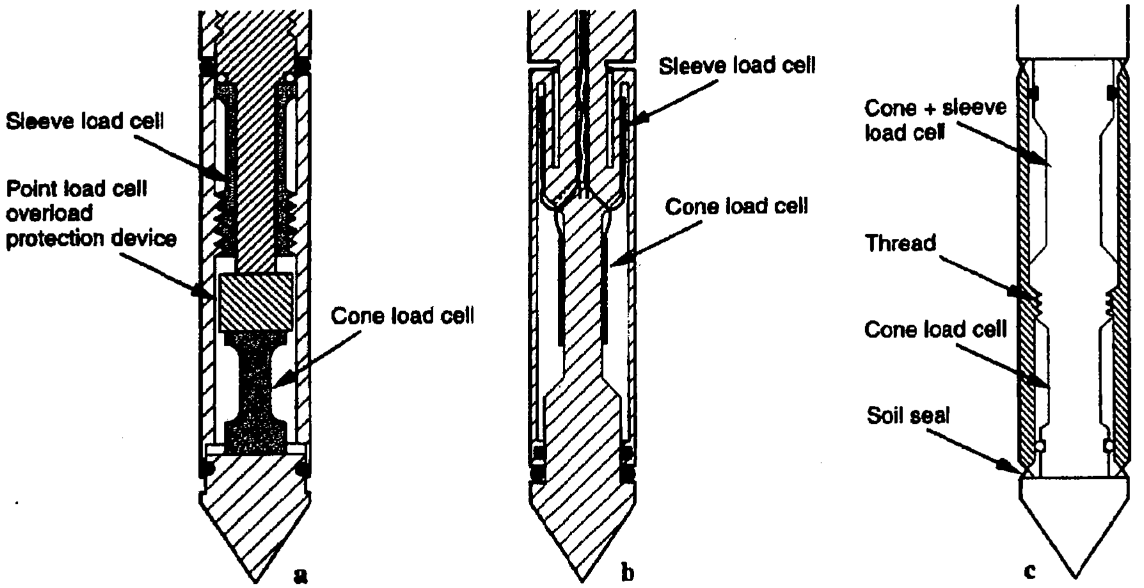


FIG. 1 Common Configurations for Electric Friction-Cone Penetrometers (2) Showing: (a) Compression-type Tip and Sleeve Load Cells, (b) Tension-type Sleeve Design, and (c) Subtraction-type Penetrometer

Expensive preboring efforts may be required to avoid damage in these cases. The selection of penetrometer type and resolution should consider such factors as practicality, availability, calibration requirements, cost, risk of damage, and preboring requirements.

7.1.1.3 The user or client should select the cone design requirements by consulting with experienced users or manufacturers. The need for a specific cone design depends on the design data requirements outlined in the exploration program.

7.1.1.4 Regardless of penetrometer type, the friction sleeve load cell system must operate in such a way that the system is sensitive to only shear stresses applied to the friction sleeve and not to normal stresses.

7.1.2 *Cone*—Nominal dimensions, with manufacturing and operating tolerances, for the cone are shown on Fig. 2. The cone has a diameter d = 35.7 mm, projected base area $A_c = 1000$ mm^2, + 2 %–5 % with an apex angle of 60°. A cylindrical extension, h_e, of 5 mm should be located behind the base of the cone to protect the outer edges of the cone base from excessive wear. The 10 cm^2 cone is considered the reference standard for which results of other penetrometers with proportionally scaled dimensions can be compared.

7.1.2.1 In certain cases, it may be desirable to increase the cone diameter in order to add room for sensors or increase ruggedness of the penetrometer. The standard increase is to a base diameter of 43.7 mm which provides a projected cone base area of 1500 mm^2 while maintaining a 60° apex angle. Nominal dimensions, with manufacturing and operating tolerances for the 15 cm^2 cone, are shown in Fig. 2, based on the international guides (3).

7.1.2.2 The cone is made of high strength steel of a type and hardness suitable to resist wear due to abrasion by soil. Cone tips which have worn to the operating tolerance shown in Fig. 2 should be replaced. Piezocone tips should be replaced when the tip has worn appreciably (as shown) and the height of the cylindrical extension has reduced considerably (as shown).

NOTE 2—In some applications it may be desirable to scale the cone diameter down to a smaller projected area. Cone penetrometers with 5 cm^2 projected area find use in the field applications and even smaller sizes (1 cm^2) are used in the laboratory for research purposes. These cones should be designed with dimensions scaled in direct proportion to standard 10-cm^2 penetrometers. In thinly layered soils, the diameter affects how accurately the layers may be sensed. Smaller diameter cones may sense thinner layers more accurately than larger cones. If there are questions as to the effect of scaling the penetrometer to either larger or smaller size, results can be compared in the field to the 10-cm^2 penetrometer for soils under consideration. This is because the 10-cm^2 cone is considered the reference penetrometer for field testing.

7.1.3 *Friction Sleeve*—The outside diameter of the manufactured friction sleeve and the operating diameter are equal to the diameter of the base of the cone with a tolerance of +0.35 mm and –0.0 mm. The friction sleeve is made from high strength steel of a type and hardness to resist wear due to abrasion by soil. Chrome-plated steel is not recommended due to differing frictional behavior. The surface area of the friction sleeve is 150 cm^2 ± 2 %, for a 10-cm^2 cone. If the cone base area is increased to 15 cm^2, as provided for in 7.1.2.1, the surface area of the friction sleeve should be adjusted proportionally, with the same length to diameter ratio as the 10-cm^2 cone. With the 15-cm^2 tip, a sleeve area of 225 cm^2 is similar in scale.

7.1.3.1 The top diameter of the sleeve must not be smaller than the bottom diameter or significantly lower sleeve resistance will occur. During testing, the top and bottom of the sleeve should be periodically checked for wear with a micrometer. Normally, the top of the sleeve will wear faster than the bottom.

7.1.3.2 Friction sleeves must be designed with equal end areas which are exposed to water pressures (**2, 3, 4, 5, 6**). This will remove the tendency for unbalanced end forces to act on the sleeve. Sleeve design must be checked in accordance with A1.7 to ensure proper response.

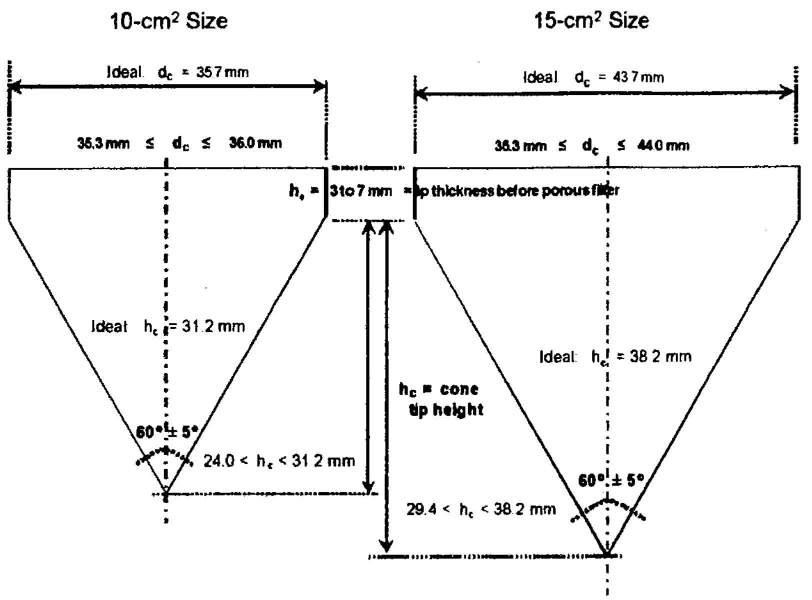


FIG. 2 Manufacturing and Operating Tolerances of Cones (3)

7.1.4 *Gap*—The gap (annular space) between the cylindrical extension of the cone base and the other elements of the penetrometer tip should be kept to the minimum necessary for operation of the sensing devices and should be designed and constructed in such a way to prevent the entry of soil particles. Gap requirements apply to the gaps at either end of the friction sleeve and to other elements of the penetrometer tip.

7.1.4.1 The gap between the cylindrical extension of the cone base and other elements of the penetrometer tip, e_c, must not be larger than 5 mm for the friction cone penetrometer.

7.1.4.2 If a seal is placed in the gap, it should be properly designed and manufactured to prevent entry of soil particles into the penetrometer tip. It must have a deformability at least two orders of magnitude greater than the material comprising the load transferring components of the sensing devices in order to prevent load transfer from the tip to the sleeve.

7.1.4.3 *Filter Element in the Gap*—If a filter element for a piezocone is placed in the gap between cone and sleeve the sum of the height of cylindrical extension, h_e, plus element thickness filling the gap, e_c, can range from 8 to 20 mm (see 7.1.8 for explanation).

7.1.5 *Diameter Requirements*—The friction sleeve should be situated within 5 to 15 mm behind the base of the cone tip. The annular spaces and seals between the friction sleeve and other portions of the penetrometer tip must conform to the same specifications as described in 7.1.4. Changes in the diameter of the penetrometer body above the friction sleeve should be such that tip or sleeve measurements are not influenced by increases in diameter. International reference test procedures require that the penetrometer body have the same diameter as the cone for the complete length of the penetrometer body (3, 7, 8).

7.1.5.1 For some penetrometer designs, it may be desirable to increase the diameter of the penetrometer body to house additional sensors or reduce friction along push rods. These diameter changes are acceptable if they do not have significant influence on tip and sleeve data. If there is question regarding a specific design with diameter increases, comparison studies can be made to a penetrometer with constant diameter. Information on diameters of the complete penetrometer body should be reported.

NOTE 3—The effects caused by diameter changes of the penetrometer on tip and sleeve resistance are dependent on the magnitude of diameter increase and location on the penetrometer body. Most practitioners feel that diameter increases equivalent to addition of a friction reducer with area increases of 15 to 20 % should be restricted to a location at least eight to ten cone diameters behind the friction sleeve.

7.1.6 The axis of the cone, the friction sleeve (if included), and the body of the penetrometer tip must be coincident.

7.1.7 *Force Sensing Devices*—The typical force sensing device is a strain gauge load cell that contains temperature compensated bonded strain gages. The configuration and location of strain gages should be such that measurements are not influenced by possible eccentricity of loading.

7.1.8 *Electronic Piezocone Penetrometer*—A piezocone penetrometer can contain porous filter element(s), pressure transducer(s), and fluid filled ports connecting the elements to the transducer to measure pore water pressure. Fig. 3 shows the common design types used in practice including: 10-cm^2 friction-type, type 1 and type 2 piezocone, and 15-cm^2 size. The standard penetrometer should be the type 2 piezocone with filter located at the shoulder (both 10-cm^2 and 15-cm^2) to allow correction of tip resistances. The electric friction penetrometer without porewater transducers can be used in soils with minor porewater pressure development, such as clean sands, granular soils, as well as soils and fills well above the groundwater table. The type 1 with face filter element finds use in fissured geomaterials and materials prone to desaturation, as well as dissipation readings. Numerous design and configuration aspects can affect the measurement of dynamic water pressures. Variables such as the element location, design and volume of ports, and the type and degree of saturation of the fluids,

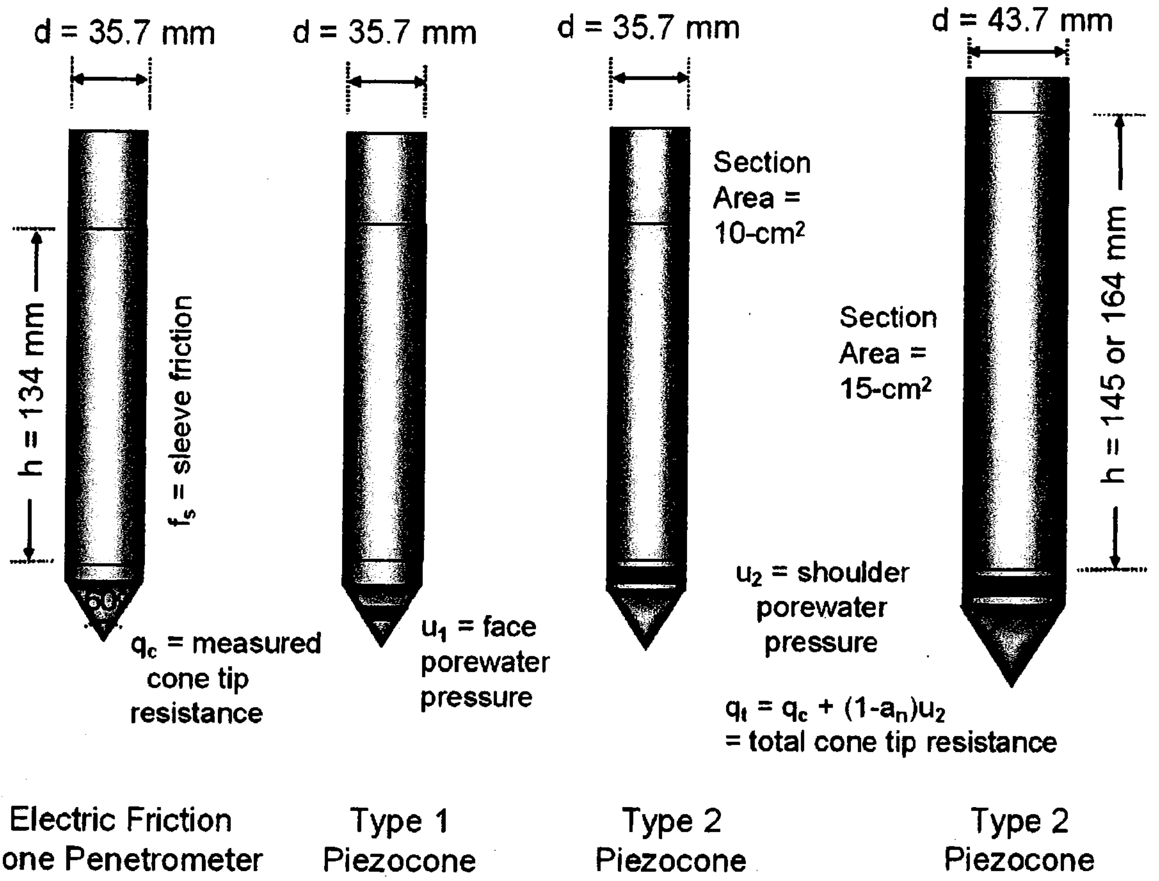


FIG. 3 Penetrometer Design Configurations: (a) Electronic Friction-type, (b) Type 1 Piezocone, (c) Standard 10-cm² Type 2 Piezocone, and (d) 15-cm² Type 2 Version (5)

cavitation of the element fluid system and resaturation lag time, depth and saturation of soil during testing all affect the dynamic porewater pressure measured during testing and dissipation tests of dynamic pressures (**1, 6**). It is beyond the scope of the procedure to address all of these variables. As a minimum, complete information should be reported as to the design, configuration, and the preparation of the piezocone system that is used for the particular sounding.

7.1.8.1 Measurement of hydrostatic water pressures during pauses in testing are more straightforward. The presence of air entrained in the system only affects dynamic response. In high permeability soils (that is, clean sands), hydrostatic pressures will equalize within seconds or minutes. In low permeability materials such as high plasticity clays, equalization can take many hours. If the goal of the exploration program is only to acquire hydrostatic pressures in sands, some of the preparation procedures for dynamic pressure measuring can be relaxed, such as deairing fluids.

7.1.8.2 The porewater pressure measurement locations of the porous element are limited to the face or tip of the cone, u_1, directly behind the cylindrical extension of the base of the cone, u_2, or behind the sleeve, u_3. Some penetrometers used for research purposes may have multiple measurement locations.

7.1.8.3 There are several advantages to locating the porous element immediately behind the tip of the cone in location u_2, primarily the required correction of measured q_c to total tip stress, q_t, as detailed extensively (**1-6**). Also, the element is less subject to damage and abrasion, as well as fewer compressibility effects (**1, 6**). Elements located in the u_2 location may be subject to cavitation at shallow depths in dense sands because the zone behind the height of cylindrical extension is a zone of dilation in drained soils. Similar response can occur in stiff fissured clays and crusts (**1**). Porewater pressure measurements obtained at the u_1 face location are more effective for compressibility determinations and layer detection, particularly in fissured soils, but are more subject to wear (**9**). At the u_2 location, a minimum 2-mm cylindrical extension of the cone tip (h_e) should be maintained for protection of the cone. Typical filter element thickness at all locations in the horizontal plane ranges from 5 to 10 mm.

7.1.8.4 The miniature diaphragm-type electronic pressure transducer is normally housed near the tip of the cone. For dynamic pressure measurements, the filter and ports are filled with deaired fluid to measure dynamic porewater pressure response. The volume of connecting ports to the transducer should be minimized to facilitate dynamic pressure response. These electronic transducers are normally very reliable, accurate, and linear in response. The transducer shall have a precision of at least ±14 kPa (±2 psi). The porewater pressure transducer must meet requirements given in 10.2.

7.1.8.5 *Element*—The element is a fine porous filter made from plastic, sintered steel or bronze, or ceramic. Typical pore size is between 20 to 200 microns (6, 9). Different materials have different advantages. Smearing of metallic element openings by hard soil grains may reduce dynamic response of the system, thus normally not used for face elements but best suited for shoulder filter positions. Ceramic elements are very brittle and may crack when loaded, but perform well on the cone face as they reduce compressibility concerns. Polypropylene plastic elements are most commonly used in practice, particularly at the shoulder. Plastic filters (as high-density polyethylene, HDPE, or high-density polypropylene, HDPP) may be inappropriate for environmental type CPTs where contaminant detection is sought. Typically, the filter element is wedged at the tip or midface (u_1) location, or located at the shoulder in the gap immediately above the cone extension (designated u_2) location. At these locations, it is important to design the penetrometer such that compression of the filter elements is minimized.

7.1.8.6 *Fluids for Saturation*—Glycerine, or alternatively silicone oil, is most often used for deairing elements for dynamic response. These stiff viscous oils have less tendency to cavitate, although cavitation may be controlled by the effective pore size of the element mounting surfaces. Water can be used for the fluid if the entire sounding will be submerged, or if dynamic response is not important. The fluids are deaired using procedures described in 11.2.

7.2 *Measuring System*—The signals from the penetrometer transducers are to be displayed at the surface during testing as a continuously updated plot against depth. The data are also to be recorded electronically for subsequent processing. Electronic recording shall be digital and use at least twelve bit (one part in 4096) resolution in the analog to digital conversion, although 16-bit resolution and higher may be preferable in very soft ground. Either magnetic (disk or tape) or optical (disk) non-volatile storage may be used. In analog systems, the temperature stability and accuracy of the A-to-D converter shall be such that the overall cone-transmission-recording system complies with calibration requirements set forth in the annex.

7.2.1 Use of analog systems is acceptable but the system resolution may be lower than requirements in the annex and Section 10. Use of an analog recorder as a supplement to digital system is advantageous because it can provide system backup.

NOTE 4—Depending upon the equipment, data stored digitally on magnetic drives, tapes, floppy disks, or other media are often used. The data files should include project, location, operator, and data format information (for example, channel, units, corrected or uncorrected, etc.) so that the data can be understood when reading the file with a text editor.

7.3 *Push Rods*—Steel rods are required having a cross sectional area adequate to sustain, without buckling, the thrust required to advance the penetrometer tip. For penetrometers using electrical cables, the cable is prestrung through the rods prior to testing. Push rods are supplied in 1-meter lengths. The push rods must be secured together to bear against each other at the joints and form a rigid-jointed string of push rods. The deviation of push rod alignment from a straight axis should be held to a minimum, especially in the push rods near the penetrometer tip, to avoid excessive directional penetrometer drift. Generally, when a 1-m long push rod is subjected to a permanent circular bending resulting in 1 to 2 mm of center axis rod shortening, the push rod should be discarded. This corresponds to a horizontal deflection of 2 to 3 mm at the center of bending. The locations of push rods in the string should be varied periodically to avoid permanent curvature.

7.3.1 For the 10-cm^2 penetrometer, standard 20-metric ton high tensile strength steel push rods are 36-mm outside diameter, 16-mm inside diameter, and have a mass per unit length of 6.65 kg/m. For 15-cm^2 penetrometers, the test may be pushed with 44.5-mm outside diameter rods or with standard rods used for the 10-cm^2 penetrometer.

7.4 *Friction Reducer*—Friction reducers are normally used on the push rods to reduce rod friction. If a friction reducer is used, it should be located on the push rods no closer than 0.5 m behind the base of the cone. Friction reducers, that increase push rod outside diameter by approximately 25 %, are typically used for 10-cm^2 cones. If a 15-cm^2 penetrometer is advanced with 36-mm push rods there may be no need for friction reducers since the penetrometer itself will open a larger hole. The type, size, amount, and location of friction reducer(s) used during testing must be reported.

7.5 *Thrust Machine and Reaction*—The thrust machine will provide a continuous stroke, preferably over a distance greater than 1 m. The thrust machine should be capable of adjusting push direction through the use of a leveling system such that push initiates in a vertical orientation. The machine must advance the penetrometer tip and push rods at a smooth, constant rate (see 12.1.2) while the magnitude of thrust can fluctuate. The thrust machine must be anchored or ballasted, or both, so that it provides the necessary reaction for the penetrometer and does not move relative to the soil surface during thrust.

NOTE 5—Cone penetration soundings usually require thrust capabilities ranging from 100 to 200 kN (11 to 22 tons) for full capacity. High mass ballasted vehicles can cause soil surface deformations which may affect penetrometer resistance(s) measured in near surface layers. Anchored or ballasted vehicles, or both, may induce changes in ground surface reference level. If these conditions are evident, they should be noted in reports.

7.6 *Other Sensing Devices*—Other sensing devices can be included in the penetrometer body to provide additional information during the sounding. These instruments are normally read at the same continuous rate as tip, sleeve, and porewater pressure sensors, or alternatively, during pauses in the push (often at 1-m rod breaks). Typical sensors are inclinometer, temperature, resistivity (or its reciprocal, electrical conductivity), or seismic sensors, such as geophones that can be used to obtain downhole shear wave velocity. These sensors should be calibrated if their use is critical to the investigation program. The use of an inclinometer is highly recommended since it will provide information on potentially damaging situations during the sounding process. An inclinometer can provide a useful depth reliability check because it provides information on verticality. The configuration and methods of operating such sensors should be reported.

8. Reagents and Materials

8.1 *O-Ring Compound*—A petroleum or silicon compound for facilitating seals with O-rings. Use of silicon compounds may impede repair of strain gages if the strain gauge surface is exposed to the compound.

8.2 *Glycerine*, or $CHOH(CH_2OH)_2$, for use in porewater pressure measurement systems. Approximately 95 % pure glycerine can be procured from most drug stores.

8.3 *Silicone Oil (or fluid)*, for use in porewater pressure measurement systems. This material is available in varying viscosities ranging from 1400 to 10 000 CP.

Note 6—Detailed comparisons and discussions on the use of these fluids can be found elsewhere (**6, 9**).

9. Hazards

9.1 *Technical Precautions—General*:

9.1.1 Use of penetrometer components that do not meet required tolerances or show visible signs of non-symmetric wear can result in erroneous penetration resistance data.

9.1.2 The application of thrust in excess of rated capacity of the equipment can result in damage to equipment (see Section 6).

9.1.3 A cone sounding must not be performed any closer than 25 borehole diameters from any existing unbackfilled or uncased bore hole.

9.1.4 When performing cone penetration testing in prebored holes, an estimate of the depth below the prebored depth which is disturbed by drilling, should be made and penetration resistance data obtained in this zone should be noted. Usually, this depth of disturbance is assumed to be equal to at least three borehole diameters.

9.1.5 Significant bending of the push rods can influence penetration resistance data. The use of a tubular rod guide is recommended at the base of the thrust machine and also in prebored holes to help prevent push rod bending.

9.1.6 Push rods not meeting requirements of 7.3 may result in excessive directional penetrometer drift and possibly unreliable penetration resistance values.

9.1.7 Passing through or alongside obstructions may deflect the penetrometer and induce directional drift. Note any indications of encountering such obstructions, such as gravels, and be alert for possible subsequent improper penetrometer tip operation.

9.1.8 If the proper rate of advance of the penetrometer is not maintained for the entire stroke through the measurement interval, penetration resistance data will be erroneous.

9.2 *Technical Precautions—Electronic Friction Cone Penetrometer*:

9.2.1 Failure of O-ring seals can result in damage to or inaccurate readings from electronic transducers. The O-ring seals should be inspected regularly, after each sounding, for overall condition, cleanliness and watertightness.

9.2.2 Soil ingress between different elements of a penetrometer tip can result in unreliable data. Specifically, soil ingress will detrimentally affect sleeve resistance data. Seals should be inspected after each sounding, maintained regularly, and replaced when necessary. If very accurate sleeve resistance data is required, it is recommended to clean all seals after each sounding.

9.2.3 Electronic cone penetrometer tips should be temperature compensated. If extreme temperatures outside of the range established in A1.3.3 are to be encountered, the penetrometer should be checked for the required temperature range to establish they can meet the calibration requirements. Also, harsh environments may severely affect the data acquisition system of power supplies, notebook or field computers, and other electronics.

9.2.4 If the shift in baseline reading after extracting the penetrometer tip from the soil is so large that the conditions of accuracy as defined in 10.1.2.1 are no longer met, penetration resistance data should be noted as unreliable. If baseline readings do not conform to allowable limits established by accuracy requirements in 10.1.2.1, the penetrometer tip must be repaired, and recalibrated or replaced.

9.2.5 Electronic friction cone penetrometers having unequal end areas on their friction sleeves can yield erroneous f_s readings because of dynamic porewater pressures acting unevenly on the sleeve (**2, 3, 4, 6**). Friction sleeve design should be checked in accordance with A1.7 to ensure balanced response. The response is also dependent on location of water seals. If O-ring water seals are damaged during testing, and sleeve data appear affected, the sounding data should be noted as unreliable and the seals should be repaired.

9.3 *Piezocone Penetrometer*—The electronic piezocone penetrometer tip measures pore water pressures on the exterior of the penetrometer tip by transferring the pressure through a de-aired fluid system to a pressure transducer in the interior of the tip. For proper dynamic response, the measurement system (consisting of fluid ports and porous element) must be completely saturated prior to testing. Entrained air must be removed from the fluid-filled system or porewater pressure fluctuation during penetrometer tip advancement will be incorrect due to response lag from compression of air bubbles (see 11.2, 12.3.2, and 12.3.3). For soundings where dynamic response is important, the prepared filter elements should be replaced after every sounding.

10. Calibration and Standardization

10.1 *Electronic Friction Cone Penetrometers*:

10.1.1 The requirements for newly manufactured or repaired cone penetrometers are of importance. Newly manufactured or repaired electronic cone penetrometers are to be checked to meet the minimum calibration requirements described in the annex. These calibrations include load tests, thermal tests, and mechanical tests for effects of imbalanced hydrostatic forces. Calibration procedures and requirements given in the annex are for subtraction-type cone penetrometers. Calibration requirements for independent-type cone penetrometers should equal or exceed those requirements. The calibration records must be certified as correct by a registered professional engineer or other responsible engineer with knowledge and experience in materials testing for quality assurance. Applied forces or masses must be traceable to calibration standard forces or masses retained by the National Institute of Standards and Technology (NIST), formerly the

National Bureau of Standards. For description of calibration terms and methods for calibrating, refer to the annex.

10.1.2 *Baseline Readings*—Baseline or zero-load readings for both cone and friction sleeve load cells and porewater pressure transducers must be taken before and after each sounding. The baseline reading is a reliable indicator of output stability, temperature-induced apparent load, soil ingress, internal friction, threshold sensitivity, and unknown loading during zero setting. Take the initial baseline reading after warming electrical circuits according to the manufacturer's instructions, generally for 15 to 30 min, and in a temperature environment as close as possible to that of the material to be sounded. If temperature is of concern, immerse the penetrometer tip in a bucket of fresh tap water, or insert the penetrometer tip in the ground while electrically warming circuits to stabilize its temperature and then extracted for rapid determination of initial baseline. After a sounding is completed, take a final baseline. The change in initial and final baseline values should not exceed 2 % FSO for the cone tip, sleeve, and pressure transducer.

10.1.2.1 Maintain a continuous record of initial and final baselines during production testing. After each sounding, compare the final baseline to the initial baseline for agreement within the tolerances noted above. In some cases during heavy production testing where the cone is not disassembled and cleaned after each sounding, the initial baseline for the next sounding can serve as the final baseline to the previous sounding as long as agreement is within allowable limits.

10.1.2.2 If the post sounding baseline shift exceeds above criteria, inspect the cone for damage by inspecting the tip and checking to see that the sleeve can be rotated by hand. If there is apparent damage, replace parts as required. Clean the cone and allow temperatures to equalize to presounding conditions, and obtain a new baseline. If this value agrees with the initial baseline within the above criteria, a load range calibration check is not required. If the pre and post baselines are still not within the above criteria then it is likely that the shift was caused by an obstacle or obstruction and linearity should be checked with a load range calibration.

10.1.2.3 If the baseline shift still exceeds the above criteria, perform a load range calibration as described in 10.1.2.1. If the cone load cell baseline shift exceeds 2 % FSO, the cone is likely damaged and will not meet load range criteria in 10.1.2.2. Sleeve load cell baseline shifts for subtraction-type penetrometers usually can exceed 2 % FSO and still meet load range criteria.

10.1.2.4 Report data for the sounding where unacceptable baseline shift occurs as unreliable. In some cases it may be obvious where the damage occurred and data prior to that point may be considered reliable. The location where obvious damage occurred should be clearly noted in reports.

10.1.3 *Penetrometer Wear and Usage*

10.1.3.1 For penetrometers used regularly during production, periodic load range checks should be performed. The inspection period can be based on production footage such as once every lineal 3000 m (approx. 10^4 linear feet) of soundings. If field load range equipment is not available, the penetrometer may be checked in the laboratory at the end of a project.

10.1.3.2 For penetrometers that are used infrequently, a periodic check may be based on time period, such as once every year. If a penetrometer has not been used for a long period of time, checking it before use is advisable.

10.1.3.3 For projects requiring a high level of quality assurance, it may be required to do load range checks before and after the project.

10.1.3.4 Load range calibrations are required if the initial and final baselines for a sounding do not meet requirements given in 10.1.2.1.

10.1.3.5 Records documenting the history of an individual penetrometer should be maintained for evaluation of performance.

10.2 *Porewater Pressure Transducer*—Calibrate newly manufactured or repaired transducers in accordance with requirements in the annex. During production, the transducer should be calibrated at regularly scheduled intervals and whenever linear performance is suspect. The reference gauge can be a Bourdon tube pressure gauge, or electronic pressure transducer that is calibrated annually to NIST traceable loading device (dead weight testing apparatus).

10.2.1 Prior to testing, baseline values or initial zeroing of the transducer is performed on the porewater pressure transducer at ambient air pressures at the surface. Maintain records as to the baseline values for the transducer in similar fashion to those for tip and sleeve resistance. If significant changes in baseline values occur, normally 1 to 2 % FSO, perform load range tests to check for possible damage and nonlinear response.

10.3 *Calibrations of Other Sensing Devices*—Calibration data for other sensors in the penetrometer body may require calibrations using procedures similar to those given in the annex for load cells and pressure transducers. The need for calibration depends on the requirements of the individual investigation program. For noncritical programs, the occurrence of reasonable readings may be sufficient. In critical programs, it may be necessary to load the sensor through the range of interest with reference standards to ensure accurate readings.

11. Conditioning

11.1 Power electronic cone penetrometer and data acquisition systems for a minimum time period to stabilize electric circuits before performing soundings. Power the system to manufacturer's recommendations prior to obtaining reference baselines. For most electronic systems this time period is 15 to 30 min.

11.2 Electronic piezocone penetrometer soundings require special preparation of the transmitting fluid and porous elements such that entrained air is removed from the system. For soundings where dynamic response is important, replace the prepared filter elements and the ports flushed after every sounding. Some of the techniques discussed below have been successful for preparation of elements. Regardless of the techniques used, report the equipment and methods.

11.2.1 Field or laboratory tests can be performed to evaluate assembled system response, if desired. Place the cone tip and element in a pressurized chamber and subject to rapid pressure change. Compare the response of the system to the applied pressure changes and if responses match, the system is properly prepared.

11.2.2 Place elements in a pure glycerine or silicone oil bath under a vacuum of at least 90 % of one atmosphere (–90 kPa). Maintain vacuum until air bubble generation is reduced to a minimum. Application of ultrasonic vibration and low heat (T < 50°C) will assist in removal of air. Generally with use of combined vacuum, ultrasonic vibration, and low heat, filter elements can be deaired in about 4 h, although it is best to allow for 24 h to ensure best performance. Results will depend upon the viscosity of the fluid and pore size of the filter element.

11.2.3 Elements can be prepared in water by boiling the elements while submerged in water for at least 4 h, although damage may result from prolongued exposure in this approach (1).

11.2.4 *Other Suitable Means*—Report other techniques, such as commercially-purchased pre-saturated filter elements that are available, or grease-filled slot (2, 5).

11.2.5 *Storage*—Store prepared elements submerged in the prepared fluid until ready for use. Fill the containers and evacuate during storage. Allowable storage length depends on the fluid. If elements are prepared in water they must be deaired again one day after containers are opened and exposed to air. Elements stored in glycerine or silicone may be stored for longer periods, up to several months, after storage containers have been exposed to air.

12. Procedure

12.1 *General Requirements*:

12.1.1 Prior to beginning a sounding, perform site surveys to ensure hazards such as overhead and underground utilities will not be encountered. Position the thrust machine over the location of the sounding, and lower leveling jacks to raise the machine mass off the suspension system. Set the hydraulic rams of the penetrometer thrust system to as near vertical as possible. The axis of the push rods must coincide with the thrust direction.

12.1.2 Set the hydraulic ram feed rate to advance the penetrometer at a rate of 20 ± 5 mm/s for all electronic cone penetrometers. This rate must be maintained during the entire stroke during downward advance of the rods while taking readings.

12.1.3 Check push rods for straightness and permanent bending (See Section 7.3). Push rods are assembled and tightened by hand, but care must be taken and threads may need cleaning to ensure that the shoulders are tightly butted to prevent damage to the push rods. For electronic cone penetrometers using cables, the cable is prestrung through the push rods. Add friction reducer to the string of push rods as required, usually the first push rod behind the penetrometer tip and other rods as required.

12.1.4 Inspect penetrometer tips before and after soundings for damage, soil ingress, and wear. In very soft and sensitive soils where accurate sleeve data is required, dismantle electronic cone penetrometer tips and friction sleeves after each sounding to clean and lubricate as required. If damage is found after a sounding, note and record this information on the sounding data record or report.

12.2 *Friction Cone Penetrometers*:

12.2.1 Power up the penetrometer tip and data acquisition system according to the manufacturer's recommendations, typically 15 to 30 min, prior to use.

12.2.2 Obtain an initial baseline reading for the penetrometer in an unloaded condition at a temperature as close as possible to ground conditions. Obtain baseline readings with the penetrometer tip hanging freely in air or in water, out of direct sunlight. Compare baseline readings with the previous baseline reading for the requirements given in 10.1.2.1. If thermal stability needs to be assured, immerse the penetrometer tip in water at temperature close to ground; or perform an initial short penetration test hole, stop penetration and allow the penetrometer tip to reach soil temperature, and withdraw the penetrometer.

12.2.3 Measure the depth at which readings were taken with an accuracy of at least ±100 mm from the ground surface.

12.2.4 Determine the cone resistance and friction sleeve resistance, continuously with depth, and record the data at intervals of depth not exceeding 50 mm.

12.2.5 During the progress of sounding, monitor tip and sleeve forces continuously for signs of proper operations. It is helpful to monitor other indicators such as ram pressure or inclination to ensure that damage may not occur if highly resistant layers or obstructions are encountered. Inclination is a particularly useful indicator of imminent danger to the system (see 12.4).

12.2.6 At the end of a sounding, extract the penetrometer tip, obtain a final set of baseline readings with the penetrometer tip hanging freely in air or in water, and check them against the initial baseline. Record initial and final baselines on all documents related to the sounding.

12.3 *Electronic Piezocone Penetrometers*:

12.3.1 Power up the penetrometer tip and data acquisition system according to the manufacturer's recommendations, typically 15 to 30 min, prior to use.

12.3.2 Assemble the piezo elements with all fluid chambers submerged in the de-aired medium used to prepare the elements. Flush all confined areas with fluid to remove air bubbles. Tighten the cone tip to effectively seal the flat surfaces. For water fluid systems, protect the assembled system from evaporation by enclosing the porous element inside a fluid-filled plastic bag or cap sealed to the penetrometer tip.

12.3.3 If unsaturated soil is first penetrated and it is desired to obtain accurate dynamic porewater pressure response once below the ground water, it may be necessary to prebore or sound a pilot hole to the water table. In many cases, the piezocone fluid system may cavitate during penetration through unsaturated soil or in dilating sand layers below the water table and this can adversely affect dynamic response. As the cone is advanced deeper, the saturation levels may recover as air bubbles are driven back into solution according to Boyles Law. Evaluation of proper interpretation of dynamic response requires experience (1, 6). Pre-punching or pre-boring with a two-level phase approach to soundings may help alleviate desaturation problems.

12.3.4 Record baseline readings with the penetrometer tip hanging freely in air, or in water, out of direct sunlight. Compare baseline readings with reference baseline readings for requirements given in 10.1.2.1 and 10.2. A baseline for the porewater pressure transducer is obtained immediately after assembly to avoid evaporation effects. If evaporation is a problem, temporarily immerse the penetrometer in a bucket of water until ready for baseline. Do not obtain transducer baselines with protective caps or covers in place as these may induce pressure in the system. Note the pressure from the pressure transducer to see if it is a reasonable value for the equipment and assembly technique used.

12.3.5 Follow procedures similar to electric friction cone in 12.2.4-12.2.6 with the addition of recording porewater pressure readings.

12.3.6 *Dissipation Tests*—If dissipation tests are to be conducted during progress of the sounding, penetration is temporarily stopped at the location of interest. If porewater pressures are measured at the u_2 or u_3 locations, it is common practice to release the force on the push rods. If porewater pressures are measured at the midface location u_1, maintain the force on the push rods. Record porewater pressure versus time during conduct of the dissipation test. Monitor pressures until equilibrium porewater pressure is reached or 50 % of the initial excess porewater pressure has dissipated. In fine grained soils of very low conductivity, very long times may be required to reach the 50 % dissipation. Depending on the requirements of the program, and any concern of friction buildup on the push rods, dissipation testing may be terminated prior to reaching the 50 % level. Report dissipation test data as a record of porewater pressure versus time, or more commonly, u versus logarithm of time.

12.3.7 *Hydrostatic Porewater Condition*:

If full dissipations are carried out, then the porewater transducer will eventually record the hydrostatic condition, thus providing an evaluation of the position of the groundwater table or phreatic surface.

12.4 *Penetrometer Operation and Data Interpretation-Guidelines*:

12.4.1 *Directional Drift of Penetrometer*:

12.4.1.1 The penetrometer may drift directionally from vertical alignment. Large deviations in inclination can create nonuniform loading and result in unreliable penetration resistance data. Reduce drift by accurately setting thrust alignment and using push rods which meet tolerances given in 7.3.

12.4.1.2 Passing through or alongside obstructions such as boulders, cobbles, coarse gravel, soil concretions, thin rock layers, or inclined dense layers will deflect the penetrometer tip and induce drifting. Note and record any indication of encountering such obstructions, and be alert for possible subsequent improper penetrometer tip operations as a sign of serious directional drift.

12.4.1.3 Penetrometer inclination is typically monitored in cone penetrometers. Impose limitations on inclination in the system to prevent damage to push rods and non-symmetric loading of the penetrometer tip. Generally, a 5° change in inclination over 1 m of penetration can impose detrimental push rod bending. Total drift of over 12° in 10 m of penetration imposes non-symetric loading and possible unreliable penetration resistance data.

12.4.2 *Push Rod Addition Interruptions*—Short duration interruptions in the penetration rate during addition of each new push rod can affect initial cone and friction sleeve readings at the beginning of the next push. If necessary, note and record the depths at which push rods are added and where long pauses may have affected initial startup resistances.

12.4.3 *Piezocone Porewater Pressure Dissipation Interruptions*—Porewater pressure dissipation studies, for which soundings are stopped and rod load is released for varying time durations, can affect the initial cone, friction sleeve, and dynamic porewater pressure readings at resumptions of cone penetration. If dissipation tests are performed, be aware of possible rebound effects on initial excess porewater pressures. Note and record the depth and duration for which dissipation values are taken.

12.4.4 *Interruptions Due to Obstructions*—If obstructions are encountered and normal advance of the sounding is stopped to bore through the obstructions, obtain further penetration resistance data only after the penetrometer tip has passed through the estimated zone of disturbance due to drilling. As an alternative, readings may be continued without first making the additional penetration and the disturbed zone evaluated from these data. Note and record the depth and thickness of obstructions and disturbed zones in areas where obstructions are drilled through.

12.4.5 *Excessive Thrust Capacity*—If excessive thrust pressure begins to impede the progress of the sounding, it may be necessary to withdraw and change friction reducers. Alternately, sometimes friction may be reduced by withdrawing the penetrometer and rods up to one third to one half of the penetration depth and then repushing to depth at which the friction caused stopping. Continue collection of sounding data from the point of stopping. Note and record the delay time and depths to which the penetrometer was moved. Long delays and pauses may cause buildup of friction on the rods. Hold delays to the minimum required to perform dissipation tests or equipment repairs.

12.4.5.1 If a high resistance layer is encountered, and the hydraulic thrust machine is physically moved during penetration, terminate the sounding. Another indicator of reaching thrust capacity is the rebound of rods after they are released. The magnitude of rebound depends on the flexibility of the thrust machine and the push rods. An operator must become familiar with the safe deflection of the system and decide when excessive deflections are being reached.

12.4.6 *Unusual Occurrences*—As data are recorded, it is important to note unusual occurrences in testing. When penetrating gravels, it is important to note "crunching" sounds that may occur when particle size and percentage of coarse particles begin to influence penetration. Note and report all occurrences of coarse gravels.

12.5 *Withdrawal*:

12.5.1 Withdraw the push rods and penetrometer tip as soon as possible after attaining complete sounding depth.

12.5.2 Upon complete withdrawal of the penetrometer, inspect the penetrometer tip for proper operation. The friction sleeve should be able to be rotated through 360° by hand without detectable binding.

12.5.3 Record baseline readings with the penetrometer tip hanging freely in air, or in water, out of direct sunlight. Compare baseline readings with initial baseline reading for requirements given in 10.1.2.1.

12.6 *Hole Closure*—In certain cases, it may be prudent or required by state law or specificiations, that the cone hole be filled, sealed, or grouted and closed after the sounding is completed. For example, in complex groundwater regimes, hole closure should be made to protect the water aquifer. Details on various methods for hole closure are provided elsewhere (**10**).

13. Calculation

13.1 *Friction Cone Penetrometers*—Most electronic cone penetrometers in use at the present time measure a change in voltage across a strain gauge element to determine change in length of the strain element. Using known constitutive relationships between stress and strain for the strain element, the applied force may be determined for the cone or friction sleeve. The applied force may then be converted to stresses using the basic equations given in 13.2 and 13.3. Since there are a wide variety of additional, optional measurements currently being obtained with electronic cone penetrometers and new ones being continually developed, it is beyond the scope of this procedure to detail the makeup, adjustments, and calculations for these optional measurements.

13.2 *Cone Resistance, q_c—Required*:

$$q_c = Q_c/A_c \qquad (1)$$

where:

q_c = cone resistance MPa (for example, ton/ft^2, kg$_f$/cm^2, or bar),
Q_c = force on cone kN (for example, ton, or kg$_f$), and
A_c = cone base area, typically 10 cm^2, or 15 cm^2.

13.2.1 *Corrected Total Cone Resistance (Required)*—Calculation of corrected total cone resistance requires measurement of porewater pressures measured at the shoulder in the u_2 position.

$$q_t = q_c + u_2\,(1 - a_n) \qquad (2)$$

where:

q_t = corrected total cone resistance, MPa (ton/ft^2, kg$_f$/cm^2, bar, or suitable units for stress),
u_2 = porewater pressure generated immediately behind the cone tip, kPa (for example, tsf, kg$_f$/cm^2, bar, or suitable units for pressure), and
a_n = net area ratio (see A1.7).

13.2.1.1 The correction to total cone resistance is particularly important when porewater pressures are generated during penetration (for example, saturated clays, silts, and soils with appreciable fines). Generally, the correction is not so significant for CPTs in clean sands, dense to hard geomaterials, and dry soils. The correction is due to porewater pressures acting on opposing sides of both the face and joint annulus of the cone tip (**1, 2, 4, 6**).

NOTE 7—In all cases, the total value q_t should be used, substituted for (or both) q_c, wherever possible. In no cases should q_c be backdetermined from q_t for use in equations, charts, formulae, or other purposes. It is always a forward procedure with corrected total q_t to be preferred.

13.2.1.2 Empirical adjustment factors based on select soil types have been developed for some pressure elements in the u_1 position, however these are not reliable. On a site-by-site basis, a relationship between u_1 and u_2 may be possible.

13.3 *Friction Sleeve Resistance, f_s—Required*:

$$f_s = Q_s/A_s \qquad (3)$$

where:

f_s = friction sleeve resistance kPa (ton/ft^2, kg$_f$/cm ^{2}, bar, or suitable units for stress),
Q_s = force on friction sleeve kN (ton, kg$_f$, or suitable units for force), and
A_s = area of friction sleeve, typically 150 cm^2 for 10-cm^2 tip, or 200 to 300 cm^2 for larger 15-cm^2 cones.

NOTE 8—A corrected sleeve friction resistance may also be obtained (f_t), yet this requires both u_2 and u_3 measurements simulaneously (**2, 3, 4, 6**). Thus, the raw f_s has been accepted for practical reasons. A simplified correction has been adopted by selected organizations (for example, (**6**)).

13.4 *Friction Ratio, R_f—(Optional)*:

$$R_f = (f_s/q_c)\cdot 100 \qquad (4)$$

where:

R_f = friction ratio, %,
f_s = friction sleeve resistance kPa (ton/ft^2, kg$_f$/cm^2, bar, or suitable units for stress),
q_c = cone resistance kPa (ton/ft^2, kg$_f$/cm^2, bar, or suitable units for stress), and
100 = conversion from decimal to percent.

13.4.1 Determination of the friction ratio requires obtaining a cone resistance and friction sleeve resistance at the same point in the soil mass. The point of the cone is taken as the reference depth. Typically, a previous cone tip resistance reading at friction sleeve midpoint depth is used for the calculations. For the 10-cm^2 penetrometer, the standard offset is 100 mm. If an offset other than midheight is used it must be reported.

NOTE 9—In some cases, if readings are compared at the same point in a soil mass which has alternating layers of soft and hard materials erratic friction ratio data will be generated. This is because cone resistance is sensed, to varying degrees, ahead of the cone. The erratic data may not be representative of soils actually present.

NOTE 10—The friction sleeve resistance and friction ratio obtained from the mechanical friction cone penetrometers will differ considerably from values obtained from electronic friction cone penetrometers. When using soil classification charts that use R_f and q_c, it is important to use charts based on correlations for the type of penetrometer being used.

13.5 *Porewater Pressure Data*:

13.5.1 SI metric units for reporting porewater pressure data are kPa.

13.5.2 *Conversion of Measured Porewater Pressures to Equivalent Height of Water—Optional*—If it is desired to display porewater pressure in equivalent height of water, convert the dynamic or static water pressures to height by dividing pressure by the unit weight of freshwater, γ_w= 9.8 kN/m^3(62.4 lb$_f$/ft^3). For salt water, use γ_w= 10.0 kN/m^3(64.0 lbf/ft^3).

13.5.3 *Estimate of Equilibrium Porewater Pressure (Hydrostatic Porewater Pressure)*—Excess porewater pressure can only be calculated by knowing equilibrium pore water pressure, u_o (see 3.2.14). The equilibrium water pressure can be measured by dissipation test or estimated by calculation as follows (see Terminology D 653):

$$u_o = \text{estimated equilibrium water pressure} = h_w \cdot \gamma_w \tag{5}$$

In saturated soils below the groundwater level, the hydrostatic case is obtained from:

$$u_o = (z - z_w)\,\gamma_w \tag{6}$$

For soils above the groundwater table that are saturated due to full capillarity, Eq 6 is also applicable. For dry soils above the groundwater table, it is commonly adopted that $u_o = 0$. In partially-saturated soils (vadose zone), there can be great transient variations and variability in the u_o profile.

where:

h_w = height of water, m (or feet), evaluate from site conditions,

γ_w = unit weight of (fresh) water = 9.8 kN/m^3(or 62.4 lbs/ft^3),

z = depth of interest (m or feet),

z_w = depth to the groundwater table (phreatic surface).

In layered soils with multiple perched aquifers the assumption of a single height of water may be in error.

13.6 *Normalized CPT Measurments* In the latest soil behavioral classification charts and CPT interpretation methods, normalized readings for cone tip resistance, sleeve friction, and porewater pressure are utilized (**2, 4, 11,**), as defined below.

13.6.1 Normalized cone tip resistance:

$$Q = (q_t - \sigma_{vo}) / \sigma_{vo}' \tag{7}$$

13.6.2 *Normalized Porewater Pressure Parameter,* B_q—This parameter is normally calculated with the shoulder porewater pressure measurement (location immediately behind the cone tip), designated u_2.

$$B_q = \Delta_2/(q - \sigma_{vo}) \tag{8}$$

13.6.3 Normalized friction ratio:

$$F = f_s/(q_t - \sigma_{vo}) \tag{9}$$

where:

Δu = excess pore water pressure ($u_2 - u_o$) (see 3.2.13),

u_o = estimated equilibrium water pressure, or hydrostatic porewater (see 13.5.3),

σ_{vo} = total vertical overburden stress, and

σ_{vo}' = effective overburden stress = $\sigma_{vo} - u_o$

The total overburden stress is calculated:

$$\sigma_{vo} = \Sigma\,(\gamma_{ti}\,\Delta z_i) \tag{10}$$

where:

Δz_i = layer thickness, and

γ_{ti} = total soil unit weight for layer.

14. Report

14.1 Report the following information:

14.1.1 General—Each sounding log should provide as a minimum:

14.1.1.1 Operator name,

14.1.1.2 Project information,

14.1.1.3 Feature notes,

14.1.1.4 Ground surface elevation and water surface elevation (if available),

14.1.1.5 Sounding location, including coordinates

14.1.1.6 Sounding number, and

14.1.1.7 Sounding date.

14.1.2 Reports should contain information concerning:

14.1.2.1 *Equipment Used*—Design drawings and data on all sensors,

14.1.2.2 Graphical data,

14.1.2.3 Electronic digital data or tabular data (optional),

14.1.2.4 Procedures followed, and

14.1.2.5 *Calibration Information*—For all sensors, information required in Section 10.

14.1.3 The report should contain a text that discusses items required in 14.2 and 14.3. Each sounding should be documented with:

14.1.3.1 Sounding plot.

14.1.3.2 *Accompanying Tabular Output*—Tabular output is considered optional due to its bulk. It is optional as long as computer data files are preserved and archived for later use.

14.1.3.3 *Computer Data Files*—Provide in ASCII format, spreadsheet file, or text, or other common file format. Computer data files must contain header as required in 14.1, sounding log information. Certain interpretation programs require data to be in a particular format. It is the responsibility of the user to determine acceptable formats.

14.1.3.4 The comments should contain notes on equipment and procedures, particular to the individual sounding.

14.2 *Equipment*—The report should include notes concerning:

14.2.1 Penetrometer manufacturer,

14.2.2 Types of penetrometer tips used,

14.2.3 Penetrometer details such as net area ratio, friction sleeve end areas, location and types of sensors, location and type of friction reducers,

14.2.4 Offset between tip and sleeve resistance used for friction ratio determination,

14.2.5 Serial numbers of penetrometer tips,

14.2.6 Type of thrust machine,

14.2.7 Method used to provide reaction force—with notes as to possible surface deformations,

14.2.8 Location and type of friction reduction system (if any),

14.2.9 Method of recording data,

14.2.10 Condition of push rods and penetrometer tip after withdrawal,

14.2.11 Any special difficulties or other observations concerning performance of the equipment,

14.2.12 Details on piezocone design, filter elements, and fluid conditioning procedures, and

14.2.13 Information on other sensing devices used during the sounding.

14.3 *Calibration Certifications*—For each project the report should include the load range calibrations of the cones used that were performed in accordance with Section 10. The report should include the initial and final baseline readings for each sounding. Calibration records for the porewater pressure transducers are required as given in 10.2. If the project requires calibrations of other sensors they should also be submitted in final reports.

14.4 *Graphs*—Every report of friction cone penetration sounding is to include a cone tip resistance plot, q_c MPa, or preferably total cone tip resistance, q_t MPa (or ton/ft^2, kg$_f$/cm^2, bar, or other acceptable unit of stress) with depth below ground surface m (ft), friction sleeve resistance, f_s, kPa (ton/ft^2, kg$_f$/cm^2, bar, or other acceptable units of stress), and friction ratio, R_f (%), on the same plot. (See Fig. 4 and Fig. 5 for example plots.) As a minimum, the plot should provide general information as outlined in 14.1. Electronic piezocone penetrometer soundings should provide an additional plot of porewater pressure kPa (or lb$_f$/in.^{2}, kg$_f$/cm^2, bar, or other acceptable units of pressure) versus depth, m (ft). Porewater readings can be plotted as pressures, or alternatively, the pressure may be converted to equivalent heights of water (that is, $h_w = u_2/\gamma_w$).

14.4.1 Symbols q_t and f_s for tip and sleeve resistance are accepted by the International Society for Soil Mechanics and Geotechnical Engineering (**1, 2, 3, 7**).

14.4.2 For uniform presentation of data, the vertical axis (ordinate) should display depth and the horizontal axis (abscissa) should display the test values. There are many preferences in plotting such that uniform plotting scales and presentation will not be required.

15. Precision and Bias

15.1 *Precision*—There are little direct data on the precision of this test method, in particular because of the natural variability of the ground. Committee D-18 is actively seeking comparative studies. Judging from observed repeatability in approximate uniform deposits, persons familiar with this test estimate its precision as follows:

15.1.1 *Cone Resistance*—Provided that compensation is made for unequal area effects as described in 13.2.1, a standard deviation of approximately 2 % FSO (that is, comparable to the basic electromechanical combined accuracy, nonlinearity, and hysteresis).

15.1.2 *Sleeve Friction—Subtraction Cones*—Standard deviation of 15 % FSO.

15.1.3 *Sleeve Friction—Independent Cones*—Standard deviation of 5 % FSO.

15.1.4 *Dynamic Porewater Pressure*—Strongly dependent upon operational procedures and adequacy of saturation as described in 11.2. When carefully carried out a standard deviation of 2 % FSO can be obtained.

15.2 *Bias*—This test method has no bias because the values determined can be defined only in terms of this test method.

NOTE 11—Jefferies and Davies (**11**) report q_t repeatability of the two different soundings in compact clean sand using two different cones by the same manufacturer. Approximately 50 % of the data lay within 8 % of the average of the two tests, and 90 % of the data lay within 15 % of the average. In this trial the transducers (that conformed to the requirements in A1.5) were loaded to between one tenth and one fifth of their rated FSO, so confirming a standard deviation of better than 2 % FSO.

16. Keywords

16.1 cone penetration test; cone penetrometer; explorations; field test; friction resistance; geotechnical test; in-situ testing; penetration tests; penetrometer; piezocone; point resistance; porewater pressures; resistance; sleeve friction; soil investigations

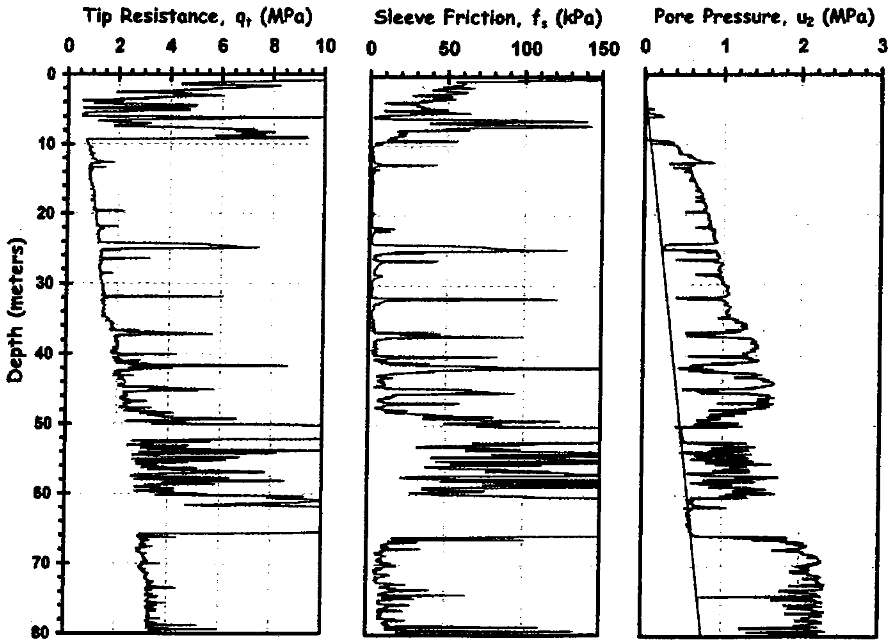


FIG. 4 Example Graph Presentation Results from a Conventional Piezocone Penetration Test

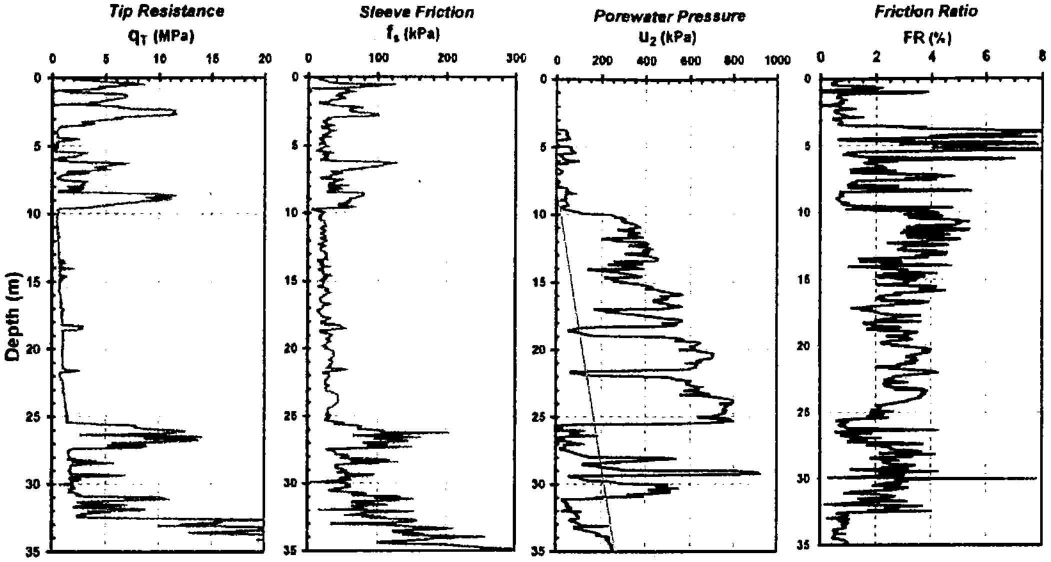


FIG. 5 Illustrative Piezocone Graph Showing Tip Resistance, Sleeve Friction, Penetration Porewater Pressure, and Friction Ratio

ANNEX

(Mandatory Information)

A1. CALIBRATION REQUIREMENTS ON NEWLY MANUFACTURED OR REPAIRED ELECTRONIC FRICTION CONE AND PIEZOCONE PENETROMETERS

A1.1 *Introduction:*

A1.1.1 This annex describes procedures and requirements for calibrating electronic cone penetrometers. The evaluation of cone penetrometer calibration as described in this annex is a quality assurance standard for newly manufactured and repaired penetrometer tips. Many of the standards may be impractical to evaluate under field operating conditions. Therefore, determination of these calibration errors for any individual penetrometer tip should be performed in a laboratory environment under ideal conditions by the manufacturer or other qualified personnel with necessary knowledge, experience, and facilities.

A1.1.2 The electronic cone penetrometer is a delicate instrument subjected to severe field conditions. Proper use of such an instrument requires detailed calibration after manufacture and continuous field calibrations. Years of cone penetrometer design and performance experience have resulted in refined cone designs and calibration procedures which make the electronic cone penetrometer a highly reliable instrument. Reports of these experiences form the basis for requirements in this annex (**1, 2, 3, 9**).

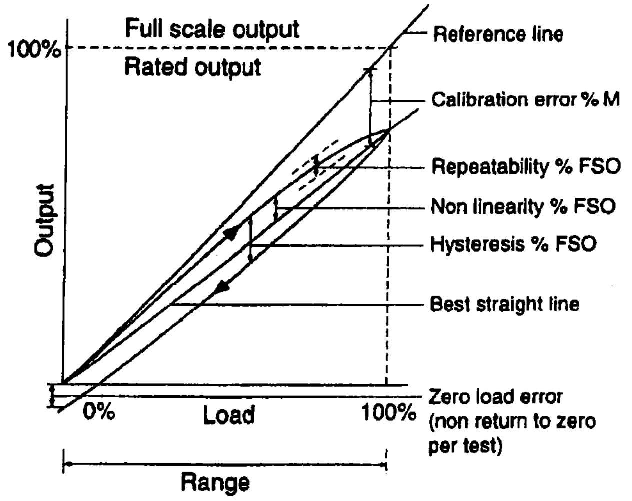
A1.1.3 The required calibration tolerances developed in this annex are based on subtraction type electronic cone penetrometers. These penetrometers are more robust than electronic cone penetrometers with independent tip and sleeve load cells and are the most widely used design. The subtraction type penetrometer, however, has less precision due to the subtraction process (**3, 9**). As a result, calibration tolerances given here are considered maximum values and requirements for more sensitive cone penetrometers imply smaller tolerances having greater precision. The calibration process consists of loading the penetrometer tip with reference forces and pressures and then comparing measured output to the reference.

A1.1.4 Calibrations in the laboratory environment should be performed with the complete penetrometer system to be used in the field. The same make and model computer, cable, signal conditioning system, and penetrometer to be used in the field shall be calibrated in the laboratory. Depending on the components of the system some components may be substituted with acceptable replacements. Each individual penetrometer must be tested over a range of loads to assure adequate performance.

A1.2 *Terms Related to Force Transducer Calibrations:*

A1.2.1 Fig. A1.1 is a graphical depiction of terms related to transducer calibrations and defines the concepts of zero-load error, nonlinearity, hysteresis, and calibration error (**2, 8**).

A1.2.2 To evaluate several of these values, the FSO (full scale output) of the penetrometer tip is needed. The manufacturer shall provide full scale output information for the system. Cone penetrometer tips usually are available in nominal



% FSO = percentage of full-scale output

% M = percentage of measured output

FIG. A1.1 Definition of Calibration Terms for Load Cells and Transducers (2, 8)

capacities of 2, 5, 10, and 15 metric tons. Typical full-scale outputs for these penetrometer tip ranges as follows:

Nominal Capacity	Full-Scale Output of Cone, q_c		Full-Scale Output of Friction Sleeve, f_s	
metric tons	ton/ft^2	MPa	ton/ft^2	kPa
2	200	20	2	200
5	500	50	5	500
10	1000	100	10	1000
15	1000	100	10	1000

A1.2.3

It is important to check with the manufacturer on the full scale output of electronic cone penetrometer tips to avoid overloading and damaging penetrometer tips.

A1.3 *Zero Load Baseline Values:*

A1.3.1 Zero-load output variation of the cone penetrometer during testing and calibration is a reliable indicator of output stability, internal O-ring friction, and temperature-induced apparent load. The variation in zero load output is affected by temperature fluctuation because temperature compensated strain gages do not compensate for material effects and system component effects (**1, 2, 3, 8**).

A1.3.2 Systems with microprocessors provide "reference baseline" values for the transducers that are not equal to zero but are measured positive or negative values depending on the electronics of the system. For the particular penetrometer and penetrometer system used, the baseline values should remain relatively constant through the life of the penetrometer. As testing is performed in the field, the baseline resistances are monitored for changes. If large changes are noted the penetrometer should be loaded to check for linearity and possible damage. Evaluate the zero-load error during load range calibration by taking the difference between initial and final baseline values.

A1.3.3 *Thermal Stability*—For ensurance of thermal stability, evaluate a particular design of a newly manufactured cone under a range of temperature conditions. Newly manufactured penetrometer tips are first cycled to a minimum of 80 % of FSO five times at room temperature, to remove any residual nonlinearity. After cycling, establish an initial reference baseline value at room temperature after the cone has been electrically powered for about 30 min. To evaluate thermal stability, stabilize the penetrometer tip at temperatures of 10 and 30°C and new baseline values are obtained. The change in baseline values must be ≤ 1.0 % FSO of either cone or friction sleeve resistances.

A1.4 *Load Range Calibration:*

A1.4.1 Calibrate newly manufactured or repaired cone penetrometers over a range of loads after production or repair. Load test the cone penetrometer system in a universal testing machine or specially designed cone penetrometer calibration device capable of independently loading the cone and friction sleeve. If a universal testing machine is used, a calibration certificate (current within the last year) in accordance with Practice E 4 must be available. If a cone calibration apparatus is used, it should also have a calibration document current within the last year. The calibration document shows that applied forces or masses are traceable to standard forces or masses retained by the National Institute of Standards and Technology. The universal testing machine or cone calibration devices must be capable of loading the penetrometer tip to 100 % FSO.

A1.4.2 Selection of loading steps and maximum loading varies depending on need and application. Select the load steps and maximum load to cover the range of interest and not necessarily the maximum capacity of the cone. Some calibrations stress more frequent load steps at lower loads to evaluate weaker materials. Selection of more frequent lower load steps may result in higher levels of calibration error since the best fit line is more influenced by the low range data.

A1.4.3 Perform the loading after the cone is subjected to five cycles of compressive loading and reference baselines, or internal zeroing, have been obtained at room temperature. The penetrometer is loaded in a minimum of six increments at forces equivalent to 0, 2, 5, 10, 25, 50, and 75 % FSO. At each increment of force, record both cone and sleeve resistances. Compute the actual cone tip resistance by dividing the applied force by the cone base area. The friction sleeve resistance is taken as the corresponding axial force over the sleeve area. Determine the "best fit straight line" by linear regression of applied force and measured output. The linearity is the difference between measured cone resistance and best-straight line cone resistance divided by the cone FSO. Evaluate hysteresis by comparing the difference between cone resistance at the same level of applied force in loading and unloading and dividing by cone FSO. Calculate calibration error by taking the difference between the best-fit-straight line cone resistance and actual cone resistance and dividing by the actual cone resistance. Calibration error can become larger with smaller measured outputs and, therefore, it is not evaluated at loadings equivalent to less than 20 % of cone FSO.

A1.4.3.1 When calibrating the penetrometer, monitor the friction sleeve resistance to evaluate apparent load transfer. With a subtraction-type electronic cone penetrometer tip, the apparent friction sleeve resistance is caused by electrical subtraction error, crosstalk, and any load transferred mechanically to the sleeve. With a cone, that provides for independent cone and sleeve measurements, apparent friction sleeve resistances are caused by electrical crosstalk and mechanical load transfer. Apparent load transfer must be less than 1.5 % of FSO of the friction sleeve (1000 kPa).

A1.4.3.2 Maximum nonlinearity should be 0.2 %, maximum calibration error should be 0.5 %, and maximum apparent load transfer should be 1.2 %. For this calibration, the zero load error was zero. Hysteresis was not evaluated in this example because the testing machine was incapable of producing the exact same force on the loading and unloading steps.

A1.4.4 For calibration of the friction sleeve element, apply the forces in seven increments at 0, 2, 5, 10, 25, 50, and 75 % of FSO. Nonlinearity, hysteresis, and calibration error are evaluated in the same manner as calibrations for the cone tip reading. During friction sleeve calibration, monitor cone tip resistance to evaluate apparent load transfer that was not apparent in this calibration.

A1.5 *Force Transducer Calibration Requirements:*

A1.5.1 Calibration requirements developed for electronic cone penetrometers are based on past experience with subtraction-type electronic cone penetrometers and, as a result of this experience, represent the minimum precision requirement of electronic cone penetrometers. In cases where a higher level of precision is required, stricter calibration requirements would be required. Newly manufactured or repaired electronic cone penetrometers are required to meet the following requirements:

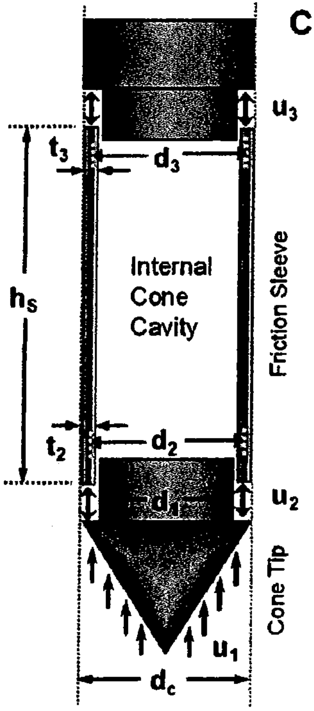
Calibration Parameter	Element	Requirement
Zero-load error	Tip and sleeve	≤ ± 0.5 % FSO
Zero-load thermal stability	Cone tip and sleeve	≤ ± 1.0 % FSO
Nonlinearity	Cone tip	≤ ± 0.5 % FSO
	Sleeve	≤ ± 1.0 % FSO
Hysteresis	Tip and sleeve	≤ ± 1.0 % FSO
Calibration error	Cone tip	≤ ± 1.5 % MO at >20 % FSO
	Sleeve	≤ ± 1.0 % MO at >20 % FSO
Apparent load	While loading cone tip	≤ ± 1.5 % FSO of sleeve transfer
	While loading sleeve	≤ ± 0.5 % FSO of cone tip

A1.6 *Pressure Transducer Calibrations:*

A1.6.1 Newly manufactured or repaired pressure transducers shall be supplied with a load range calibration provided by the manufacturer. The load range calibration shall consist of a minimum of six points of loading to at least 75 % of FSO. The applied pressures shall be traceable to reference forces maintained by NIST. The calibration shall meet the manufacturer's stated tolerances. Minimum requirements are linearity better than 1 % of FSO and zero load error less than ±7 kPa (±1.0 lb/in.^{2}).

A1.6.2 The transducer shall be subjected to regular periodic inspection meeting requirements in A1.6.1.

A1.7 Correction of Tip and Sleeve Areas:



Corrections for Tip and Sleeve Readings

d_j = diameter geometry (as shown)
t_j = thickness of friction sleeve
u_i = measured porewater pressure
q_c = measured cone tip resistance
f_s = measured sleeve friction
q_t = total cone tip resistance
f_t = total sleeve resistance
a_n = tip net area ratio from triaxial test
b_n = sleeve net ratio from triaxial test
h_s = height of sleeve

Sleeve Friction:

$$f_t = f_s - (\pi d_2 t_2 u_2 + \pi d_3 t_3 u_3)/(\pi d_c h_s)$$

$$f_t \approx f_s - b_n u_2$$

Tip Resistance:

$$q_t = q_c + (1 - a_n) u_2$$

FIG. A1.2 Determination of Net Area Ratio (a_n) for Corrections of Cone Tip Resistances (4)

A1.7.1 The conceptual regions where water pressures can act on the cone tip and sleeve elements are shown in Fig. A1.2. Water pressure that acts behind the cone tip will reduce measured cone resistance, q_c, by the magnitude of water pressure acting on unequal areas of the tip geometry. It is therefore advantageous to use a penetrometer having a net area ratio $a_n = 0.80$ in order to minimize the effect of the correction (**1, 2**). Water pressure may also act on both ends of the sleeve, resulting in an imbalance of forces if the sleeve is not designed with equal effective end areas. The water pressures acting on the ends of the sleeve are not just a function of geometry, they are also a function of the location of water seals. Water pressures during penetration are not often measured at both ends of the sleeve (that is, simultaneous u_2 and u_3) so a correction is not normally made for f_s (**3**).

A1.7.2 Equal end area friction sleeves should be required for use and should be designed by the manufacturer. The best method for evaluating sleeve imbalance is to seal the penetrometer in a pressure chamber and apply forces to measure the sleeve resistance after zeroing the system. Manufacturers should perform this check for a particular design to assure minimal imbalance.

A1.7.3 In order to calculate the corrected total cone resistance, q_t, as shown in 13.2.1, it will be necessary to determine the area ratio of the cone. The penetrometer can be enclosed in a sealed pressure vessel (for example, triaxial cell) and water pressures should be applied as shown in the example in Fig. A1.3. The net area ratio is then used in computing the corrected total tip resistance.

A1.8 Other Calibrations—Other sensors such as inclination, temperature, etc. may require calibration depending on the requirements of the investigation. Perform such calibrations using similar techniques given in this annex or by other reference procedures. Report such calibrations when required.

A1.9 *Documentation of Calibrations:*

A1.9.1 Laboratory calibration documents consisting of a short report on the equipment and methods of testing, along with tables and figures similar to those in this annex, are required for the following occurrences:

A1.9.1.1 When new penetrometer tips are received, and

A1.9.1.2 When damaged penetrometer tips are repaired.

A1.9.2 The report must be certified by a registered professional engineer or other responsible engineer with knowledge and experience in materials testing for quality assurance. Calibration documents are retained on file by the offices responsible for performing soundings and should be updated at required intervals. For contract soundings, calibration documents should be obtained prior to contract acceptance and after testing on unaltered equipment.

A1.9.3 If the electronic cone penetrometer meets the field calibration requirements given in 10.1.3, it is only necessary to

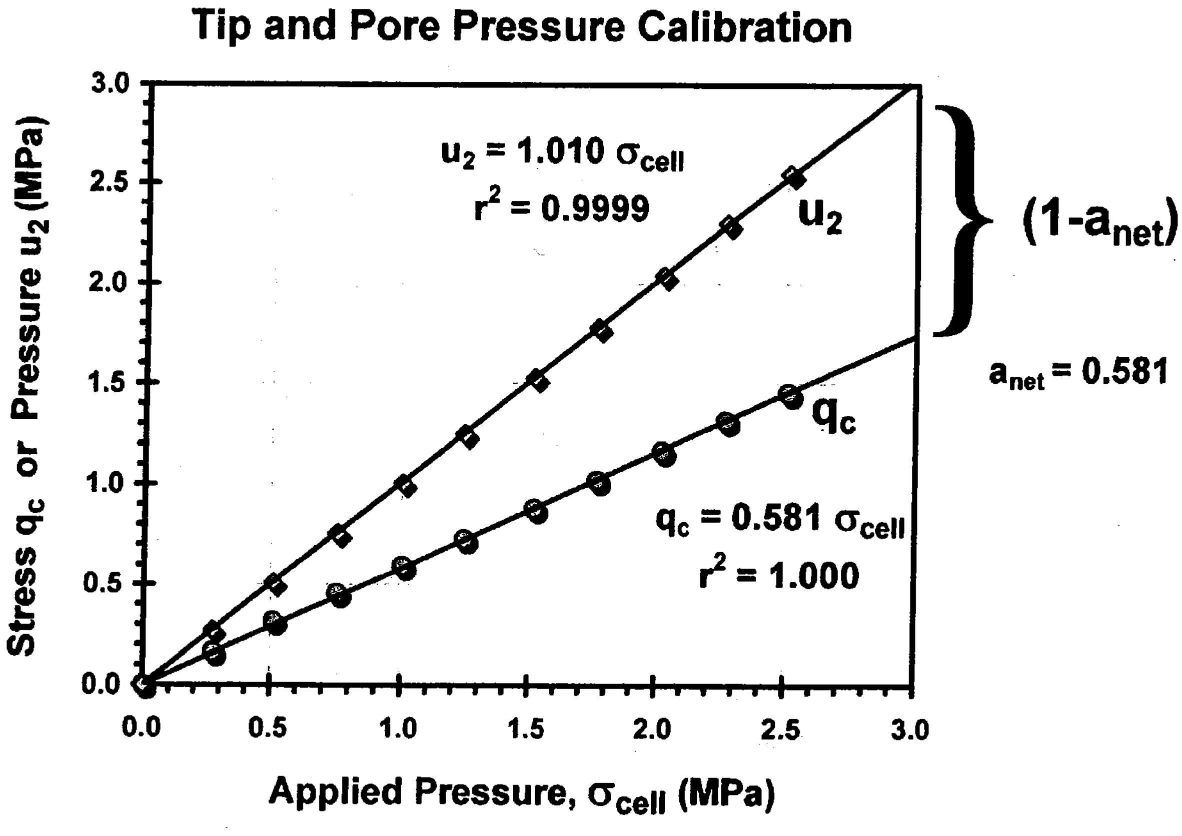


FIG. A1.3 Illustrative Example Determination of Unequal End Area for Correction of Tip Resistances Using Pressurized Triaxial Cell Calibration adjust the penetrometer tip to the laboratory requirements on a yearly basis. Cone penetrometers should be calibrated using laboratory procedures prior to use on each new project, but they do not need to meet calibration tolerances as required for newly manufactured cones.

REFERENCES

(1) Campanella, R. G., and Robertson, P. K. (1988), "Current status of the piezocone test," *Penetration Testing 1988* (Proceedings, ISOPT-1, Orlando), Vol. 1, Balkema, Rotterdam, 93–116.

(2) Lunne, T., Robertson, P.K. and Powell, J.J.M. (1997), *Cone Penetration Testing in Geotechnical Practice*, Blackie Academic/Routledge Publishing, New York, 312 pages.

(3) *International Reference Standard for the Cone Penetration Test* (1999), Technical Committee TC 16, ISSMGE, Proceedings, 121th European Conf. on Soil Mechanics & Geotechnical Engineering (Copenhagen), Vol. 3, Balkema, Rotterdam, 2195–2222.

(4) Jamiolkowski, M., Ladd, C.C., Germaine, J.T. and Lancelotta, R. (1985), "New developments in field and lab testing of soils," Proceedings, *11th International Conference on Soil Mechanics & Foundation Engineering*, Vol. 1, San Francisco, 57–154.

(5) Mayne, P.W. (2007), *Synthesis 368 on Cone Penetration Testing*, NCHRP 20-05 (Task 37-14), National Academy Press, Washington, D.C., 162 p.

(6) Mulabdić, M., Eskilson, S., and Larsson, R. (1990), "Calibration of piezocones for investigations in soft soils and demands for accuracy of the equipment," *SGI Varia* No. 270, Swedish Geotechnical Insitute, Linköping, 62 p.

(7) DeBeer, E.E., Goelen, E., Heynen, W.J. and Joustra, K. (1988). "Cone penetration test: International reference test procedure," *Penetration Testing 1988*, (Proceedings, ISOPT-1, Orlando), Vol. 1, Balkema, Rotterdam, 27–52.

(8) Schaap, L. H. J., and Zuidberg, H. M. (1982), "Mechanical and electrical aspects of the electric cone penetrometer tip," *Proceedings of the Second European Symposium on Penetration Testing*, Vol. 2, Amsterdam, 841–851.

(9) DeJong, J.T, Yafrate, N.J., and DeGroot, D.J. (2007), "Design of a miniature piezoprobe for high resolution stratigraphic profiling," *ASTM Geotechnical Testing Journal*, Vol. 30 (4), 11 p.

(10) Lutenegger, A.J. and DeGroot, D.J. (1995), "Techniques for sealing cone penetrometer holes," *Canadian Geotechnical Journal*, Vol. 32 (5), 880–891.

(11) Jefferies, M. G., and Davies, M. P. (1993), "Use of the CPTu to Estimate Equivalent SPT N60," *Geotechnical Testing Journal*, Vol. 16, No. 4, ASTM, 458–468.

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 5778 – 95 (2000)) that may impact the use of this standard. (Approved November 1, 2007.)

(*1*) New references added.

(*2*) Excess porewater pressure definition corrected in 3.2.13.

(*3*) Fig. 2 reference citation updated.

(*4*) Revised Fig. 3.

(*5*) Normalized cone tip resistance added to 13.

(*6*) Generally overall improvement in many graphs with newer figures that show better detailing and annotation.

(*7*) Fig. 1 includes three basic cone penetrometer designs (rather than older figure showing only two designs), that is, compression-, tension-, and subtraction-types.

(*8*) Fig. A1.1 and Fig. A1.1 have been replaced with newer figures to show the pressurization calibration.

(*9*) Section 12.6 on hole closure has been added.

(*10*) Use of capital U for porewater pressures is replaced with small lowercase u in 7.1.8.5.

(*11*) Penetrometer gap has now been labeled as e_c in 7.1.4.3.

(*12*) Added reference to Practice D 3740.

(*13*) Common stress and pressure values have been mentioned.

(*14*) Numerous general cleanup and correction of grammatical and spelling errors, too numerous to mention here.

Appendix 2

Geotechnical Investigation Report

Detailed Site Investigation
Proposed Utility Waste Disposal Area
Ameren Labadie Power Plant

Prepared by: GREDELL Engineering Resources, Inc.

REPORT
2008012455

AMEREN MISSOURI LABADIE POWER PLANT UTILITY WASTE LANDFILL, DETAILED SITE INVESTIGATION FRANKLIN COUNTY, MISSOURI

SUMMARY OF GEOTECHNICAL INVESTIGATION

Prepared for

Ameren
MISSOURI

Prepared by

REITZ & JENS, INC.
CONSULTING ENGINEERS

JEFFREY LYNN FOUSE
NUMBER E-21043
11/10/10

November 10, 2010

The Professional whose signature and personal seal appear hereon assumes responsibility only for what appears in the attached report and disclaims (pursuant to Section 327.411 RSMo) any responsibility for all other plans, estimates, specifications, reports, or other documents or instruments not sealed by the undersigned Professional relating to or intended to be used for any part or parts of the project to which this report refers.

TABLE OF CONTENTS

APPENDICES

AMEREN MISSOURI LABADIE POWER PLANT
UTILITY WASTE LANDFILL DETAILED SITE INVESTIGATION
LABADIE, MISSOURI

SUMMARY OF GEOTECHNICAL INVESTIGATION

1.0 INTRODUCTION

This geotechnical investigation was a component of the Detailed Site Investigation (DSI) for the proposed Utility Waste Landfill (UWL) at the Ameren Missouri Labadie Power Plant in Franklin County, Missouri. The purpose of this geotechnical investigation was to utilize the "temporary" borings required for the DSI to provide data of subsurface conditions for the subsequent geotechnical analyses and design of the UWL. Of these temporary geotechnical borings, about one-quarter were standard borings and the remaining were cone penetrometer test soundings (CPT).

This report describes the field investigation and laboratory testing program conducted for this geotechnical investigation, and presents the boring logs and laboratory test data in several appendices.

The geotechnical investigation was conducted in general accordance with the approved DSI Work Plan, dated May 2009, with the exceptions noted herein.

Reitz & Jens' Senior Project Manager was Jeffrey Fouse, P.E. The supervising geologist was Mikel Carlson, R.G., who also supervised installation of the piezometer borings. Jason Pruett, a Reitz & Jens' Soil Technician, directed the standard geotechnical borings in the field, and logged the borings and samples. Christopher Cook, a Reitz & Jens' Geological Engineer, conducted the CPT soundings.

2.0 FIELD INVESTIGATION

2.1 Plan of Boring Locations

The field investigation consisted of 119 borings and 93 CPT soundings for a total of 212. Of the 119 borings, 22 were temporary geotechnical borings (labeled "B-"), and 97 were piezometer borings (labeled "P-"). The CPT soundings (labeled "C-") were alternated with the piezometer borings on a regular grid-like pattern. The plan of the borings and CPT soundings is shown in Figure 8. Some locations were moved from a linear pattern due to geographic restrictions or to better characterize the subsurface conditions. Confirmation borings for some of the CPT soundings were made and are numbered the same (for example B-50 and C-50). Confirmation CPT soundings were also made at randomly selected locations, such as C-46 and C-46A. Temporary geotechnical borings were generally located near the perimeter of the disposal area. These borings were in addition to the preliminary geotechnical investigation by Reitz & Jens in 2007, which included the installation of three piezometers (P-1, P-2, and P-3) and five temporary geotechnical borings (B-4, B-5, B-6, B-7, and B-8). The report of this investigation was included in the Preliminary Site Investigation (PSI) request submitted to MDNR-DGLS in December 2008, and in the approved DSI Work Plant (reproduced in Appendix 1). These 8 logs are included in Appendix A to this report for reference.

Reitz & Jens located and staked the boring and sounding locations before drilling using a hand-held global positioning system (GPS). The borings and soundings were staked after completion and were subsequently surveyed by Kuhlmann *design* Group, Inc. (K*d*G) under a subcontract to Reitz & Jens, Inc.

2.2 Criteria for Completion Depths

All of the temporary and piezometer borings were made to a minimum depth of 35 feet, which is a minimum of 25 feet below the assumed depth of the UWL (10 feet below current ground surface). The actual depth of UWL probably will not be more than 5 feet below the current ground surface, based in part of the monitoring of groundwater levels, and thus a minimum depth of 30 feet would satisfy the regulatory requirement. One of the borings (B-100) was extended to auger refusal, primarily to obtain N-values from the Standard Penetration Test (SPT) for seismic site classification and liquefaction analyses. This boring was in addition to the two borings that were included in the preliminary geotechnical investigation which extended to probable bedrock (P-1 and B-7). The shallow borings were extended beyond the minimum depth of 35 feet if necessary to meet the one of the following two criteria: 1) the uncorrected N-value from the SPT was a minimum of 8 blows/foot, or 2) the last 15 feet of soil was classified as sand or gravel (Unified Soil Classification of SW, SP, SM, GW, GP, GP-SP). Several borings were planned to extend to a depth of 50 feet for later geotechnical analyses and design. Due to these criteria, 11 borings were extended beyond the minimum depth of 35 feet.

The three deep borings were extended to drilling or sampler refusal on bedrock or boulders. Drilling refusal was defined as a penetration rate with a drill bit of less than 0.2-inches per minute for 5 minutes and with a downward pressure of at least 500 psi. Sampler refusal was defined as less than 6 inches of penetration after 50 blows with a SPT hammer. The final depths of the deep borings were: 91.5 feet in P-1, 104.5 feet in B-7, and 107.6 feet in B-100.

CPT soundings were advanced to a minimum depth of 35 feet or cone refusal. Cone refusal was defined as the inability of the cone to be advanced without potential damage, as determined by the operator, due to overloading of the cone, bending of the rod string, or sharp bending of the cone. Refusal may also occur due to the rig’s inability to advance the cone, either due to reaching the maximum down pressure that the rig could hydraulically produce, or by failure of the soil – anchor interface to provide a reaction force for the rig. Refusal occurred in very dense coarse sands and gravely sands on many occasions. In the cases where refusal occurred at depths shallower than 30 feet, a follow-up sounding was performed to attempt to penetrate farther. Because C-92 refused at only 23.3 feet, a temporary geotechnical boring (B-92A) was made to 45 feet next to C-92.

2.3 Drilling Procedures for Temporary Geotechnical Borings

The temporary geotechnical borings were made by TerraDrill, Inc. of Dupo, Illinois under subcontract with Reitz & Jens, using a CME 550 drilling rig mounted on an all-terrain vehicle (ATV).

Borings were advanced from the ground surface to the depth of the saturated sandy soils using 4.25-inch I.D. hollow-stem augers. The actual depth of augering ranged from 5 feet to 15 feet, and averaged about 10.5 feet. The depth of the water inside the hollow-stem augers was maintained at the same depth as the surrounding ground water. Hollow-stem augers were advanced with the center plug attached to the drill rods, to prevent soil from entering the augers. After the sand strata were reached below the prevailing ground water table, the borings were advanced using rotary drilling techniques with slurry of Bentonite and soil cuttings to stabilize the hole. The slurry was recirculated, and the loss of drilling fluid was noted in the boring log. A tri-cone bit was used which had a center discharge of the drill fluid; however, the discharge was partially obstructed such that the soil below the bit was not disturbed.

Soil cuttings were removed prior to sampling. Reitz & Jens' Soils Technician noted the length of drilling rod in the hole before it was extracted and after the sampler was set on the bottom of the boring. If the change in depth was more than 3 inches, then the sampler was removed and the hole was re-cleaned to the sample depth.

2.4 Sampling Procedures for Temporary Geotechnical Borings

From the ground surface to a depth of 10 feet: Four samples of the subsurface soils were taken in the top 10 feet, at intervals of about 2.5 feet. Samples were taken using either: 1) a hydraulically pushed, 3-inch O.D., thin-wall "Shelby tube" sampler in general accordance with ASTM D1587 “Thin-Walled Tube Sampling for Geotechnical Purposes”; or 2) a 2-inch O.D., split-spoon sampler driven by an automatic SPT hammer in conjunction with a Standard Penetration Test, in general accordance with ASTM D1586 “Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils”. At least one Shelby tube sample of soils was taken in the first 10 feet of each boring where fine-grain soils were present. The depths of the Shelby tube samples were varied. If the uncorrected N-value from a SPT was less than 5 blows/foot and the sample was fine-grain soil, then the following sample was taken with a Shelby tube.

From a depth of 10 feet to a depth of 50 feet: Samples were taken at intervals of about 5 feet. Samples were obtained using a 2-in. O.D., split-spoon sampler in conjunction with a SPT. If soft, fine-grain soils were found below a depth of 10 feet, then a second Shelby tube was to be taken.

From a depth of 50 feet to refusal: Samples were taken at intervals of about 10 feet using a 2-in. O.D., split-spoon sampler in conjunction with a SPT.

A representative soil sample was taken from each split-spoon. If there was a change in soil type, then two samples were taken. Each sample was placed in a glass jar and immediately sealed to prevent loss of moisture. Each jar was labeled with the boring number, sample number, sample depth, and the blow count for each 6-in. increment. The samples were protected against extreme temperature changes.

The bottom end of each Shelby tube sample was trimmed and then sealed with a tight-fitting plastic cap and duct tape. Excess fluid and loose material were removed from the upper end of the tube and the length of the recovered sample was measured. The top end of the tube was then sealed with a tight-fitting plastic cap and duct tape. The boring number, sample number, sample depth, and recovered length were written on the outside of the tube with a permanent marker. Shelby tube samples were maintained in a vertical position with the bottom end down at all times. Samples were protected from extreme changes in temperature or disturbance.

Samples were preserved and transported in general accordance with ASTM D4220 “Standard Practice for Preserving and Transporting Soil Samples.” Relatively undisturbed Shelby tube samples were transported vertically in a rack to prevent disturbance. Reitz & Jens was responsible for transporting of all geotechnical samples and for maintaining records.

Published tests have shown that the blow counts from a SPT using an automatic hammer are lower than the blow count obtained using a 140-lbs. manual drop hammer, rope and cathead. Manual SPT hammers have been used to develop correlations between blow counts, or N-values, and soil properties. Therefore, N-values from an automatic hammer should be increased in order to use such correlations. ASTM D6066 “Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential” is the standard procedure for correcting N-values due to the greater energy efficiency of an automatic hammer and other factors. An independent testing firm performed a study of the energy efficiency of Terra Drill’s automatic SPT hammer. The reported average efficiency is shown on the boring logs. The uncorrected field blow counts and N-values are shown on the individual boring logs.

2.5 Field Boring Logs for Temporary Geotechnical Borings

A log of each boring was recorded by Reitz & Jens’ Soils Technician in general accordance with ASTM D5434 "Field Logging of Subsurface Explorations of Soil and Rock." The field log included the following information at a minimum:

1. An accurate description of any deviation from the planned boring location.
2. Drilling method(s) used, including diameter of augers.
3. Depths of generalized soil and rock boundaries encountered, based upon drilling characteristics, samples, cuttings, color of drilling fluid, etc.
4. Depths of samples, including: type, length sampled, length recovered, hammer blows for each 6-in. interval for SPT’s.
5. Loss of drilling fluid, if applicable.
6. Water level readings (to 0.1 foot) when free water is first encountered
7. Identification of the soil.
8. Pocket penetrometer readings on firm to stiff cohesive soil samples
9. Note the length and cause of significant delays in field operations.
10. Record the depth of material sloughed into the hole or the depth to collapse of the hole, if any.
11. Note how the boring was backfilled.

Soils were classified in general accordance with ASTM D2487 “Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)” and ASTM D2488 “Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)”. Soil classifications were subsequently checked in the laboratory, and modified if necessary based on the lab classification and tests.

2.6 Backfilling of Temporary Geotechnical Borings

Borings were backfilled immediately after drilling. Backfilling of borings was done in accordance with the approved DSI Workplan. The deep boring (B-100) and the borings near the existing Missouri River levee (B-10, B-13, and B-14) were grouted with "neat grout" as defined by the U.S. Army Corps of Engineers. The other shallow borings were backfilled with cuttings or sand.

2.7 Procedure for Cone Penetration Test Soundings

The CPT soundings were made by Terra Drill, Inc. using an AMS-probe rig. The cone penetrometer consists of a 1.5-inch diameter, 100-MPa capacity, electronic piezocone, which records tip pressure, sleeve friction and porewater pressure every 20 millimeters as the cone is hydraulically pushed into the ground at a specified rate. The testing was carried out according to ASTM D5778 "Electronic Friction Cone and Piezocone Penetration Testing of Soils". The field investigation was done under the direction of a Reitz & Jens' Geological Engineer, who set up and operated the CPT equipment, monitored data collection, and determined cone refusal. The CPT sounding were backfilled immediately after extraction of the probe using Bentonite crumbles. The final CPT sounding logs are presented in Appendix C. The analysis of the raw data from the CPT soundings is discussed in Appendix D. This appendix also includes the side by side comparisons between the CPT sounding and other borings, and comparisons between CPT soundings performed side by side in the field.

3.0 LABORATORY TESTING PROGRAM

3.1 Laboratory Procedures

All laboratory testing was done in general accordance with the latest applicable ASTM procedures as contained in Reitz & Jens' Quality Manual. Reitz & Jens' soils laboratory maintains an AMRL certification from NIST. The general procedures were:

1. All samples were logged in on Reitz & Jens' standard form for the request of laboratory soils tests, which included the boring number, sample number, sample depth interval, and sample type.
2. Jar samples from the split-spoons were classified in the lab by a different technician, geotechnical engineer or geologist than the one who performed the field classifications. A moisture content test, ASTM D2216 "Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass", was performed on all fine-grained soil samples.
3. Selected coarse-grained samples were washed through a U.S. #200 sieve to determine the percentage of fines according to ASTM D422 "Particle-Size Analysis of Soils", and the portion retained on the #200 sieve was dried, weighed, and resealed in a glass jar.

A copy of the field boring log and the laboratory test request form was given to the Senior Project Manager. The Senior Project Manager assigned laboratory tests based upon the field classifications and the anticipated geotechnical analyses required for the geotechnical design of the UWL. The criteria for the selection of laboratory tests are described in Section 3.2.

Shelby tube samples were extruded immediately prior to performing the assigned tests. Each tube sample was "micro-logged." If the soil sample differed from the presumed soil classification on the field log, then the Senior Project Manager examined the soil sample and modified the test assignments accordingly. Portions of selected Shelby tube samples were saved for possible future testing. These samples were wrapped in aluminum foil, placed in cardboard tubes, and the annular space was filled with paraffin wax.

Once all laboratory testing for given boring was complete, the laboratory classifications and test data were combined with the information in the field boring log and entered into Reitz & Jens' computer program GEOSYSTEM for Windows. Draft logs were printed. The draft logs were reviewed by the Laboratory Manager, a licensed Professional Engineer, both for accuracy (i.e. correct blow counts, sample types, sample depths, recovery percentages and laboratory test results) and consistency of the information provided. The sample description on the field log, the sample description from the laboratory, and the laboratory test results were verified to be consistent in representing each sample. In certain instances, a judgment call was made to reconcile these three aspects of each sample. Unless there was strong evidence to the contrary, the stratification lines identified in the field boring log are shown on the final boring log.

The final boring logs were subsequently reviewed and edited, as needed, by the Senior Project Manager. The final logs of the temporary geotechnical borings are included in Appendix A.

3.2 Criteria for Assigning Lab Tests and Results

The general purpose of the testing program was to obtain soil properties for the determination of: bearing capacity, short-term and long-term slope stability, seepage characteristics of the top stratum fine-grain soils and the underlying sand strata, liquefaction potential, settlement characteristics, and soil classifications for the potential use of soils for fill materials. The results from the laboratory tests are summarized in Table B-1 in Appendix B, and results are depicted graphically, where applicable, in the figures in Appendix B. These figures can be referenced from the table in Appendix B. Both the borings and the figures are arranged in increasing numerical order by boring number from B-9 through B-202.

The guidelines generally used by Reitz & Jens for assigning lab tests were as follows. In addition, GREDELL Engineering assigned grain-size analyses to samples from some of the piezometer borings.

Grain-size analyses (ASTM D422) were performed on selected cohesionless samples (Unified Soil Classifications of SW, SP, SM, GW, GP, or GP-SP). Hydrometer analyses (ASTM D422) were run on 3 selected samples which had a high percentage of fine-grain soils (passing U.S. #200 sieve). The results of the grain-size analyses were previously submitted to GREDELL Engineering.

Unconsolidated-undrained (UU) triaxial shear strength tests, ASTM D2850 "Unconsolidated-Undrained Triaxial Compression Test on Cohesive soils", were performed on selected Shelby tube samples from each major cohesive soil stratum. The UU tests were performed at the estimated confining pressure of the sample in the field conditions, to measure the *in situ* undrained shear strength of the soil. Nine UU tests were performed.

Series of consolidated-undrained (CU) triaxial shear strength tests, ASTM D4767 "Consolidated Undrained Triaxial Compression Test for Cohesive Soils," were performed on each major cohesive soil stratum from different locations around the disposal area. The tests were performed with the measurement of internal pore water pressures so that the effective strength properties of the soil could be determined. Each series has a minimum of two points, and three points where possible. Five series of CU tests were performed.

Three one-dimensional consolidation tests, ASTM D2435 "One-Dimensional Consolidation Properties of Soil Using Incremental Loading," were performed on selected relatively undisturbed Shelby tube samples from each major cohesive soil stratum beneath the UWL.

3.3 Hydraulic Conductivity Tests

Two flexible-wall hydraulic conductivity tests, ASTM D5084 "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter," were performed on selected relatively undisturbed Shelby tube samples of the upper clays. Also, two flexible-wall hydraulic conductivity tests were performed on samples from the preliminary Boring B-4: one on high plastic clay and one on sandy silt, both of which were obtained from 3.5 to 5.5 feet deep. The data from the hydraulic conductivity test are included in Appendix B and are summarized in the following table:

Boring No.	Sample	Depth, feet	Soil Description	k, cm/sec
B-4	ST-2	3.5 – 5.5	High Plastic Clay (CH)	1.2×10^{-8}
B-4	ST-2	3.5 – 5.5	Sandy Silt (SM)	2.0×10^{-3}
B-52	ST-2	4 – 6	High Plastic Clay (CH)	5.6×10^{-9}
P-175	ST-0	1 – 3	High Plastic Clay (CH)	5.5×10^{-8}

Appendix A

INDIVIDUAL BORING LOGS

KEY TO BORING LOGS

Symbol	Description
	KEY TO SOIL SYMBOLS
✓	Topsoil
▥	Silty SAND or Sandy SILT (SM)
▨	High plastic CLAY (CH)
░	Poorly-graded SAND (SP)
▨	Medium to high plastic CLAY
▨	Low plastic Silty CLAY (CL)
▓	Poorly-graded SAND & GRAVEL (GP)
▤	Very Weathered LIMESTONE
▥	Clayey Sandy SILT (ML)
░	Poorly-graded SAND with traces of fines
▨	Low plastic CLAY (CL)
▨	Clayey SAND or Sandy CLAY (SC)
▥	Low plastic Clayey SILT (ML)
▒	Well-graded SAND with no fines (SW)
▥	Inorganic, non-plastic SILT (ML)

Symbol	Description
▩	Clayey Silty SAND (SC-SM)
▦	LIMESTONE
	MISCELLANEOUS SYMBOLS
▽	Water table during drilling
●	Moisture content (%)
▲	N-value from Standard Penetration Test, ASTM D-1586 (blows/ft)
■	Shear strength from Pocket Penetrometer (tsf)
⌁	Boring continues
▼	Delayed Reading of Water table
◇	Shear strength from Pocket Torvane (tsf)
△	Shear strength (Qu/2) from Unconfined Compression Test, ASTM D-2166 (tsf)
	SOIL SAMPLERS
◩	2-in. O.D. Split-Spoon
◫	3-in. O.D. Shelby Tube

Notes:

Stratification lines shown on the logs represent approximate soil boundaries; actual changes in strata may be gradual or occur between samples.

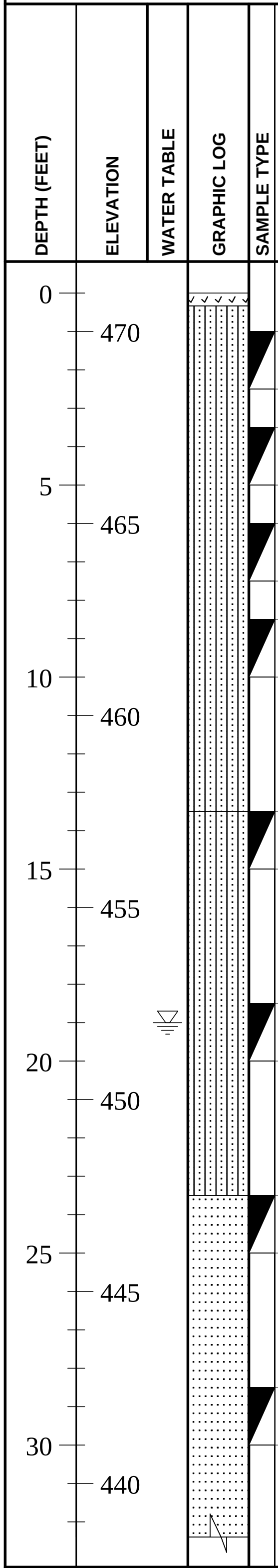
Figure A-0

REITZ & JENS, INC.
CONSULTING ENGINEERS

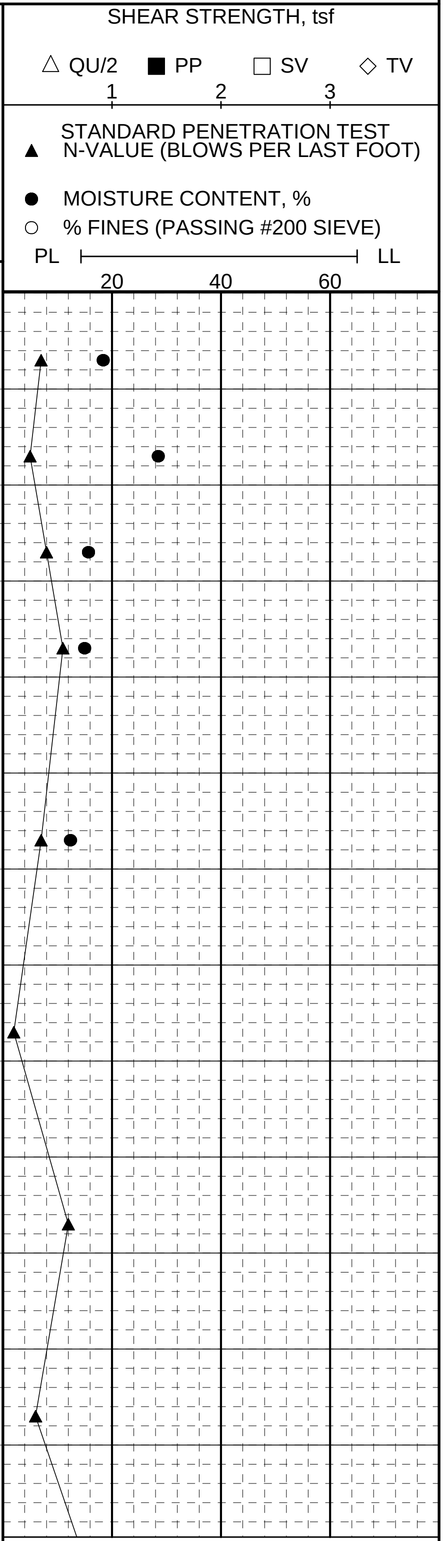
BORING LOG P-1

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 996214.1 E 727590.3
ELEVATION: 471 DATUM: NAVD88
DATE DRILLED: 3-14-2007



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	TOPSOIL (4")		
83	Sandy SILT (ML), brown, loose, dry	3-4-3	18.4
78	Becoming grayish brown, less sandy, with clay laminations, moist	2-2-3	28.5
67	Becoming more sandy, medium-dense, dry	2-3-5	15.7
72	Becoming tan	3-5-6	15.0
89	Silty SAND (SP-SM), tan, fine, loose	3-3-4	12.4
100	Becoming gray, slightly silty, very loose, with clay balls, free water	1-1-1	
94	SAND (SP), tan, fine, medium-dense	3-5-7	
89	Becoming gray, fine- to medium-grain, with decaying wood, loose	3-2-4	



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 19 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT 30 FEET

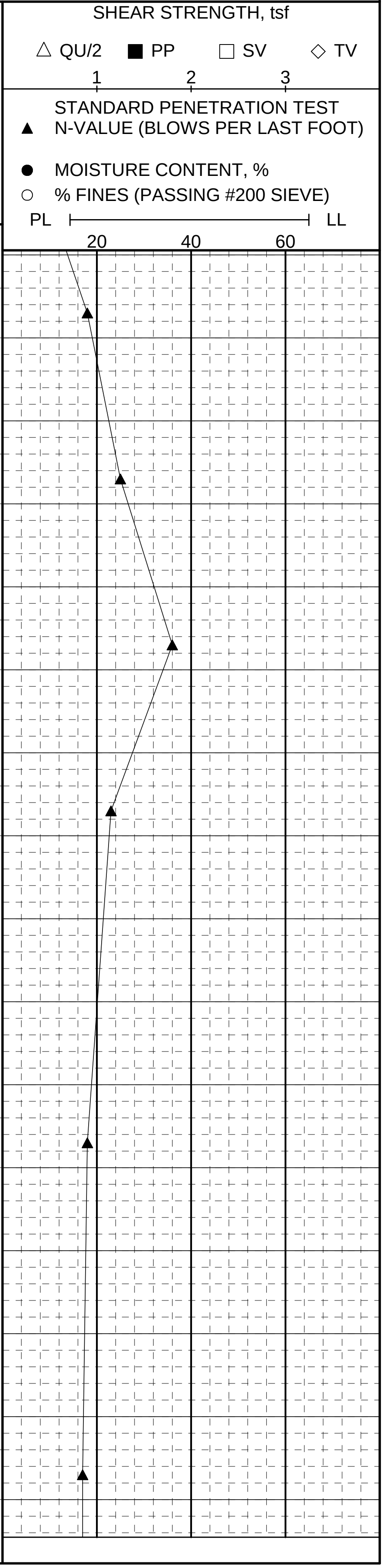
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-1

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					83	Becoming tan, fine- to coarse, medium- dense	6-8-10	
35	435							
					72	Becoming gray, fine- to medium-grain, dense, with decaying wood	10-15-10	
40	430							
					72	Without decaying wood	13-21-15	
45	425							
					39	SAND and GRAVEL (SP-GP), gray, dense, with clay balls and fragments of dolomite (up to 1.5") Very stiff drilling at 51' (heavy gravels and cobbles)	9-16-7	
50	420							
55	415							
					78	Becoming medium-dense, without clay and fragments of dolomite Very stiff drilling from 60.5' to 61.5' possible limestone cobbles or boulders	12-10-8	
60	410							
65	405							
					72		2-8-9	
70	400							

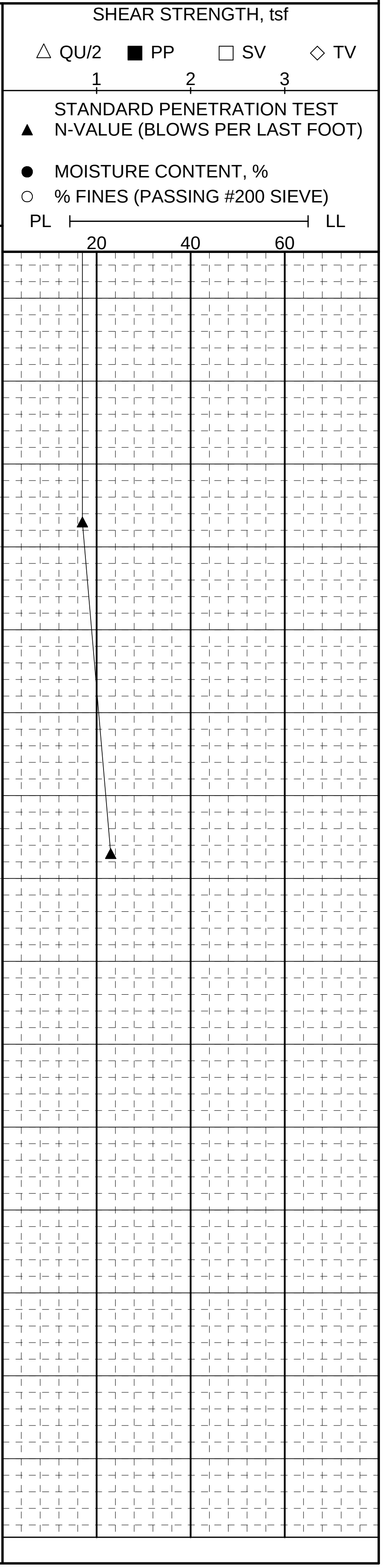


REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-1

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
						Very stiff drilling at 71', 73', and 77' to 78', possible cobbles or boulders		
75	395							
					44		7-8-9	
80	390					Very stiff drilling from 80' to 91.5' possible cobbles		
85	385							
					33	Becoming dense	10-11-12	
90	380							
						Boring terminated at 91'-6" in cobbles. Note: terminated boring @ 91.5 feet due to very difficult drilling; rods were binding during advancement, near breaking point.		
95	375							
100	370							
105	365							



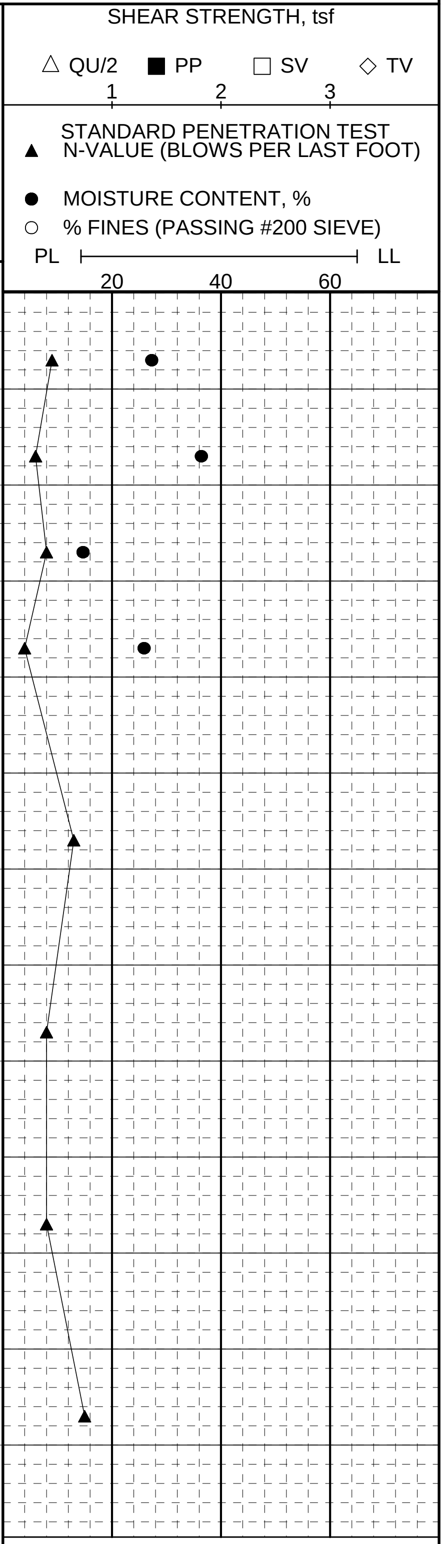
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG P-2

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 993370.6 E 728605.5
ELEVATION: 467 DATUM: NAVD88
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						TOPSOIL (5")		
	465				100	CLAY (CH), dark grayish brown, high plastic, moist, stiff	3-3-6	27.3
					94	Becoming firm, with seams of grayish brown silt	3-3-3	36.4
5								
	460				100	SILT (ML), tan, medium-dense, with fine sand, dry	3-4-4	14.7
					89	Becoming loose, with traces of iron stains	2-1-3	25.9
10								
	455							
		▽			100	SAND (SP), grayish tan, fine, medium- dense	4-6-7	
15								
	450							
					78	Becoming dark gray	1-3-5	
20								
	445							
					100	Becoming fine- to medium-grain	2-3-5	
25								
	440							
					100	Becoming fine to coarse	7-7-8	
30						Boring terminated at 30'-0"		
	435							



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 14 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT 30 FEET

File: 2008012455

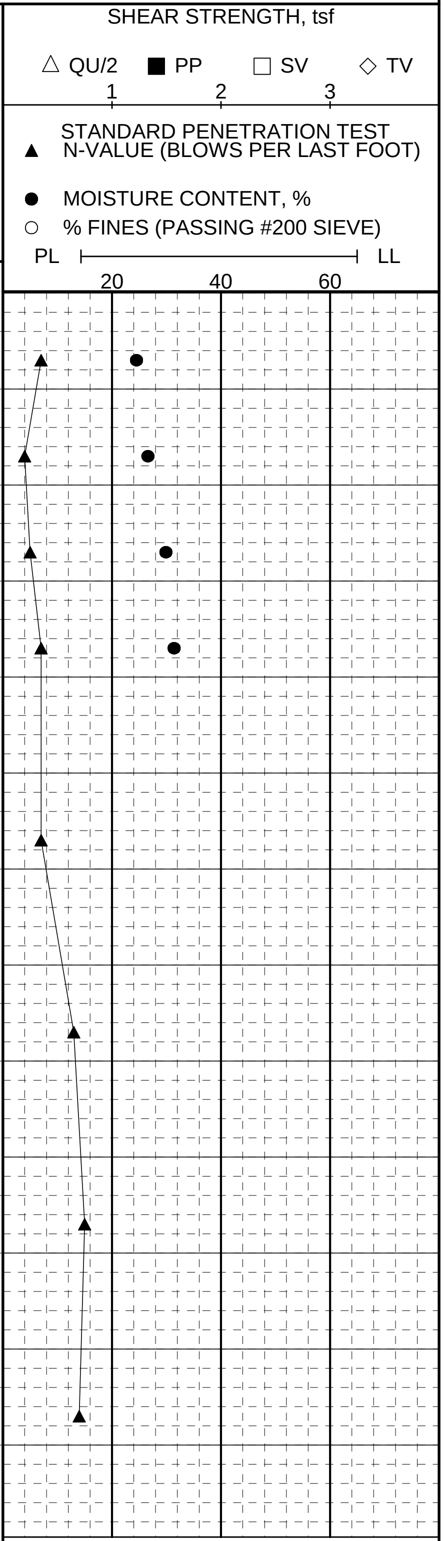
Figure A-2 Sheet 1 of 1

BORING LOG P-3

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 990178.7 E 728523.0
ELEVATION: 467 DATUM: NAVD88
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						TOPSOIL (5")		
	465				78	CLAY (CH), dark gray, high plastic, with silt seams, moist, stiff	2-3-4	24.5
						SILT (ML), grayish tan, loose, with fine sand		
					94	Silty SAND (SP-SM), grayish tan, fine, loose	1-3-1	26.6
5								
	460				100	With lenses of gray high plastic clay	1-1-4	29.9
					100	With alternating layers of fine silty sand and high plastic clay	2-3-4	31.4
10								
	455							
		▽			83	SAND (SP), gray, fine, loose	2-4-3	
15								
	450							
					100	Becoming medium-dense	2-5-8	
20								
	445							
					100		5-7-8	
25								
	440							
					100		6-7-7	
30						Boring terminated at 30'-0"		
	435							



DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): ______
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 13.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT 30 FEET

File: 2008012455

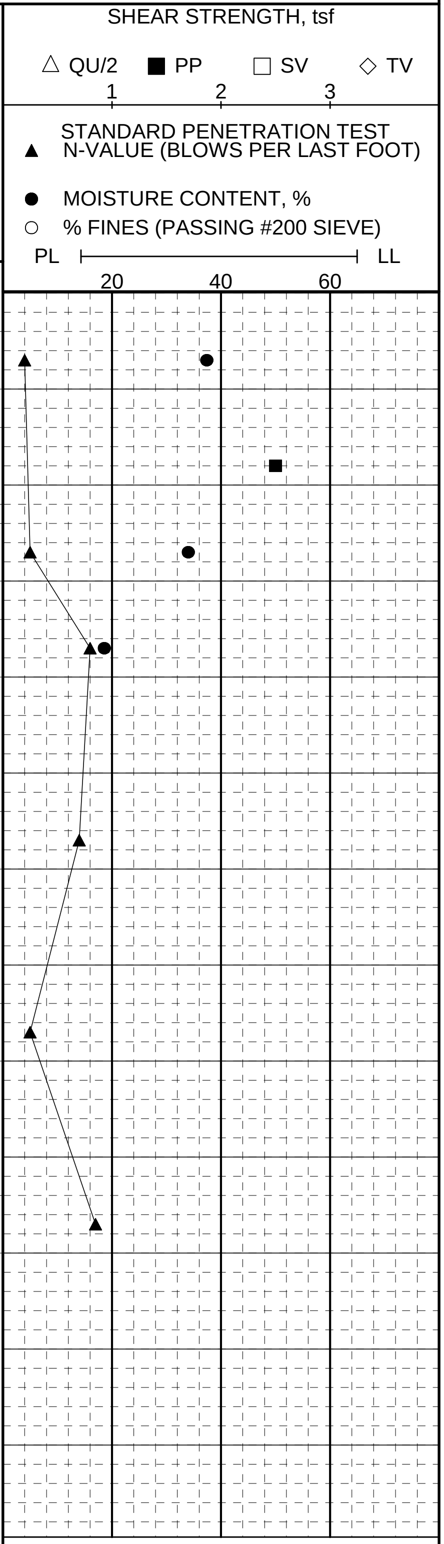
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-4

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N E
ELEVATION: 468 DATUM: NAVD88
DATE DRILLED: 3-9-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				TOPSOIL (3")		
			78	Sandy SILT (ML-SM), tan, loose, wet	3-3-1	37.4
	465			CLAY (CH), grayish brown, high plastic, moist, soft		
5			100			
			89	Becoming dry and firm	1-2-3	34.0
	460		72	Sandy SILT (ML-SM), tan, medium-dense, moist	5-9-7	18.6
10						
	455					
15			67	SAND (SP), tan, fine, medium-dense with organic clay balls	4-4-10	
	450	▽	89	Becoming tan and gray, fine- to medium-grain, loose	1-2-3	
20						
	445					
25			100	Becoming medium-dense	4-7-10	
				Boring terminated at 25'-0"		
	440					
30						



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 18.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

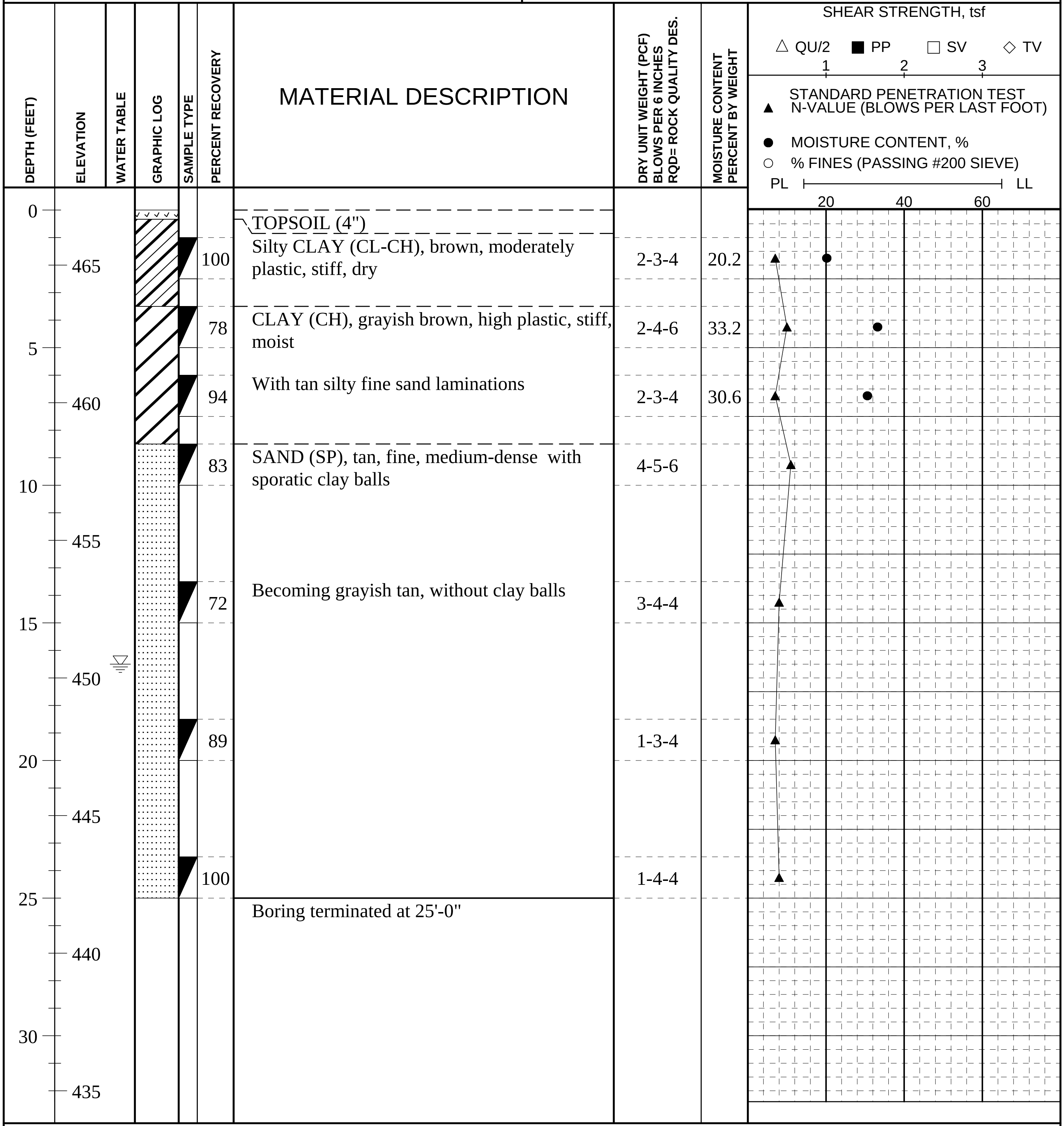
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-5

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N E
ELEVATION: 467 DATUM: NAVD88
DATE DRILLED: 3-12-2007



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	TOPSOIL (4")		
100	Silty CLAY (CL-CH), brown, moderately plastic, stiff, dry	2-3-4	20.2
78	CLAY (CH), grayish brown, high plastic, stiff, moist	2-4-6	33.2
94	With tan silty fine sand laminations	2-3-4	30.6
83	SAND (SP), tan, fine, medium-dense with sporatic clay balls	4-5-6	
72	Becoming grayish tan, without clay balls	3-4-4	
89		1-3-4	
100		1-4-4	
	Boring terminated at 25'-0"		

DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 16.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

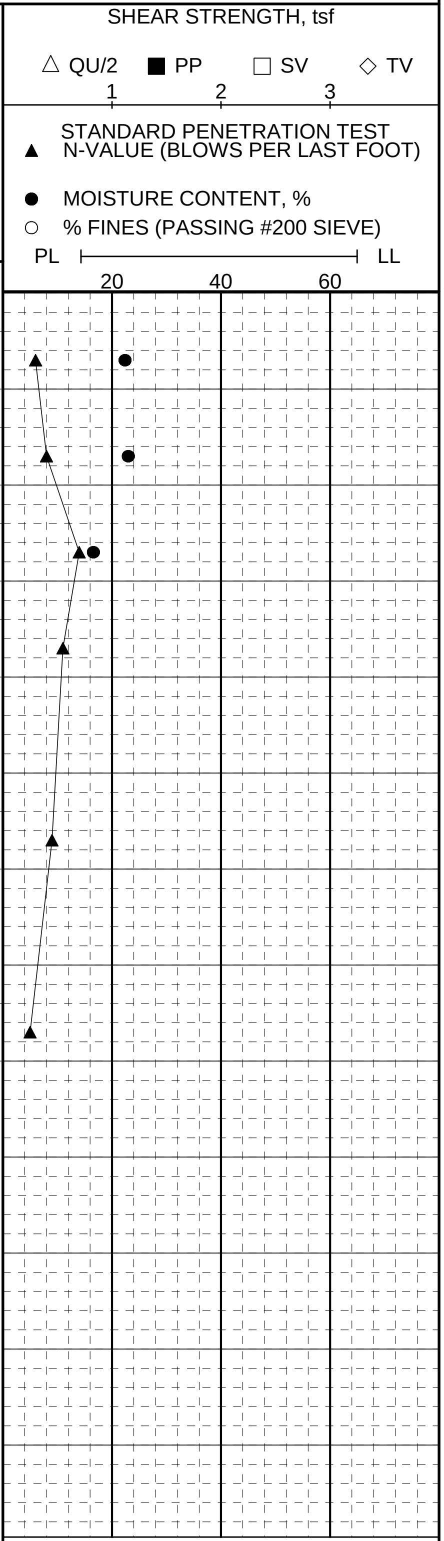
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-6

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N E
ELEVATION: 467 DATUM: NAVD88
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						TOPSOIL (4")		
	465				61	CLAY (CH), grayish brown, high plastic, slightly silty, firm, dry	2-3-3	22.4
					78	Sandy SILT (ML-SM), tan, medium-dense, becoming more sandy with depth	3-4-4	23.0
5								
	460				94	With seams of dark grayish brown, stiff, high plastic clay	3-5-9	16.6
					100	SAND (SP), tan, fine, medium-dense	6-6-5	
10								
	455							
					72	Becoming brown	3-4-5	
15								
		▽						
	450							
					78	Becoming loose	1-2-3	
20						Boring terminated at 20'-0"		
	445							
25								
	440							
30								
	435							



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 16 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

Figure A-6 Sheet 1 of 1

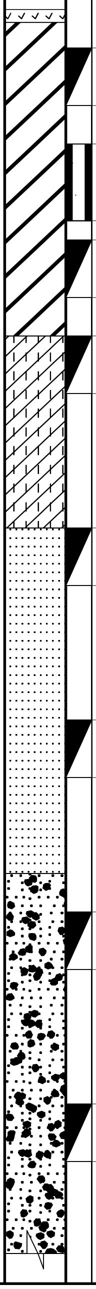
REITZ & JENS, INC.
CONSULTING ENGINEERS

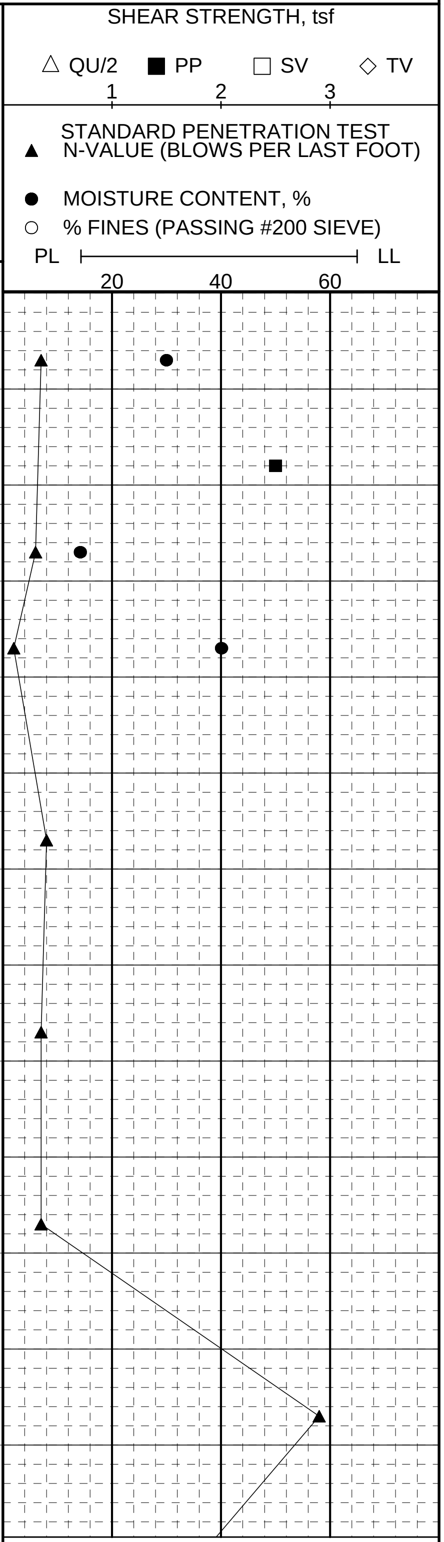
BORING LOG B-7

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N E
ELEVATION: 465 DATUM: NAVD88
DATE DRILLED: 3-12-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465			TOPSOIL (4")		
			100	CLAY (CH), grayish brown, high plastic, with silty fine sand laminations, firm, moist	2-3-4	30.0
			83			
5	460					
			94	Becoming dry	1-2-4	14.2
			100	Silty CLAY (CL), gray and tan, very soft, becoming more silty with depth, wet	1-1-1	40.1
10	455					
		▽	100	SAND (SP), gray, fine, slightly silty, medium-dense	1-4-4	
15	450					
			100	Becoming grayish tan and gray	2-2-5	
20	445					
			100	SAND and GRAVEL (GP-SP), grayish tan, fine sand to coarse gravel, medium-dense	3-2-5	
25	440					
			28	Becoming very dense, with less coarse gravel	23-30-28	
30	435					





DRILLER: Midwest
METHOD: CFA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

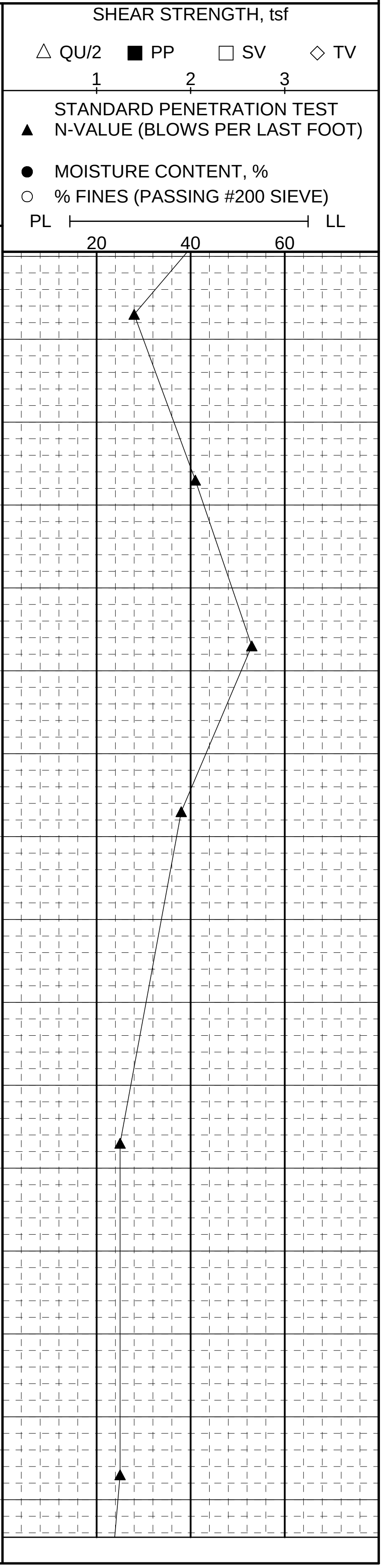
WATER LEVELS: DURING DRILLING 14 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-7

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					78	Becoming dense with coarse gravel (up to 1")	17-15-13	
35	430							
					100	SAND (SP), gray, fine, very dense	10-17-24	
40	425							
					100		15-23-30	
45	420							
					89		14-19-19	
50	415							
55	410							
					94	SAND & GRAVEL (SP-GP), gray, coarse sand and fine gravel, dense	9-13-12	
60	405							
65	400							
					100	With medium gravel (to 3/8")	11-11-14	
70	395							

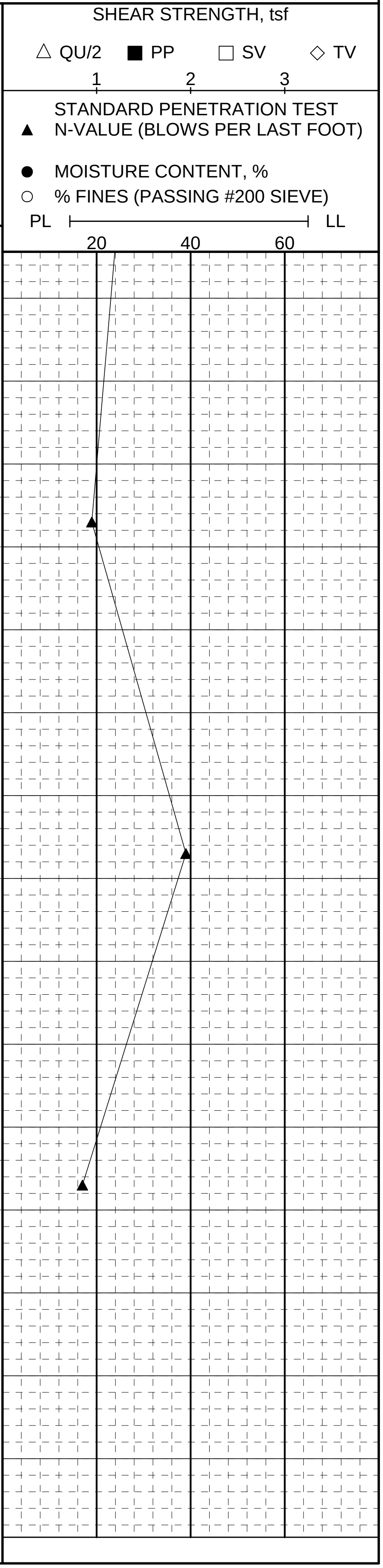


REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-7

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
75	390							
					100	Becoming medium-dense	9-9-10	
80	385							
85	380							
					89	Becoming very dense, with black shale fragments	11-19-20	
90	375							
95	370							
					78	Becoming medium-dense	8-9-8	
100	365							
						LIMESTONE, very weathered, soft		
105	360					Auger Refusal at 104'-6"		



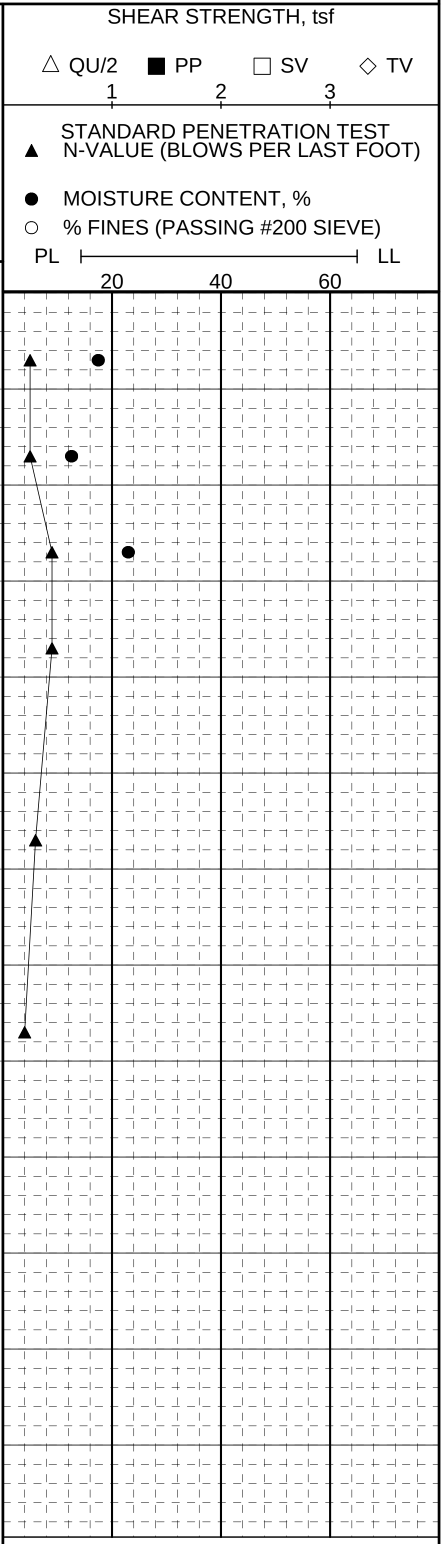
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-8

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N E
ELEVATION: 468 DATUM: NAVD88
DATE DRILLED: 3-9-2007

DEPTH (FEET)	ELEVATION	WATER TABLE	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0					TOPSOIL (4")		
			◣	83	Sandy SILT (ML-SM), gray and tan, loose, with seams of grayish brown high plastic clay, dry	2-2-3	17.5
	465						
5			◣	67		2-2-3	12.6
			◣	89	Becoming medium-dense, without clay seams, with fine sand laminations	3-5-4	23.0
	460						
10			◣	94	SAND (SP), tan, fine, medium-dense, with sporatic clay balls	3-5-4	
	455						
15			◣	78	Becoming grayish brown, loose	2-3-3	
	450	▽					
20			◣	94	Becoming very loose	1-1-3	
					Boring terminated at 20'-0"		
	445						
25							
	440						
30							



DRILLER: Midwest
METHOD: CFA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 17.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

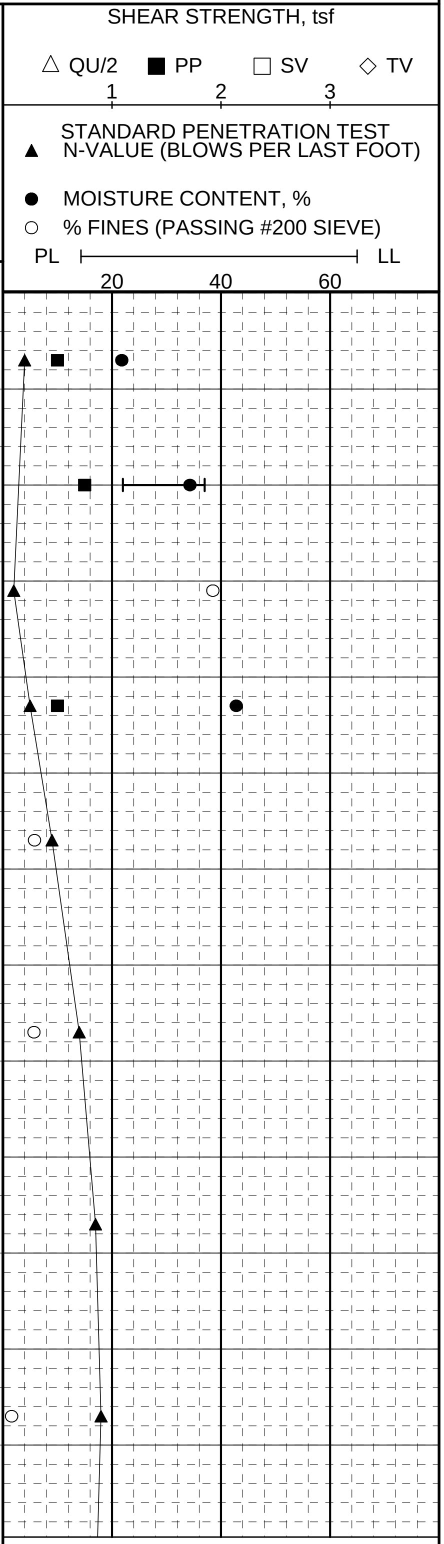
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-10

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 996103.2 E 727271.4
ELEVATION: 469.4 DATUM: NAVD88
DATE DRILLED: 11-02-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0			67	Clayey Sandy SILT (ML), brown, with traces limonite, loose, moist	2-2-2	21.8
5	465	▽	94	Very Silty CLAY (CL), brown, firm, low plastic, with fine sand, lignite, sand seams, wet	86.9	34.3
			100	Silty SAND (SM), brown, fine, very loose, saturated	0-1-1	
10	460		100	With silty clay seam Note: switched to mud rotary after sample.	1-2-3	42.8
15	455		67	SAND (SP-SM), brown, fine, medium-dense, with silt Some wood pieces in mud return from 15' to 23.5'	4-4-5	
20	450		78		3-6-8	
25	445		89	Coarse sand in mud return from 25' to 28.5'	5-6-11	
30	440		83	SAND (SP), gray, medium-dense, fine to coarse, with fine gravel (<3/8")	4-7-11	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

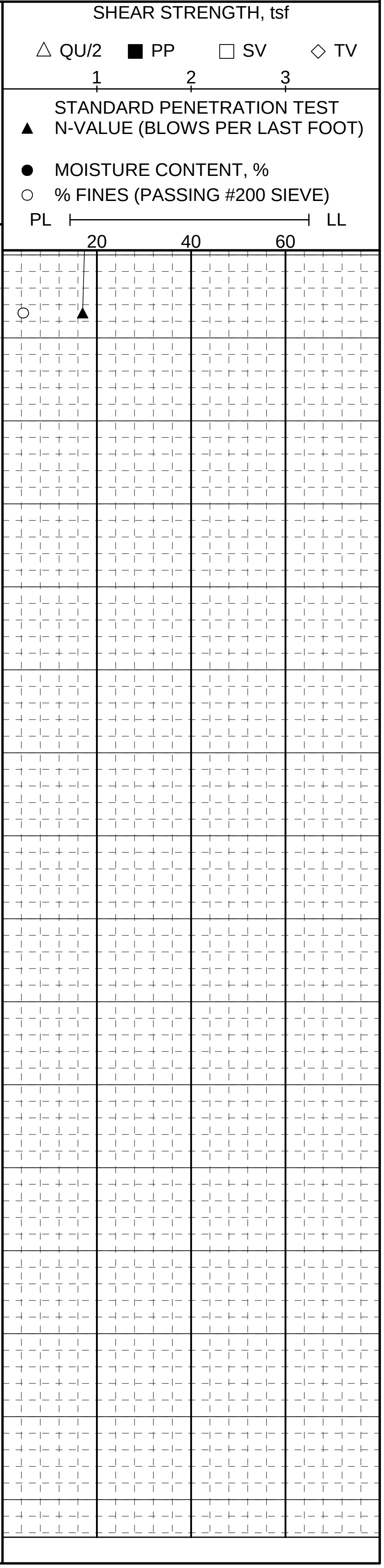
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-10

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	435				22		5-6-11	
35						Boring terminated in sand at 35'-0"		
40	430							
45	425							
50	420							
55	415							
60	410							
65	405							
70	400							



File: 2008012455

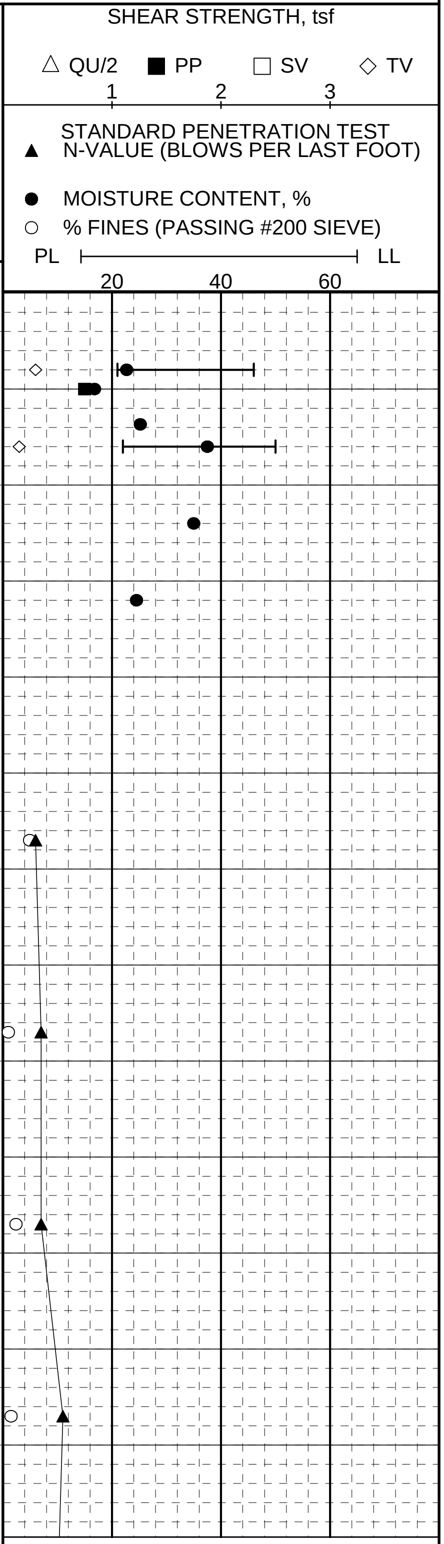
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-13

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 996065.7 E 728454.8
ELEVATION: 468.4 DATUM: NAVD88
DATE DRILLED: 11-02-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						
			50	CLAY (CL), dark grayish brown, stiff, low plastic, with seams and laminations of sandy clayey silt, traces lignite, limonite, fine sand, moist	103.1	22.7 16.8
	465	▽	50	Sandy Silty CLAY (CL), brown, stiff, trace high plastic clay, fine sand seams, dry	93.3 82.4	25.2 37.5
5		▽	17	CLAY (CH), grayish brown, stiff, high plastic, with brown clayey silt, moist		35.0
	460		63	Clayey Silty SAND (SC), light brown, medium-dense, fine, with clay seams With layers of grayish brown silty clay and high plastic clay, traces of lignite and limonite, saturated	100.5	24.5
10				Silty SAND (SM), brown & grayish brown, medium-dense, fine, trace roots		
	455		89	SAND (SP), tan, fine to medium grain, loose	0-2-4	
15						
	450		78	Becoming medium-dense, with trace fine gravel (<1/8")	3-3-4	
20						
	445		89	Becoming fine grain	2-3-4	
25						
	440		89	Becoming gray, fine to coarse, with fine gravel (<3/4")	3-5-6	
30						



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 6.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 3.0 FEET AFTER 40 HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

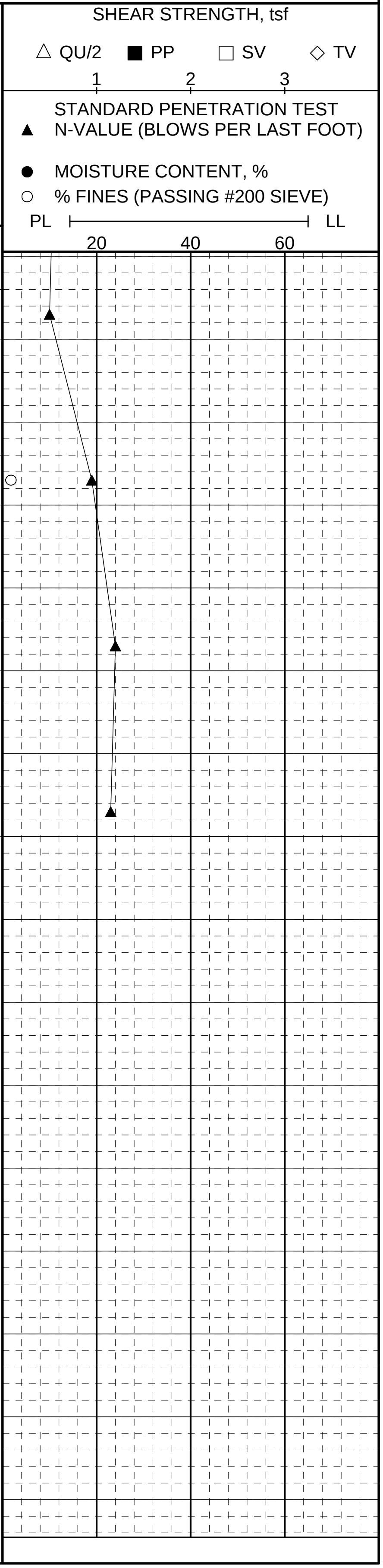
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-13

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	435				6	With coarse gravel (<1-1/4") Note: coarse sand and fine gravel in mud return.	4-5-5	
35								
	430				78	Becoming fine to coarse, with less coarse gravel Note: very rough drilling in gravel layers below 40 feet; fine gravel and limestone fragments in mud return.	6-8-11	
40								
	425				22	GRAVEL & SAND (GP-SP), gray, dense, coarse sand, fine gravel, weathered rock fragments Note: 750 to 1000 psi down pressure from 45.5' to 46.5'.	18-13-11	
45								
	420				6	Becoming medium- to coarse-grain sand, with fine gravel (<3/8") and chert fragments	6-11-12	
50						Boring terminated in sand and gravel at 50'-0"		
	415							
55								
	410							
60								
	405							
65								
	400							
70								



File: 2008012455

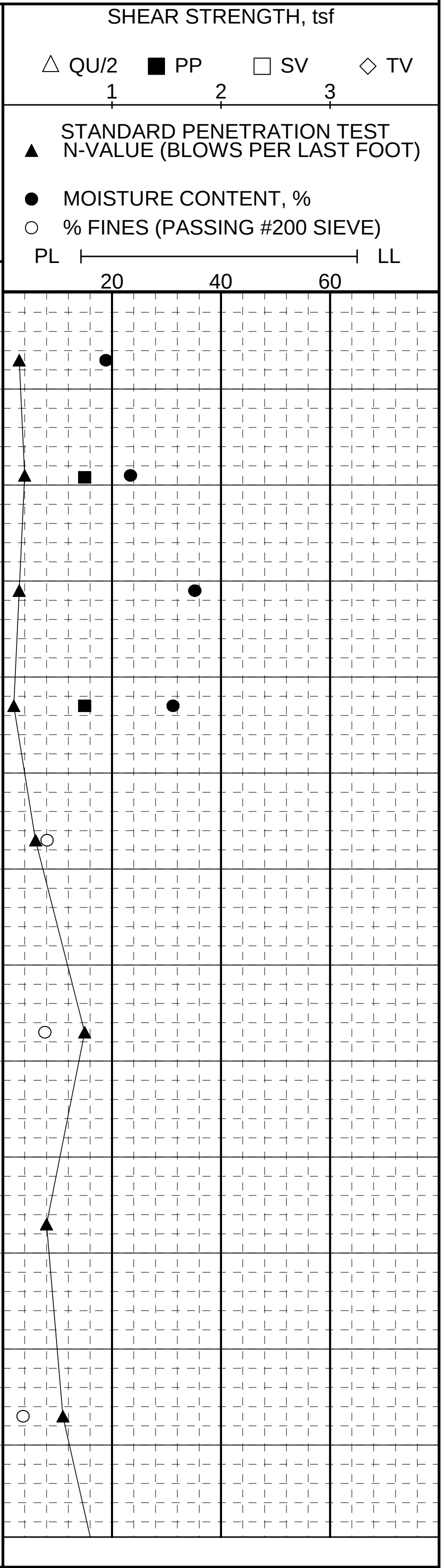
Figure A-10 Sheet 2 of 2

BORING LOG B-14

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 995811.2 E 726971.9
ELEVATION: 470.0 DATUM: NAVD88
DATE DRILLED: 10-28-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	470					Sandy SILT (SM), brown, very loose slightly clayey, with fine- to medium-grain sand and small roots, dry		
				◣	100		2-1-2	18.9
				◣	56	CLAY (CH), dark grayish brown, high plastic, with seams and laminations of fine sand, traces of lignite, firm, moist	3-1-3	23.4
5	465							
				◣	78	Clayey SILT (ML), grayish brown, soft, with traces of lignite and limonite, saturated	1-1-2	35.2
10	460							
				◣	67		0-0-2	31.2
						Silty SAND (SM), grayish brown, fine, very loose		
		▽						
				◣	78	SAND (SP-SM), grayish brown, fine, with silt, loose Note: switched to mud rotary; hole collapsed to 4 feet, flushed out before continuing.	1-2-4	
15	455							
				◣	78	Becoming tan, medium-dense	6-8-7	
20	450							
				◣	78	Becoming tan to light gray, fine- to medium-grain	3-3-5	
25	445							
				◣	89	SAND (SP), tan and light gray, medium-dense, fine to coarse, traces fine gravel and silt	7-7-4	
30	440							



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 13 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

BORING LOG B-14

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					89	Becoming gray, fine- to medium-grain	5-6-13	
35	435					Boring terminated in sand at 35'-0"		
40	430							
45	425							
50	420							
55	415							
60	410							
65	405							
70	400							

SHEAR STRENGTH, tsf

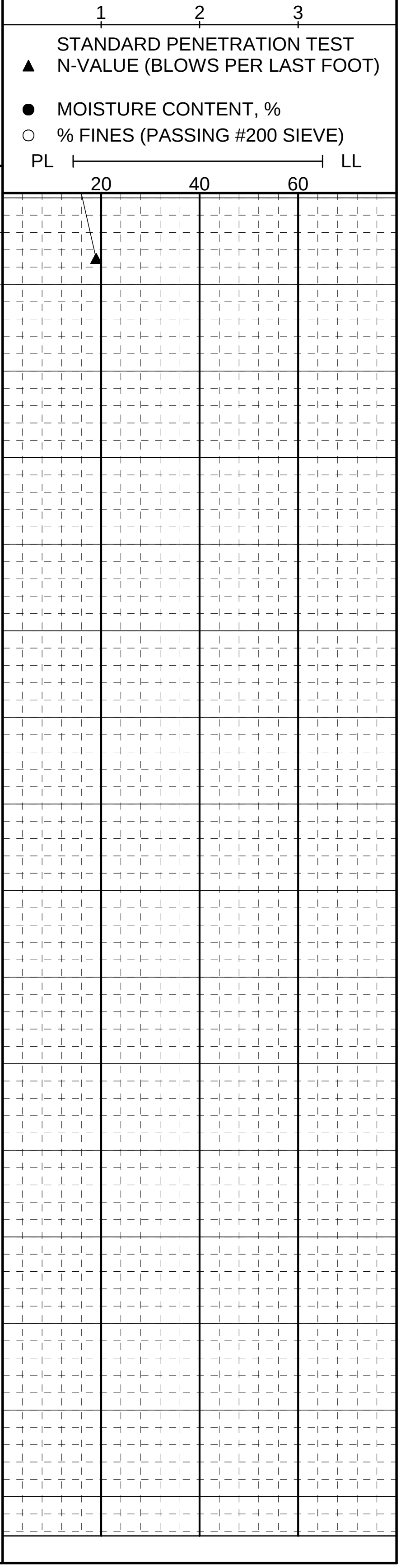
△ QU/2 ■ PP □ SV ◇ TV

▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ├──┤ LL

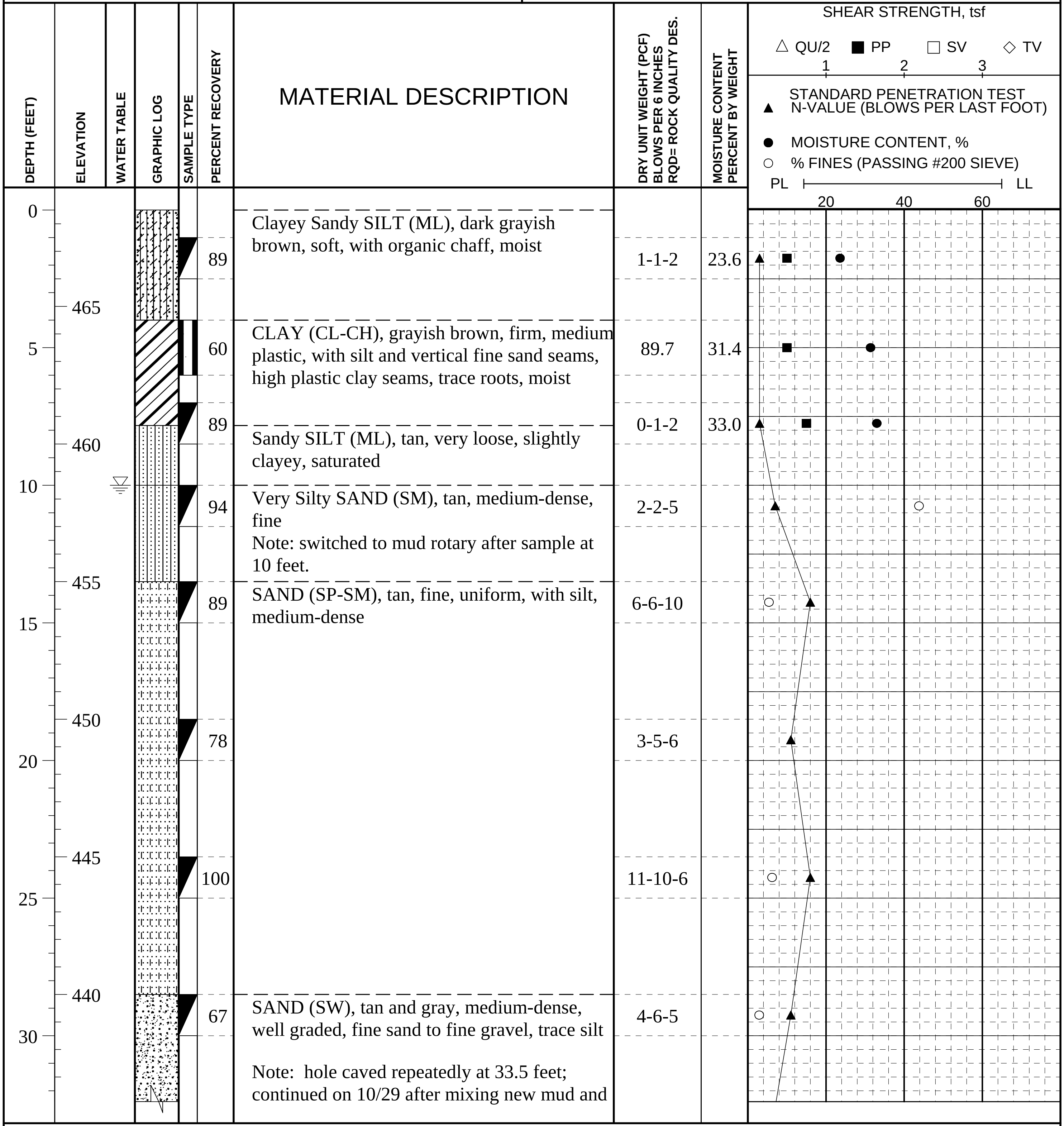


REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-26

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 995220.6 E 726964.1
ELEVATION: 468.5 DATUM: NAVD88
DATE DRILLED: 10-28-2009



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
89	Clayey Sandy SILT (ML), dark grayish brown, soft, with organic chaff, moist	1-1-2	23.6
60	CLAY (CL-CH), grayish brown, firm, medium plastic, with silt and vertical fine sand seams, high plastic clay seams, trace roots, moist	89.7	31.4
89		0-1-2	33.0
	Sandy SILT (ML), tan, very loose, slightly clayey, saturated		
94	Very Silty SAND (SM), tan, medium-dense, fine Note: switched to mud rotary after sample at 10 feet.	2-2-5	
89	SAND (SP-SM), tan, fine, uniform, with silt, medium-dense	6-6-10	
78		3-5-6	
100		11-10-6	
67	SAND (SW), tan and gray, medium-dense, well graded, fine sand to fine gravel, trace silt Note: hole caved repeatedly at 33.5 feet; continued on 10/29 after mixing new mud and	4-6-5	

DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 10 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

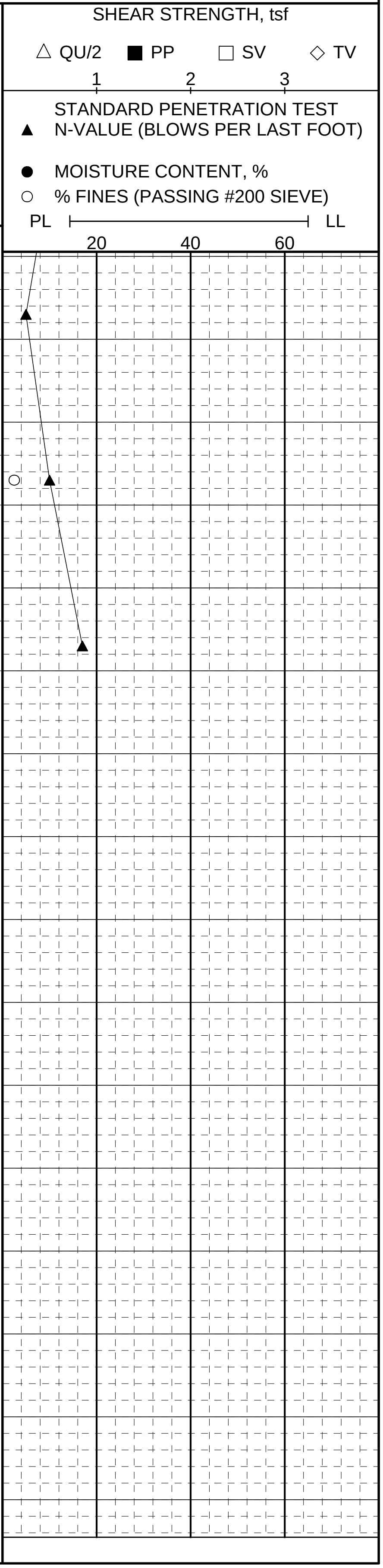
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-26

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
						re-drilled to 33.5 feet.		
	435							
					28	Note: blow counts low due to disturbance.	1-2-3	
35								
	430							
					67		3-4-6	
40								
						Gravelly SAND (GP-SP), gray, medium-dense, coarse, with coarse gravel Note: drill rig bouncing below 40 feet.		
	425							
					56	With gravel (<1")	8-8-9	
45								
						Boring terminated in gravelly sand at 45'-0"		
	420							
50								
	415							
55								
	410							
60								
	405							
65								
	400							
70								



File: 2008012455

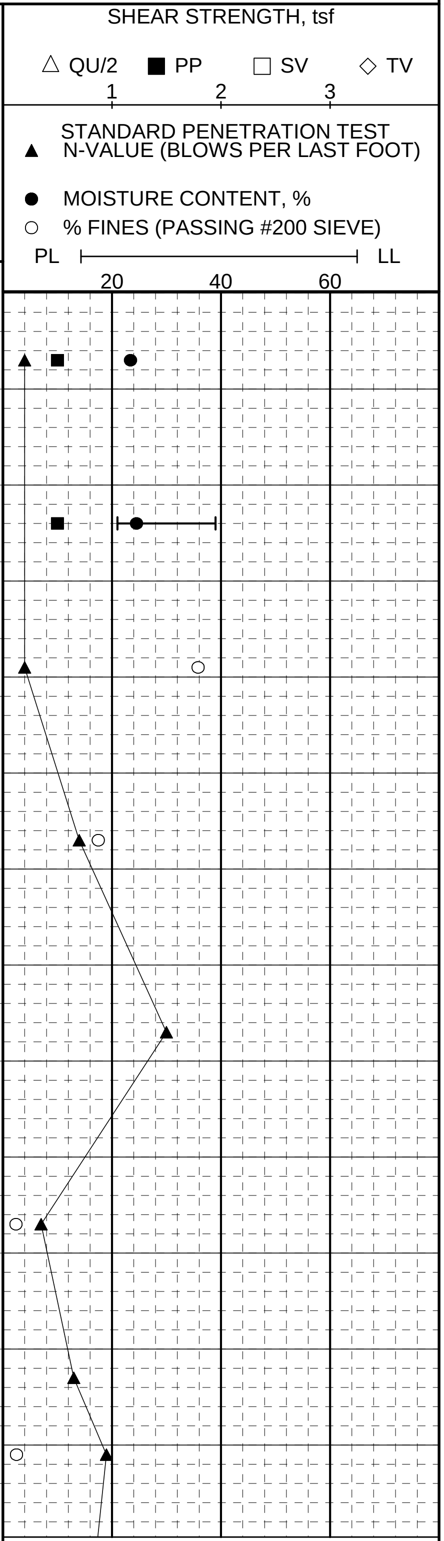
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-50

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 994279.7 E 729167.7
ELEVATION: 467.7 DATUM: NAVD88
DATE DRILLED: 11-04-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0			94	Silty CLAY (CL), grayish brown, firm, with organic chaff and roots, fine sandy silt seams and high plastic clay seams, moist	1-1-3	23.4
	465	▼				
5		▽	63	Becoming very silty, with silty fine sand and fine sand seams	97.8	24.5
	460					
10			94	Silty SAND (SM), brown, fine, loose Note: switched to mud rotary after sample at 9 feet.	1-1-3	
	455		94	Becoming tan, medium-dense, uniform	4-6-8	
15	450					
20			100	SAND (SP), gray, fine, dense, with lignite and decayed wood fragments	9-12-18	
	445		89	Becoming fine to coarse, medium-dense, traces coal fragments and silt	1-3-4	
25	440		72	Becoming fine- to medium-grain, no coal fragments	3-6-7	
30			89	Becoming tan, fine, uniform	6-8-11	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 6 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 3.6 FEET AFTER 19 HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

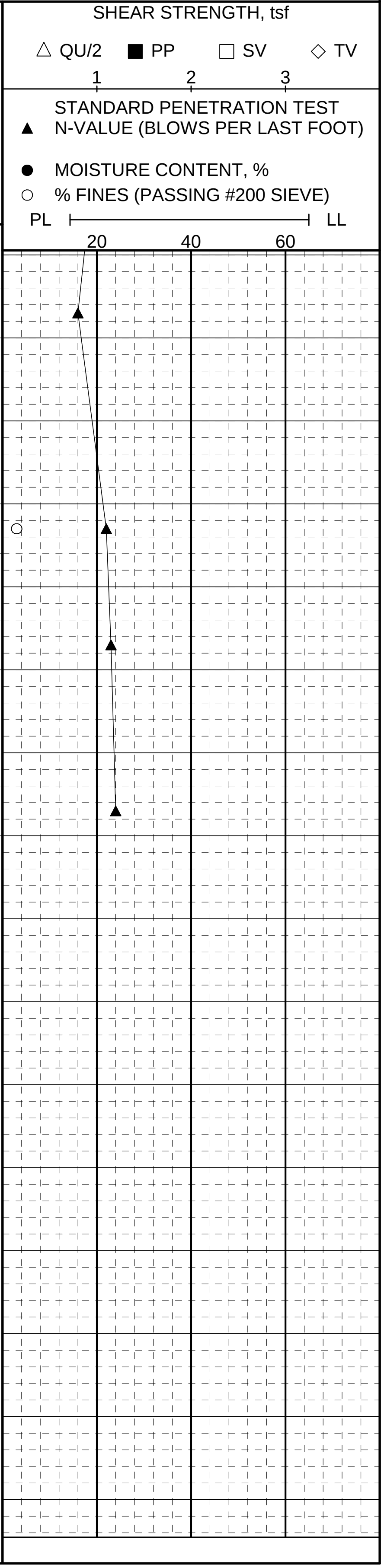
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-50

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	435							
					100	Becoming gray, fine- to medium-grain	6-9-7	
35								
	430							
40								
					100	Becoming dense, fine to coarse, with fine gravel (<3/4"), trace silt	10-10-12	
	425							
					3	Becoming more gravelly, with fine sand and gray clay balls	11-13-10	
45								
						Note: gravelly drilling from 45.5' to 46', with lignite in mud return		
	420							
					78	Becoming fine to coarse, less gravel	6-11-13	
50								
						Boring terminated in sand at 50'-0"		
	415							
55								
	410							
60								
	405							
65								
	400							
70								



File: 2008012455

Figure A-13 Sheet 2 of 2

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-52

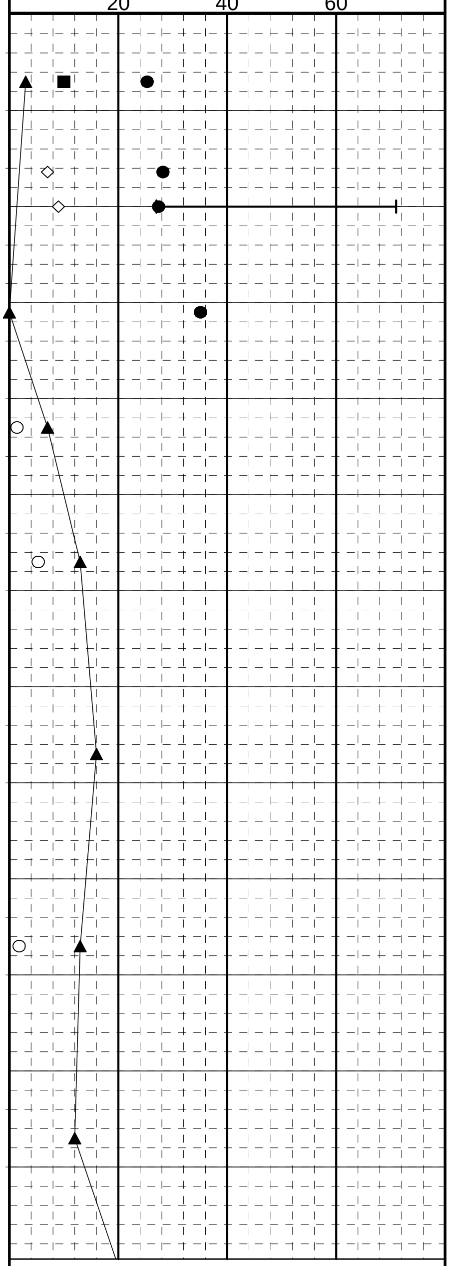
Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 994257.0 E 729758.6
ELEVATION: 465.3 DATUM: NAVD88
DATE DRILLED: 11-04-2009

DEPTH (FEET)	ELEVATION	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465	78	Silty CLAY (CL), grayish brown, soft, with chaff and roots, trace of limonite, moist	1-1-2	25.3
5	460	50	With trace fine sand CLAY (CH), dark grayish brown, high plastic, soft, with traces fine sand and roots, moist	94.8	28.2 27.4
		100	Becoming slightly silty, with seams of clayey silt and tan fine sand, very soft, saturated	0-0-0	35.1
10	455	100	SAND (SP), tan, fine- to medium-grain, medium-dense, trace silt Note: switched to mud rotary at 10 feet prior to sampling.	1-3-4	
15	450	94	SAND (SP-SM), tan, medium-dense, fine with medium-grain sand and silt	3-6-7	
20	445	100	SAND (SP), grayish tan, medium-dense, fine- to medium-grain	5-8-8	
25	440	89	Becoming gray fine to coarse, with fine gravel (<1/2"), trace silt	4-5-8	
30	435	94	Becoming gray, fine- to medium-grain, without gravel	4-5-7	

SHEAR STRENGTH, tsf
△ QU/2 ■ PP ☐ SV ◇ TV
1 2 3

▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)
● MOISTURE CONTENT, %
○ % FINES (PASSING #200 SIEVE)
PL ⊢—⊣ LL
20 40 60



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Autmoatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

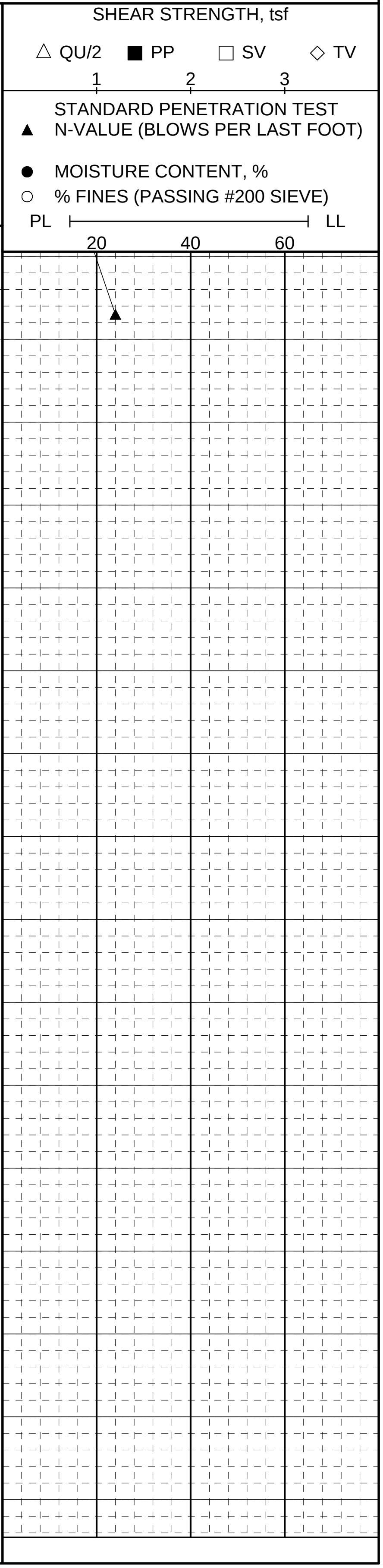
WATER LEVELS: DURING DRILLING 6.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 1.92 FEET AFTER 21 HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-52

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					78	Becoming dense	5-11-13	
35	430					Boring terminated in sand at 35'-0"		
40	425							
45	420							
50	415							
55	410							
60	405							
65	400							
70	395							



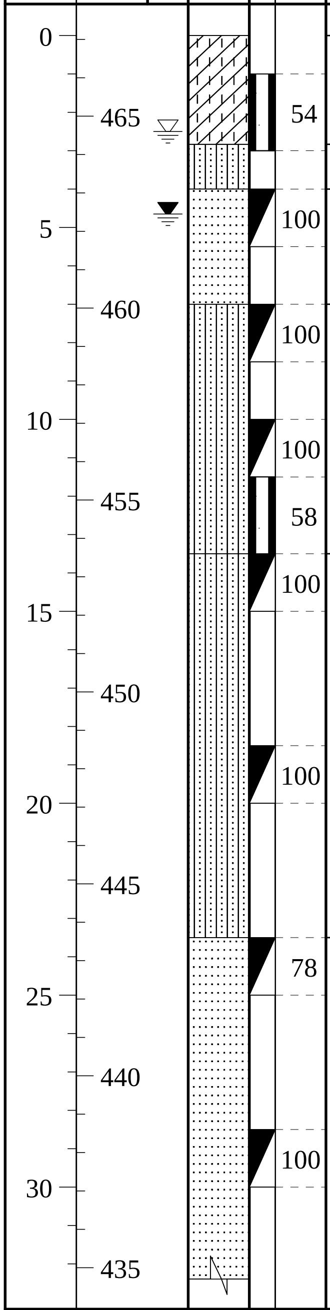
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-54

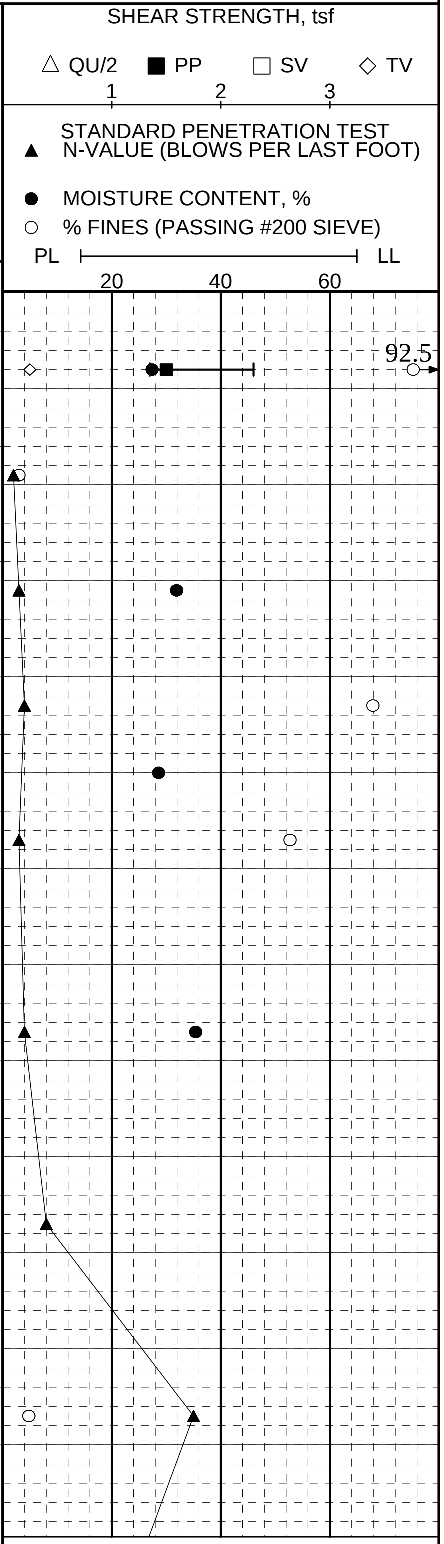
Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 994252.3 E 730351.6
ELEVATION: 467.1 DATUM: NAVD88
DATE DRILLED: 11-03-2009



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
54	Silty CLAY (CL), brown, firm, with tan fine sand, lignite, limonite, small roots, moist	94.5	27.4
	Silty SAND (SM), gray with tan, fine		
100	SAND (SP), tan, fine, very loose, with trace silt Note: 1 ft blow-in after sample; switched to mud rotary.	2-1-1	
100	Sandy SILT (ML), brown, loose, with fine sand, trace clay, saturated	0-1-2	31.9
100	Becoming gray and tan	1-2-2	
58	Becoming gray	89.6	28.6
100	Very Sandy SILT (ML), gray, loose, with fine sand, saturated	1-1-2	
100	With traces of clay	3-1-3	35.4
78	SAND (SP), tan, fine- to medium-grain, medium-dense	4-3-5	
100	Becoming gray, very dense, fine, with traces medium-grain and silt	11-16-19	

SHEAR STRENGTH, tsf
△ QU/2 ■ PP ☐ SV ◇ TV
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)
● MOISTURE CONTENT, %
○ % FINES (PASSING #200 SIEVE)



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 2.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 4.65 FEET AFTER 23.5 HOURS
AT ____ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-54

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					100	Becoming dense	6-9-13	
35						Boring terminated in sand at 35'-0"		
	430							
40								
	425							
45								
	420							
50								
	415							
55								
	410							
60								
	405							
65								
	400							
70								

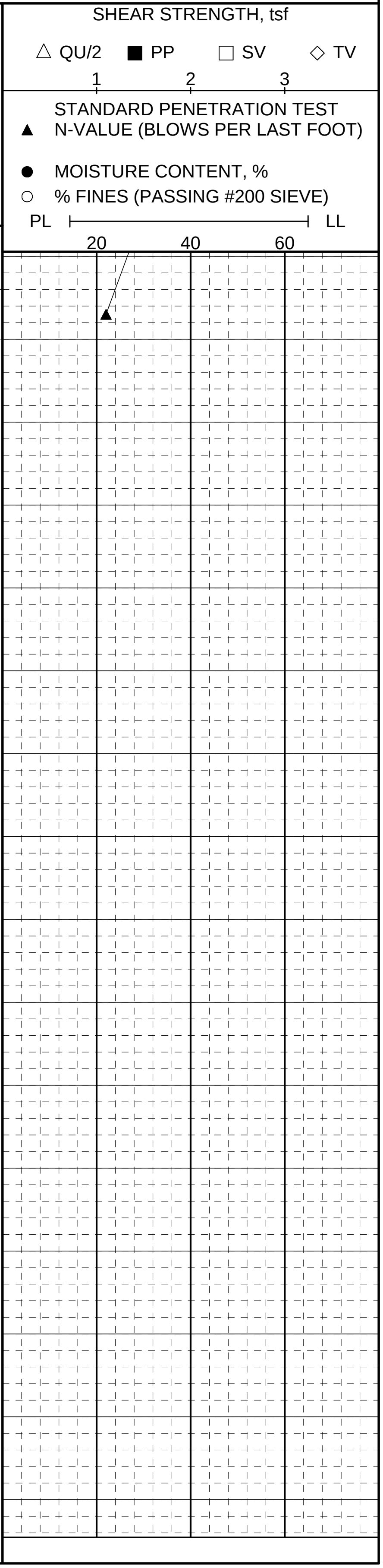


Figure A-15 Sheet 2 of 2

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

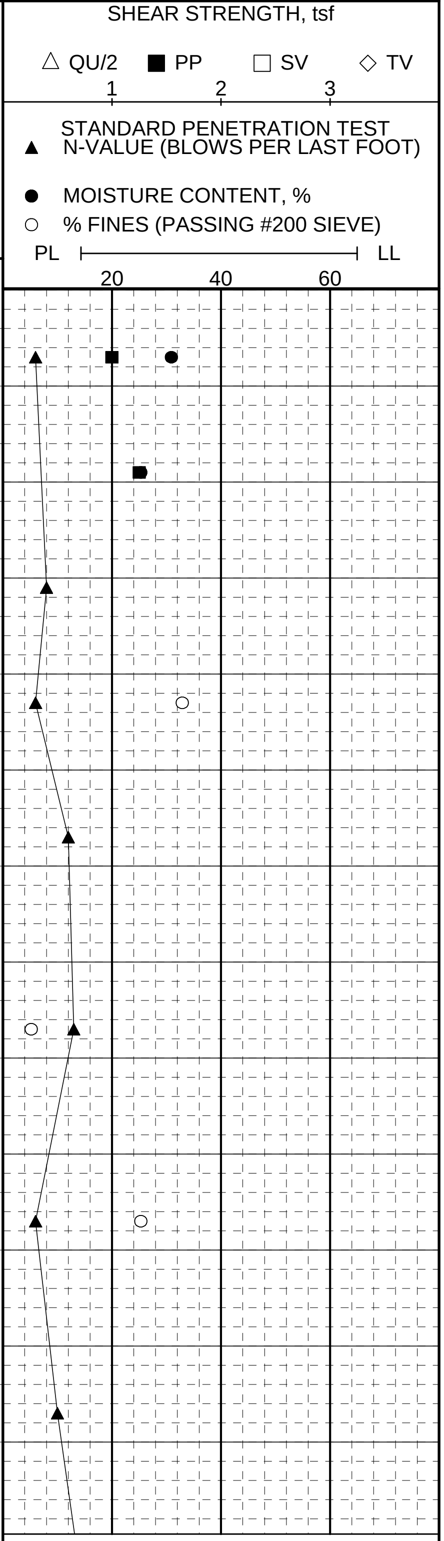
BORING LOG B-56

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 994240.1 E 730939.3
ELEVATION: 467.4 DATUM: NAVD88
DATE DRILLED: 11-03-2009

DEPTH (FEET): 0, 5, 10, 15, 20, 25, 30
ELEVATION: 465, 460, 455, 450, 445, 440

PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
78	CLAY (CL-CH), dark grayish brown, moderately plastic, slightly silty, with roots, firm, moist	0-3-3	30.9
100	Silty SAND (SM), tan, fine, medium-dense	96.0	25.3
100	Note: 1 ft blow-in after sample; switched to mud rotary.	4-4-4	
78	Becoming loose	2-3-3	
89	Becoming medium-dense	3-5-7	
89	SAND (SP-SM), tan, fine- to medium-grain, medium-dense, with silt and coarse sand	8-7-6	
83	Silty SAND (SM), gray, fine, loose, with lignite	1-2-4	
94	SAND (SP), gray, fine- to medium-grain, medium-dense, trace silt	3-5-5	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 5.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 4.3 FEET AFTER 27 HOURS
AT ___ FEET AFTER ___ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

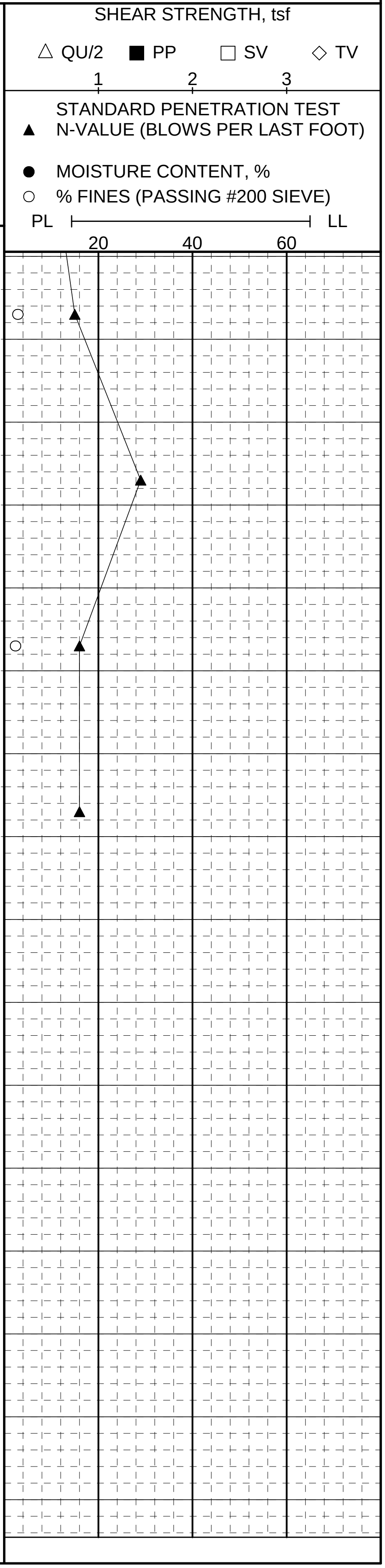
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-56

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	435							
					100		7-7-8	
35								
	430					Gravelly SAND (SP), gray, dense, fine to coarse, with fine gravel		
					89	SAND (SP), gray, fine, dense, with 3" wood seam	6-7-22	
40								
	425					Note: gravelly drilling from 42.5' to 43'		
					94	Becoming medium-dense, fine to coarse, trace silt	3-7-9	
45								
	420							
					100	With fine gravel (<3/4")	5-8-8	
50						Boring terminated in sand at 50'-0"		
	415							
55								
	410							
60								
	405							
65								
	400							
70								



File: 2008012455

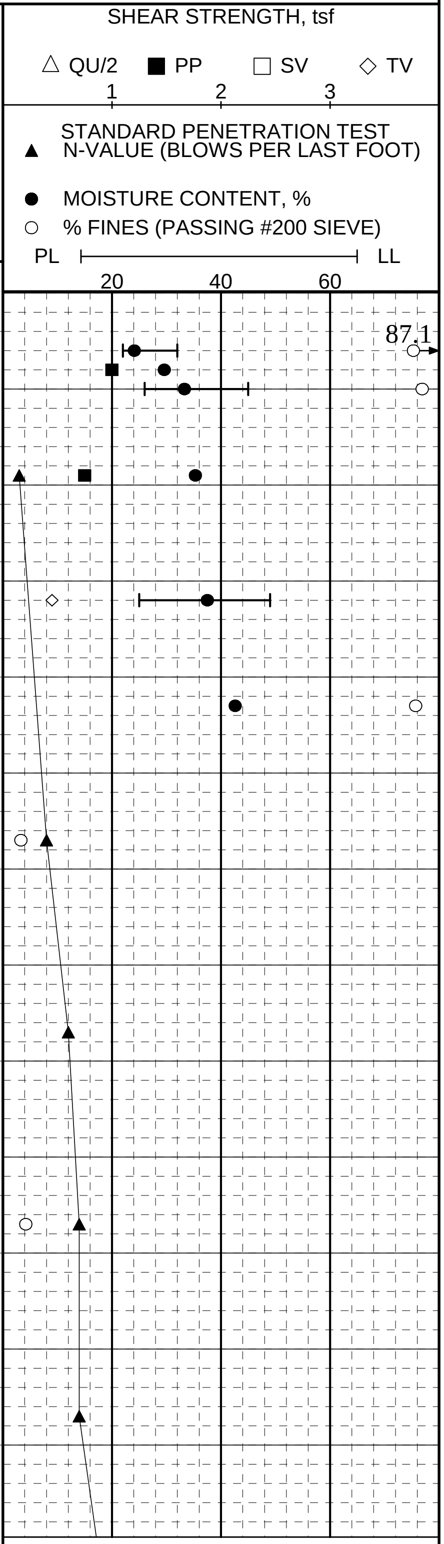
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-58

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 994038.1 E 726928.7
ELEVATION: 464.3 DATUM: NAVD88
DATE DRILLED: 11-06-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0		▼			79	CLAY (CL), grayish brown, soft, slightly silty, with fine sand and silt seams, and roots, moist	97.2 87.3 88.0	24.1 29.6 33.3
5	460	▽			78	With lignite and limonite, no roots	1-1-2	35.3
					90		82.4	37.5
10	455				100	Sandy SILT (ML), gray and tan, with fine sand, very loose With traces of clay, saturated Note: switched to mud rotary after sample.	0-0-1	42.6
15	450				100	SAND (SP), grayish tan, medium-dense, fine with traces medium-grain sand and silt	2-4-4	
20	445				72		3-5-7	
25	440				100	Becoming fine- to medium-grain, traces coarse sand and silt	8-6-8	
30	435				83		3-6-8	



DRILLER: Terra Drill
METHOD: 4.25"
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 4 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT 1 FEET AFTER 23 HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

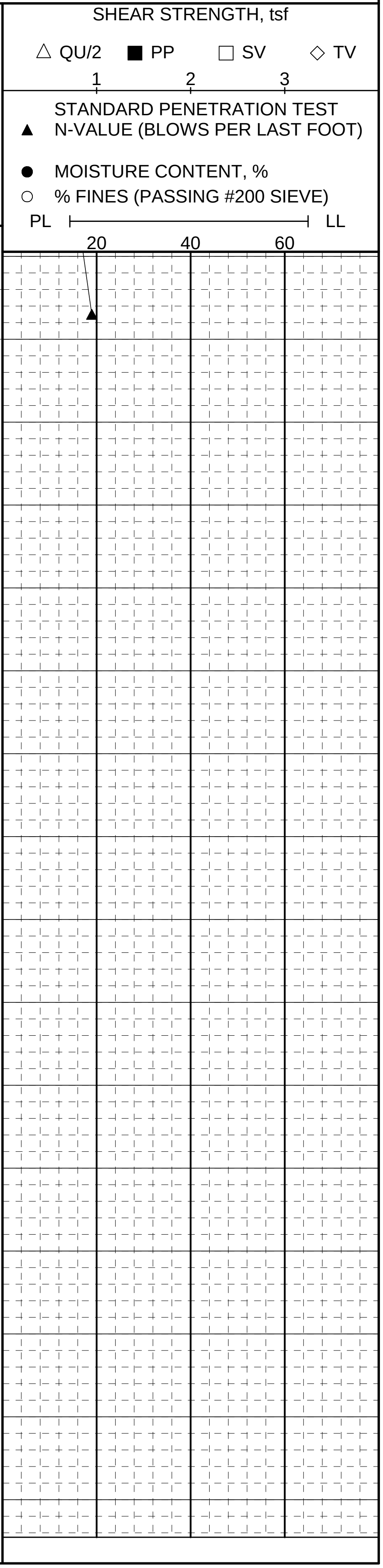
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-58

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	430				100	With traces of gravel (<1")	6-8-11	
35						Boring terminated in sand at 35'-0"		
	425							
40								
	420							
45								
	415							
50								
	410							
55								
	405							
60								
	400							
65								
	395							
70								



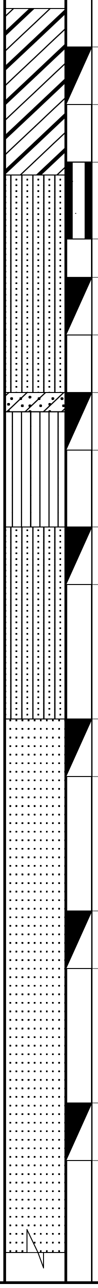
BORING LOG B-72

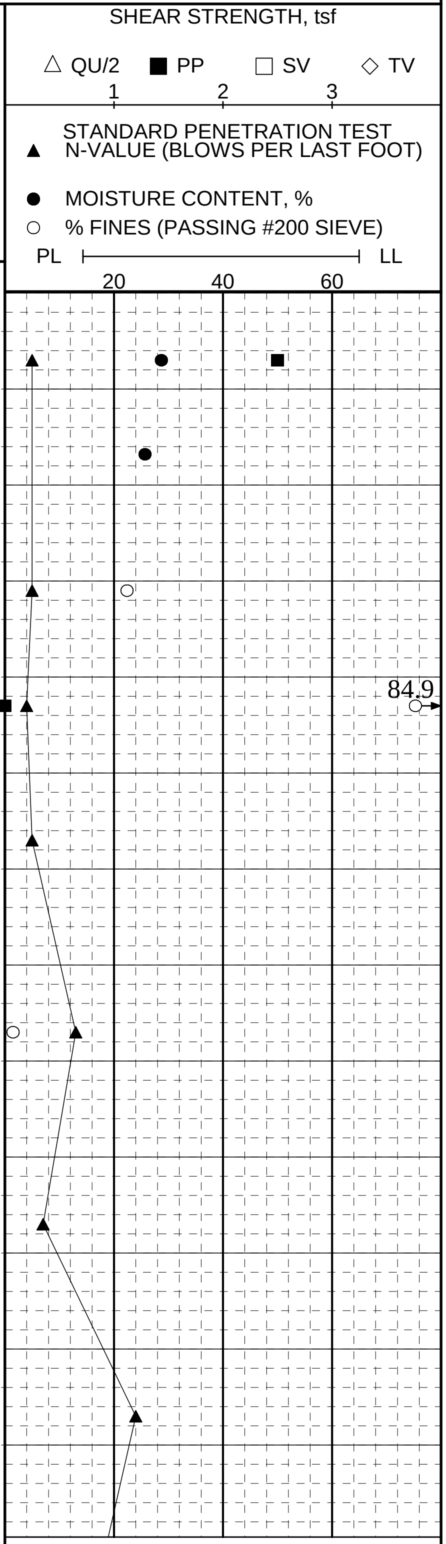
REITZ & JENS, INC.
CONSULTING ENGINEERS

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 993933.7 E 731225.4
ELEVATION: 467.3 DATUM: NAVD88
DATE DRILLED: 11-10-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465		100	Silty CLAY (CL-CH), grayish brown, firm, moderately plastic, with roots, traces of lignite, limonite, and organic chaff, moist	1-2-3	28.7
5		▽	79	Silty SAND (SM), light brown, fine, loose	98.1	25.7
	460		83	With trace clay Note: switched to mud rotary after sample.	6-3-2	
10	455		94	Silty Sandy CLAY (SC), gray, loose, with fine sand and limonite SILT (ML), tan, loose, with fine sand	0-1-3	
15	450		100	Silty SAND (SM), gray, loose, fine, with some clayey sand seams	1-4-1	
20	445		83	SAND (SP), gray, medium-dense, fine- to medium-grain, with trace coarse sand and fine gravel	7-6-7	
25	440		61	Becoming loose	3-3-4	
30	435		83	Becoming grayish tan, dense	8-13-11	





DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-72

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					94	Becoming medium-dense, traces fine gravel and silt	11-9-7	
35						Boring terminated in sand at 35'-0"		
	430							
40								
	425							
45								
	420							
50								
	415							
55								
	410							
60								
	405							
65								
	400							
70								

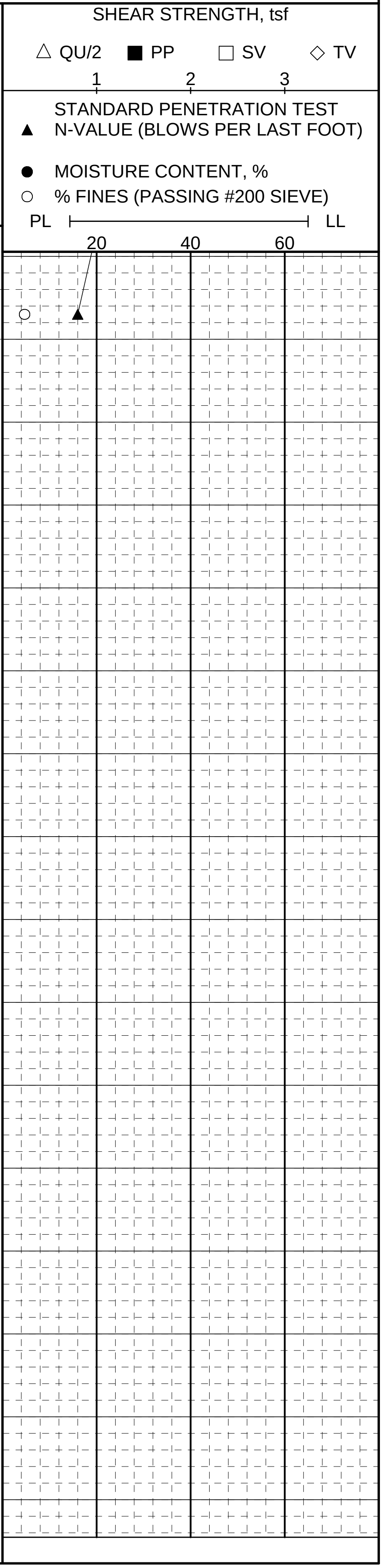


Figure A-18 Sheet 2 of 2

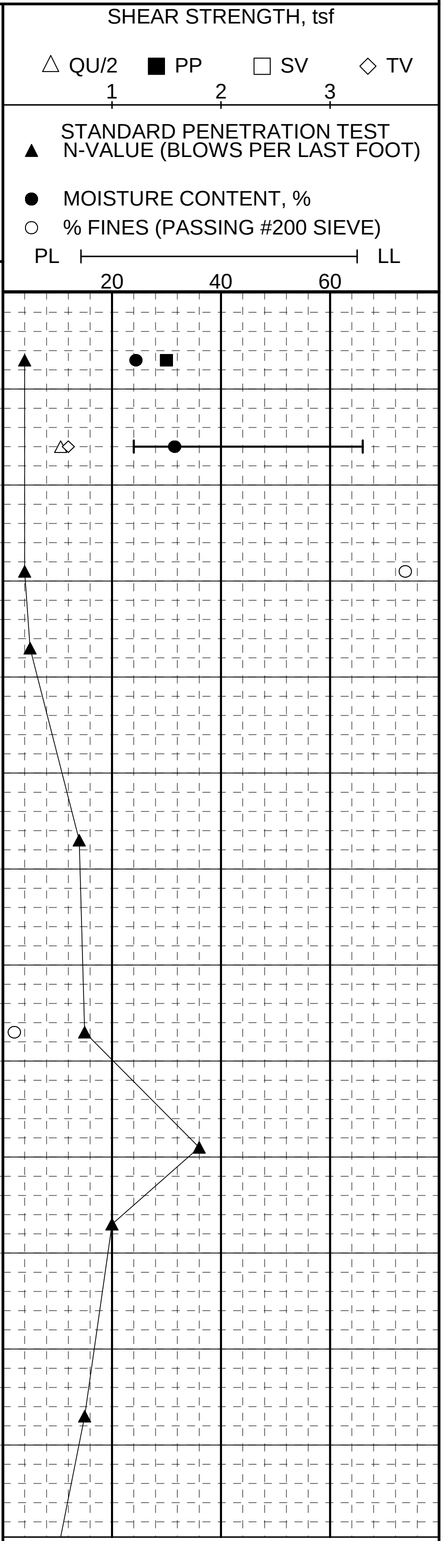
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-92

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 993398.4 E 728845.9
ELEVATION: 465.7 DATUM: NAVD88
DATE DRILLED: 11-09-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465		94	Silty CLAY (CL-CH), grayish brown, firm, moderately plastic, with roots and chaff, traces lignite and limonite, moist	2-2-2	24.4
5	460	∇	50	CLAY (CH), dark grayish brown, stiff, high plastic, trace of lignite, saturated	89.9	31.5
			100	SILT (ML), tan, with fine sand, loose	1-2-2	
10	455		100	Note: switched to mud rotary after sample.	2-2-3	
15	450		100	SAND (SP), tan, fine- to medium-grain, medium-dense	2-4-10	
20	445		100		2-5-10	
			100	Becoming gray, fine, dense	15-20-16	
25	440		100	Becoming medium-dense	4-9-11	
30	435		100	Becoming medium- to coarse-grain	6-7-8	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 6.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-92

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
35	430				100	Becoming fine to coarse, with fine gravel, trace coarse gravel	2-4-4	
40	425				67	Clayey Silty SAND (SM), gray, medium-dense, fine to coarse, with coarse gravel (<1"), clay balls Note: gravelly drilling through layers from 41' to 43.2'	2-3-6	
45	420				100	SAND (SP), gray, medium-dense, medium- to coarse grain Boring terminated in sand at 45'-0"	2-8-8	
50	415							
55	410							
60	405							
65	400							
70	395							

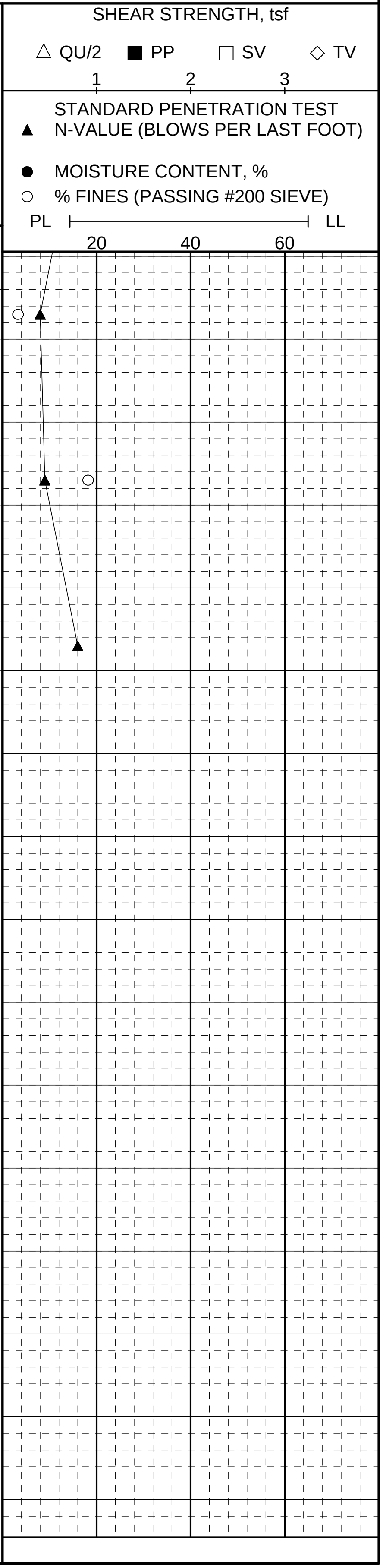


Figure A-19 Sheet 2 of 2

File: 2008012455

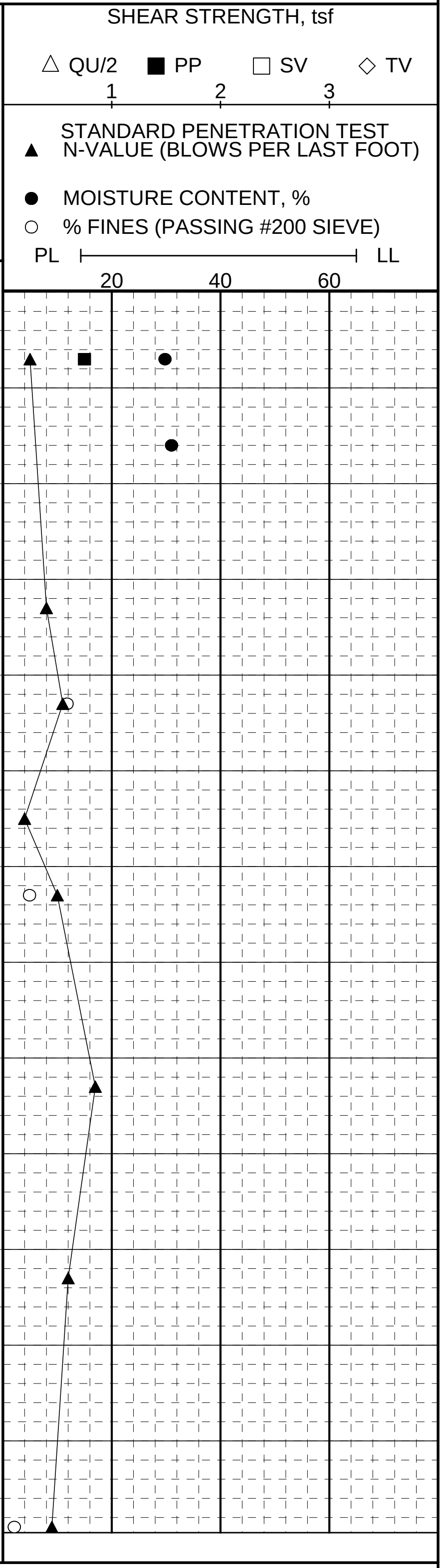
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-100

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 993325.3 E 731205.0
ELEVATION: 465.7 DATUM: NAVD88
DATE DRILLED: 11-11-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465			100	CLAY (CL-CH), grayish brown, firm, moderately pastic, slightly silty with roots, trace lignite, limonite, and chaff, moist	2-3-2	29.8
				58	SAND (SP-SM), tan, fine, with silt, medium-dense	90.6	31.0
5	460	▽			Note: bent bottom of Shelby tube.		
				100	Note: switched to mud rotary after sample.	1-3-5	
10	455			100	Silty SAND (SM), tan, medium-dense, fine- to medium-grain	3-6-5	
				100	Becoming loose	2-2-2	
15	450			100	SAND (SP), tan and gray, fine- to medium-grain, medium-dense, trace silt	5-5-5	
20	445			100	Note: stopped after sample at 21.5'; continued on 11/12.	6-8-9	
25	440			100	Becoming gray	8-6-6	
30	435						
					Gravelly SAND (GP-SP), gray, medium-		



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

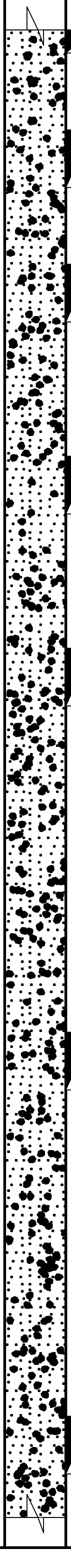
WATER LEVELS: DURING DRILLING 5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

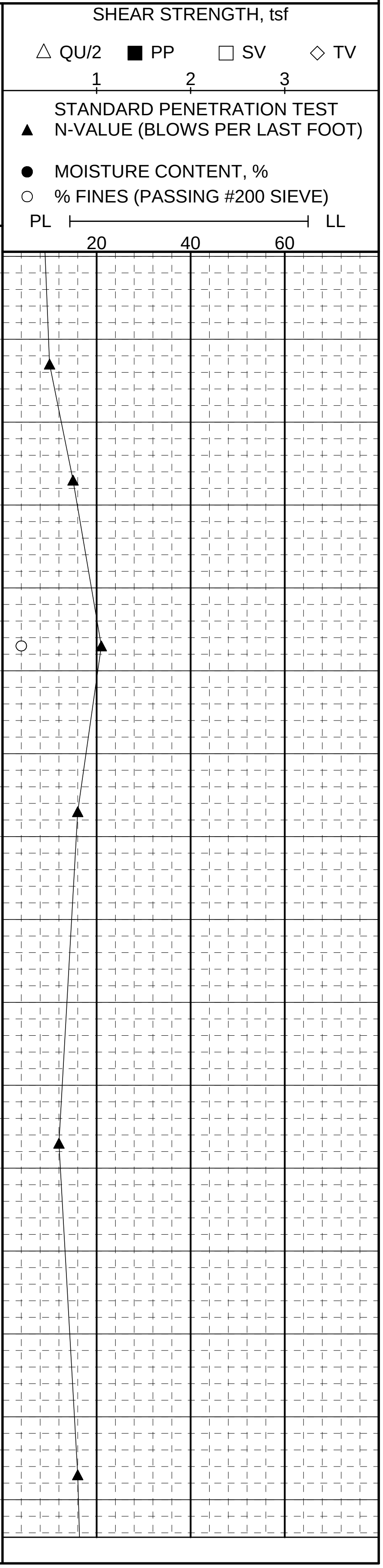
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-100

Labadie Power Plant UWL DSI



DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					44	dense, fine to coarse, poorly graded, with fine gravel (<3/4")	4-3-6	
35								
	430				56		7-4-6	
						Note: gravelly drilling from 37.5' to 37.8'		
						With some coarse gravel (<1")		
					78		4-6-9	
40								
	425							
						Note: harder drilling through 3" seam at 42.5'.		
					100	Becoming dense, trace silt, with fine gravel seam	3-9-12	
45								
	420							
					94	Becoming medium-dense, medium- to coarse, with fine gravel seam	5-8-8	
50								
	415					Note: heavier gravel from 50.5' to 51.7'; very stiff drilling. Slurry is thinning during drilling below 50'. Rods clogged at 55'; hole caved to 20' after rods pulled. Advanced augers to 50' to continue.		
55								
	410							
					83	Becoming coarse, with fine gravel Note: hole caved to 46.5' after pulling rods.	5-7-5	
60								
	405							
65								
	400							
					94		2-6-10	
70								
						NOTE: losing large amounts of drilling slurry		
	395							

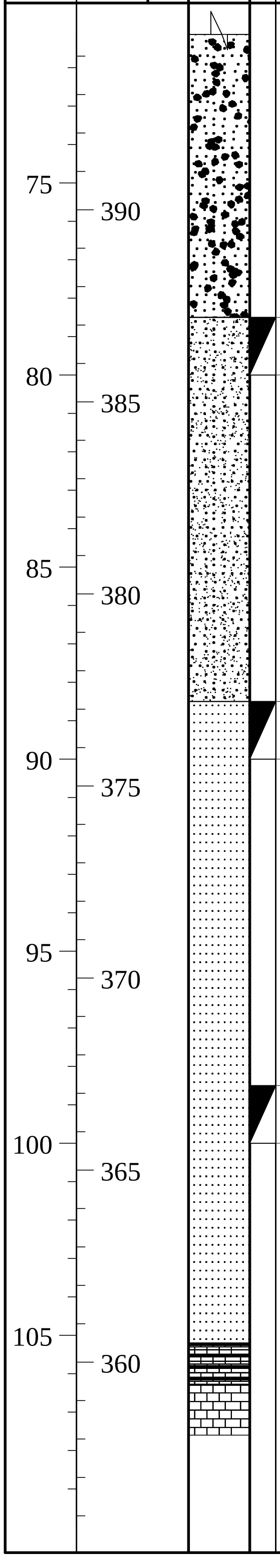


File: 2008012455

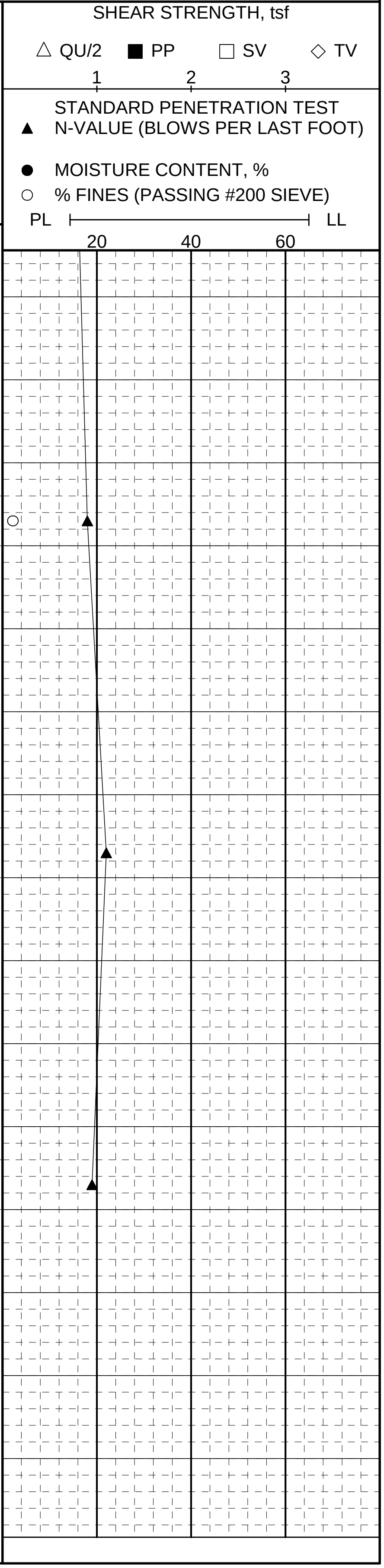
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-100

Labadie Power Plant UWL DSI



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	into the formation below 70'. Resumed drilling on 11/13 after advancing augers to 70'.		
78	SAND (SW), gray, medium-dense, fine to coarse, with fine gravel (<3/4") Note: hole caved to 66' after pulling rods and sample. Note: coarse gravel or cobble drilling from 81.5' to 83.5', and 87' to 88.5'	4-9-9	
44	SAND (SP), gray, dense, fine to coarse, with fine gravel (<3/8") Note: hole caved to 85' after pulling rods and sample. Note: coarse gravel or cobble drilling from 92' to 93'	5-10-12	
61	Becoming medium-dense	8-10-9	
	LIMESTONE, weathered (at 105'-2")		
	LIMESTONE (at 106'-3")		
	Boring terminated in limestone at 107'-7"		



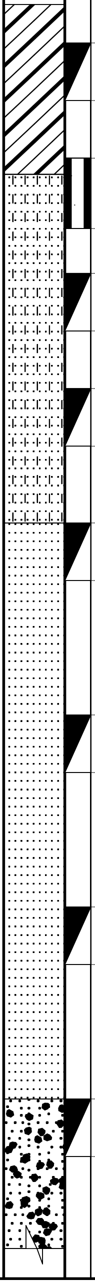
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

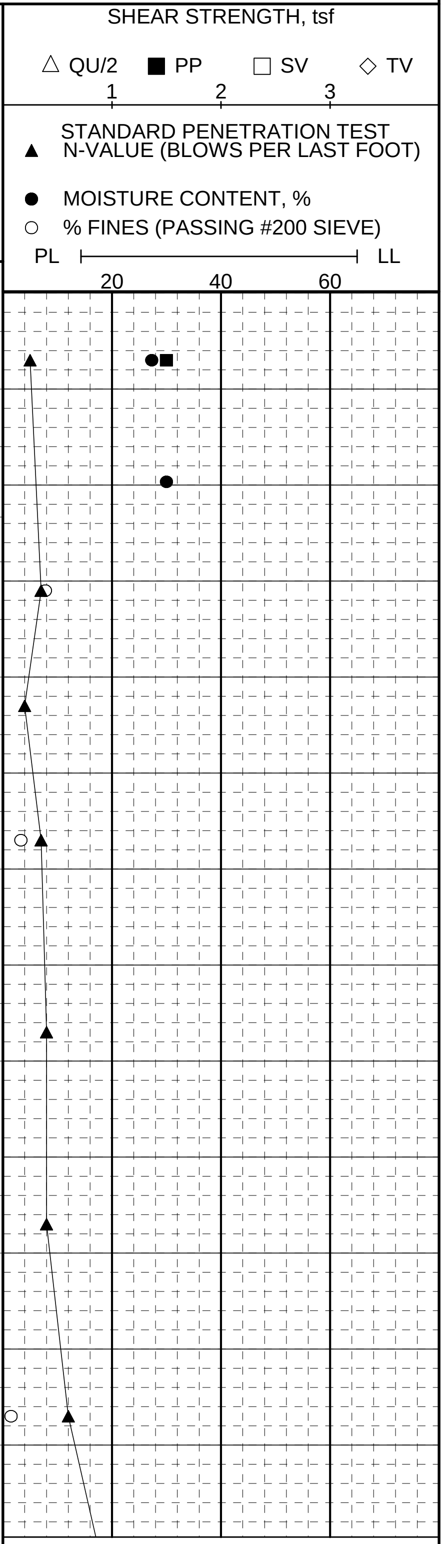
BORING LOG B-101

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 993154.9 E 727200.6
ELEVATION: 466.0 DATUM: NAVD88
DATE DRILLED: 11-07-2009



DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465		67	Silty CLAY (CL-CH), dark gray and brown, firm, medium plastic, with lignite, limonite, roots, and chaff, moist	1-2-3	27.3
5	460	▽	73	SAND (SP-SM), tan, fine, with silt, loose	91.6	30.0
			100	Note: switched to mud rotary after sample.	1-3-4	
10	455		100	Becoming loose, fine- to medium-grain, with lignite	2-2-2	
15	450		100	SAND (SP), tan, fine, loose, trace silt	2-3-4	
20	445		89	Becoming becoming gray and tan, fine to coarse, medium-dense	5-4-4	
25	440		94	With fine gravel (<1/2") and coarse sand seams	4-3-5	
30	435		67	Gravelly SAND (SP), gray and tan, medium-dense, fine to coarse, with fine gravel (<1/2")	4-5-7	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 6.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

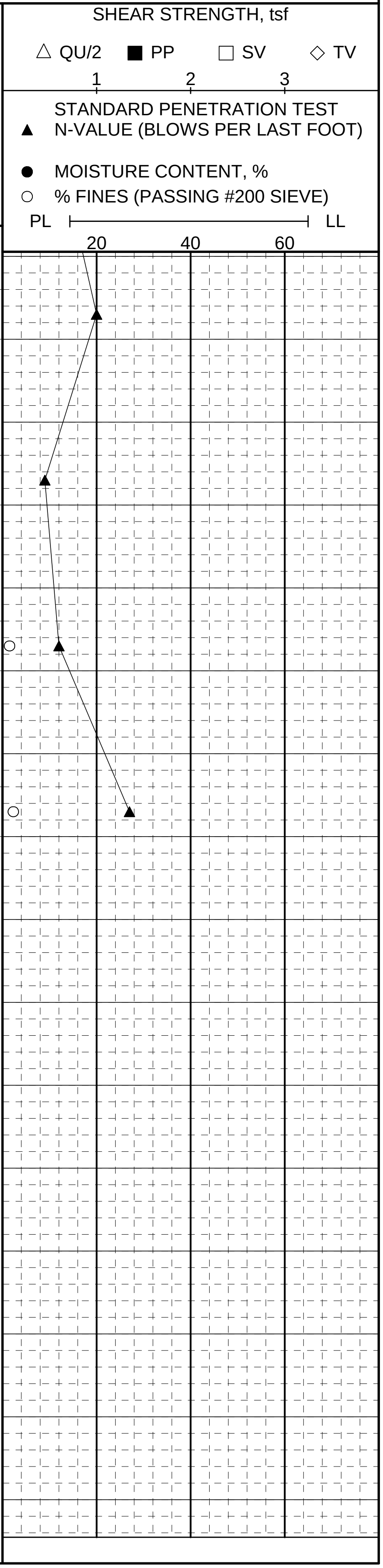
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-101

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					78	SAND (SP), gray & tan, medium-dense, fine- to medium-grain, with 2" seam of weathered coal or lignite	4-8-12	
35	430							
					11	Becoming coarse, with coarse gravel (<1-1/4")	3-5-4	
40	425							
					78	Becoming fine to coarse, with fine gravel	4-5-7	
45	420							
						Note: heavy gravelly drilling at 47'		
					89	Becoming dense, gray, fine- to medium-grain, with fine gravel (<3/4")	6-12-15	
50	415					Boring terminated in sand at 50'-0"		
55	410							
60	405							
65	400							
70	395							



REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-115

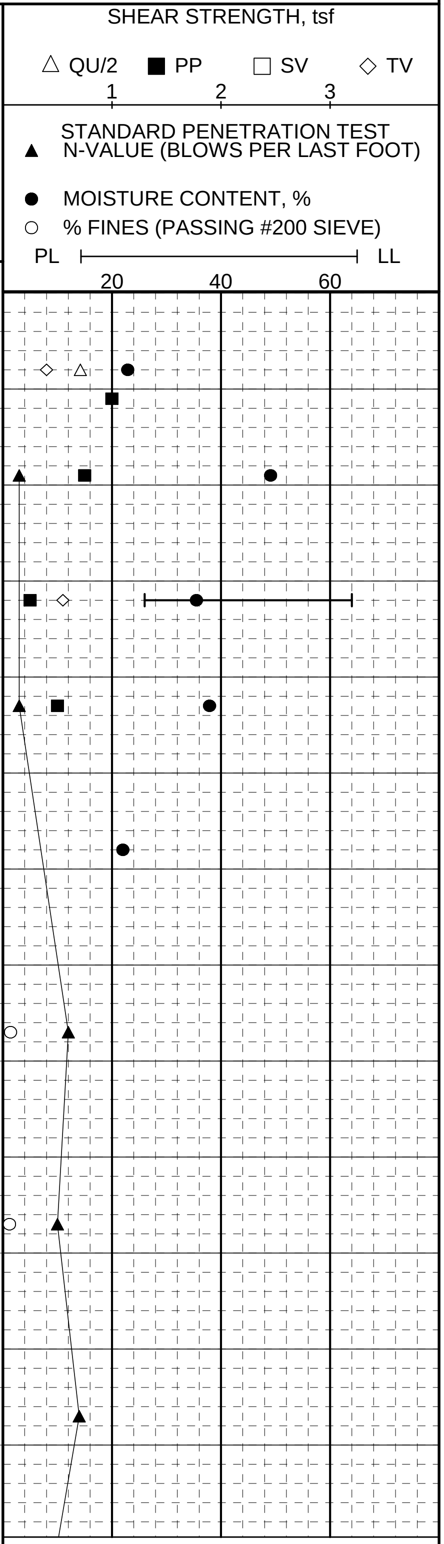
Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 992864.4 E 727489.2
ELEVATION: 465.3 DATUM: NAVD88
DATE DRILLED: 11-07-2009

DEPTH (FEET)	ELEVATION
0	465
5	460
10	455
15	450
20	445
25	440
30	435

WATER TABLE: ∇ (about 7 ft)

PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
58	Silty CLAY (CL-CH), dark grayish brown, stiff, medium plastic, with roots and chaff, moist	101.8	22.9
	Silty CLAY (CL), brown, firm, with fine sand and silt seams, moist		
100	CLAY (CL-CH), dark gray and brown, soft, medium plastic, slightly silty, with lignite and limonite, wet	1-1-2	49.1
100	CLAY (CH), gray, firm, high plastic, with silt seams, traces lignite and limonite, wet	83.8	35.5
100	Silty CLAY (CL), brown, soft, with traces of fine sand, lignite and limonite, wet	0-1-2	37.9
96	Sandy CLAY (SC), gray, with fine- to medium-grain sand, wet	91.4	22.0
	Silty SAND (SM), tan and gray, medium-dense, fine- to medium-grain		
	SAND (SP-SM), gray and tan, medium-dense, medium-grain, with silt, trace fine gravel Note: switched to mud rotary after sample.		
72	SAND (SP), tan, medium-dense, fine- to medium-grain	6-6-6	
72	Becoming fine, with medium-grain sand	5-6-4	
89	Silty SAND (SM), gray, fine, medium-dense	4-6-8	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 7 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-115

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					72	SAND (SP), gray, medium-dense, fine to coarse, with fine gravel and coal fragments	2-3-5	
35	430							
					83	With medium gravel (<3/4")	3-5-6	
40	425							
						Note: gravelly drilling from 41' to 42'		
					67	Becoming dense, with coarse gravel (<1")	6-8-24	
45	420					Boring terminated in sand at 45'-0"		
50	415							
55	410							
60	405							
65	400							
70	395							

SHEAR STRENGTH, tsf

△ QU/2 ■ PP □ SV ◇ TV

1 2 3

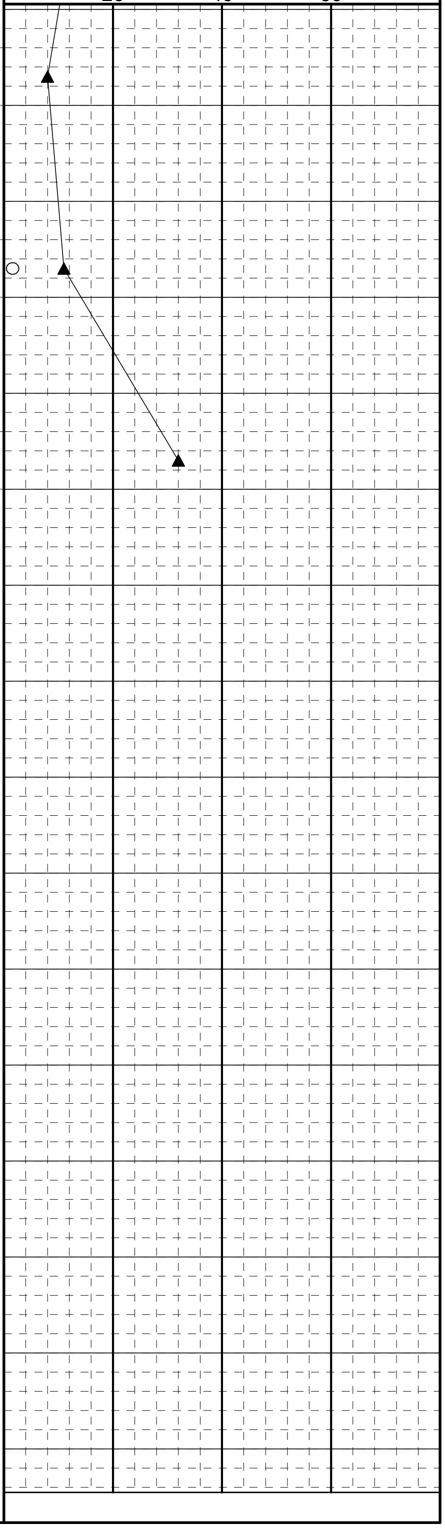
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ├────┤ LL

20 40 60



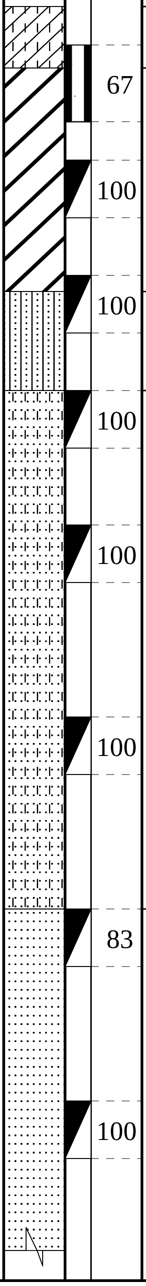
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

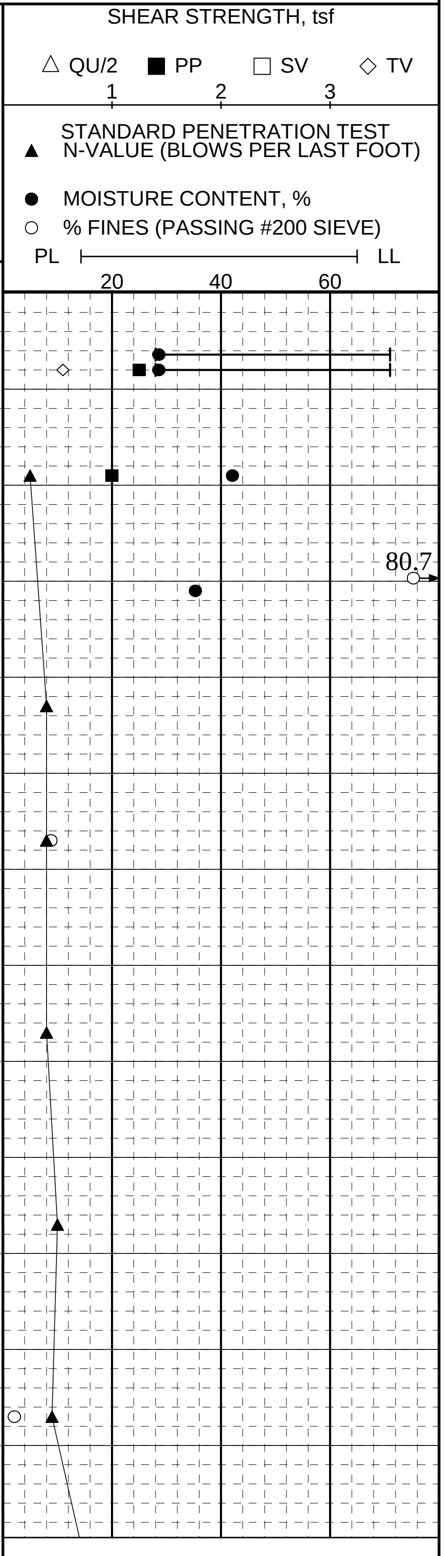
BORING LOG B-127

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 992782.4 E 731193.3
ELEVATION: 463.4 DATUM: NAVD88
DATE DRILLED: 11-10-2009



DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						Silty CLAY (CL), brown, firm, low plastic, traces lignite and limonite, roots and chaff, moist		
					67	CLAY (CH), dark gray-brown, stiff, high plastic, slightly silty, with silty clay seams, lignite, limonite, iron stains, moist	96.0 96.0	28.6 28.6
	460	∇						
5					100		1-2-3	42.1
					100	Sandy SILT (SM), brown, with clay, traces of lignite and limonite, loose Note: pushed Shelby tube with no recovery, pushed split-spoon sampler; switched to mud rotary after sample.	Pushed	35.3
	455							
10					100	SAND (SP-SM), tan, medium-dense, fine, with silt, 3" layer of gray fine sand	3-3-5	
	450							
					100		1-3-5	
15								
	445							
					100	With traces of medium-grain sand	2-3-5	
20								
	440							
					83	SAND (SP), tan and gray, medium-dense, fine to coarse, with fine gravel (<1/2")	4-5-5	
25								
	435							
					100	Note: hole caved to 15' after pulling rods and sample; redrilled to 33.5'.	3-5-4	
30								



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 3.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

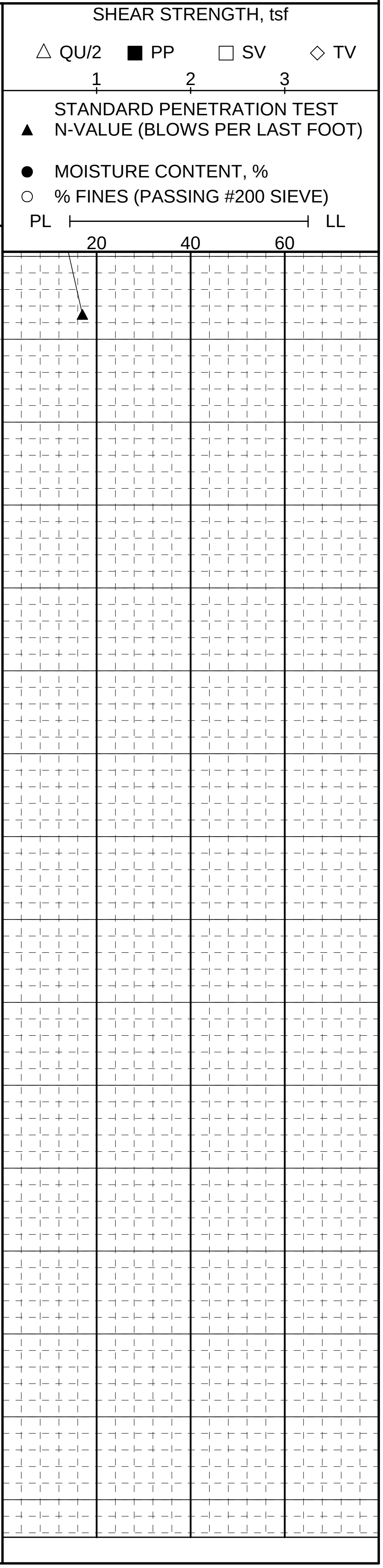
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-127

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	430				83	With coarse gravel (<1-1/4")	11-9-8	
35						Boring terminated in sand at 35'-0"		
	425							
40								
	420							
45								
	415							
50								
	410							
55								
	405							
60								
	400							
65								
	395							
70								



File: 2008012455

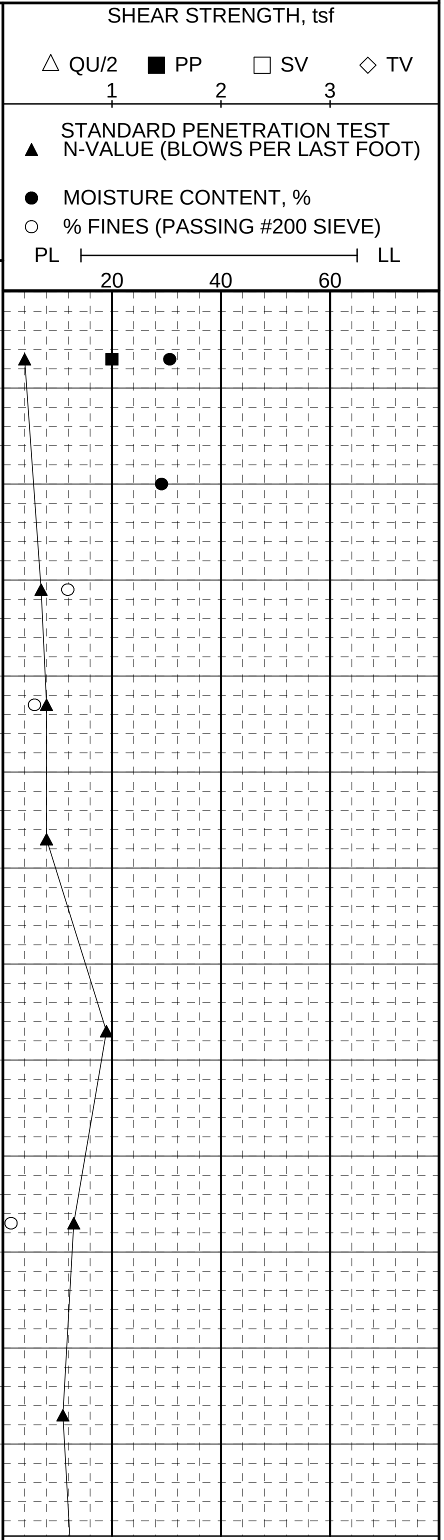
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-141

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 992258.3 E 727479.8
ELEVATION: 466.2 DATUM: NAVD88
DATE DRILLED: 11-07-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465				72	CLAY (CL-CH), gray-brown, firm, low to high plastic, slightly silty, with lignite, limonite, roots, and chaff, moist	0-2-2	30.6
5	460	▽			75	SAND (SP-SM), tan, fine, with silt, medium-dense		29.1
					89	Note: switched to mud rotary after sample.	2-3-4	
10	455				100		2-3-5	
15	450				100	With trace of coal fragments	5-4-4	
20	445				100	SAND (SP), tan, fine- to medium-grain, medium-dense, with trace fine gravel	3-9-10	
25	440				100	Becoming gray	6-6-7	
30	435				78	With fine gravel (<3/8")	4-4-7	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 5.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-141

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					56		4-5-8	
35						Boring terminated in sand at 35'-0"		
	430							
40								
	425							
45								
	420							
50								
	415							
55								
	410							
60								
	405							
65								
	400							
70								

SHEAR STRENGTH, tsf

△ QU/2 ■ PP □ SV ◇ TV

1 2 3

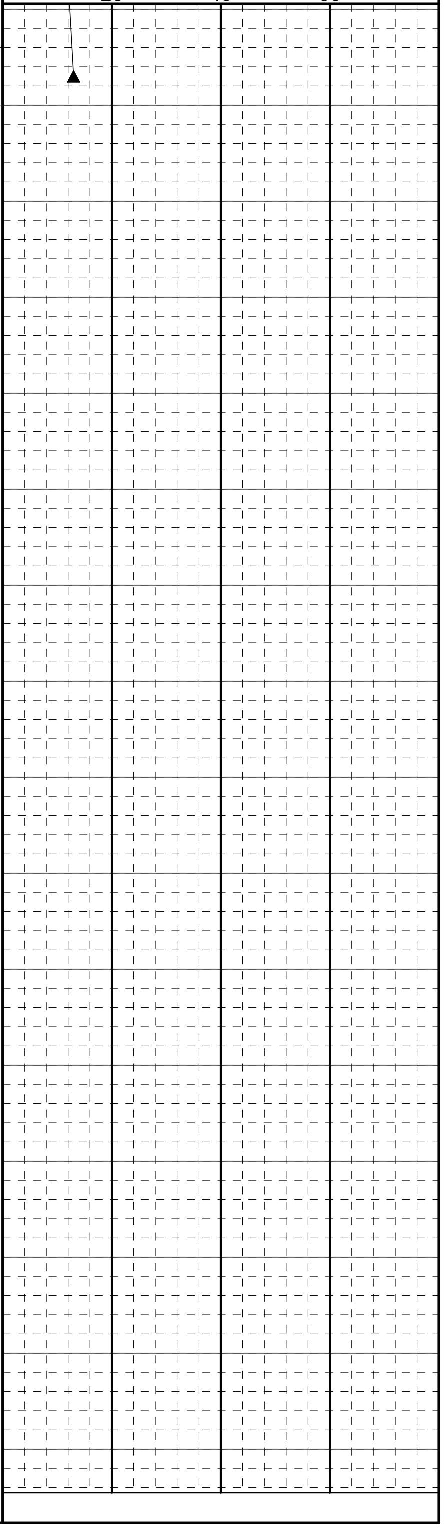
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ⊢⊣ LL

20 40 60



File: 2008012455

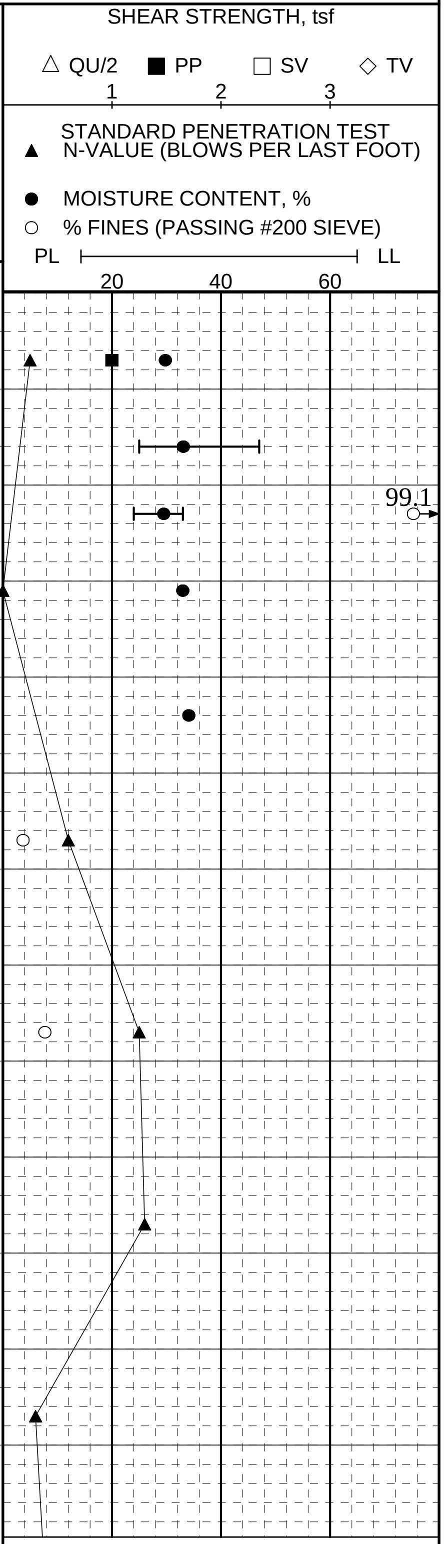
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-153

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 992163.2 E 731176.8
ELEVATION: 463.7 DATUM: NAVD88
DATE DRILLED: 11-11-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0								
					100	CLAY (CL-CH), gray and brown, firm, low to high plastic, slightly silty, with lignite, limonite, roots, and chaff, moist	1-2-3	29.8
	460							
5					54	Clayey SILT (ML), grayish brown, very soft, with high plastic clay layers and seams, wet	89.5	33.1
		▽				Clayey Silty SAND (SM), brown and tan, fine, with high plastic clay seams, very loose, saturated	89.1	29.5
					100	Sandy CLAY (CL), gray, very soft, wet	0-0-0	33.0
	455							
10					79	Silty SAND (SM), gray and tan, very loose, fine, slightly clayey With silty clay seams Note: switched to mud rotary after sample.	90.0	34.1
	450				100	SAND (SP), tan, fine- to medium-grain, medium-dense	3-5-7	
15								
	445				100	SAND (SP-SM), tan, dense, fine, uniform, with silt	8-10-15	
20								
	440				100	Note: hole caved to 18' after pulling rods and sample; flushed hole before continuing; drilling mud keeps thinning out below 20'.	7-12-14	
25								
	435				11	SAND (SP), gray, fine to coarse, with fine gravel (<3/4"), loose Note: hole caved to 8' after pulling rods and sample; flushed with mud prior to continuing.	3-3-3	
30								



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

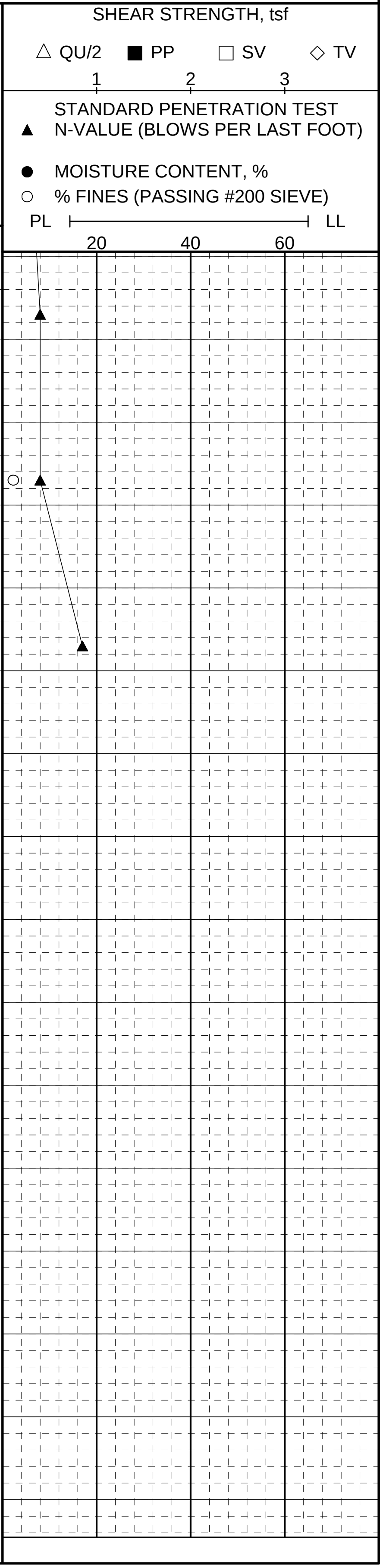
WATER LEVELS: DURING DRILLING 5.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-153

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
35	430			◣	17	Becoming medium-dense, with fine gravel (<3/8")	3-4-4	
40	425			◣	78	SAND (SW), gray, medium-dense, well-graded fine to coarse, with fine gravel (<3/4") Note: hole caved to 20' after pulling rods and sample; advanced augers to 23.5' and flushed hole before continuing.	4-3-5	
45	420			◣	11	SAND and GRAVEL (GP-SP), gray, medium-dense, coarse sand, fine gravel Boring terminated in sand and gravel at 45'-0" Notes: hole stood open to 35' after hollow-stem augers were advanced to 23.5'.	11-8-9	
50	415							
55	410							
60	405							
65	400							
70	395							



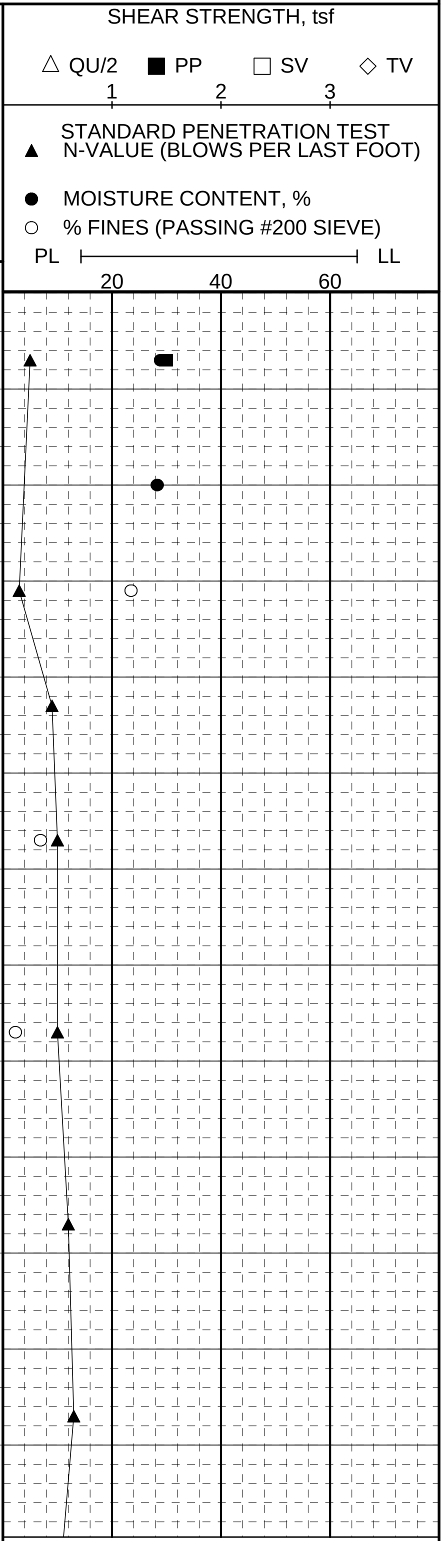
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-154

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 991956.9 E 727759.7
ELEVATION: 465.1 DATUM: NAVD88
DATE DRILLED: 11-09-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0	465					
			100	CLAY (CL-CH), dark grayish brown, low to high plastic, slightly silty, with roots and chaff, trace lignite, moist, firm	0-2-3	28.9
5	460		79	Silty SAND (SM), tan, fine, very loose	94.1	28.3
		∇				
			100	Note: switched to mud rotary after sample.	2-1-2	
10	455		100	SAND (SP-SM), brown and tan, fine- to medium-grain, with silt, medium-dense	2-4-5	
			100	Becoming fine to coarse	1-5-5	
15	450					
			100	SAND (SP), tan and gray, medium-dense, fine- to medium-grain	7-6-4	
20	445					
			100	Becoming gray, fine to coarse, with fine gravel (<1/2") Note: lost mud return from 25' to 26'.	5-6-6	
25	440					
			100	With gravel up to 1"	3-6-7	
30	435					



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 6.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-154

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					83	With fine gravel (<3/4")	3-5-5	
35	430							
					44	With gravel up to 1/2", traces of clay balls	5-6-7	
40	425					Boring terminated in sand at 40'-0"		
45	420							
50	415							
55	410							
60	405							
65	400							
70	395							

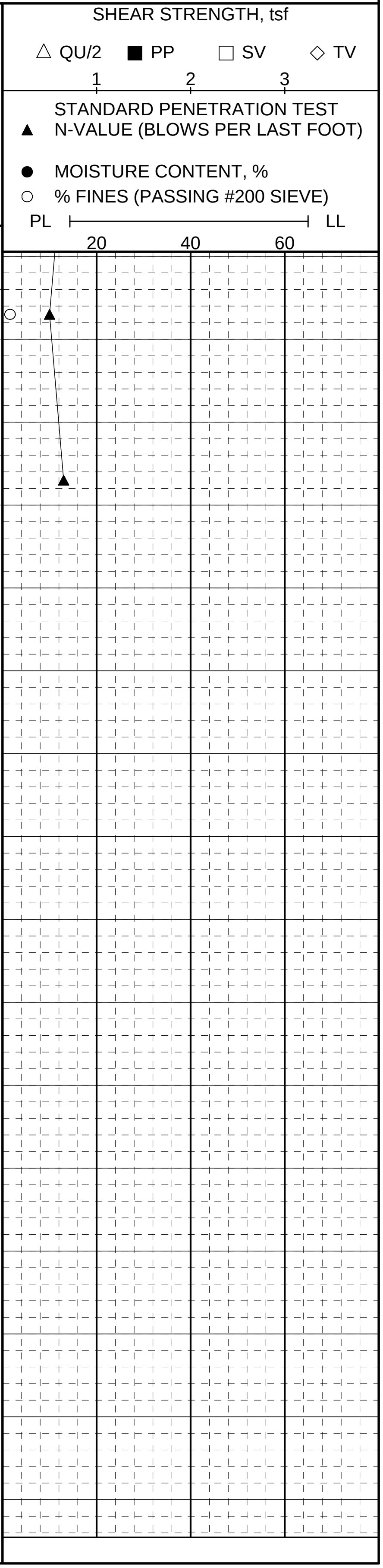


Figure A-26 Sheet 2 of 2

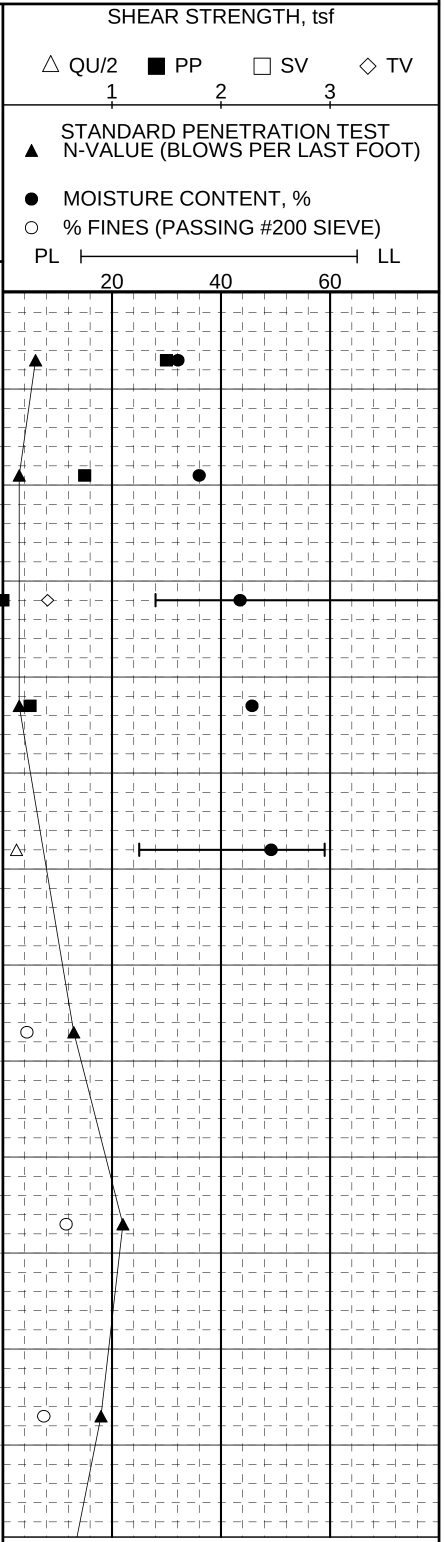
File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-176

Labadie Power Plant UWL DSI	LOCATION: N 991570.9 E 731163.5
Franklin County, Missouri	ELEVATION: 462.7 DATUM: NAVD88
CLIENT: **Ameren Missouri**	DATE DRILLED: 01-19-2010

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				Silty CLAY (CL), gray-brown, firm, with roots		
			89	CLAY (CH), dark grayish brown, firm, high plastic, blocky, with silt, moist	2-3-3	32.1
	460					
5			94	Becoming brown, soft, slighltly silty, with tan sandy clay seams, moist	2-1-2	36.0
	455		63	Becoming gray, with tan sandy clayey silt seam, and laminations of tan sandy silt, silty clay and silty sand	75.8	43.5
10						
		▽	94	Becoming gray and bluish gray, saturated, slightly silty	0-1-2	45.7
	450					
			63	With decaying wood and strong organic odor, traces of lignite and limonite	69.3	49.2
15				SAND (SP), gray, fine- to medium-grain, medium-dense Note: switched to mud rotary after sample; 3' blow-in while mixing mud.		
	445					
			78	Becoming very fine, trace silt	7-6-7	
20						
	440					
			89	SAND (SP-SM), tannish gray, dense, fine, uniform, with silt and lenses of silt	5-10-12	
25						
	435					
			100	Becoming gray, medium-dense, less silty, with traces of lignite and carbon	5-10-8	
30						



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 11 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

BORING LOG B-176

Labadie Power Plant UWL DSI

PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
78	Silty SAND (SM), gray, medium-dense, fine, with layers of medium-grain sand, traces of silt and high plastic clay laminations Note: rough gravelly drilling from 36' to 37'	3-3-8	
56	SAND (SP), gray, medium-dense, medium- to coarse-grain, with fine gravel (<3/4") Note: 10" then 7" of blow-in before taking sample; flushed hole with bit.	5-3-5	
100	CLAY (CH), gray, stiff, high plastic, with traces of sand and gravel, lenses of silt and fine sand Note: hole caved 2' after pulling rods and sample; flushed hole with bid.	3-3-5	32.7
100	Silty SAND (SM), brownish gray, medium dense, fine, traces of medium-grain sand	7-8-11	
	Boring terminated in sand at 50'-0"		

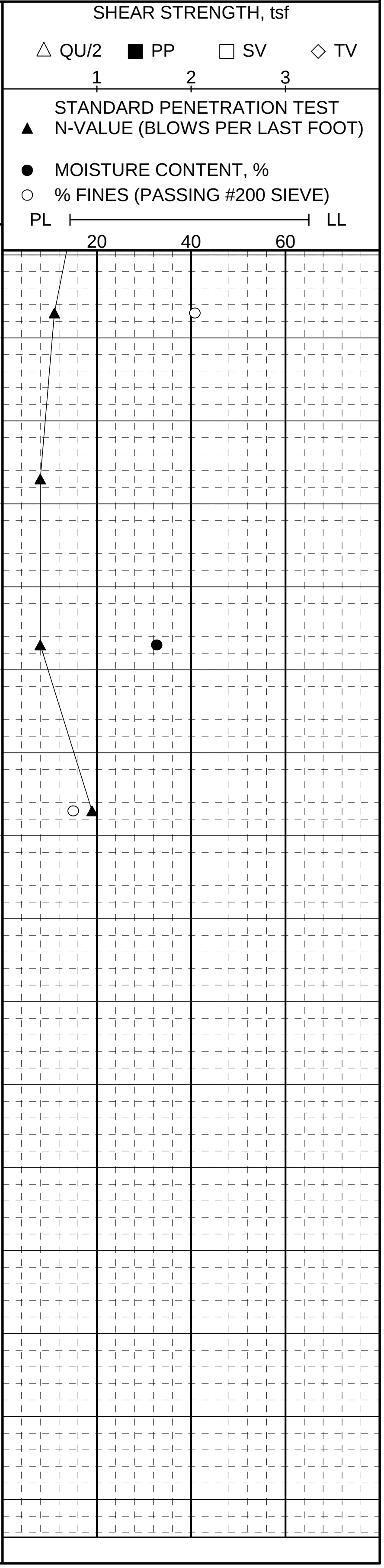
DEPTH (FEET): 35, 40, 45, 50, 55, 60, 65, 70

ELEVATION: 430, 425, 420, 415, 410, 405, 400, 395

WATER TABLE

GRAPHIC LOG

SAMPLE TYPE



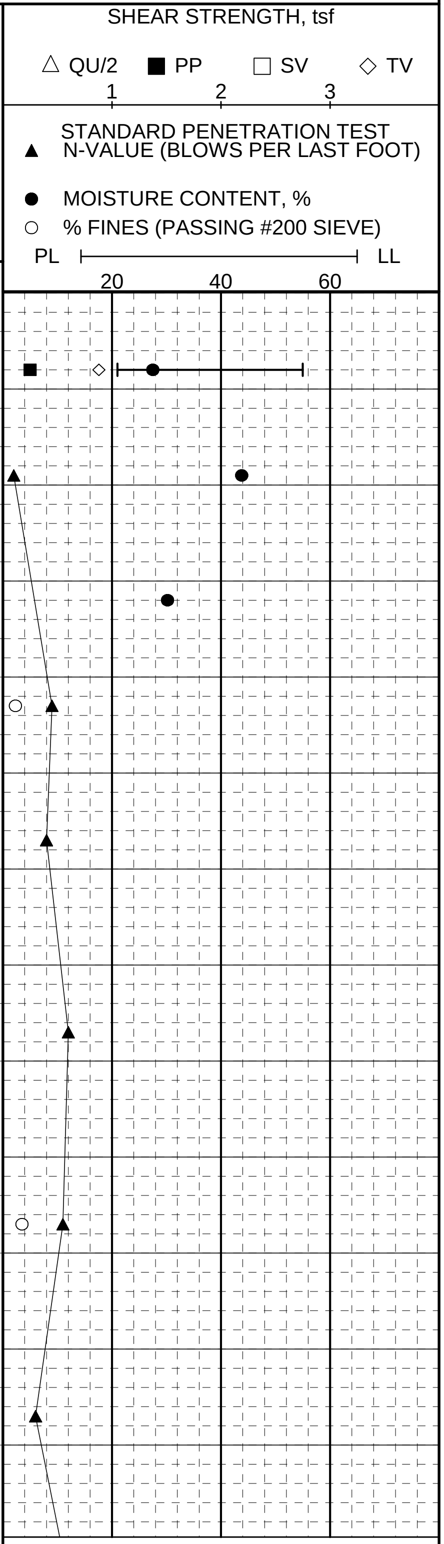
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-188

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 991065.40 E 728033.6
ELEVATION: 464.9 DATUM: NAVD88
DATE DRILLED: 11-09-2009

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						Silty CLAY (CH), brown, soft, high plastic, with fine roots and chaff, strong decaying organic odor, lignite and limonite, moist		
					50		95.6	27.5
						Clayey Sandy SILT (ML), tan and gray, very loose, very wet		
5	460				100		1-1-1	43.8
					13	With limonite, traces of lignite, small roots, and wood pieces Note: switched to mud rotary after sample.		30.2
10	455							
					83	SAND (SP), tan, fine, trace medium-grain, medium-dense	3-4-5	
					100	Becoming gray, fine- to medium-grain	2-3-5	
15	450							
					100	Becoming gray and tan	4-6-6	
20	445							
					100		3-5-6	
25	440							
					83	Becoming loose, with fine gravel (<3/8")	2-3-3	
30	435							



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 7 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-188

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
				▼	67	Becoming fine to coarse, with fine gravel (<1/2"), medium-dense	5-6-7	
35	430					Boring terminated in sand at 35'-0"		
40	425							
45	420							
50	415							
55	410							
60	405							
65	400							
70	395							

SHEAR STRENGTH, tsf

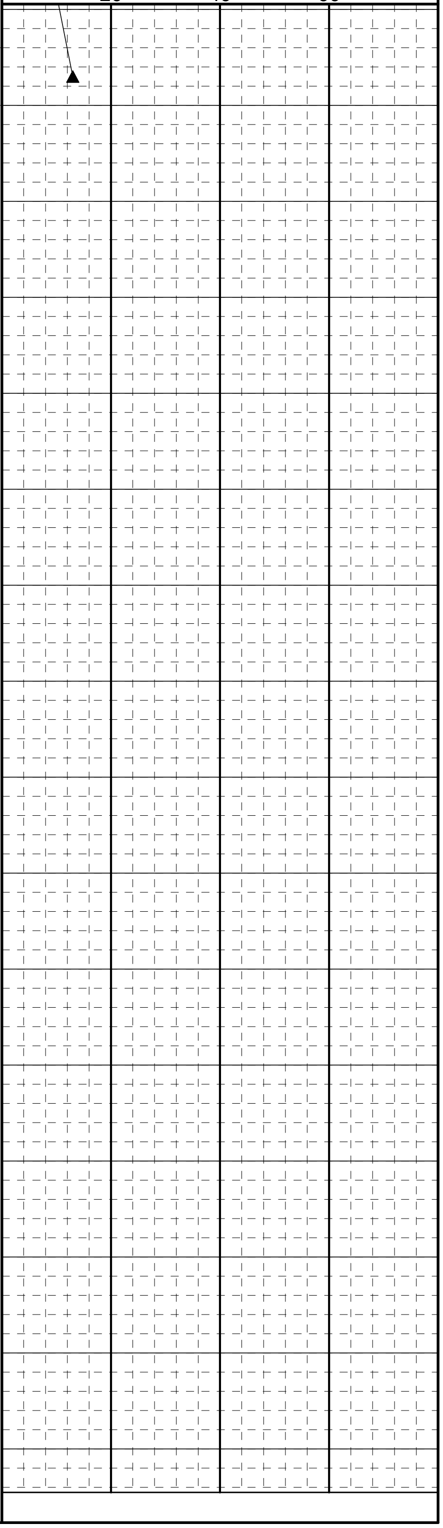
△ QU/2 ■ PP □ SV ◇ TV

1 2 3

STANDARD PENETRATION TEST
▲ N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %
○ % FINES (PASSING #200 SIEVE)
PL LL

20 40 60



File: 2008012455

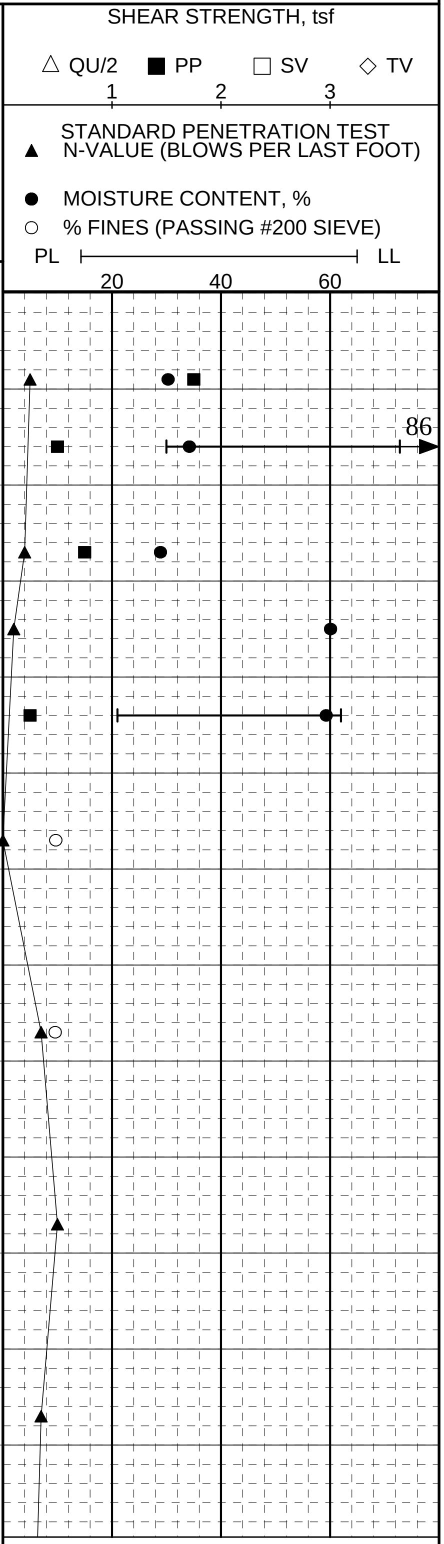
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-200

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 990737.1 E 729073.3
ELEVATION: 464.8 DATUM: NAVD88
DATE DRILLED: 01-18-2010

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0			89	CLAY (CH), dark gray-brown, high plastic, with traces of fine roots and organics, firm, moist	8-2-3	30.3
			100	With traces of lignite and limonite	85.6	34.2
5	460	∇		SILT (ML), tan and brown, with lenses of brown high plastic clay and tan fine sand		
			100	CLAY (CH), dark gray-brown, high plastic, soft, moist	2-2-2	28.9
			100	Sandy SILT (ML), light brown, fine, loose, with high plastic clay seams	1-1-1	60.1
10	455		96	CLAY (CH), gray, high plastic, with heavy iron stains, saturated, soft With layers and laminations of low and high plastic clay, with laminations of brown and gray silt and tan fine sand	64.9	59.3
15	450		67	SAND (SP-SM), gray, fine, with silt, traces of iron stains, very loose Note: switched to mud rotary after sample.	0-0-0	
20	445		67	Becoming medium-dense, grayish tan	4-3-4	
25	440		78		3-5-5	
30	435		61	SAND (SP), gray, fine- to medium-grain, medium-dense	3-3-4	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-200

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
					44	Becoming loose, with traces of coarse sand and fine gravel (<3/8")	1-1-5	
35	430							
					78	Becoming medium-dense, grayish tan, fine- to medium-grain, trace silt	2-4-4	
40	425							
					89	Becoming loose, tan, fine	2-3-3	
45	420							
					56	SAND and GRAVEL (GP-SP), gray, loose, fine to coarse sand, fine and coarse gravel (<1.5")	1-2-2	
50	415							
55	410							
						Note: at 58', hole caved to 51' while mixing mud; flushed prior to sampling at 58.5'.		
					78	SAND (SP), tan, medium-dense, fine- to medium-grain	3-7-9	
60	405					Boring terminated in sand at 60'-0"		
65	400							
70	395							

SHEAR STRENGTH, tsf

△ QU/2 ■ PP ☐ SV ◇ TV

1 2 3

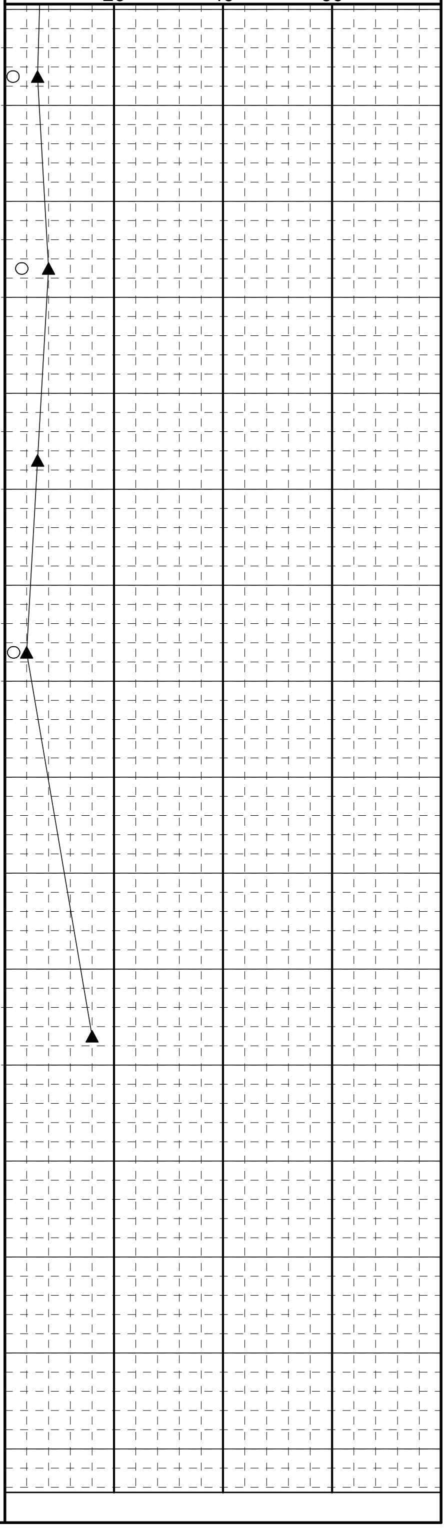
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ⊢—⊣ LL

20 40 60



File: 2008012455

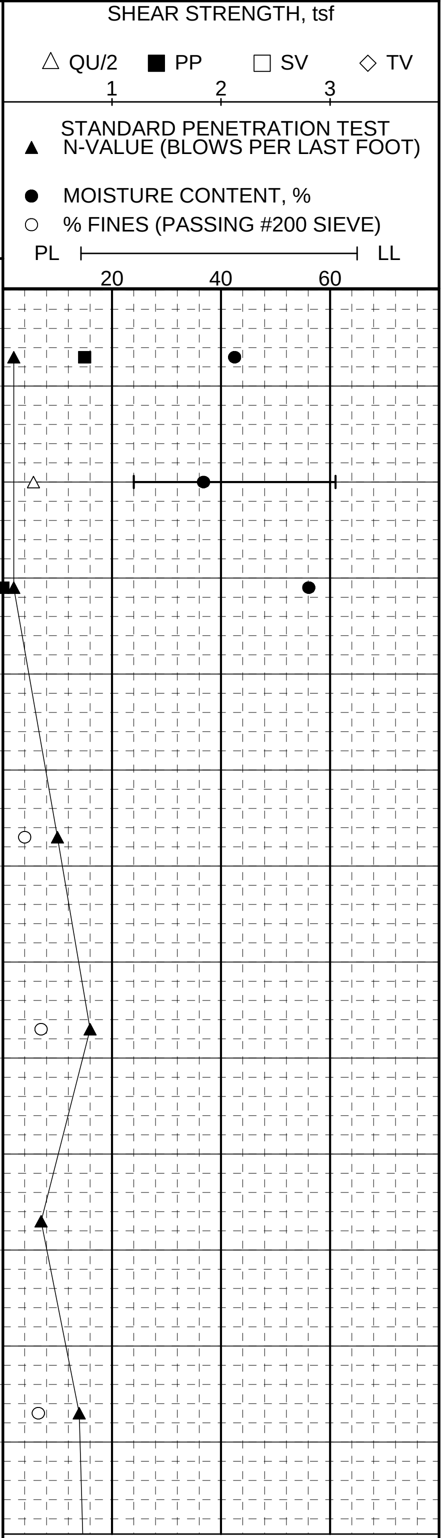
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-202

Labadie Power Plant UWL DSI
Franklin County, Missouri
CLIENT: **Ameren Missouri**

LOCATION: N 990727.0 E 729660.5
ELEVATION: 463.8 DATUM: NAVD88
DATE DRILLED: 01-18-2010

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0					94	CLAY (CH), dark brownish gray, high plastic, slightly silty, with fine roots, lignite, and iron stains, blocky, moist, soft	1-1-1	42.5
5	460				42	With layers of silty clay and seams of fine sand and silt, trace lignite	83.3	36.8
					100	Becoming brown, slightly silty, very wet	0-1-1	56.1
	455							
10		▽			83	SAND (SP), tan, medium-dense, fine, uniform, with traces of limonite and silt		
15	450				100	Note: switched to mud rotary after sample; resumed 1/19; 5' blow-in overnight.	3-6-4	
20	445				89	SAND (SP-SM), tannish gray, medium dense, fine, with silt	5-8-8	
25	440				94	Becoming gray, traces of lignite and coarse sand	2-3-4	
30	435				83	Becoming gray, fine- to medium-grain, with silt, traces coarse sand and fine gravel	3-6-8	



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 86.3
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 10 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2008012455

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-202

Labadie Power Plant UWL DSI

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	430				56	Becoming tannish gray	5-6-9	
35						Boring terminated in sand at 35'-0"		
	425							
40								
	420							
45								
	415							
50								
	410							
55								
	405							
60								
	400							
65								
	395							
70								

SHEAR STRENGTH, tsf

△ QU/2 ■ PP □ SV ◇ TV

▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (PASSING #200 SIEVE)

PL ⊢—⊣ LL

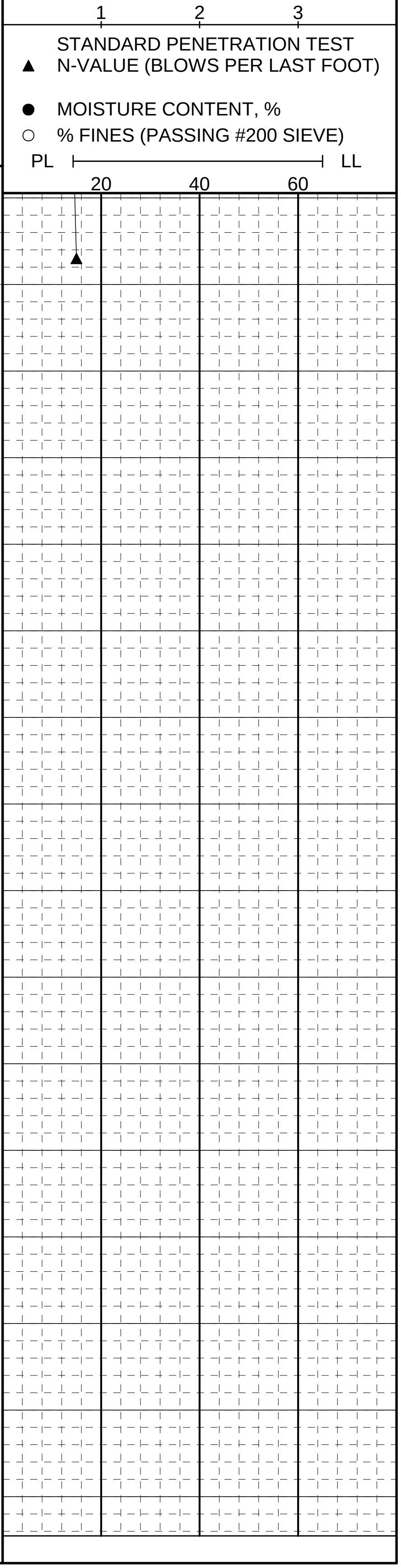


Figure A-30 Sheet 2 of 2

File: 2008012455

Appendix B

LAB TEST DATA

This page intentionally left blank

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
B-4	ST-2	3.5-5.5	24	CH	26.5																**B-1**
B-4	ST-2	3.5-5.5	24	SM																	**B-2**
P-9	GS-1	2.75			26.5																
P-9	SS-2	10-11.5	3		34.3																
P-9	SS-3	15-16.5	18																		
P-9	SS-4	20-21.5	18																		
P-9	SS-5	25-26.5	18	SP-SM					**B-3**	8.2											
P-9	SS-6	30-31.5	17																		
P-9	SS-7	35-36.5	18	SP					**B-4**	2.1											
B-10	SS-1	1-2.5	14		21.8								0.50								
B-10	ST-2	4-6	22.5	CL	34.3	86.9	37	22					0.75				**B-5**				
B-10	SS-3	7-8.5	18							38.5											
B-10	SS-4	10-11.5	18		42.8																
B-10	SS-5	13.5-15	12							5.8											
B-10	SS-6	18.5-20	14	SP-SM					**B-6**	5.7											
B-10	SS-7	23.5-25	16																		
B-10	SS-8	28.5-30	15	SP					**B-7**	1.6											
B-10	SS-9	33.5-35	4	SP					**B-8**	4.4											
P-12	GS-1	1.3			30.9																
P-12	SS-2	15-16.5	13																		
P-12	SS-3	20-21.5	12																		
P-12	SS-4	25-26.5	6																		
P-12	SS-5	30-31.5	11																		
P-12	SS-6	35-36.5	18																		
B-13	ST-1	1-3	12	CL	22.7	103.1	46	21					0.75	0.30		**B-9**					
B-13	ST-2	3-5	12	CH	25.2	93.3	50	28						0.15							
B-13	ST-2	3-5	12		37.5	82.5								0.15							
B-13	ST-3	5-7	2		35.0																
B-13	ST-4	7-9	15		24.5	100.5															
B-13	SS-5	13.5-15	16	SP					**B-10**	4.9											
B-13	SS-6	18.5-20	14							1.0											
B-13	SS-7	25.5-27	16							2.4											
B-13	SS-8	28.5-30	16	SP					**B-11**	1.5											
B-13	SS-9	33.5-35	1																		
B-13	SS-10	38.5-40	14	SP					**B-12**	1.8											
B-13	SS-11	43.5-45	4																		
B-13	SS-12	48.5-50	1																		
B-14	SS-1	1-2.5	18		18.9																
B-14	SS-2	4-5.5	10		23.4																
B-14	SS-3	7-8.5	14		35.2																
B-14	SS-4	10-11.5	12		31.2																
B-14	SS-5	13.5-15	14							8.1											
B-14	SS-6	18.5-20	14	SP-SM					**B-13**	7.7											
B-14	SS-7	23.5-25	14																		
B-14	SS-8	28.5-30	16	SP					**B-14**	3.7											
B-14	SS-9	33.5-35	16																		
P-15	GS-1	3.5			27.2																
P-15	SS-2	10-11.5	18		31.6																
P-15	SS-3	15-16.5	8																		
P-15	SS-4	20-21.5	8																		
P-15	SS-5	25-26.5	11																		
P-15	SS-6	30-31.5	11																		
P-15	SS-7	35-36.5	18																		
P-17	GS-1	2.5			19.8																
P-17	SS-2	15-16.5	14																		
P-17	SS-3	20-21.5	14																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-17	SS-4	25-36.5	10																		
P-17	SS-5	30-31.5	18																		
P-17	SS-6	35-36.5	18																		
P-19	GS-1	2			29.1																
P-19	GS-2	6			24.7																
P-19	SS-3	10-11.5	17																		
P-19	SS-4	15-16.5	14																		
P-19	SS-5	25-26.5	1	SP					**B-15**	3.6											
P-19	SS-6	30-31.5	13	SP					**B-16**	3.2											
P-19	SS-7	35-36.5	18	SW					**B-17**	1.8											
P-20	SS-1	10-11.5	18		34.5																
P-20	SS-2	15-16.5	10		31.8																
P-20	SS-3	20-21.5	12		31.2																
P-20	SS-4	25-26.5	0																		
P-20	SS-5	30-31.5	18																		
P-20	SS-6	35-36.5	0																		
P-22	GS-1	3			31.1																
P-22	GS-2	6.5			35.0																
P-22	SS-3	15-16.5	18		27.1																
P-22	SS-4	20-21.5	16		28.4																
P-22	SS-5	25-26.5	11	SP-SM					**B-18**	5.7											
P-22	SS-6	30-31.5	18	SP-SM					**B-19**	8.5											
P-22	SS-7	35-36.5	18	SP					**B-20**	3.2											
P-24	GS-1	2.5			17.6																
P-24	SS-3	15-16.5	18																		
P-24	SS-4	20-21.5	11																		
P-24	SS-5	25-26.5	7																		
P-24	SS-6	30-31.5	8	SP-SM					**B-21**	5.3											
P-24	SS-7	35-36.5	18	SP-SM					**B-22**	9.8											
B-26	SS-1	1-2.5	16		23.6								0.50								
B-26	ST-2	4-6	14.5		31.4	89.7							0.50			**B-23**					
B-26	SS-3	7-8.5	16		33.0																
B-26	SS-4	10-11.5	17							43.8											
B-26	SS-5	13.5-15	16	SP-SM					**B-24**	5.4											
B-26	SS-6	18.5-20	14																		
B-26	SS-7	23.5-25	18	SP-SM					**B-25**	6.2											
B-26	SS-8	28.5-30	12	SW					**B-26**	2.9											
B-26	SS-9	33.5-35	5																		
B-26	SS-10	38.5-40	12	SW					**B-27**	2.5											
B-26	SS-11	43.5-45	10																		
P-27	GS-1	2.5			20.8																
P-27	GS-2	4			27.5																
P-27	SS-3	10-11.5	17																		
P-27	SS-4	15-16.5	4		31.2																
P-27	SS-5	20-21.5	11		29.4																
P-27	SS-6	25-26.5	12																		
P-27	SS-7	30-31.5	18																		
P-27	SS-8	35-36.5	18																		
P-29	ST-0	2.0-4.0	24		20.8	95.1							2.00		0.4						
P-29	ST-0	2.0-4.0	24		27.4	92.6									0.7						
P-29	SS-1	15-16.5	6		36.7																
P-29	SS-2	20-21.5	18																		
P-29	SS-3	25-26.5	18																		
P-29	SS-4	30-31.5	18																		
P-29	SS-5	35-36.5	16																		
P-31	GS-1	12.5																			

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-31	SS-2	15-16.5	12																		
P-31	SS-3	20-21.5	17																		
P-31	SS-4	25-26.5	18																		
P-31	SS-5	30-31.5	18	SM					**B-28**	29.5											
P-31	SS-6	35-36.5	18	SP-SM					**B-29**	5.0											
P-33	GS-1	2.5			20.7																
P-33	GS-2	7.5			38.0																
P-33	SS-3	15-16.5	17		29.6																
P-33	SS-4	20-21.5	10																		
P-33	SS-5	25-26.5	7																		
P-33	SS-6	30-31.5	13	SP					**B-30**	1.8											
P-33	SS-7	35-36.5	8	SP					**B-31**	2.5											
P-35	GS-1	2.5			19.9																
P-35	GS-2	10			28.0																
P-35	SS-3	15-16.5	9		28.8																
P-35	SS-4	20-21.5	12		25.2																
P-35	SS-5	25-26.5	18																		
P-35	SS-6	30-31.5	15	SP					**B-32**	0.8											
P-35	SS-7	35-36.5	8	SP					**B-33**	2.8											
P-36	GS-1	2.5			18.8																
P-36	SS-2	15-16.5	18																		
P-36	SS-3	20.21.5	7		23.9																
P-36	SS-4	25-26.5	11																		
P-36	SS-5	30-31.5	7																		
P-36	SS-6	35-36.5	13																		
P-38	GS-1	2.5			33.1																
P-38	GS-2	8			37.0																
P-38	SS-3	15-16.5	18																		
P-38	SS-4	20-21.5	11																		
P-38	SS-5	25-26.5	16																		
P-38	SS-6	30-31.5	18																		
P-38	SS-7	35-36.5	18																		
P-40	SS-1	15-16.5	18																		
P-40	SS-2	20-21.5	12																		
P-40	SS-3	25-26.5	8																		
P-40	SS-5	30-31.5	5																		
P-40	SS-6	35-36.5	18																		
P-42	GS-1	2.5			26.8																
P-42	GS-2	5			22.7																
P-42	SS-3	15-16.5	13																		
P-42	SS-4	20-21.5	11																		
P-42	SS-5	25-26.5	18	SP					**B-34**	2.6											
P-42	SS-6	30-31.5	11																		
P-42	SS-7	35-36.5	10	SP					**B-35**	4.0											
P-43	GS-1	1.5			22.2																
P-43	SS-2	10-11.5	13		42.3																
P-43	SS-3	15-16.5	8		33.2																
P-43	SS-4	20-21.5	18		30.7																
P-43	SS-5	25-26.5	18																		
P-43	SS-6	30-31.5	16																		
P-43	SS-7	35-36.5	18																		
P-45	ST-1	3-5	12	CH	26.6	95.6	61	25					2.25		1.1						
P-45	SS-1	10-11.5	14																		
P-45	SS-2	15-16.5	11		27.5																
P-45	SS-3	20-21.5	12																		
P-45	SS-4	25-26.5	14																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-45	SS-5	30-31.5	18																		
P-45	SS-6	35-36.5	0																		
P-47	GS-1	2.5			32.6																
P-47	SS-2	10-11.5	11		34.1																
P-47	SS-3	15-16.5	10		28.8																
P-47	SS-4	20-21.5	13																		
P-47	SS-5	25-26.5	11	SM					**B-36**	12.7											
P-47	SS-6	30-31.5	12																		
P-47	SS-7	35-36.5	7																		
P-49	GS-1	1			24.5																
P-49	SS-2	10-11.5	18		43.7																
P-49	SS-3	15-16.5	18																		
P-49	SS-4	20-21.5	15																		
P-49	SS-5	25-26.5	5																		
P-49	SS-6	30-31.5	9																		
P-49	SS-7	35-36.5	11																		
B-50	SS-1	1-2.5	17		23.4								0.50								
B-50	ST-2	5-7	19	CL	24.5	97.8	39	21					0.50				**B-37**				
B-50	SS-3	9-10.5	17	SM						35.8											
B-50	SS-4	13.5-15	17	SM					**B-38**	17.5											
B-50	SS-5	18.5-20	18																		
B-50	SS-6	23.5-25	16							2.4											
B-50	SS-7	27.5-29	13																		
B-50	SS-8	29.5-31	16	SP					**B-39**	2.5											
B-50	SS-9	33.5-35	18																		
B-50	SS-10	40-41.5	18	SP					**B-40**	3.0											
B-50	SS-11	43.5-45	0.5																		
B-50	SS-12	48.5-50	14																		
P-51	GS-1	2			24.4																
P-51	GS-2	5.5			31.4																
P-51	SS-3	10-11.5	9		33.4																
P-51	SS-4	15-16.5	18																		
P-51	SS-5	20-21.5	18																		
P-51	SS-6	25-26.5	10																		
P-51	SS-7	30-31.5	18																		
P-51	SS-8	35-36.5	18																		
B-52	SS-1	1-2.5	14		25.3								0.50								
B-52	ST-2 Top	4-6	12		28.2									0.35							
B-52	ST-2 Bot.	4-6	12	CH	27.4	94.8	71	27					0.50	0.45							**B-41**
B-52	SS-3	7-8.5	18		35.1																
B-52	SS-4	10-11.5	18							1.4											
B-52	SS-5	13.5-15	17	SP-SM					**B-42**	5.3											
B-52	SS-6	18.5-20	18																		
B-52	SS-7	23.5-25	16	SP					**B-43**	1.8											
B-52	SS-8	28.5-30	17																		
B-52	SS-9	33.5-35	14																		
P-53	GS-1	1.75			33.7																
P-53	GS-2	5			31.2																
P-53	SS-3	10-11.5	13																		
P-53	SS-4	15-16.5	18																		
P-53	SS-5	20-21.5	12																		
P-53	SS-6	25-26.5	12																		
P-53	SS-7	30-31.5	18	SP					**B-44**	4.9											
P-53	SS-8	35-36.5	12	SP					**B-45**	1.9											
B-54	ST-1	1-3	13	CL	27.4	94.5	46	27	**B-46**	92.5			1.50	0.25		**B-47**					
B-54	SS-2	4-5.5	18							3.0											

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
B-54	SS-3	7-8.5	18		31.9																
B-54	SS-4	10-11.5	18	ML					**B-48**	67.9											
B-54	ST-5	11.5-13.5	14		28.6	89.6															
B-54	SS-6	13.5-15	18							52.7											
B-54	SS-7	18.5-20	18		35.4																
B-54	SS-8	23.5-25	14																		
B-54	SS-9	28.5-30	18	SP					**B-49**	4.8											
B-54	SS-10	33.5-35	18																		
P-55	GS-1	1.5			27.0																
P-55	GS-2	6			29.9																
P-55	SS-3	10-11.5	18																		
P-55	SS-4	15-16.5	18																		
P-55	SS-5	25-26.5	16																		
P-55	SS-6	30-31.5	11																		
P-55	SS-7	35-36.5	18																		
B-56	SS-1	1-2.5	14		30.9								1.00								
B-56	ST-2	4-6	18		25.3	96.0							1.25								
B-56	SS-3	7-8.5	18																		
B-56	SS-4	10-11.5	14	SM					**B-50**	32.9											
B-56	SS-5	13.5-15	16																		
B-56	SS-6	18.5-20	16	SP-SM					**B-51**	5.2											
B-56	SS-7	23.5-25	15							25.4											
B-56	SS-8	28.5-30	17																		
B-56	SS-9	33.5-35	18	SP					**B-52**	2.9											
B-56	SS-10	38.5-40	16																		
B-56	SS-11	43.5-45	17	SP					**B-53**	2.4											
B-56	SS-12	48.5-50	18																		
P-57	GS-1	1.5			30.5																
P-57	ST-1	1-3	10		26.5	97.8							0.00		0.6						
P-57	GS-2	6			29.3																
P-57	SS-3	10-11.5	16																		
P-57	SS-4	15-16.5	11																		
P-57	SS-5	20-21.5	17																		
P-57	SS-6	25-26.5	17	SP					**B-54**	3.9											
P-57	SS-7	30-31.5	18																		
P-57	SS-8	35-36.5	18	SP					**B-55**	1.0											
B-58	ST-1	1-3	19		29.6	87.3							1.00					**B-56**			
B-58	ST-1	1-3	19	CL	24.1	87.1	32	22		87.1											
B-58	ST-1	1-3	19	CL	33.3	88.0	45	26		76.9							**B-57**				
B-58	SS-2	4-5.5	14		35.3								0.75								
B-58	ST-3	7-9	21.5	CL	37.5	82.4	49	25						0.45		**B-58**					
B-58	SS-4	10-11.5	18		42.6					75.7											
B-58	SS-5	13.5-15	18	SP					**B-59**	3.3											
B-58	SS-6	18.5-20	13																		
B-58	SS-7	23.5-25	18	SP					**B-60**	4.2											
B-58	SS-8	28.5-30	15																		
B-58	SS-9	33.5-35	18																		
P-59	GS-1	2.5			35.8																
P-59	GS-2	7.5			29.6																
P-59	SS-3	15-16.5	18																		
P-59	SS-4	20-21.5	17																		
P-59	SS-5	25.26.5	12																		
P-59	SS-6	30-31.5	10																		
P-59	SS-7	36-36.5	9																		
P-61	GS-1	2.5			31.7																
P-61	SS-2	15-16.5	17		40.3																

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-61	SS-3	20-21.5	18		32.1																
P-61	SS-4	25-26.5	18	SM					**B-61**	24.1											
P-61	SS-5	30-31.5	16	SP					**B-62**	3.9											
P-61	SS-6	35-36.5	18	SP-SM					**B-63**	14.8											
P-63	GS-1	4.1			31.4																
P-63	GS-2	7			41.0																
P-63	SS-3	15-16.5	12																		
P-63	SS-4	20-21.5	14																		
P-63	SS-5	25-26.5	18																		
P-63	SS-6	30-31.5	16																		
P-63	SS-7	35-36.5	12																		
P-65	GS-1	1			25.4																
P-65	GS-2	5.5			23.2																
P-65	GS-3	11.5			46.1																
P-65	SS-4	15-16.5	17																		
P-65	SS-5	20-21.5	8																		
P-65	SS-6	25-26.5	14																		
P-65	SS-7	30-31.5	7																		
P-65	SS-8	35-36.5	1																		
P-67	GS-1	2.5			27.2																
P-67	GS-2	6			27.7																
P-67	SS-3	15-16.5	17																		
P-67	SS-4	20-21.5	18																		
P-67	SS-5	25-26.5	18																		
P-67	SS-6	30-31.5	18																		
P-67	SS-7	35-36.5	10																		
P-69	GS-1	3			40.2																
P-69	GS-2	6			36.7																
P-69	SS-3	10-11.5	18		35.0																
P-69	SS-4	15-16.5	14																		
P-69	SS-5	20-21.5	18																		
P-69	SS-6	25-26.5	18																		
P-69	SS-7	30-31.5	13																		
P-69	SS-8	35-36.5	18																		
P-71	SS-1	10-11.5	15		33.2																
P-71	SS-2	15-16.5	13		38.1																
P-71	SS-3	20-21.5	16																		
P-71	SS-4	25-26.5	15																		
P-71	SS-5	30-31.5	9																		
P-71	SS-6	35-36.5	18																		
B-72	SS-1	1-2.5	18		28.7								2.50								
B-72	ST-2	4-6	19		25.7	98.1															
B-72	SS-3	7-8.5	15							22.4											
B-72	SS-4	10-11.5	17	ML					**B-64**	84.9											
B-72	SS-5	13.5-15	18																		
B-72	SS-6	18.5-20	15	SP					**B-65**	1.5											
B-72	SS-7	23.5-25	11																		
B-72	SS-8	28.5-30	15																		
B-72	SS-9	33.5-35	17	SP					**B-66**	4.7											
P-73	SS-1	10-11.5	14																		
P-73	SS-2	15-16.5	18																		
P-73	SS-3	20-21.5	18																		
P-73	SS-4	25-26.5	18	SP-SM					**B-67**	14.2											
P-73	SS-5	30-31.5	18																		
P-73	SS-6	35-36.5	18	SM					**B-68**	18.9											
P-75	GS-1	2.5			29.9																

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-75	GS-2	8.75			45.0																
P-75	SS-3	15-16.5	10																		
P-75	SS-4	20-21	14																		
P-75	SS-5	25-26.5	14																		
P-75	SS-6	30-31.5	10																		
P-75	SS-7	35-36.5	18																		
P-77	GS-1	2			22.4																
P-77	GS-2	5			31.1																
P-77	SS-3	15-16.5	12																		
P-77	SS-4	20-21.5	15																		
P-77	SS-5	25-26.5	18																		
P-77	SS-6	30-31.5	18																		
P-77	SS-7	35-36.5	18																		
P-79	GS-1	2.5			31.5																
P-81	GS-1	2.5			24.0																
P-81	GS-2	20																			
P-81	GS-3	25		SP					**B-69**	2.9											
P-81	GS-4	30		SP					**B-70**	1.5											
P-81	GS-5	35		SP					**B-71**	4.2											
P-83	GS-1	3			37.3																
P-83	GS-2	5.25			46.0																
P-83	GS-3	10																			
P-83	SS-4	15-16.5	16																		
P-83	SS-5	20-21.5	18																		
P-83	SS-6	25-26.5	11																		
P-83	SS-7	30-31.5	8																		
P-83	SS-8	35-36.5	11																		
P-85	GS-1	2			40.7																
P-85	SS-2	10-11.5	18		35.9																
P-85	SS-3	15-16.5	18																		
P-85	SS-4	20-21.5	18																		
P-85	SS-5	25-26.5	18	SP-SM					**B-72**	7.7											
P-85	SS-6	30-31.5	11	SP					**B-73**	4.3											
P-85	SS-7	35-36.5	12	SM					**B-74**	13.4											
P-87	GS-1	2.5																			
P-87	SS-2	15-16.5	18		31.9																
P-87	SS-3	20-21.5	12																		
P-87	SS-4	25-26.5	10																		
P-87	SS-5	30-31.5	12																		
P-87	SS-6	35-36.5	15																		
P-88	SS-1	10-11.5	11																		
P-88	SS-2	15-16.5	18																		
P-88	SS-3	20-21.5	18																		
P-88	SS-4	25-26.5	18																		
P-88	SS-5	30-31.5	18																		
P-88	SS-6	35-36.5	16																		
P-88	SS-7	35-36.5	12																		
P-90	GS-1	2.5			35.0																
P-90	GS-2	7																			
P-90	GS-3	11.5																			
P-90	SS-4	15-16.5	18																		
P-90	SS-5	20-21.5	18																		
P-90	SS-6	25.26.5	18																		
P-90	SS-7	30-31.5	18																		
P-90	SS-8	35-36.5	18																		
B-92	SS-1	1-2.5	17		24.4								1.50								

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
B-92	ST-2	3-5	12	CH	31.5	89.9	66	24					1.00	0.60	0.5			**B-75**			
B-92	SS-3	6.5-8	18							73.8											
B-92	SS-4	8.5-10	18																		
B-92	SS-5	13.5-15	18																		
B-92	SS-6	18.5-20	18	SP					**B-76**	2.1											
B-92	SS-7	21.5-23	18																		
B-92	SS-8	23.5-25	18																		
B-92	SS-9	28.5-30	18																		
B-92	SS-10	33.5-35	18	SP					**B-77**	3.3											
B-92	SS-11	38.5-40	12							18.2											
B-92	SS-12	43.5-45	18																		
P-93	GS-1	2.5			31.1																
P-93	GS-2	6			26.0																
P-93	SS-3	10-11.5	16		32.8																
P-93	SS-4	15-16.5	17																		
P-93	SS-5	20-21.5	11																		
P-93	SS-6	25-26.5	17																		
P-93	SS-7	30-31.5	18																		
P-93	SS-8	35-36.5	11																		
P-95	GS-1	1.5			26.5																
P-95	GS-2	6.75			26.7																
P-95	GS-3	12			61.7																
P-95	SS-4	15-16.5	16																		
P-95	SS-5	20-21.5	16																		
P-95	SS-6	25-26.5	16																		
P-95	SS-7	30-31.5	14																		
P-95	SS-8	35-36.5	6																		
P-97	GS-1	1.5			21.5																
P-97	GS-2	11			52.3																
P-97	SS-3	15-16.5	13																		
P-97	SS-4	20-21.5	13																		
P-97	SS-5	25-26.5	11																		
P-97	SS-6	30-31.5	10																		
P-97	SS-7	35-36.5	11																		
P-99	GS-1	1			27.5																
P-99	GS-2	5.5			35.5																
P-99	SS-3	10-11.5	13		36.2																
P-99	SS-4	15-16.5	18																		
P-99	SS-5	20-21.5	18																		
P-99	SS-6	25-26.5	18																		
P-99	SS-7	30-31.5	18																		
P-99	SS-8	35-36.5	18																		
B-100	SS-1	1-2.5	18		29.8								0.75								
B-100	ST-2	3-5	14		31.0	90.6															
B-100	SS-3	7.5-9	18																		
B-100	SS-4	10-11.5	18							16.8											
B-100	SS-5	13-14.5	18																		
B-100	SS-6	15-16.5	18	SP					**B-78**	4.9											
B-100	SS-7	20-21.5	18																		
B-100	SS-8	25-26.5	18																		
B-100	SS-9	31.5-33	8	SP					**B-79**	2.1											
B-100	SS-10	35-36.5	10																		
B-100	SS-11	38.5-40	14																		
B-100	SS-12	43.5-45	18	SP					**B-80**	4.0											
B-100	SS-13	48.5-50	17																		
B-100	SS-14	58.5-60	15																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
B-100	SS-15	68.5-70	17																		
B-100	SS-16	78.5-80	14	SW					**B-81**	2.2											
B-100	SS-17	88.5-90	8																		
B-100	SS-18	98.5-100	11																		
B-101	SS-1	1-2.5	12		27.6								1.50								
B-101	ST-2	4-6	16		30.0	91.6															
B-101	SS-3	7-8.5	18							7.8											
B-101	SS-4	10-11.5	18																		
B-101	SS-5	13.5-15	18							3.3											
B-101	SS-6	18.5-20	16																		
B-101	SS-7	23.5-25	17																		
B-101	SS-8	28.5-30	12	SP					**B-82**	1.5											
B-101	SS-9	33.5-35	14																		
B-101	SS-10	38.5-40	2																		
B-101	SS-11	43.5-45	14	SP					**B-83**	1.5											
B-101	SS-12	48.5-50	16							2.3											
P-102	GS-1	4			42.0																
P-102	GS-2	9.5			42.2																
P-102	SS-3	15-16.5	12		37.2																
P-102	SS-4	20-21.5	13																		
P-102	SS-5	25-26.5	8																		
P-102	SS-6	30-31.5	11																		
P-102	SS-7	35-36.5	18																		
P-104	GS-1	1.5			26.4																
P-104	GS-2	5.5			36.1																
P-104	SS-3	15-16.5	12																		
P-104	SS-4	20-21.5	14																		
P-104	SS-5	25-26.5	12																		
P-104	SS-6	30-31.5	14	SM					**B-84**	24.5											
P-104	SS-7	35-36.5	14	SP-SM					**B-85**	7.8											
P-106	ST-1	1-3	16	CH	31.2	90.5	69	28								**B-86**					
P-106	GS-1	6			38.7																
P-106	GS-2	10																			
P-106	GS-3	15																			
P-106	GS-4	20																			
P-106	GS-5	25																			
P-106	GS-6	30																			
P-106	GS-7	35																			
P-108	GS-1	1.5			31.7																
P-108	SS-2	15-16.5	11																		
P-108	SS-3	20-21.5	18																		
P-108	SS-4	25-26.5	15																		
P-108	SS-5	30-31.5	18																		
P-108	SS-6	35-36.5	18																		
P-110	GS-1	2			25.9																
P-110	SS-2	15-16.5	14																		
P-110	SS-3	20-21.5	11																		
P-110	SS-4	25-26.5	14																		
P-110	SS-5	30-31.5	18																		
P-110	SS-6	35-36.5	18																		
P-112	GS-1	3			33.0																
P-112	GS-2	13			57.8																
P-112	SS-3	15-16.5	13																		
P-112	SS-4	20-21.5	18																		
P-112	SS-5	25-26.5	18																		
P-112	SS-6	30-31.5	16																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-112	SS-7	35-36.5	18																		
P-114	GS-1	1.5			30.3																
P-114	SS-2	10-11.5	16																		
P-114	SS-3	15-16.5	11																		
P-114	SS-4	20-21.5	7																		
P-114	SS-5	25-26.5	18	SP					**B-87**	2.1											
P-114	SS-6	30-31.5	17																		
P-114	SS-7	35-36.5	13	SP					**B-88**	0.9											
B-115	ST-1	1-3	14		22.9	101.8							1.00	0.40	0.7						
B-115	SS-2	4-5.5	18		49.1								0.75								
B-115	ST-3	7-9	24	CH	35.5	83.8	64	26					0.25	0.55		**B-89**		**B-90**			
B-115	SS-4	10-11.5	18		37.9																
B-115	ST-5	13.5-15.5	23		22.0	91.4															
B-115	SS-6	18.5-20	13							1.4											
B-115	SS-7	23.5-25	13	SP					**B-91**	1.2											
B-115	SS-8	28.5-30	16																		
B-115	SS-9	33.5-35	13																		
B-115	SS-10	38.5-40	15	SP					**B-92**	1.6											
B-115	SS-11	43.5-45	12																		
P-116	GS-1	3			36.6																
P-116	GS-2	6.5			35.8																
P-116	GS-3	12.75			41.6																
P-116	SS-4	15-16.5	18																		
P-116	SS-5	20-21.5	12																		
P-116	SS-6	25-26.5	13																		
P-116	SS-7	30-31.5	12																		
P-116	SS-8	35-36.5	14																		
P-118	GS-1	1.5			26.0																
P-118	GS-2	6			28.6																
P-118	SS-3	15-16.5	17																		
P-118	SS-4	20-21.5	17																		
P-118	SS-5	25-26.5	14																		
P-118	SS-6	30-31.5	13																		
P-118	SS-7	35-36.5	18		37.2																
P-120	GS-1	2.5			33.7																
P-120	SS-2	10-11.5	14		35.9																
P-120	SS-3	15-16.5	15																		
P-120	SS-4	20-21.5	17																		
P-120	SS-5	25-26.5	17	SP-SM					**B-93**	6.5											
P-120	SS-6	30-31.5	18	SP-SM					**B-94**	5.3											
P-120	SS-7	35-36.5	18	SP					**B-95**	4.2											
P-122	SS-1	15-16.5	17																		
P-122	SS-2	20-21-5	18																		
P-122	SS-3	25-26.5	18																		
P-122	SS-4	30-31.5	18																		
P-122	SS-5	35-36.5	13																		
P-124	GS-1	1			27.9																
P-124	GS-2	8			38.7																
P-124	GS-3	11			54.4																
P-124	GS-4	16																			
P-124	SS-5	20-21.5	10																		
P-124	SS-6	25-26.5	13																		
P-124	SS-7	30-31.5	18																		
P-124	SS-8	35-36.5	18																		
P-126	GS-1	0.7			33.0																
P-126	SS-2	10-11.5	18		34.5																

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-126	SS-3	15-16.5	17																		
P-126	SS-4	20-21.5	17																		
P-126	SS-5	25-26.5	14	SM					**B-96**	19.4											
P-126	SS-6	30-31.5	18																		
P-126	SS-7	35-36.5	18	SP-SM					**B-97**	6.2											
B-127	ST-1	1-3	16	CH	28.6	96.0	71	28					1.25	0.55							
B-127	SS-2	4-5.5	18		42.1								1.00								
B-127	SS-3	7-8.5	18		35.3					80.7											
B-127	SS-4	10-11.5	18																		
B-127	SS-5	13.5-15	18	SP-SM					**B-98**	8.8											
B-127	SS-6	18.5-20	18																		
B-127	SS-7	23.5-25	15																		
B-127	SS-8	28.5-30	18	SP					**B-99**	2.1											
B-127	SS-9	33.5-35	15																		
P-128	ST-1	0.7-2.7	13	CH	27.3	95.3	57	22								**B-100**					
P-128	GS-1	1.5			23.4																
P-128	SS-2	10-11.5	18																		
P-128	SS-3	15-16.5	18																		
P-128	SS-4	20-21.5	18																		
P-128	SS-5	25-26.5	18	SP-SM					**B-101**	5.5											
P-128	SS-6	30-31.5	18																		
P-128	SS-7	35-36.5	18	SP					**B-102**	3.5											
P-130	GS-1	1.75			31.8																
P-130	GS-2	6			30.2																
P-130	SS-3	15-16.5	12																		
P-130	SS-4	20-21.5	18																		
P-130	SS-5	25-26.5	12																		
P-130	SS-6	30-31.5	14																		
P-130	SS-7	35-36.5	17																		
P-132	GS-1	2			31.4																
P-132	GS-2	7			31.0																
P-132	SS-3	10-11.5	15																		
P-132	SS-4	15-16.5	18																		
P-132	SS-5	20-21.5	11																		
P-132	SS-6	25-26.5	18																		
P-132	SS-7	30-31.5	18																		
P-132	SS-8	35-36.5	18																		
P-134	SS-1	1-2.5	18																		
P-134	SS-2	15-16.5	18																		
P-134	SS-3	20-21.5	18																		
P-134	SS-4	25-26.5	13																		
P-134	SS-5	30-31.5	14																		
P-134	SS-6	35-36.5	18																		
P-136	SS-1	15-16.5	16																		
P-136	SS-2	20-21.5	18																		
P-136	SS-3	25-26.5	18	SP					**B-103**	3.5											
P-136	SS-4	30-31.5	16																		
P-136	SS-5	35-36.5	18	SP					**B-104**	4.2											
P-138	SS-1	15-16.5	7		32.3																
P-138	SS-2	20-21.5	18																		
P-138	SS-3	25-26.5	10																		
P-138	SS-4	30-31.5	13																		
P-138	SS-5	35.36.5	11																		
P-140	GS-1	1			30.3																
P-140	SS-2	15-16.5	11																		
P-140	SS-3	20-21.5	13																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-140	SS-4	25-26.5	15																		
P-140	SS-5	30-31.5	18																		
P-140	SS-6	35-36.5	11																		
B-141	SS-1	1-2.5	13		30.6								1.00								
B-141	ST-2	4-6	18		29.1																
B-141	SS-3	7-8.5	16							11.9											
B-141	SS-4	10-11.5	18	SP-SM					**B-105**	5.8											
B-141	SS-5	13.5-15	18																		
B-141	SS-6	18.5-20	18																		
B-141	SS-7	23.5-25	18	SP					**B-106**	1.5											
B-141	SS-8	28.5-30	14																		
B-141	SS-9	33.5-35	10																		
P-142	SS-1	10-11.5	16																		
P-142	SS-2	15-16.5	12																		
P-142	SS-3	20-21.5	18																		
P-142	SS-4	25-26.5	18																		
P-142	SS-5	30-31.5	14																		
P-142	SS-6	35-36.5	10																		
P-144	GS-1	1.5			30.7																
P-144	GS-2	6			33.6																
P-144	SS-3	13.5-15	18																		
P-144	SS-4	15-16.5	16																		
P-144	SS-5	20-21.5	8																		
P-144	SS-6	25-26.5	13	SM					**B-107**	21.2											
P-144	SS-7	30-31.5	18																		
P-144	SS-8	35-36.5	13	SP-SM					**B-108**	5.6											
P-146	SS-1	10-11.5	16																		
P-146	SS-2	15-16.5	16																		
P-146	SS-3	20-21.5	16																		
P-146	SS-4	25-26.5	18																		
P-146	SS-5	30-31.5	18																		
P-146	SS-6	35-36.5	18																		
P-148	SS-1	10-11.5	13																		
P-148	SS-2	15-16.5	18																		
P-148	SS-3	20-21.5	18																		
P-148	SS-4	25-26.5	13																		
P-148	SS-5	30-31.5	13																		
P-148	SS-6	35-36.5	18																		
P-150	ST-1	1-3	12	CH	33.1	86.8	70	27						0.55	0.6						
P-150	GS-1	12.5			49.5																
P-150	GS-2	19																			
P-150	SS-3	20-21.5	18																		
P-150	SS-4	25-26.5	18																		
P-150	SS-5	30-31.5	18																		
P-150	SS-6	35-36.5	18																		
P-152	GS-1	1.25			29.4																
P-152	GS-2	6.5			42.9																
P-152	SS-3	10-11.5	18																		
P-152	SS-4	15-16.5	18																		
P-152	SS-5	20-21.5	18																		
P-152	SS-6	25-16.5	15																		
P-152	SS-7	30-31.5	18																		
P-152	SS-8	35-36.5	18																		
B-153	SS-1	1-2.5	18		29.8								1.00								
B-153	ST-2 Top	4-6	13	CL	33.1	89.5	47	25													
B-153	ST-2 Bot.	4-6	13	ML	29.5	89.1	33	24		99.1	**B-109**										

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
B-153	SS-3	7-8.5	18		33.0																
B-153	ST-4	10-12	19		34.1	90.0															
B-153	SS-5	13.5-15	18							3.7											
B-153	SS-6	18.5-20	18	SP-SM					**B-110**	7.7											
B-153	SS-7	23.5-25	18																		
B-153	SS-8	28.5-30	2																		
B-153	SS-9	33.5-35	3																		
B-153	SS-10	38.5-40	14	SW					**B-111**	2.3											
B-153	SS-11	43.5-45	2																		
B-154	SS-1	1-2.5	18		28.9																
B-154	ST-2	4-6	19		28.3	94.1															
B-154	SS-3	7-8.5	18							23.5											
B-154	SS-4	10-11.5	18																		
B-154	SS-5	13.5-15	18							6.9											
B-154	SS-6	18.5-20	18	SP					**B-112**	2.3											
B-154	SS-7	23.5-25	18																		
B-154	SS-8	28.5-30	18																		
B-154	SS-9	33.5-35	15	SP					**B-113**	1.6											
B-154	SS-10	38.5-40	8																		
P-155	GS-1	2.5			41.3																
P-155	GS-2	8			63.4																
P-155	SS-3	15-16.5	6		48.6																
P-155	SS-4	20-21.5	6		43.2																
P-155	SS-5	25-26.5	13																		
P-155	SS-6	30-31.5	18																		
P-155	SS-7	35-36.5	15																		
P-156	GS-1	1			30.5																
P-156	SS-2	15-16.5	13																		
P-156	SS-3	20-21.5	14																		
P-156	SS-4	25-26.5	18																		
P-156	SS-5	30-31.5	18																		
P-156	SS-6	35-36.5	10																		
P-158	GS-1	1			29.4																
P-158	GS-2	14.25																			
P-158	SS-3	15-16.5	11																		
P-158	SS-4	20-21.5	1																		
P-158	SS-5	25-26.5	9																		
P-158	SS-6	30-31.5	15																		
P-160	SS-1	10-11.5	18																		
P-160	SS-2	15-16.5	1																		
P-160	SS-3	20-21.5	18																		
P-160	SS-4	25-26.5	18																		
P-160	SS-5	30-31.5	0																		
P-160	SS-6	35-36.5	18																		
P-162	GS-1	12																			
P-162	SS-2	15-16.5	17																		
P-162	SS-3	20-21.5	18																		
P-162	SS-4	25-26.5	18	SP-SM					**B-114**	5.9											
P-162	SS-5	30-31.5	15																		
P-162	SS-6	35-36.5	18	SP					**B-115**	2.5											
P-164	SS-1	10-11.5	13																		
P-164	SS-3	15-16.5	18		46.1																
P-164	SS-3	20-21.5	18		35.7																
P-164	SS-4	25-26.5	18	SM					**B-116**	19.2											
P-164	SS-5	30-31.5	18																		
P-164	SS-6	35-36.5	18	SP					**B-117**	0.9											

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-165	GS-1	1	2		30.6																
P-165	SS-2	10-11.5	12																		
P-165	SS-3	15-16.5	12																		
P-165	SS-4	20-21.5	14																		
P-165	SS-5	25-26.5	15	SP					**B-118**	3.0											
P-165	SS-6	30-31.5	18																		
P-165	SS-7	35-36.5	14	SP					**B-119**	1.7											
P-167	GS-1	1.5			31.0																
P-167	GS-2	5.5			28.0																
P-167	SS-3	15-16.5	13																		
P-167	SS-4	20-21.5	15																		
P-167	SS-5	25-26.5	14																		
P-167	SS-6	30-31.5	11																		
P-167	SS-7	35-36.5	15																		
P-169	SS-1	10-11.5	18		44.0																
P-169	SS-2	15-16.5	18																		
P-169	SS-3	20-21.5	18																		
P-169	SS-4	25-26.5	18	SP-SM					**B-120**	6.6											
P-169	SS-5	30-31.5	12																		
P-169	SS-6	35-36.5	18	SP					**B-121**	2.1											
P-171	SS-1	10-11.5	15																		
P-171	SS-2	15-16.5	17																		
P-171	SS-3	20-21.5	18																		
P-171	SS-4	25-26.5	18																		
P-171	SS-5	30-31.5	11																		
P-171	SS-6	35-36.5	14																		
P-173	SS-1	10-11.5	12																		
P-173	SS-1	15-16.5	18																		
P-173	SS-3	20-21.5	18																		
P-173	SS-4	25-26.5	18																		
P-173	SS-5	30-31.5	18																		
P-173	SS-6	35-36.5	18																		
P-175	ST-0	1-3	24	CH	35.8	85.8	69	26		99.6	**B-122**		0.75								**B-123**
P-175	SS-1	10-11.5	18																		
P-175	SS-2	15-16.5	18																		
P-175	SS-3	20-21.5	18																		
P-175	SS-4	25-26.5	18																		
P-175	SS-5	30-31.5	14																		
P-175	SS-6	35-36.5	15																		
B-176	SS-1	1-2.5	16		32.1								1.50								
B-176	SS-2	4-5.5	17		36.0								0.75								
B-176	ST-3	7-9	17	CH	43.5	75.8	80	52					0.25	0.41		**B-124**		**B-125**			
B-176	SS-4	10-11.5	17		45.7								0.25								
B-176	ST-5	13.5-15.5	15	CH	49.1	69.4	59	25							0.1						
B-176	SS-6	18.5-20	14							4.4											
B-176	SS-7	23.5-25	16	SP-SM	32.7				**B-126**	11.6											
B-176	SS-8	28.5-30	18							7.5											
B-176	SS-9	33.5-35	14							40.8											
B-176	SS-10	38.5-40	10																		
B-176	SS-11	43.5-45	18																		
B-176	SS-12	48.5-50	18							15.0											
P-177	ST-0	2-4	24	CH/ML	32.3	86.5	68	26		99.7	**B-127**			0.20			**B-128**				
P-177	SS-1	16-17.5	15																		
P-177	SS-2	20-21.5	18																		
P-177	SS-3	25-26.5	15																		
P-177	SS-4	30-31.5	18																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-177	SS-5	35-36.5	18																		
P-179	GS-1	13																			
P-179	SS-2	15-16.5	18																		
P-179	SS-3	20-21.5	18																		
P-179	SS-4	25-26.5	18																		
P-179	SS-5	30-31.5	18																		
P-179	SS-6	35-36.5	18																		
P-181	ST-1	1.0-3.0	12	CH	32.1	85.8	66	25							0.7						
P-181	GS-1	12			31.2																
P-181	SS-2	15-16.5	18																		
P-181	SS-3	20-21.5	18		34.8																
P-181	SS-4	25-26.5	17																		
P-181	SS-5	30-31.5	18																		
P-181	SS-6	35-36.5	14																		
P-183	GS-1	12																			
P-183	SS-2	15-16.5	3																		
P-183	SS-3	20-21.5	18																		
P-183	SS-4	25-26.5	18																		
P-183	SS-5	30-31.5	18																		
P-183	SS-6	35-36.5	18																		
P-185	SS-1	10-11.5	18																		
P-185	SS-2	15-16.5	17																		
P-185	SS-3	20-21.5	18																		
P-185	SS-4	25-26.5	17																		
P-185	SS-5	30-31.5	13																		
P-185	SS-6	35-36.5	18																		
P-187	GS-1	1			29.7																
P-187	GS-2	8			45.1																
P-187	SS-3	15-16.5	9		43.1																
P-187	SS-4	20-21.5	12																		
P-187	SS-5	25-26.5	14																		
P-187	SS-6	30-31.5	10																		
P-187	SS-7	35-36.5	18																		
B-188	ST-1	1-3	12	CH	27.5	95.6	55	21					0.25	0.88							
B-188	SS-2	4-5.5	18		43.8																
B-188	ST-3	7-9	3		30.0																
B-188	SS-4	10-11.5	15							2.3											
B-188	SS-5	13.5-15	18																		
B-188	SS-6	18.5-20	18																		
B-188	SS-7	23.5-25	18	SP					**B-129**	3.5											
B-188	SS-8	28.5-30	15																		
B-188	SS-9	33.5-35	12																		
P-189	GS-1	1			29.8																
P-189	GS-2	6.25			49.2																
P-189	GS-3	13.25			66.1																
P-189	SS-4	15-16.5	18																		
P-189	SS-5	20-21.5	18																		
P-189	SS-6	25-26.5	18																		
P-189	SS-7	30-31.5	18																		
P-189	SS-8	35-36.5	18																		
P-191	GS-1	12.9			28.6																
P-191	SS-2	15-16.5	18																		
P-191	SS-3	20-21.5	18																		
P-191	SS-4	25-26.5	18																		
P-191	SS-5	30-31.5	18																		
P-191	SS-6	35-36.5	18																		

*Figures in Appendix B

Table B-1

Client: Ameren Missouri
Project: Labadie UWL
Location: Labadie

Reitz & Jens Project Number: 2008012455
Reitz & Jens Project Manager: Jeff Fouse

Sample Identification				Index Properties											Strength			Consolidation			Permeabilty
Boring Number	Sample Number	Depth (ft)	Sample Recovery (inches)	Soil Classification (USCS) ASTM D2487	Water Content (%) ASTM D2216	Dry Density (pcf)	Liquid Limit ASTM D4318	Plastic Limit ASTM D4318	Sieve Analysis* (#200 wash before) ASTM D422	#200 Wash (Fines Content %) ASTM D2488	Hydrometer* ASTM D422	Specific Gravity ASTM D854	Penetrometer (tsf)	Torvane (tsf)	Unconfined Compression (tsf) ASTM D2166	UU Triaxial* ASTM D2850	CU Triaxial* ASTM D4767	Full Loading (load to 16 tsf)* ASTM D2435	Additional Unload-Reload Cycle* ASTM D2435	Swell Test* ASTM D4546	Hydraulic Conductivity Using Flexible Wall Permeameter* ASTM D5084
P-193	GS-1	10																			
P-193	SS-2	15-16.5	18		36.7																
P-193	SS-3	20-21.5	9																		
P-193	SS-4	25-26.5	18	SP					**B-130**	4.8											
P-193	SS-5	30-31.5	18	SP					**B-131**	1.3											
P-193	SS-6	35-36.5	18	SP					**B-132**	2.2											
P-195	ST-1	2-4	9		32.3	85.7								0.85							
P-195	SS-1	10-11.5	15																		
P-195	SS-2	15-16.5	18																		
P-195	SS-3	20-21.5	15																		
P-195	SS-4	25-26.5	18																		
P-195	SS-5	30-31.5	18																		
P-195	SS-6	35-36.5	18																		
P-197	SS-1	10-11.5	18																		
P-197	SS-2	15-16.5	14																		
P-197	SS-3	20-21.5	18																		
P-197	SS-4	25-26.5	11	SP					**B-133**	2.2											
P-197	SS-5	30-31.5	15	SP					**B-134**	1.2											
P-197	SS-6	35-36.5	18	SP					**B-135**	2.7											
P-199	SS-1	10-11.5	12																		
P-199	SS-2	15-16.5	18																		
P-199	SS-3	20-21.5	18																		
P-199	SS-4	25-27.5	16	SP-SM					**B-136**	11.4											
P-199	SS-5	30-31.5	18																		
P-199	SS-6	35-36.5	15	SP					**B-137**	1.3											
B-200	SS-1	1.5-3	16		30.3								1.75								
B-200	ST-2	3-5	24	CH	34.2	85.6	86	30					0.50			**B-138**					
B-200	SS-3	6-7.5	18		28.9								0.75								
B-200	SS-4	8-9.5	18		60.1																
B-200	ST-5	10-12	23	CH	59.3	64.9	62	21					0.25				**B-139**				
B-200	SS-6	13.5-15	12							9.7											
B-200	SS-7	18.5-20	12	SP-SM					**B-140**	9.6											
B-200	SS-8	23.5-25	14																		
B-200	SS-9	28.5-30	11																		
B-200	SS-10	33.5-35	8	SP					**B-141**	1.5											
B-200	SS-11	38.5-40	14							3.1											
B-200	SS-12	43.5-45	16																		
B-200	SS-13	48.5-50	10	SP					**B-142**	1.6											
B-200	SS-14	58.5-60	14																		
P-201	GS-1	2.5			34.8																
P-201	SS-2	15-16.5	7																		
P-201	SS-3	20-21.5	18																		
P-201	SS-4	25-26.5	18																		
P-201	SS-5	30-31.5	18																		
P-201	SS-6	35-36.5	14																		
B-202	SS-1	1-2.5	17		42.5								0.75								
B-202	ST-2	5-7	10	CH	36.8	83.3	61	24							0.3						
B-202	SS-3	7-8.5	18		56.1								0.00								
B-202	ST-4	10-12	20																		
B-202	SS-5	13.5-15	18	SP					**B-143**	4.0											
B-202	SS-6	18.5-20	16							7.0											
B-202	SS-7	23.5-25	17																		
B-202	SS-8	28.5-30	15	SP-SM					**B-144**	6.5											
B-202	SS-9	33.5-35	10																		

*Figures in Appendix B

Ameren Missouri; Labadie Power Plant
Utility Waste Landfill, Preliminary Study
Sample B-4, ST- 2, 3.5'-5.5' High Plastic Clay
Hydraulic Conductivity

Soil Conditions	
Pre-test conditions	**Post-test Conditions**
Wet Density = 121.8 (lbs/ft^3)	Wet Density = 122.6 (lbs/ft^3)
% Moisture = 26.5%	% Moisture = 27.0%
Dry Density = 96.3 (lbs/ft^3)	Dry Density = 96.5 (lbs/ft^3)

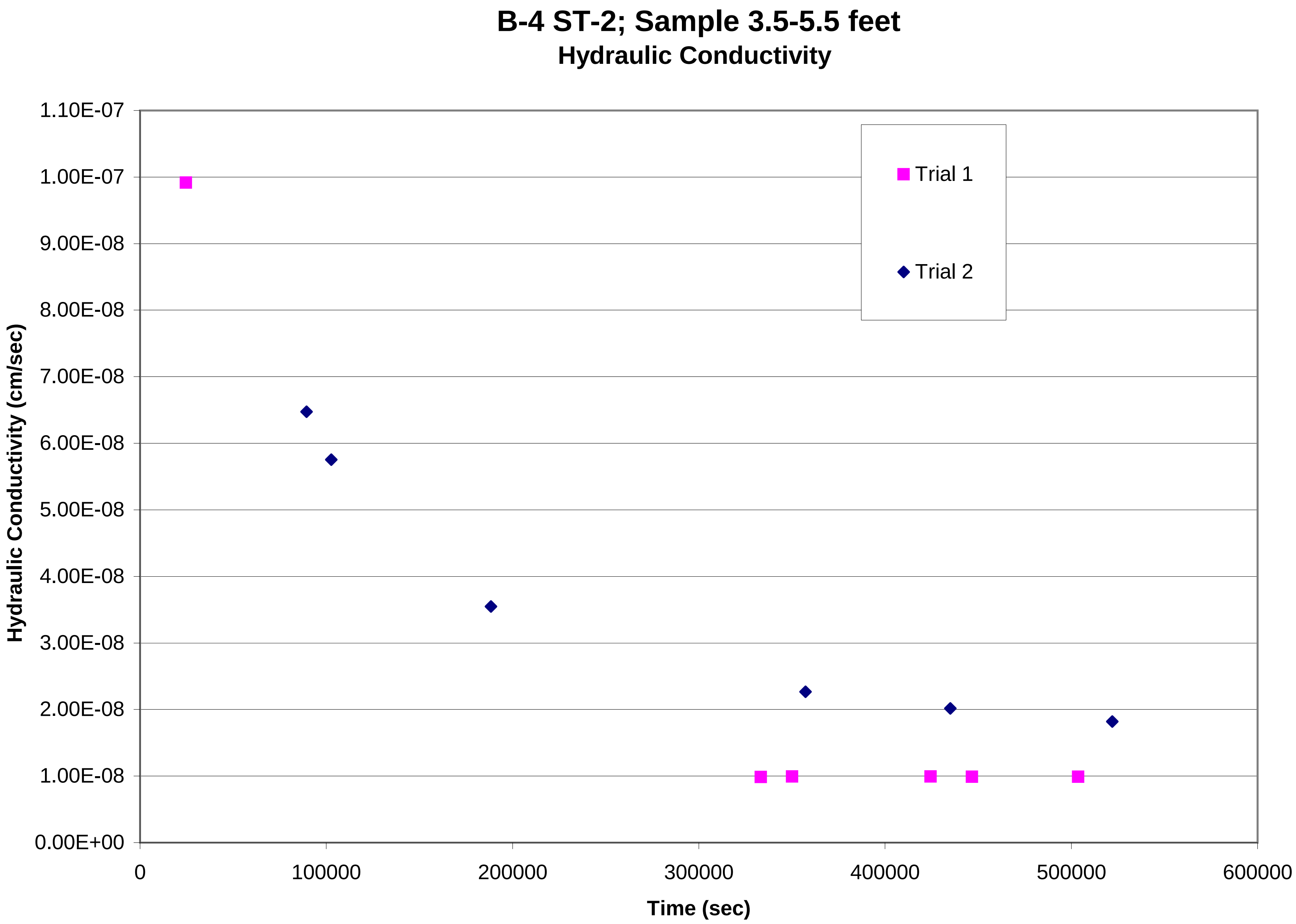
Test Information	
a (cm^2)=	0.19685
L (cm)=	8.86079
A (cm^2)=	20.778156

Trial 1

Date	Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Base Burette		Top Burette		Total Head Across Sample (cm of water)	Temperature (℃)	Weighted Average Temp. (℃)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Corrected Hydraulic Conductivity (cm/sec)
				Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)						
5/4/2007	11:25	0	7.85	10.00	27.200	1.00	72.920	80.900	23.2				
5/7/2007	7:45	24600	8.25	9.57	29.384	1.54	70.177	75.972	23.4	23.30	1.07E-07	0.9246806	9.91E-08
5/8/2007	8:00	333300	8.30	9.44	30.045	1.72	69.262	74.398	22.2	22.84	1.06E-08	0.9347140	9.86E-09
	12:40	350100	8.20	9.41	30.197	1.76	69.059	74.042	23	22.83	1.06E-08	0.9349624	9.93E-09
5/9/2007	9:20	424500	8.25	9.29	30.807	1.91	68.297	72.670	22.9	22.85	1.06E-08	0.9344857	9.91E-09
	15:30	446700	8.25	9.26	30.959	1.96	68.043	72.264	23.2	22.86	1.06E-08	0.9342658	9.91E-09
5/10/2007	7:20	503700	8.35	9.18	31.366	2.08	67.434	71.248	22.9	22.88	1.06E-08	0.9337901	9.89E-09

Trial 2

Date	Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Base Burette		Top Burette		Total Head Across Sample (cm of water)	Temperature (℃)	Weighted Average Temp. (℃)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Corrected Hydraulic Conductivity (cm/sec)
				Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)						
5/10/2007	7:20	0	8.35	9.18	31.366	2.08	67.434	71.248	22.9				
5/11/2007	8:10	89400	8.45	9.06	31.975	2.25	66.570	69.775	23	22.95	6.95E-08	0.9322477	6.48E-08
	11:50	102600	8.47	9.04	32.077	2.27	66.468	69.572	23	22.96	6.17E-08	0.9321077	5.75E-08
5/12/2007	11:40	188400	8.45	8.93	32.636	2.44	65.605	68.149	23.7	23.14	3.82E-08	0.9282213	3.55E-08
5/14/2007	10:25	357300	8.60	8.73	33.652	2.74	64.081	65.609	23.9	23.45	2.46E-08	0.9214735	2.27E-08
5/15/2007	8:10	435000	8.50	8.64	34.109	2.88	63.370	64.441	24.2	23.56	2.19E-08	0.9191873	2.02E-08
5/16/2007	8:20	522000	8.95	8.57	34.464	3.04	62.557	63.272	22.4	23.51	1.98E-08	0.9200993	1.82E-08



B-4 ST-2; Sample 3.5-5.5 feet

Hydraulic Conductivity

Figure B-1

Ameren Missouri; Labadie Power Plant

Utility Waste Landfill, Preliminary Study

Sample B-4, ST- 2, 3.5'-5.5' Sandy Silt

Hydraulic Conductivity

Soil Conditions	
Pre-test conditions	**Post-test Conditions**
Wet Density = 116.4 (lbs/ft^3)	Wet Density = 122.6 (lbs/ft^3)
% Moisture = 24.8%	% Moisture = 29.0%
Dry Density = 93.2 (lbs/ft^3)	Dry Density = 95.1 (lbs/ft^3)

Test Information	
a (cm^2)=	0.19685
L (cm)=	9.85393
A (cm^2)=	19.7680845

Trial 1

				Base Burette		Top Burette							
Date	Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (℃)	Weighted Average Temp. (℃)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Corrected Hydraulic Conductivity (cm/sec)
5/4/2007	11:26	0	8.6	10.00	27.200	0.80	73.936	46.736	23.2				
	11:27	60	8.6	5.65	49.298	5.12	51.990	2.692	23.2	23.20	2.33E-03	0.9268326	2.16E-03

Trial 2

				Base Burette		Top Burette							
Date	Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (℃)	Weighted Average Temp. (℃)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Corrected Hydraulic Conductivity (cm/sec)
5/4/2007	11:30	0	8.6	10.00	27.200	1.04	72.717	45.517	23.2				
		20	8.6	7.42	40.306	3.80	58.696	18.390	23.2	23.20	2.29E-03	0.9268326	2.12E-03
		40	8.6	6.34	45.793	4.72	54.022	8.230	23.2	23.20	2.13E-03	0.9268326	1.97E-03
		60	8.6	5.84	48.333	5.18	51.686	3.353	23.2	23.20	2.15E-03	0.9268326	2.00E-03

Trial 3

				Base Burette		Top Burette							
Date	Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (℃)	Weighted Average Temp. (℃)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Corrected Hydraulic Conductivity (cm/sec)
5/4/2007	11:33	0	8.7	10.00	27.200	1.30	71.396	44.196	23.2				
		20	8.7	7.44	40.205	3.86	58.391	18.186	23.2	23.20	2.32E-03	0.9268326	2.15E-03
		45	8.7	6.21	46.453	5.04	52.397	5.944	23.2	23.20	2.25E-03	0.9268326	2.08E-03
		60	8.7	5.94	47.825	5.33	50.924	3.099	23.2	23.20	2.22E-03	0.9268326	2.06E-03

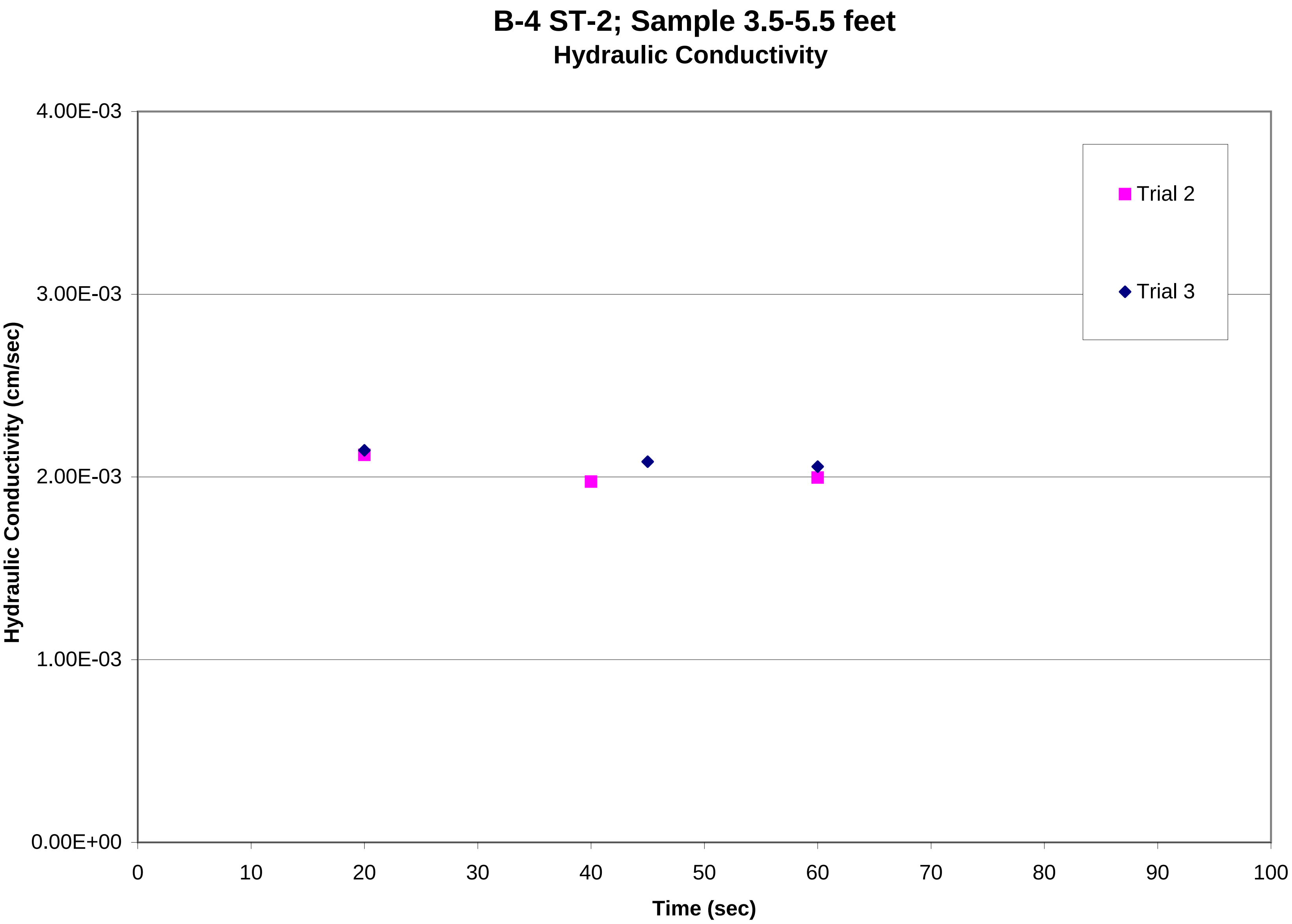
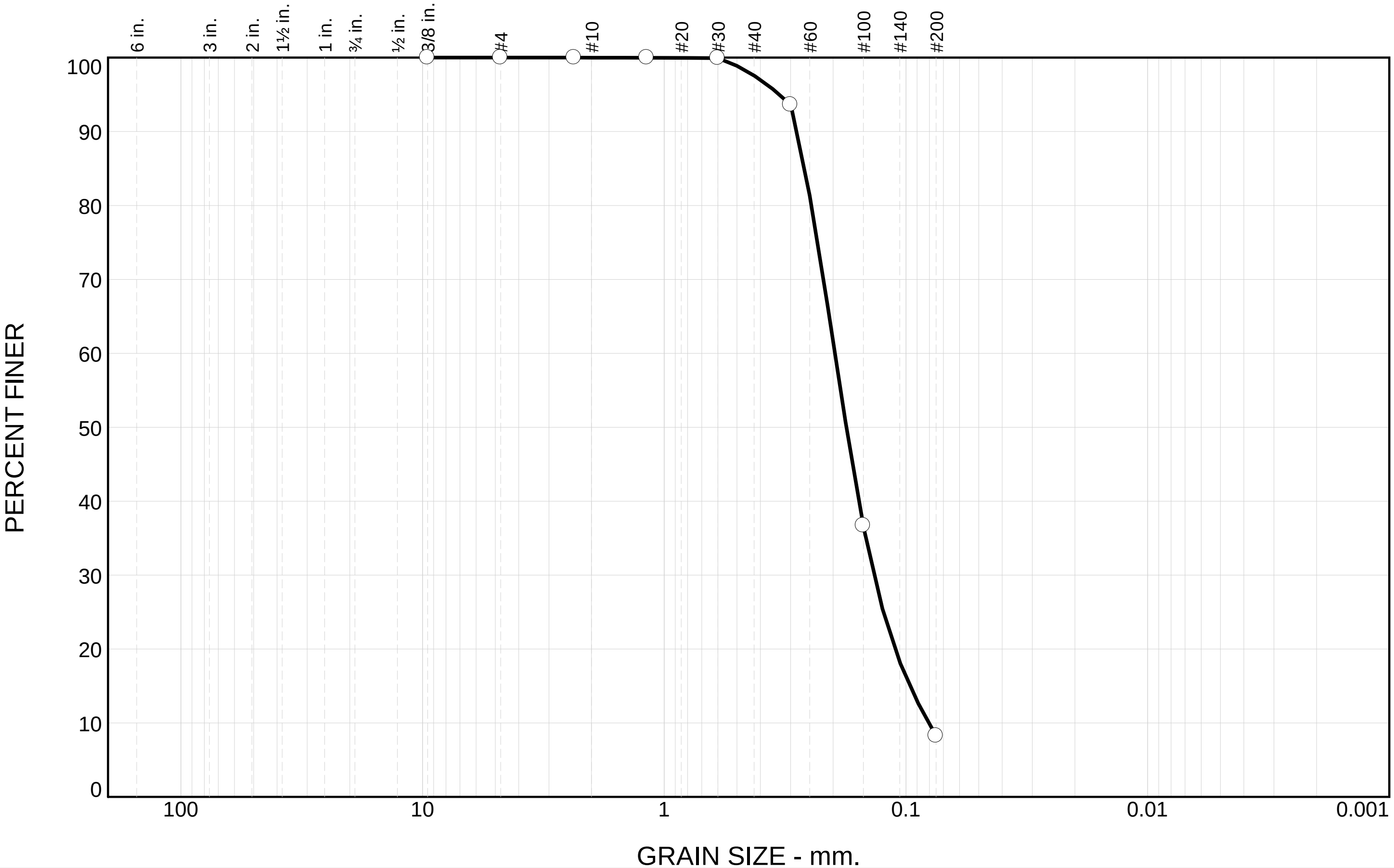

B-4 ST-2; Sample 3.5-5.5 feet
Hydraulic Conductivity
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Hydraulic Conductivity (cm/sec)
0
10
20
30
40
50
60
70
80
90
100
Time (sec)
■ Trial 2
◆ Trial 3

Figure B-2

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.4	89.4	8.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	93.6		
#100	36.7		
#200	8.2		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2621 D_{60}= 0.1967 D_{50}= 0.1764
D_{30}= 0.1357 D_{15}= 0.0963 D_{10}= 0.0804
C_u= 2.45 C_c= 1.16

Date Tested: 12-09-09 **Tested By:** L. Crose

Remarks

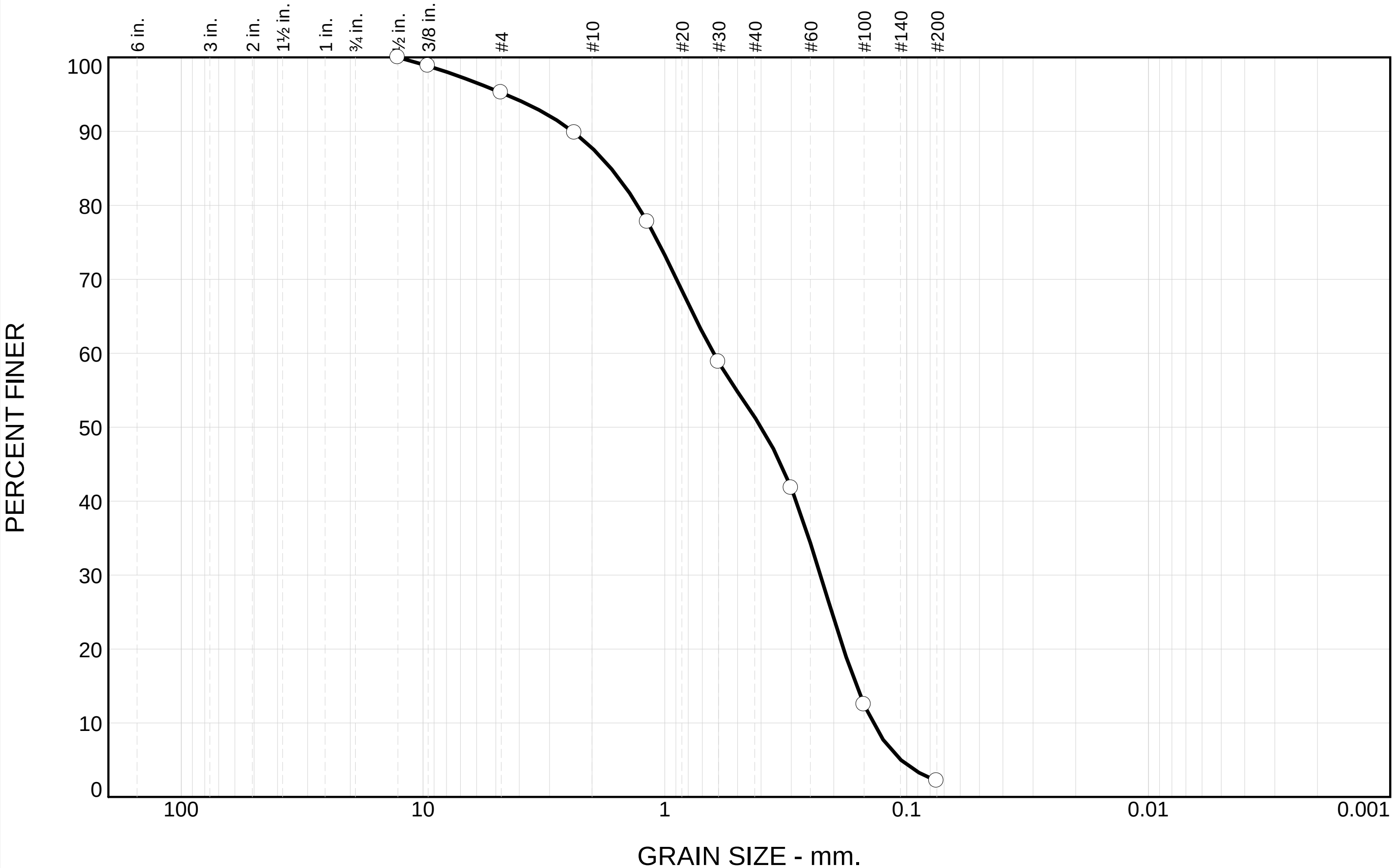
Sample No.: SS-5 **Source of Sample:** P-9 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-3

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.8	7.4	36.4	49.3	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.8		
#4	95.2		
#8	89.8		
#16	77.7		
#30	58.8		
#50	41.8		
#100	12.5		
#200	2.1		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS= SP **AASHTO=**

Coefficients

D_{85}= 1.6689 D_{60}= 0.6294 D_{50}= 0.4000
D_{30}= 0.2273 D_{15}= 0.1613 D_{10}= 0.1378
C_u= 4.57 C_c= 0.60

Date Tested: 12-09-09 **Tested By:** M. Tierney/J. Pruett

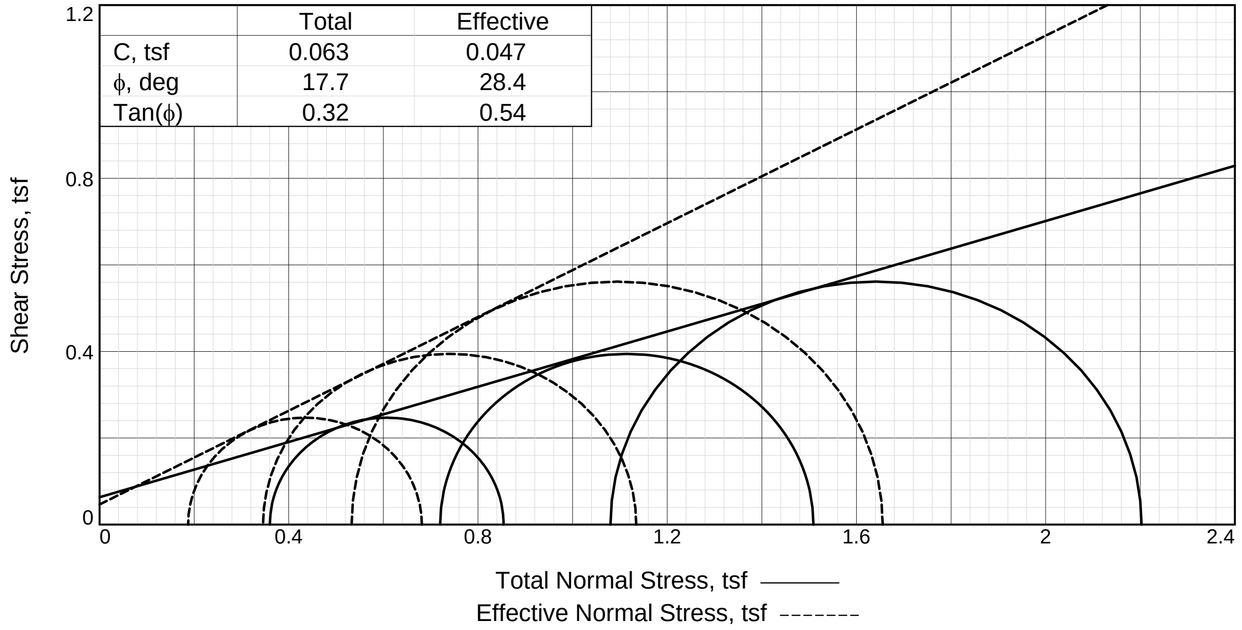
Remarks

Sample No.: SS-7 **Source of Sample:** P-9 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

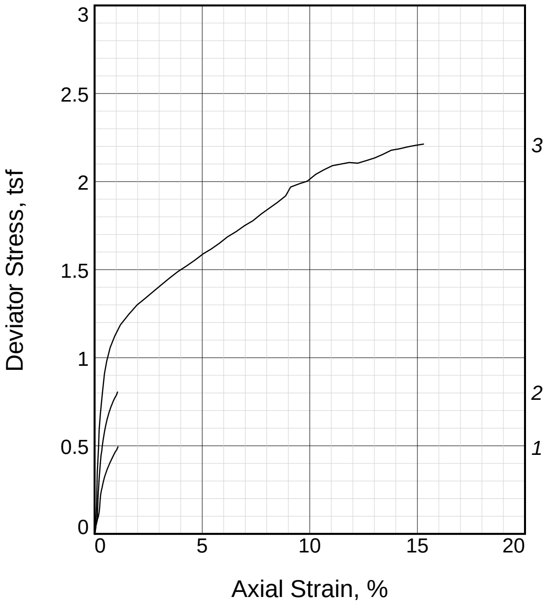
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-4



	Total	Effective
C, tsf	0.063	0.047
ϕ, deg	17.7	28.4
Tan(ϕ)	0.32	0.54



	Sample No.	1	2	3
Initial	Water Content,	34.3	34.3	34.3
	Dry Density, pcf	86.9	86.9	86.9
	Saturation,	99.4	99.4	99.4
	Void Ratio	0.9244	0.9244	0.9244
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.82	5.82	5.82
At Test	Water Content,	34.1	33.6	33.3
	Dry Density, pcf	87.4	88.0	88.4
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.9135	0.9005	0.8935
	Diameter, in.	2.84	2.85	2.87
	Height, in.	5.81	5.73	5.67
	Strain rate, %/min.	0.13	0.09	0.10
	Back Pressure, tsf	3.96	4.32	5.04
	Cell Pressure, tsf	4.32	5.04	6.12
	Fail. Stress, tsf	0.49	0.79	1.12
	Total Pore Pr., tsf	4.13	4.69	5.59
	Ult. Stress, tsf	0.49	0.81	2.21
	Total Pore Pr., tsf	4.13	4.70	5.32
	$\bar{\sigma}_1$ Failure, tsf	0.68	1.13	1.66
	$\bar{\sigma}_3$ Failure, tsf	0.19	0.35	0.53

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: Very Silty CLAY (CL), brown, with traces of fine sand and lignite

LL= 37 **PL=** 22 **PI=** 15

Assumed Specific Gravity= 2.68

Remarks: Staged test.

Figure B-5

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-10 **Depth:** 4

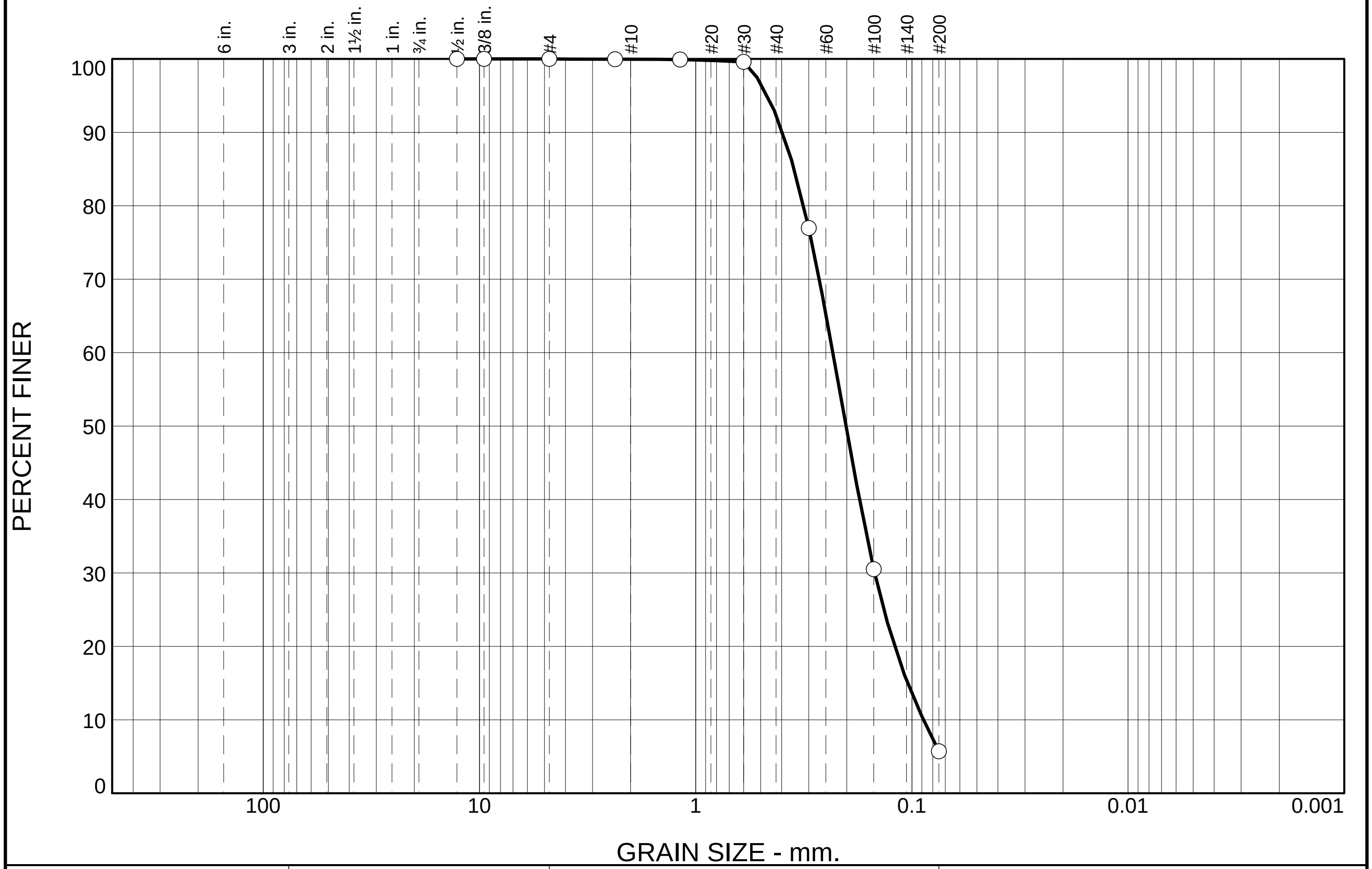
Sample Number: ST-2

Proj. No.: 2008012455 **Date:** 4/13/2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Fouse

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	7.6	86.7	5.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.6		
#50	77.0		
#100	30.5		
#200	5.7		

* (no specification provided)

Material Description

SAND (SP-SM), brown, medium-dense, with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= AASHTO=

Coefficients

D_{85}= 0.3504 D_{60}= 0.2319 D_{50}= 0.2018
D_{30}= 0.1486 D_{15}= 0.1046 D_{10}= 0.0883
C_u= 2.63 C_c= 1.08

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

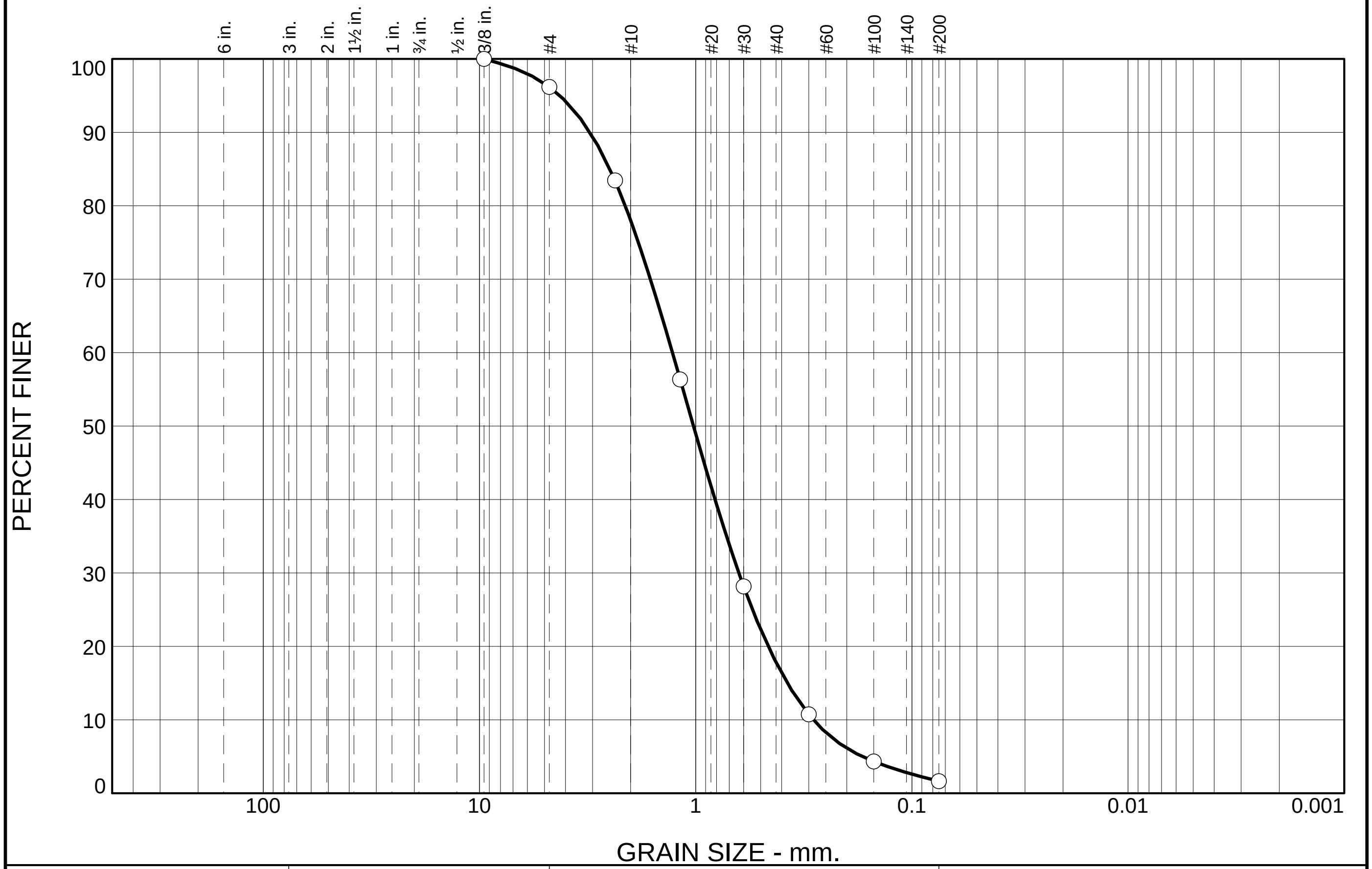
Sample No.: SS-6 **Source of Sample:** B-10 **Date Sampled:** 02-01-2010
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-6

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.8	18.1	60.3	16.2	1.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	96.2		
#8	83.5		
#16	56.4		
#30	28.2		
#50	10.8		
#100	4.3		
#200	1.6		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.4917 D_{60}= 1.2812 D_{50}= 1.0227
D_{30}= 0.6313 D_{15}= 0.3766 D_{10}= 0.2855
C_u= 4.49 C_c= 1.09

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

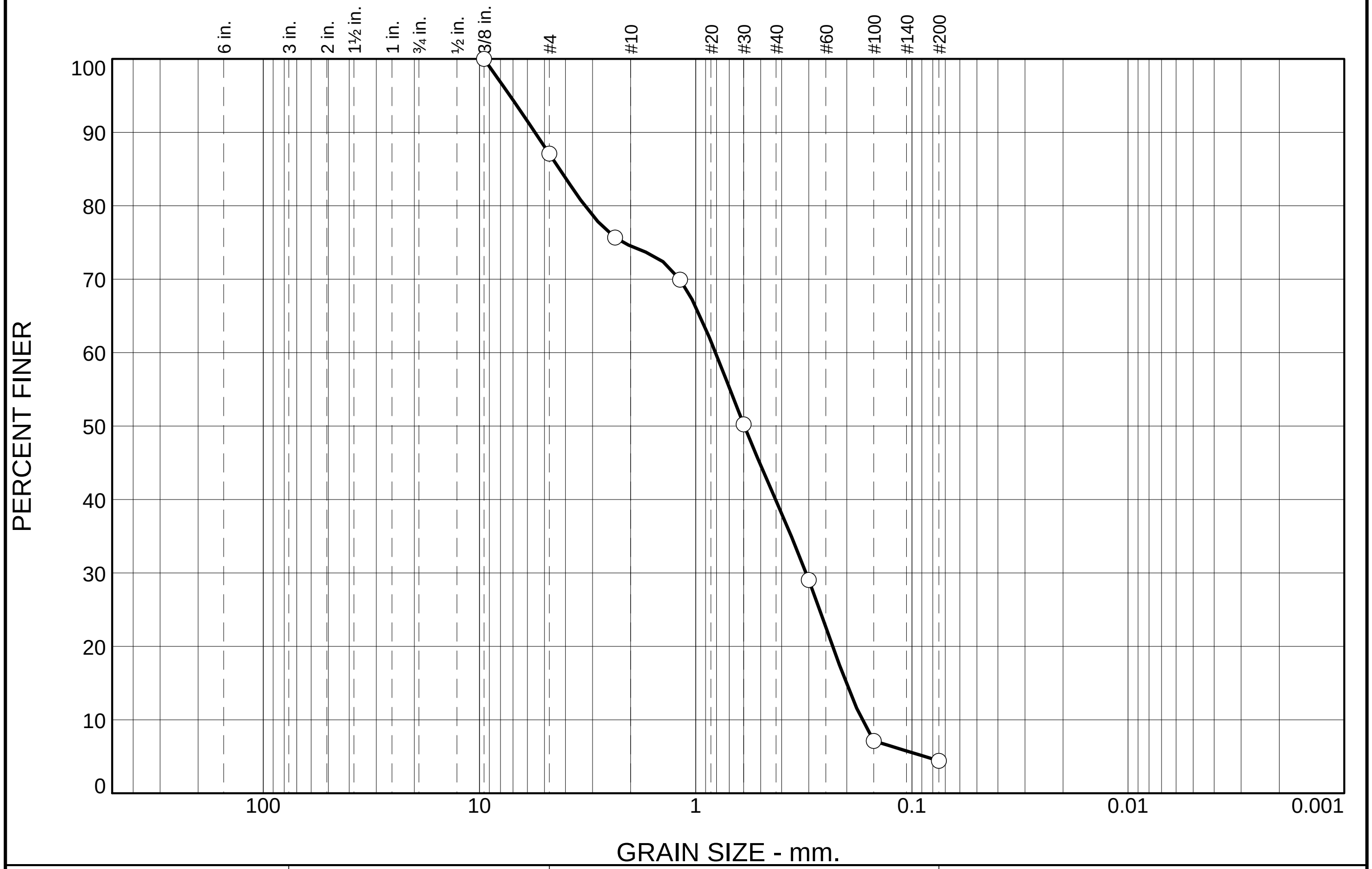
Sample No.: SS-8 **Source of Sample:** B-10 **Date Sampled:** 02-01-2010
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-7

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	12.9	12.6	34.6	35.5	4.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	87.1		
#8	75.7		
#16	69.9		
#30	50.2		
#50	29.0		
#100	7.1		
#200	4.4		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 4.2624 D_{60}= 0.8083 D_{50}= 0.5954
D_{30}= 0.3087 D_{15}= 0.2010 D_{10}= 0.1700
C_u= 4.75 C_c= 0.69

Date Tested: 02-03-10 **Tested By:** J. Crose

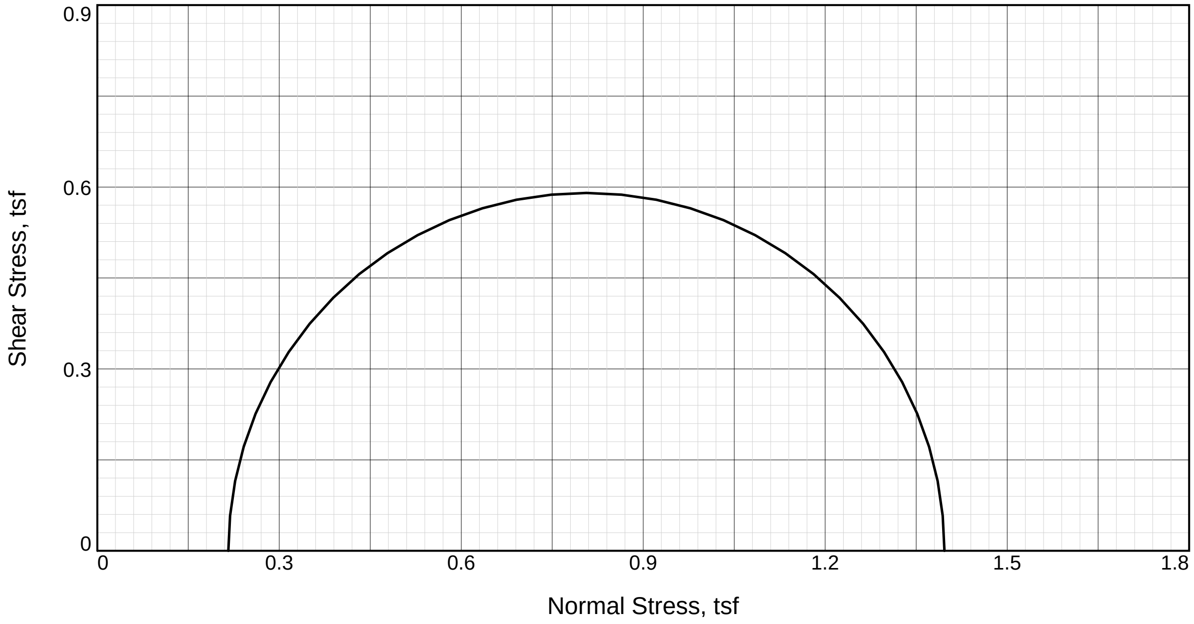
Remarks

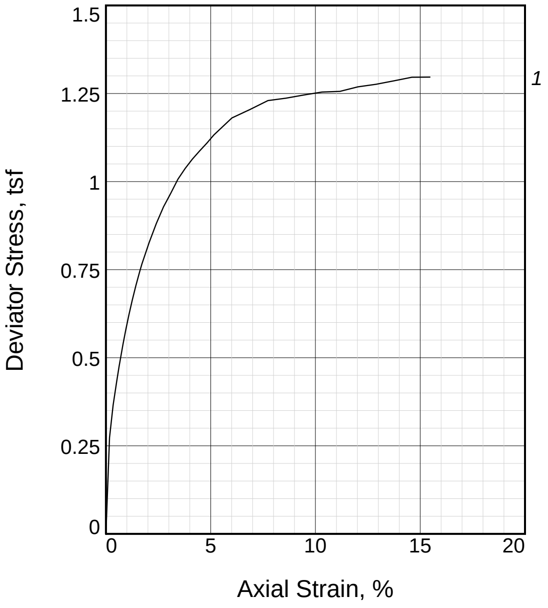
Sample No.: SS-9 **Source of Sample:** B-10 **Date Sampled:** 02-01-2010
Location: **Elev./Depth:** 33.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-8





Sample No.		1
Initial	Water Content,	22.7
	Dry Density, pcf	103.1
	Saturation,	97.7
	Void Ratio	0.6222
	Diameter, in.	2.85
	Height, in.	5.82
At Test	Water Content,	22.7
	Dry Density, pcf	103.1
	Saturation,	97.7
	Void Ratio	0.6222
	Diameter, in.	2.85
	Height, in.	5.82
Strain rate, %/min.		0.83
Back Pressure, tsf		0.00
Cell Pressure, tsf		0.22
Fail. Stress, tsf		1.18
Ult. Stress, tsf		1.30
σ_1 Failure, tsf		1.40
σ_3 Failure, tsf		0.22

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CL), dark gray-brown, low plastic, traces of lignite, limonite, fine sand

LL= 46 **PL=** 21 **PI=** 25

Assumed Specific Gravity= 2.68

Remarks:

Figure B-9

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-13 **Depth:** 1

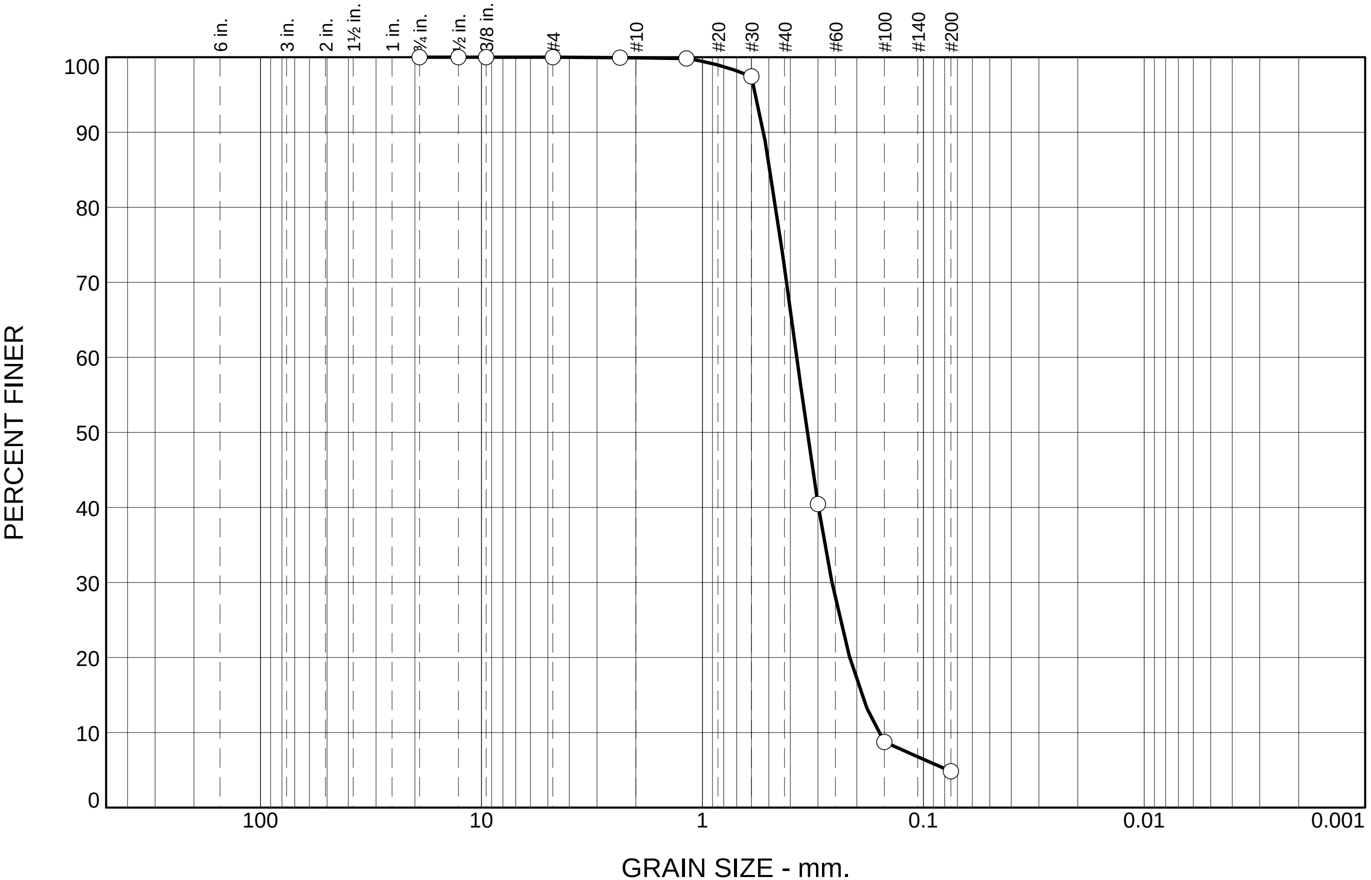
Sample Number: ST-1

Proj. No.: 2008012455 **Date:** 03-30-2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Crose **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	27.9	67.1	4.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.8		
#30	97.5		
#50	40.5		
#100	8.7		
#200	4.9		

* (no specification provided)

Material Description

SAND (SP), gray & tan, loose

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.4941 D_{60}= 0.3738 D_{50}= 0.3355
D_{30}= 0.2591 D_{15}= 0.1900 D_{10}= 0.1594
C_u= 2.34 C_c= 1.13

Date Tested: 2/15/10 **Tested By:** J. Pruett

Remarks

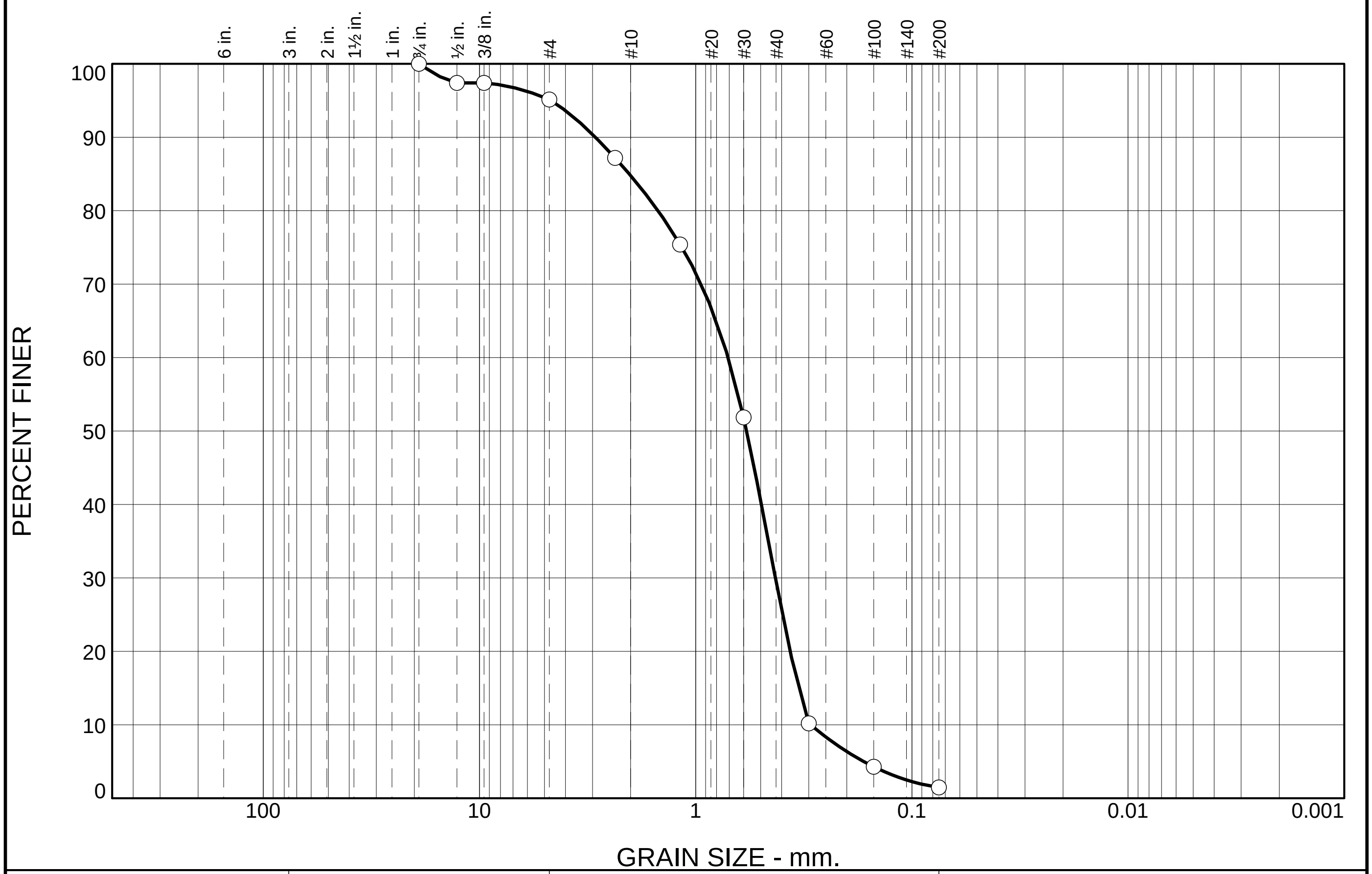
Sample No.: SS-5 **Source of Sample:** B-13 **Date Sampled:** 11/02/2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-10

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.9	10.3	55.2	28.1	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	97.4		
3/8	97.4		
#4	95.1		
#8	87.2		
#16	75.4		
#30	51.9		
#50	10.2		
#100	4.3		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= AASHTO=

Coefficients

D_{85}= 2.0282 D_{60}= 0.7072 D_{50}= 0.5809
D_{30}= 0.4278 D_{15}= 0.3339 D_{10}= 0.2942
C_u= 2.40 C_c= 0.88

Date Tested: 02-15-10 **Tested By:** J. Pruett

Remarks

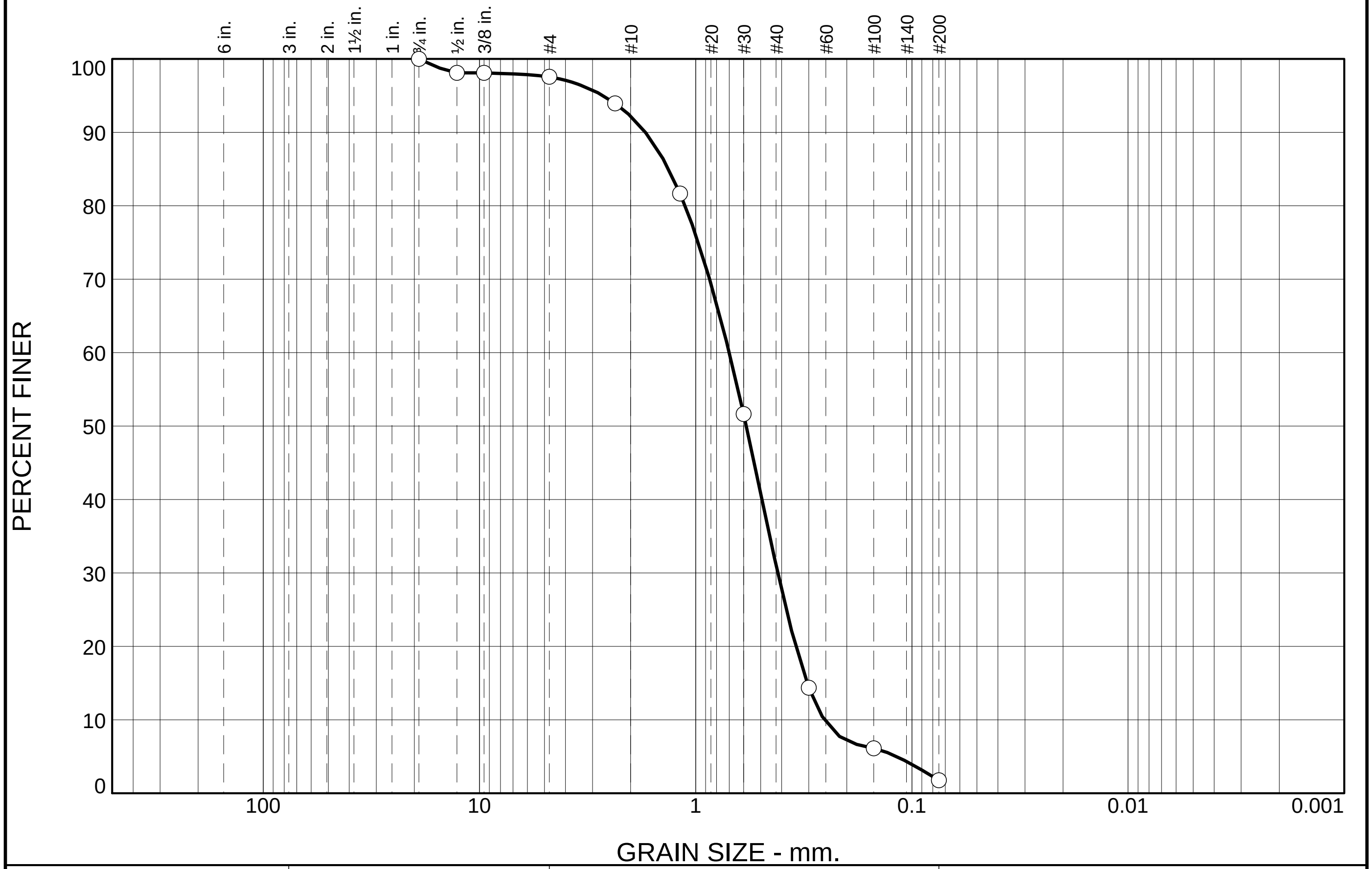
Sample No.: SS-8 **Source of Sample:** B-13 **Date Sampled:** 11/02/2009
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-11

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	5.4	61.1	29.3	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	98.1		
3/8	98.1		
#4	97.6		
#8	94.0		
#16	81.7		
#30	51.6		
#50	14.4		
#100	6.1		
#200	1.8		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense to dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.3335 D_{60}= 0.6989 D_{50}= 0.5832
D_{30}= 0.4171 D_{15}= 0.3054 D_{10}= 0.2540
C_u= 2.75 C_c= 0.98

Date Tested: 2/15/10 **Tested By:** J. Pruett

Remarks

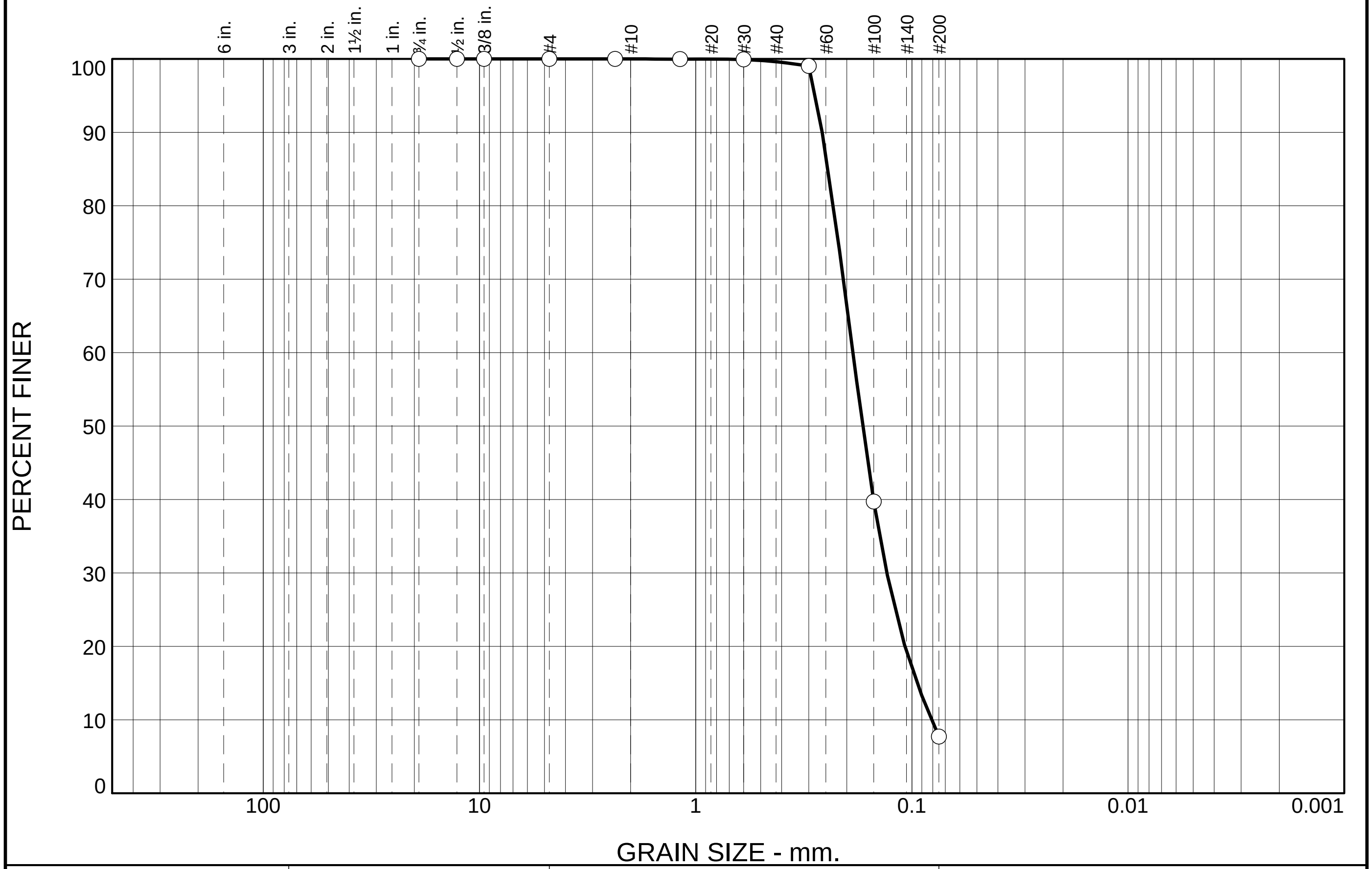
Sample No.: SS-10 **Source of Sample:** B-13 **Date Sampled:** 11/02/2009
Location: **Elev./Depth:** 38.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-12

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	91.9	7.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	99.0		
#100	39.7		
#200	7.7		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2443 D_{60}= 0.1875 D_{50}= 0.1689
D_{30}= 0.1306 D_{15}= 0.0945 D_{10}= 0.0810
C_u= 2.32 C_c= 1.12

Date Tested: 02-15-10 **Tested By:** J. Pruett

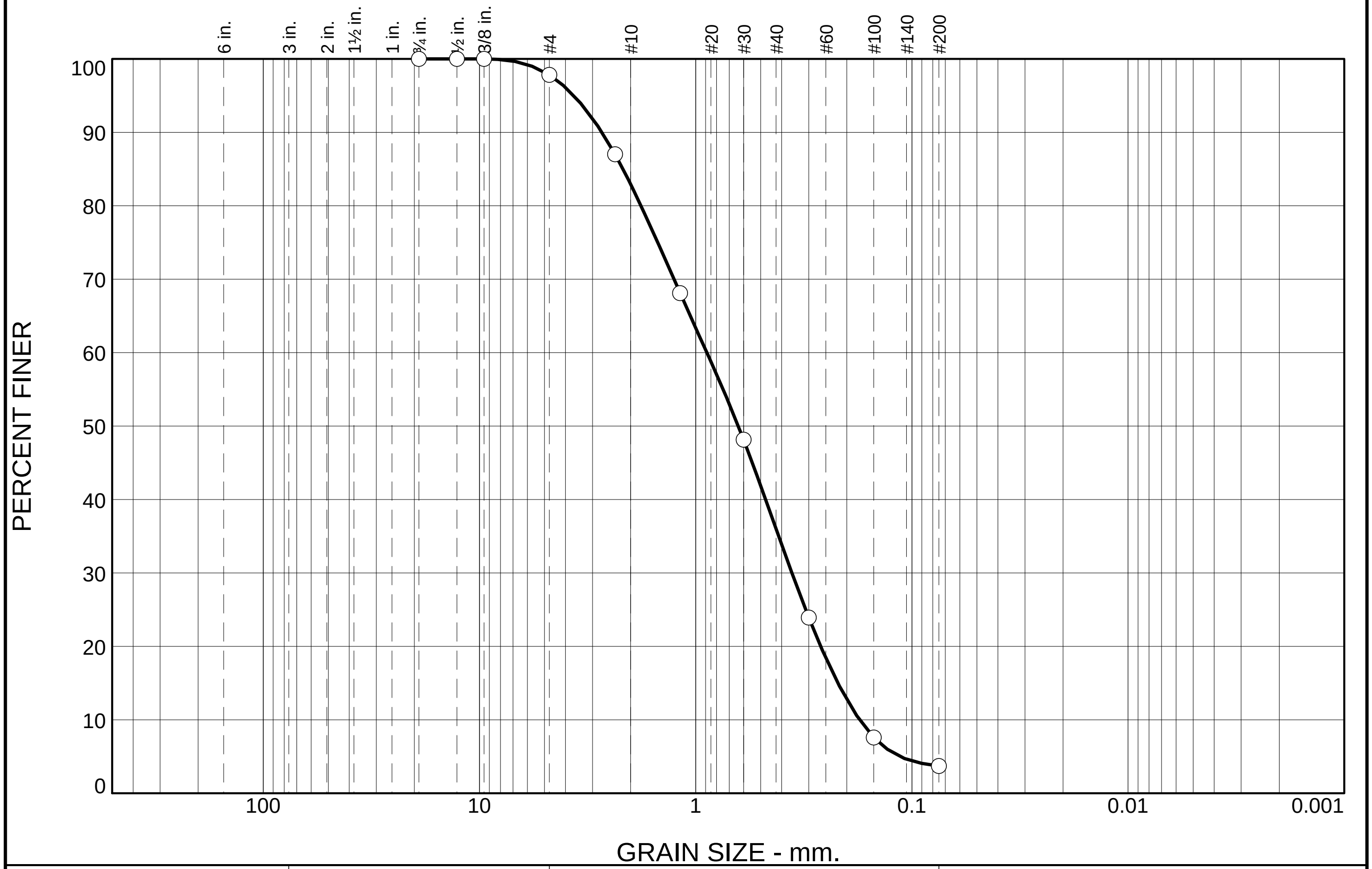
Remarks

Sample No.: SS-6 **Source of Sample:** B-14 **Date Sampled:** 10-28-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-13

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.2	14.8	47.0	32.3	3.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	97.8		
#8	87.0		
#16	68.1		
#30	48.2		
#50	23.9		
#100	7.6		
#200	3.7		

* (no specification provided)

Material Description

SAND (SP) tan and light gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.1677	D_{60}= 0.8860	D_{50}= 0.6349
D_{30}= 0.3590	D_{15}= 0.2199	D_{10}= 0.1745
C_u= 5.08	C_c= 0.83	

Date Tested: 02-15-10 **Tested By:** J. Pruett

Remarks

Sample No.: SS-8 **Source of Sample:** B-14 **Date Sampled:** 10-28-2009

Location: **Elev./Depth:** 28.5

Checked By: K. Kocher **Title:** Engineer

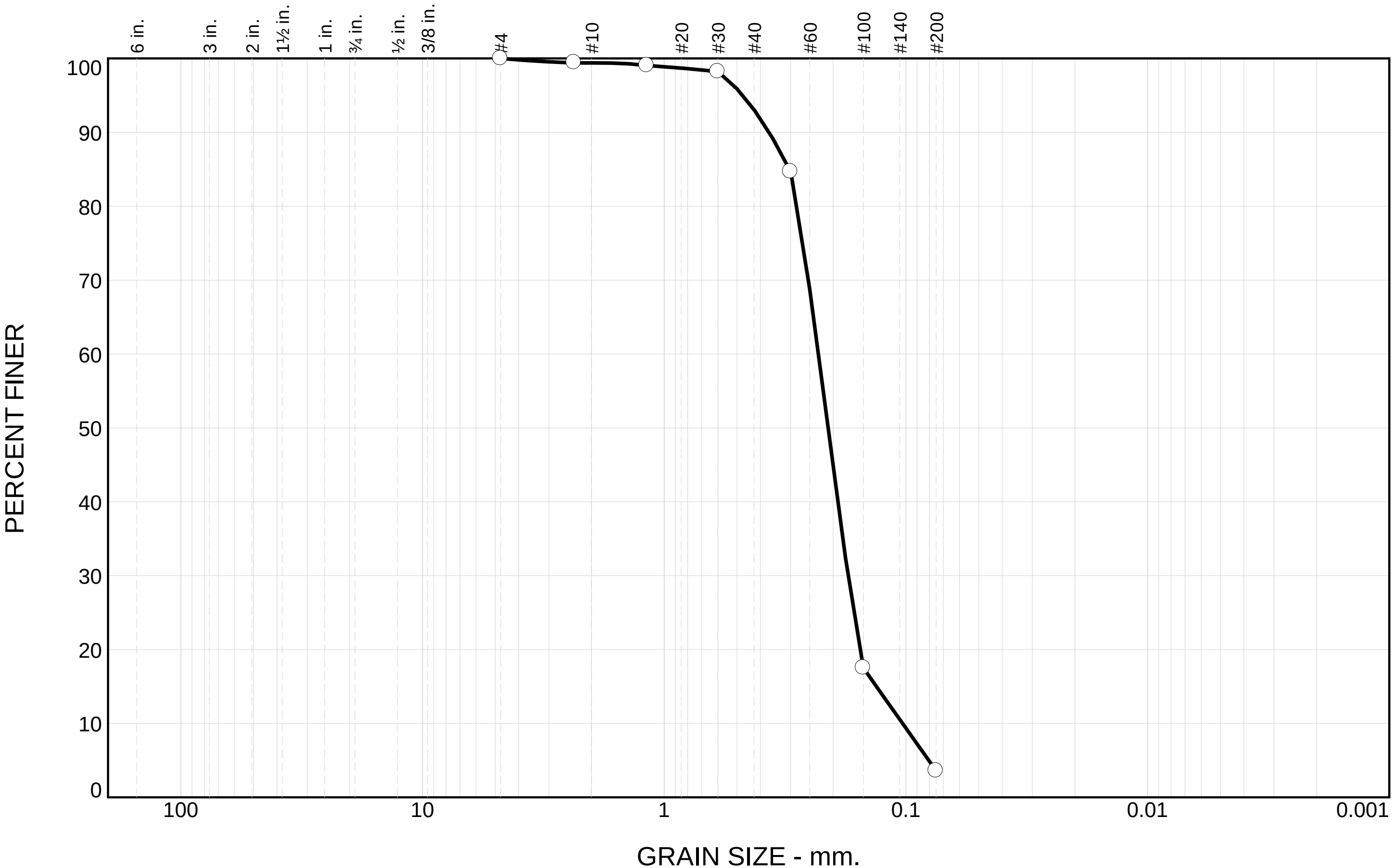
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-14

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	6.3	89.5	3.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.4		
#16	99.0		
#30	98.2		
#50	84.7		
#100	17.5		
#200	3.6		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3034 D_{60}= 0.2299 D_{50}= 0.2098
D_{30}= 0.1736 D_{15}= 0.1324 D_{10}= 0.1032
C_u= 2.23 C_c= 1.27

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

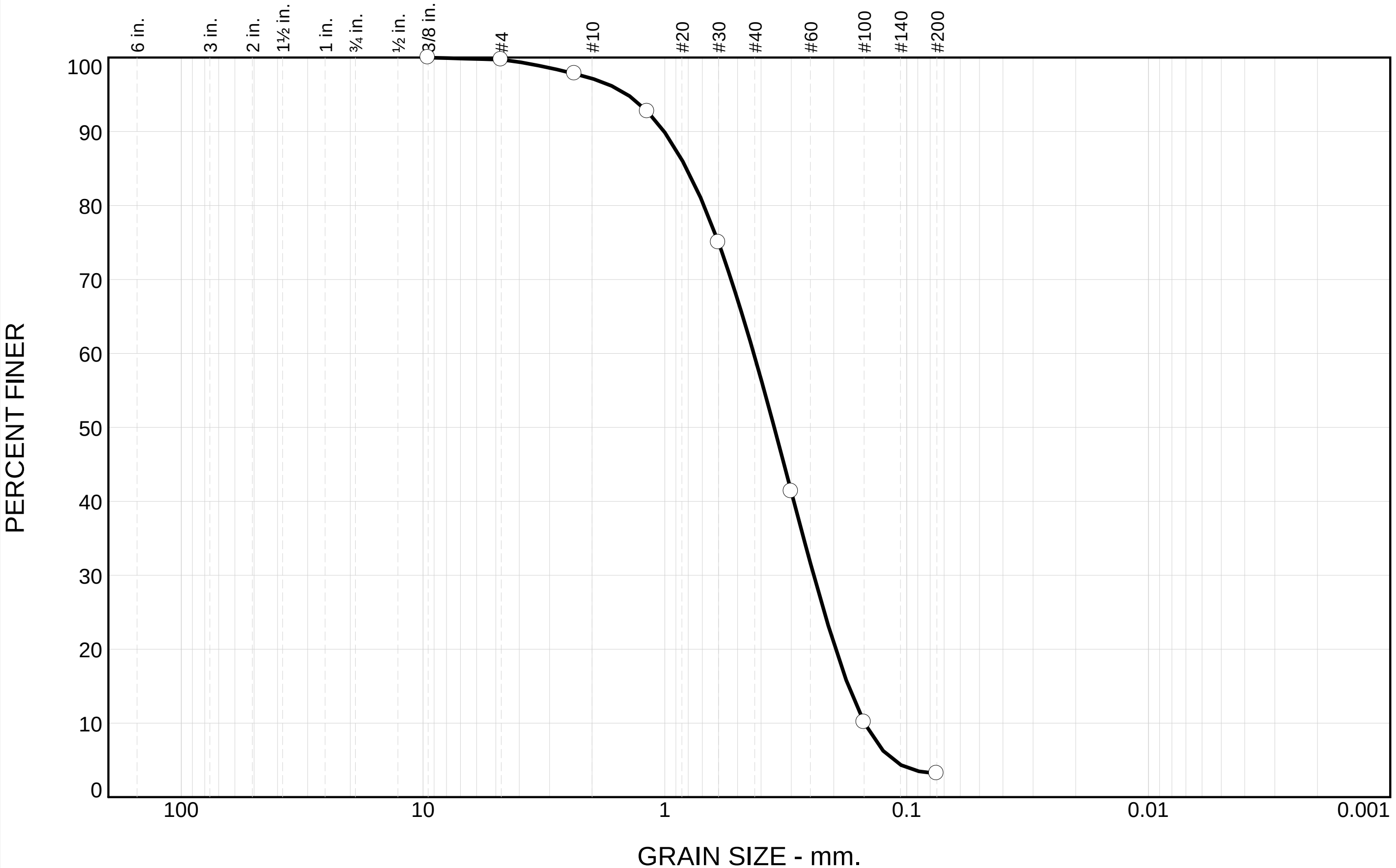
Sample No.: SS-5 **Source of Sample:** P-19 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-15

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	2.5	37.7	56.3	3.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.7		
#8	97.8		
#16	92.7		
#30	75.0		
#50	41.3		
#100	10.1		
#200	3.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.8129 D_{60}= 0.4292 D_{50}= 0.3531
D_{30}= 0.2421 D_{15}= 0.1740 D_{10}= 0.1493
C_u= 2.87 C_c= 0.91

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

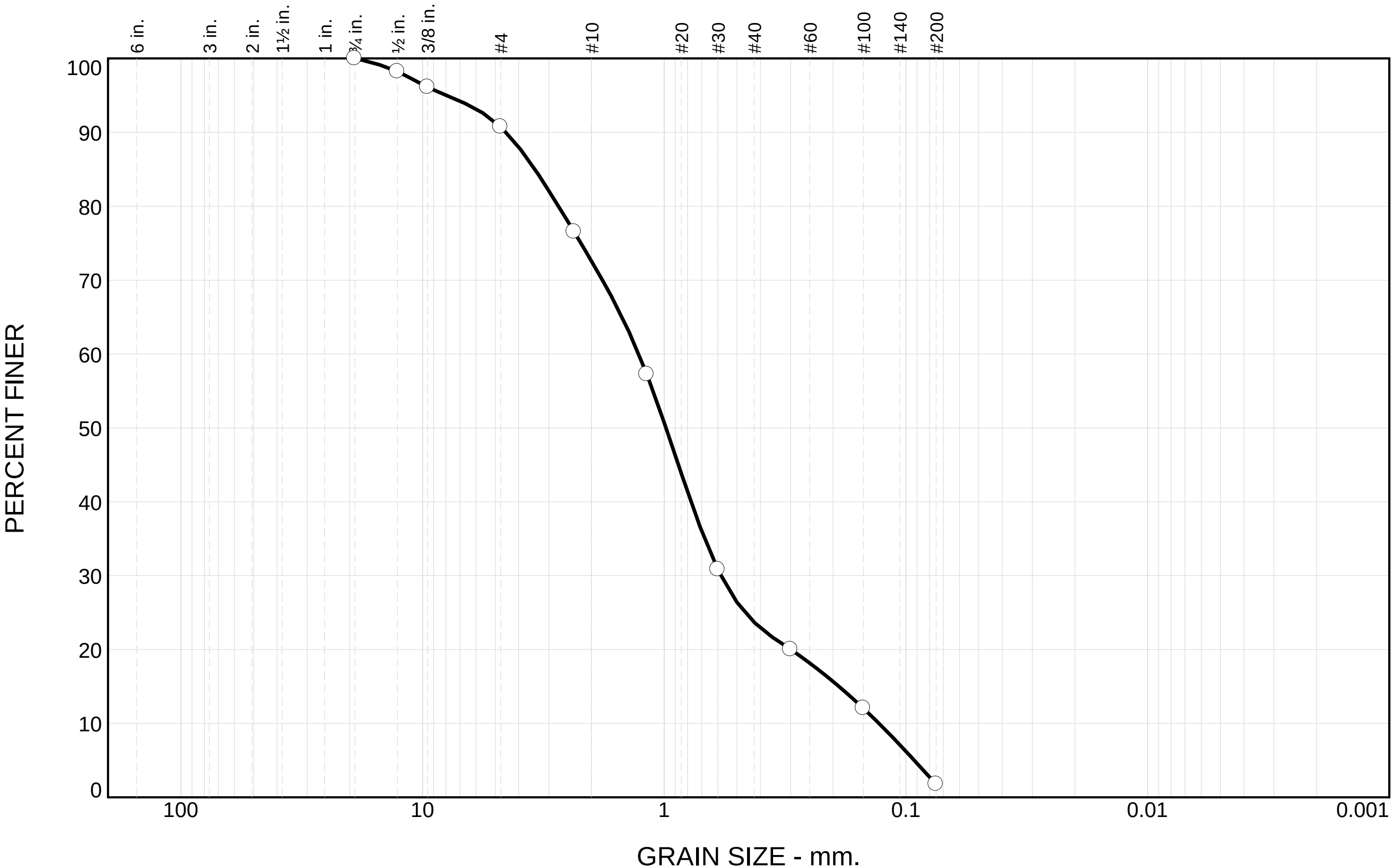
Sample No.: SS-6 **Source of Sample:** P-19 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

Reitz & Jens, Inc.
Consulting Engineers

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-16

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.3	18.1	48.9	21.9	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	98.2		
3/8	96.1		
#4	90.7		
#8	76.5		
#16	57.3		
#30	30.8		
#50	20.0		
#100	12.0		
#200	1.8		

* (no specification provided)

Material Description

SAND (SW)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SW AASHTO=

Coefficients

D_{85}= 3.4284 D_{60}= 1.2751 D_{50}= 0.9836
D_{30}= 0.5829 D_{15}= 0.1890 D_{10}= 0.1294
C_u= 9.86 C_c= 2.06

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

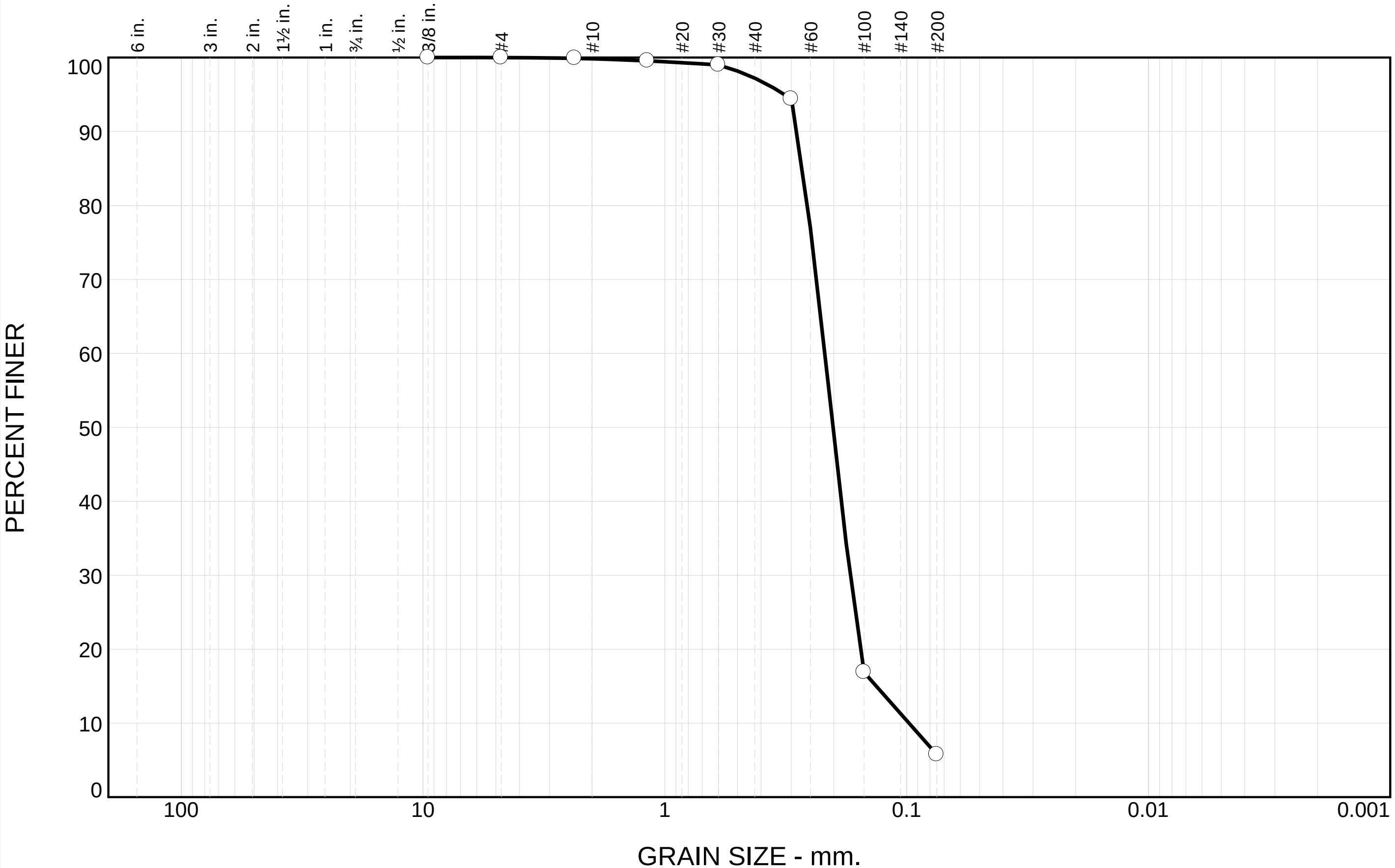
Sample No.: SS-7 **Source of Sample:** P-19 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-17

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.6	91.5	5.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.6		
#30	99.0		
#50	94.4		
#100	16.9		
#200	5.7		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2693 D_{60}= 0.2178 D_{50}= 0.2016
D_{30}= 0.1713 D_{15}= 0.1335 D_{10}= 0.0978
C_u= 2.23 C_c= 1.38

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

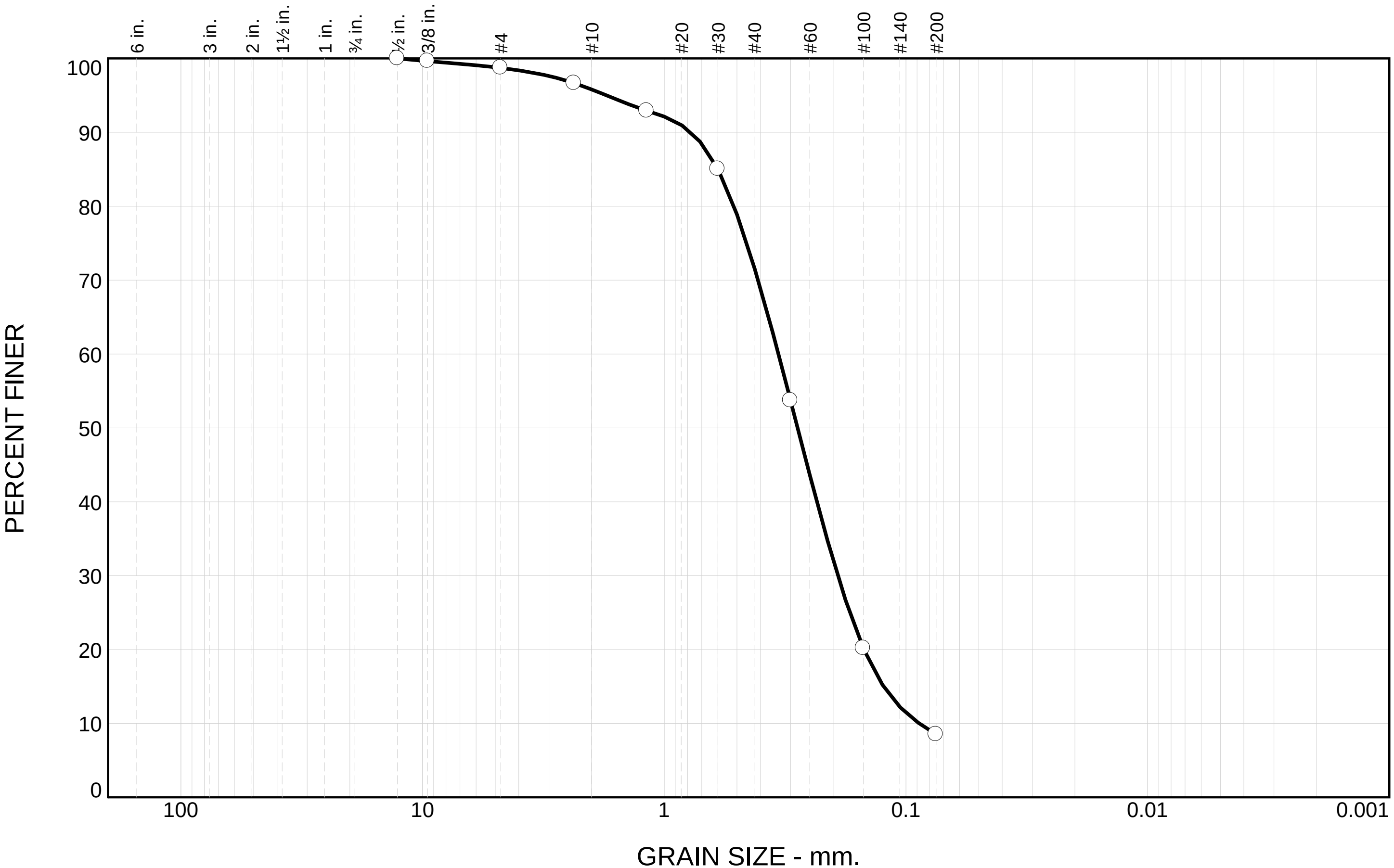
Sample No.: SS-5 **Source of Sample:** P-22 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-18

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	2.9	24.0	63.3	8.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	99.6		
#4	98.7		
#8	96.7		
#16	92.9		
#30	85.0		
#50	53.7		
#100	20.2		
#200	8.5		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.5994 D_{60}= 0.3368 D_{50}= 0.2806
D_{30}= 0.1914 D_{15}= 0.1237 D_{10}= 0.0881
C_u= 3.82 C_c= 1.23

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

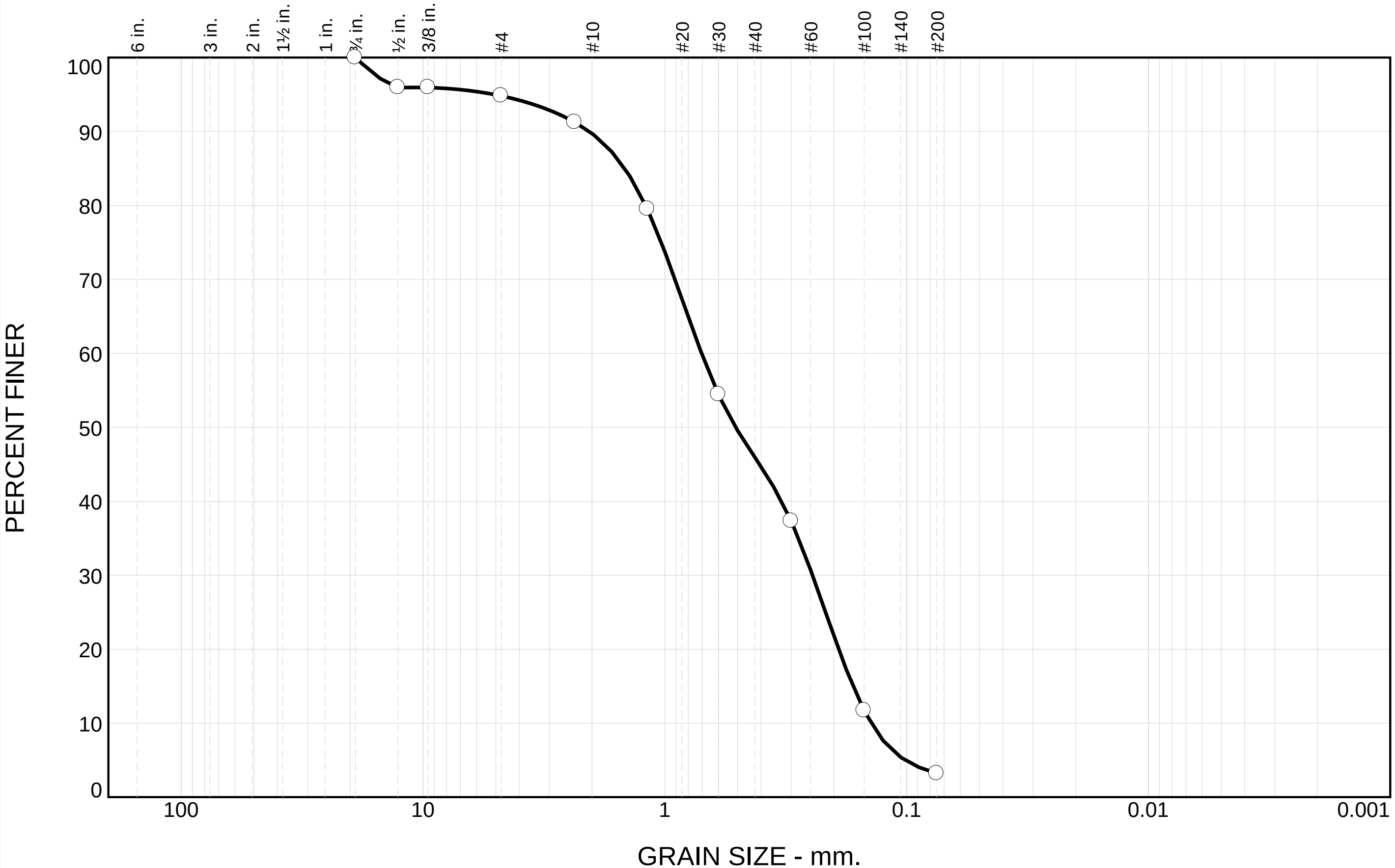
Sample No.: SS-6 **Source of Sample:** P-22 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-19

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.2	5.1	43.7	42.8	3.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	96.0		
3/8	96.0		
#4	94.8		
#8	91.3		
#16	79.5		
#30	54.4		
#50	37.3		
#100	11.7		
#200	3.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.4634 D_{60}= 0.7050 D_{50}= 0.5093
D_{30}= 0.2450 D_{15}= 0.1668 D_{10}= 0.1405
C_u= 5.02 C_c= 0.61

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

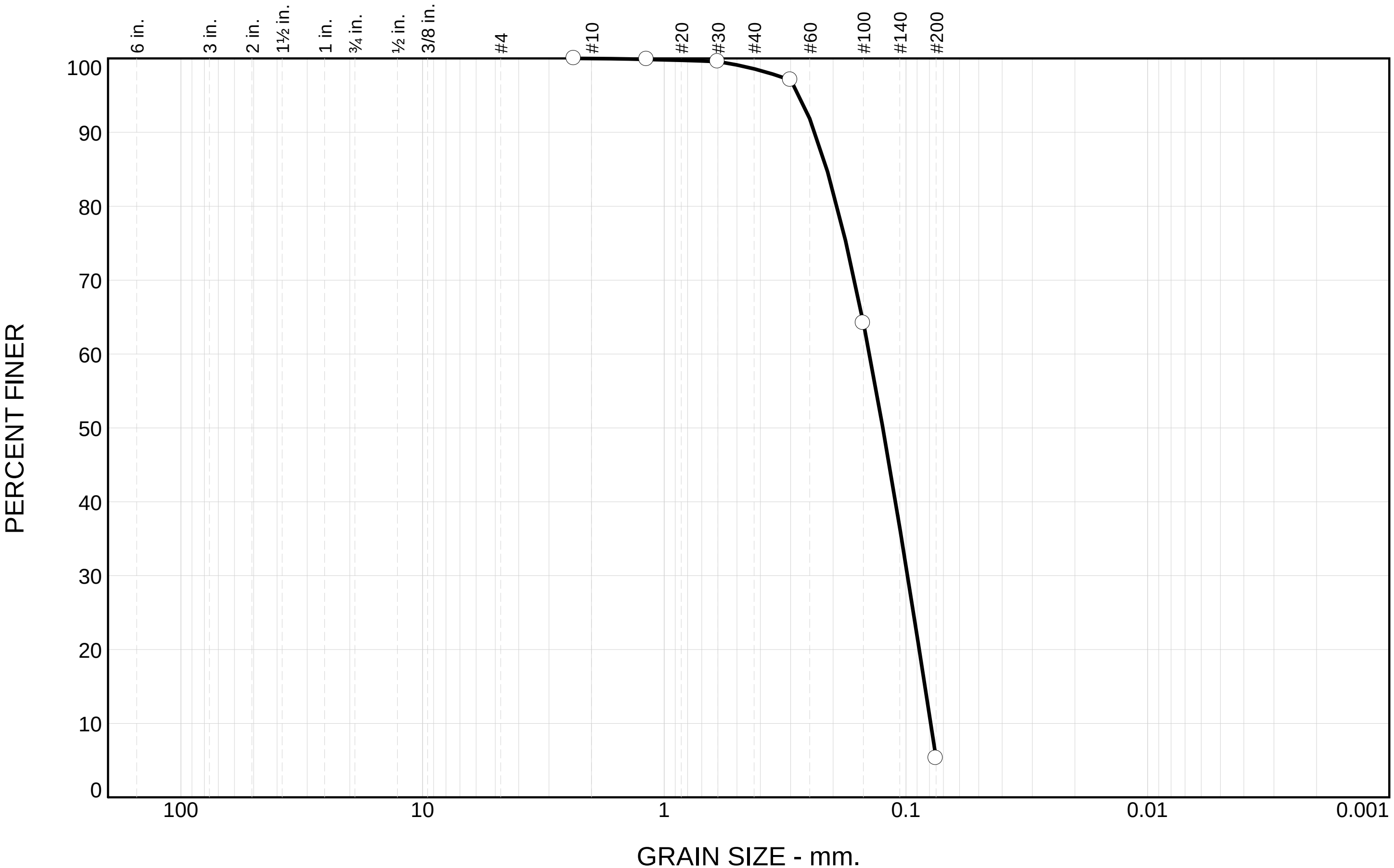
Sample No.: SS-7 **Source of Sample:** P-22 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-20

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.4	93.3	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#16	99.9		
#30	99.6		
#50	97.1		
#100	64.2		
#200	5.3		

* (no specification provided)

Material Description

SAND (SP), fine grain, trace silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2124 D_{60}= 0.1416 D_{50}= 0.1245
D_{30}= 0.0985 D_{15}= 0.0834 D_{10}= 0.0790
C_u= 1.79 C_c= 0.87

Date Tested: 9/22/09 **Tested By:** J. Crose

Remarks

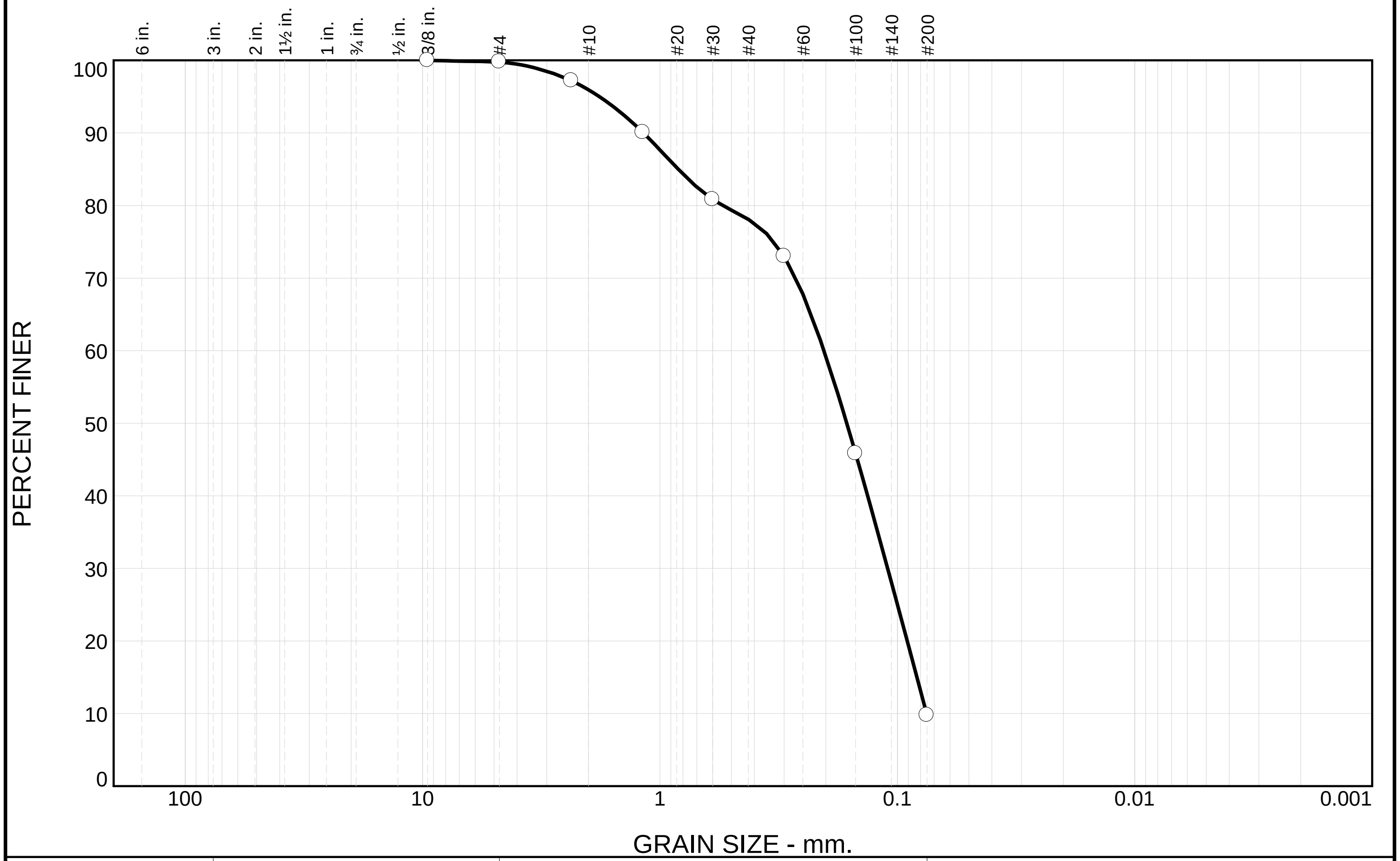
Sample No.: SS-6 **Source of Sample:** P-24 **Date Sampled:**
Location: P-24 **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-21

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	3.9	17.8	68.3	9.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.8		
#8	97.2		
#16	90.1		
#30	80.8		
#50	73.0		
#100	45.8		
#200	9.8		

* (no specification provided)

Material Description

SAND (SP), fine grain, with medium sand, trace silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.8376 D_{60}= 0.2037 D_{50}= 0.1634
D_{30}= 0.1099 D_{15}= 0.0827 D_{10}= 0.0753
C_u= 2.70 C_c= 0.79

Date Tested: 9/22/09 **Tested By:** J. Crose

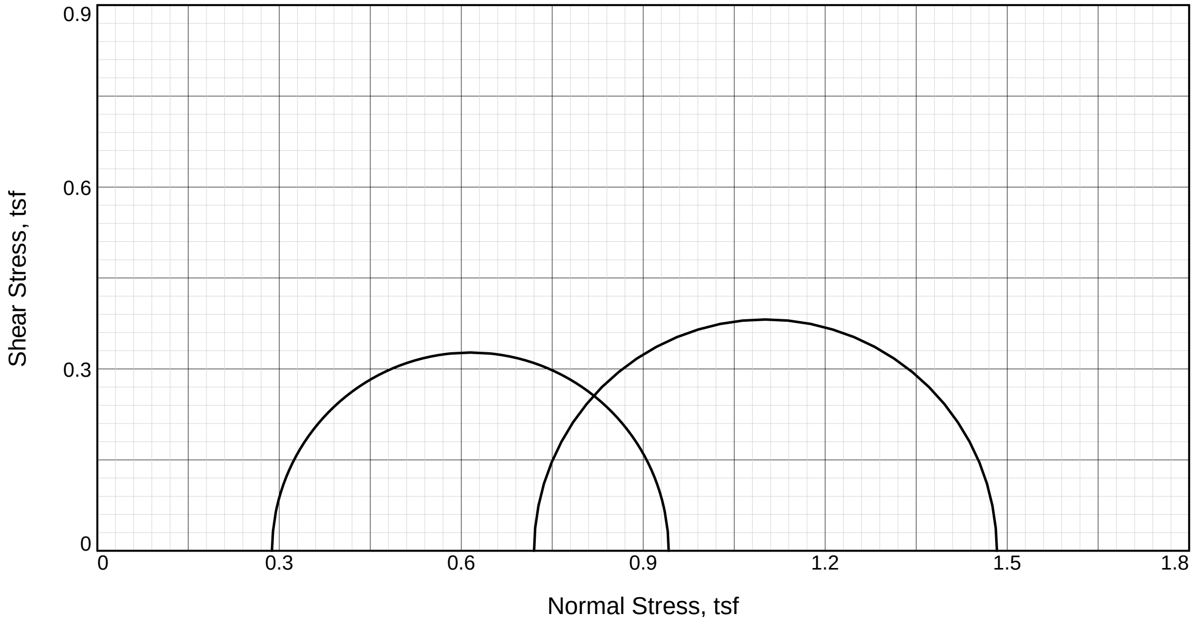
Remarks

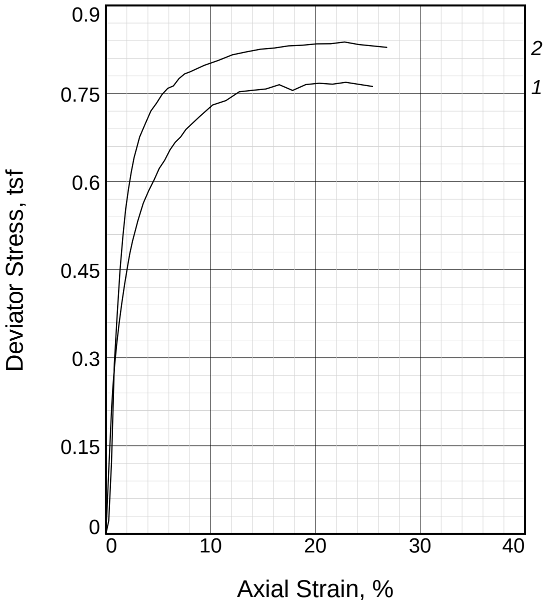
Sample No.: SS-7 **Source of Sample:** P-24 **Date Sampled:**
Location: P-24 **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-22





	Sample No.	1	2
Initial	Water Content,	30.1	32.6
	Dry Density, pcf	92.4	87.0
	Saturation,	99.5	94.5
	Void Ratio	0.8102	0.9231
	Diameter, in.	2.02	2.02
	Height, in.	3.93	3.73
At Test	Water Content,	30.1	32.6
	Dry Density, pcf	92.4	87.0
	Saturation,	99.5	94.5
	Void Ratio	0.8102	0.9231
	Diameter, in.	2.02	2.02
	Height, in.	3.93	3.73
	Strain rate, %/min.	0.80	0.87
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.29	0.72
	Fail. Stress, tsf	0.65	0.76
	Ult. Stress, tsf	0.77	0.83
	σ_1 Failure, tsf	0.94	1.48
	σ_3 Failure, tsf	0.29	0.72

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (Cl-CH), dark gray-brown, medium plastic, with silt, high plastic clay seams

Assumed Specific Gravity= 2.68

Remarks:

Figure B-23

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-26 **Depth:** 4

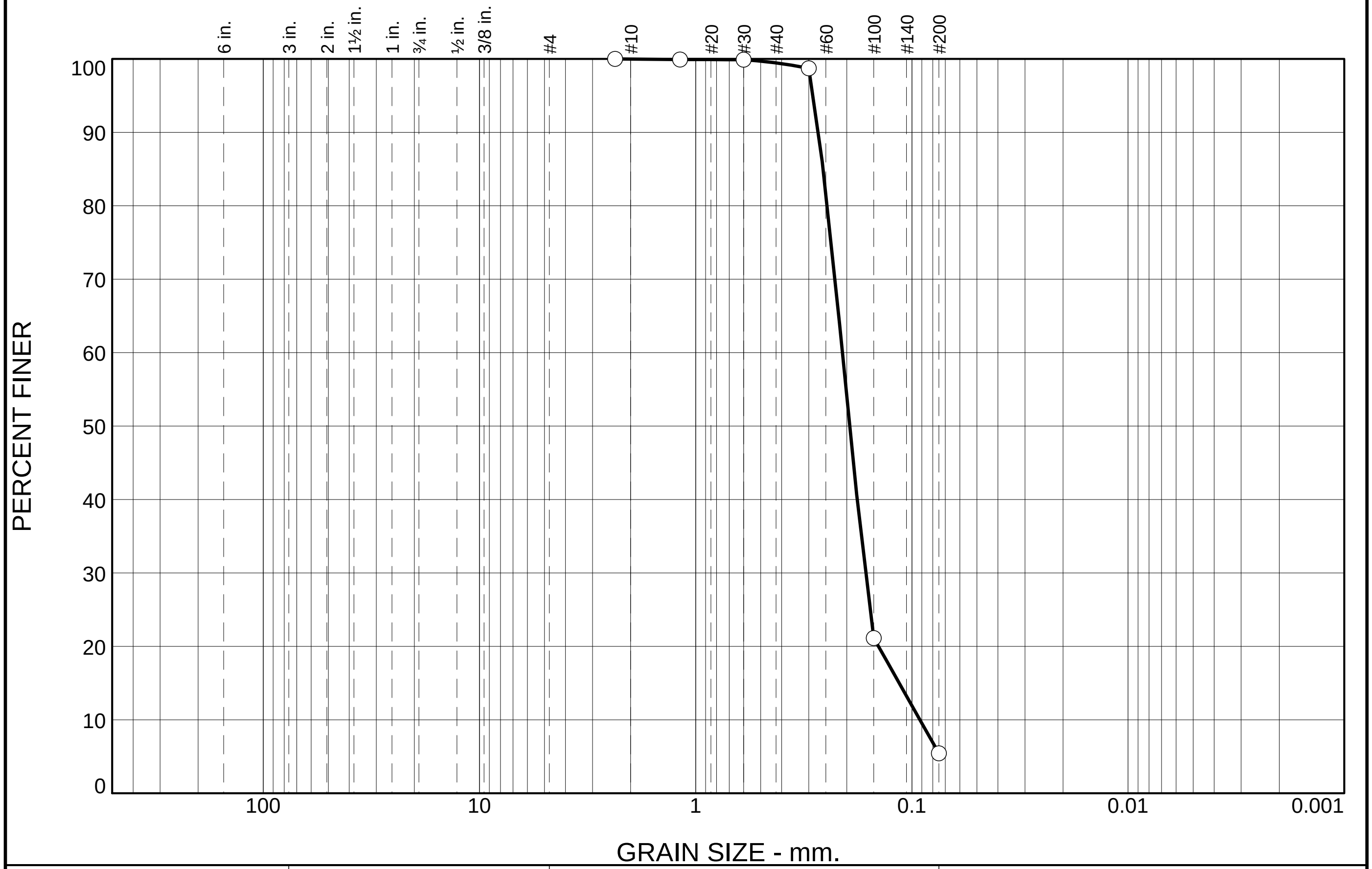
Sample Number: ST-2

Proj. No.: 2008012455 **Date:** 03-31-10

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. David/J. Pruett **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.5	94.1	5.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#16	99.9		
#30	99.9		
#50	98.7		
#100	21.1		
#200	5.4		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2574 D_{60}= 0.2096 D_{50}= 0.1940
D_{30}= 0.1642 D_{15}= 0.1144 D_{10}= 0.0917
C_u= 2.29 C_c= 1.40

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

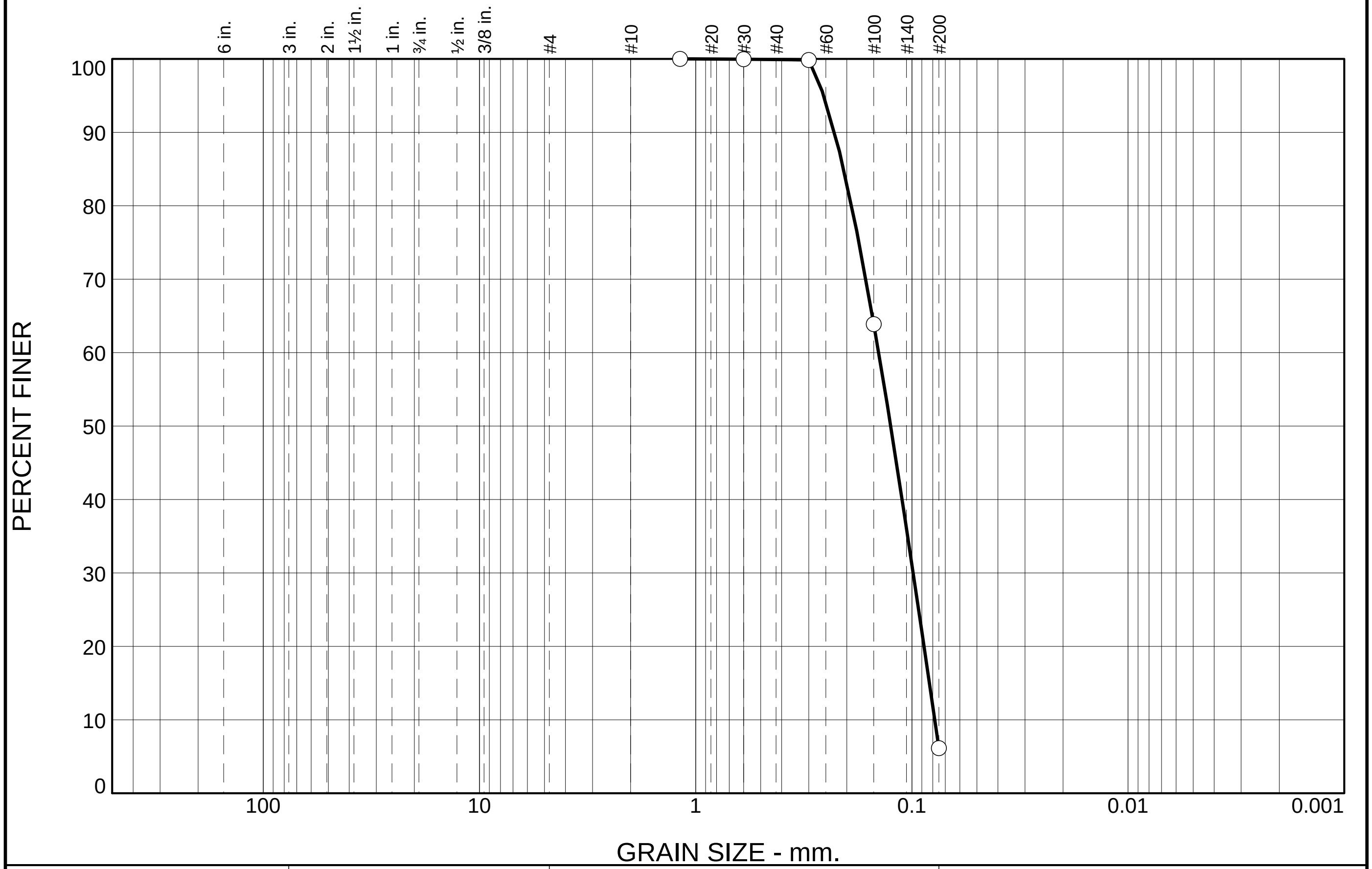
Sample No.: SS-5 **Source of Sample:** B-26 **Date Sampled:** 10-28-2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-24

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	93.7	6.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#30	100.0		
#50	99.9		
#100	63.9		
#200	6.2		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2069 D_{60}= 0.1424 D_{50}= 0.1253
D_{30}= 0.0986 D_{15}= 0.0829 D_{10}= 0.0784
C_u= 1.82 C_c= 0.87

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

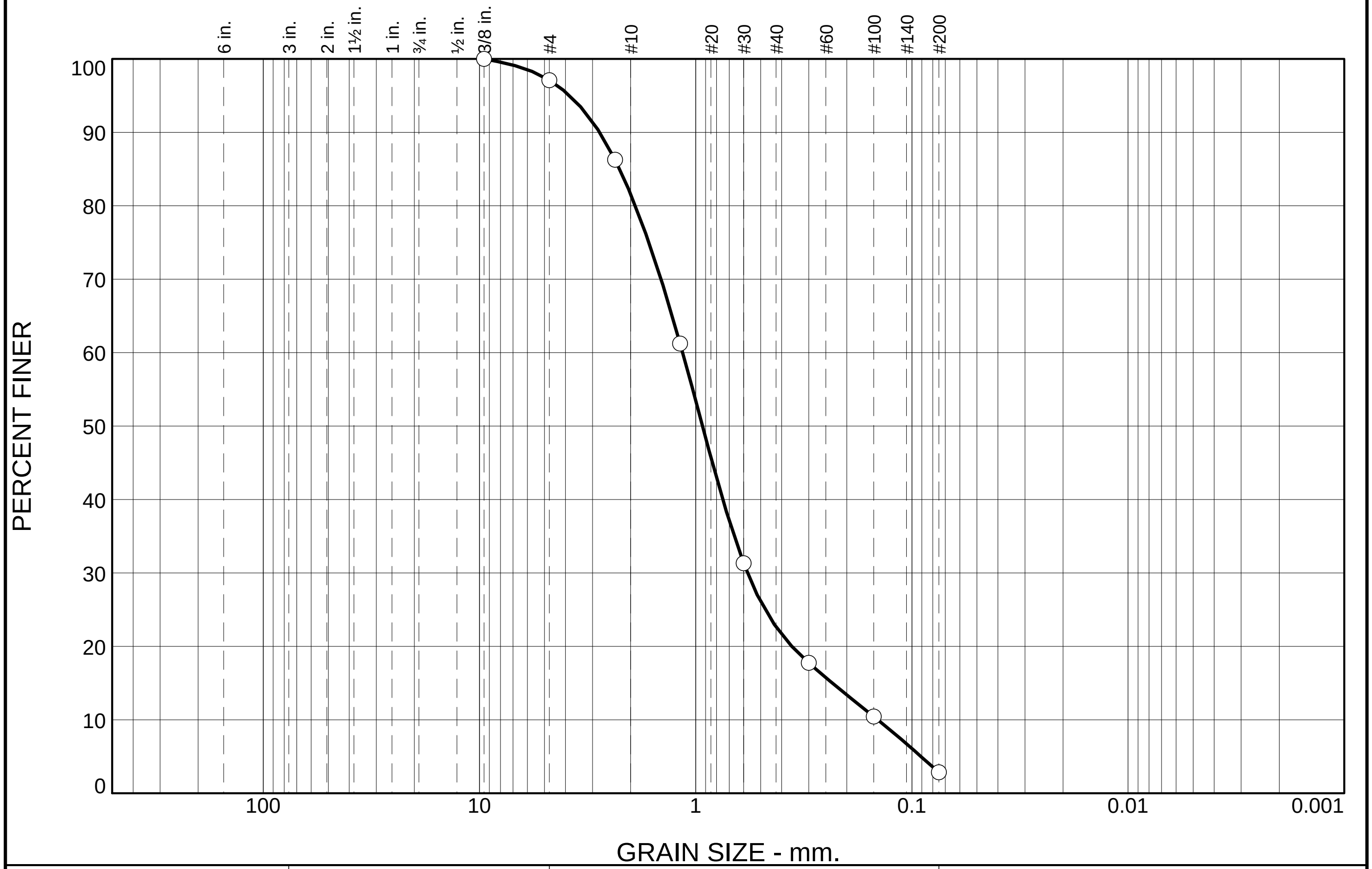
Sample No.: SS-7 **Source of Sample:** B-26 **Date Sampled:** 10-28-2009
Location: **Elev./Depth:** 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-25

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.9	15.5	58.9	19.8	2.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	97.1		
#8	86.3		
#16	61.2		
#30	31.3		
#50	17.8		
#100	10.5		
#200	2.9		

* (no specification provided)

Material Description

SAND (SW), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SW AASHTO=

Coefficients

D_{85}= 2.2472 D_{60}= 1.1483 D_{50}= 0.9297

D_{30}= 0.5760 D_{15}= 0.2332 D_{10}= 0.1435

C_u= 8.00 C_c= 2.01

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

Sample No.: SS-8 **Source of Sample:** B-26 **Date Sampled:** 10-28-2009

Location: **Elev./Depth:** 28.5

Checked By: K. Kocher **Title:** Engineer

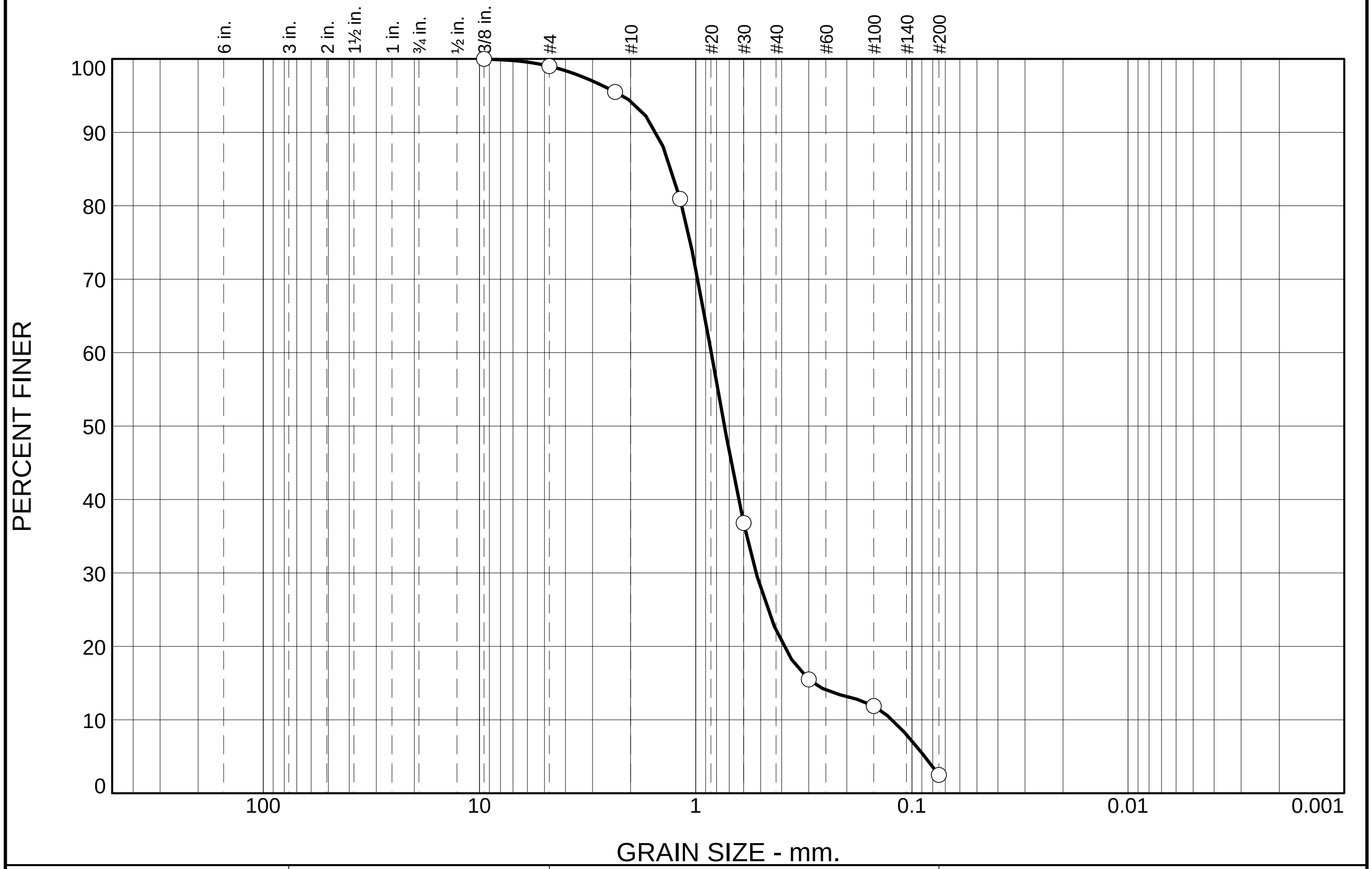
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-26

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	4.7	72.1	19.7	2.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.0		
#8	95.5		
#16	81.0		
#30	36.8		
#50	15.5		
#100	11.9		
#200	2.5		

* (no specification provided)

Material Description

SAND (SW), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SW AASHTO=

Coefficients

D_{85}= 1.2945 D_{60}= 0.8464 D_{50}= 0.7355
D_{30}= 0.5250 D_{15}= 0.2848 D_{10}= 0.1233
C_u= 6.86 C_c= 2.64

Date Tested: 02-01-10 **Tested By:** J. Crose

Remarks

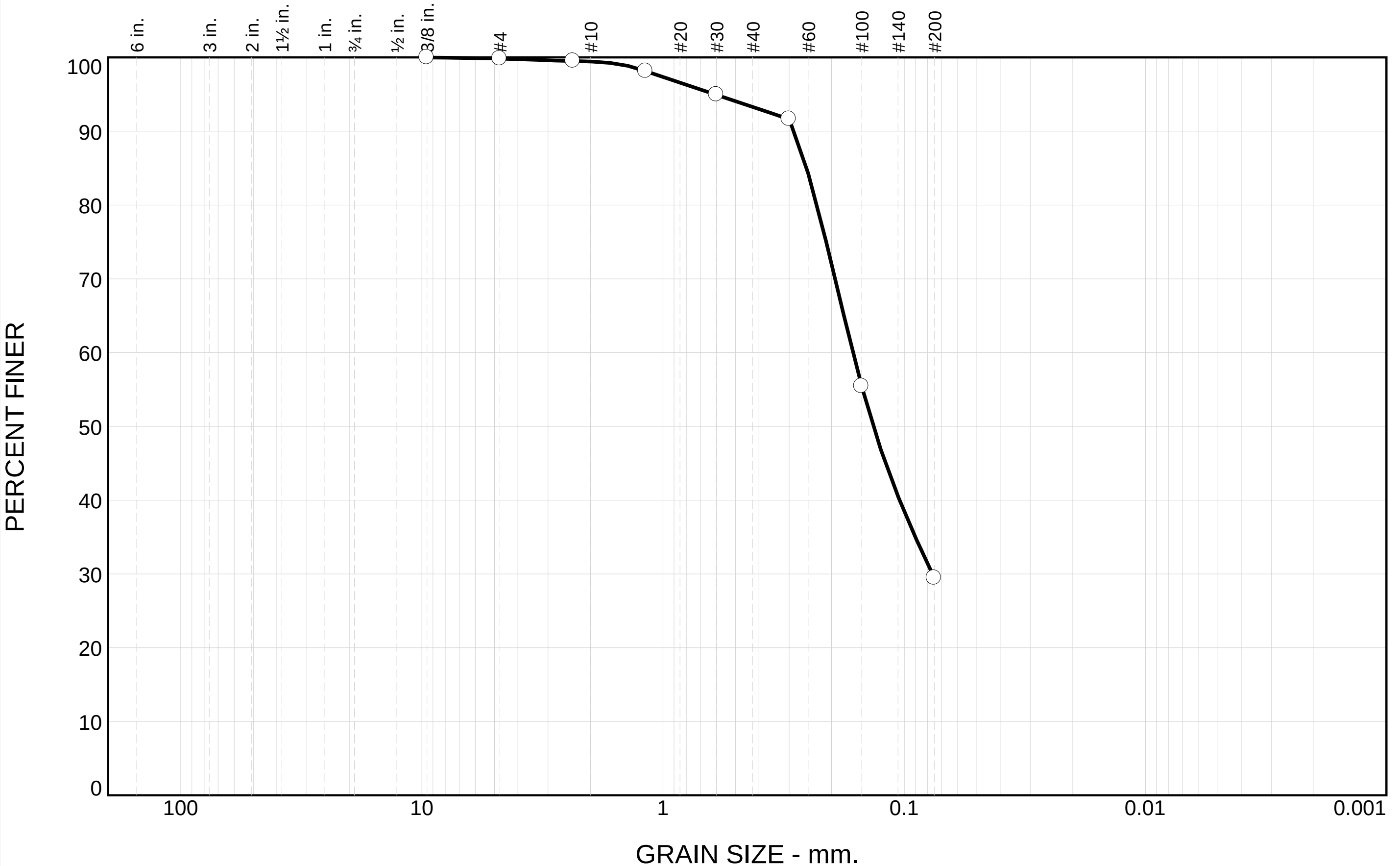
Sample No.: SS-10 **Source of Sample:** B-26 **Date Sampled:** 10-29-2009
Location: **Elev./Depth:** 38.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-27

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.4	6.1	63.8	29.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.8		
#8	99.5		
#16	98.1		
#30	94.9		
#50	91.6		
#100	55.4		
#200	29.5		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.2537 D_{60}= 0.1631 D_{50}= 0.1342

D_{30}= 0.0764 D_{15}= D_{10}=

C_u= C_c=

Date Tested: 12-09-09 **Tested By:** M. Tierney/J. Pruett

Remarks

Sample No.: SS-5 **Source of Sample:** P-31 **Date Sampled:**

Location: **Elev./Depth:** 30

Checked By: K. Kocher **Title:** Engineer

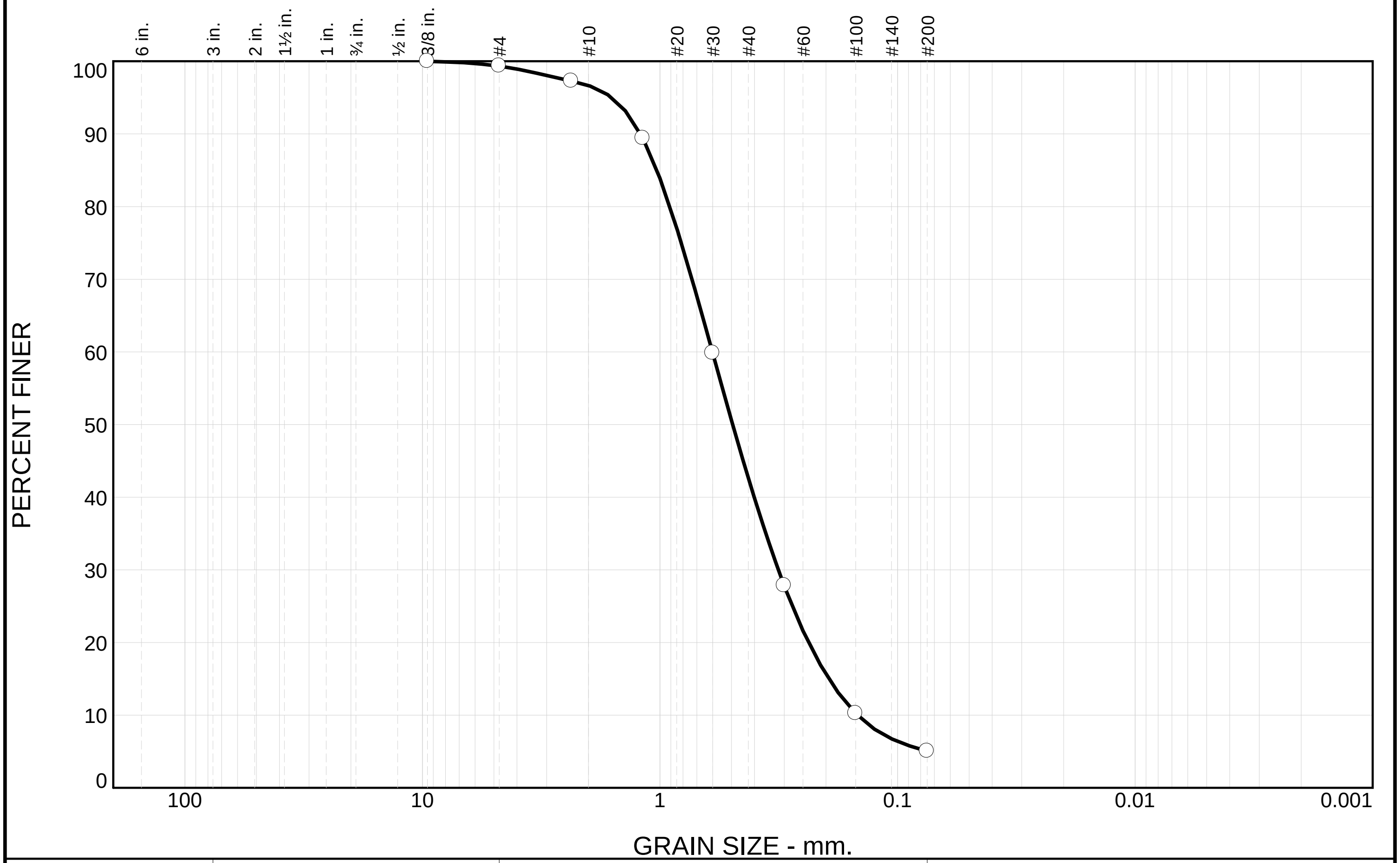
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-28

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	2.6	54.0	37.7	5.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.3		
#8	97.3		
#16	89.4		
#30	59.8		
#50	27.8		
#100	10.2		
#200	5.0		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.0302 D_{60}= 0.6021 D_{50}= 0.4940
D_{30}= 0.3176 D_{15}= 0.1947 D_{10}= 0.1475
C_u= 4.08 C_c= 1.14

Date Tested: 12-09-09 **Tested By:** 193.20

Remarks

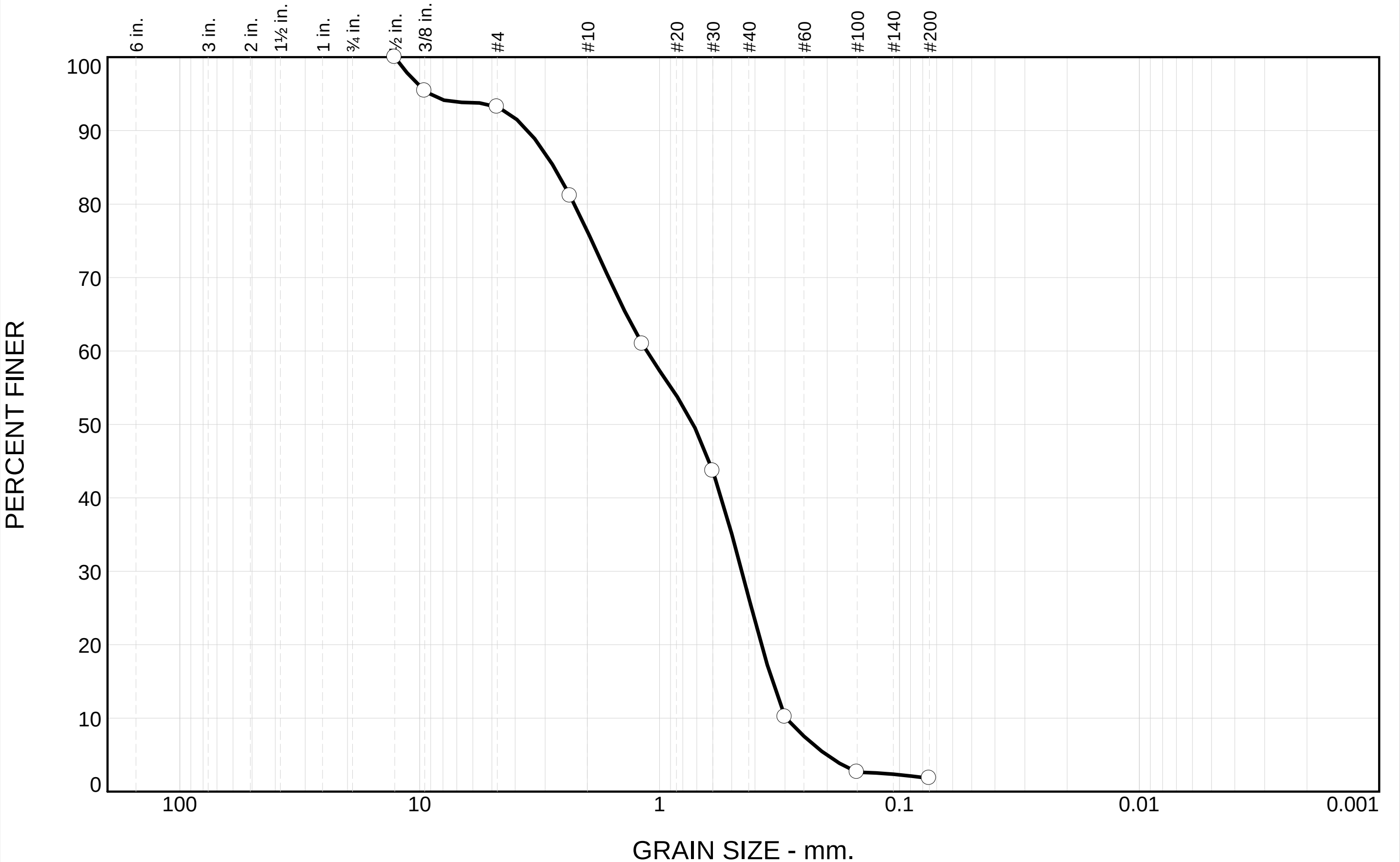
Sample No.: SS-6 **Source of Sample:** P-31 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-29

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.8	16.9	49.9	24.6	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	95.4		
#4	93.2		
#8	81.1		
#16	60.9		
#30	43.6		
#50	10.2		
#100	2.6		
#200	1.8		

* (no specification provided)

Material Description

SAND (SP), mediuum to fine grain, with coarse sand, trace of fine gravel

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.7489 D_{60}= 1.1337 D_{50}= 0.7242
D_{30}= 0.4541 D_{15}= 0.3387 D_{10}= 0.2967
C_u= 3.82 C_c= 0.61

Date Tested: 10/7/09 **Tested By:** D. Binz

Remarks

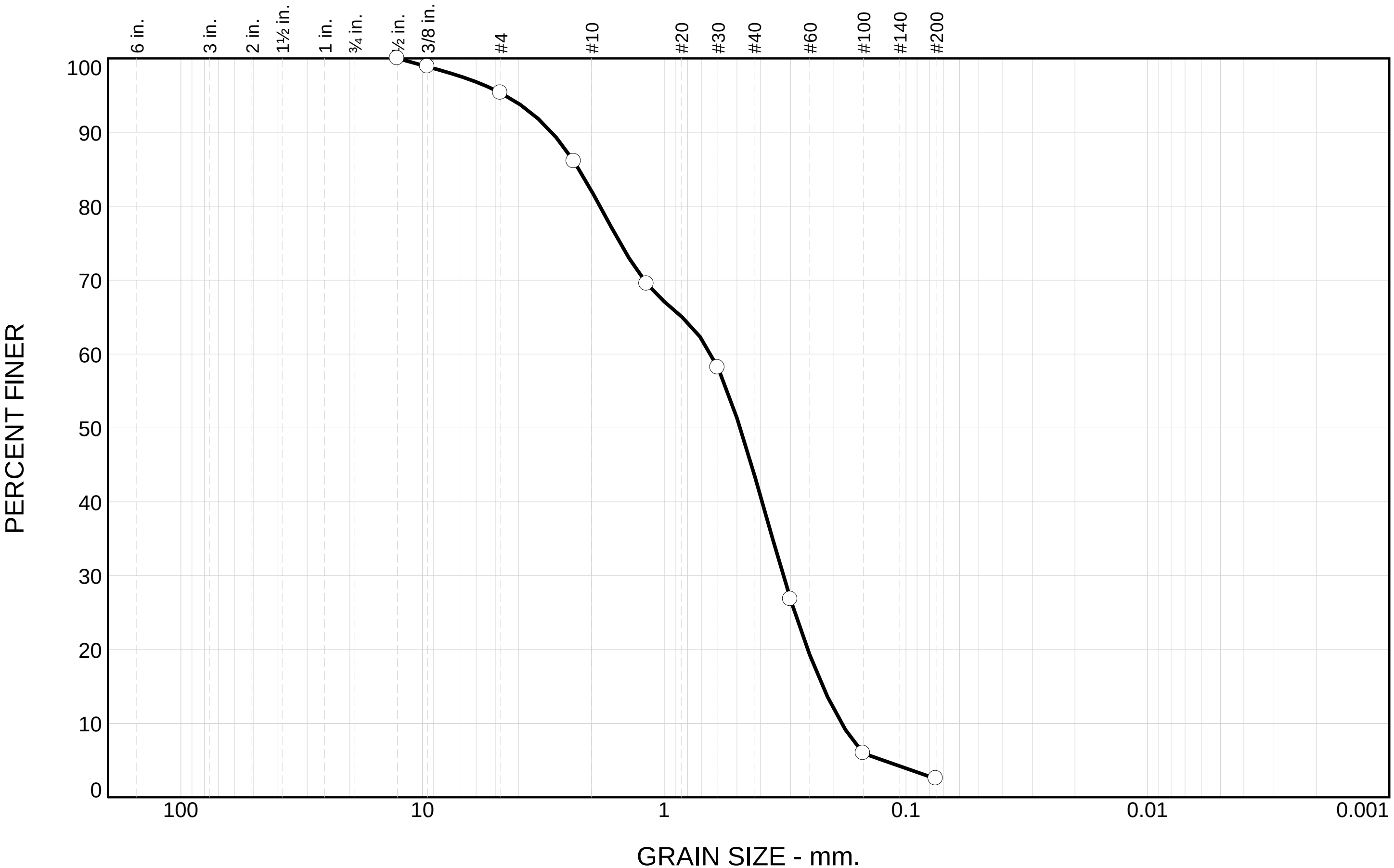
Sample No.: SS-6 **Source of Sample:** P-33 **Date Sampled:**
Location: P-33 **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

Reitz & Jens, Inc.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-30

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.7	13.2	38.3	41.3	2.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.9		
#4	95.3		
#8	86.0		
#16	69.5		
#30	58.2		
#50	26.8		
#100	5.9		
#200	2.5		

* (no specification provided)

Material Description

SAND (SP), medium to fine grain, with coarse sand, trace of fine gravel

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.2533 D_{60}= 0.6406 D_{50}= 0.4850
D_{30}= 0.3215 D_{15}= 0.2208 D_{10}= 0.1846
C_u= 3.47 C_c= 0.87

Date Tested: 10/7/09 **Tested By:** D. Binz

Remarks

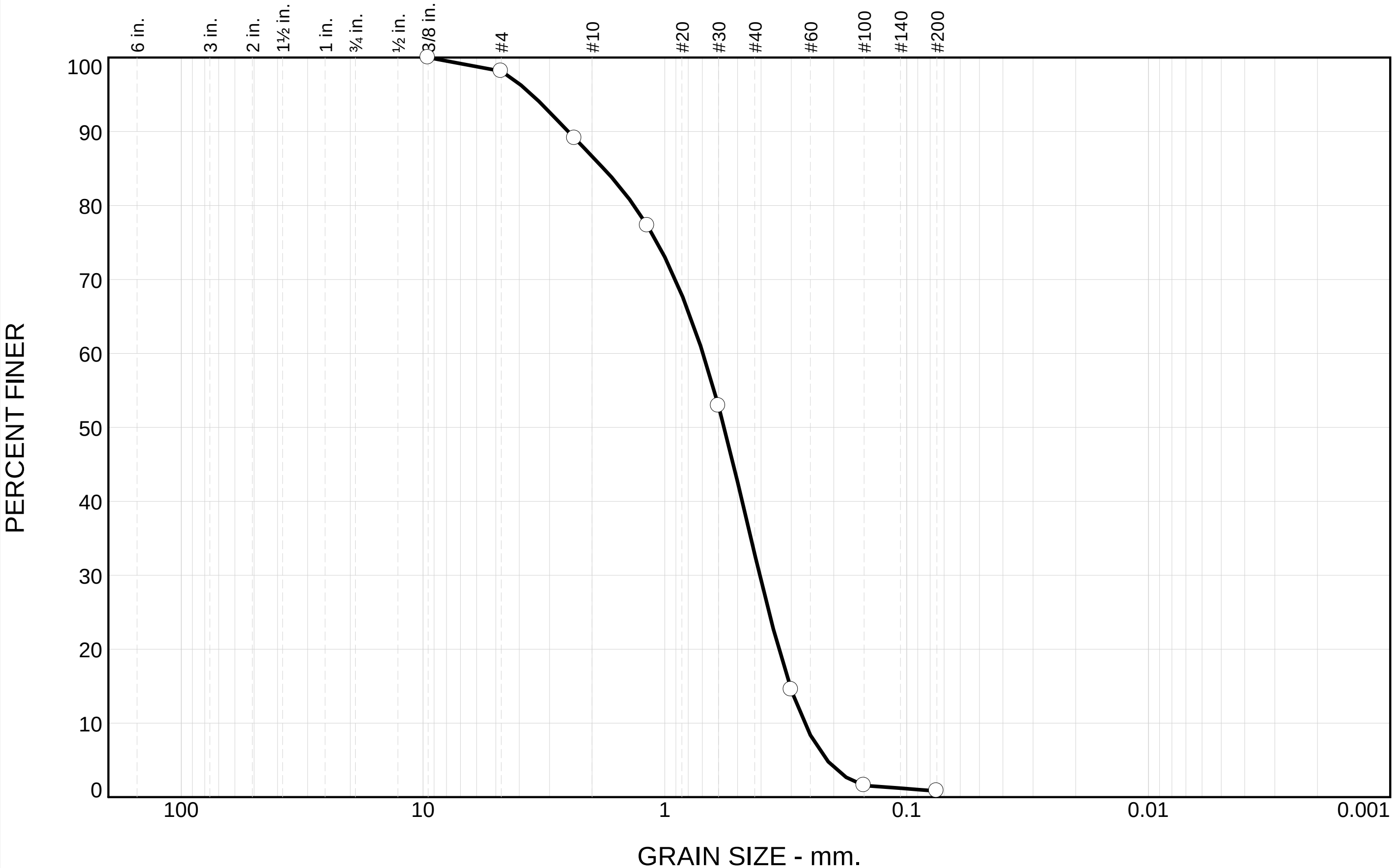
Sample No.: SS-7 **Source of Sample:** P-33 **Date Sampled:**
Location: P-33 **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Misssouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-31

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	11.5	53.8	32.1	0.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.2		
#8	89.1		
#16	77.3		
#30	52.9		
#50	14.5		
#100	1.6		
#200	0.8		

* (no specification provided)

Material Description

SAND (SP), fine grain, with medium to coarse sand, trace of fine gravel and silt.

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.7899 D_{60}= 0.6952 D_{50}= 0.5685
D_{30}= 0.4049 D_{15}= 0.3034 D_{10}= 0.2645
C_u= 2.63 C_c= 0.89

Date Tested: 10/7/09 **Tested By:** D. Binz

Remarks

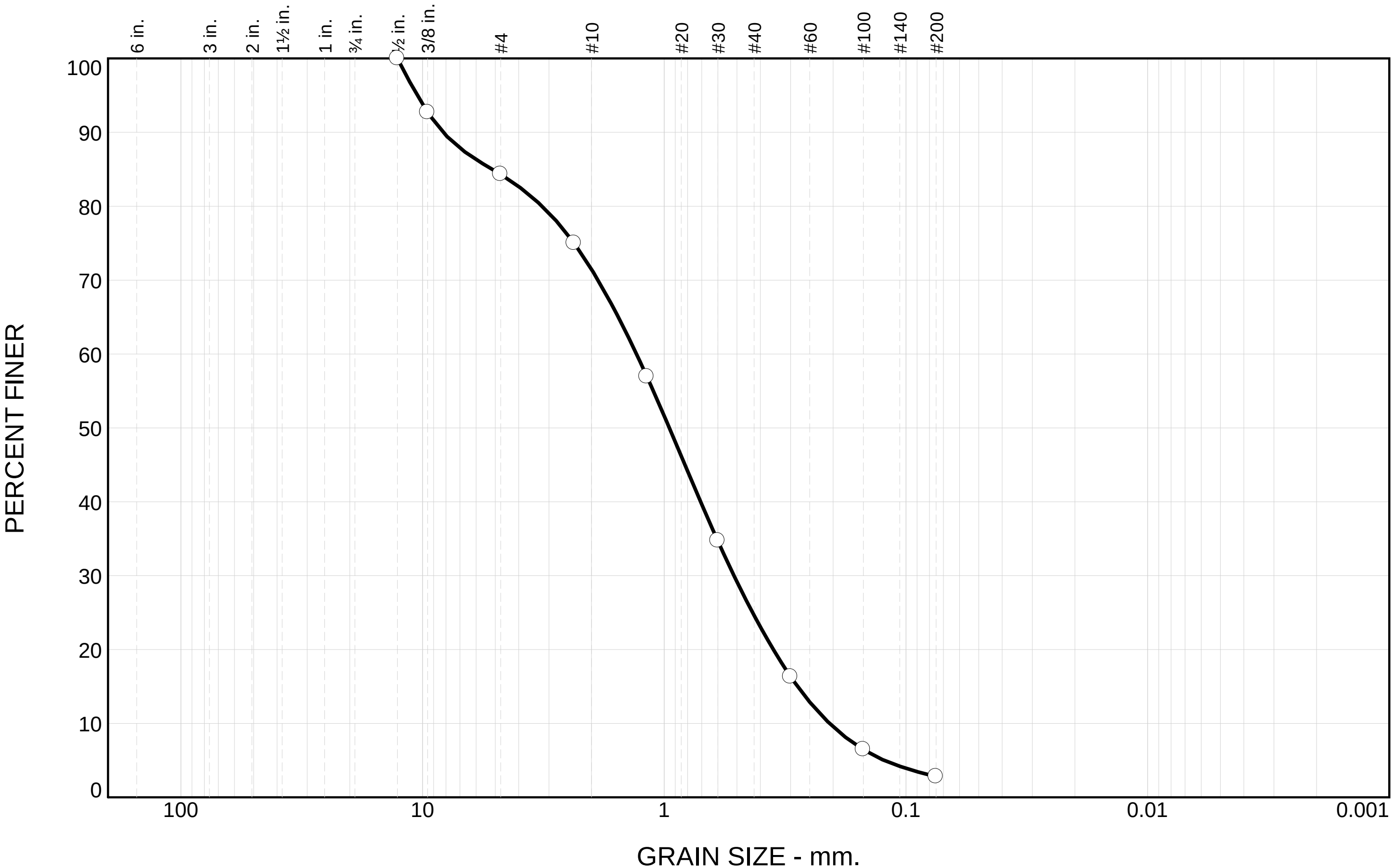
Sample No.: SS-6 **Source of Sample:** P-35 **Date Sampled:**
Location: P-35 **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-32

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	15.7	12.8	46.9	21.8	2.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	92.7		
#4	84.3		
#8	75.0		
#16	56.9		
#30	34.7		
#50	16.3		
#100	6.4		
#200	2.8		

* (no specification provided)

Material Description

SAND (SP), fine to coarse grain, with fine gravel and silt.

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 5.1465 D_{60}= 1.3035 D_{50}= 0.9532
D_{30}= 0.5144 D_{15}= 0.2809 D_{10}= 0.2070
C_u= 6.30 C_c= 0.98

Date Tested: 10/7/09 **Tested By:** D. Binz

Remarks

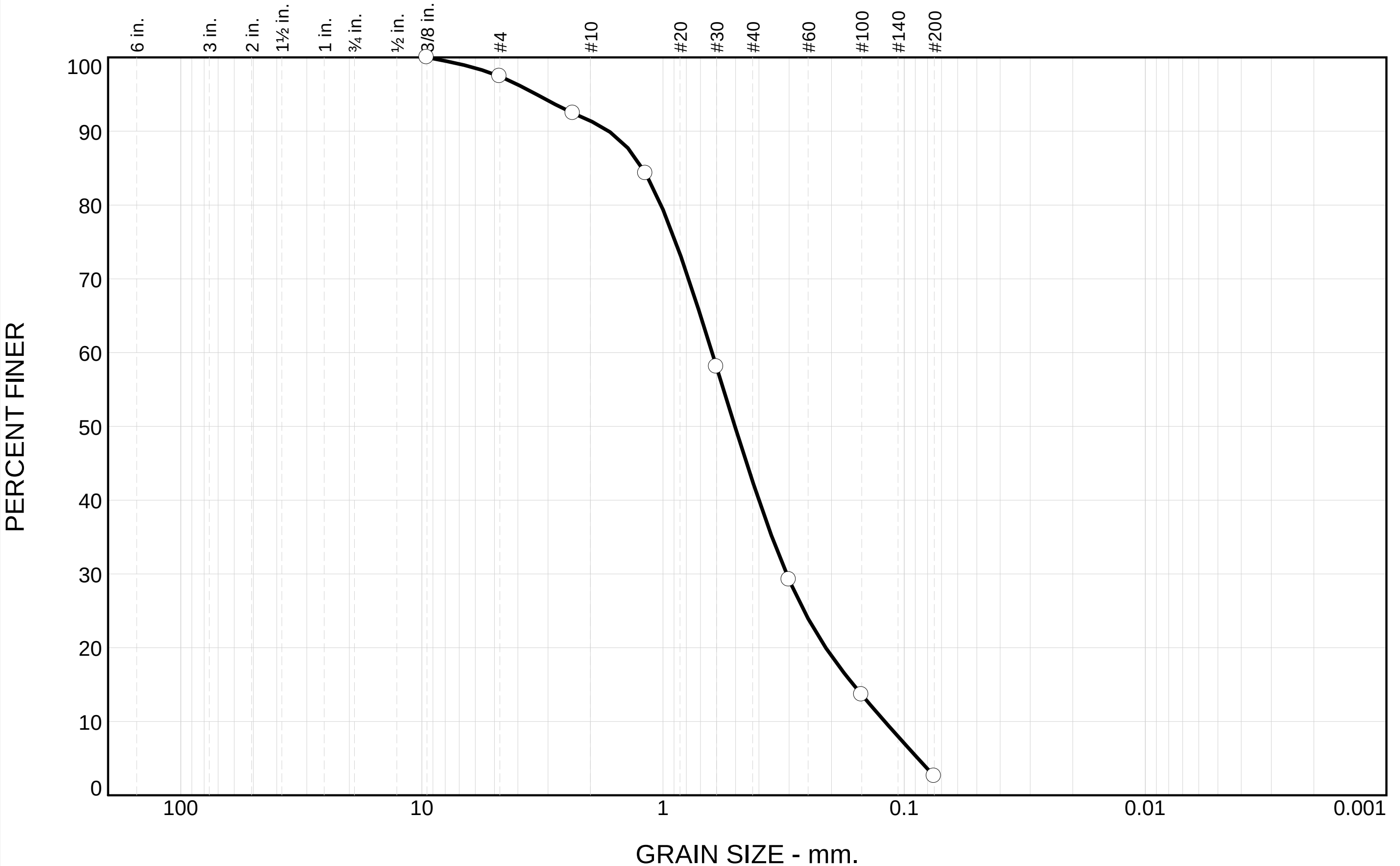
Sample No.: SS-7 **Source of Sample:** P-35 **Date Sampled:**
Location: P-35 **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-33

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.6	6.0	48.9	39.9	2.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	97.4		
#8	92.4		
#16	84.3		
#30	58.1		
#50	29.2		
#100	13.6		
#200	2.6		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.2161 D_{60}= 0.6260 D_{50}= 0.5032
D_{30}= 0.3074 D_{15}= 0.1625 D_{10}= 0.1203
C_u= 5.20 C_c= 1.25

Date Tested: 12-09-09 **Tested By:** M. Tierney/J. Pruett

Remarks

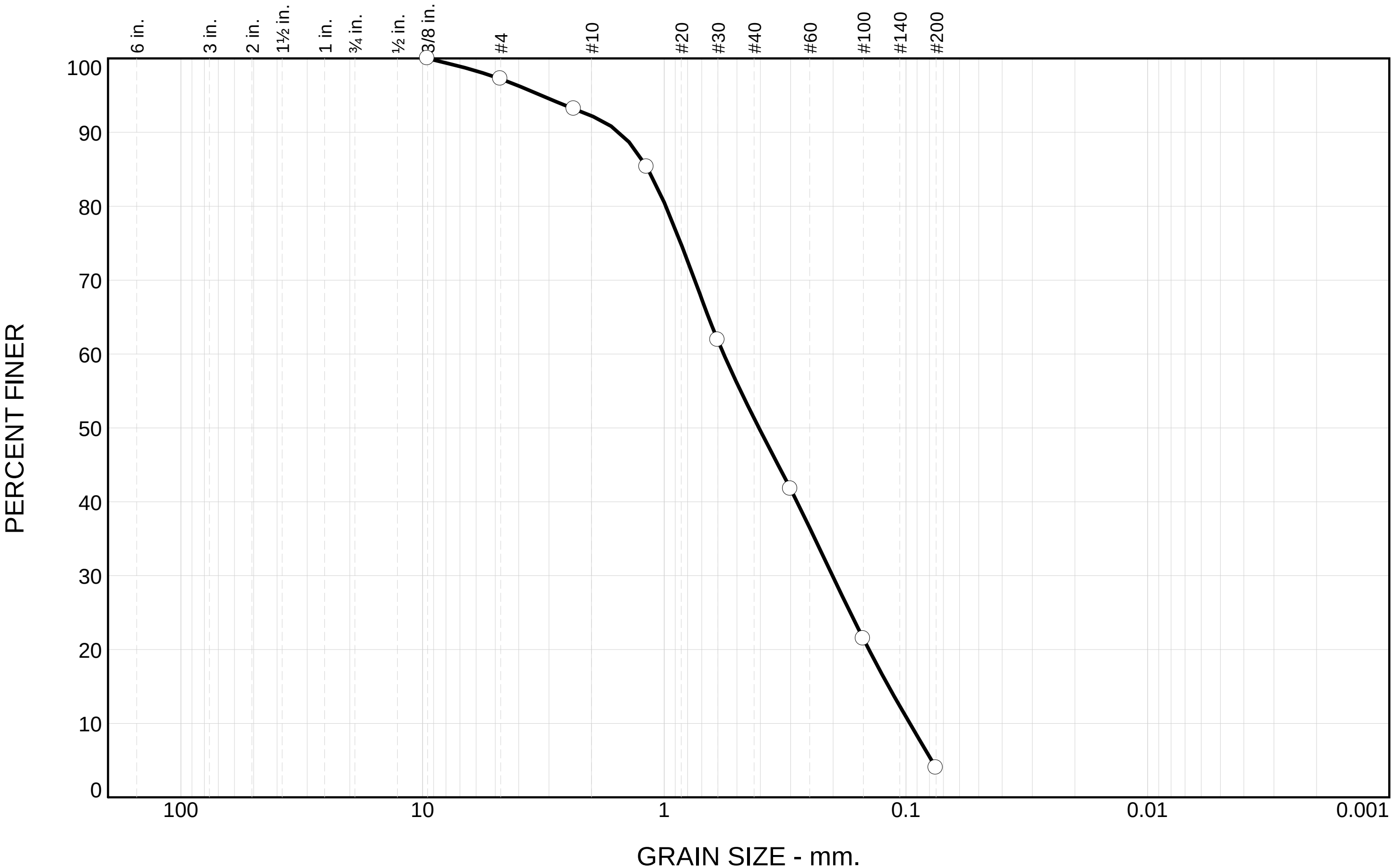
Sample No.: SS-5 **Source of Sample:** P-42 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-34

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	5.0	40.9	47.3	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	97.2		
#8	93.2		
#16	85.3		
#30	61.9		
#50	41.7		
#100	21.4		
#200	4.0		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.1660 D_{60}= 0.5675 D_{50}= 0.4056
D_{30}= 0.2013 D_{15}= 0.1177 D_{10}= 0.0963
C_u= 5.89 C_c= 0.74

Date Tested: 12-09-09 **Tested By:** M. Tierney/J. Pruett

Remarks

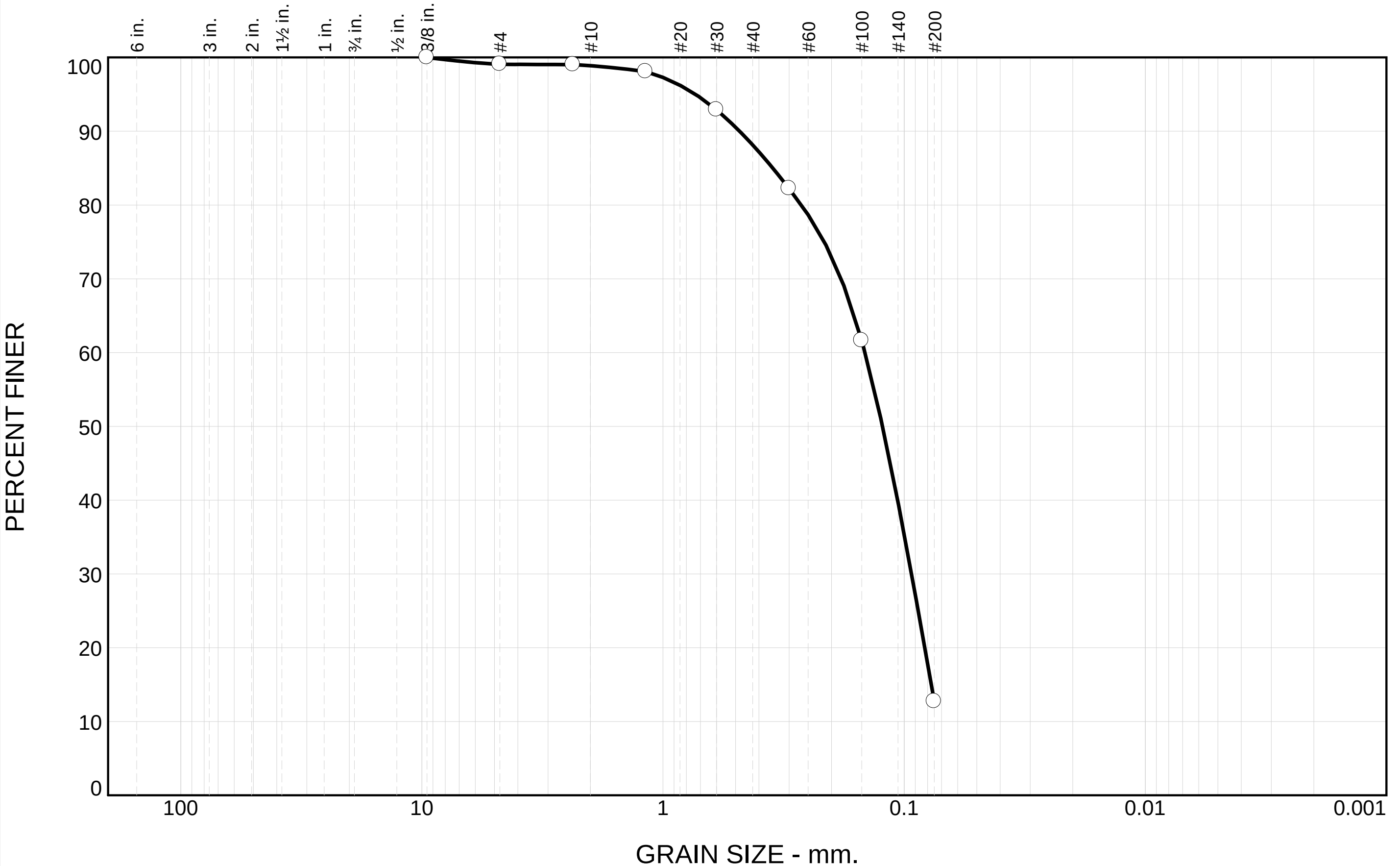
Sample No.: SS-7 **Source of Sample:** P-42 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-35

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	0.2	10.8	75.4	12.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.1		
#8	99.0		
#16	98.1		
#30	92.9		
#50	82.2		
#100	61.6		
#200	12.7		

* (no specification provided)

Material Description

SAND (SP), fine grain, trace medium sand, slightly silty

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.3508 D_{60}= 0.1454 D_{50}= 0.1229
D_{30}= 0.0932 D_{15}= 0.0772 D_{10}=
C_u= C_c=

Date Tested: 9/22/09 **Tested By:** J. Crose

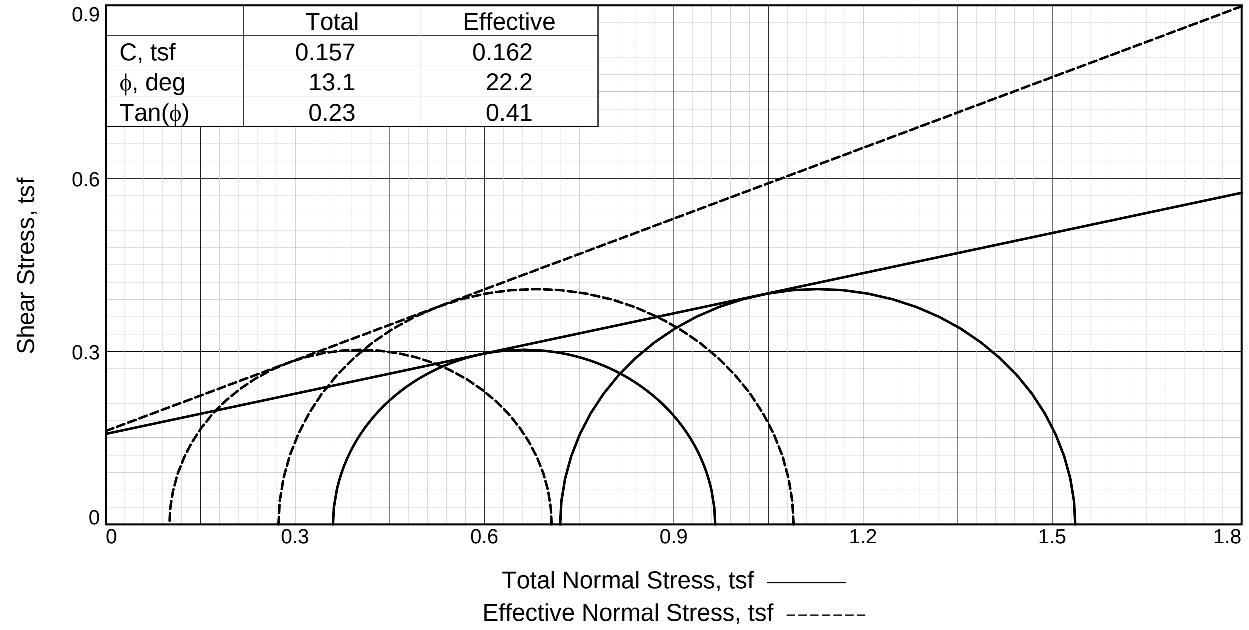
Remarks

Sample No.: SS-5 **Source of Sample:** P-47 **Date Sampled:**
Location: P-47 **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

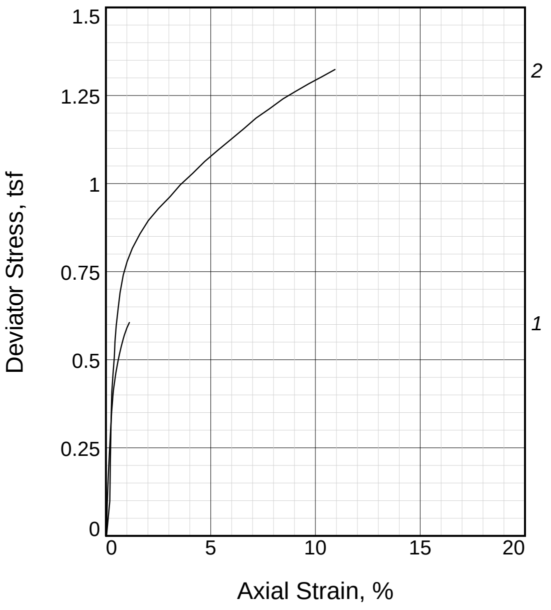
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-36



	Total	Effective
C, tsf	0.157	0.162
ϕ, deg	13.1	22.2
Tan(ϕ)	0.23	0.41



	Sample No.	1	2
Initial	Water Content,	24.5	24.5
	Dry Density, pcf	97.8	97.8
	Saturation,	92.6	92.6
	Void Ratio	0.7105	0.7105
	Diameter, in.	2.00	2.00
	Height, in.	3.36	3.36
At Test	Water Content,	24.2	23.5
	Dry Density, pcf	101.4	102.6
	Saturation,	100.0	100.0
	Void Ratio	0.6498	0.6302
	Diameter, in.	1.97	1.98
	Height, in.	3.32	3.27
	Strain rate, %/min.	0.07	0.04
	Back Pressure, tsf	3.96	4.32
	Cell Pressure, tsf	4.32	5.04
	Fail. Stress, tsf	0.61	0.82
	Total Pore Pr., tsf	4.22	4.77
	Ult. Stress, tsf	0.61	1.32
	Total Pore Pr., tsf	4.22	4.69
	$\bar{\sigma}_1$ Failure, tsf	0.71	1.09
	$\bar{\sigma}_3$ Failure, tsf	0.10	0.27

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: Silty CLAY (CL), gray to brownish gray, with decaying organics, fine sand seams

LL= 39 **PL=** 21 **PI=** 18

Assumed Specific Gravity= 2.68

Remarks: Staged test

Figure B-37

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-50 **Depth:** 5

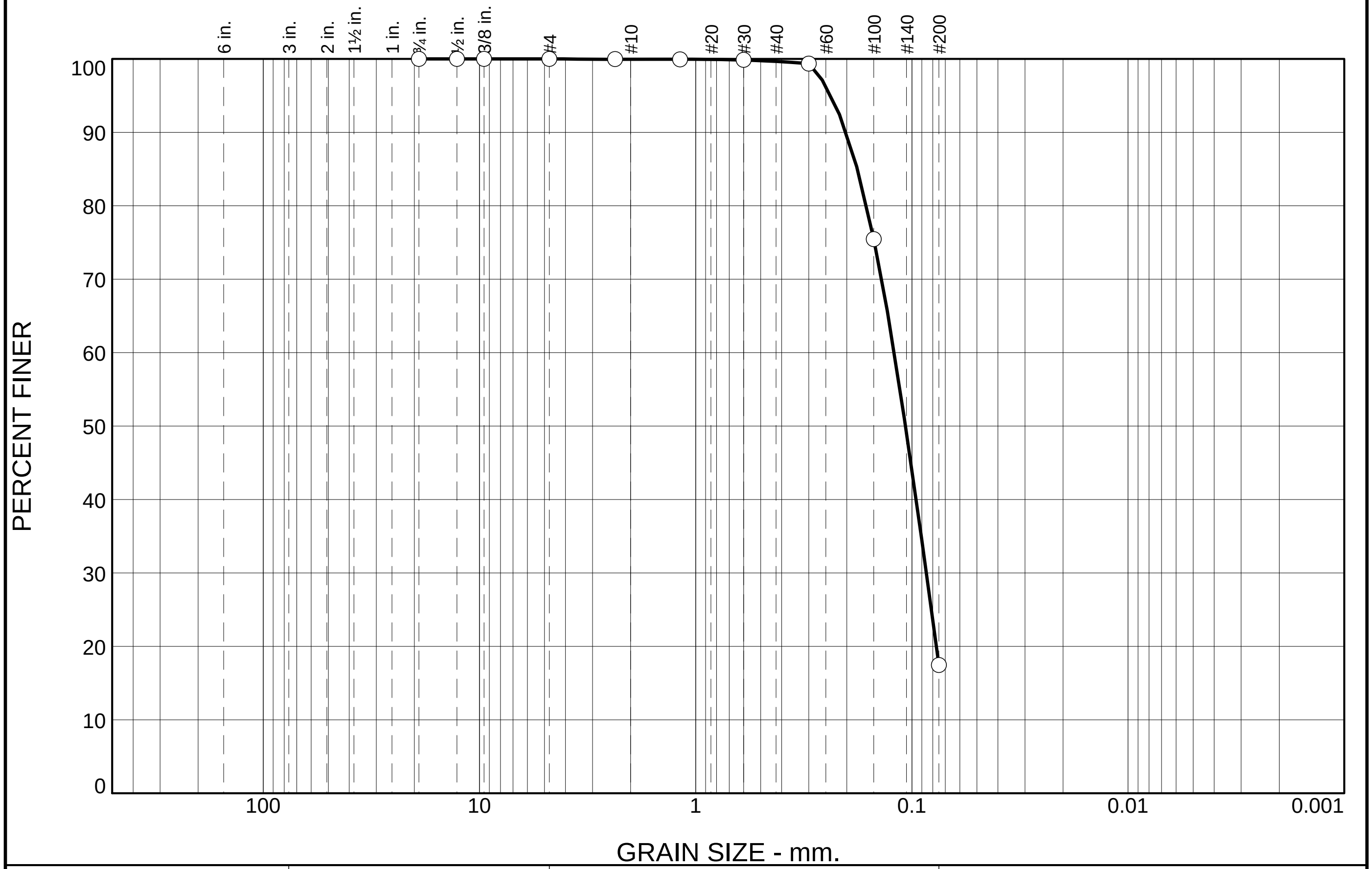
Sample Number: ST-2

Proj. No.: 2008012455 **Date:** 4-05-2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Fouse

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	82.2	17.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.9		
#50	99.4		
#100	75.5		
#200	17.5		

* (no specification provided)

Material Description

Silty SAND (SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.1788 D_{60}= 0.1207 D_{50}= 0.1070
D_{30}= 0.0857 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 02-11-10 **Tested By:** J. David

Remarks

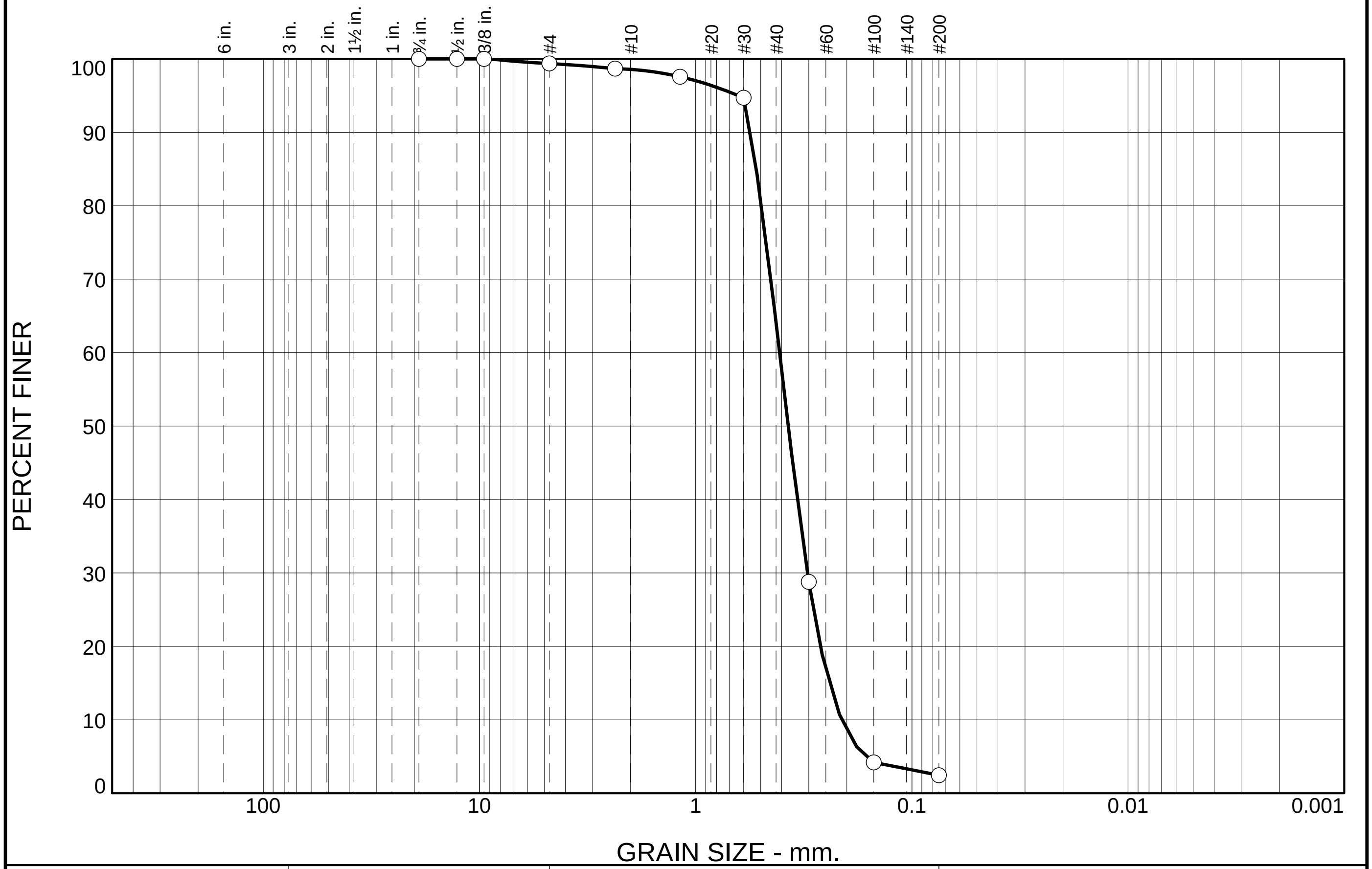
Sample No.: SS-4 **Source of Sample:** B-50 **Date Sampled:** 11-04-2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-38

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	0.8	34.4	61.7	2.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.4		
#8	98.7		
#16	97.6		
#30	94.7		
#50	28.8		
#100	4.2		
#200	2.5		

* (no specification provided)

Material Description

SAND (SP), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5243 D_{60}= 0.4090 D_{50}= 0.3731
D_{30}= 0.3044 D_{15}= 0.2411 D_{10}= 0.2113
C_u= 1.94 C_c= 1.07

Date Tested: 02-11-10 **Tested By:** J. David

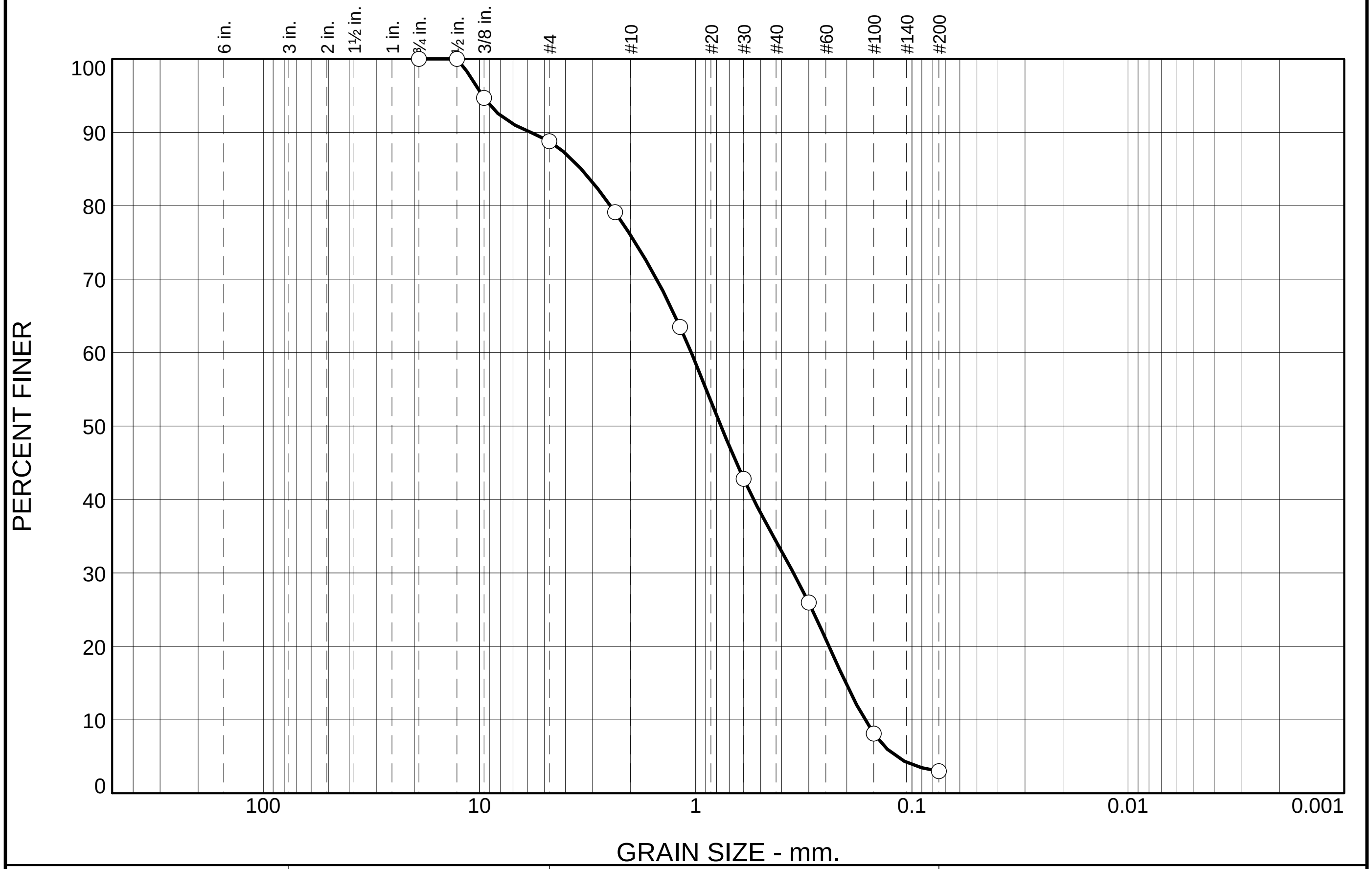
Remarks

Sample No.: SS-8 **Source of Sample:** B-50 **Date Sampled:** 11-04-2009
Location: **Elev./Depth:** 29.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-39

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.2	12.8	41.7	31.3	3.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	94.7		
#4	88.8		
#8	79.1		
#16	63.5		
#30	42.8		
#50	26.0		
#100	8.1		
#200	3.0		

* (no specification provided)

Material Description

SAND (SP), gray, dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 3.3764 D_{60}= 1.0479 D_{50}= 0.7634
D_{30}= 0.3526 D_{15}= 0.2021 D_{10}= 0.1649
C_u= 6.36 C_c= 0.72

Date Tested: 02-11-10 **Tested By:** J. David

Remarks

Sample No.: SS-10 **Source of Sample:** B-50 **Date Sampled:** 11-04-2009
Location: **Elev./Depth:** 40
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-40

Ameren Missouri; Labadie Power Plant UWL
Utility Waste Landfill, Detailed Site Investigation
Location B-52 ST-2; Sample 4-6 feet
Hydraulic Conductivity

Soil Conditions	
Pre-test conditions	**Post-test Conditions**
Wet Density = 120.8 (lbs/ft^3)	Wet Density = 122.1 (lbs/ft^3)
% Moisture = 27.4%	% Moisture = 29.5%
Dry Density = 94.8 (lbs/ft^3)	Dry Density = 94.3 (lbs/ft^3)

Test Information	
a (cm^2)=	0.1969
L (cm)=	5.1528
A (cm^2)=	20.7064

Trial 1													
			Base Burette		Top Burette								
Date and Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (°C)	Weighted Average Temp. (°C)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Cumulative Time (sec)	Corrected Hydraulic Conductivity (cm/sec)
4/7/10 8:48	0	17.6	10.00	27.200	0.00	78.000	121.158	21.1					
4/8/10 8:04	83760	17.7	9.78	28.318	0.33	76.324	118.364	21.3	21.20	6.82E-09	0.9716241	83760	6.63E-09
4/9/10 12:47	187140	18.0	9.57	29.384	0.72	74.342	115.316	21.1	21.20	6.47E-09	0.9716241	187140	6.28E-09
4/12/10 8:10	429720	18.8	9.03	32.128	1.44	70.685	108.915	21.7	21.31	6.07E-09	0.9690023	429720	5.88E-09
4/13/10 7:49	514860	18.1	8.86	32.991	1.68	69.466	106.832	21.5	21.36	5.99E-09	0.9679032	514860	5.79E-09

Trial 2													
			Base Burette		Top Burette								
Date and Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (°C)	Weighted Average Temp. (°C)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Cumulative Time (sec)	Corrected Hydraulic Conductivity (cm/sec)
4/13/10 9:12	0	18.1	10.00	27.200	0.00	78.000	121.158	21.6					
4/14/10 7:31	80340	18.2	9.83	28.064	0.26	76.679	118.974	20.8	21.20	5.55E-09	0.9716241	80340	5.39E-09
4/15/10 7:49	167820	18.2	9.64	29.029	0.52	75.358	116.688	21.3	21.12	5.49E-09	0.9734468	167820	5.34E-09
4/16/10 7:05	251580	18.1	9.45	29.994	0.78	74.038	114.402	22	21.30	5.59E-09	0.9693555	251580	5.42E-09
4/19/10 8:31	515940	18.4	8.84	33.093	1.59	69.923	107.188	20.0	21.15	5.82E-09	0.9729023	515940	5.66E-09

B-52 ST-2; Sample 4-6 feet
Hydraulic Conductivity

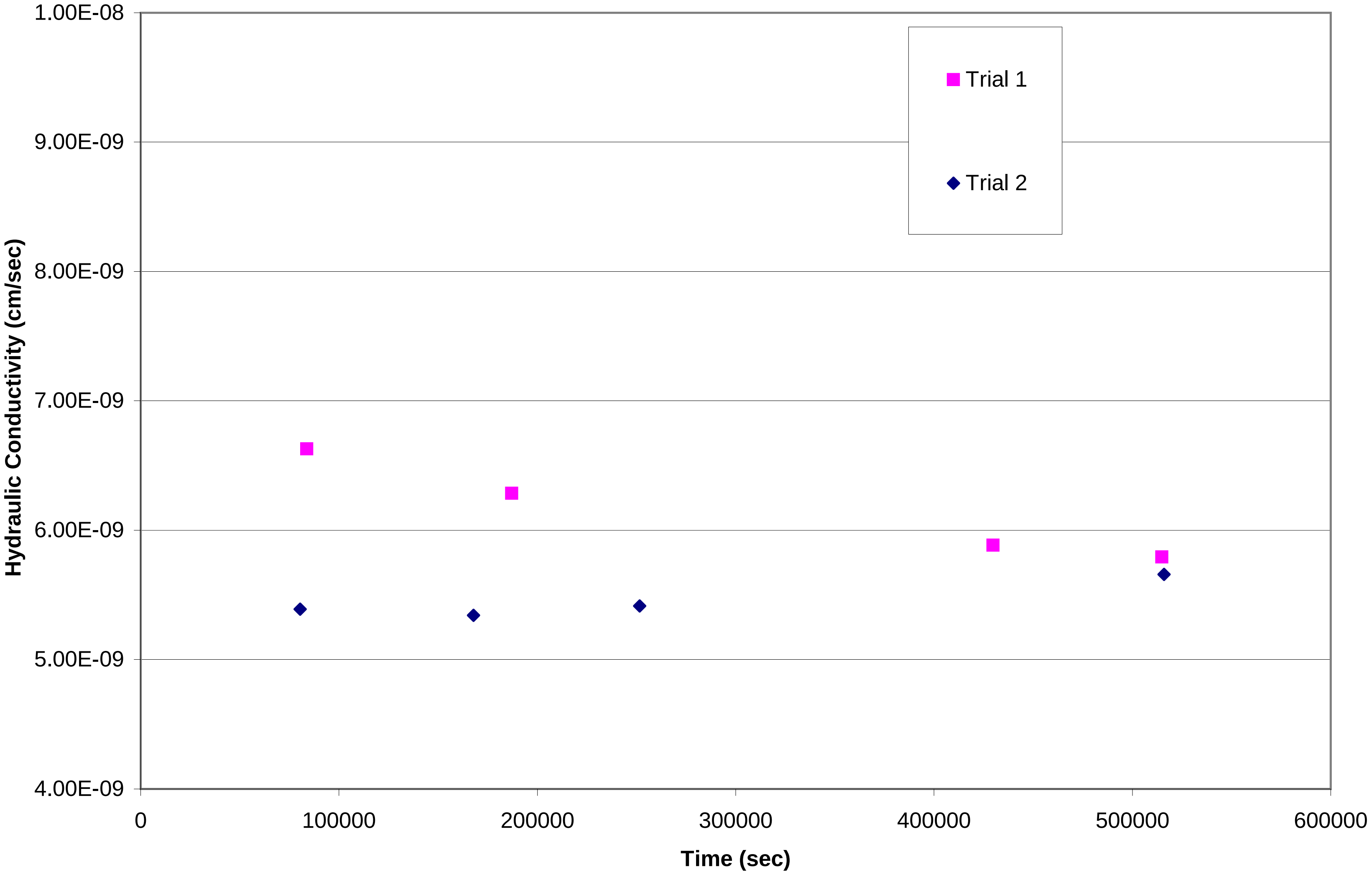
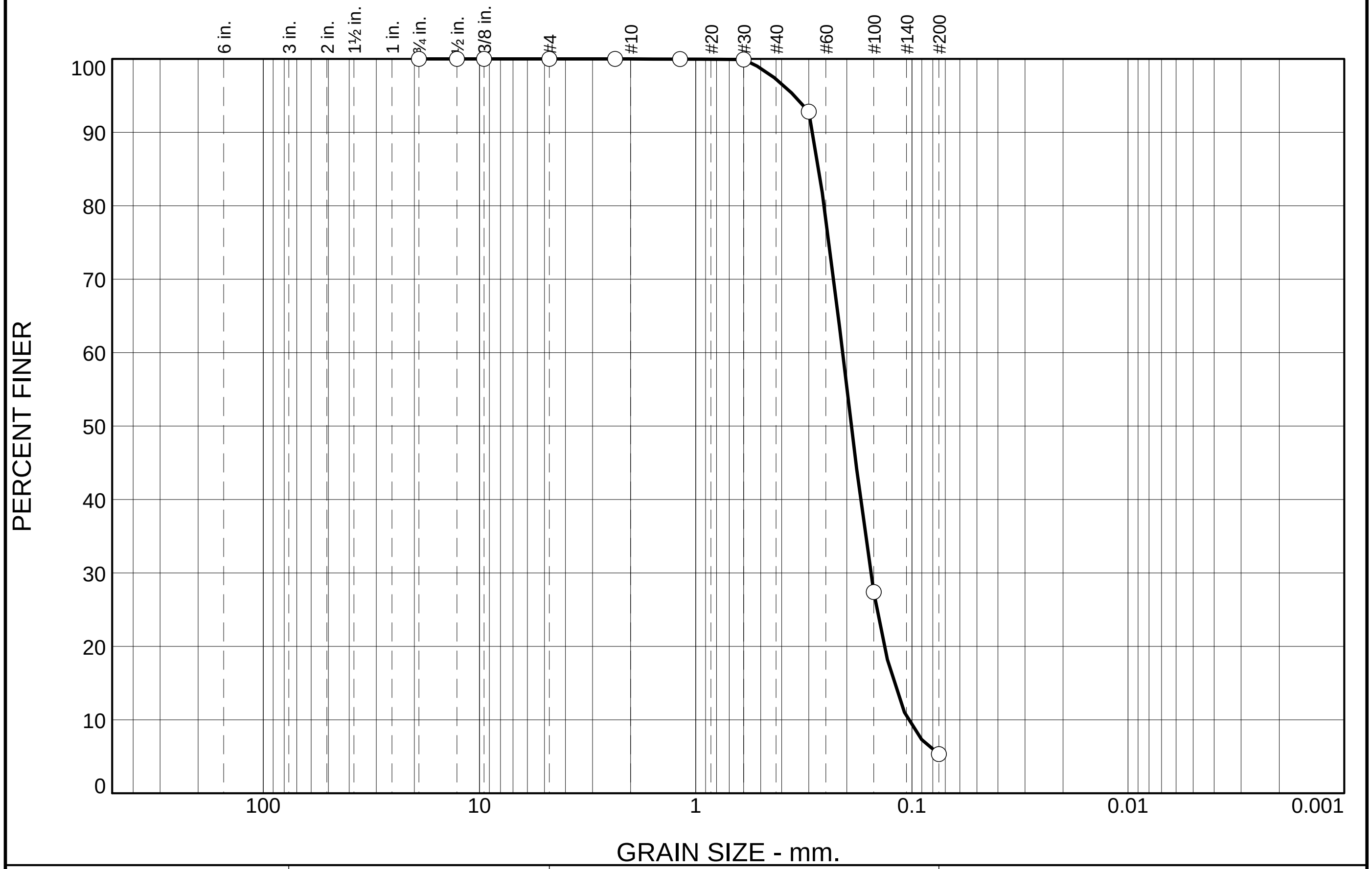


Figure B-41

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.7	92.0	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	92.8		
#100	27.4		
#200	5.3		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2695 D_{60}= 0.2092 D_{50}= 0.1905
D_{30}= 0.1549 D_{15}= 0.1212 D_{10}= 0.1039
C_u= 2.01 C_c= 1.10

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

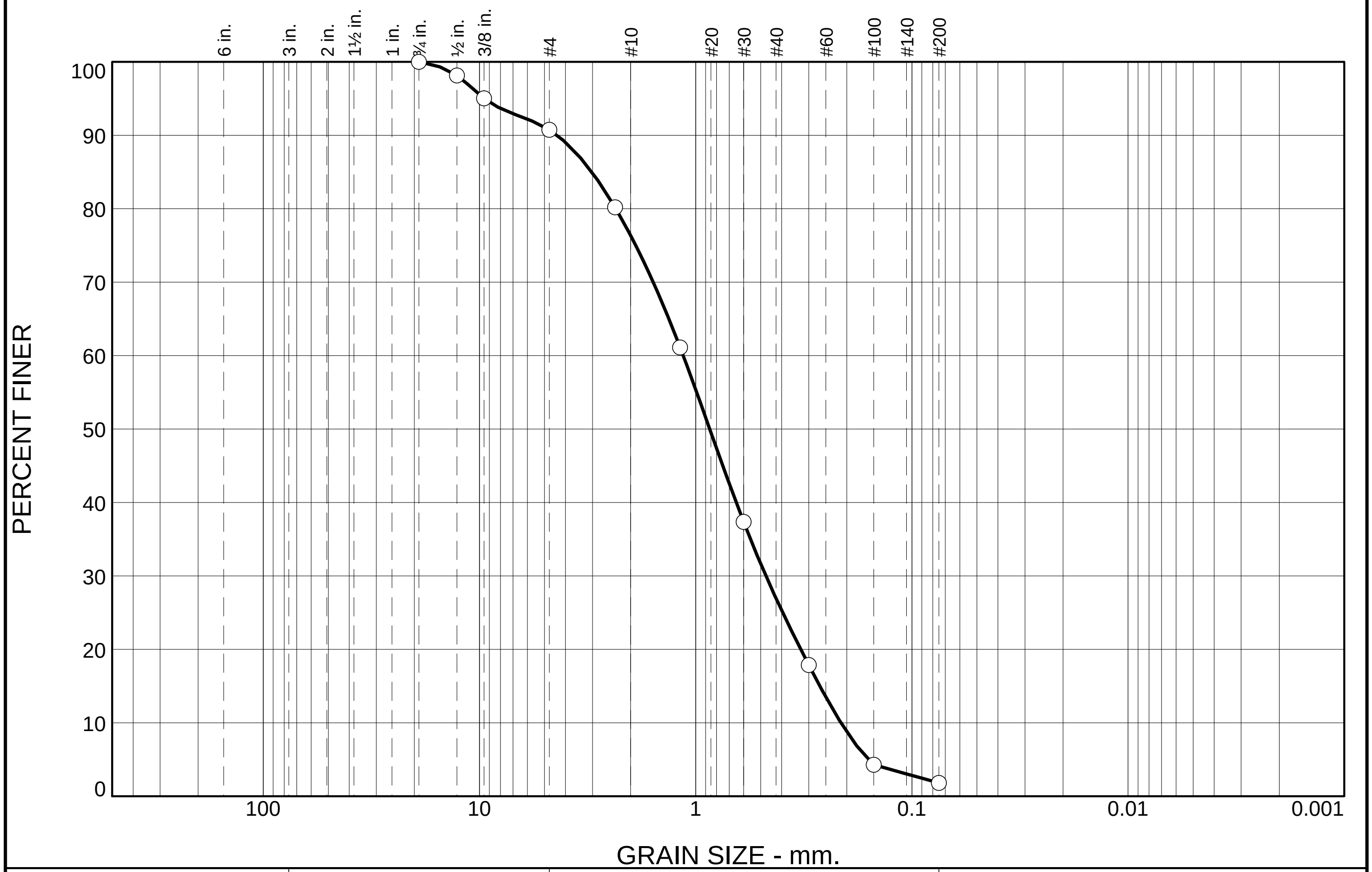
Sample No.: SS-5 **Source of Sample:** B-52 **Date Sampled:** 11-04-2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-42

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.2	14.4	49.4	25.2	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	98.1		
3/8	95.0		
#4	90.8		
#8	80.2		
#16	61.1		
#30	37.4		
#50	17.9		
#100	4.3		
#200	1.8		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 3.0220 D_{60}= 1.1416 D_{50}= 0.8604
D_{30}= 0.4730 D_{15}= 0.2665 D_{10}= 0.2130
C_u= 5.36 C_c= 0.92

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

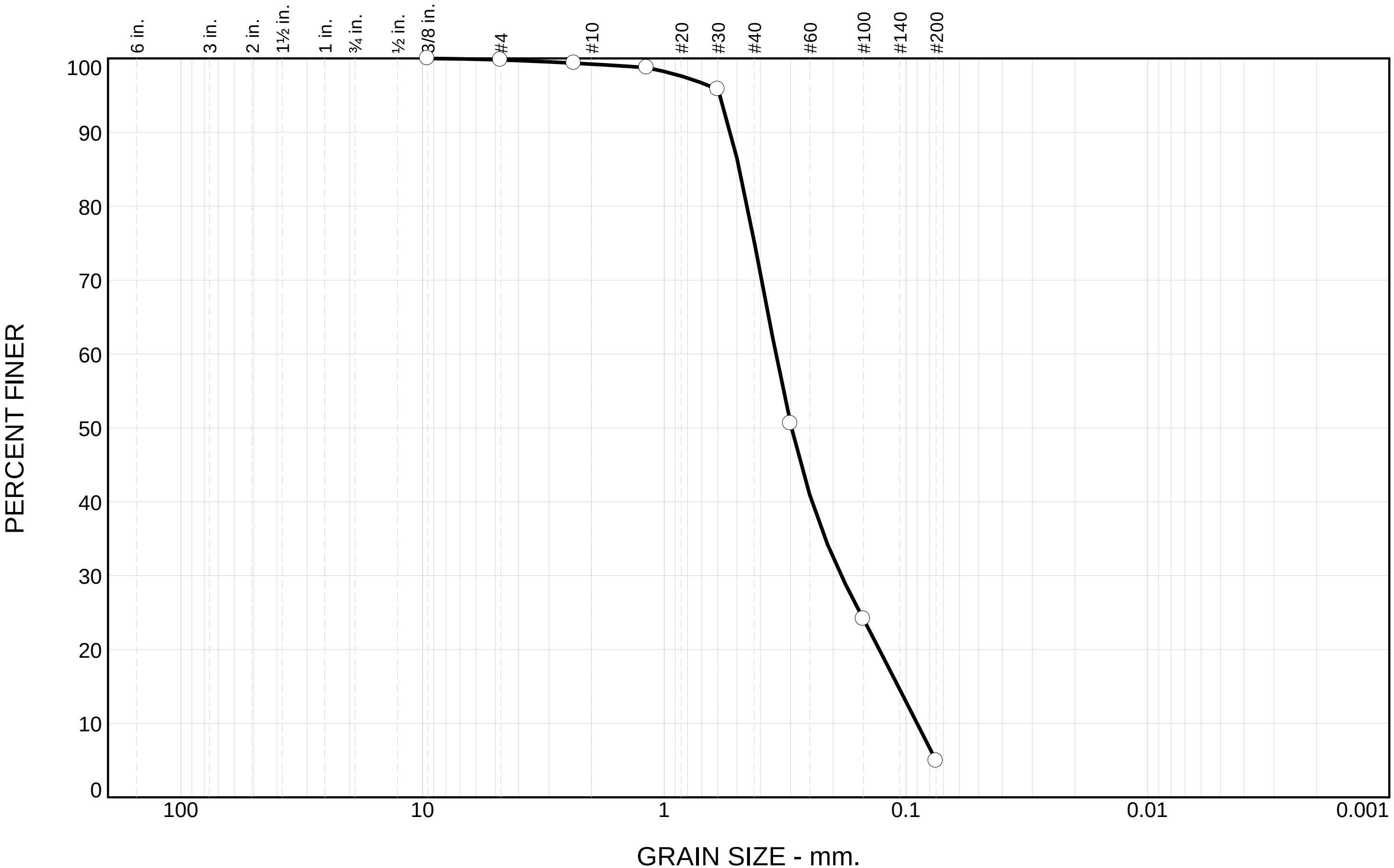
Sample No.: SS-7 **Source of Sample:** B-52 **Date Sampled:** 11-04-2009
Location: **Elev./Depth:** 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-43

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.6	23.9	70.4	4.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.8		
#8	99.4		
#16	98.8		
#30	95.8		
#50	50.6		
#100	24.1		
#200	4.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.4885 D_{60}= 0.3451 D_{50}= 0.2971
D_{30}= 0.1851 D_{15}= 0.1075 D_{10}= 0.0899
C_u= 3.84 C_c= 1.10

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

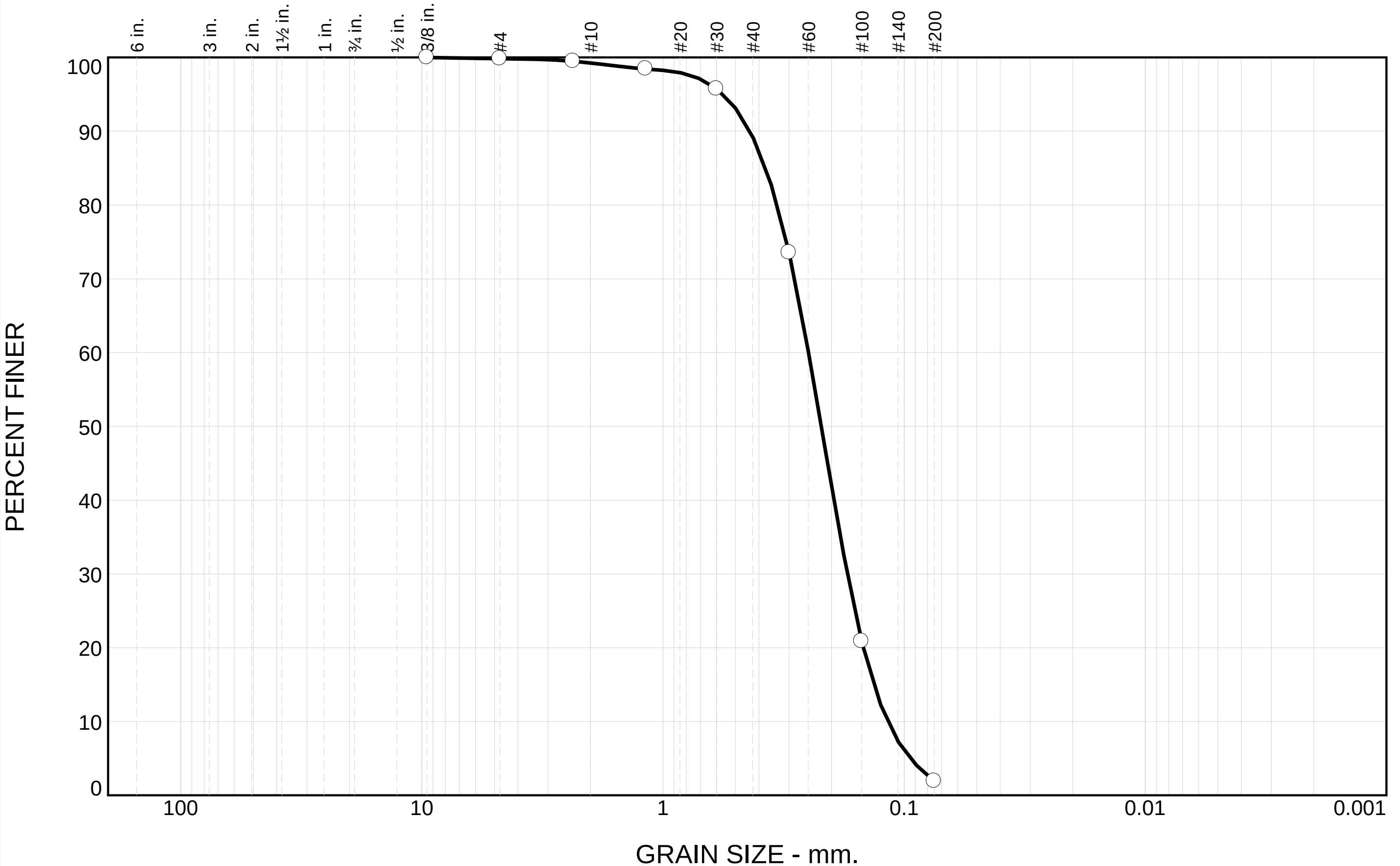
Sample No.: SS-7 **Source of Sample:** P-53 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-44

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.5	10.0	87.4	1.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.8		
#8	99.5		
#16	98.4		
#30	95.7		
#50	73.5		
#100	20.9		
#200	1.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3754 D_{60}= 0.2491 D_{50}= 0.2205
D_{30}= 0.1720 D_{15}= 0.1338 D_{10}= 0.1171
C_u= 2.13 C_c= 1.01

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

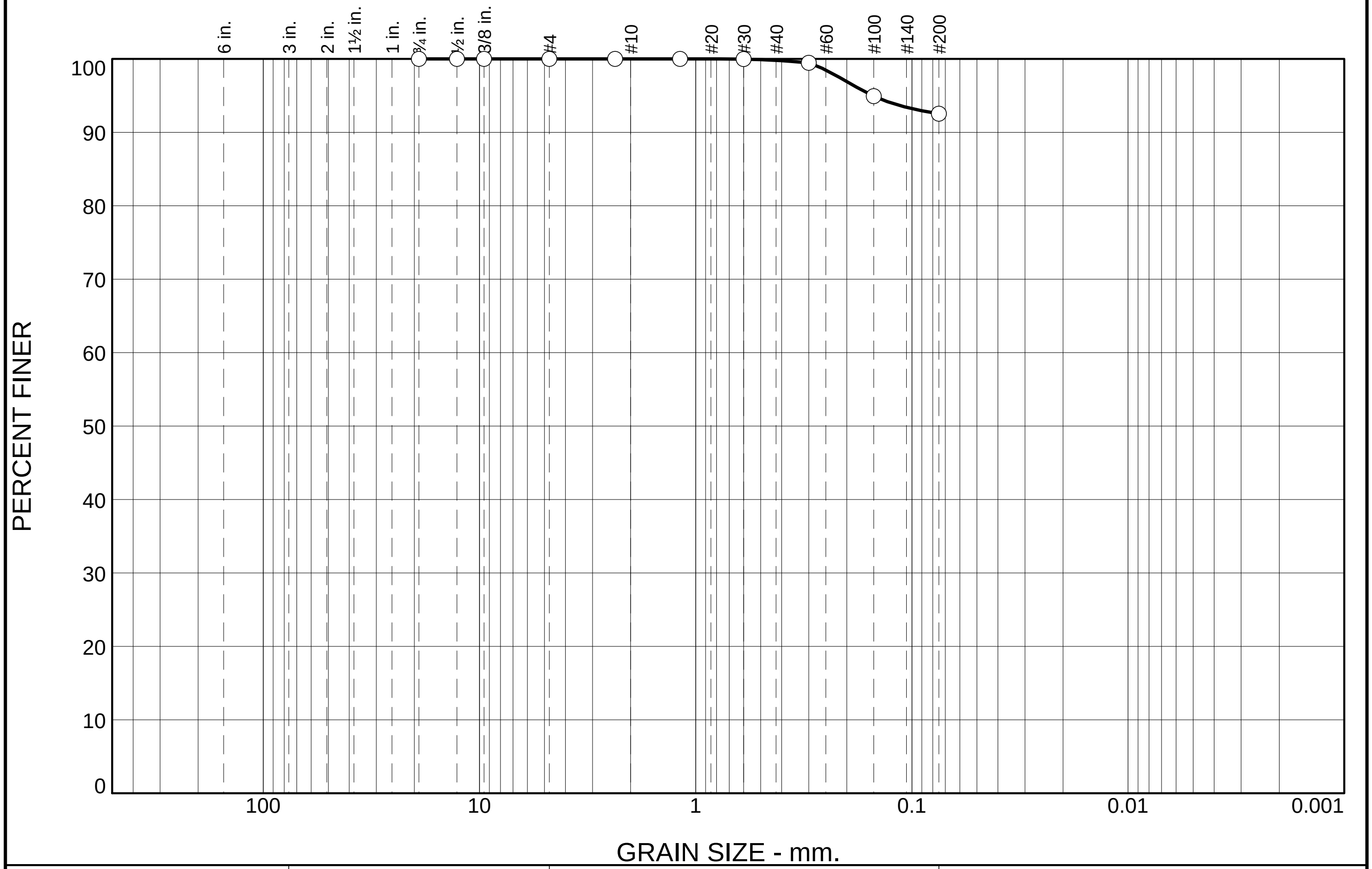
Sample No.: SS-8 **Source of Sample:** P-53 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-45

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	7.3	92.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	100.0		
#50	99.5		
#100	94.9		
#200	92.5		

* (no specification provided)

Material Description

Silty CLAY (CL), brown, with lignite, limonite, and tan vertical fine sand seam

Atterberg Limits (ASTM D 4318)

PL= 27 LL= 46 PI= 19

Classification

USCS= CL AASHTO=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Date Tested: 5/28/10 **Tested By:** J. Pruett

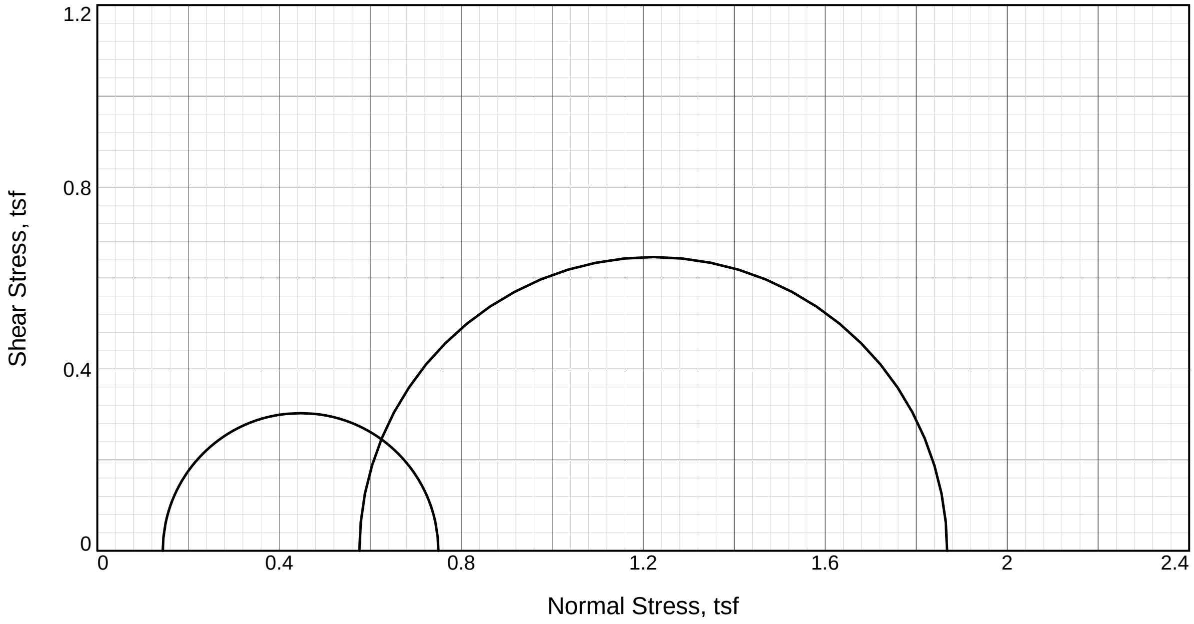
Remarks

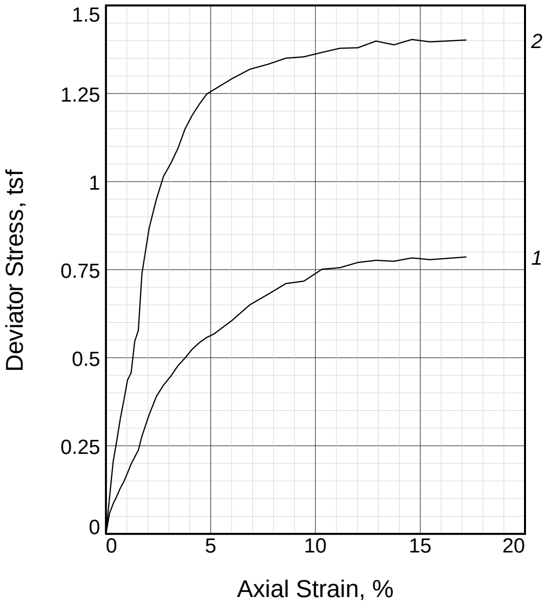
Sample No.: ST-1 **Source of Sample:** B-54 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 1
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-46





	Sample No.	1	2
Initial	Water Content,	29.3	25.5
	Dry Density, pcf	90.7	98.2
	Saturation,	92.9	96.9
	Void Ratio	0.8443	0.7046
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
At Test	Water Content,	29.3	25.5
	Dry Density, pcf	90.7	98.2
	Saturation,	92.9	96.9
	Void Ratio	0.8443	0.7046
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
	Strain rate, %/min.	0.83	0.83
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.14	0.58
	Fail. Stress, tsf	0.61	1.29
	Ult. Stress, tsf	0.78	1.40
	σ_1 Failure, tsf	0.75	1.87
	σ_3 Failure, tsf	0.14	0.58

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby tube

Description: Silty CLAY (CL), brown, with lignite, limonite, and tan vertical fine sand seam

LL= 46 **PL=** 27 **PI=** 19

Assumed Specific Gravity= 2.68

Remarks:

Figure B-47

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-54 **Depth:** 1

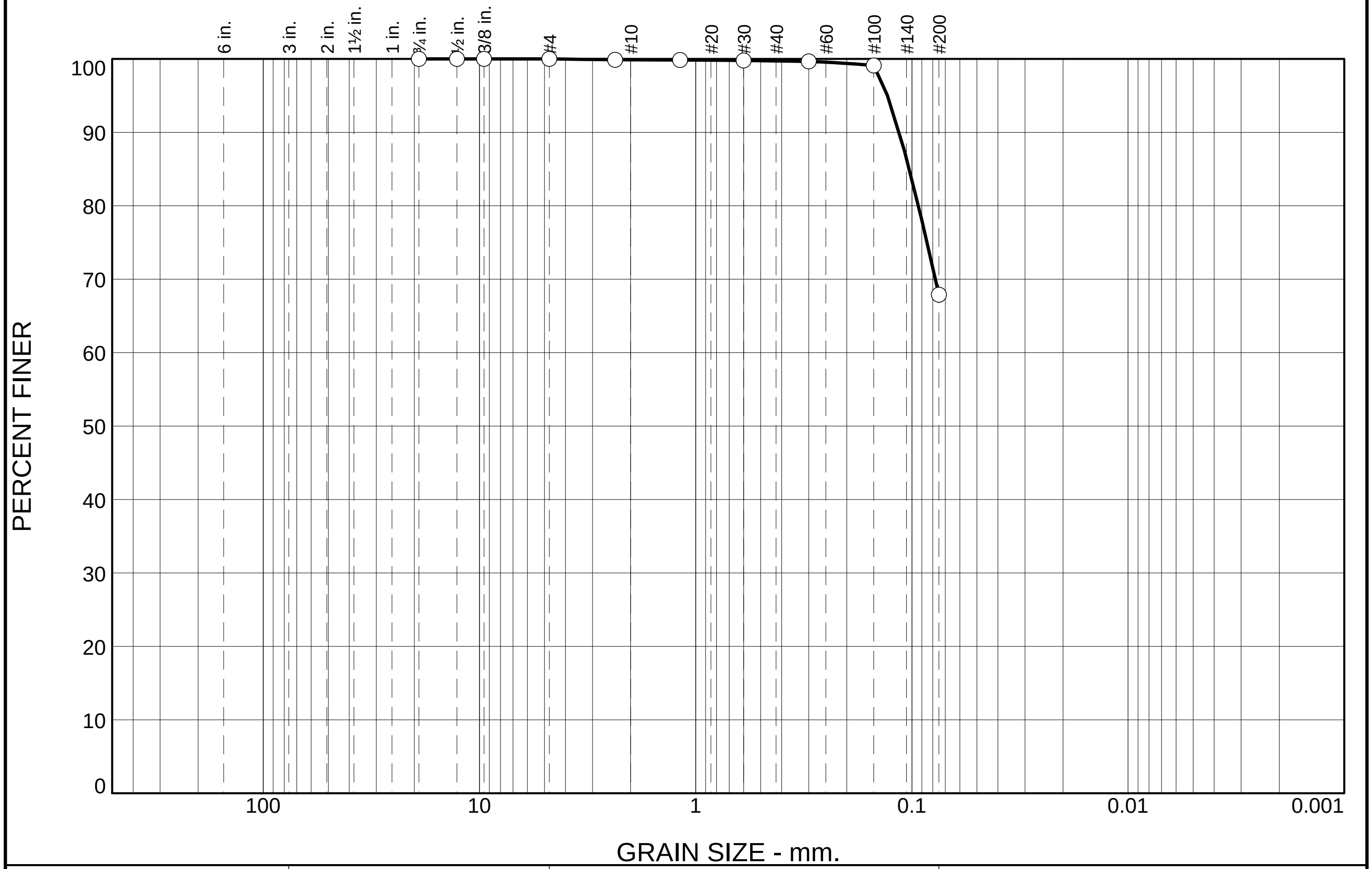
Sample Number: ST-1

Proj. No.: 2008012455 **Date:** 11-03-2009

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Pruett **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.2	31.8	67.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.9		
#30	99.8		
#50	99.7		
#100	99.1		
#200	67.9		

* (no specification provided)

Material Description

SILT (ML), with fine sand

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= ML AASHTO=

Coefficients

D_{85}= 0.1027 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

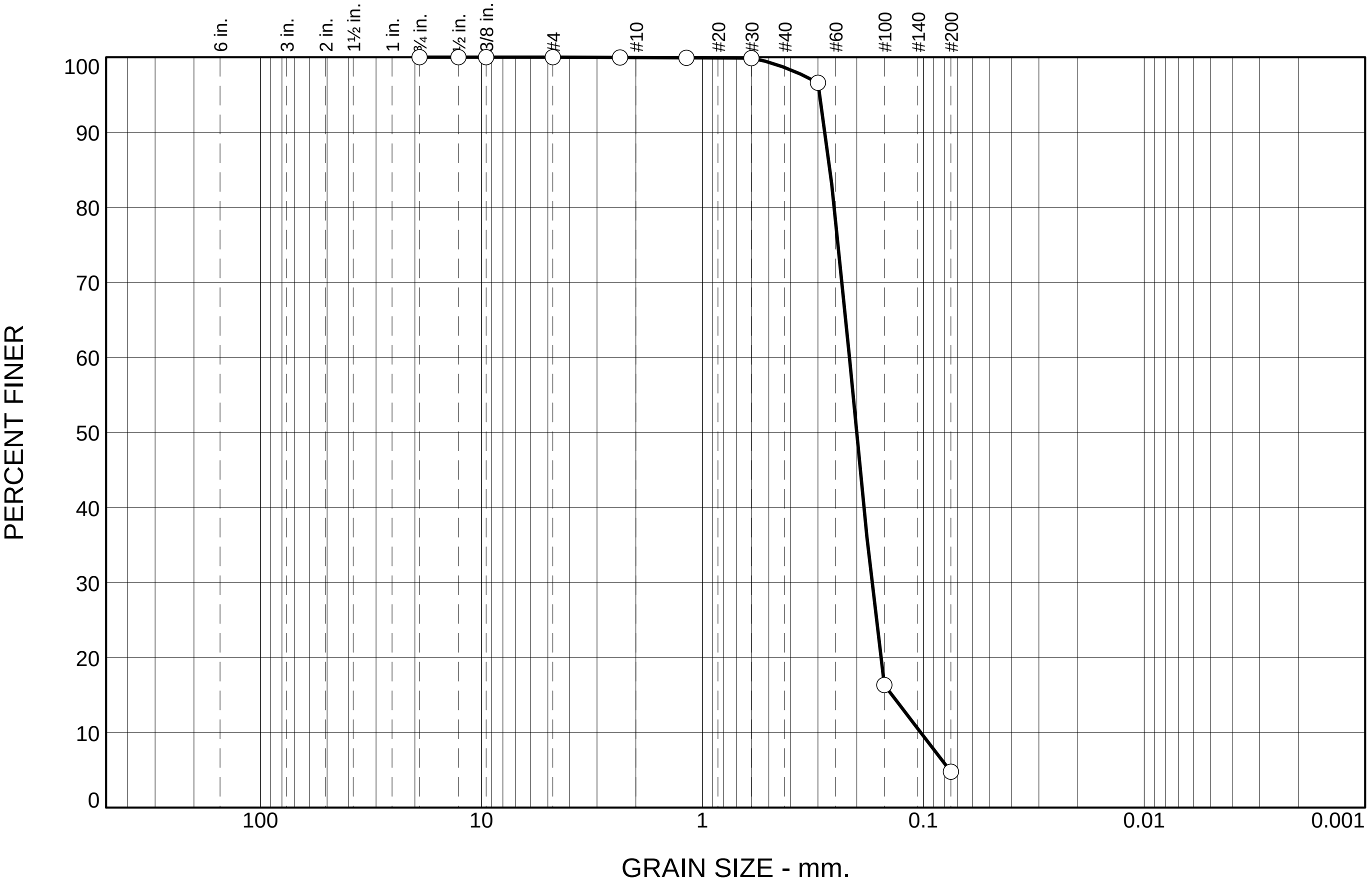
Sample No.: SS-4 **Source of Sample:** B-54 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 10
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-48

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.3	93.9	4.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.9		
#50	96.6		
#100	16.3		
#200	4.8		

* (no specification provided)

Material Description

SAND (SP), gray, dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.2643 D_{60}= 0.2160 D_{50}= 0.2005
D_{30}= 0.1713 D_{15}= 0.1384 D_{10}= 0.1025
C_u= 2.11 C_c= 1.33

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

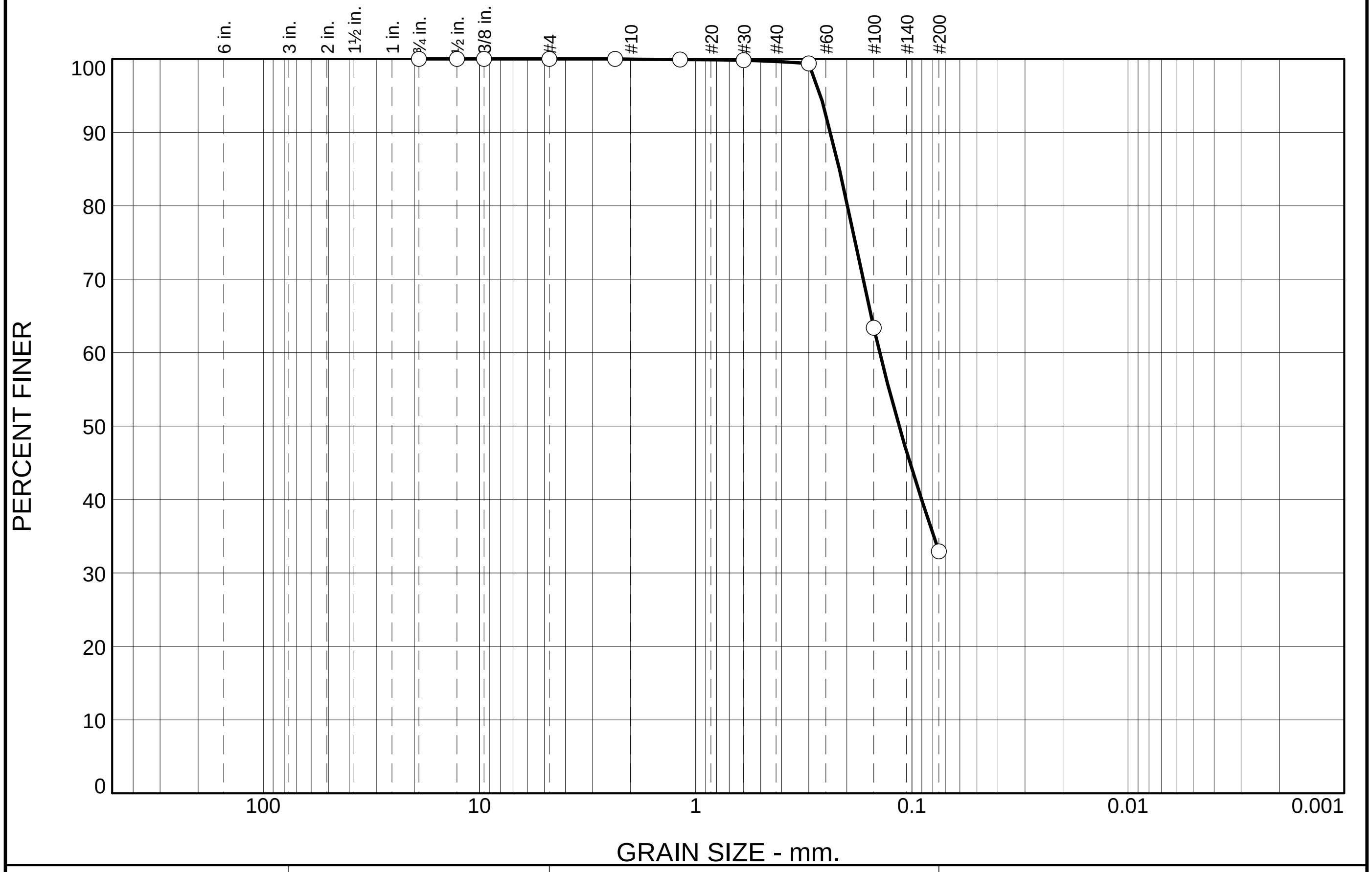
Sample No.: SS-9 **Source of Sample:** B-54 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-49

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	66.8	32.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.8		
#50	99.4		
#100	63.4		
#200	32.9		

* (no specification provided)

Material Description

Silty SAND (SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.2165 D_{60}= 0.1409 D_{50}= 0.1146
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

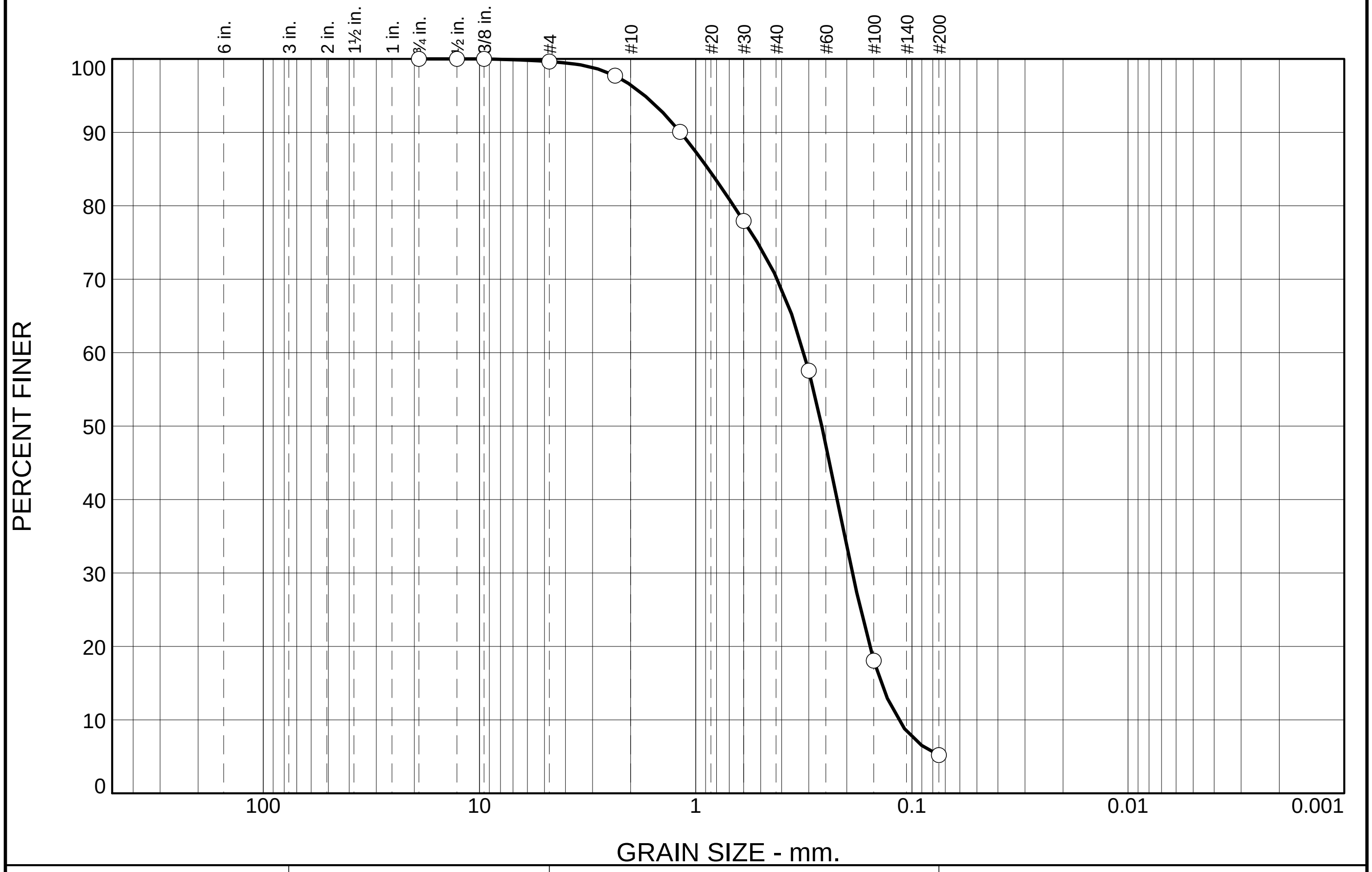
Sample No.: SS-4 **Source of Sample:** B-56 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 10
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-50

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	3.1	26.1	65.2	5.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.6		
#8	97.7		
#16	90.1		
#30	77.9		
#50	57.6		
#100	18.1		
#200	5.2		

* (no specification provided)

Material Description

SAND to Silty SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.8726 D_{60}= 0.3159 D_{50}= 0.2610
D_{30}= 0.1885 D_{15}= 0.1386 D_{10}= 0.1154
C_u= 2.74 C_c= 0.97

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

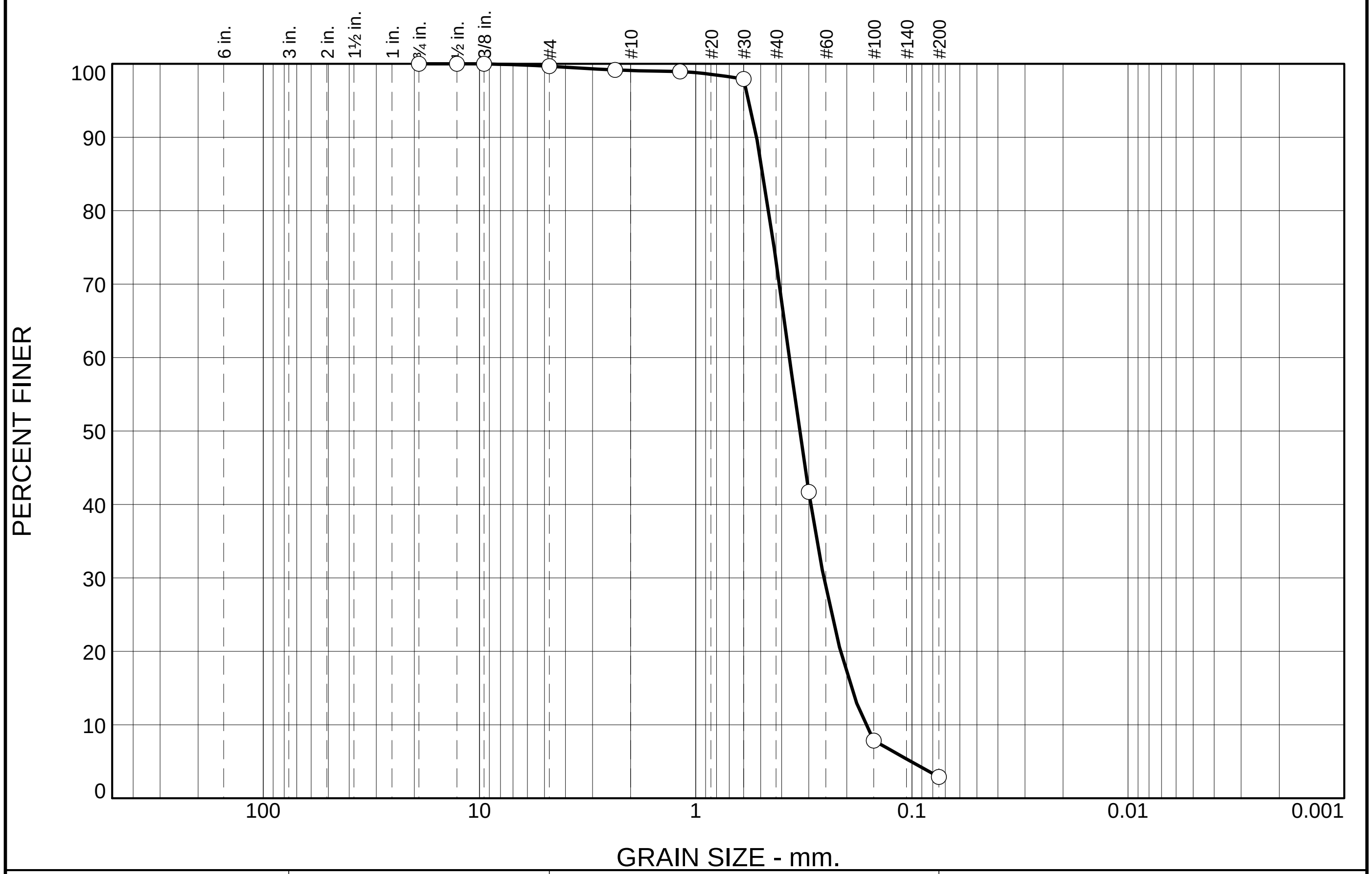
Sample No.: SS-6 **Source of Sample:** B-56 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-51

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.6	25.9	70.3	2.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.7		
#8	99.2		
#16	99.0		
#30	97.9		
#50	41.7		
#100	7.8		
#200	2.9		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.4882 D_{60}= 0.3686 D_{50}= 0.3305
D_{30}= 0.2554 D_{15}= 0.1905 D_{10}= 0.1637
C_u= 2.25 C_c= 1.08

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

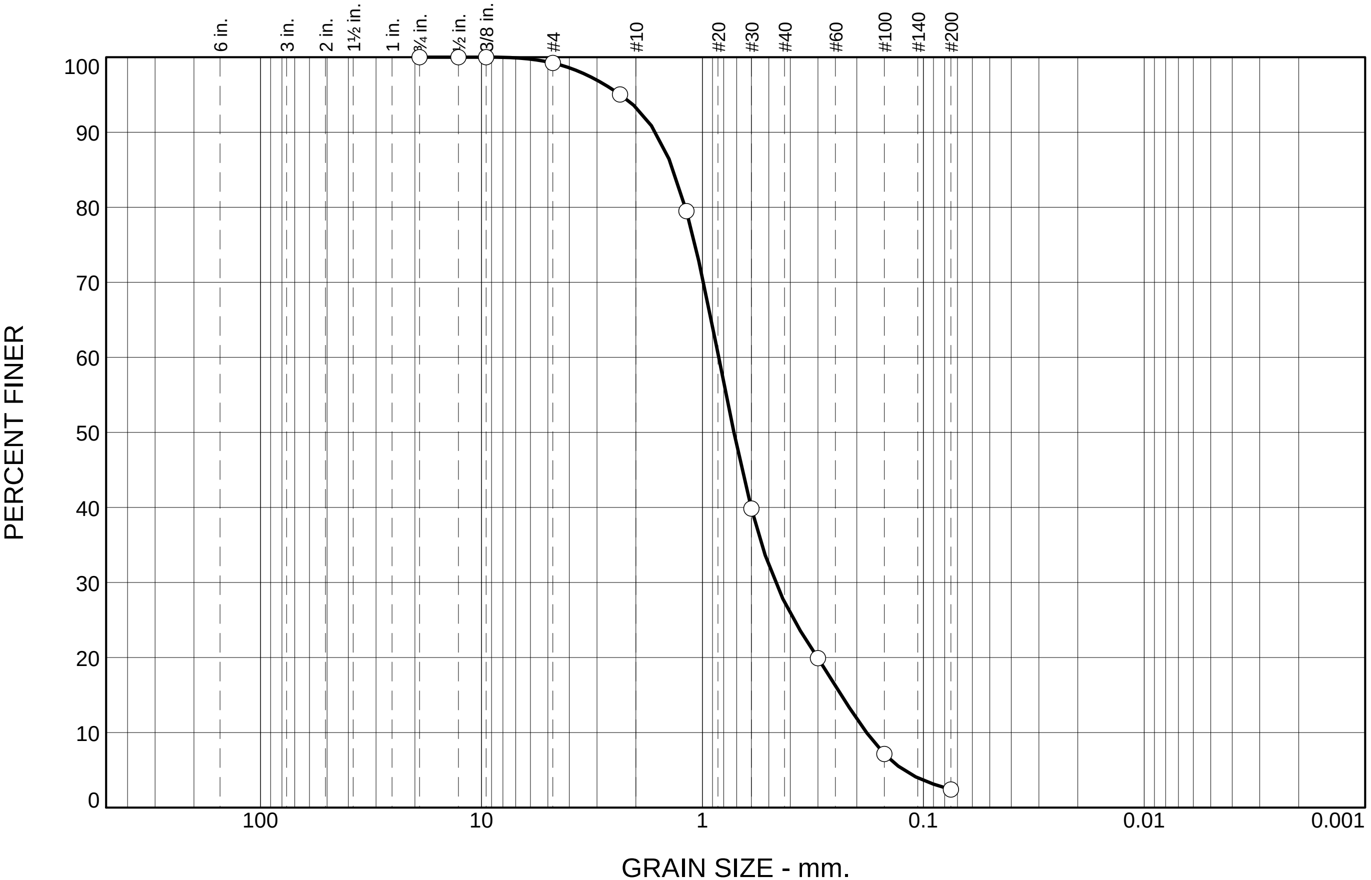
Sample No.: SS-9 **Source of Sample:** B-56 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 33.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-52

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	5.9	65.9	25.0	2.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.2		
#8	95.0		
#16	79.5		
#30	39.8		
#50	19.9		
#100	7.2		
#200	2.4		

* (no specification provided)

Material Description

SAND (SP), gray medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.3544 D_{60}= 0.8428 D_{50}= 0.7194
D_{30}= 0.4663 D_{15}= 0.2352 D_{10}= 0.1807
C_u= 4.67 C_c= 1.43

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

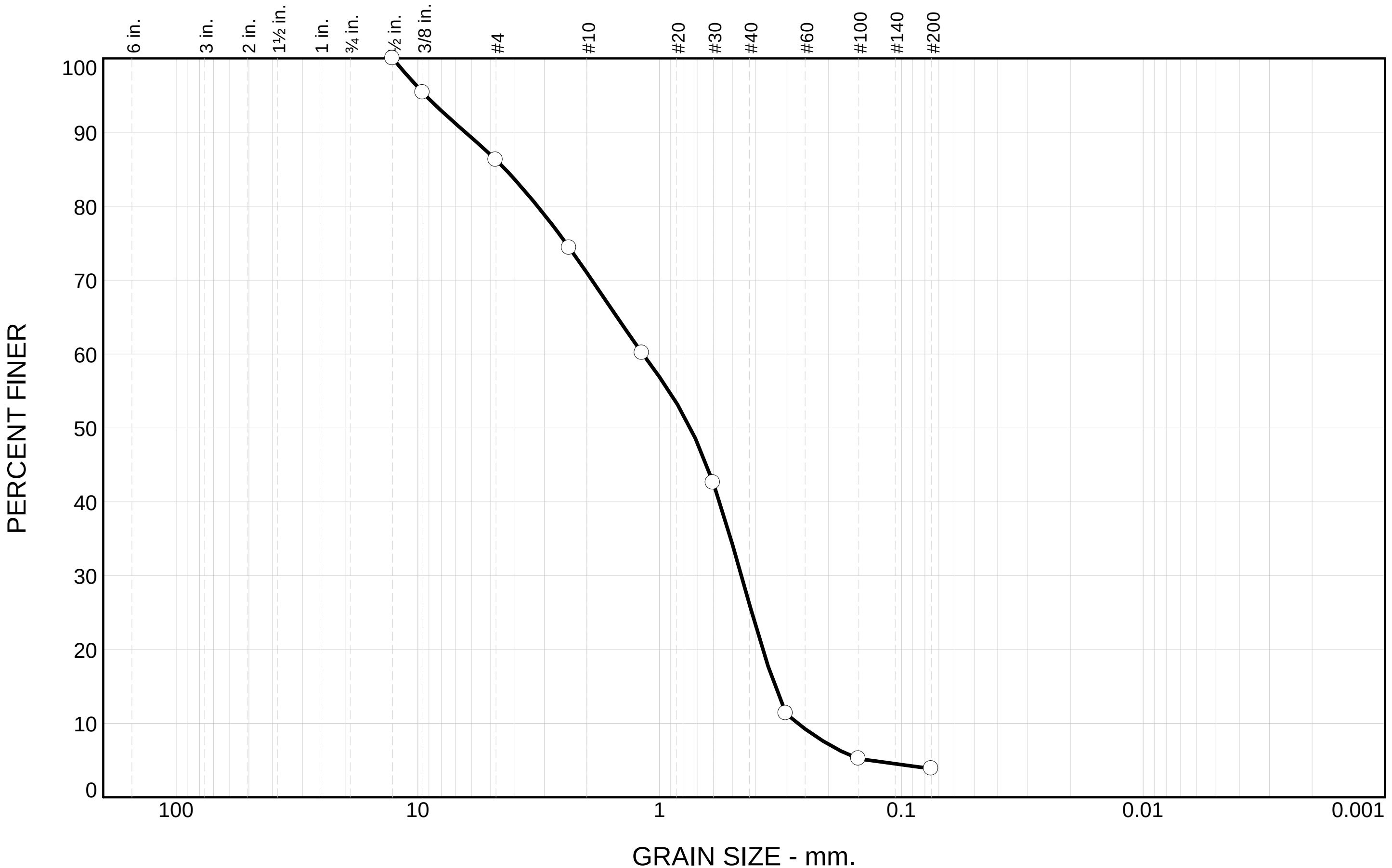
Sample No.: SS-11 **Source of Sample:** B-56 **Date Sampled:** 11-03-2009
Location: **Elev./Depth:** 43.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-53

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	13.7	15.3	44.9	22.2	3.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	95.4		
#4	86.3		
#8	74.3		
#16	60.1		
#30	42.6		
#50	11.3		
#100	5.2		
#200	3.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 4.3527 D_{60}= 1.1729 D_{50}= 0.7467

D_{30}= 0.4590 D_{15}= 0.3332 D_{10}= 0.2680

C_u= 4.38 C_c= 0.67

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

Sample No.: SS-6 **Source of Sample:** P-57 **Date Sampled:**

Location: **Elev./Depth:** 25

Checked By: K. Kocher **Title:** Engineer

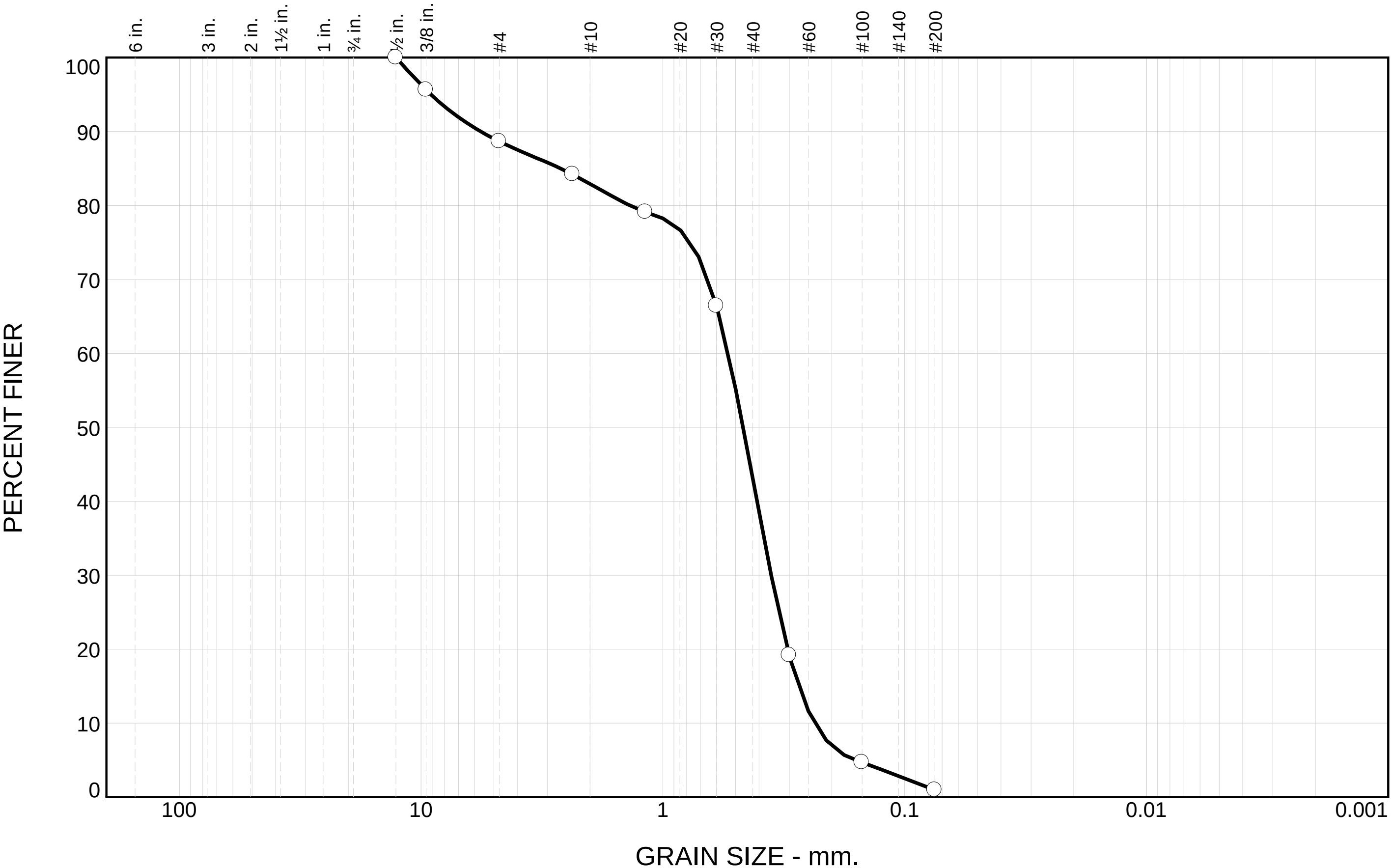
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-54

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.3	5.8	39.8	42.1	1.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	95.6		
#4	88.7		
#8	84.2		
#16	79.1		
#30	66.4		
#50	19.2		
#100	4.7		
#200	1.0		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.6529 D_{60}= 0.5369 D_{50}= 0.4654
D_{30}= 0.3564 D_{15}= 0.2746 D_{10}= 0.2360
C_u= 2.28 C_c= 1.00

Date Tested: 12-09-09 **Tested By:** M. Tierney

Remarks

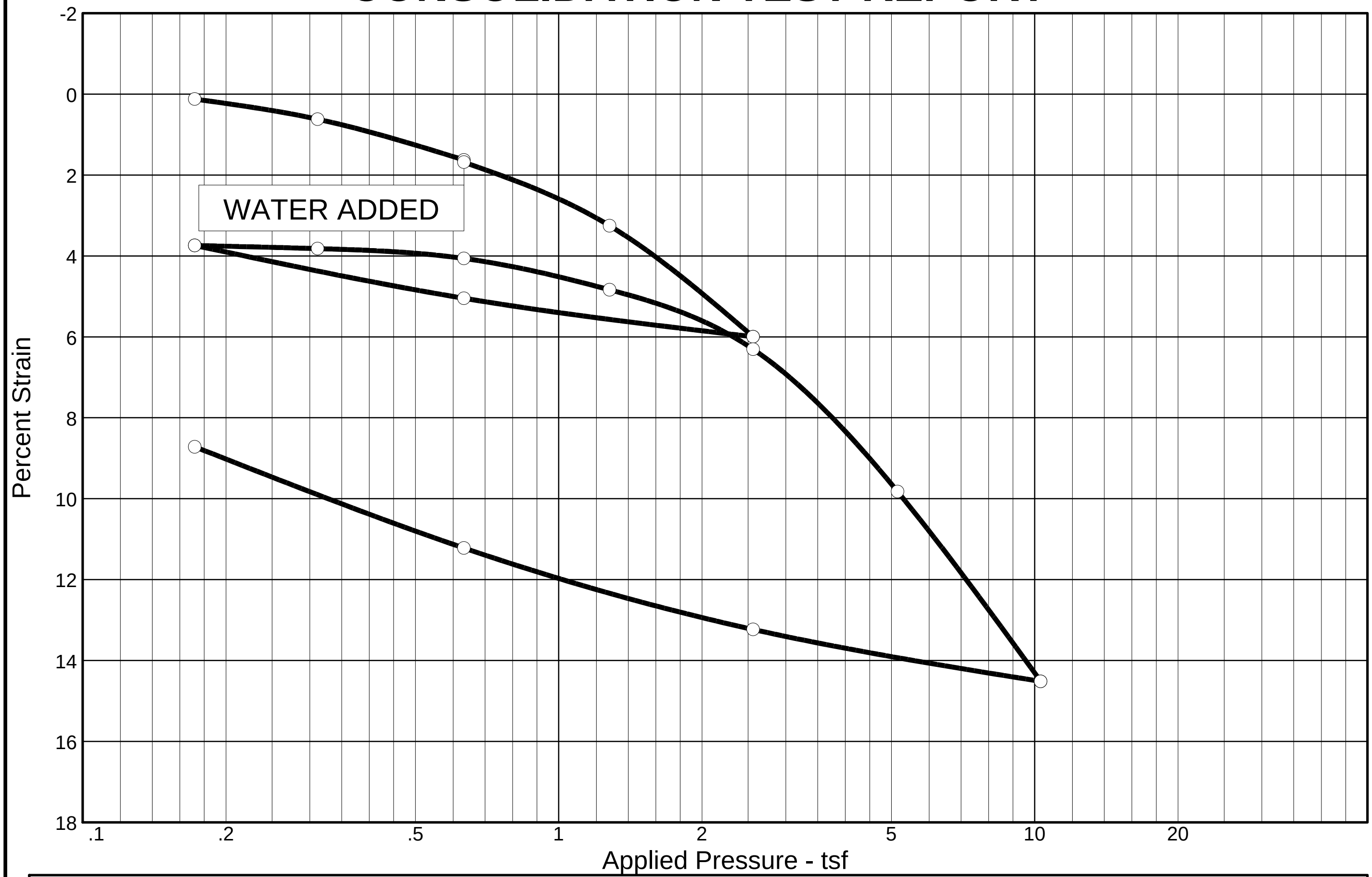
Sample No.: SS-8 **Source of Sample:** P-57 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-55

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
1	0.17	0.01	0.001	11	1.28	0.09	0.001				
2	0.31	0.05	0.001	12	2.56	0.16	0.003				
3	0.63	0.06	0.003	13	5.15	0.05	0.005				
4	0.63	0.00	0.000	14	10.29	0.03	0.004				
5	1.28	0.10	0.003	15	2.56	0.03					
6	2.56	0.08	0.003	16	0.63	0.01					
7	0.63	0.02		17	0.17	0.00					
8	0.17	0.04									
9	0.31	0.42	0.000								
10	0.63	0.10	0.001								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
86.5 %	29.6 %	87.3		19	2.68	0.12	2.26	0.30	0.05		0.1	0.917

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 2008012455 **Client:** Ameren Missouri

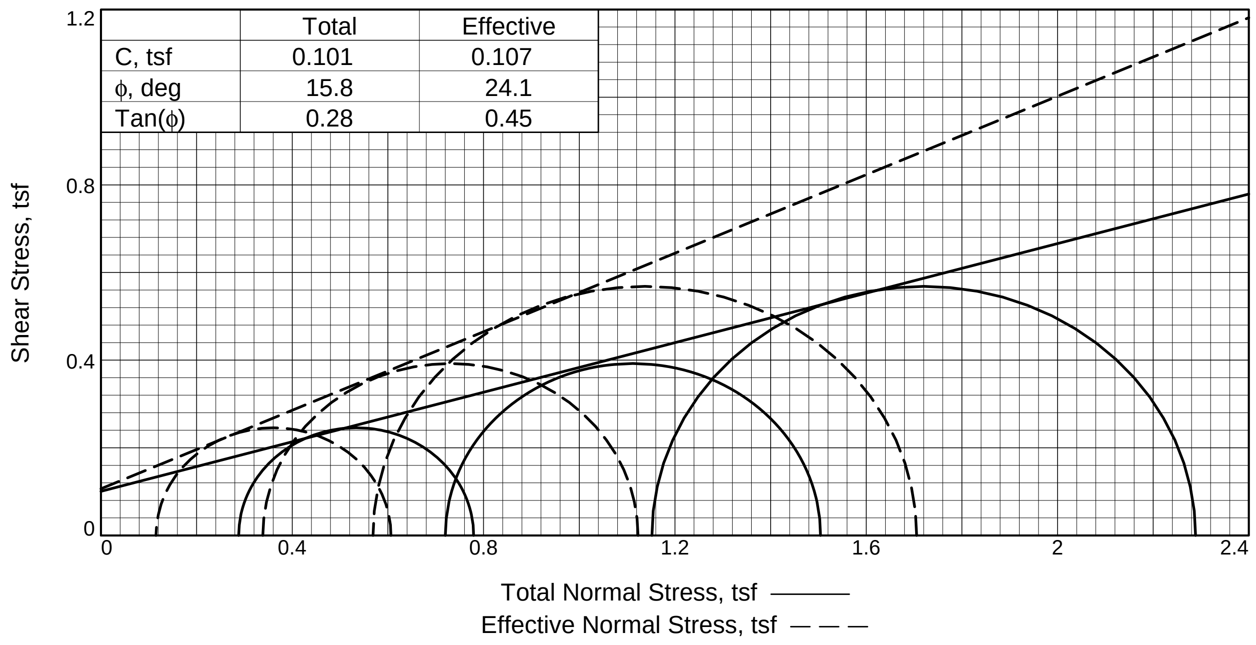
Project: Labadie Power Plant UWL DSI

Source: B-58 **Sample No.:** ST-1 **Elev./Depth:** 1

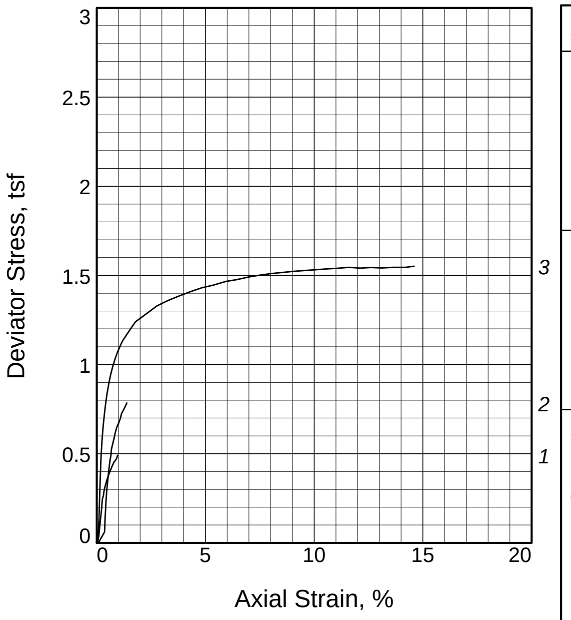
REITZ & JENS, INC.
CONSULTING ENGINEERS

Remarks:
Assumed specific gravity

Figure B-56



	Total	Effective
C, tsf	0.101	0.107
ϕ, deg	15.8	24.1
Tan(ϕ)	0.28	0.45



	Sample No.	1	2	3
Initial	Water Content,	33.3	33.3	33.3
	Dry Density, pcf	88.0	88.0	88.0
	Saturation,	99.1	99.1	99.1
	Void Ratio	0.9009	0.9009	0.9009
	Diameter, in.	1.97	1.97	1.97
	Height, in.	4.20	4.20	4.20
At Test	Water Content,	31.9	31.2	30.4
	Dry Density, pcf	90.3	91.2	92.1
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.8537	0.8349	0.8159
	Diameter, in.	1.96	1.96	1.97
	Height, in.	4.17	4.11	4.04
	Strain rate, %/min.	0.03	0.02	0.01
	Back Pressure, tsf	3.96	4.32	5.04
	Cell Pressure, tsf	4.25	5.04	6.19
	Fail. Stress, tsf	0.49	0.78	1.14
	Total Pore Pr., tsf	4.13	4.70	5.62
	Ult. Stress, tsf			
	Total Pore Pr., tsf			
	$\bar{\sigma}_1$ Failure, tsf	0.61	1.12	1.71
	$\bar{\sigma}_3$ Failure, tsf	0.12	0.34	0.57

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: CLAY (CL), grayish brown, with fine sand and silt seams/laminations

LL= 32 **PL=** 13 **PI=** 19

Assumed Specific Gravity= 2.68

Remarks:

Figure B-57

Client: Ameren Missouri

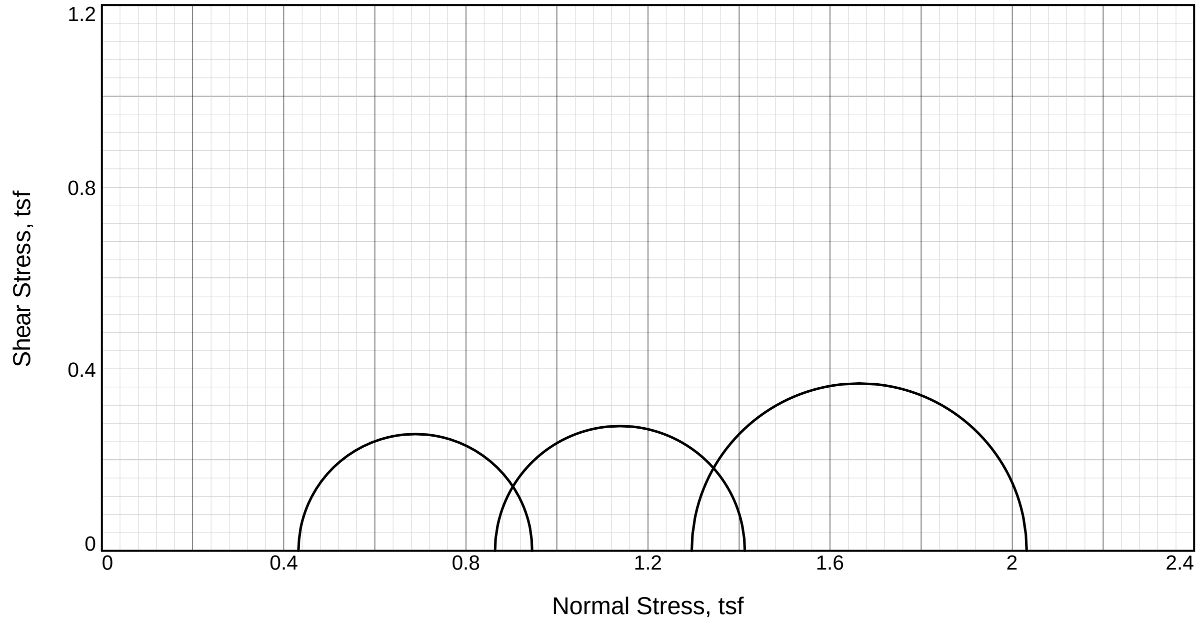
Project: Labadie Power Plant UWL DSI

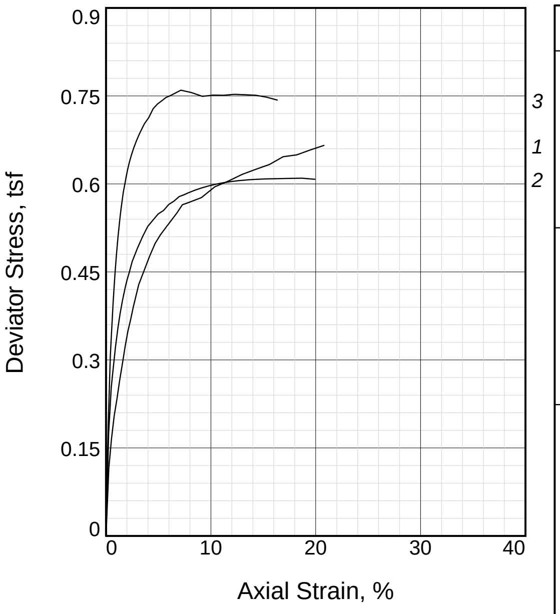
Source of Sample: B-58 **Depth:** 1.5

Proj. No.: 2008012455 **Date:** 11-06-2009

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Fouse





	Sample No.	1	2	3
Initial	Water Content,	31.8	42.2	38.6
	Dry Density, pcf	87.1	77.6	82.4
	Saturation,	92.5	98.0	100.3
	Void Ratio	0.9210	1.1558	1.0301
	Diameter, in.	1.99	1.98	1.99
	Height, in.	3.85	4.02	4.90
At Test	Water Content,	31.8	42.2	38.6
	Dry Density, pcf	87.1	77.6	82.4
	Saturation,	92.5	98.0	100.3
	Void Ratio	0.9210	1.1558	1.0301
	Diameter, in.	1.99	1.98	1.99
	Height, in.	3.85	4.02	4.90
	Strain rate, %/min.	0.83	0.83	0.83
	Back Pressure, tsf	0.00	0.00	0.00
	Cell Pressure, tsf	0.43	0.86	1.30
	Fail. Stress, tsf	0.51	0.55	0.74
	Ult. Stress, tsf	0.67	0.61	0.76
	σ_1 Failure, tsf	0.95	1.41	2.03
	σ_3 Failure, tsf	0.43	0.86	1.30

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CL), grayish brown, with seams or laminations of silt and fine sand, traces

LL= 49 **PL=** 25 **PI=** 24

Assumed Specific Gravity= 2.68

Remarks:

Figure B-58

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-58 **Depth:** 7

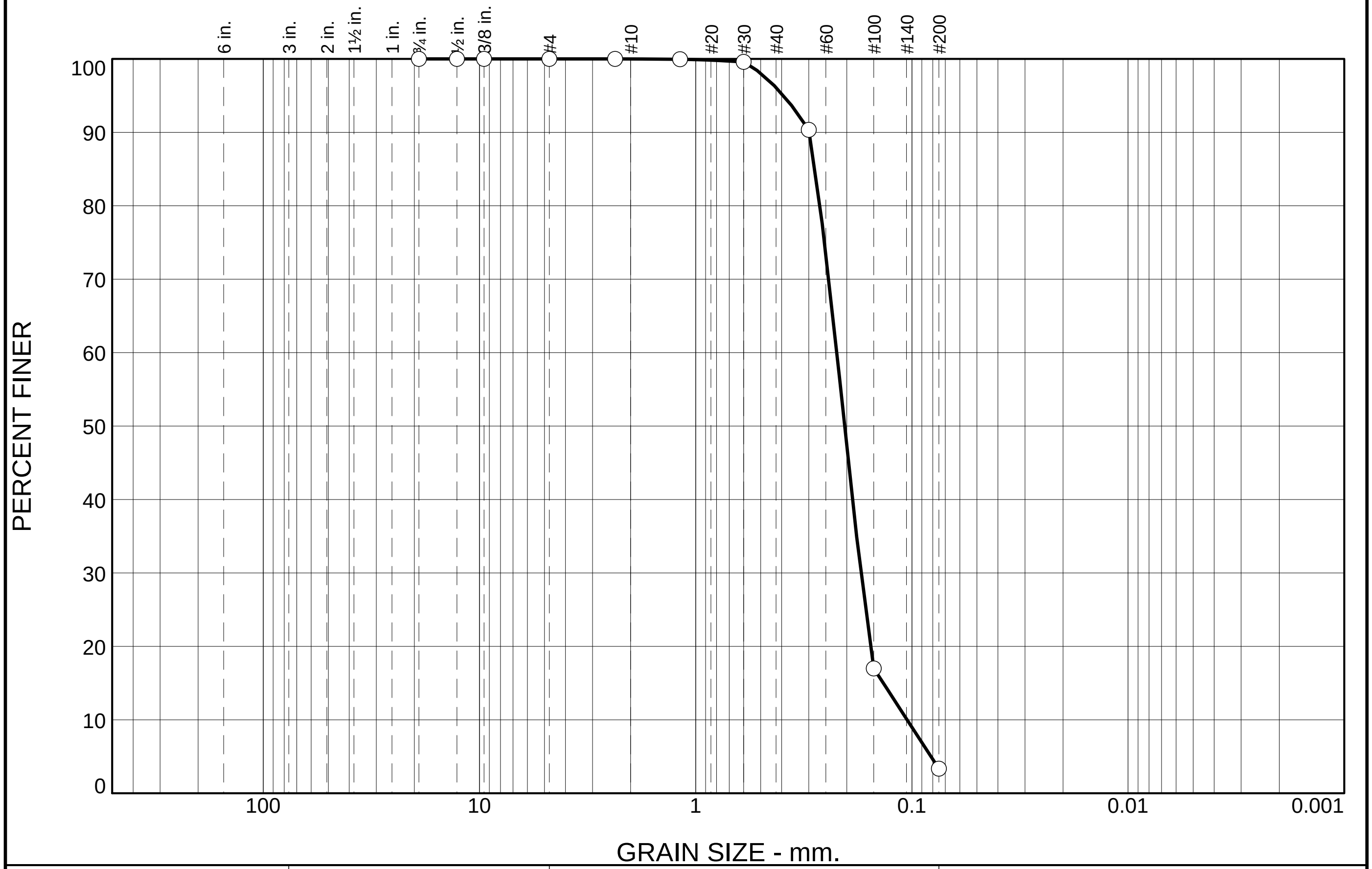
Sample Number: ST-3

Proj. No.: 2008012455 **Date:** 11-06-2009

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Crose **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.9	92.8	3.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.6		
#50	90.3		
#100	17.0		
#200	3.3		

* (no specification provided)

Material Description

SAND (SP), grayish tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.2807 D_{60}= 0.2224 D_{50}= 0.2048
D_{30}= 0.1723 D_{15}= 0.1354 D_{10}= 0.1051
C_u= 2.12 C_c= 1.27

Date Tested: 02-15-10 **Tested By:** J. Pruett

Remarks

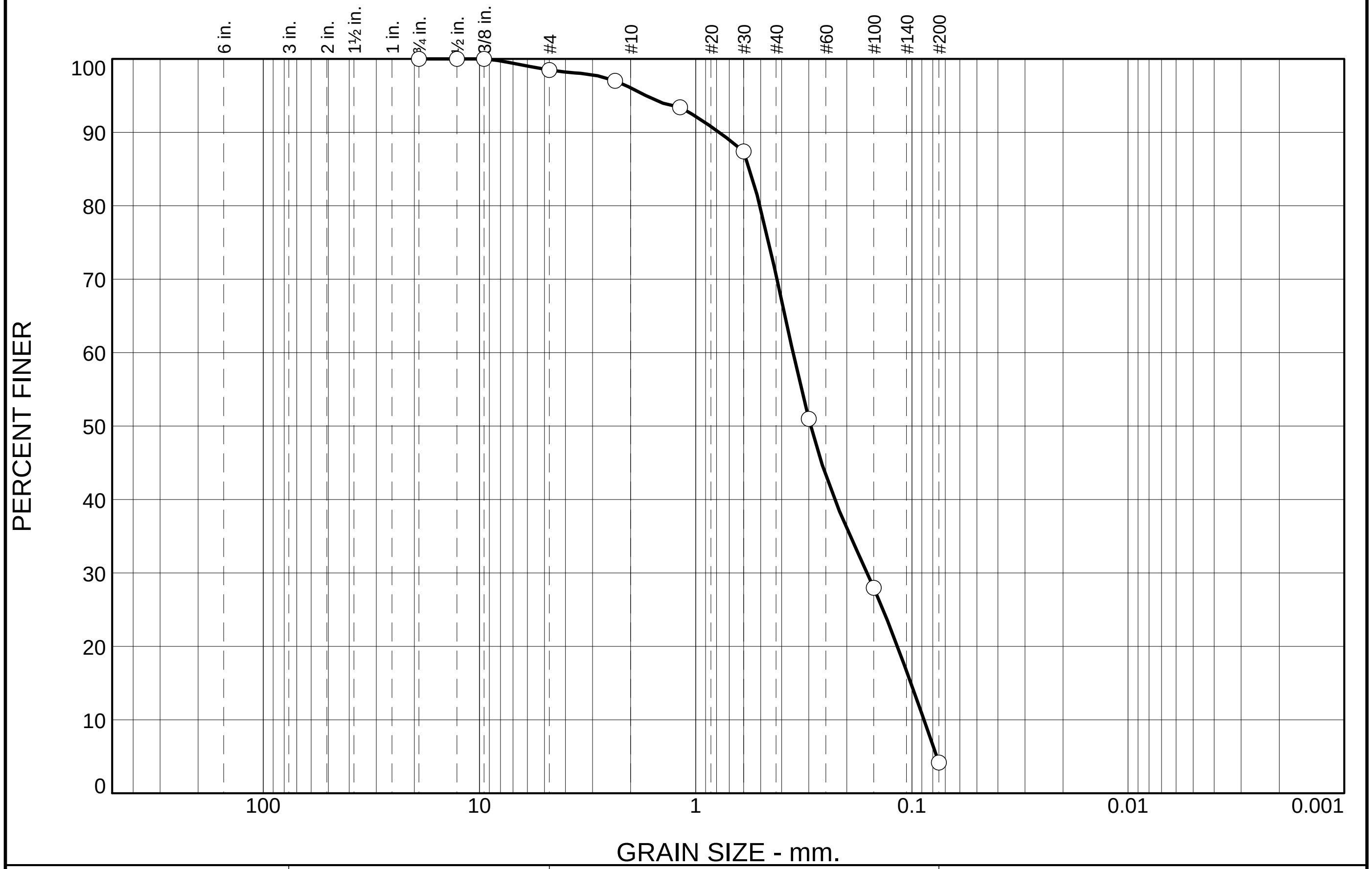
Sample No.: SS-5 **Source of Sample:** B-58 **Date Sampled:** 11-06-2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-59

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.5	2.4	25.5	66.4	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.5		
#8	97.0		
#16	93.4		
#30	87.4		
#50	51.0		
#100	28.0		
#200	4.2		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5624	D_{60}= 0.3547	D_{50}= 0.2938
D_{30}= 0.1610	D_{15}= 0.1009	D_{10}= 0.0879
C_u= 4.04	C_c= 0.83	

Date Tested: 02-15-10 **Tested By:** J. Pruett

Remarks

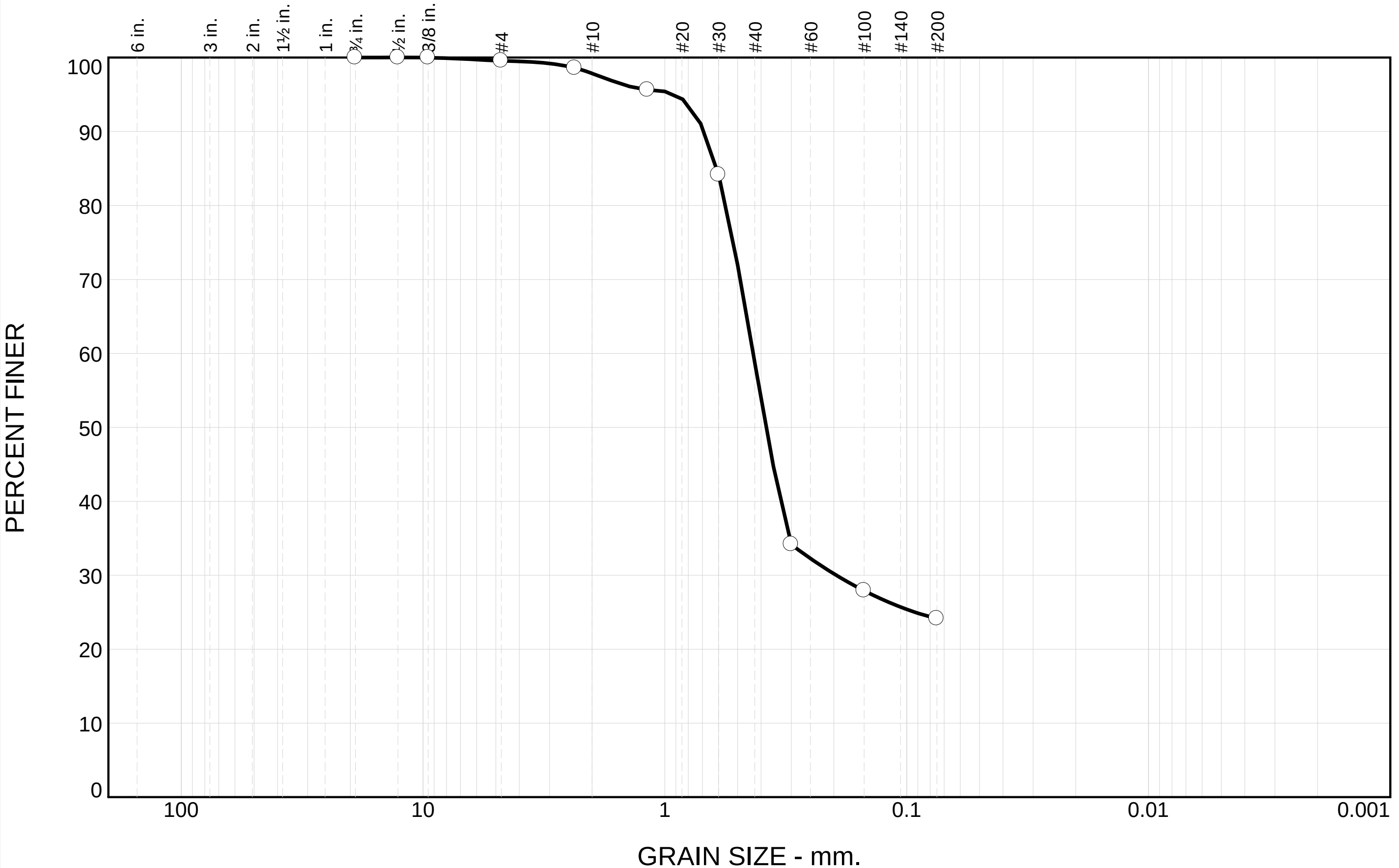
Sample No.: SS-7 **Source of Sample:** B-58 **Date Sampled:** 11-06-2009
Location:
Elev./Depth: 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-60

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.8	39.0	34.7	24.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.6		
#8	98.6		
#16	95.6		
#30	84.1		
#50	34.2		
#100	27.9		
#200	24.1		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.6098 D_{60}= 0.4312 D_{50}= 0.3814
D_{30}= 0.1954 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 12/4/09 **Tested By:** J. Pruett, C. Cook

Remarks

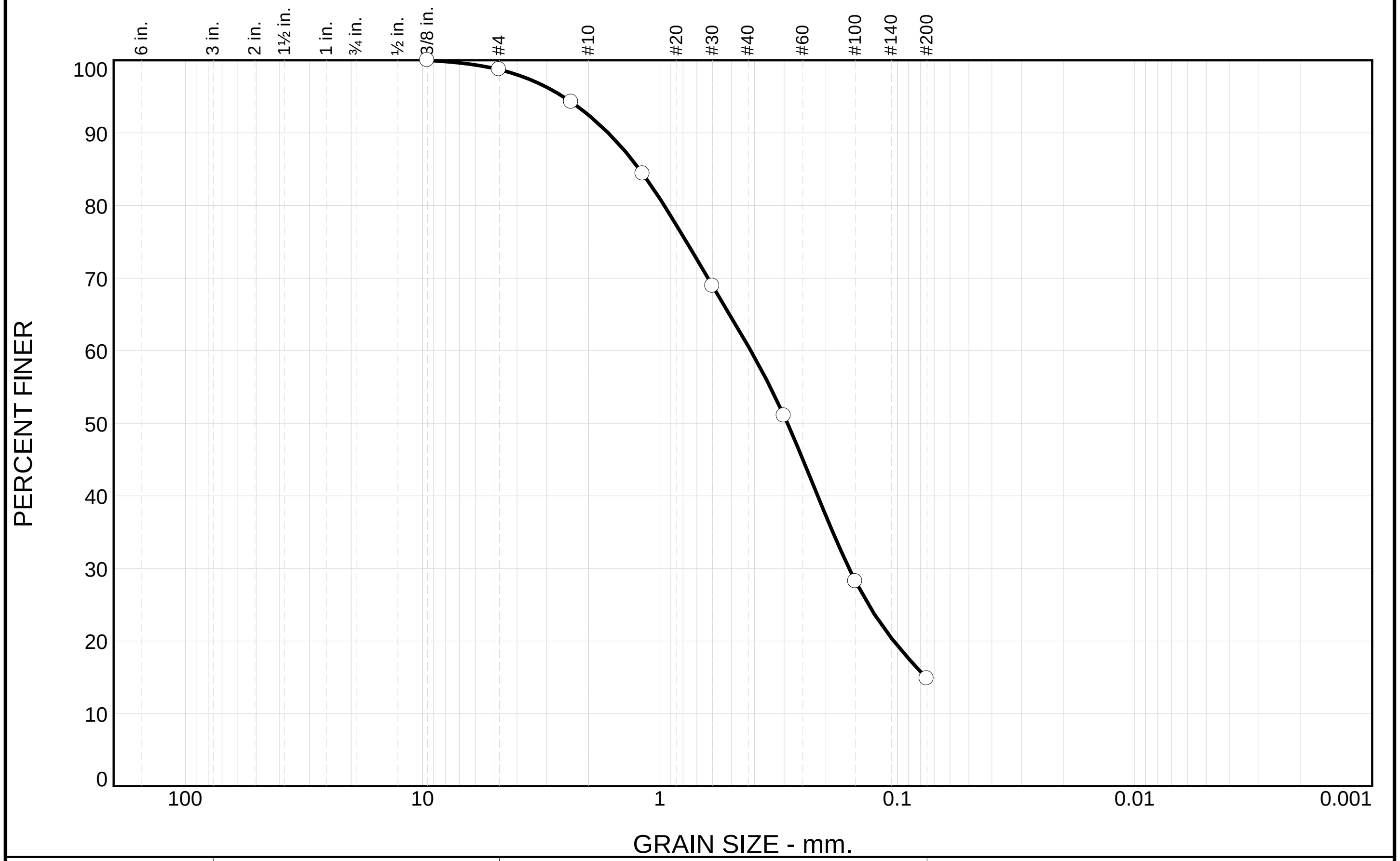
Sample No.: SS-4 **Source of Sample:** P-61 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-61

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	6.2	31.9	45.8	14.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.7		
#8	94.2		
#16	84.4		
#30	68.9		
#50	51.0		
#100	28.2		
#200	14.8		

* (no specification provided)

Material Description

SAND (SP-SM), with sitl

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 1.2194 D_{60}= 0.4144 D_{50}= 0.2905
D_{30}= 0.1598 D_{15}= 0.0760 D_{10}=
C_u= C_c=

Date Tested: **Tested By:** C. Cook/J. Pruett

Remarks

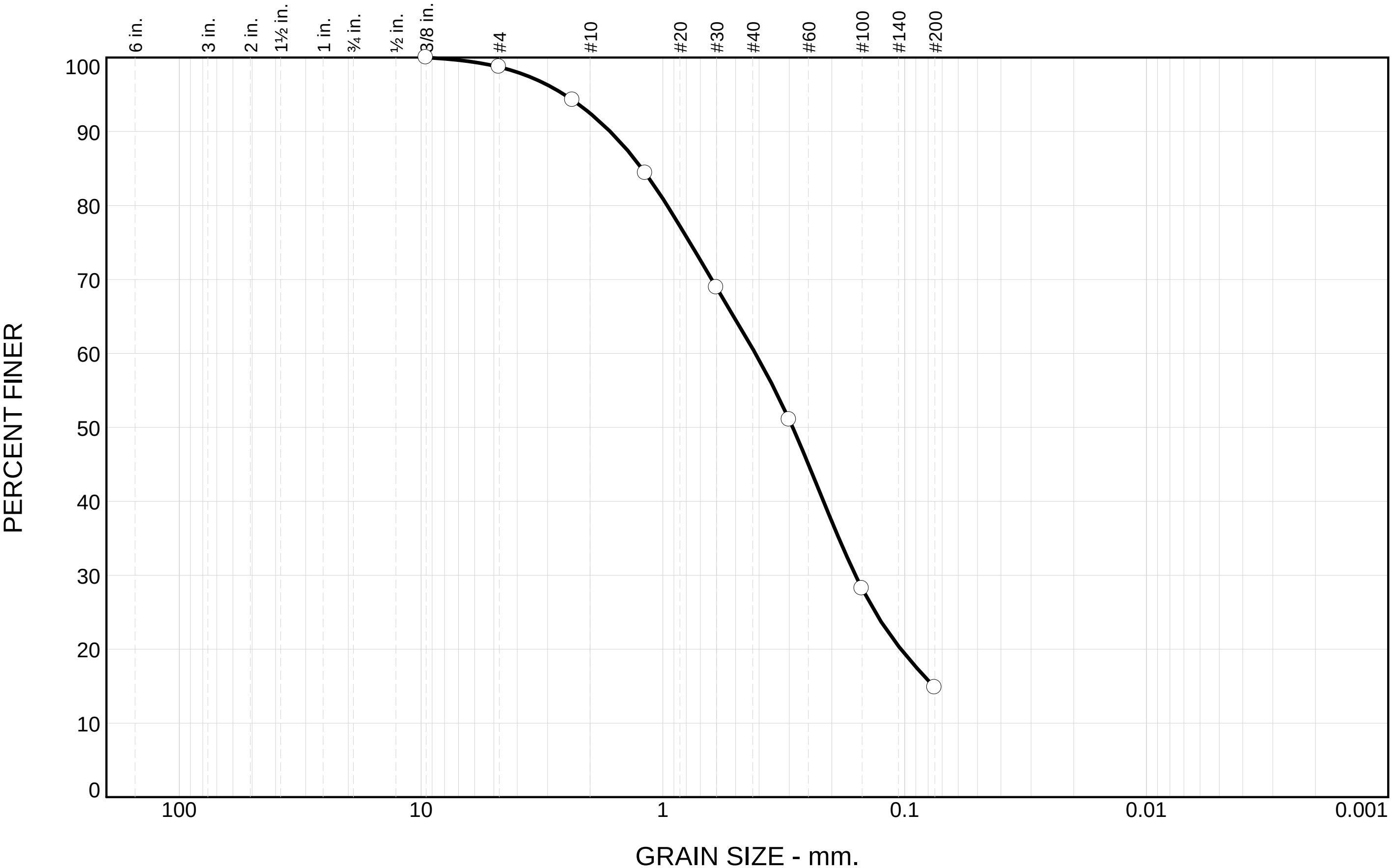
Sample No.: SS-5 **Source of Sample:** P-61 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-62

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	6.2	31.9	45.8	14.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.7		
#8	94.2		
#16	84.4		
#30	68.9		
#50	51.0		
#100	28.2		
#200	14.8		

* (no specification provided)

Material Description

SAND (SP-SM), with sitl

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS= SP-SM **AASHTO=**

Coefficients

D_{85}= 1.2194 D_{60}= 0.4144 D_{50}= 0.2905
D_{30}= 0.1598 D_{15}= 0.0760 D_{10}=
C_u= C_c=

Date Tested: **Tested By:** C. Cook/J. Pruett

Remarks

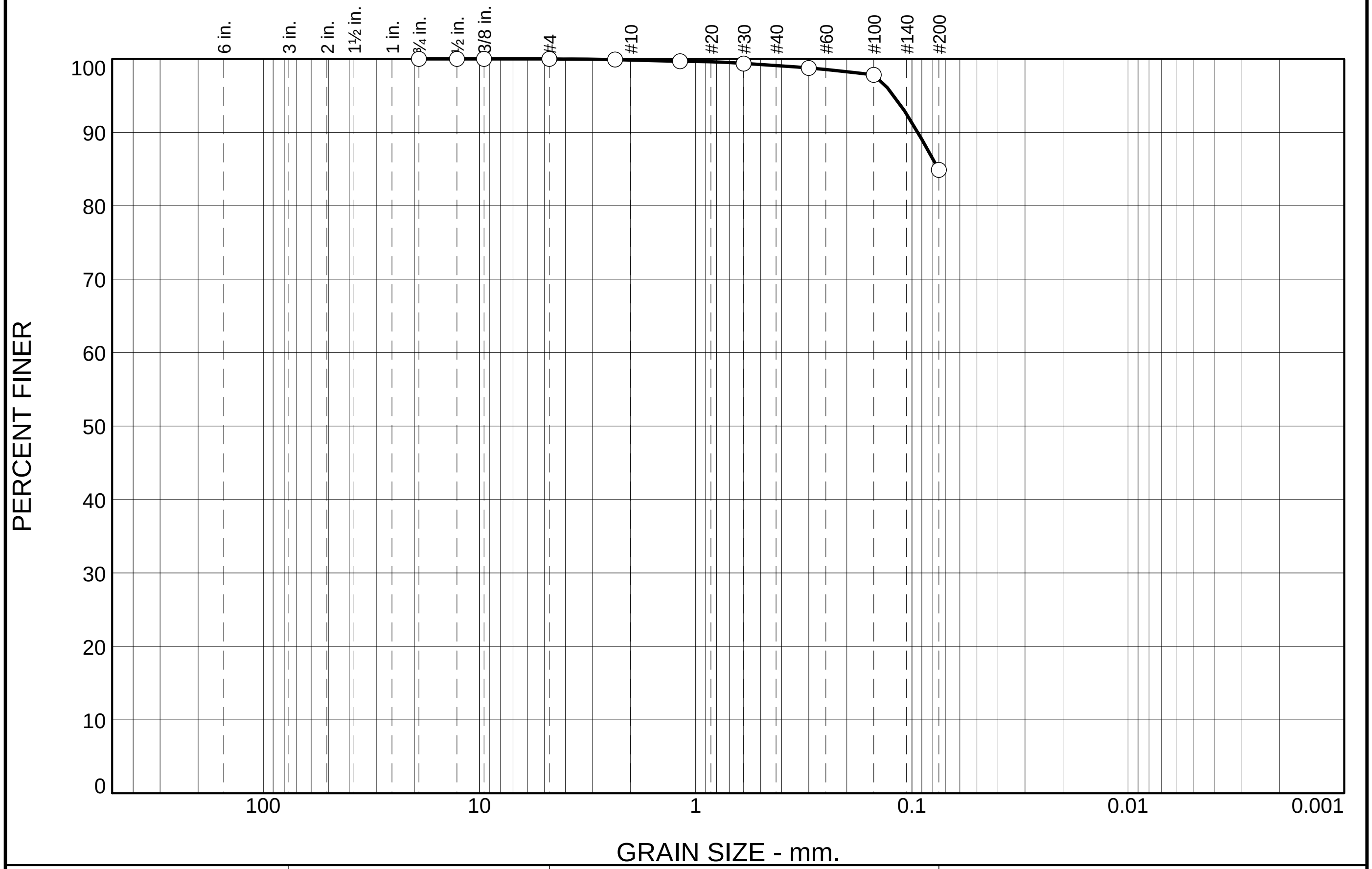
Sample No.: SS-6 **Source of Sample:** P-61 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-63

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.8	14.2	84.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.7		
#30	99.4		
#50	98.8		
#100	97.8		
#200	84.9		

* (no specification provided)

Material Description

SILT (ML), tan, loose

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SC AASHTO=

Coefficients

D_{85}= 0.0754 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Date Tested: 02-03-10 **Tested By:** J. Crose

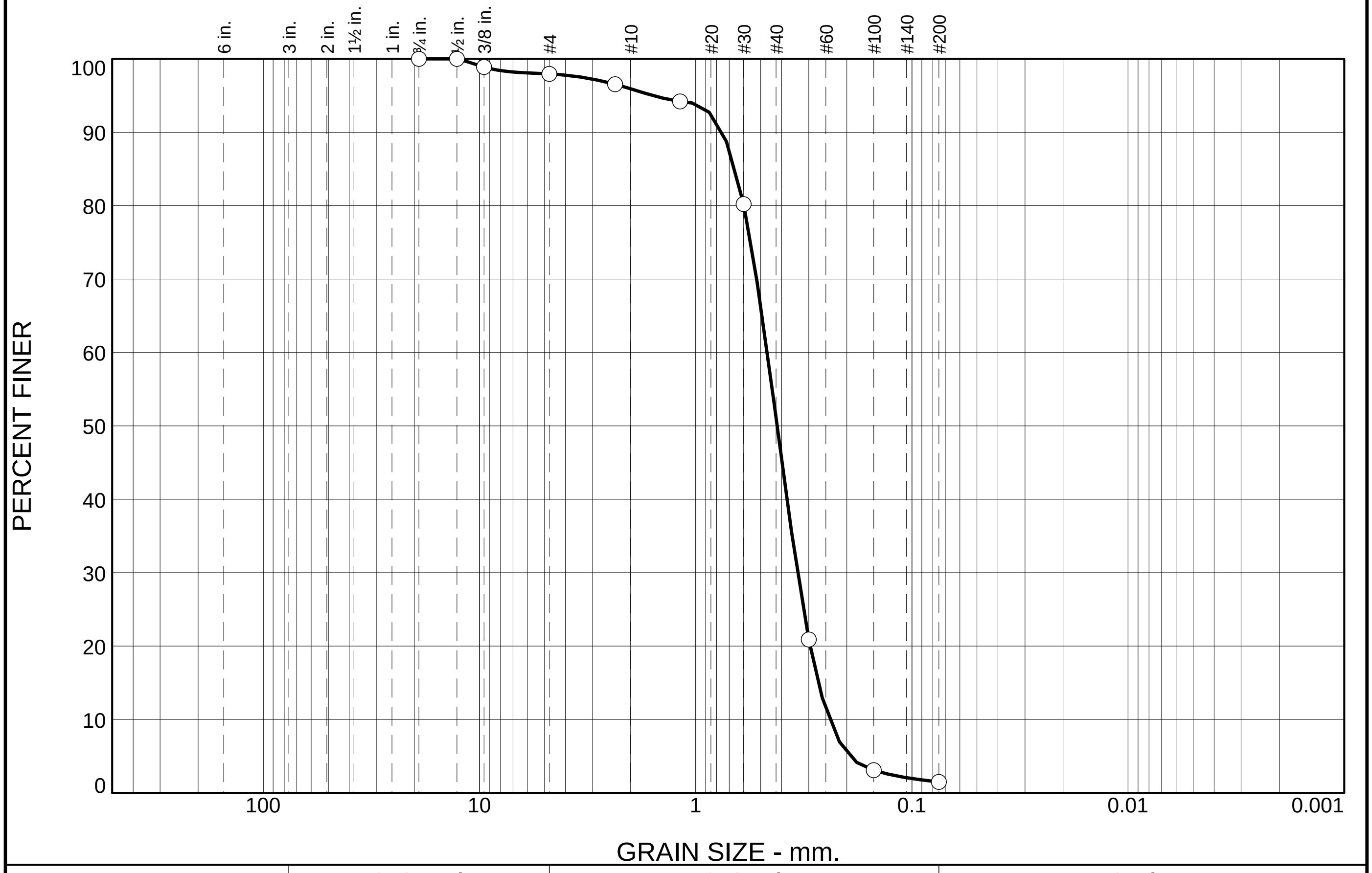
Remarks

Sample No.: SS-4 **Source of Sample:** B-72 **Date Sampled:** 11-10-2009
Location: **Elev./Depth:** 10
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-64

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.0	2.1	44.8	49.6	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	98.9		
#4	98.0		
#8	96.5		
#16	94.2		
#30	80.2		
#50	20.9		
#100	3.1		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.6552 D_{60}= 0.4665 D_{50}= 0.4200
D_{30}= 0.3381 D_{15}= 0.2712 D_{10}= 0.2409
C_u= 1.94 C_c= 1.02

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

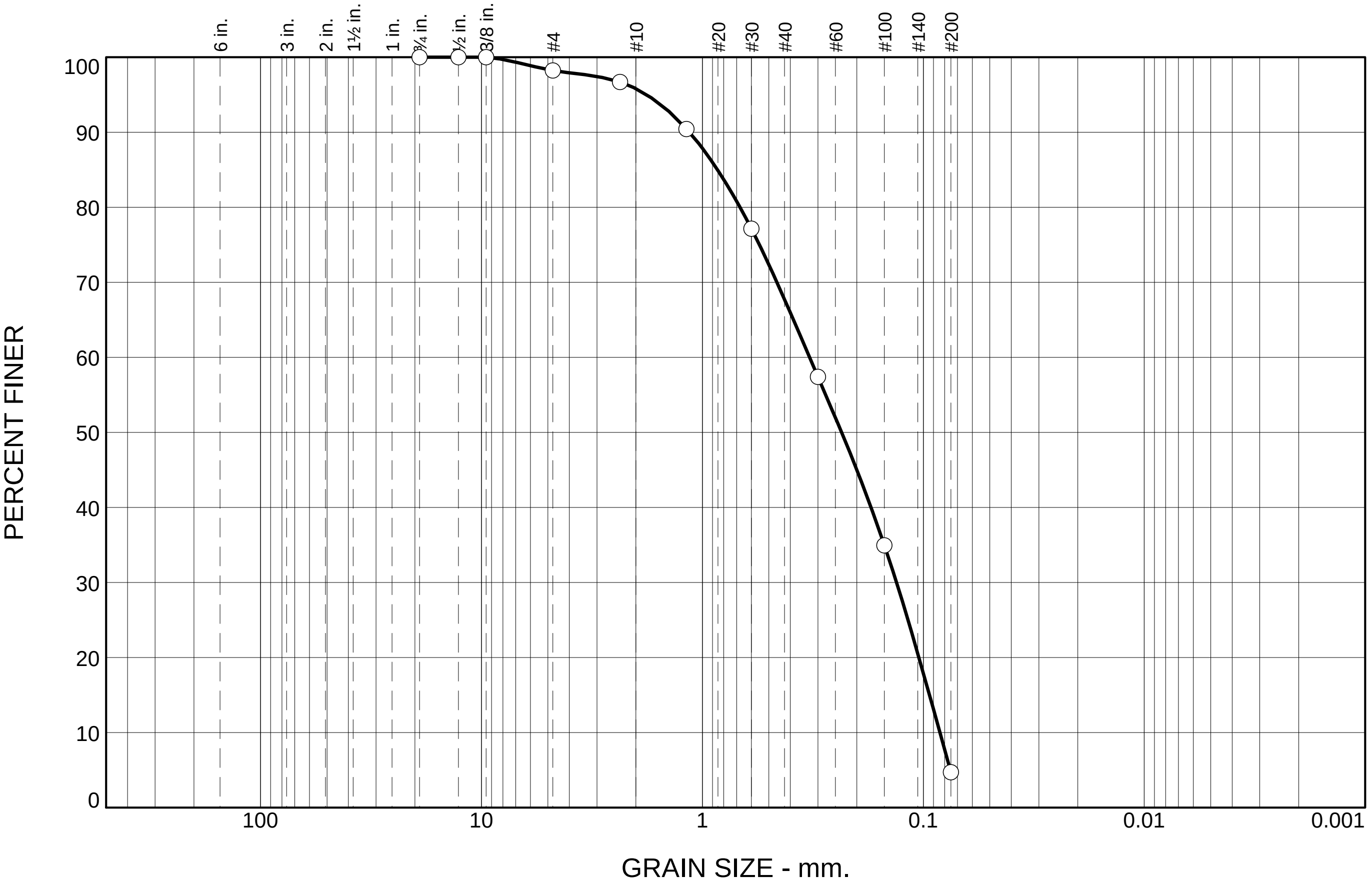
Sample No.: SS-6 **Source of Sample:** B-72 **Date Sampled:** 11-10-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-65

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	2.4	28.0	63.1	4.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.2		
#8	96.7		
#16	90.4		
#30	77.2		
#50	57.4		
#100	35.0		
#200	4.7		

* (no specification provided)

Material Description

SAND (SP), grayish tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.8538 D_{60}= 0.3271 D_{50}= 0.2345
D_{30}= 0.1322 D_{15}= 0.0937 D_{10}= 0.0840
C_u= 3.89 C_c= 0.64

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

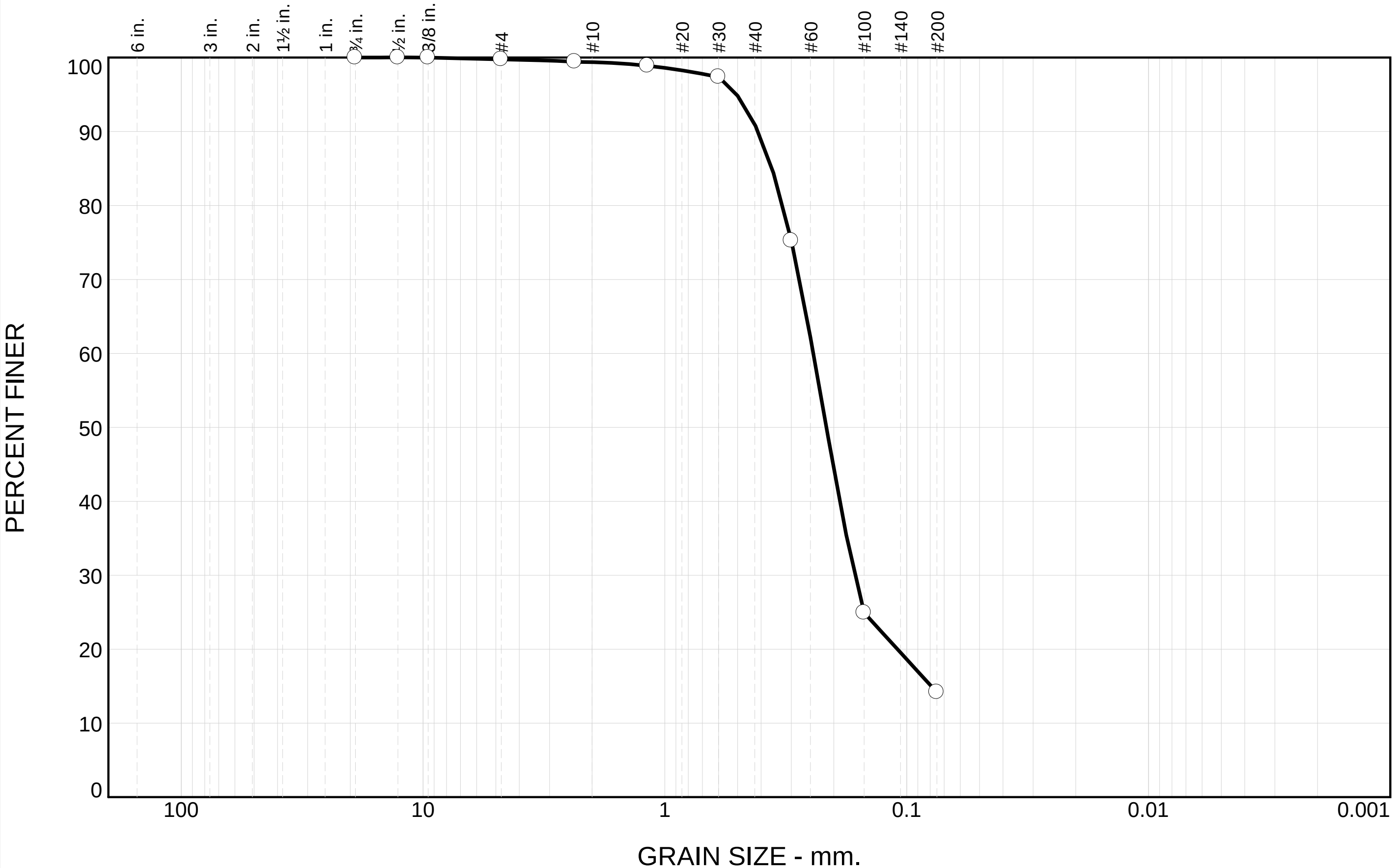
Sample No.: SS-9 **Source of Sample:** B-72 **Date Sampled:** 11-10-2009
Location: **Elev./Depth:** 33.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-66

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.3	8.4	76.8	14.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.7		
#8	99.4		
#16	98.9		
#30	97.4		
#50	75.2		
#100	24.9		
#200	14.2		

* (no specification provided)

Material Description
SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)
PL= LL= PI=

Classification
USCS= SP-SM AASHTO=

Coefficients
D_{85}= 0.3605 D_{60}= 0.2432 D_{50}= 0.2148
D_{30}= 0.1639 D_{15}= 0.0791 D_{10}=
C_u= C_c=

Date Tested: 12/4/09 **Tested By:** J. Pruett, C. Cook

Remarks

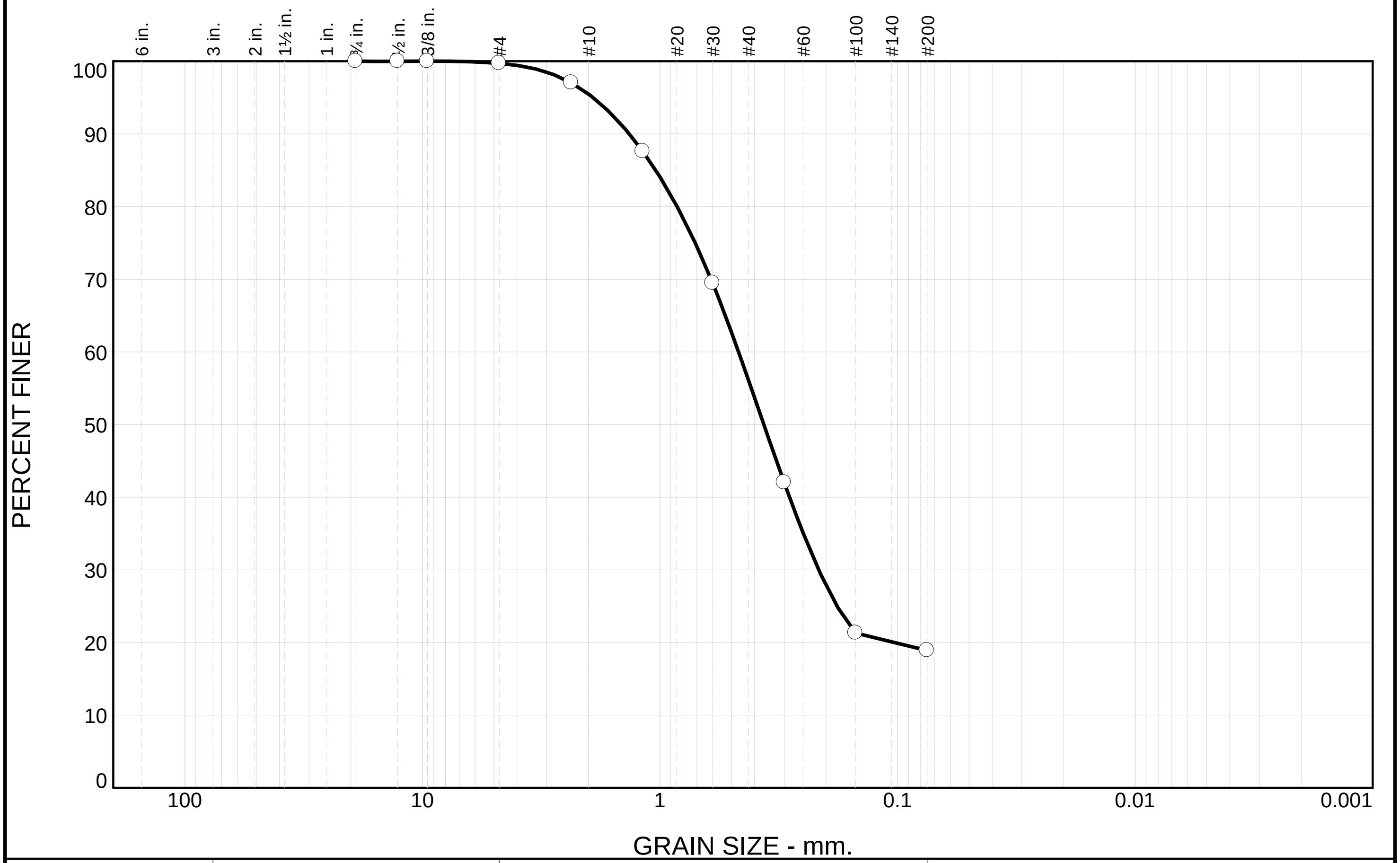
Sample No.: SS-4 **Source of Sample:** P-73 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-67

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	4.2	39.3	37.3	18.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.7		
#8	97.0		
#16	87.6		
#30	69.5		
#50	42.0		
#100	21.3		
#200	18.9		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 1.0422 D_{60}= 0.4670 D_{50}= 0.3655

D_{30}= 0.2148 D_{15}= D_{10}=

C_u= C_c=

Date Tested: 12/7/09 **Tested By:** J. Pruett, C. Cook

Remarks

Sample No.: SS-6 **Source of Sample:** P-73 **Date Sampled:**

Location: **Elev./Depth:** 35

Checked By: K. Kocher **Title:** Engineer

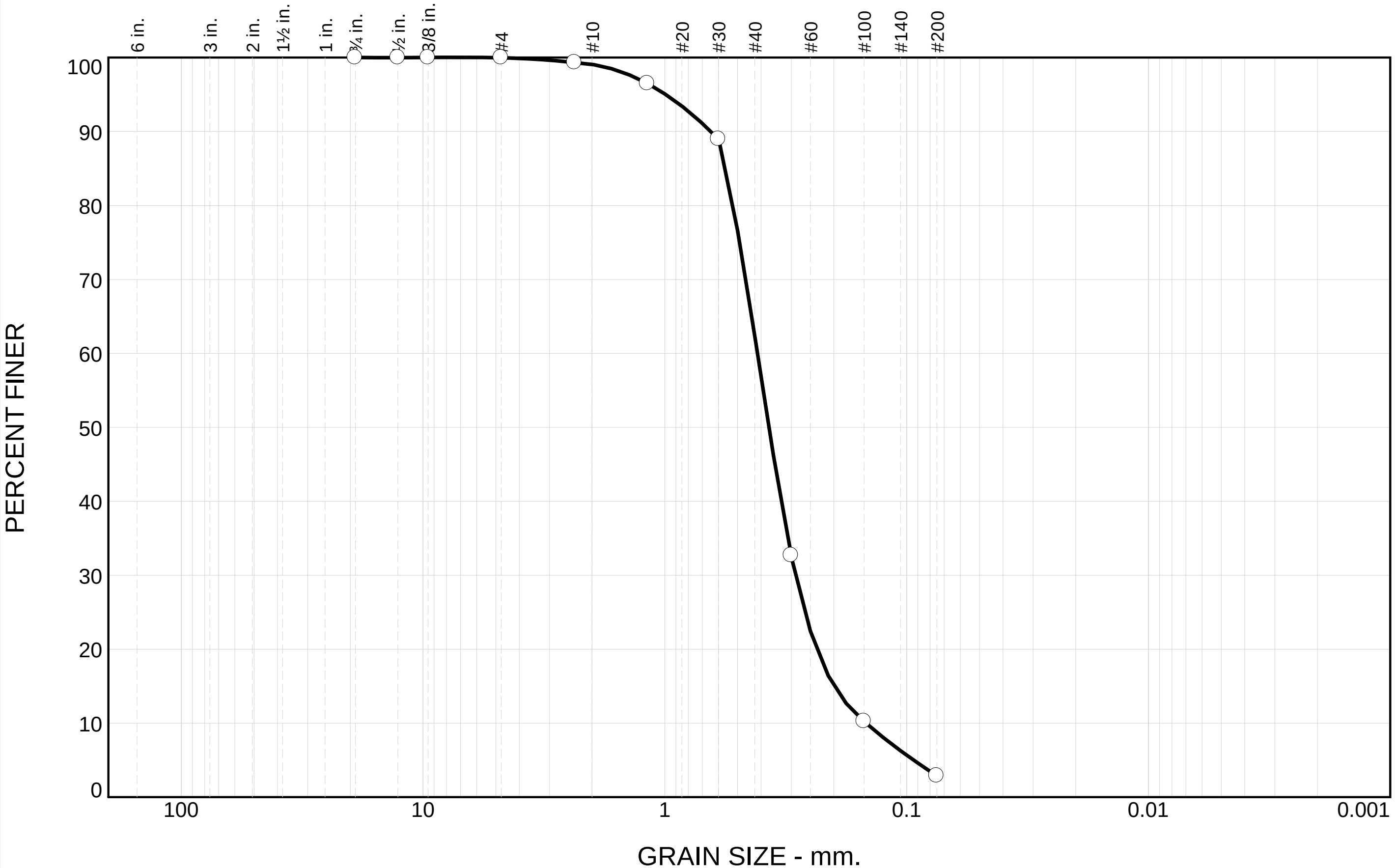
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-68

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.9	36.7	59.5	2.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.3		
#16	96.5		
#30	89.0		
#50	32.7		
#100	10.2		
#200	2.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5608 D_{60}= 0.4139 D_{50}= 0.3711
D_{30}= 0.2880 D_{15}= 0.1996 D_{10}= 0.1473
C_u= 2.81 C_c= 1.36

Date Tested: 12/7/09 **Tested By:** J. Pruett, C. Cook

Remarks

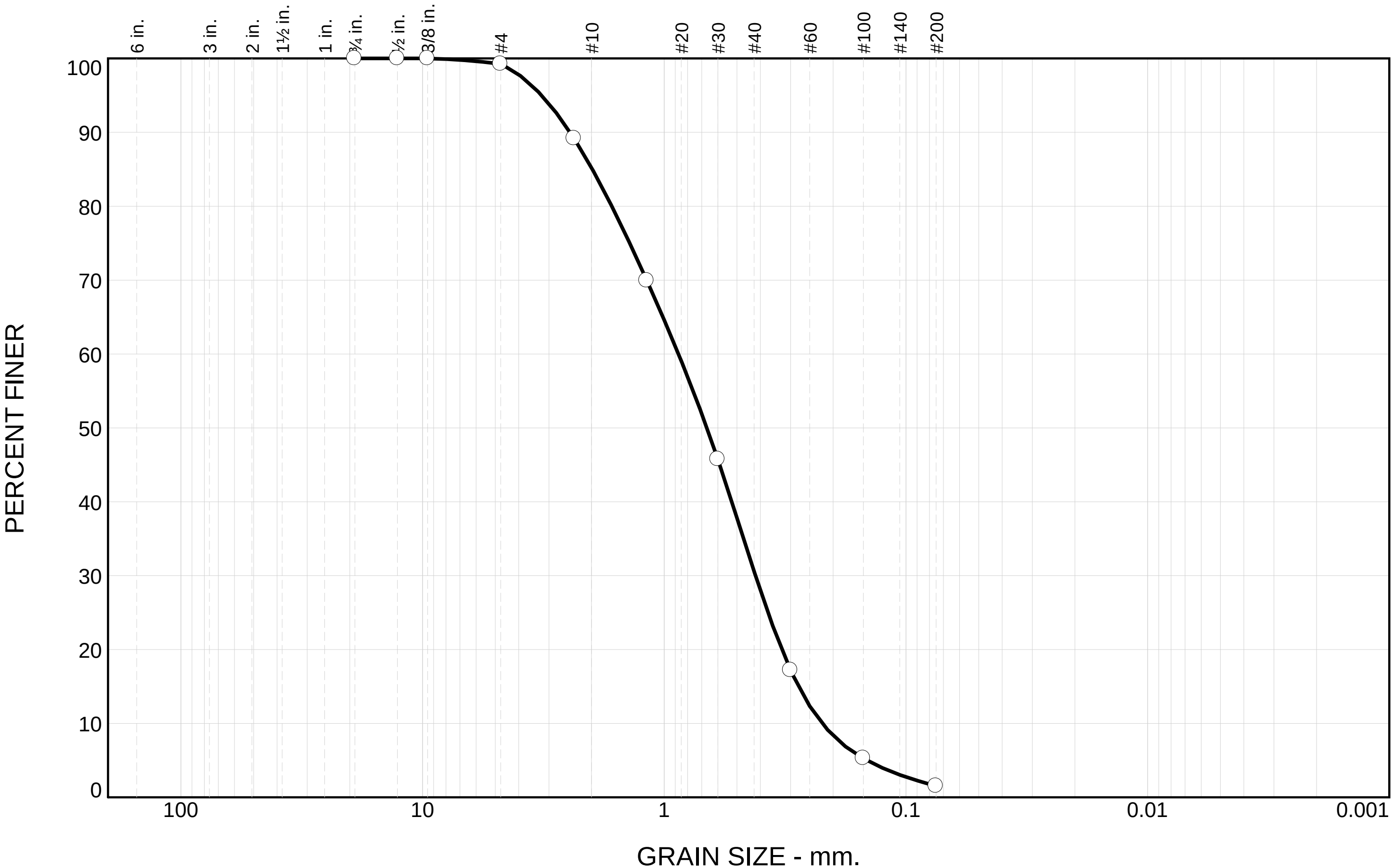
Sample No.: GS-3 **Source of Sample:** P-81 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-69

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	14.1	54.6	29.1	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.3		
#8	89.2		
#16	69.9		
#30	45.7		
#50	17.2		
#100	5.3		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.9824 D_{60}= 0.8731 D_{50}= 0.6661
D_{30}= 0.4190 D_{15}= 0.2785 D_{10}= 0.2223
C_u= 3.93 C_c= 0.90

Date Tested: 12/7/09 **Tested By:** J. Pruett

Remarks

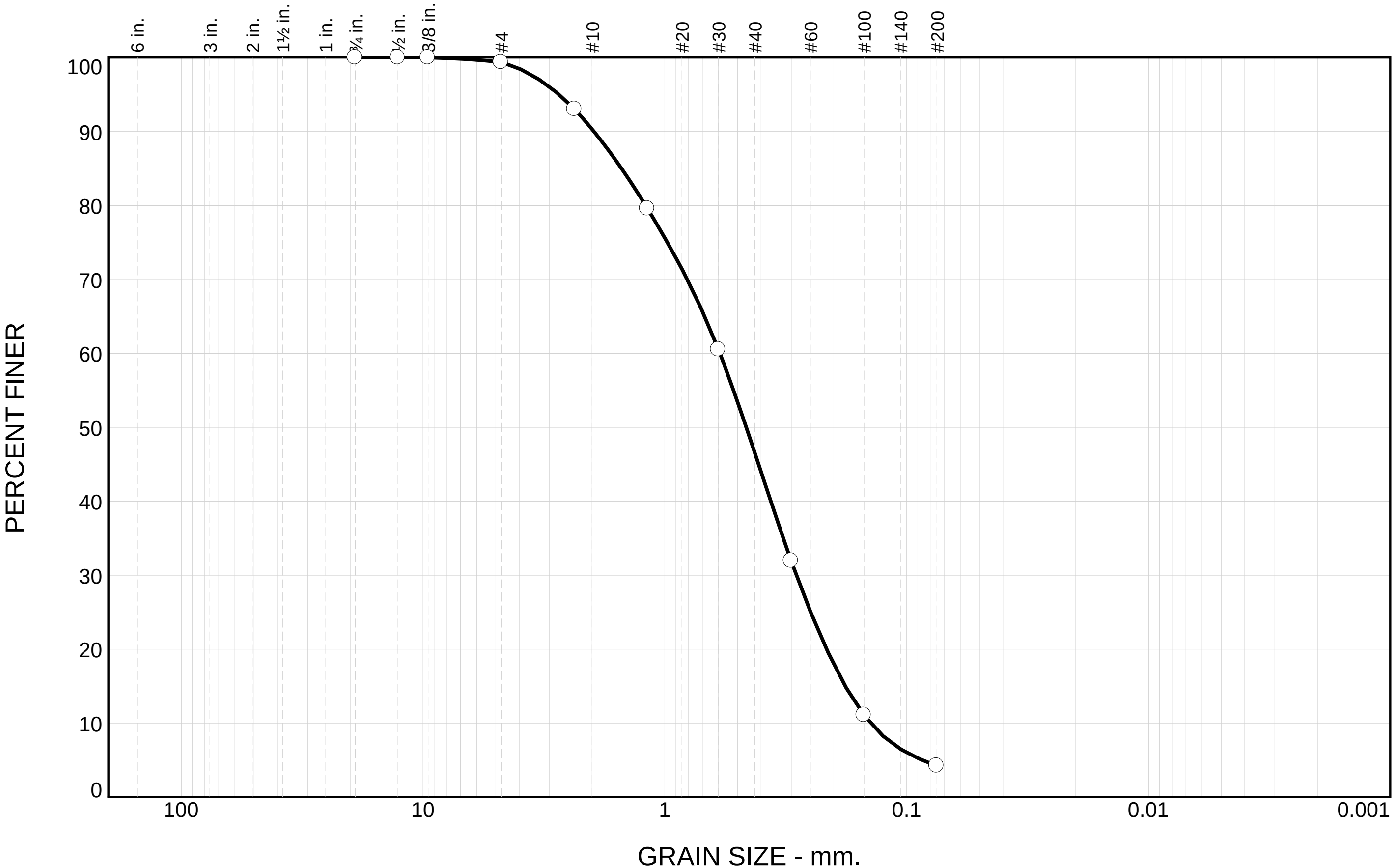
Sample No.: GS-4 **Source of Sample:** P-81 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-70

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	9.1	43.7	42.4	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.4		
#8	93.0		
#16	79.6		
#30	60.5		
#50	31.9		
#100	11.1		
#200	4.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.5126 D_{60}= 0.5919 D_{50}= 0.4606
D_{30}= 0.2856 D_{15}= 0.1794 D_{10}= 0.1411
C_u= 4.19 C_c= 0.98

Date Tested: 12/7/09 **Tested By:** J. Pruett

Remarks

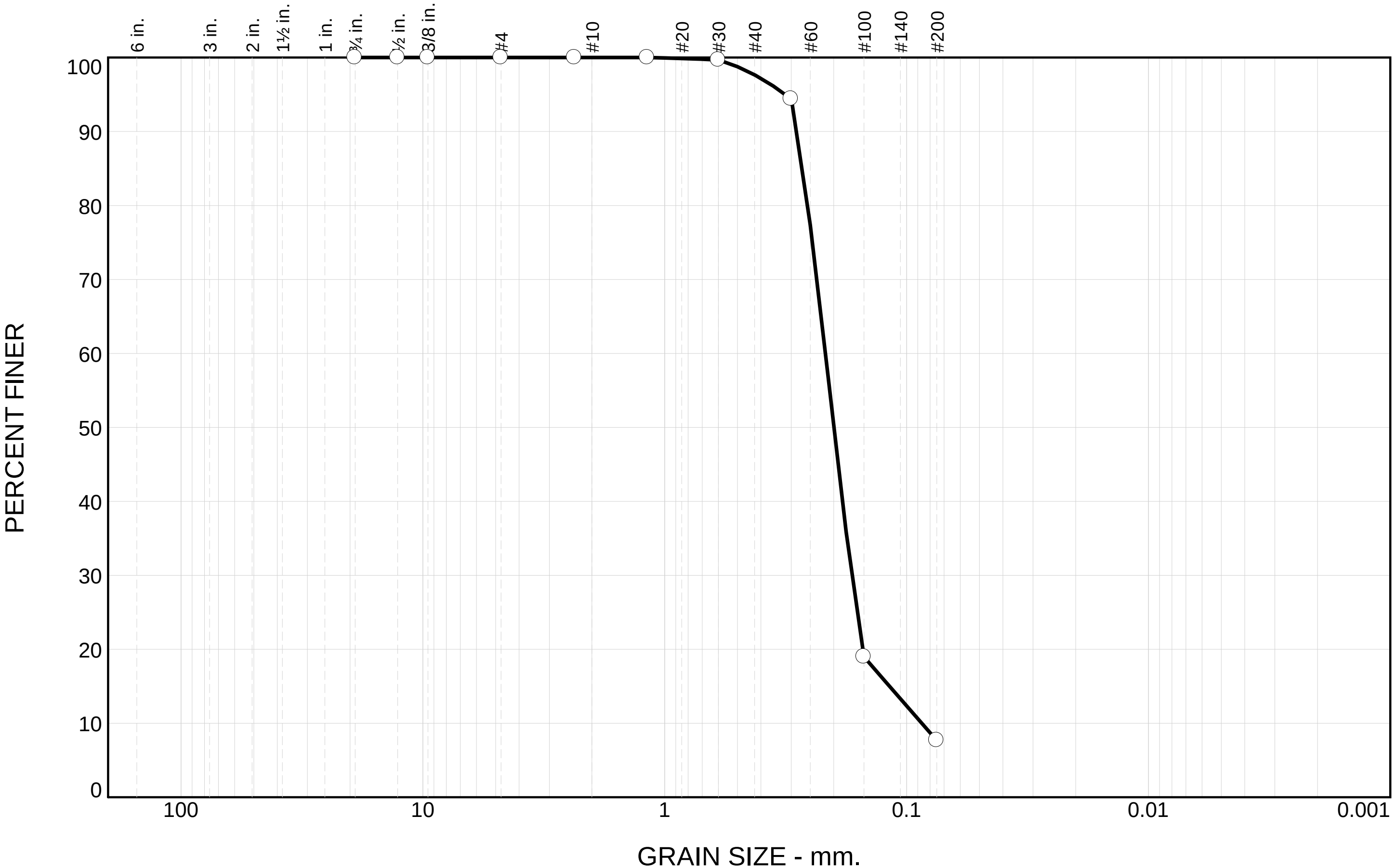
Sample No.: GS-5 **Source of Sample:** P-81 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-71

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.3	90.0	7.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.7		
#50	94.4		
#100	19.0		
#200	7.7		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2688 D_{60}= 0.2164 D_{50}= 0.1998
D_{30}= 0.1686 D_{15}= 0.1176 D_{10}= 0.0865
C_u= 2.50 C_c= 1.52

Date Tested: 12/7/09 **Tested By:** J. Pruett, C. Cook

Remarks

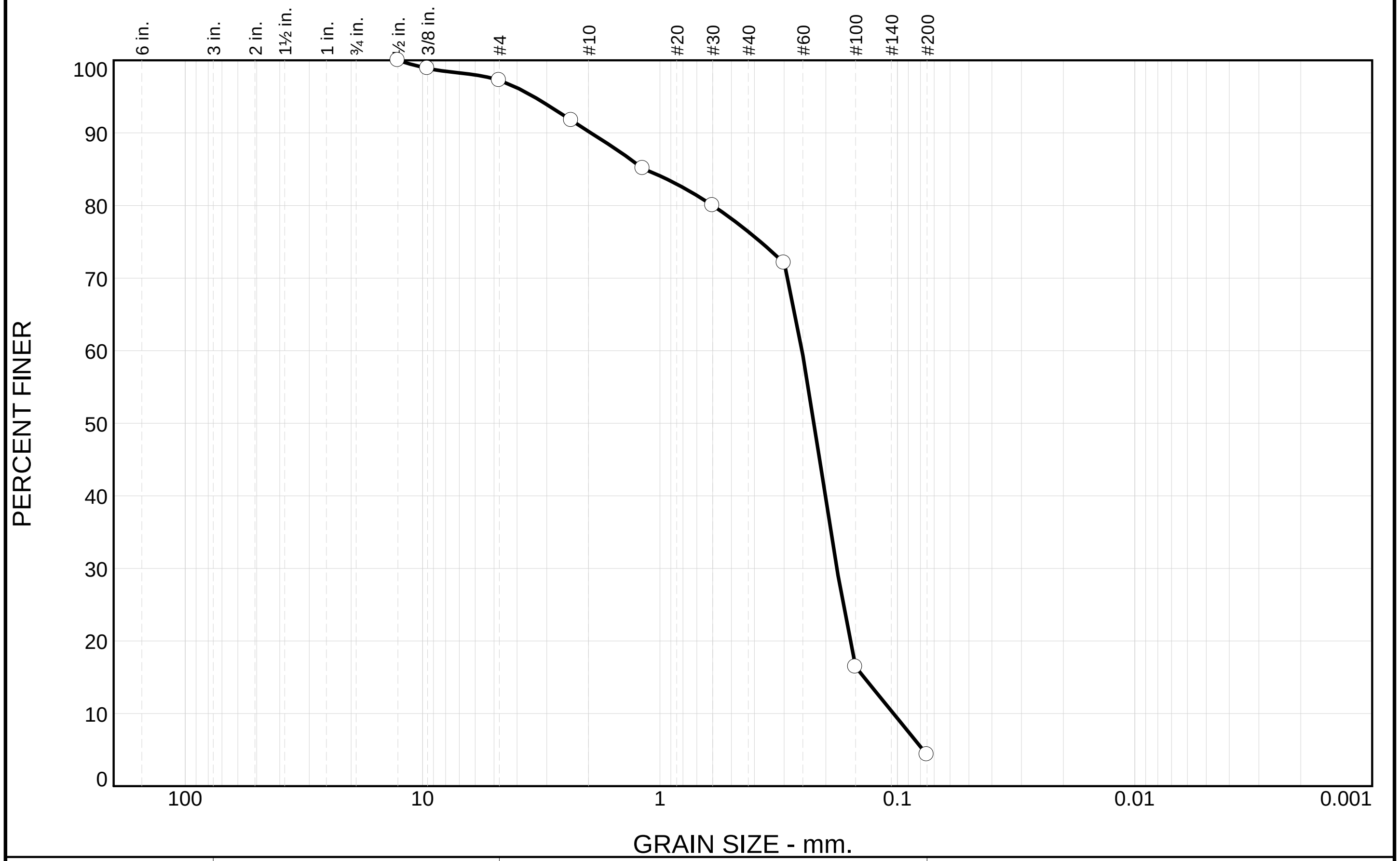
Sample No.: SS-5 **Source of Sample:** P-85 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-72

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	7.0	13.8	72.1	4.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.9		
#4	97.2		
#8	91.7		
#16	85.1		
#30	80.0		
#50	72.1		
#100	16.4		
#200	4.3		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.1601 D_{60}= 0.2520 D_{50}= 0.2245
D_{30}= 0.1799 D_{15}= 0.1382 D_{10}= 0.1038
C_u= 2.43 C_c= 1.24

Date Tested: 12-11-09 **Tested By:** C. Cook/J. Pruett

Remarks

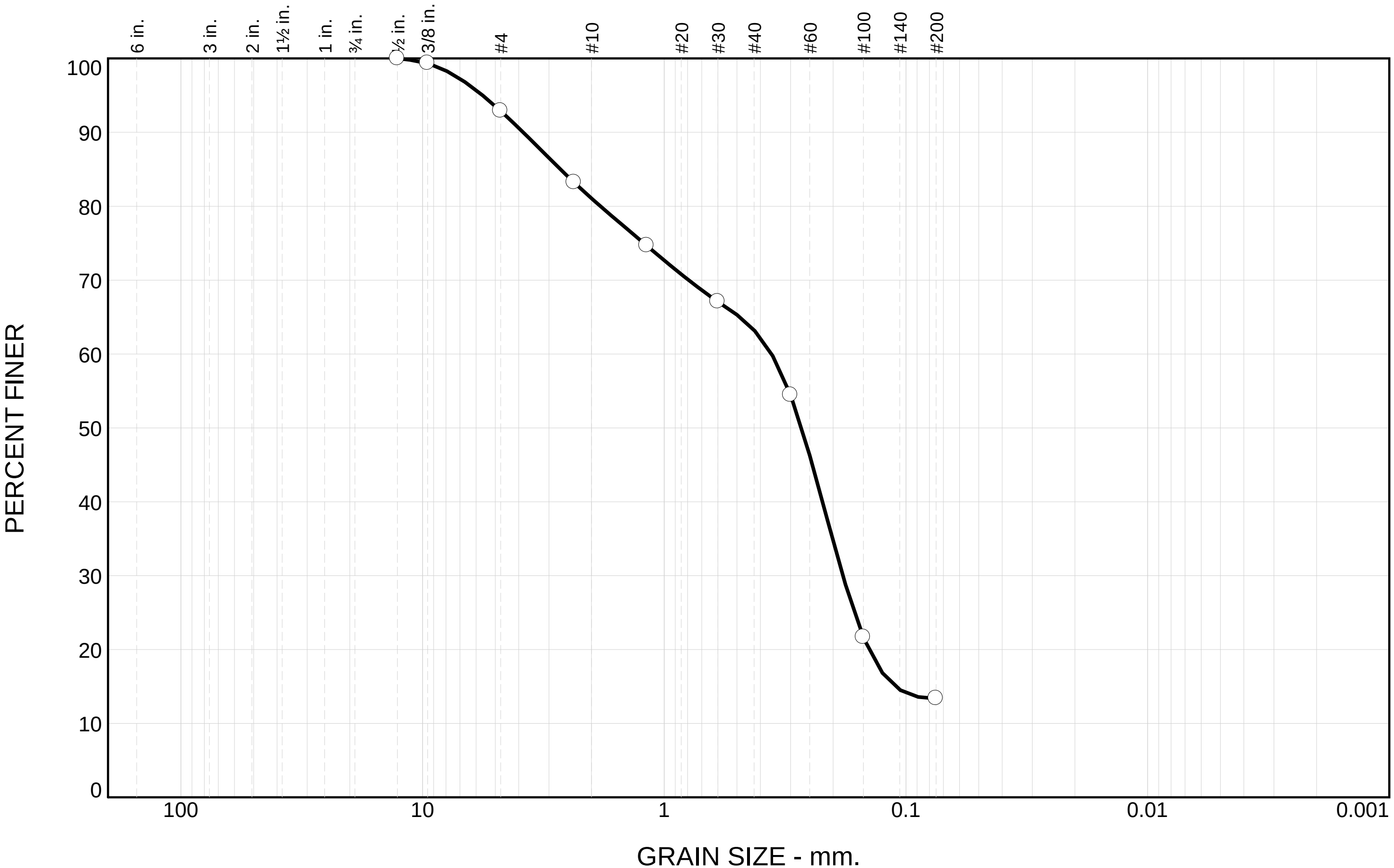
Sample No.: SS-6 **Source of Sample:** P-85 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-73

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.1	11.8	17.9	49.8	13.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	99.3		
#4	92.9		
#8	83.2		
#16	74.7		
#30	67.1		
#50	54.4		
#100	21.7		
#200	13.4		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 2.6867 D_{60}= 0.3596 D_{50}= 0.2701
D_{30}= 0.1823 D_{15}= 0.1108 D_{10}=
C_u= C_c=

Date Tested: 12-11-09 **Tested By:** C. Cook/J. Pruett

Remarks

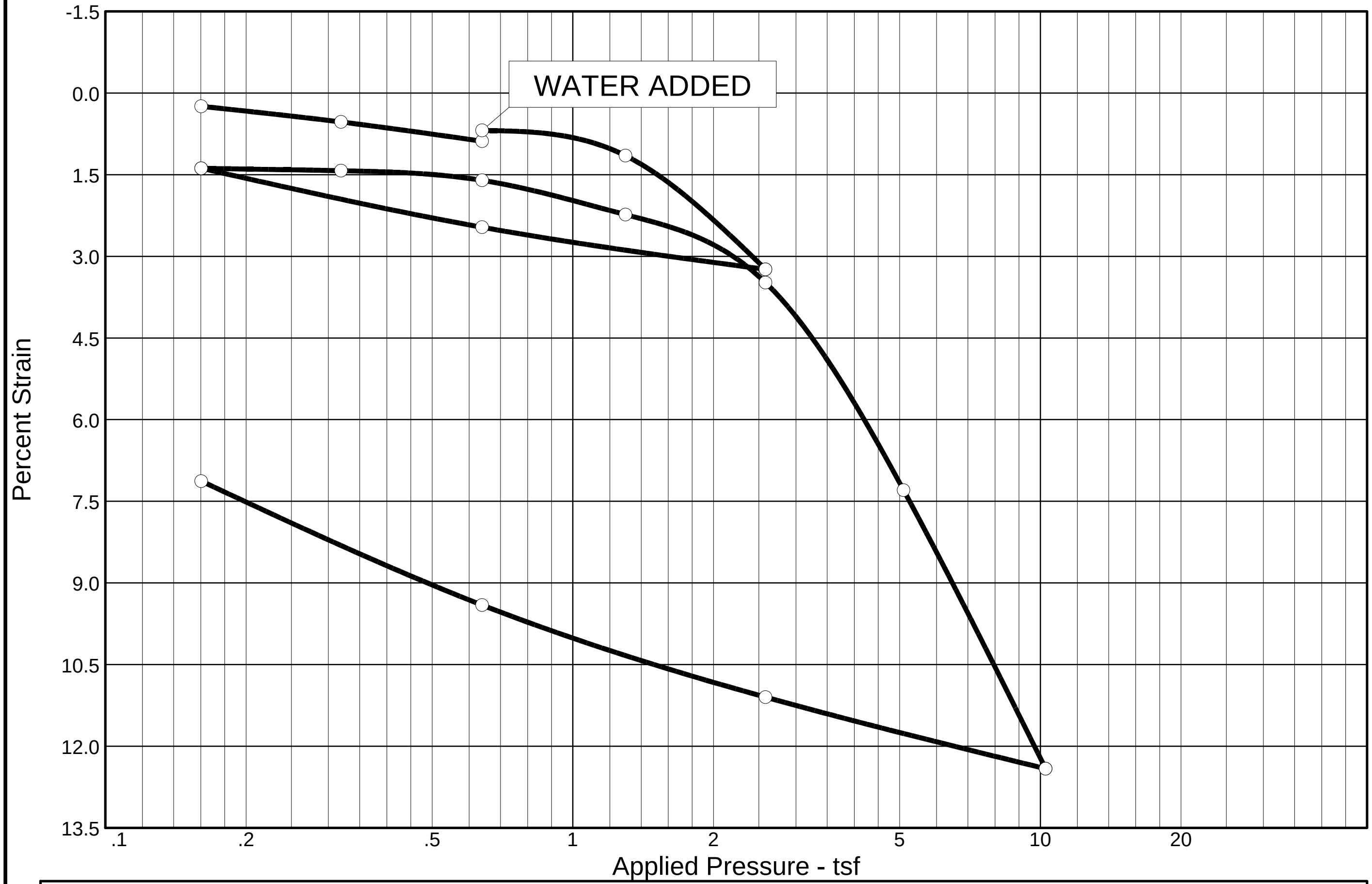
Sample No.: SS-7 **Source of Sample:** P-85 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-74

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
1	0.16	0.07	0.001	11	1.30	0.03	0.001				
2	0.32	0.10	0.001	12	2.58	0.02	0.002				
3	0.64	0.03	0.002	13	5.10	0.01	0.007				
4	0.64	0.02	0.000	14	10.26	0.01	0.004				
5	1.30	0.01	0.001	15	2.58	0.01					
6	2.58	0.02	0.004	16	0.64	0.00					
7	0.64	0.01		17	0.16	0.00					
8	0.16	0.01									
9	0.32	0.01	0.000								
10	0.64	0.01	0.000								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
Sat.	Moist.											
97.8 %	31.5 %	89.9	66	42	2.68	0.24	2.38	0.32	0.04	1.08	0.2	0.862

MATERIAL DESCRIPTION	USCS	AASHTO
CLAY (CH), dark grayish brown, stiff, high plastic, trace of lignite, saturated	CH	

Project No. 2008012455 **Client:** Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source: B-92 **Sample No.:** ST-2 **Elev./Depth:** 3

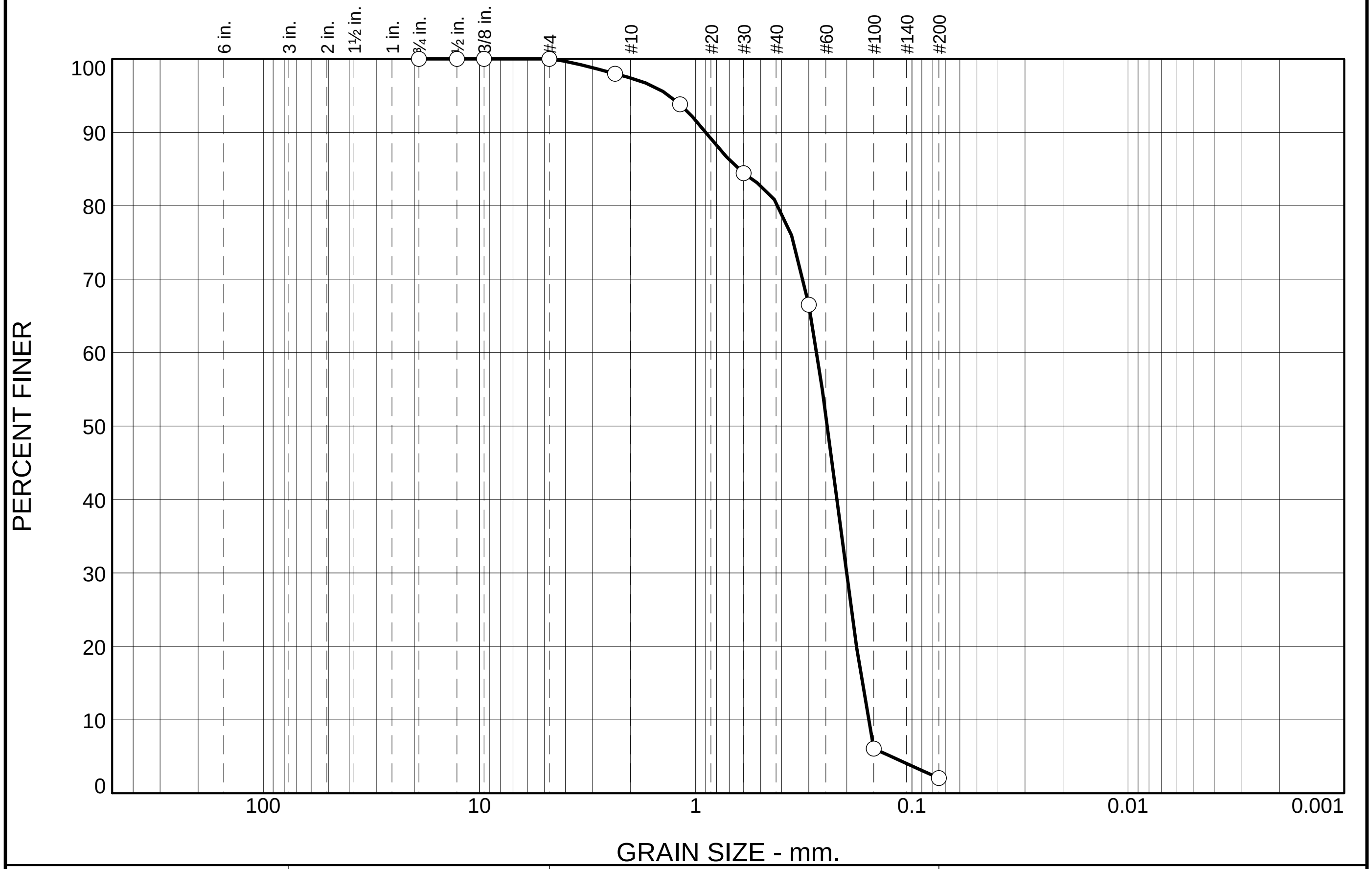
Remarks:

Assumed specific gravity

REITZ & JENS, INC.
CONSULTING ENGINEERS

Figure B-75

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.6	16.9	78.4	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	98.0		
#16	93.8		
#30	84.4		
#50	66.5		
#100	6.1		
#200	2.1		

* (no specification provided)

Material Description

SAND (SP), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.6319 D_{60}= 0.2752 D_{50}= 0.2460
D_{30}= 0.2008 D_{15}= 0.1702 D_{10}= 0.1594
C_u= 1.73 C_c= 0.92

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

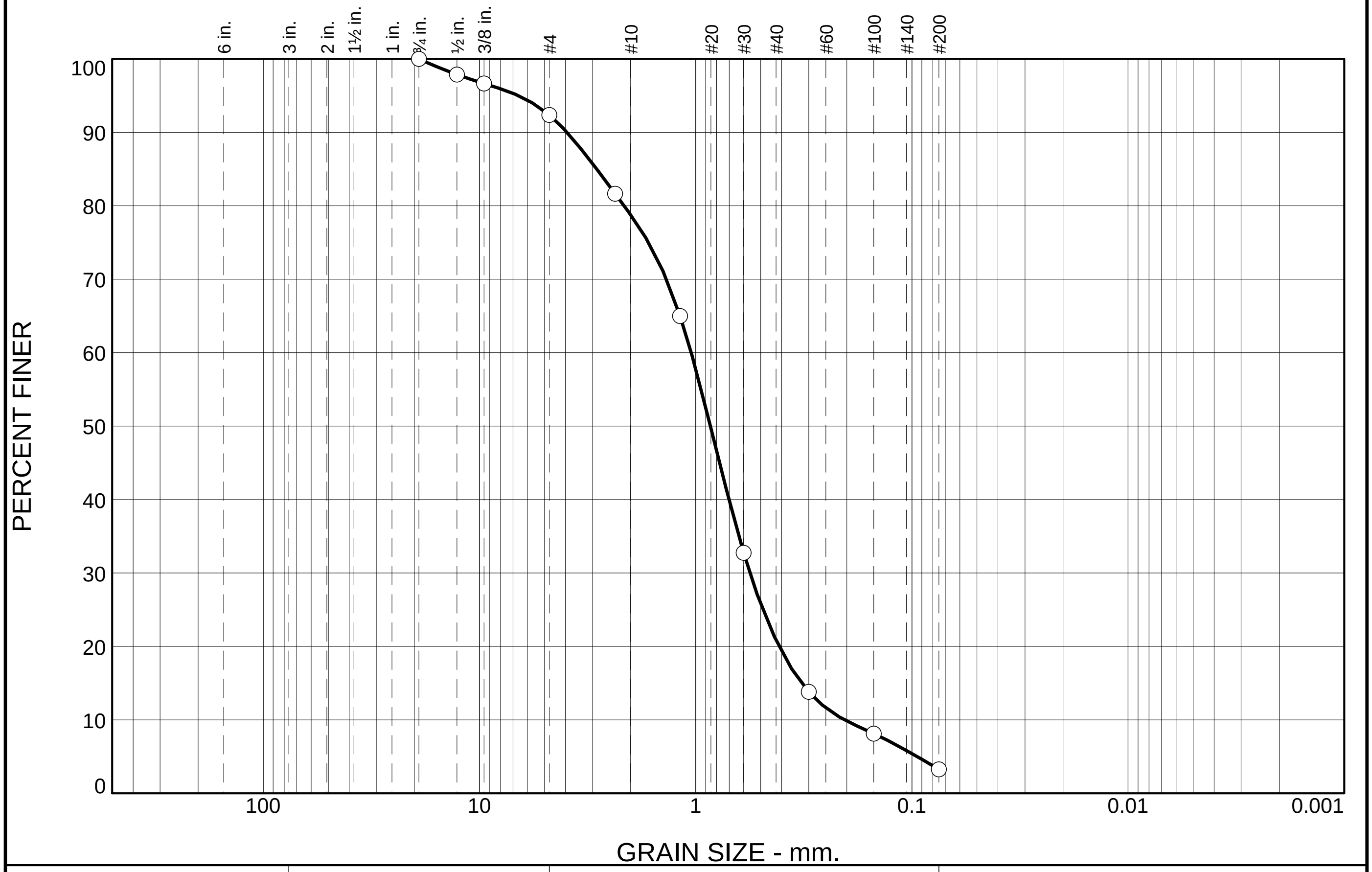
Sample No.: SS-6 **Source of Sample:** B-92 **Date Sampled:** 11-09-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-76

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.6	13.6	57.9	17.6	3.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	97.9		
3/8	96.7		
#4	92.4		
#8	81.7		
#16	65.0		
#30	32.8		
#50	13.8		
#100	8.1		
#200	3.3		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.8687 D_{60}= 1.0485 D_{50}= 0.8542

D_{30}= 0.5612 D_{15}= 0.3235 D_{10}= 0.2048

C_u= 5.12 C_c= 1.47

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

Sample No.: SS-10 **Source of Sample:** B-92 **Date Sampled:** 11-09-2009

Location: **Elev./Depth:** 33.5

Checked By: K. Kocher **Title:** Engineer

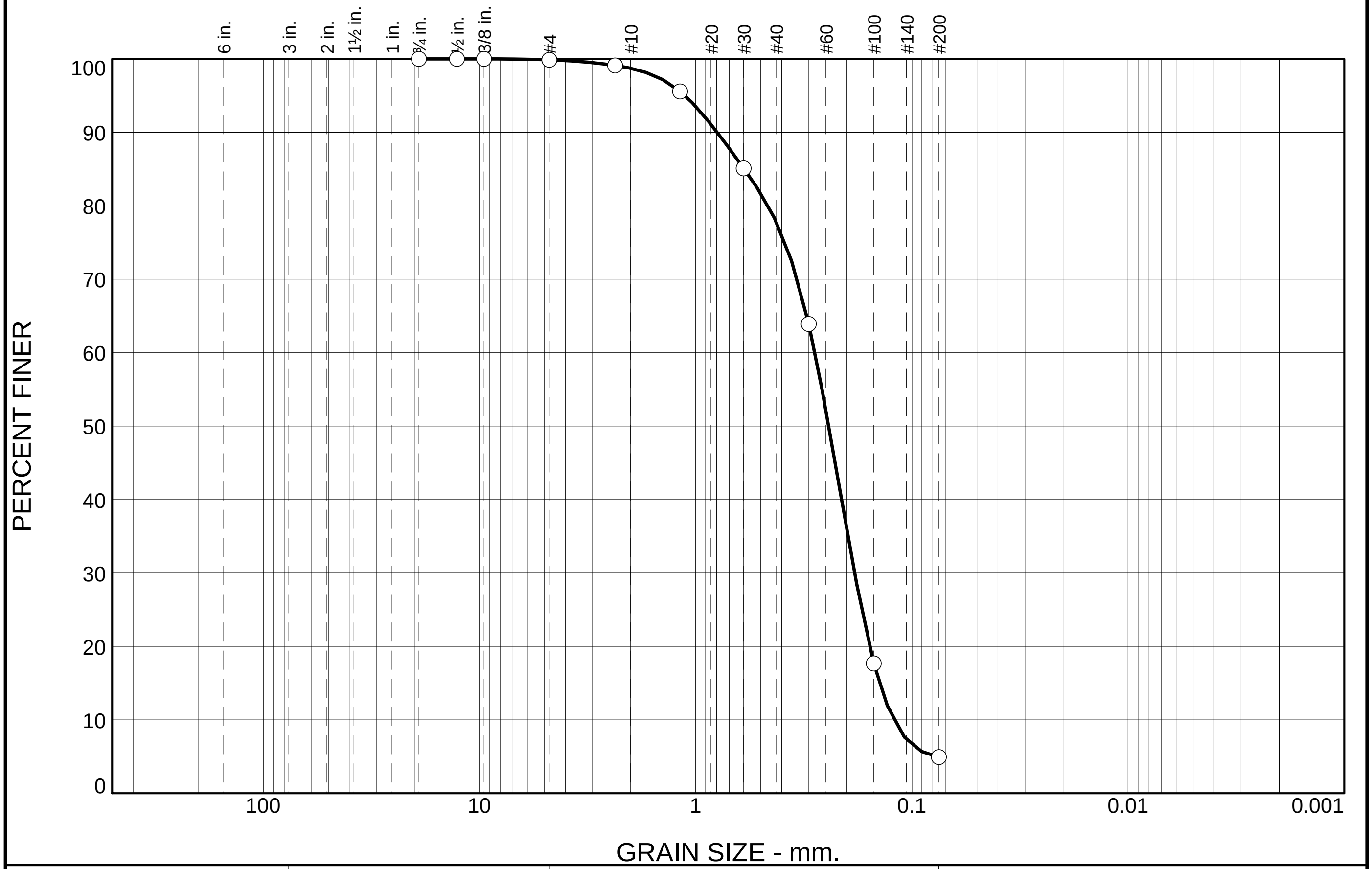
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-77

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	1.2	20.8	73.0	4.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.9		
#8	99.1		
#16	95.6		
#30	85.1		
#50	63.9		
#100	17.7		
#200	4.9		

* (no specification provided)

Material Description

SAND (SP), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5965 D_{60}= 0.2810 D_{50}= 0.2425
D_{30}= 0.1841 D_{15}= 0.1413 D_{10}= 0.1214
C_u= 2.31 C_c= 0.99

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

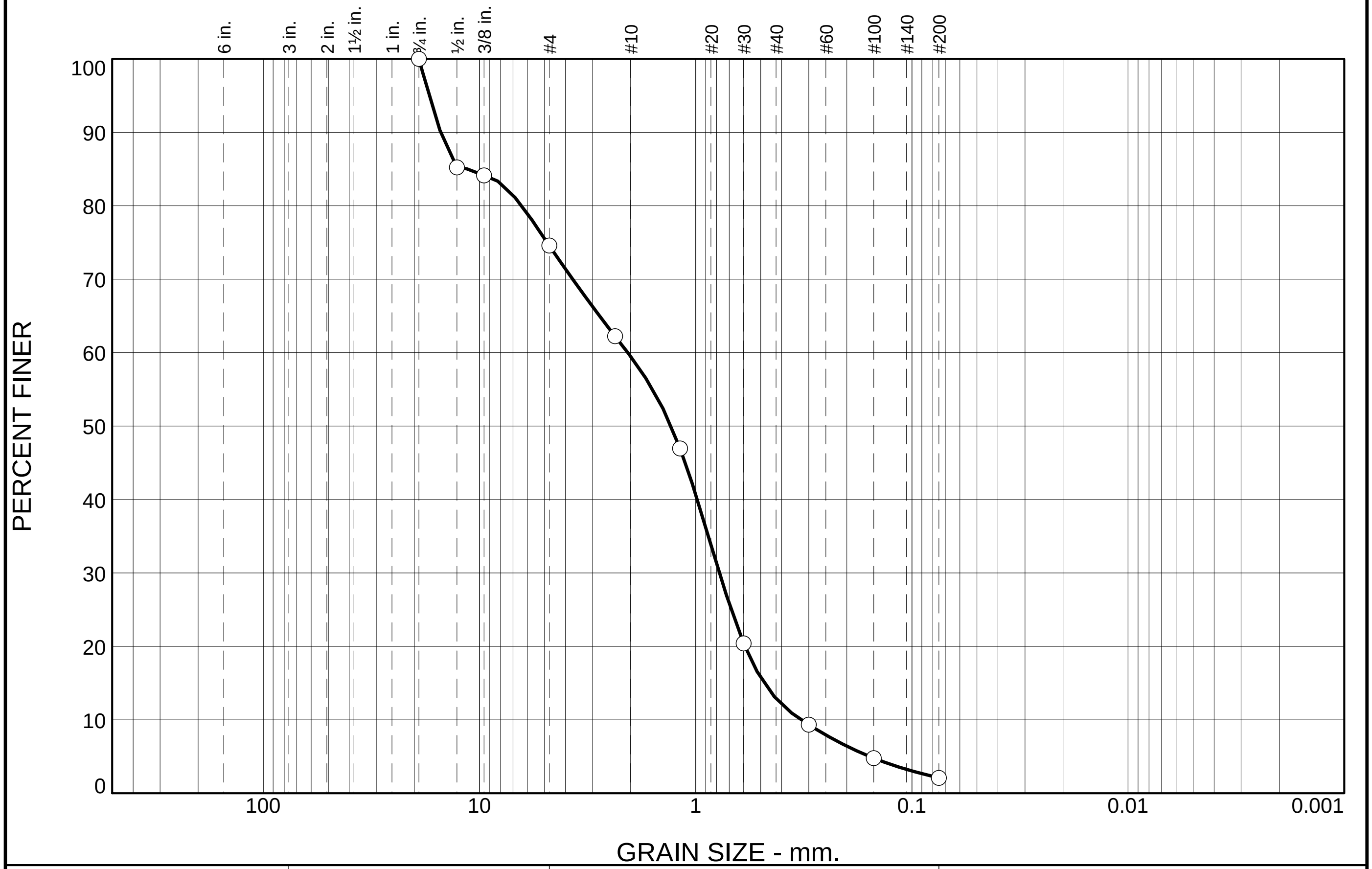
Sample No.: SS-6 **Source of Sample:** B-100 **Date Sampled:** 11-11-2009
Location: **Elev./Depth:** 15
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-78

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	25.4	15.1	46.6	10.8	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	85.2		
3/8	84.1		
#4	74.6		
#8	62.3		
#16	47.0		
#30	20.4		
#50	9.3		
#100	4.8		
#200	2.1		

* (no specification provided)

Material Description

Gravelly SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 11.3187 D_{60}= 2.0595 D_{50}= 1.2986
D_{30}= 0.7759 D_{15}= 0.4820 D_{10}= 0.3250
C_u= 6.34 C_c= 0.90

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

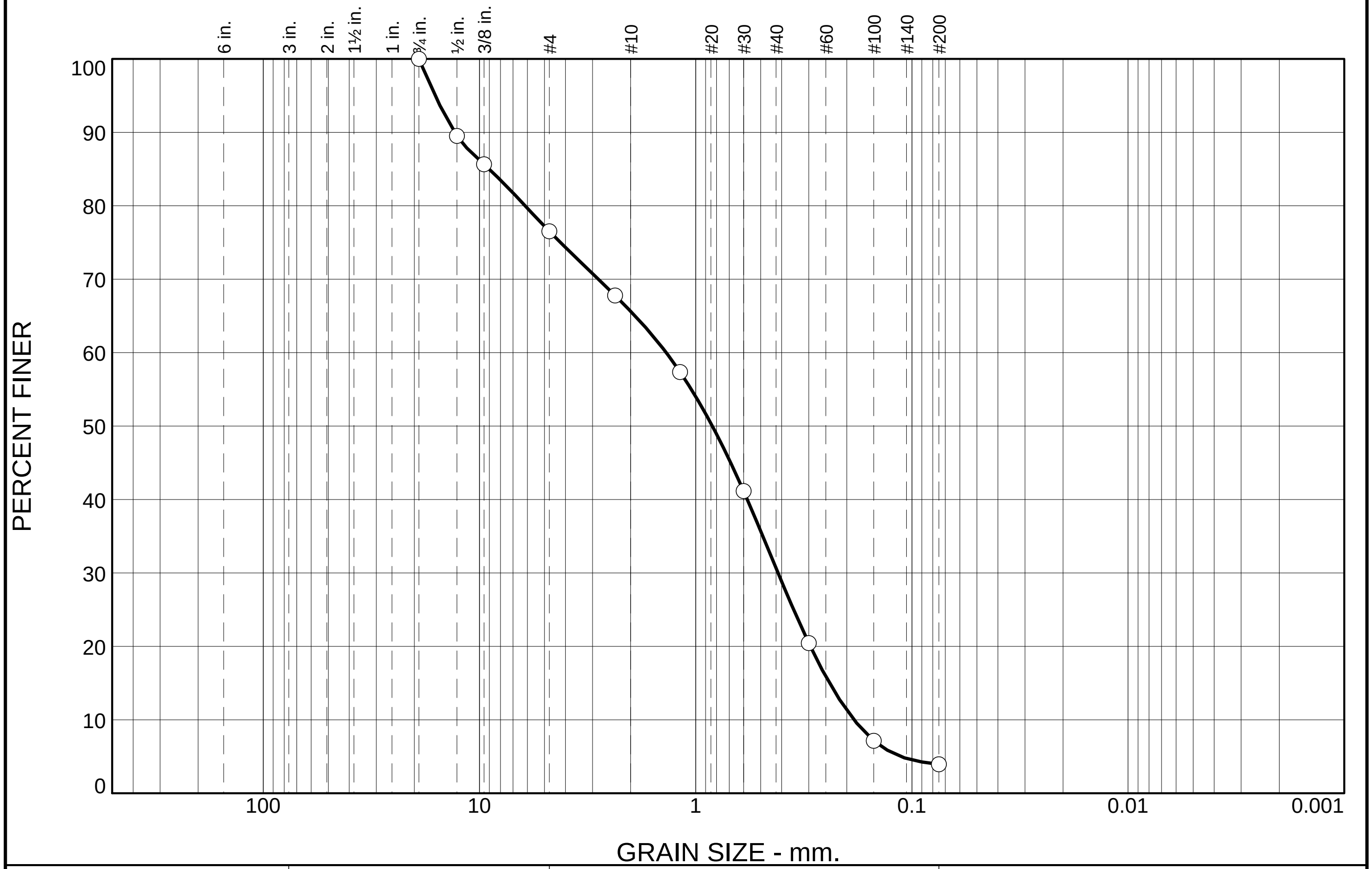
Sample No.: SS-9 **Source of Sample:** B-100 **Date Sampled:** 11-12-2009
Location: **Elev./Depth:** 31.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-79

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	23.5	10.9	34.9	26.7	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	89.5		
3/8	85.7		
#4	76.5		
#8	67.8		
#16	57.4		
#30	41.2		
#50	20.4		
#100	7.2		
#200	4.0		

* (no specification provided)

Material Description

Gravelly SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 9.0157 D_{60}= 1.3675 D_{50}= 0.8376
D_{30}= 0.4157 D_{15}= 0.2404 D_{10}= 0.1853
C_u= 7.38 C_c= 0.68

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

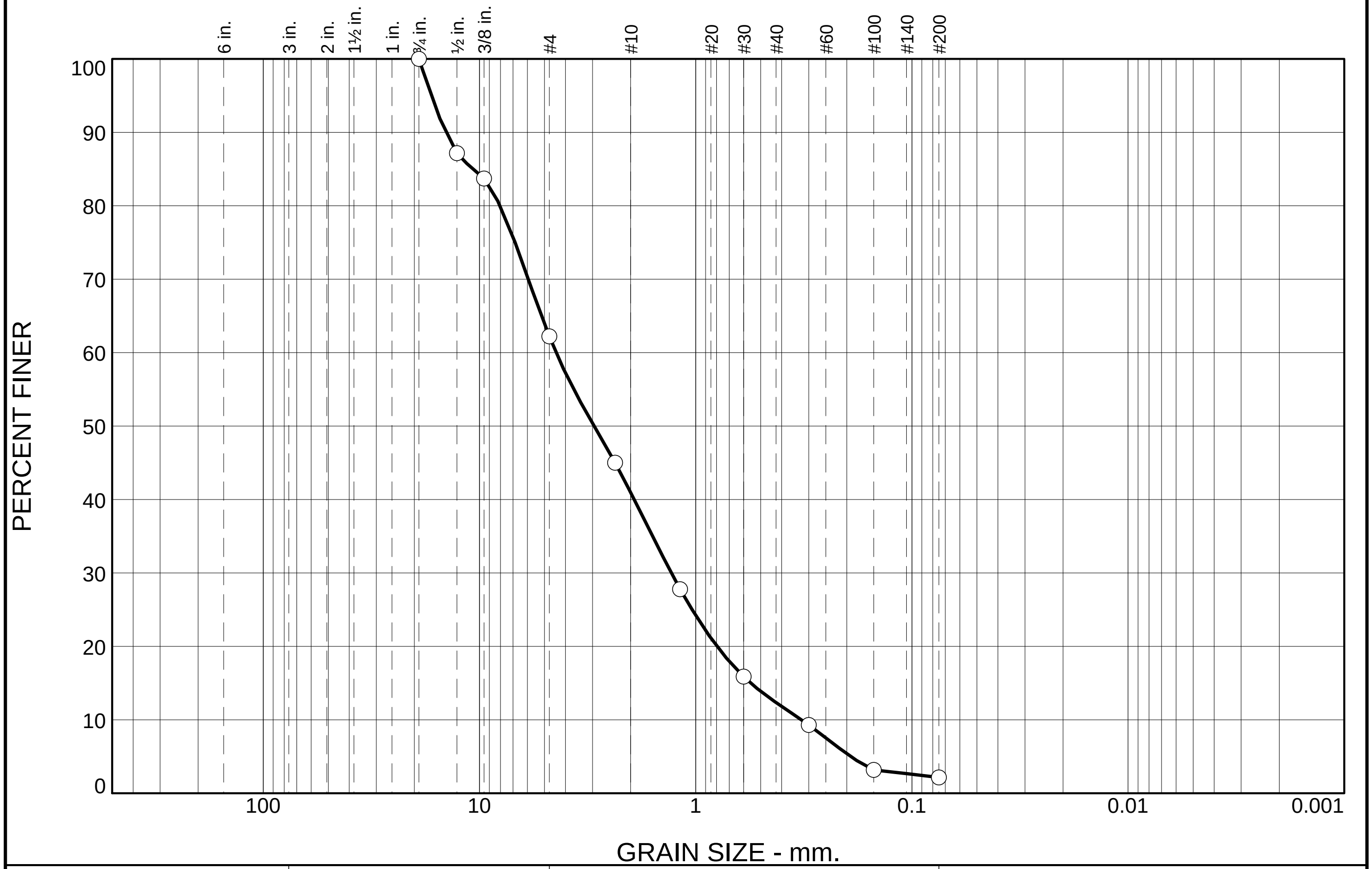
Sample No.: SS-12 **Source of Sample:** B-100 **Date Sampled:** 11-12-2009
Location:
Elev./Depth: 43.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-80

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	37.8	21.2	28.6	10.2	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	87.2		
3/8	83.7		
#4	62.2		
#8	45.0		
#16	27.8		
#30	15.9		
#50	9.3		
#100	3.2		
#200	2.2		

* (no specification provided)

Material Description

SAND (SW), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SW AASHTO=

Coefficients

D_{85}= 10.5973 D_{60}= 4.4167 D_{50}= 2.9470
D_{30}= 1.2957 D_{15}= 0.5560 D_{10}= 0.3236
C_u= 13.65 C_c= 1.17

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

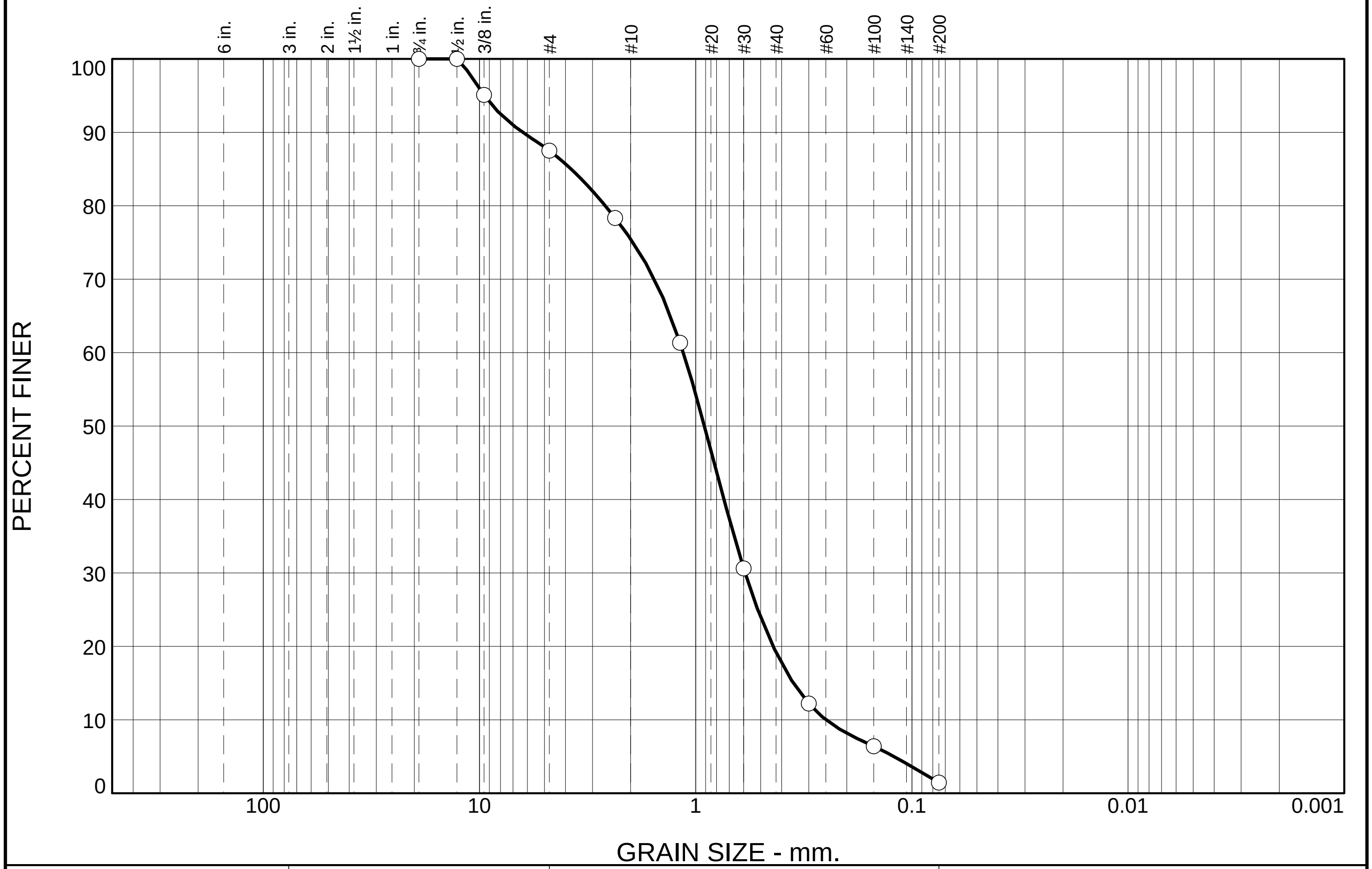
Sample No.: SS-16 **Source of Sample:** B-100 **Date Sampled:** 11-12-2009
Location: **Elev./Depth:** 78.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-81

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	12.5	12.0	56.3	17.7	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	95.1		
#4	87.5		
#8	78.3		
#16	61.3		
#30	30.6		
#50	12.2		
#100	6.4		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 3.7656 D_{60}= 1.1402 D_{50}= 0.9105
D_{30}= 0.5907 D_{15}= 0.3534 D_{10}= 0.2496
C_u= 4.57 C_c= 1.23

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

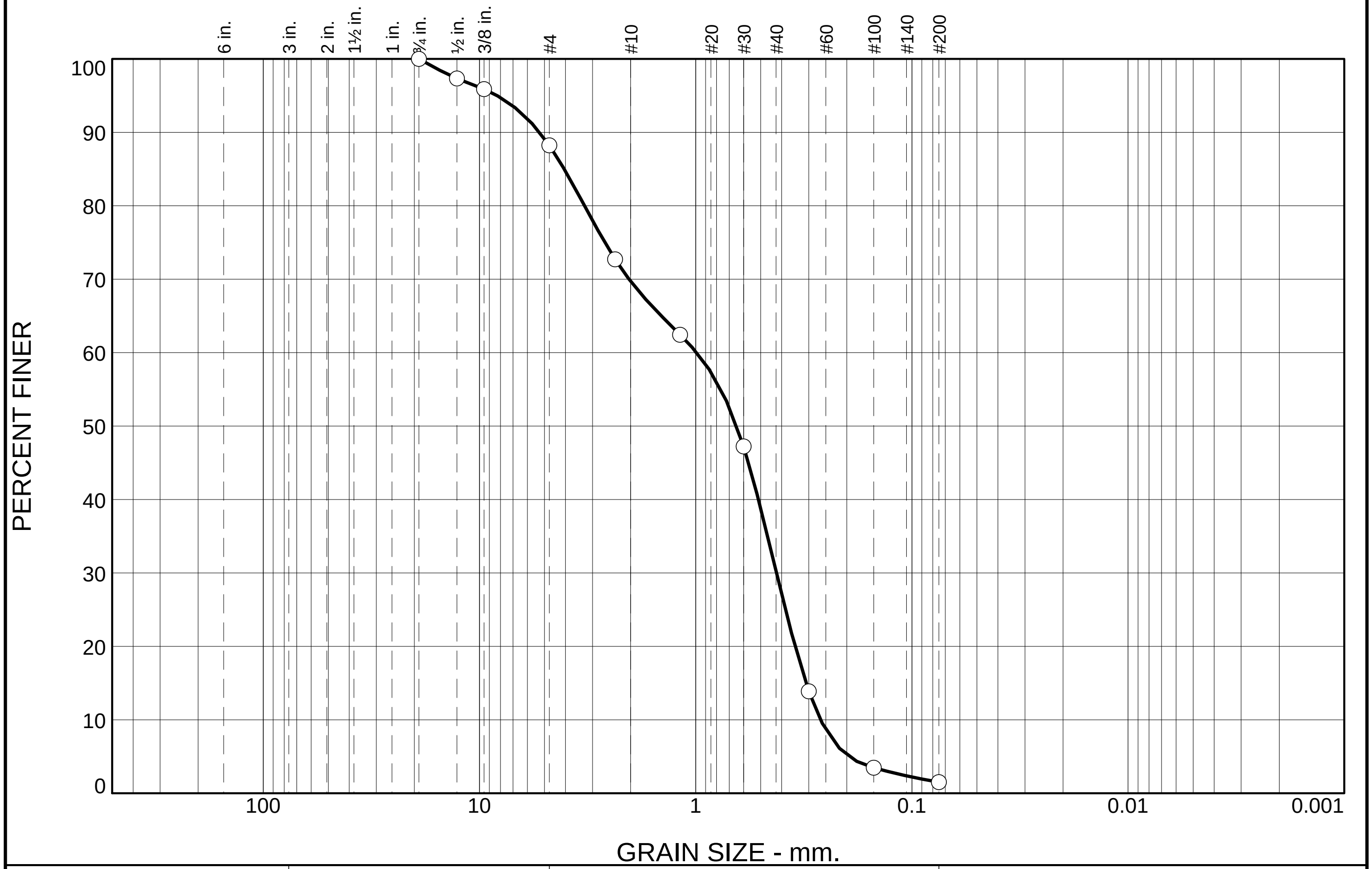
Sample No.: SS-8 **Source of Sample:** B-101 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-82

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.8	18.5	39.4	28.8	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	97.3		
3/8	95.9		
#4	88.2		
#8	72.7		
#16	62.4		
#30	47.2		
#50	13.9		
#100	3.5		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray and tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 4.0523 D_{60}= 0.9882 D_{50}= 0.6457
D_{30}= 0.4227 D_{15}= 0.3090 D_{10}= 0.2646
C_u= 3.74 C_c= 0.68

Date Tested: 02-03-10 **Tested By:** J. Crose

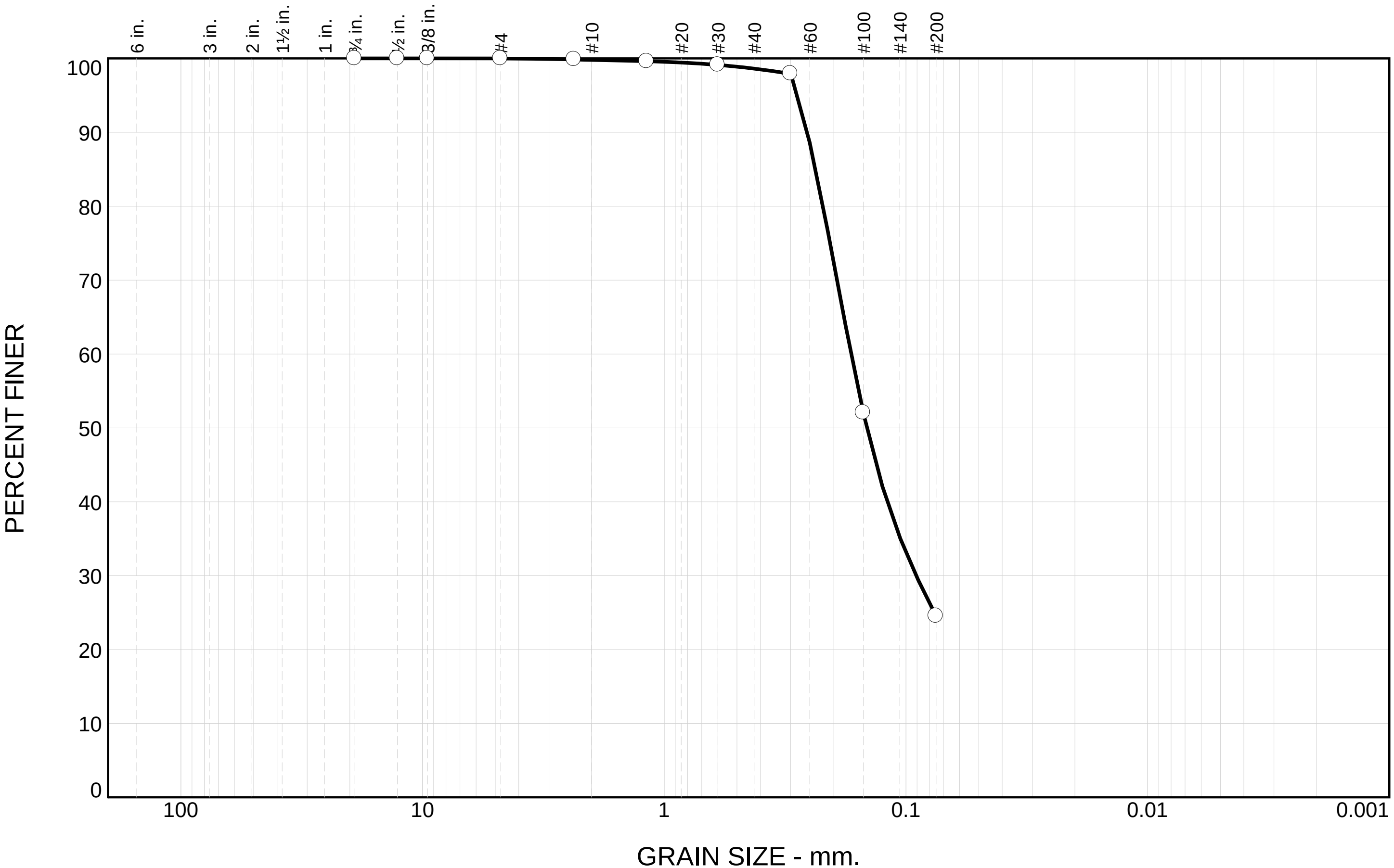
Remarks

Sample No.: SS-11 **Source of Sample:** B-101 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 43.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-83

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	1.2	74.1	24.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.6		
#30	99.1		
#50	97.9		
#100	52.0		
#200	24.5		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= AASHTO=

Coefficients

D_{85}= 0.2365 D_{60}= 0.1686 D_{50}= 0.1451
D_{30}= 0.0907 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

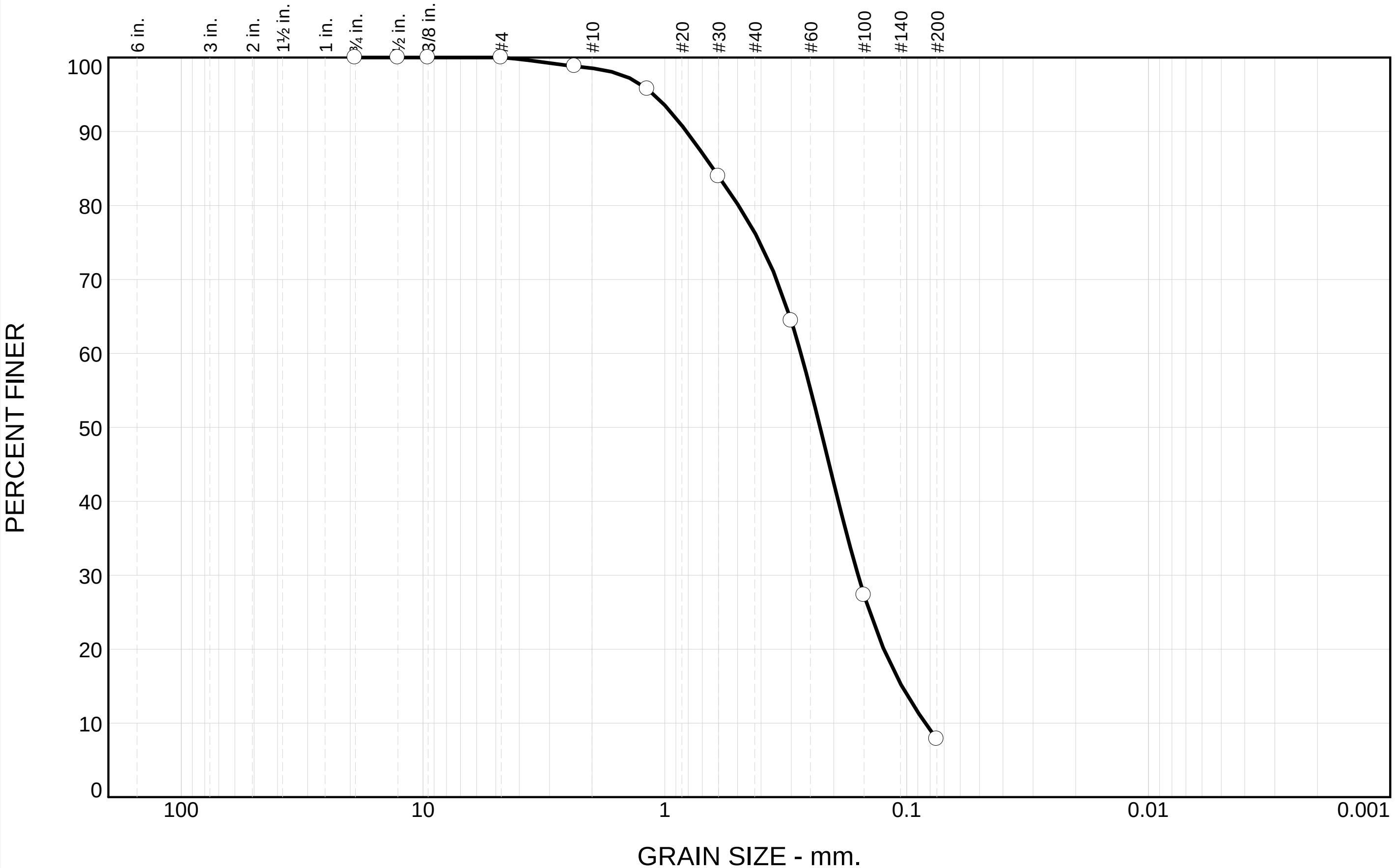
Remarks

Sample No.: SS-6 **Source of Sample:** P-104 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI
Project No: 2008012455 **Figure** B-84

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.4	22.2	68.6	7.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	98.8		
#16	95.8		
#30	83.9		
#50	64.4		
#100	27.3		
#200	7.8		

* (no specification provided)

Material Description

SAND (SP-SM), with traces of silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.6321 D_{60}= 0.2737 D_{50}= 0.2279
D_{30}= 0.1589 D_{15}= 0.1046 D_{10}= 0.0837
C_u= 3.27 C_c= 1.10

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

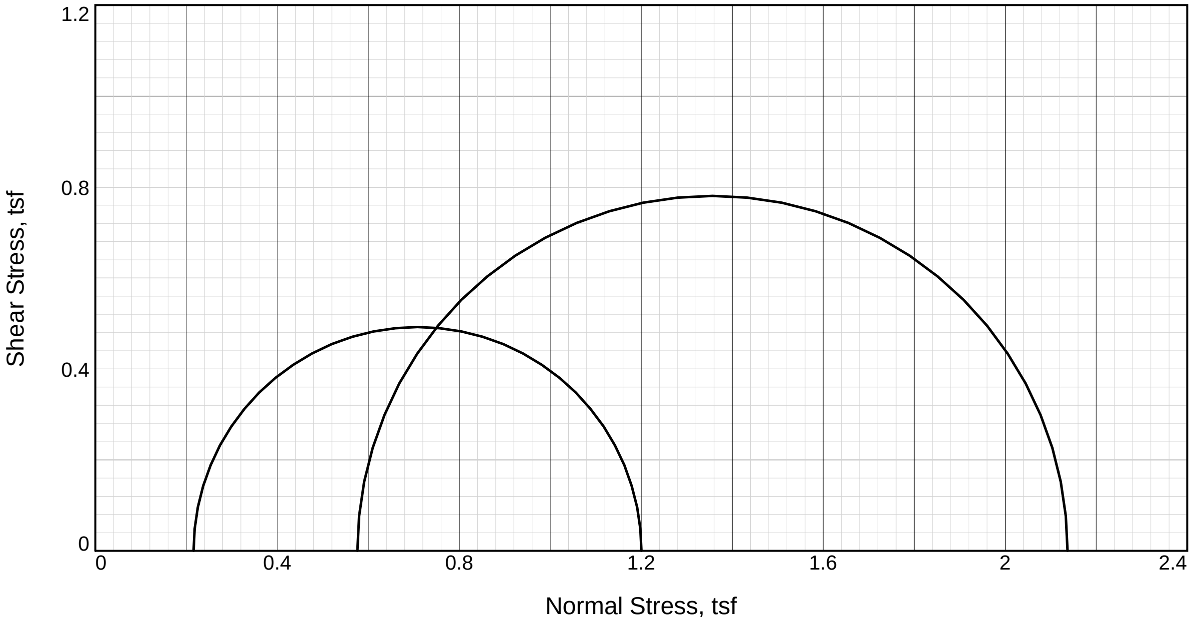
Remarks

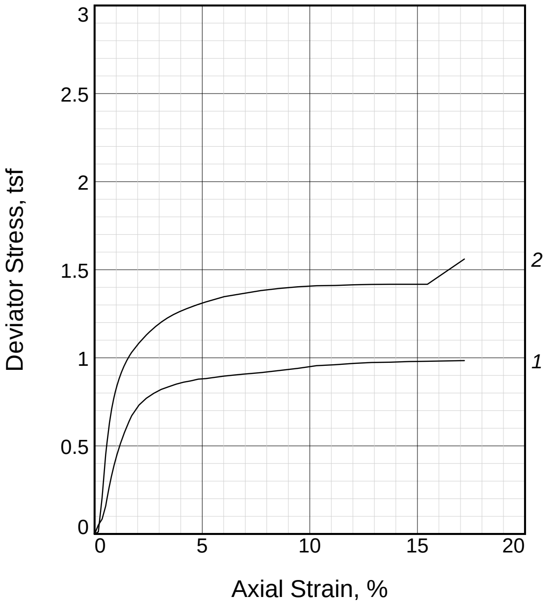
Sample No.: SS-7 **Source of Sample:** P-104 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-85





	Sample No.	1	2
Initial	Water Content,	30.0	32.4
	Dry Density, pcf	90.7	89.8
	Saturation,	95.4	100.5
	Void Ratio	0.8440	0.8636
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
At Test	Water Content,	31.5	32.2
	Dry Density, pcf	90.7	89.8
	Saturation,	100.0	100.0
	Void Ratio	0.8440	0.8636
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
	Strain rate, %/min.	0.83	0.83
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.22	0.58
	Fail. Stress, tsf	0.98	1.56
	Ult. Stress, tsf		
	σ_1 Failure, tsf	1.20	2.14
	σ_3 Failure, tsf	0.22	0.58

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: Silty CLAY (CL), brown-gray, stiff, moist

Assumed Specific Gravity= 2.68

Remarks:

Figure B-86

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: P-106 **Depth:** 1.0

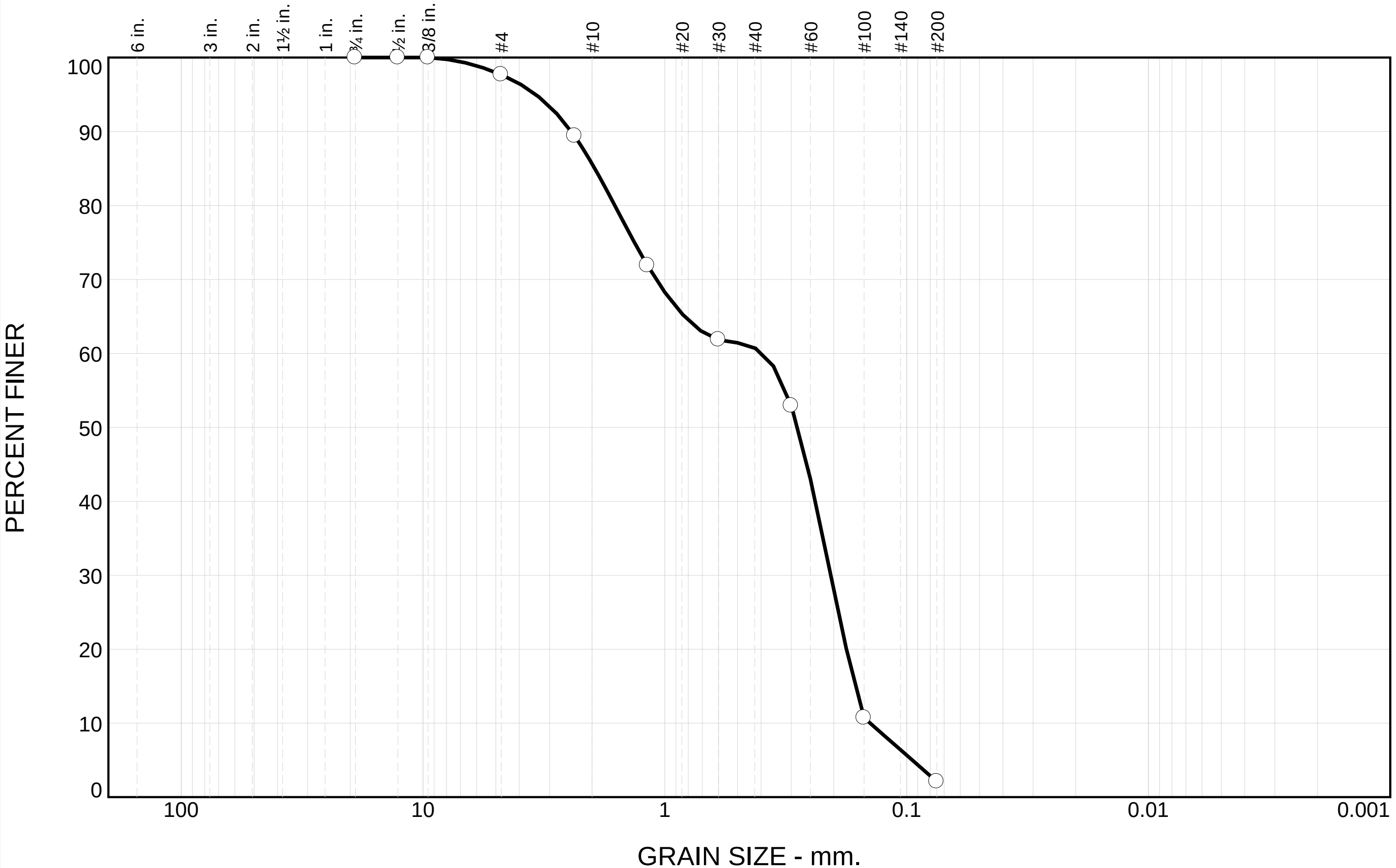
Sample Number: ST-1

Proj. No.: 2008012455 **Date:** 04-30-10

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Pruett **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	12.1	24.9	58.6	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	97.7		
#8	89.4		
#16	71.9		
#30	61.8		
#50	52.9		
#100	10.7		
#200	2.1		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.9493 D_{60}= 0.3939 D_{50}= 0.2822
D_{30}= 0.2061 D_{15}= 0.1632 D_{10}= 0.1416
C_u= 2.78 C_c= 0.76

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

Remarks

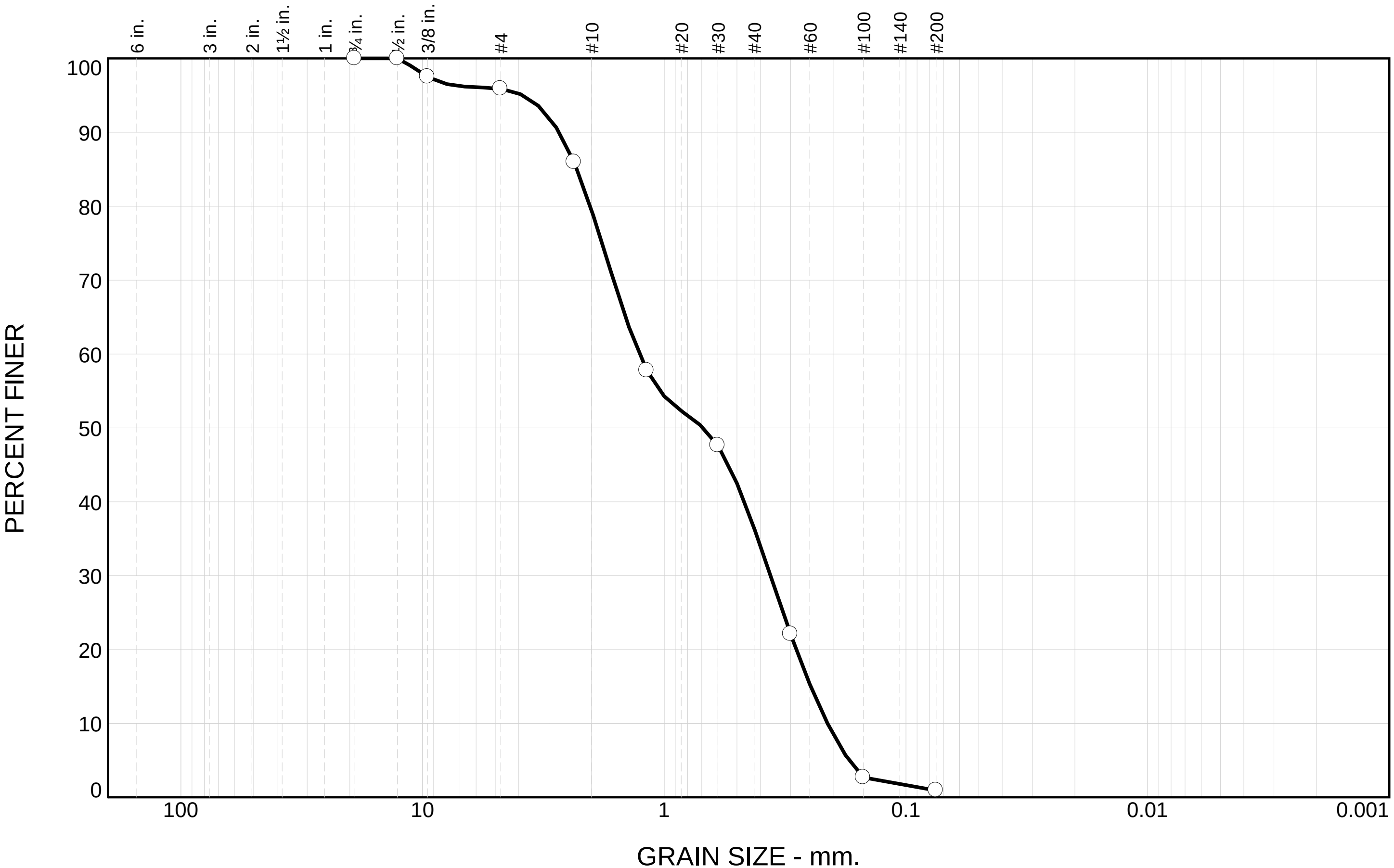
Sample No.: SS-5 **Source of Sample:** P-114 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-87

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.1	16.4	43.0	35.6	0.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	97.5		
#4	95.9		
#8	86.0		
#16	57.8		
#30	47.6		
#50	22.1		
#100	2.7		
#200	0.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.2961 D_{60}= 1.2690 D_{50}= 0.6890
D_{30}= 0.3633 D_{15}= 0.2476 D_{10}= 0.2111
C_u= 6.01 C_c= 0.49

Date Tested: 12-04-09 **Tested By:** M. Tierney

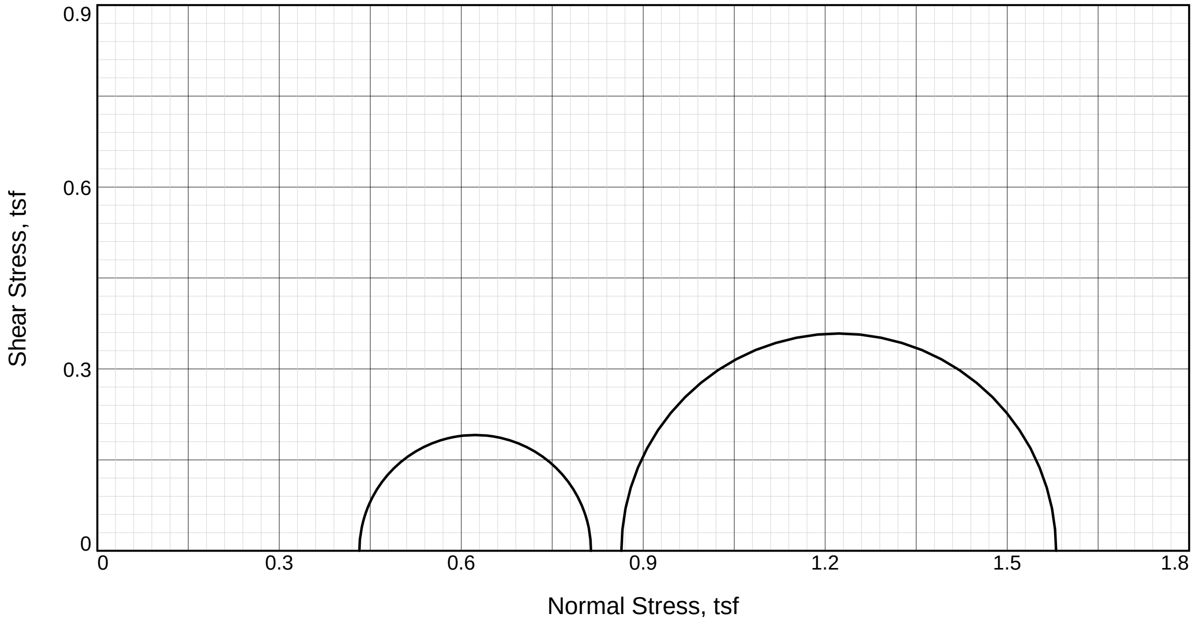
Remarks

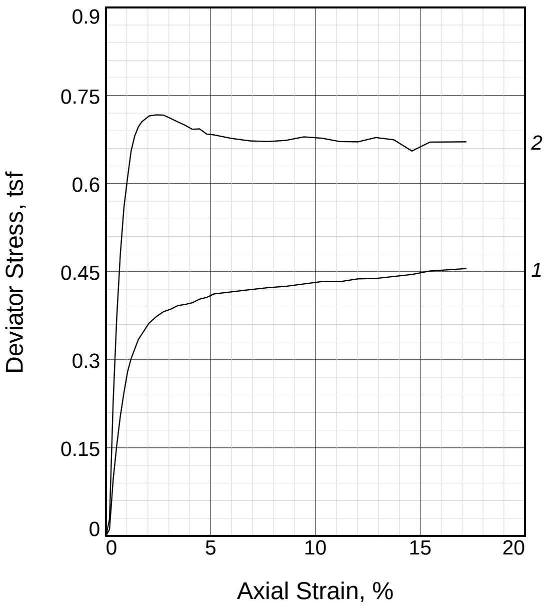
Sample No.: SS-7 **Source of Sample:** P-114 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-88





	Sample No.	1	2
Initial	Water Content,	36.9	38.1
	Dry Density, pcf	80.8	82.5
	Saturation,	92.3	99.2
	Void Ratio	1.0708	1.0282
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
At Test	Water Content,	36.9	38.1
	Dry Density, pcf	80.8	82.5
	Saturation,	92.3	99.2
	Void Ratio	1.0708	1.0282
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
	Strain rate, %/min.	0.83	0.83
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.43	0.86
	Fail. Stress, tsf	0.38	0.72
	Ult. Stress, tsf	0.46	0.72
	σ_1 Failure, tsf	0.81	1.58
	σ_3 Failure, tsf	0.43	0.86

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CH), gray, firm, high plastic, with silt seams, traces lignite and limonite, wet

LL= 64 **PL=** 26 **PI=** 38

Assumed Specific Gravity= 2.68

Remarks:

Figure B-89

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-115 **Depth:** 7

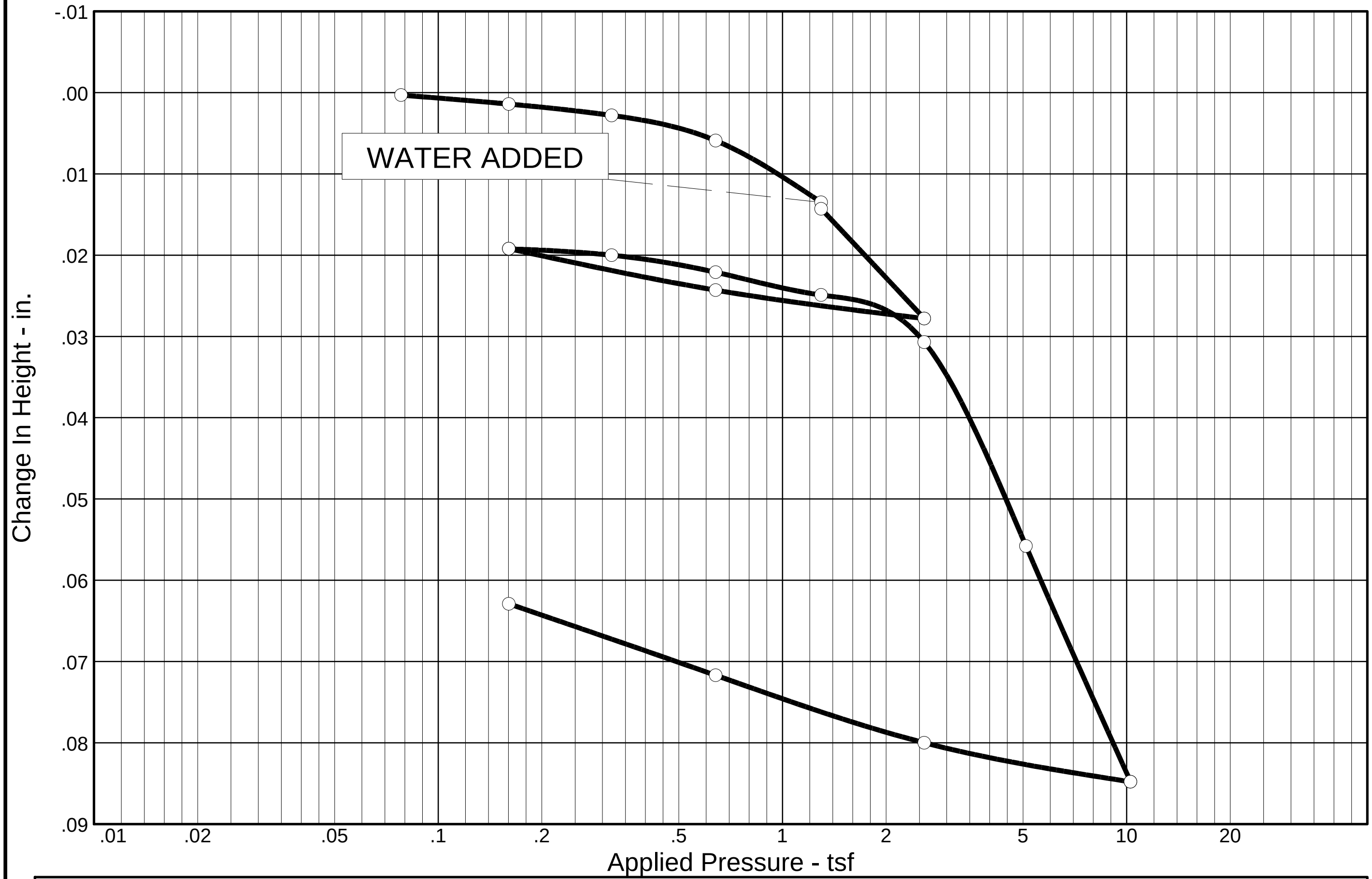
Sample Number: ST-3

Proj. No.: 2008012455 **Date:** 11-07-2009

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. David/J. Pruett **Checked By:** K. Kocher

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation

No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
1	0.08	0.02	0.000	12	1.30	3.55	0.000				
3	0.32	0.02	0.000	13	2.58	0.87	0.001				
4	0.64	0.02	0.001	14	5.10	1.97	0.002				
5	1.30	3.13	0.001	15	10.26	3.03	0.003				
6	1.30	0.04	0.000	16	2.58	3.24					
7	2.58	2.71	0.002	17	0.64	0.53					
8	0.64	0.52		18	0.16	0.07					
9	0.16	0.39									
10	0.32	0.07	0.000								
11	0.64	0.02	0.000								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
93.9 %	31.5 %	88.1	64	38	2.68	0.45	1.90	0.20	0.02		0.1	0.900

MATERIAL DESCRIPTION	USCS	AASHTO
CLAY (CH), gray, firm, high plastic, with silt seams, traces lignite and limonite, wet	CH	

Project No. 2008012455 **Client:** Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source: B-115 **Sample No.:** ST-3 **Elev./Depth:** 7

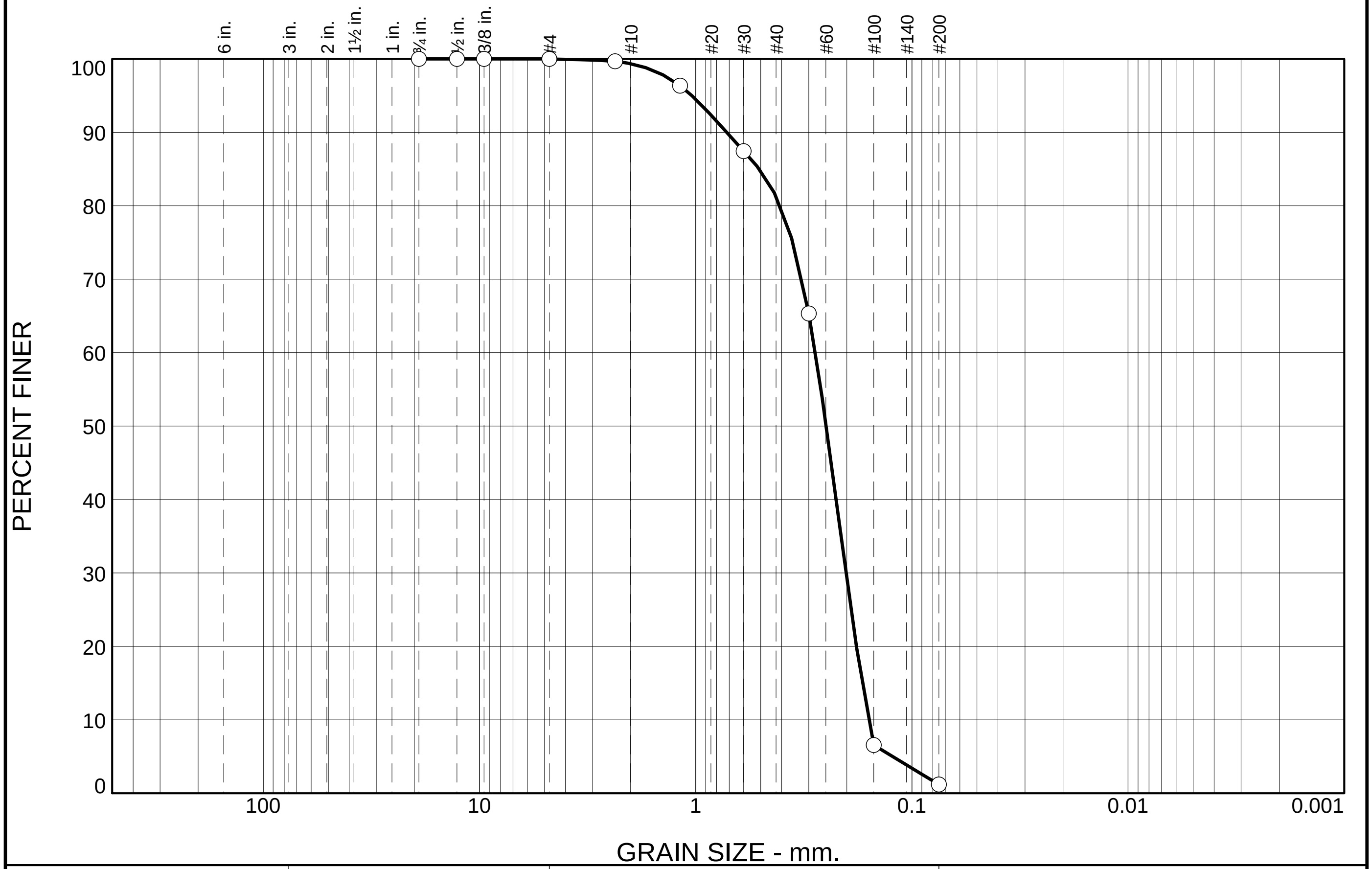
REITZ & JENS, INC.
CONSULTING ENGINEERS

Remarks:

Assumed specific gravity

Figure B-90

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.7	18.0	80.1	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.7		
#16	96.4		
#30	87.4		
#50	65.3		
#100	6.6		
#200	1.2		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5073 D_{60}= 0.2795 D_{50}= 0.2491
D_{30}= 0.2018 D_{15}= 0.1699 D_{10}= 0.1586
C_u= 1.76 C_c= 0.92

Date Tested: 02-10-10 **Tested By:** J. David

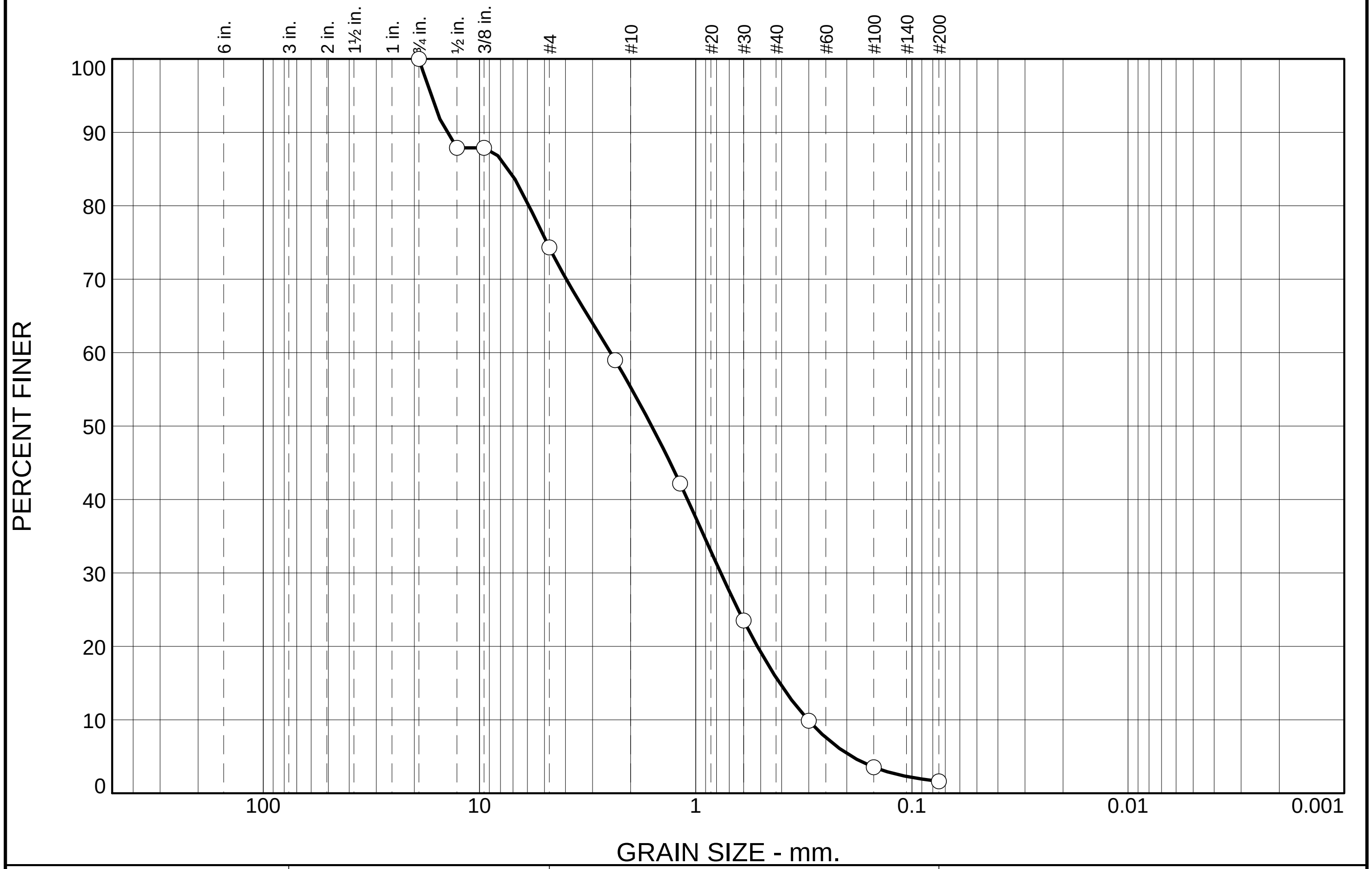
Remarks

Sample No.: SS-7 **Source of Sample:** B-115 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-91

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	25.7	19.0	39.5	14.2	1.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	87.9		
3/8	87.9		
#4	74.3		
#8	59.0		
#16	42.2		
#30	23.5		
#50	9.9		
#100	3.6		
#200	1.6		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 7.3313 D_{60}= 2.4753 D_{50}= 1.5963
D_{30}= 0.7648 D_{15}= 0.4084 D_{10}= 0.3027
C_u= 8.18 C_c= 0.78

Date Tested: 02-10-10 **Tested By:** J. David

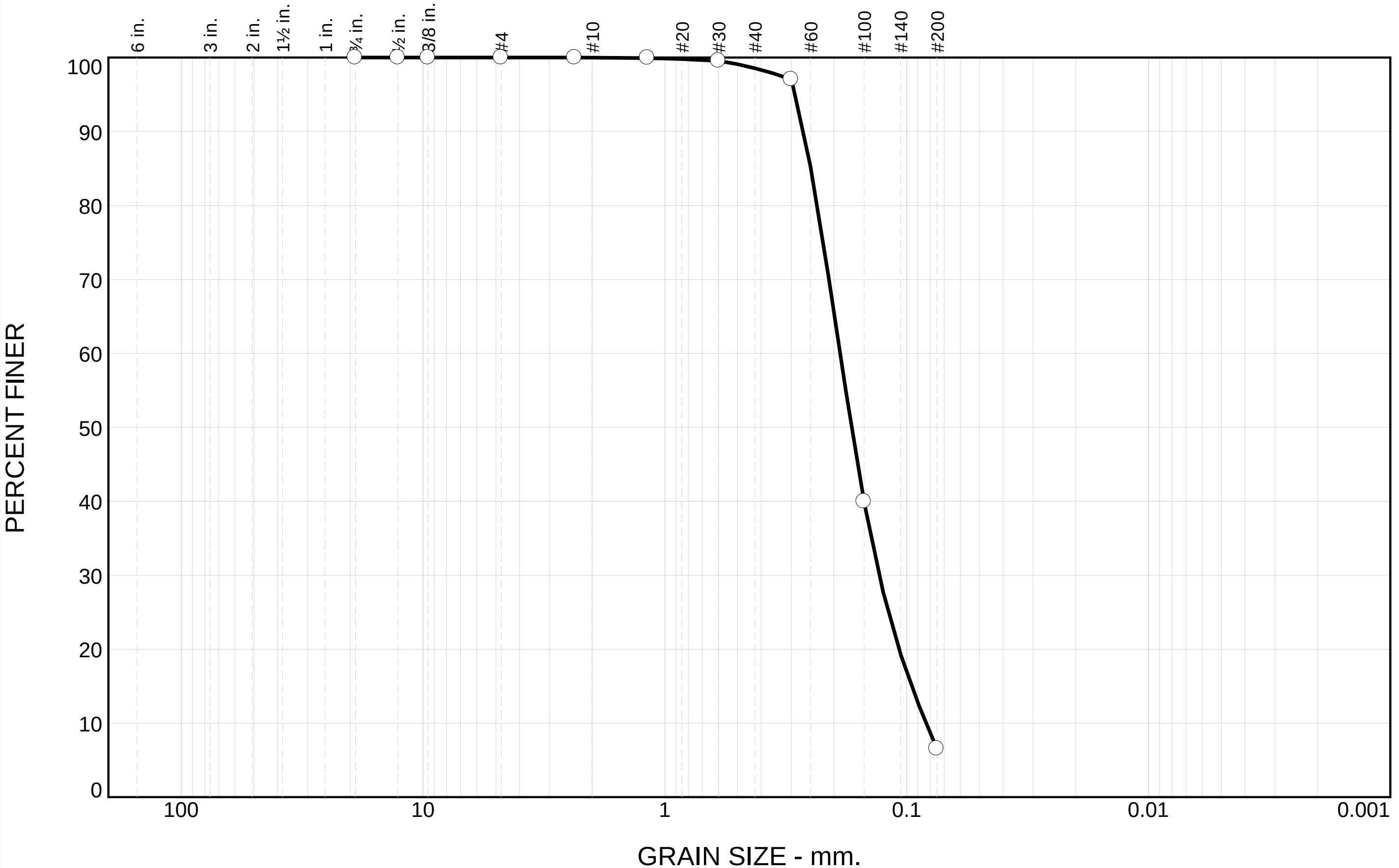
Remarks

Sample No.: SS-10 **Source of Sample:** B-115 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 38.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI
Project No: 2008012455 **Figure** B-92

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.4	92.1	6.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.6		
#50	97.0		
#100	39.9		
#200	6.5		

* (no specification provided)

Material Description

SAND (SP-SM), with traces of silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2490 D_{60}= 0.1884 D_{50}= 0.1690
D_{30}= 0.1299 D_{15}= 0.0954 D_{10}= 0.0831
C_u= 2.27 C_c= 1.08

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

Remarks

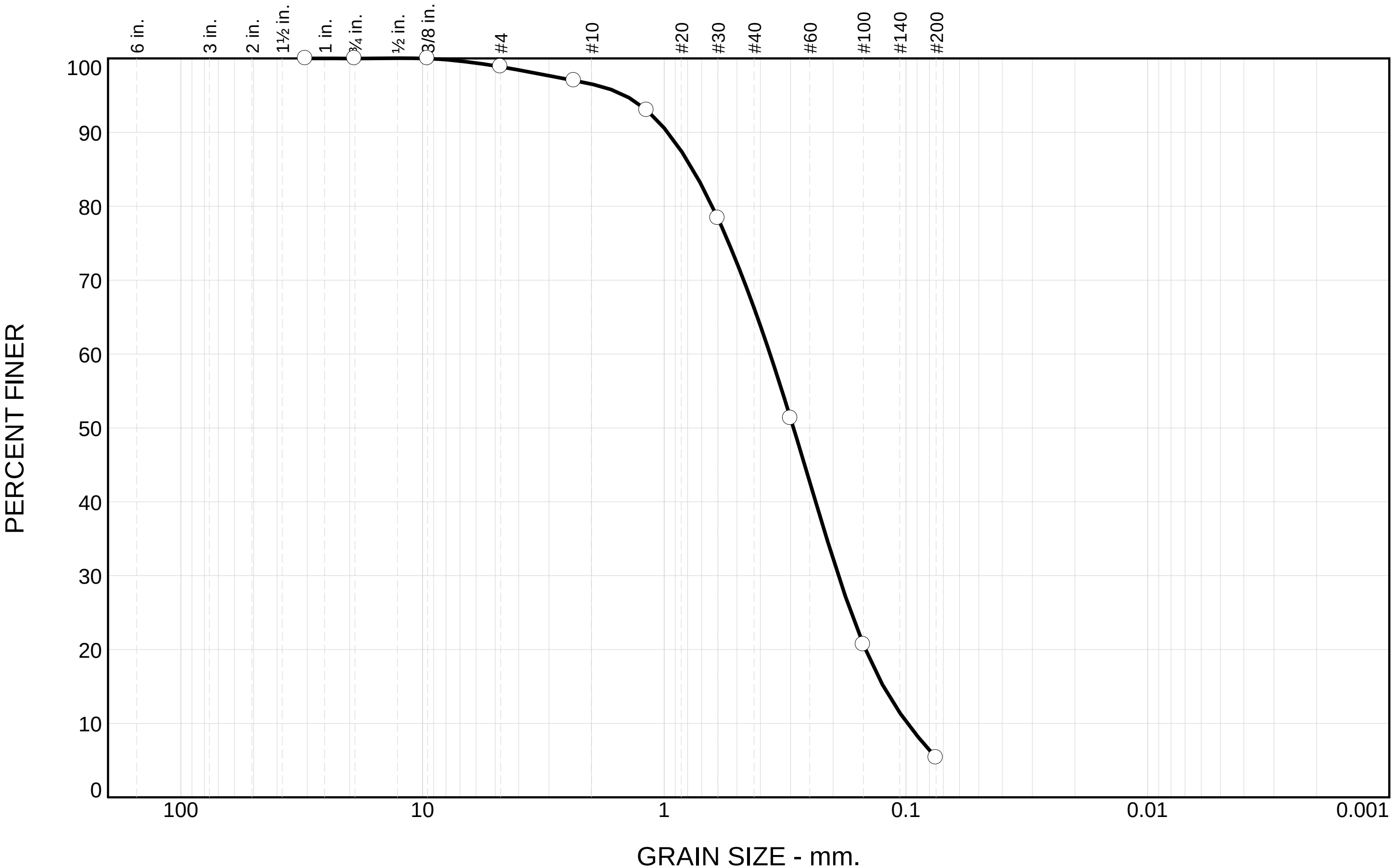
Sample No.: SS-5 **Source of Sample:** P-120 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-93

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	2.4	30.3	60.9	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.2	100.0		
3/4	100.0		
3/8	100.0		
#4	98.9		
#8	97.0		
#16	93.0		
#30	78.4		
#50	51.3		
#100	20.7		
#200	5.3		

* (no specification provided)

Material Description

SAND (SP-SM), with traces of silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.7627 D_{60}= 0.3651 D_{50}= 0.2918
D_{30}= 0.1901 D_{15}= 0.1238 D_{10}= 0.0985
C_u= 3.70 C_c= 1.00

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

Remarks

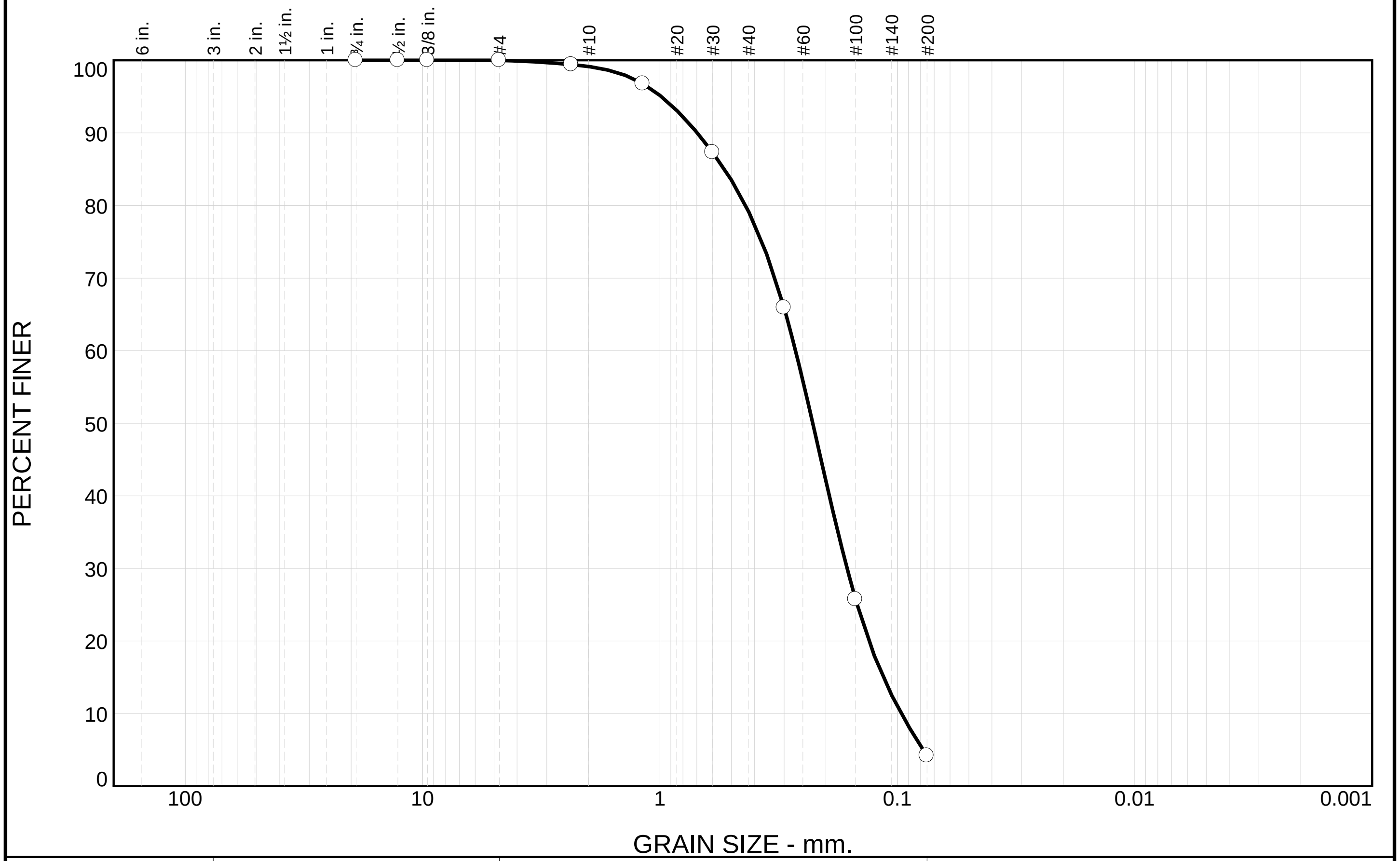
Sample No.: SS-6 **Source of Sample:** P-120 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-94

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	19.9	75.1	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.4		
#16	96.8		
#30	87.3		
#50	65.9		
#100	25.7		
#200	4.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5349 D_{60}= 0.2686 D_{50}= 0.2272
D_{30}= 0.1630 D_{15}= 0.1147 D_{10}= 0.0963
C_u= 2.79 C_c= 1.03

Date Tested: 12/4/09 **Tested By:** M. Tierney, J. Crose

Remarks

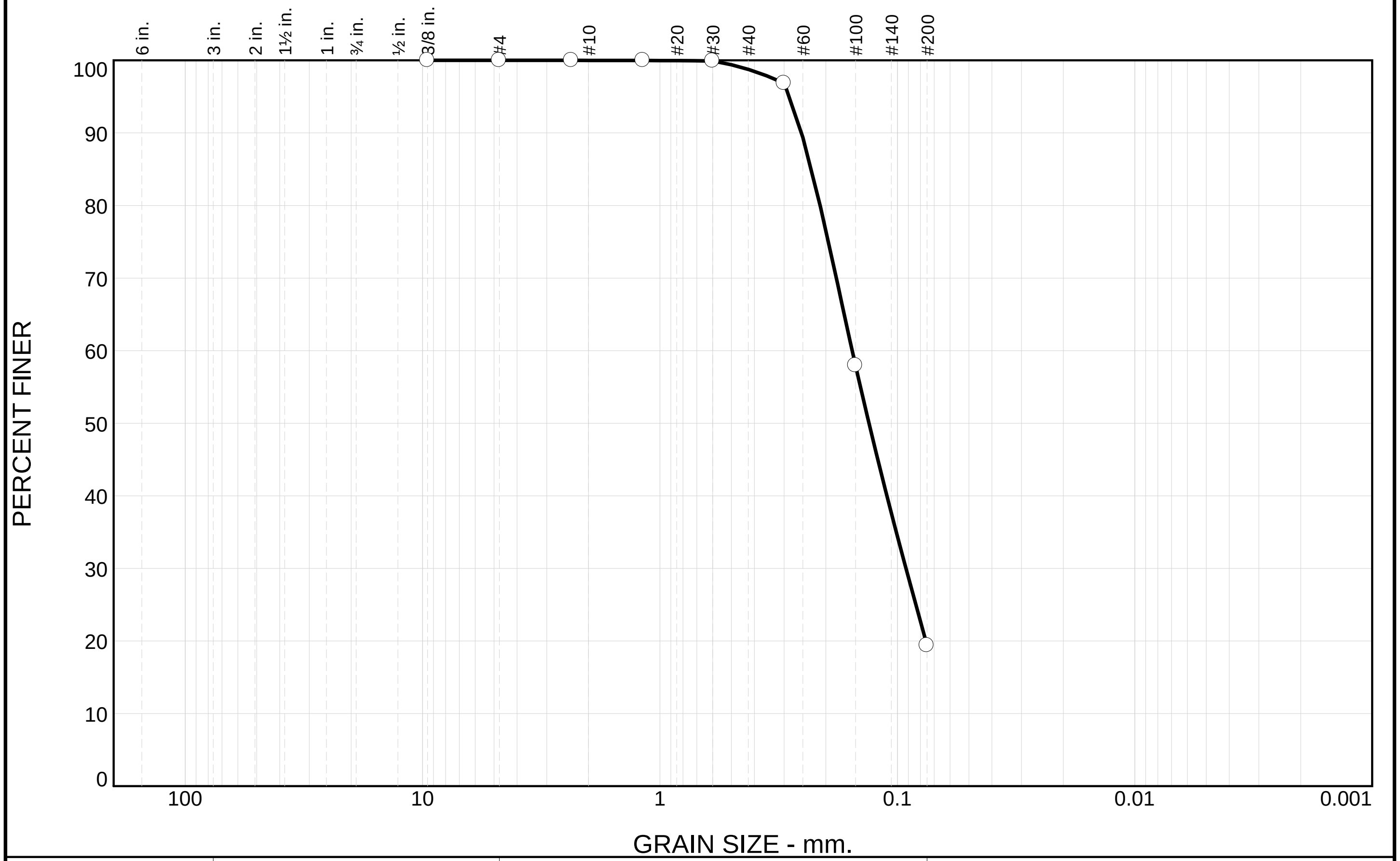
Sample No.: SS-7 **Source of Sample:** P-120 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-95

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.2	79.4	19.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	96.9		
#100	57.9		
#200	19.4		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.2303 D_{60}= 0.1550 D_{50}= 0.1318
D_{30}= 0.0919 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

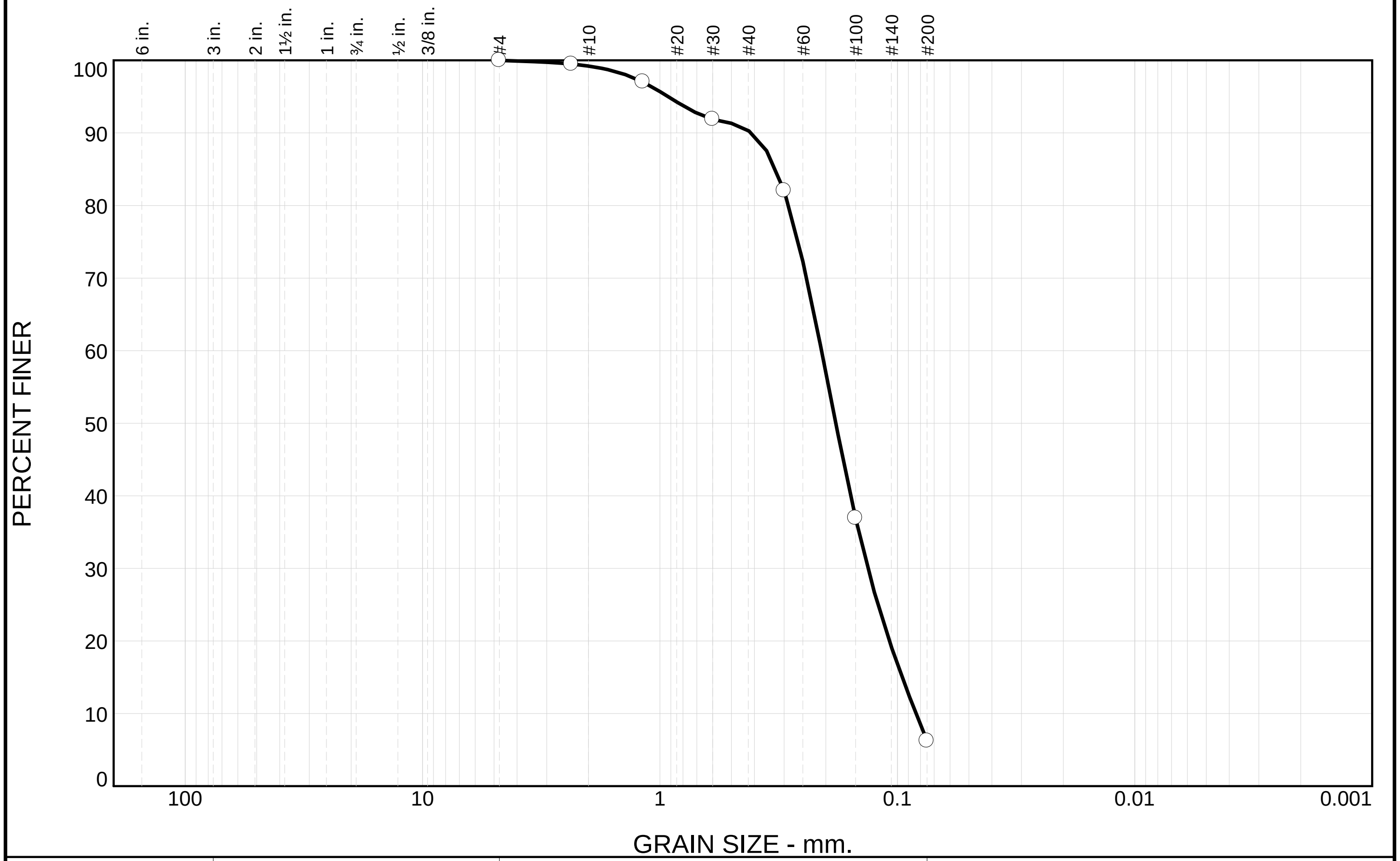
Sample No.: SS-5 **Source of Sample:** P-126 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-96

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	8.9	84.1	6.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.5		
#16	97.0		
#30	91.9		
#50	82.0		
#100	36.9		
#200	6.2		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.3245 D_{60}= 0.2086 D_{50}= 0.1817
D_{30}= 0.1331 D_{15}= 0.0955 D_{10}= 0.0834
C_u= 2.50 C_c= 1.02

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

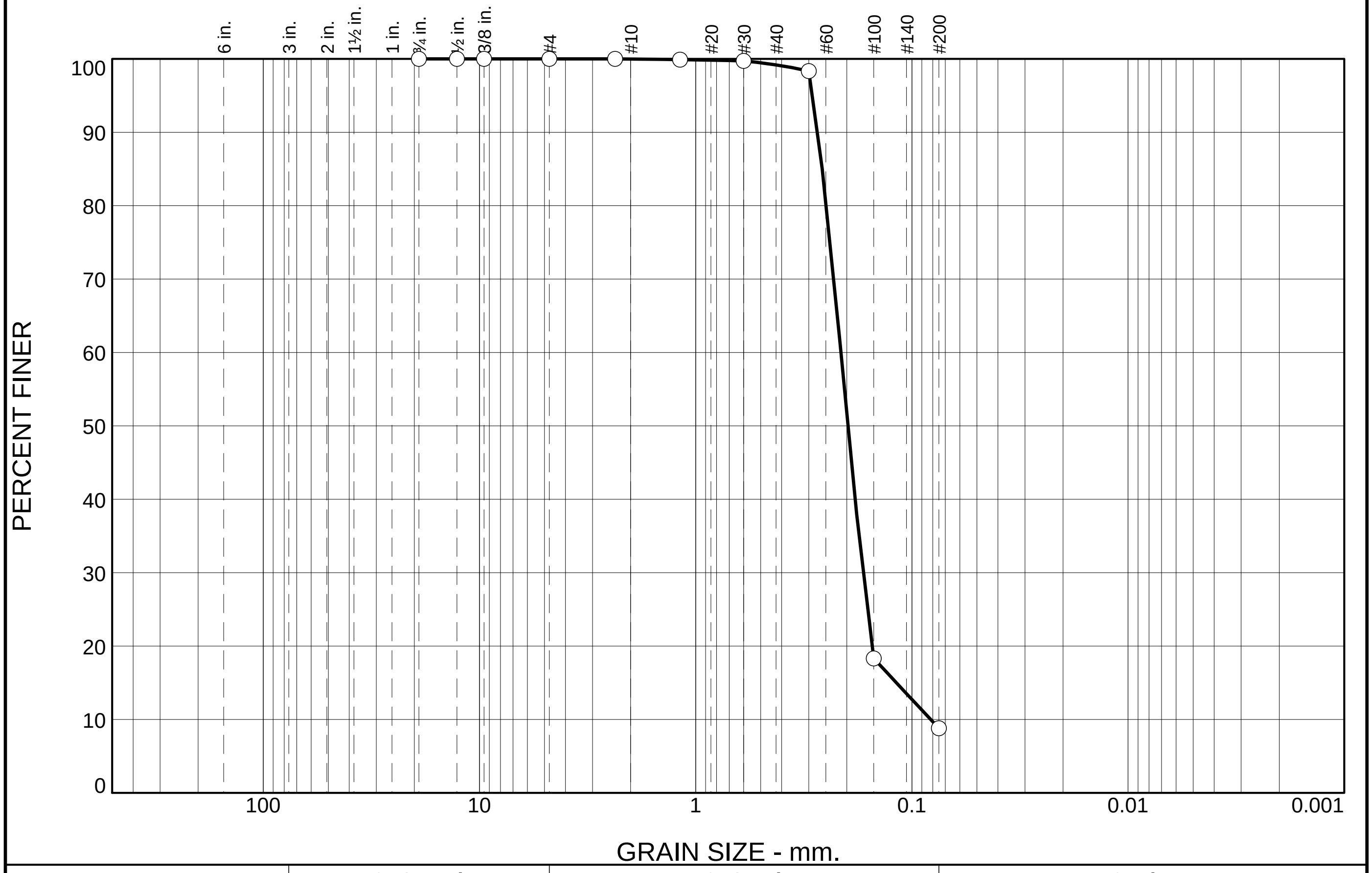
Sample No.: SS-7 **Source of Sample:** P-126 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-97

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.8	90.4	8.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.7		
#50	98.3		
#100	18.3		
#200	8.8		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2598 D_{60}= 0.2130 D_{50}= 0.1977
D_{30}= 0.1686 D_{15}= 0.1178 D_{10}= 0.0818
C_u= 2.60 C_c= 1.63

Date Tested: 02-10-10 **Tested By:** J. David

Remarks

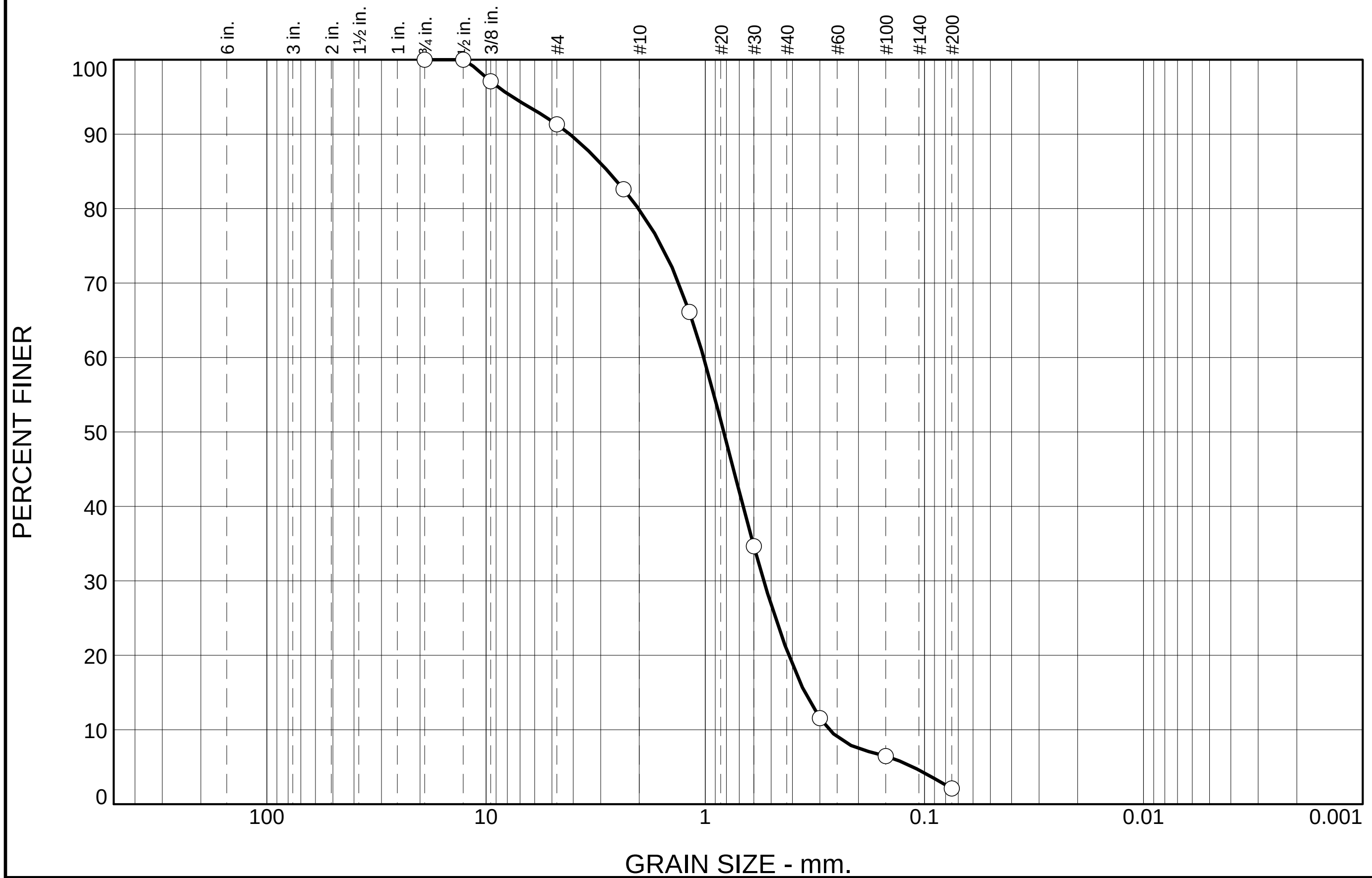
Sample No.: SS-5 **Source of Sample:** B-127 **Date Sampled:** 11-10-2009
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-98

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.7	11.4	59.2	18.6	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	97.1		
#4	91.3		
#8	82.6		
#16	66.1		
#30	34.7		
#50	11.6		
#100	6.5		
#200	2.1		

* (no specification provided)

Material Description

SAND (SP), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.7711 D_{60}= 1.0166 D_{50}= 0.8224
D_{30}= 0.5404 D_{15}= 0.3510 D_{10}= 0.2715
C_u= 3.74 C_c= 1.06

Date Tested: 02-10-10 **Tested By:** J. David

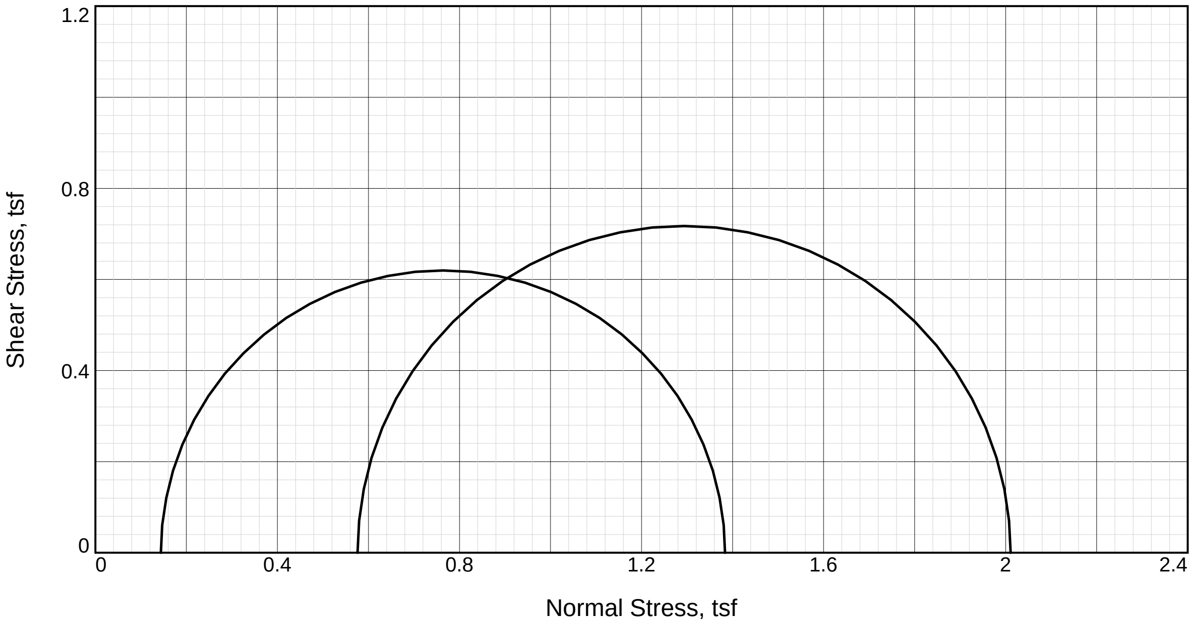
Remarks

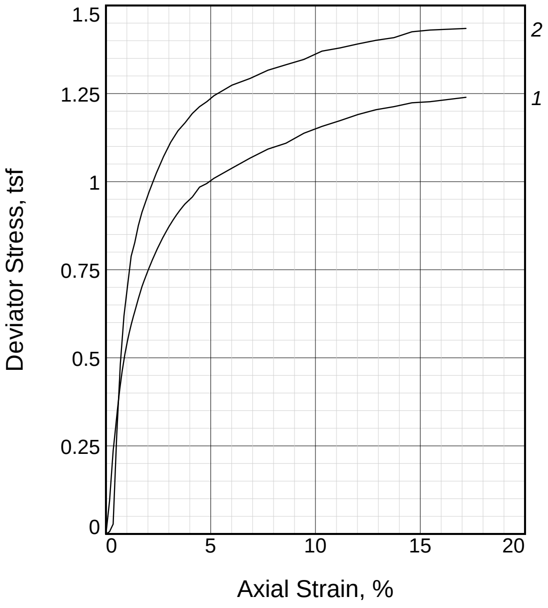
Sample No.: SS-8 **Source of Sample:** B-127 **Date Sampled:** 11-10-2009
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-99





	Sample No.	1	2
Initial	Water Content,	23.7	30.9
	Dry Density, pcf	97.9	92.8
	Saturation,	89.7	103.3
	Void Ratio	0.7089	0.8023
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
At Test	Water Content,	23.7	30.9
	Dry Density, pcf	97.9	92.8
	Saturation,	89.7	103.3
	Void Ratio	0.7089	0.8023
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
	Strain rate, %/min.	0.83	0.83
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.14	0.58
	Fail. Stress, tsf	1.24	1.43
	Ult. Stress, tsf		
	σ_1 Failure, tsf	1.38	2.01
	σ_3 Failure, tsf	0.14	0.58

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CL-CH), dark brown, low to medium plastic, silty to slightly silty, with fine sand and silt lenses

Assumed Specific Gravity= 2.68

Remarks:

Figure B-100

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: P-128 **Depth:** 0.7

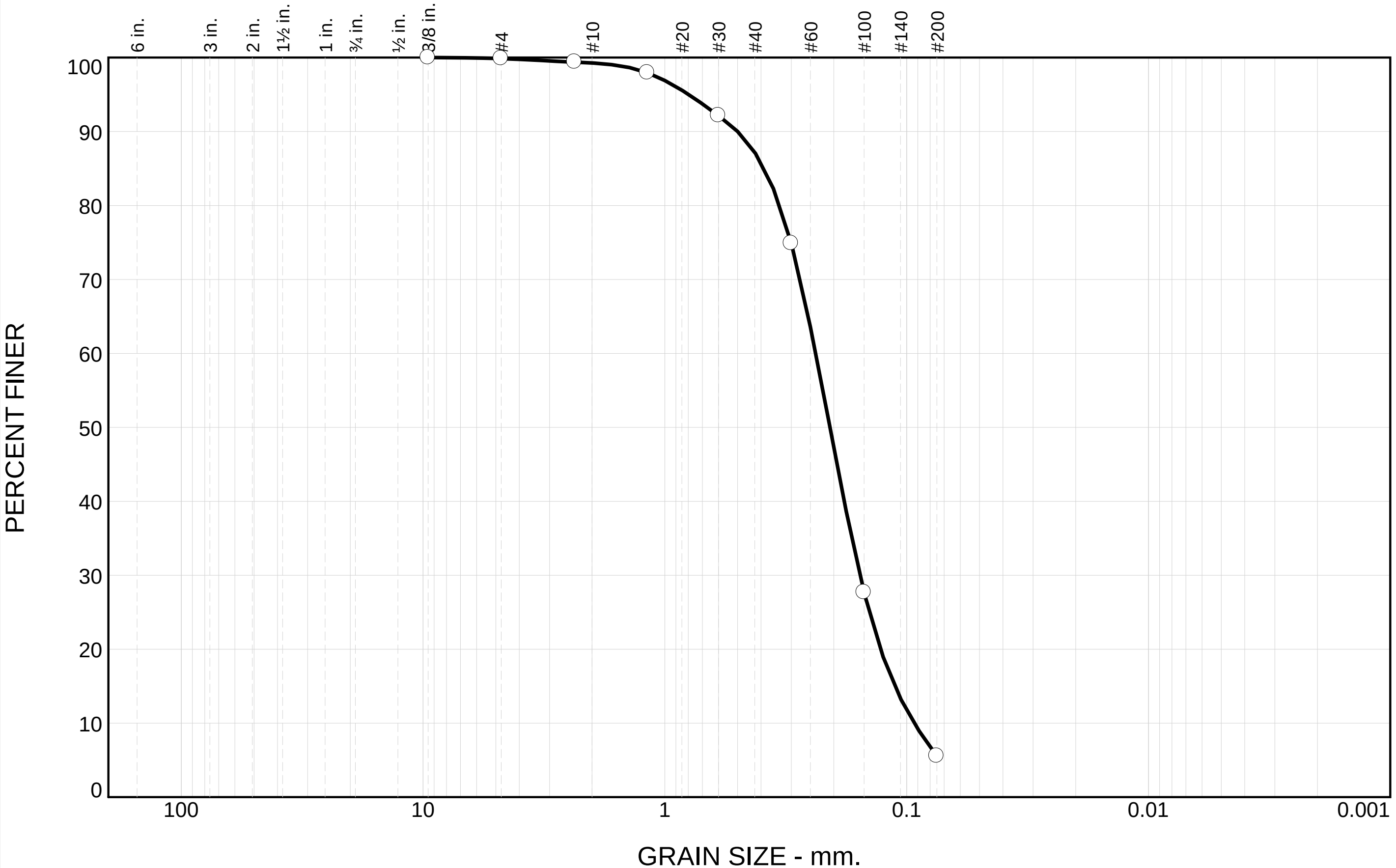
Sample Number: ST-1

Proj. No.: 2008012455 **Date:** 04-29-10

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. David/J. Pruett **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.6	12.1	81.7	5.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.9		
#8	99.4		
#16	97.9		
#30	92.1		
#50	74.9		
#100	27.7		
#200	5.5		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.3882 D_{60}= 0.2377 D_{50}= 0.2075
D_{30}= 0.1560 D_{15}= 0.1119 D_{10}= 0.0931
C_u= 2.55 C_c= 1.10

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

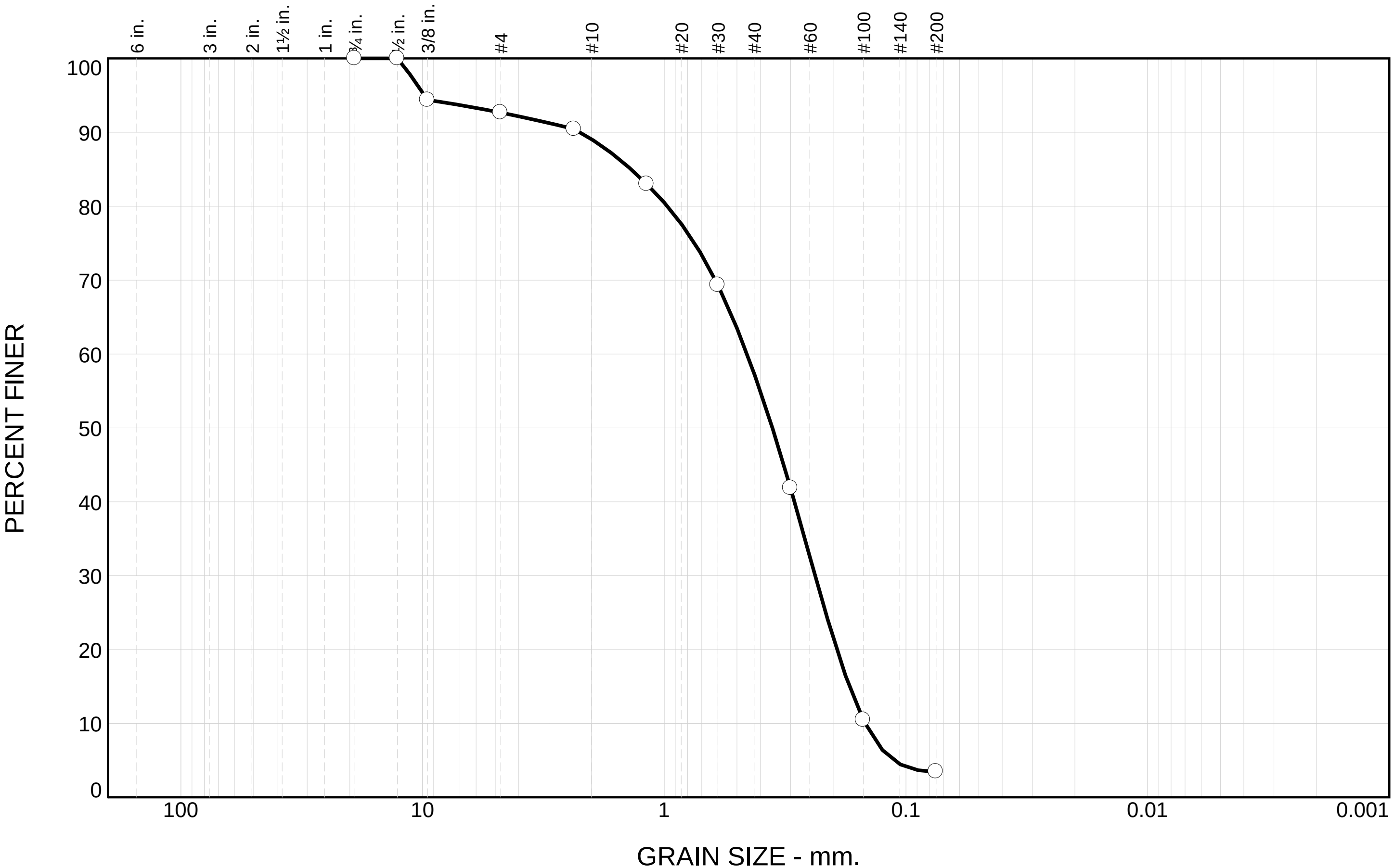
Sample No.: SS-5 **Source of Sample:** P-128 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-101

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.3	3.6	31.7	53.9	3.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	94.4		
#4	92.7		
#8	90.4		
#16	83.0		
#30	69.3		
#50	41.8		
#100	10.4		
#200	3.5		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.3712 D_{60}= 0.4543 D_{50}= 0.3569
D_{30}= 0.2375 D_{15}= 0.1714 D_{10}= 0.1477
C_u= 3.08 C_c= 0.84

Date Tested: 12/4/09 **Tested By:** J. Pruett, M. Tierney

Remarks

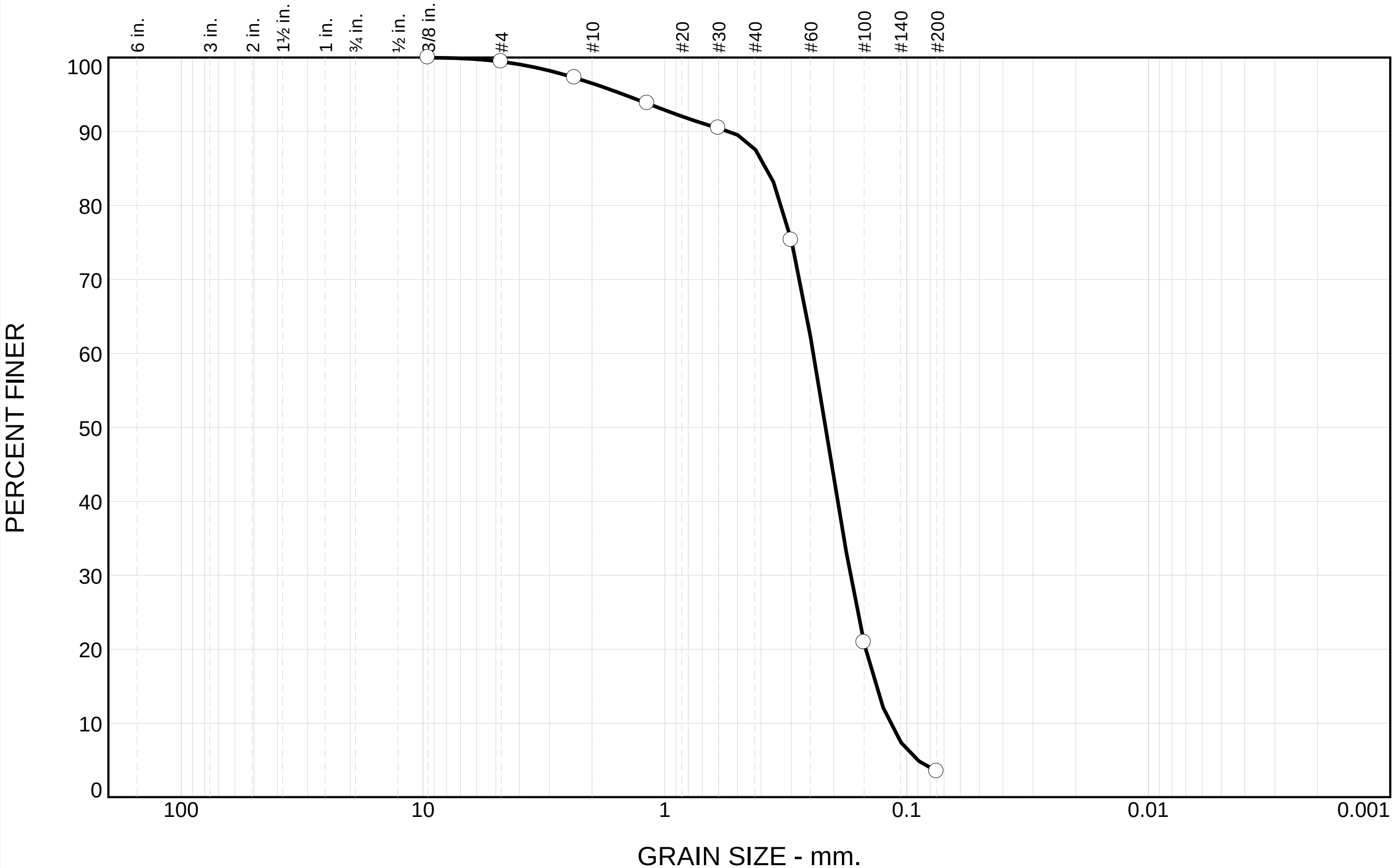
Sample No.: SS-7 **Source of Sample:** P-128 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-102

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	3.0	8.8	84.2	3.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.5		
#8	97.3		
#16	93.8		
#30	90.5		
#50	75.3		
#100	20.9		
#200	3.5		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3770 D_{60}= 0.2431 D_{50}= 0.2163
D_{30}= 0.1708 D_{15}= 0.1342 D_{10}= 0.1173
C_u= 2.07 C_c= 1.02

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

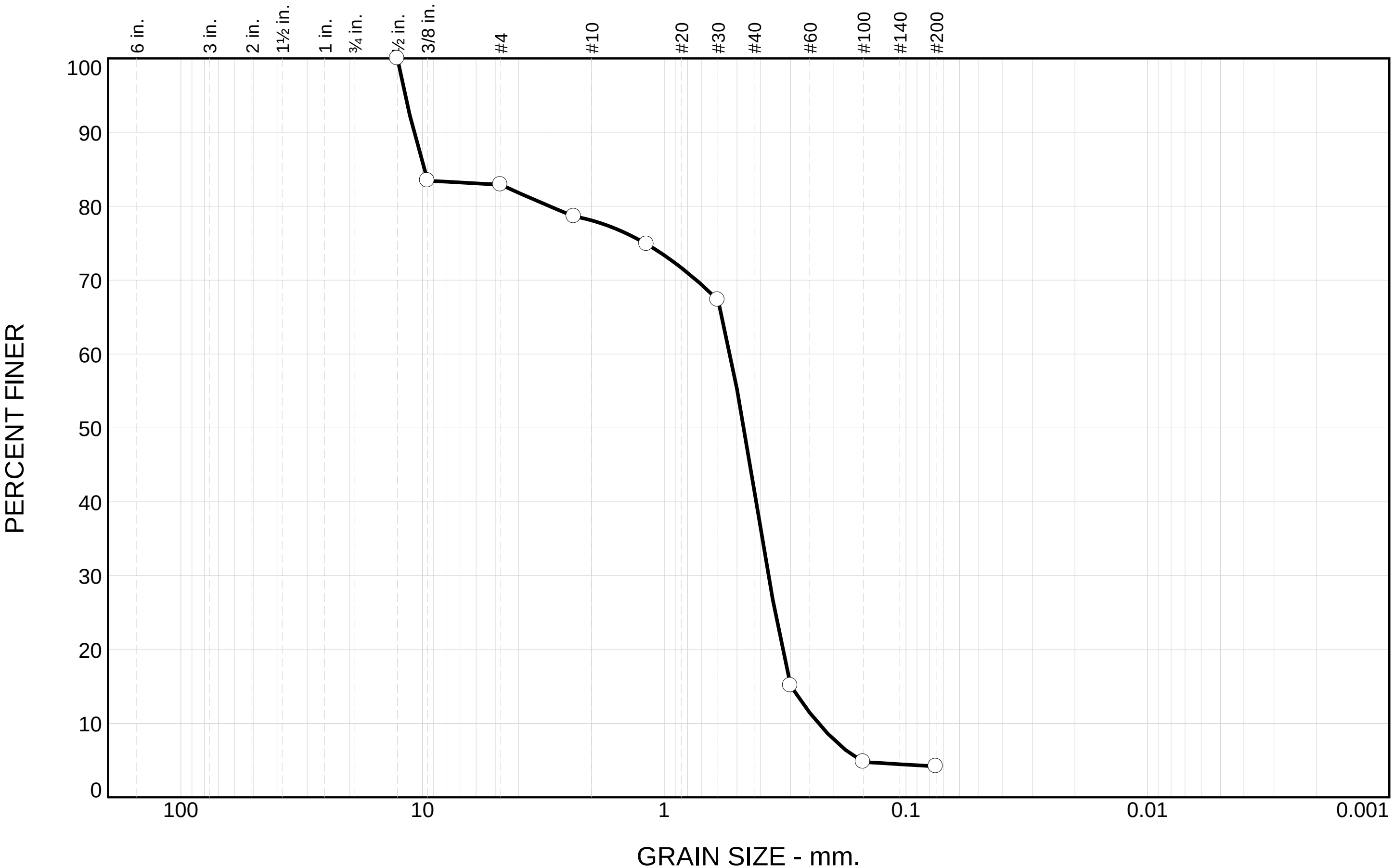
Sample No.: SS-3 **Source of Sample:** P-136 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-103

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	17.1	4.8	36.4	37.5	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	83.5		
#4	82.9		
#8	78.6		
#16	74.9		
#30	67.3		
#50	15.1		
#100	4.8		
#200	4.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 9.8806 D_{60}= 0.5328 D_{50}= 0.4684

D_{30}= 0.3702 D_{15}= 0.2985 D_{10}= 0.2300

C_u= 2.32 C_c= 1.12

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

Sample No.: SS-5 **Source of Sample:** P-136 **Date Sampled:**

Location: **Elev./Depth:** 35

Checked By: K. Kocher **Title:** Engineer

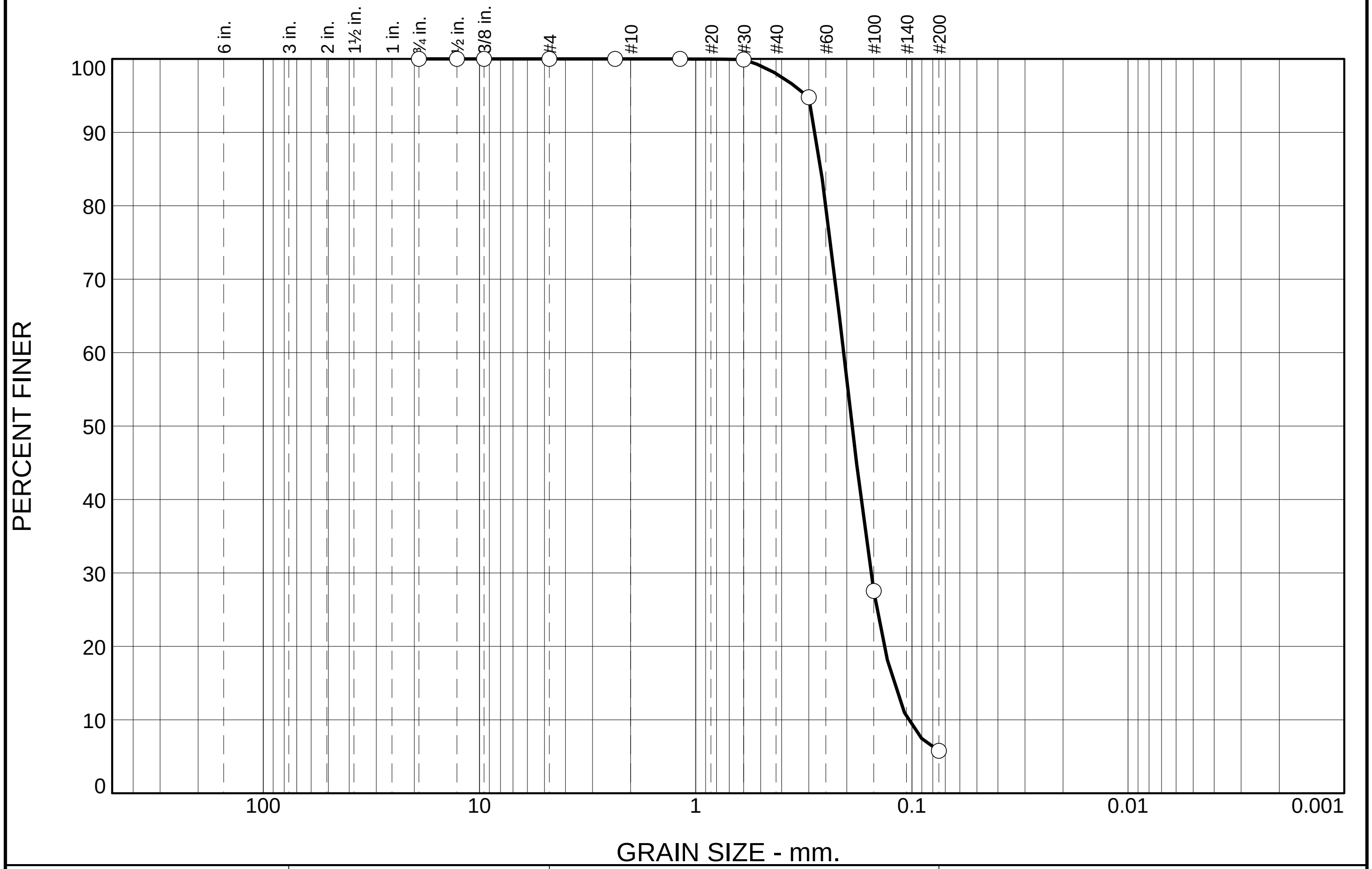
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-104

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.0	92.2	5.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	94.8		
#100	27.6		
#200	5.8		

* (no specification provided)

Material Description

SAND (SP-SM), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2637 D_{60}= 0.2069 D_{50}= 0.1890
D_{30}= 0.1545 D_{15}= 0.1215 D_{10}= 0.1041
C_u= 1.99 C_c= 1.11

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

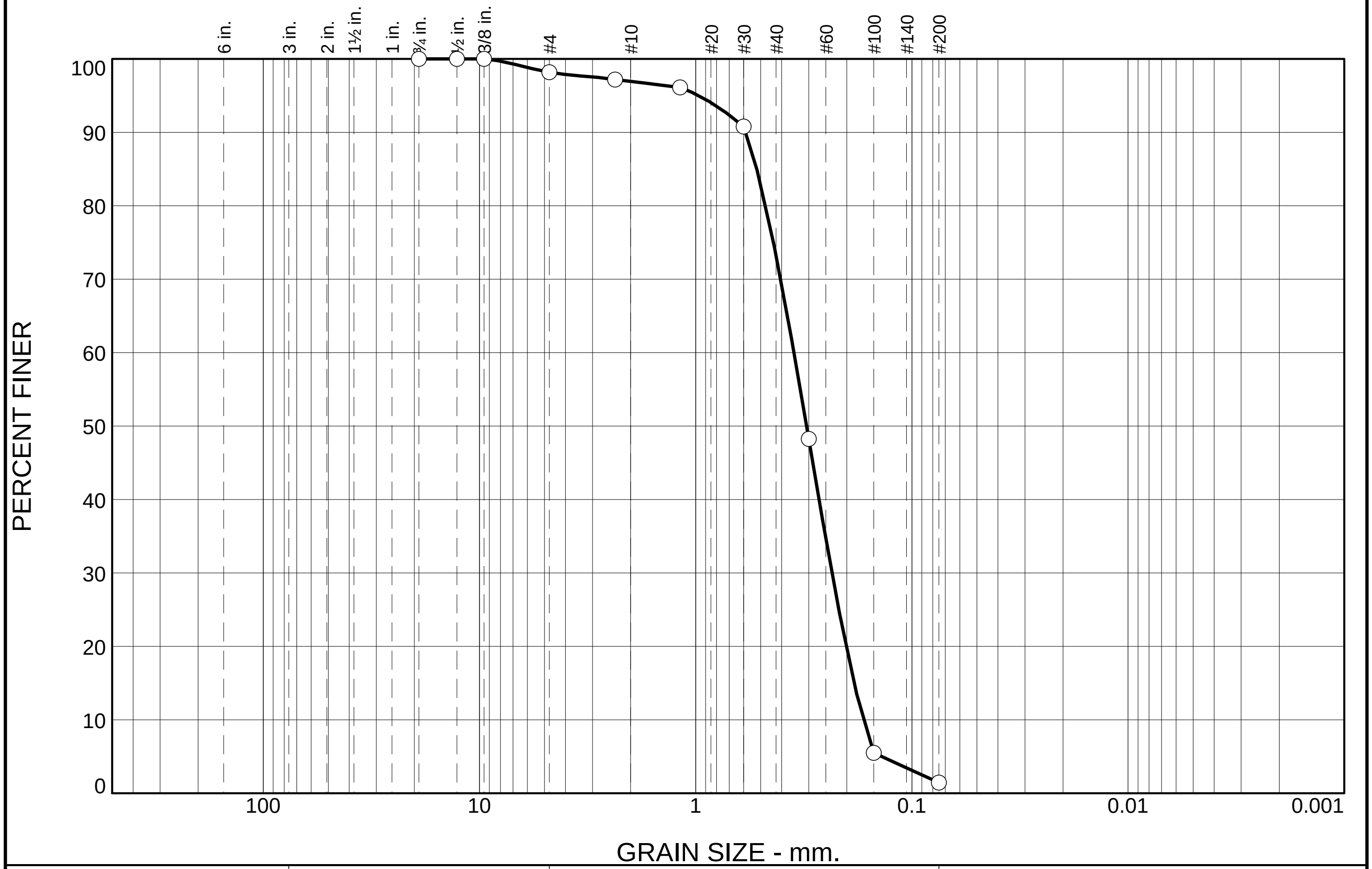
Sample No.: SS-4 **Source of Sample:** B-141 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 10
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-105

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	1.3	23.6	71.8	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.2		
#8	97.2		
#16	96.1		
#30	90.8		
#50	48.2		
#100	5.5		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5213 D_{60}= 0.3510 D_{50}= 0.3070
D_{30}= 0.2343 D_{15}= 0.1851 D_{10}= 0.1678
C_u= 2.09 C_c= 0.93

Date Tested: 02-02-10 **Tested By:** J. Crose

Remarks

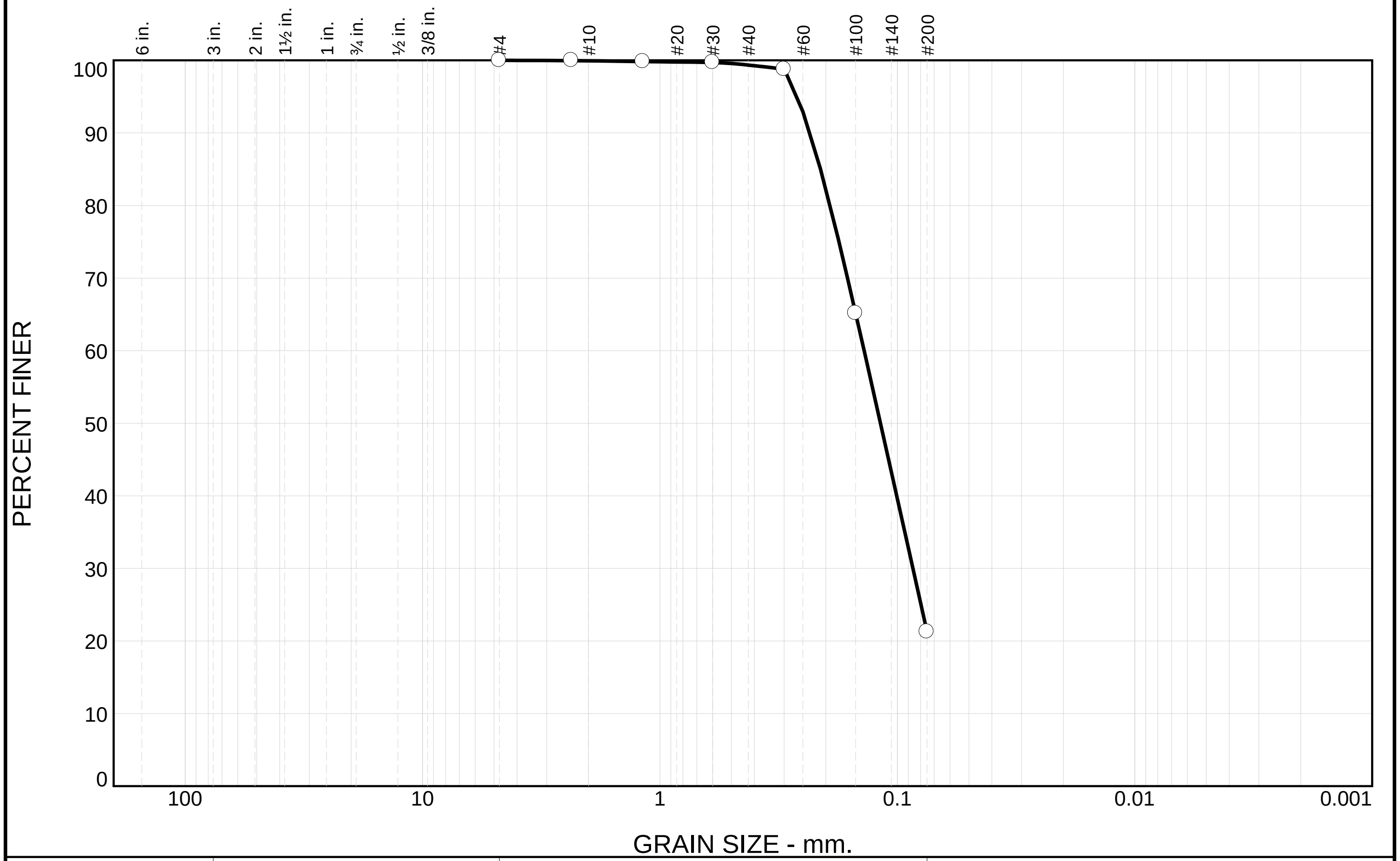
Sample No.: SS-7 **Source of Sample:** B-141 **Date Sampled:** 11-07-2009
Location: **Elev./Depth:** 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-106

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.5	78.2	21.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#16	99.8		
#30	99.7		
#50	98.8		
#100	65.2		
#200	21.2		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.2107 D_{60}= 0.1381 D_{50}= 0.1178
D_{30}= 0.0860 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 12/14/09 **Tested By:** M. Tierney/J. Pruett

Remarks

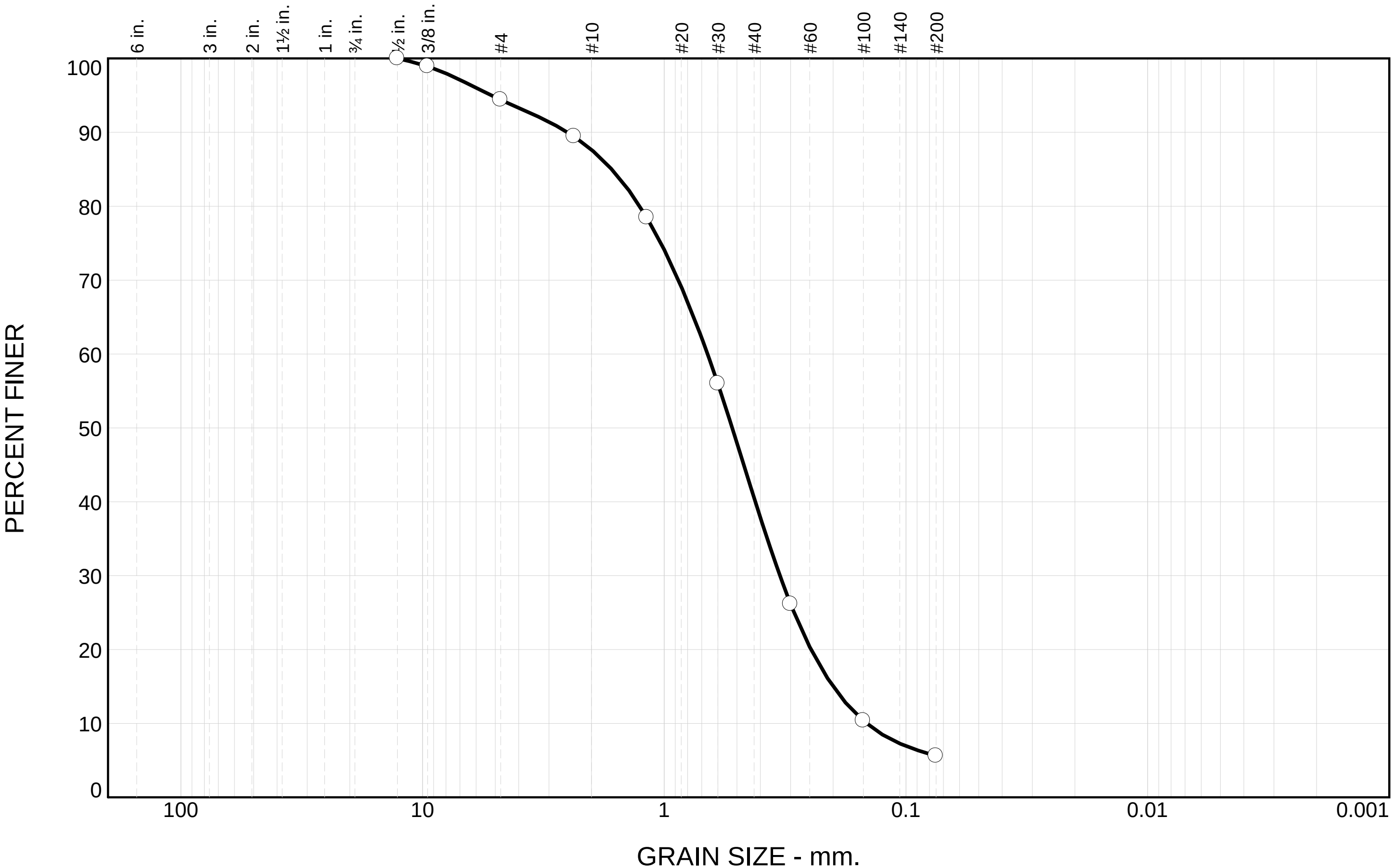
Sample No.: SS-6 **Source of Sample:** P-144 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-107

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.6	6.7	47.1	35.0	5.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.9		
#4	94.4		
#8	89.4		
#16	78.5		
#30	56.0		
#50	26.1		
#100	10.4		
#200	5.6		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 1.6487 D_{60}= 0.6620 D_{50}= 0.5233
D_{30}= 0.3322 D_{15}= 0.2003 D_{10}= 0.1455
C_u= 4.55 C_c= 1.15

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

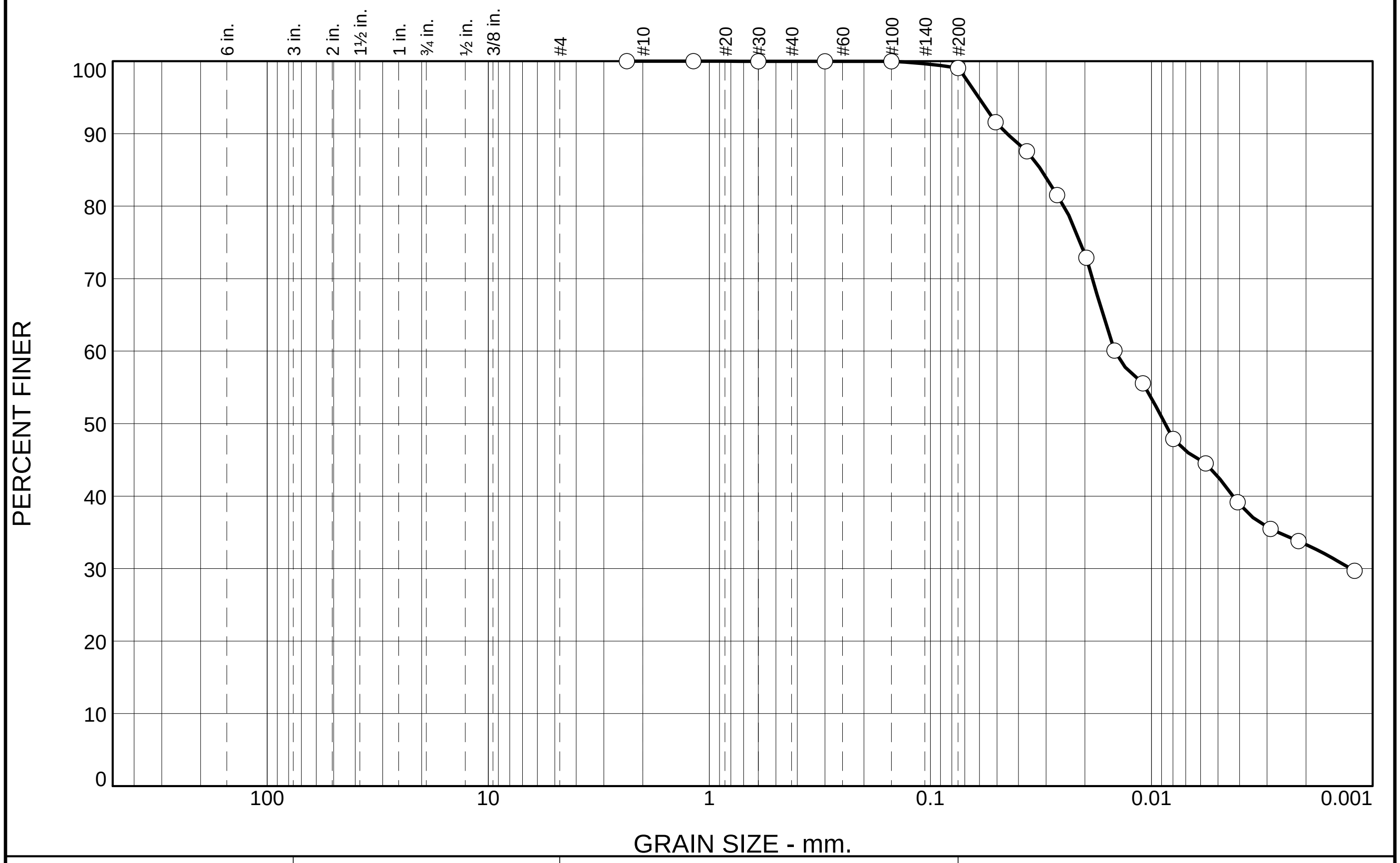
Sample No.: SS-8 **Source of Sample:** P-144 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-108

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.9	56.4	42.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#16	100.0		
#30	100.0		
#50	100.0		
#100	100.0		
#200	99.1		

* (no specification provided)

Material Description

Clayey SILT (ML), brown

Atterberg Limits (ASTM D 4318)

PL= LL= PI= 9

Classification

USCS= ML AASHTO=

Coefficients

D_{85}= 0.0315 D_{60}= 0.0147 D_{50}= 0.0087
D_{30}= 0.0013 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 4/7/10 **Tested By:** J. David

Remarks

Sample No.: ST-2 **Source of Sample:** B-153 **Date Sampled:** 11-11-2009
Location: **Elev./Depth:** 4
Checked By: K. Kocher **Title:** Engineer

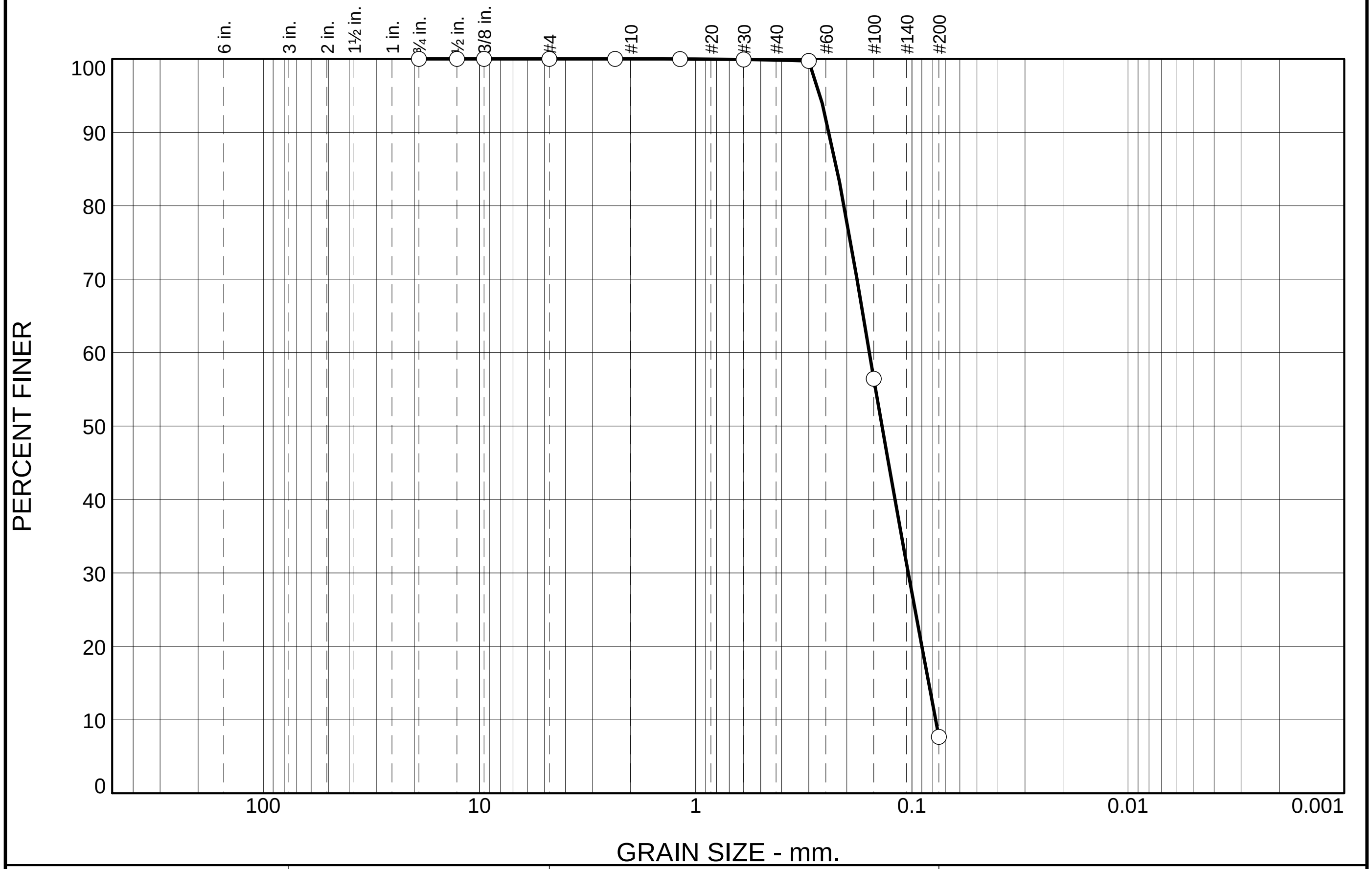
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-109

Tested By: J. David **Checked By:** K. Kocher

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	92.1	7.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	99.7		
#100	56.4		
#200	7.7		

* (no specification provided)

Material Description

SAND (SP-SM), tan, dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2221 D_{60}= 0.1573 D_{50}= 0.1375
D_{30}= 0.1039 D_{15}= 0.0835 D_{10}= 0.0776
C_u= 2.03 C_c= 0.88

Date Tested: 02-09-10 **Tested By:** J. David

Remarks

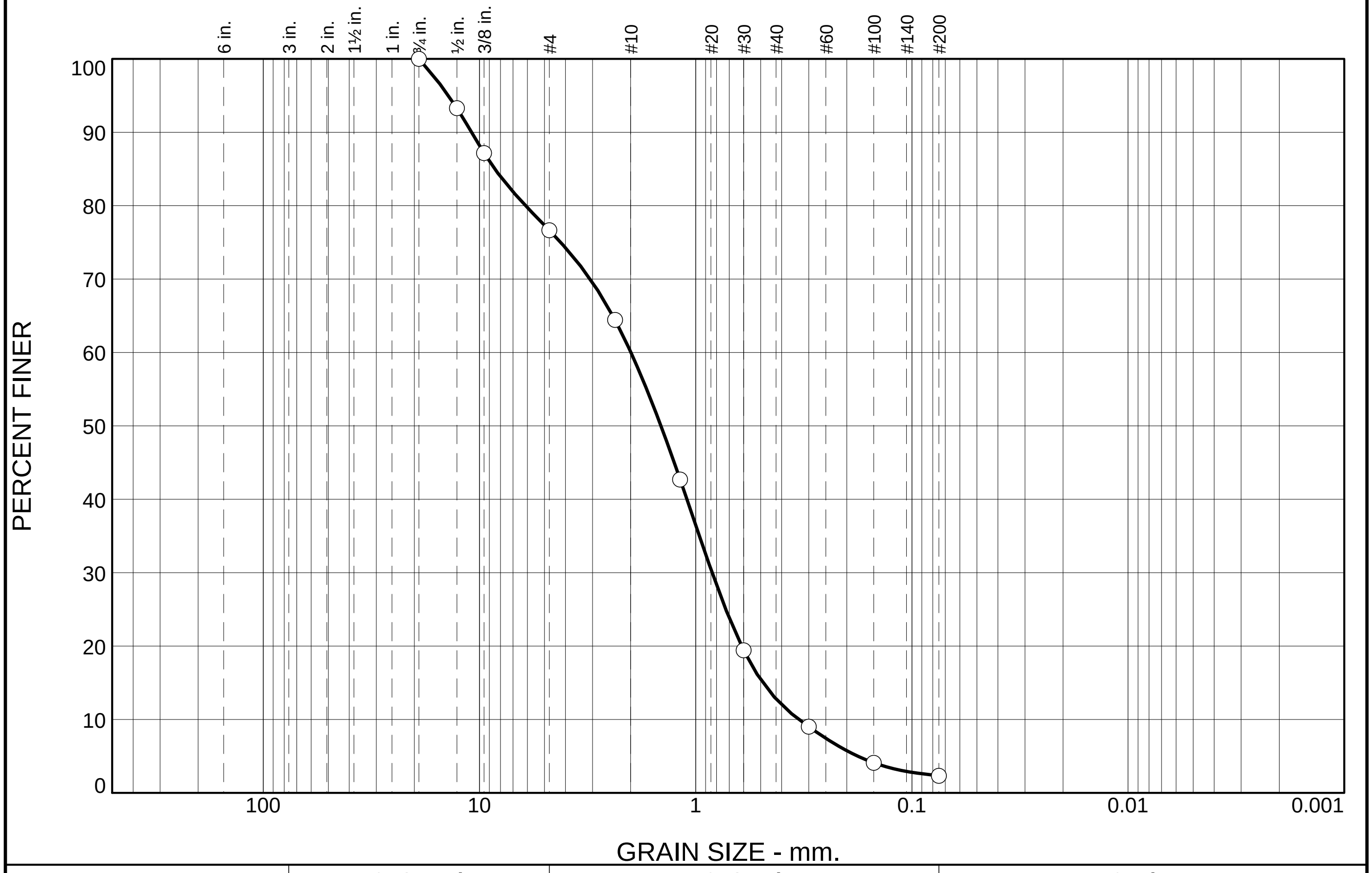
Sample No.: SS-6 **Source of Sample:** B-153 **Date Sampled:** 11-11-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-110

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	23.3	16.6	47.3	10.5	2.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	93.3		
3/8	87.2		
#4	76.7		
#8	64.4		
#16	42.7		
#30	19.4		
#50	9.0		
#100	4.1		
#200	2.3		

* (no specification provided)

Material Description

SAND (SW), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SW AASHTO=

Coefficients

D_{85}= 8.4955 D_{60}= 1.9921 D_{50}= 1.4483
D_{30}= 0.8387 D_{15}= 0.4883 D_{10}= 0.3328
C_u= 5.99 C_c= 1.06

Date Tested: 2/9/10 **Tested By:** J. Pruett

Remarks

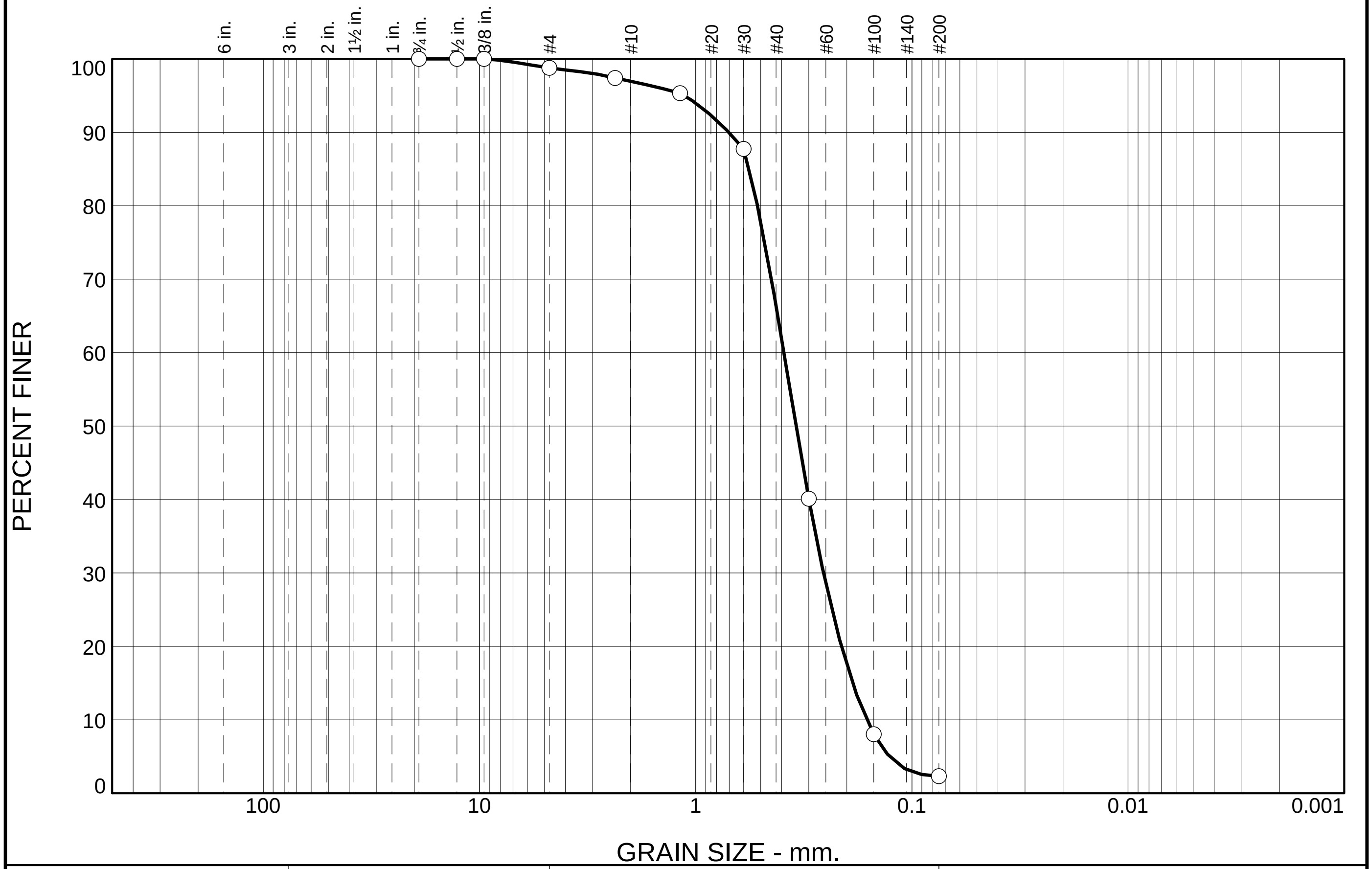
Sample No.: SS-10 **Source of Sample:** B-153 **Date Sampled:** 11-11-2009
Location:
Elev./Depth: 38.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-111

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.2	1.8	30.6	64.1	2.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.8		
#8	97.4		
#16	95.3		
#30	87.8		
#50	40.1		
#100	8.1		
#200	2.3		

* (no specification provided)

Material Description

SAND (SP), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5656 D_{60}= 0.3906 D_{50}= 0.3432
D_{30}= 0.2564 D_{15}= 0.1882 D_{10}= 0.1618
C_u= 2.41 C_c= 1.04

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

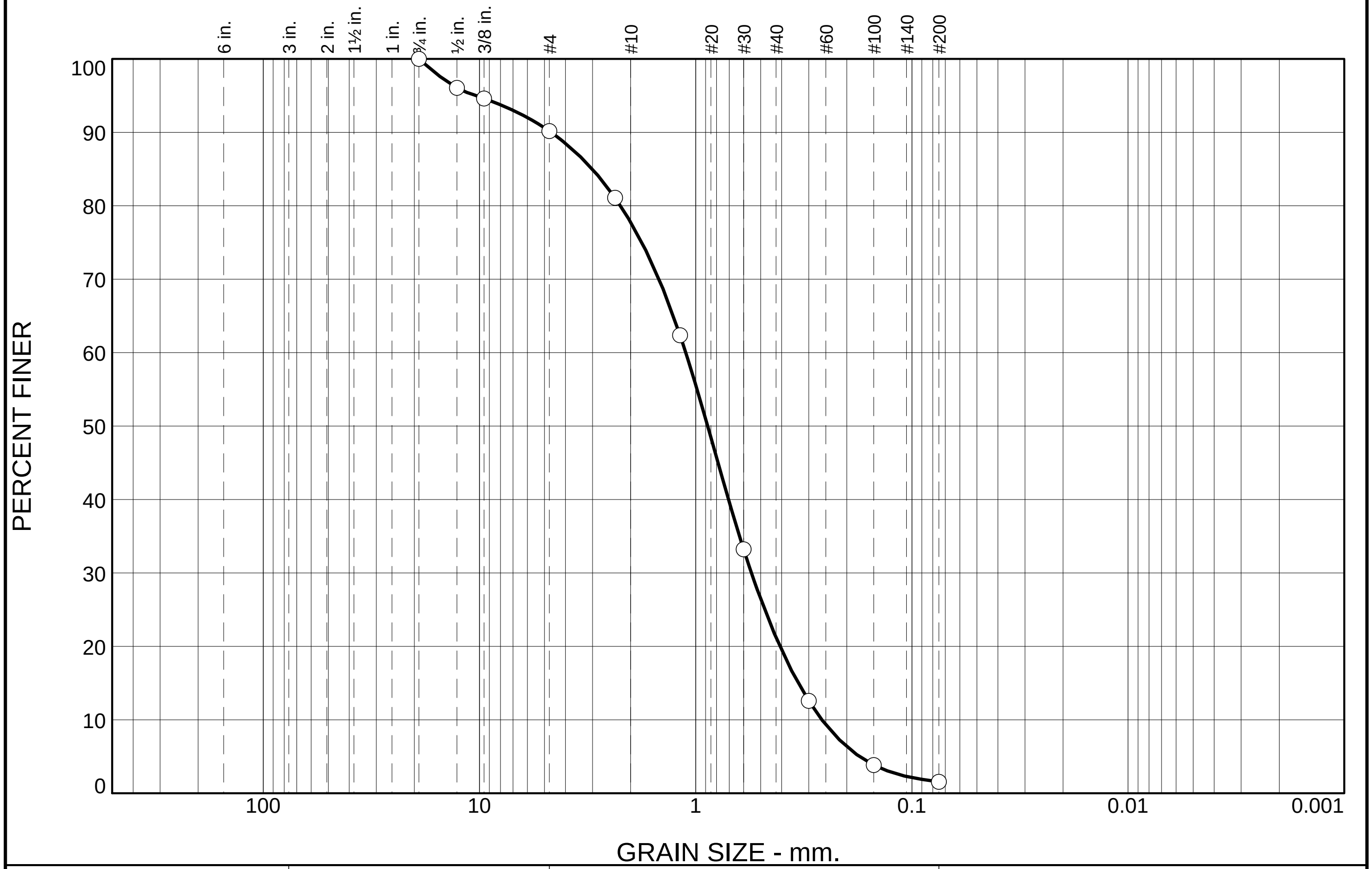
Sample No.: SS-6 **Source of Sample:** B-154 **Date Sampled:** 11-09-2009
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-112

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.8	12.4	56.6	19.6	1.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	96.1		
3/8	94.6		
#4	90.2		
#8	81.1		
#16	62.4		
#30	33.2		
#50	12.6		
#100	3.8		
#200	1.6		

* (no specification provided)

Material Description

SAND (SP), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 3.0049 D_{60}= 1.1108 D_{50}= 0.8801
D_{30}= 0.5520 D_{15}= 0.3355 D_{10}= 0.2607
C_u= 4.26 C_c= 1.05

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

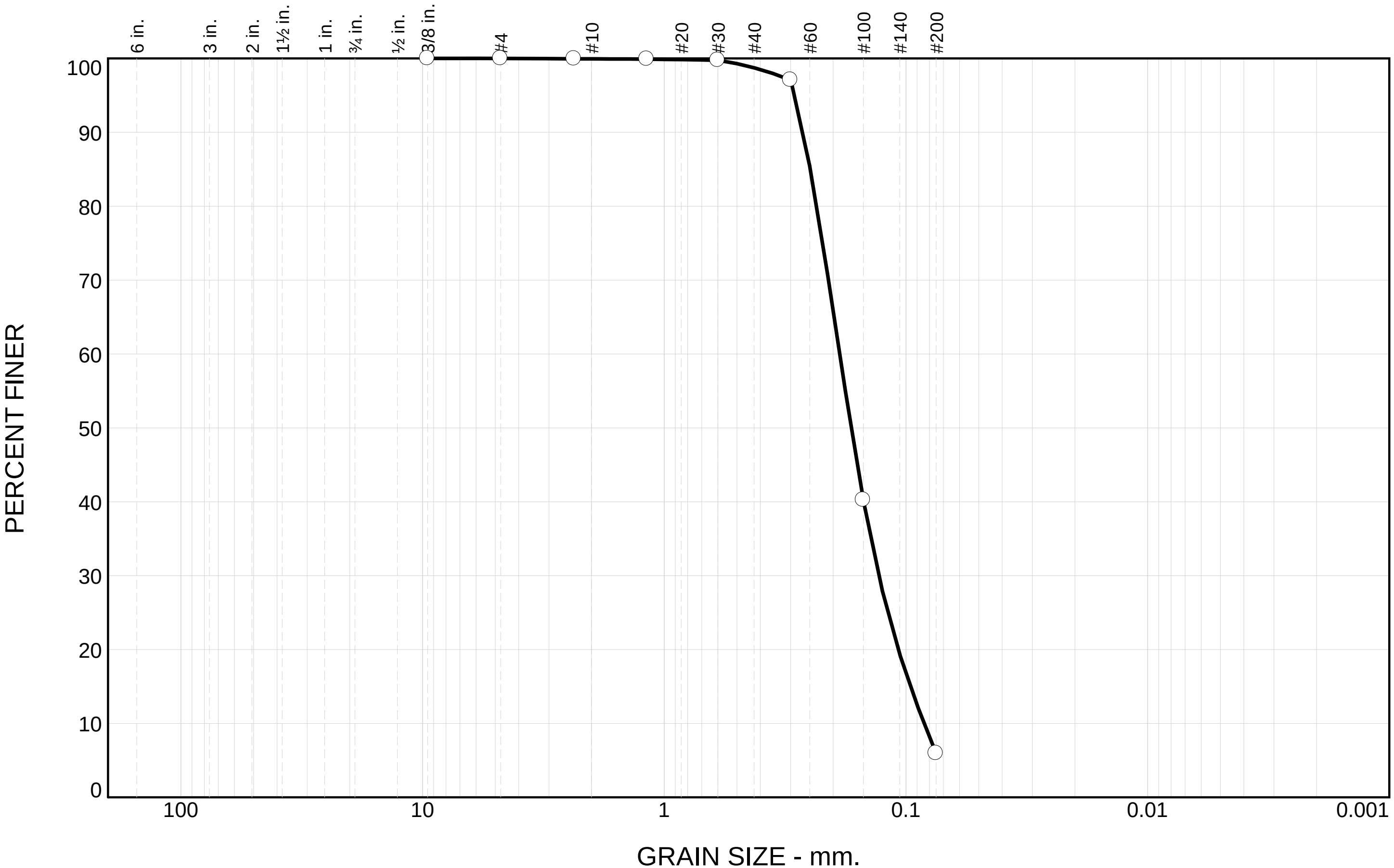
Sample No.: SS-9 **Source of Sample:** B-154 **Date Sampled:** 11-09-2009
Location: **Elev./Depth:** 33.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-113

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.2	92.8	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.8		
#50	97.1		
#100	40.2		
#200	5.9		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2486 D_{60}= 0.1878 D_{50}= 0.1685
D_{30}= 0.1295 D_{15}= 0.0958 D_{10}= 0.0840
C_u= 2.24 C_c= 1.06

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

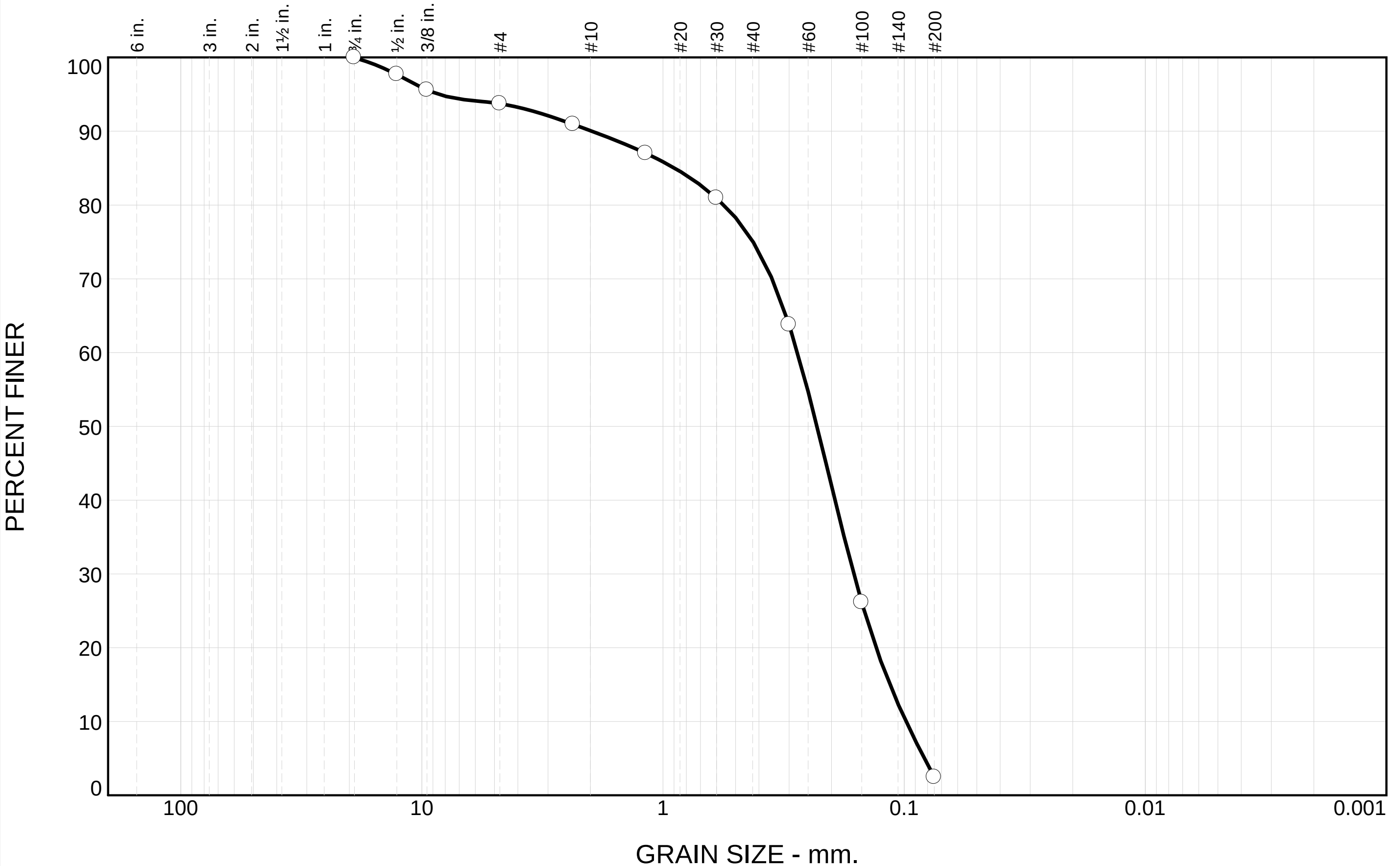
Sample No.: SS-4 **Source of Sample:** P-162 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-114

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.3	3.6	15.0	72.6	2.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	97.7		
3/8	95.6		
#4	93.7		
#8	90.9		
#16	87.0		
#30	80.9		
#50	63.8		
#100	26.1		
#200	2.5		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.8953 D_{60}= 0.2767 D_{50}= 0.2298
D_{30}= 0.1619 D_{15}= 0.1146 D_{10}= 0.0982
C_u= 2.82 C_c= 0.96

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

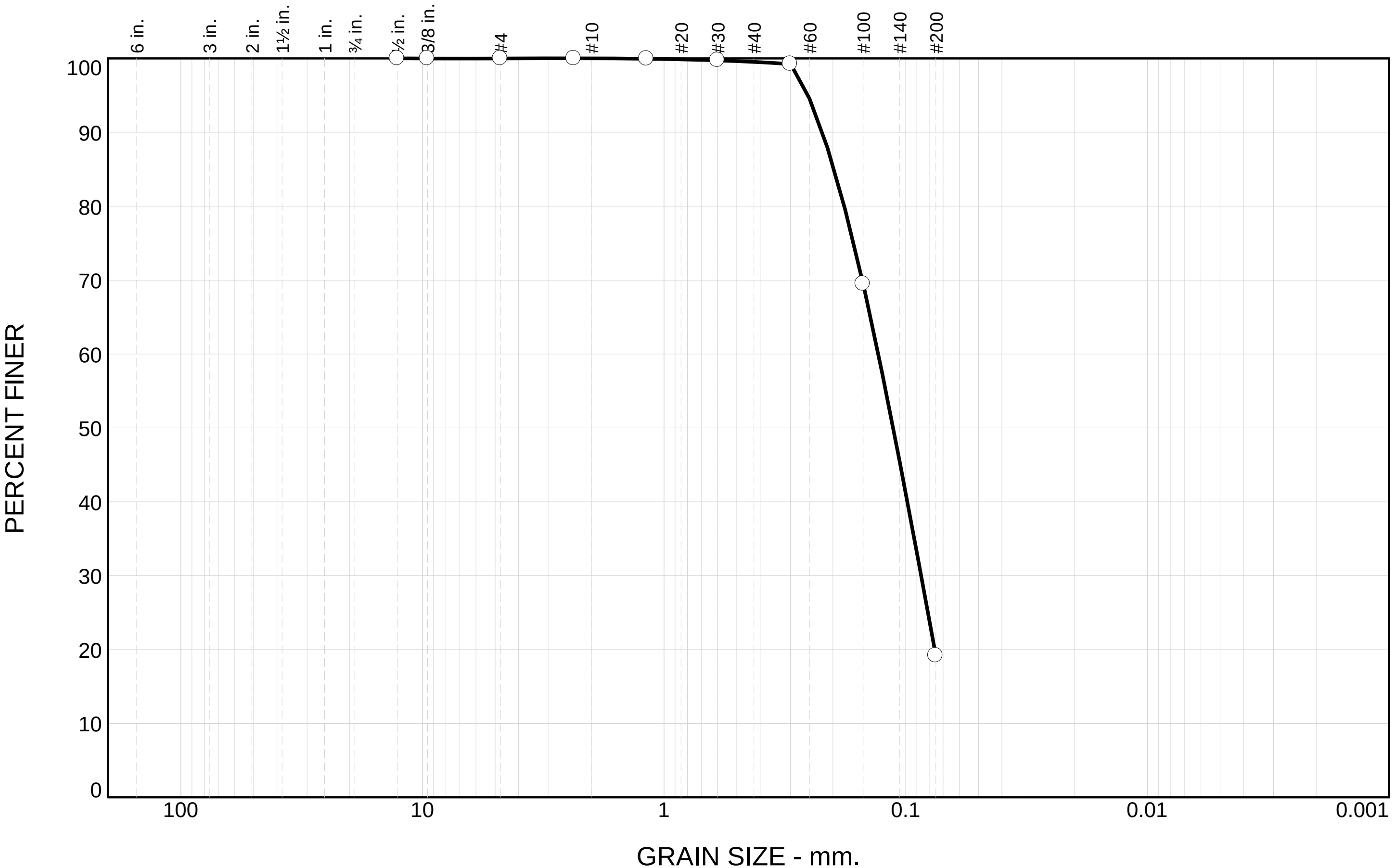
Sample No.: SS-6 **Source of Sample:** P-162 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-115

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.5	80.3	19.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.8		
#50	99.2		
#100	69.5		
#200	19.2		

* (no specification provided)

Material Description

Silty SAND (SM)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SM AASHTO=

Coefficients

D_{85}= 0.1978 D_{60}= 0.1298 D_{50}= 0.1126
D_{30}= 0.0863 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

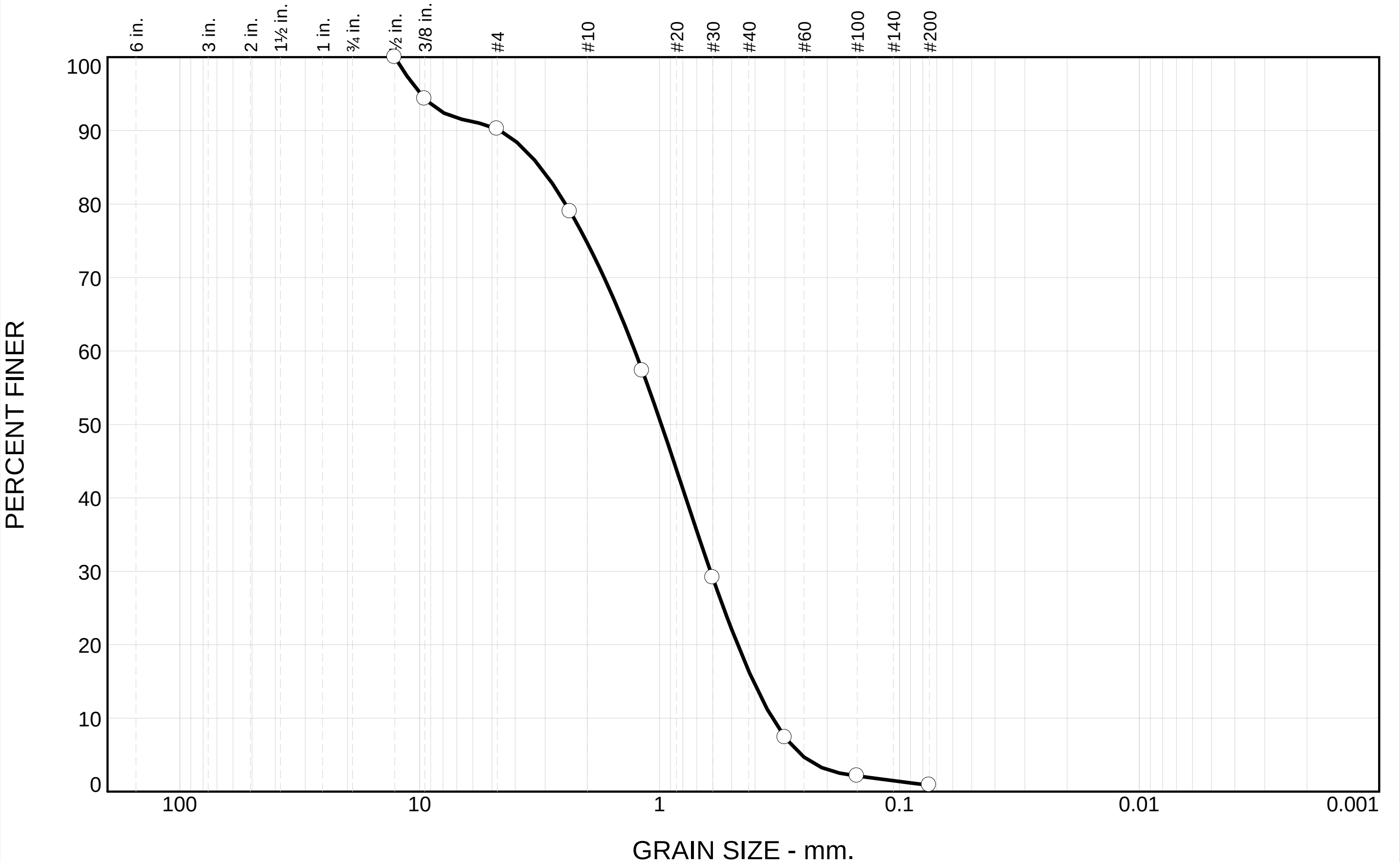
Sample No.: SS-4 **Source of Sample:** P-164 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-116

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.8	15.5	58.3	15.5	0.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	94.3		
#4	90.2		
#8	79.0		
#16	57.3		
#30	29.1		
#50	7.4		
#100	2.1		
#200	0.9		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 3.1362 D_{60}= 1.2676 D_{50}= 0.9842
D_{30}= 0.6129 D_{15}= 0.4065 D_{10}= 0.3392
C_u= 3.74 C_c= 0.87

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

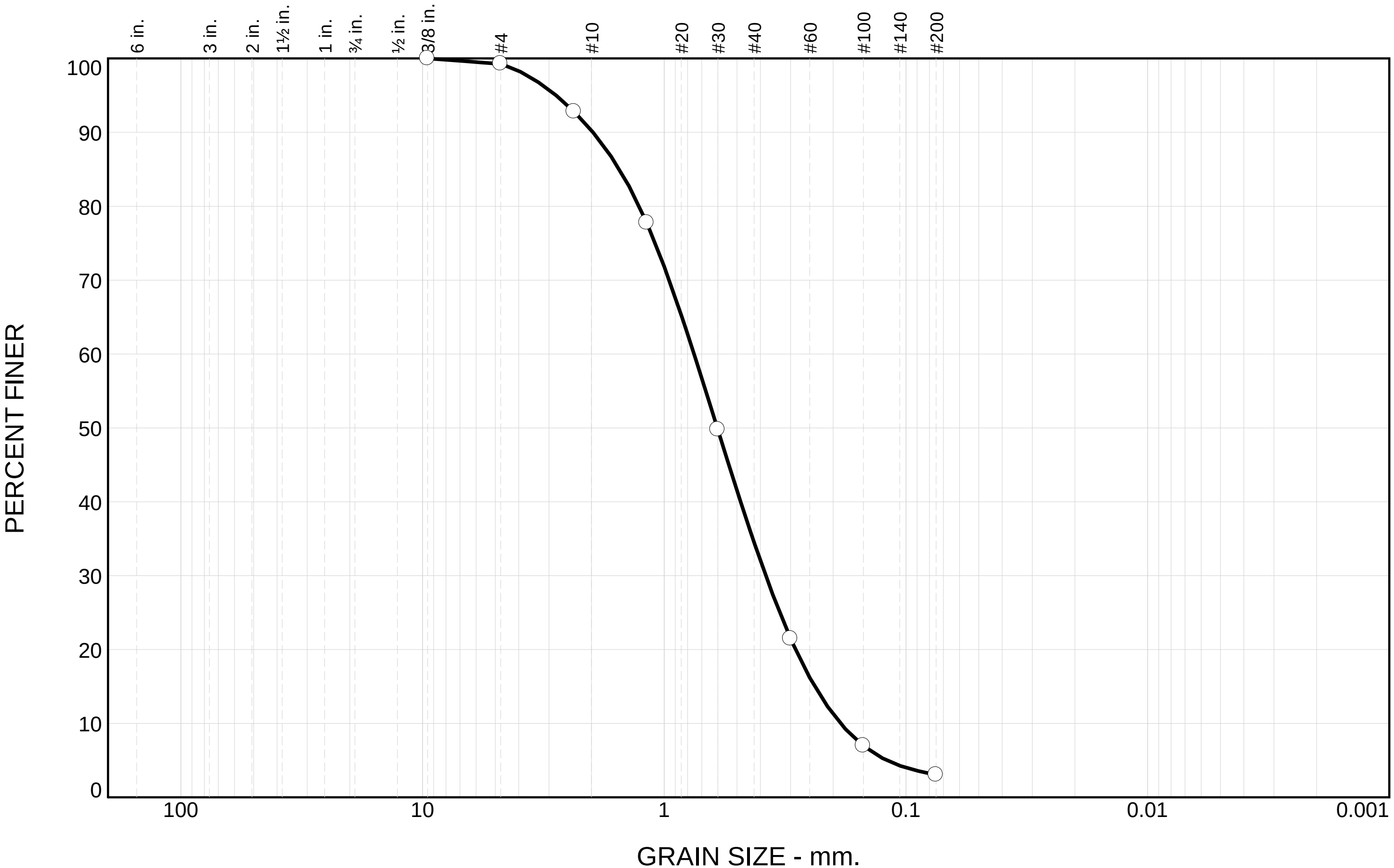
Sample No.: SS-6 **Source of Sample:** P-164 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-117

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	9.0	55.8	31.5	3.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.3		
#8	92.8		
#16	77.7		
#30	49.7		
#50	21.5		
#100	7.0		
#200	3.0		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.5340 D_{60}= 0.7529 D_{50}= 0.6033
D_{30}= 0.3803 D_{15}= 0.2382 D_{10}= 0.1864
C_u= 4.04 C_c= 1.03

Date Tested: 12-04-09 **Tested By:** M. Tierney/J. Pruett

Remarks

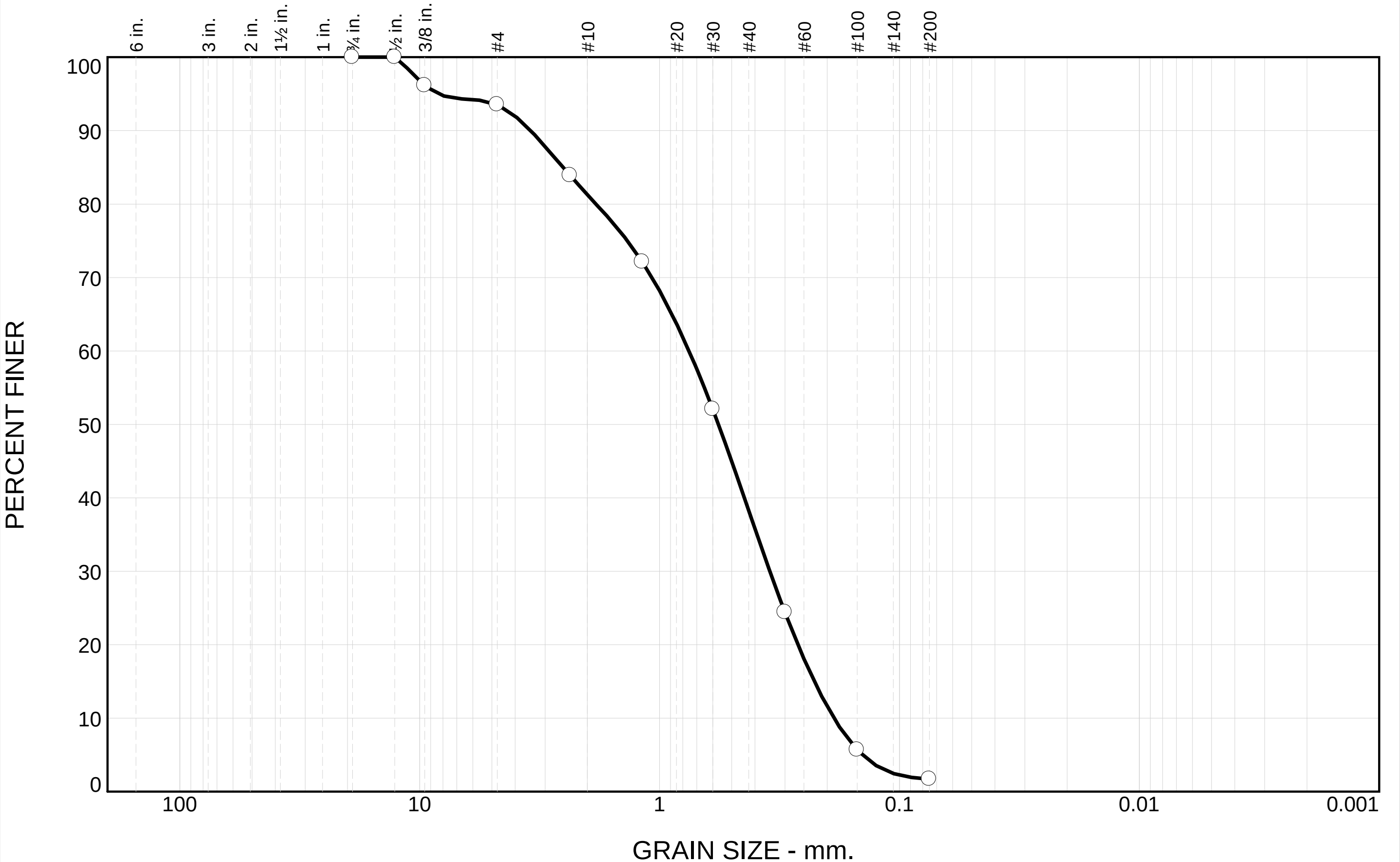
Sample No.: SS-5 **Source of Sample:** P-165 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-118

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.5	12.2	43.0	36.6	1.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	96.1		
#4	93.5		
#8	83.9		
#16	72.1		
#30	52.1		
#50	24.4		
#100	5.7		
#200	1.7		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 2.5261 D_{60}= 0.7534 D_{50}= 0.5684
D_{30}= 0.3468 D_{15}= 0.2265 D_{10}= 0.1877
C_u= 4.01 C_c= 0.85

Date Tested: 12/4/09 **Tested By:** J. Pruett, M. Tierney

Remarks

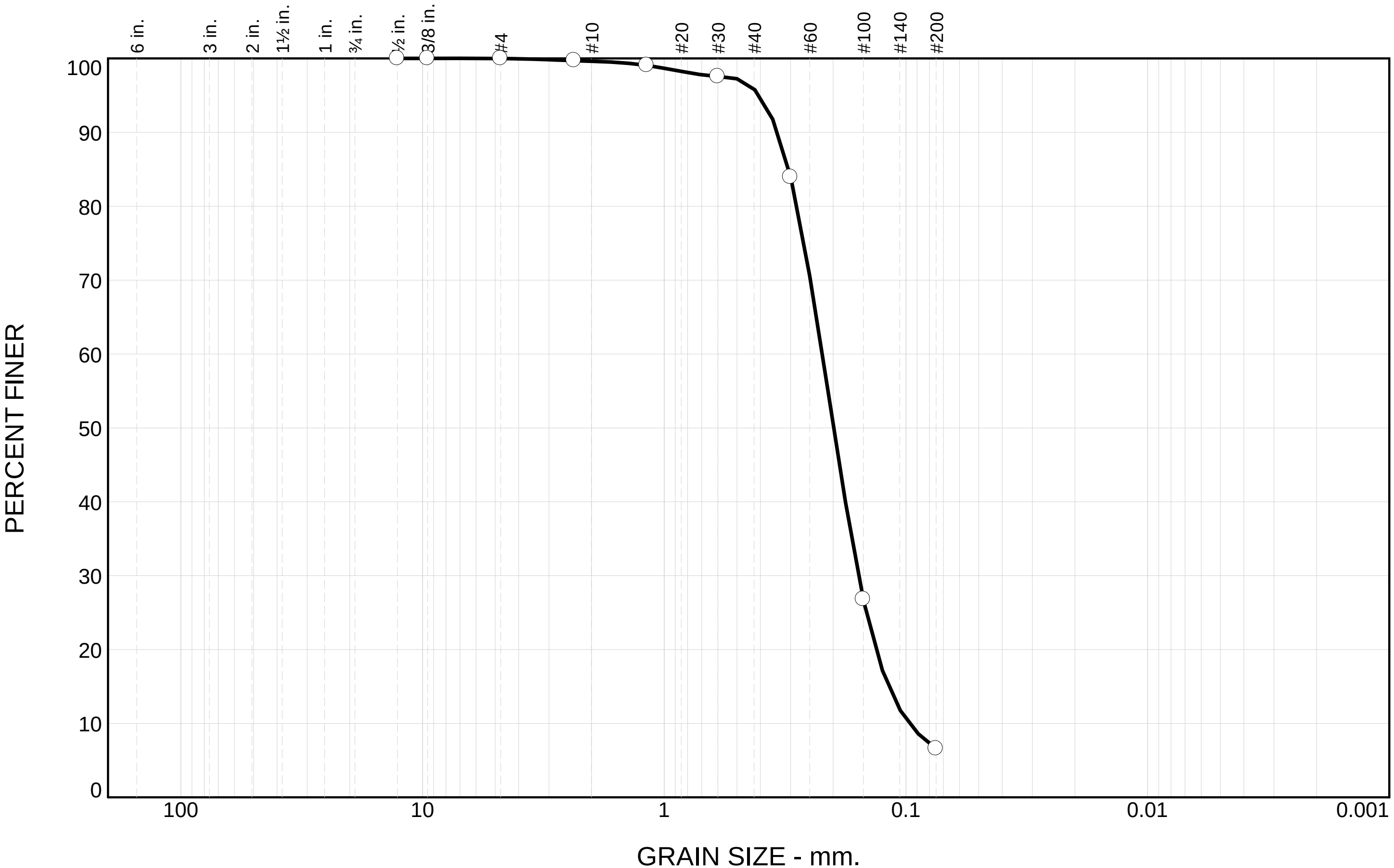
Sample No.: SS-7 **Source of Sample:** P-165 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-119

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	3.7	89.3	6.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	99.7		
#16	99.1		
#30	97.6		
#50	83.9		
#100	26.8		
#200	6.6		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.3055 D_{60}= 0.2218 D_{50}= 0.1990
D_{30}= 0.1571 D_{15}= 0.1180 D_{10}= 0.0971
C_u= 2.29 C_c= 1.15

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

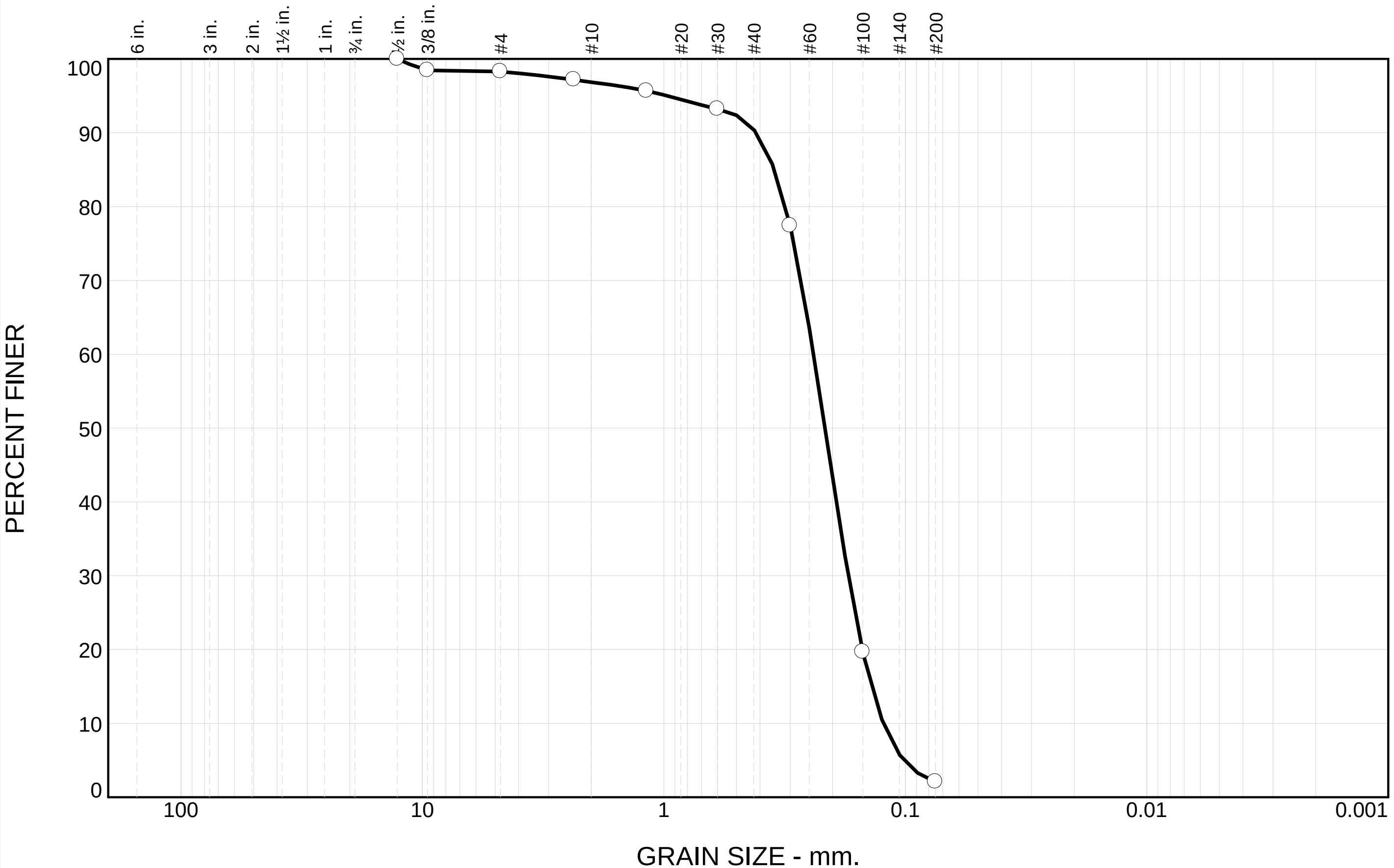
Sample No.: SS-4 **Source of Sample:** P-169 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-120

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	1.4	6.4	88.4	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.5		
#4	98.3		
#8	97.2		
#16	95.7		
#30	93.2		
#50	77.4		
#100	19.7		
#200	2.1		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3486 D_{60}= 0.2399 D_{50}= 0.2151
D_{30}= 0.1723 D_{15}= 0.1383 D_{10}= 0.1233
C_u= 1.95 C_c= 1.00

Date Tested: 01-20-10 **Tested By:** C. Cook

Remarks

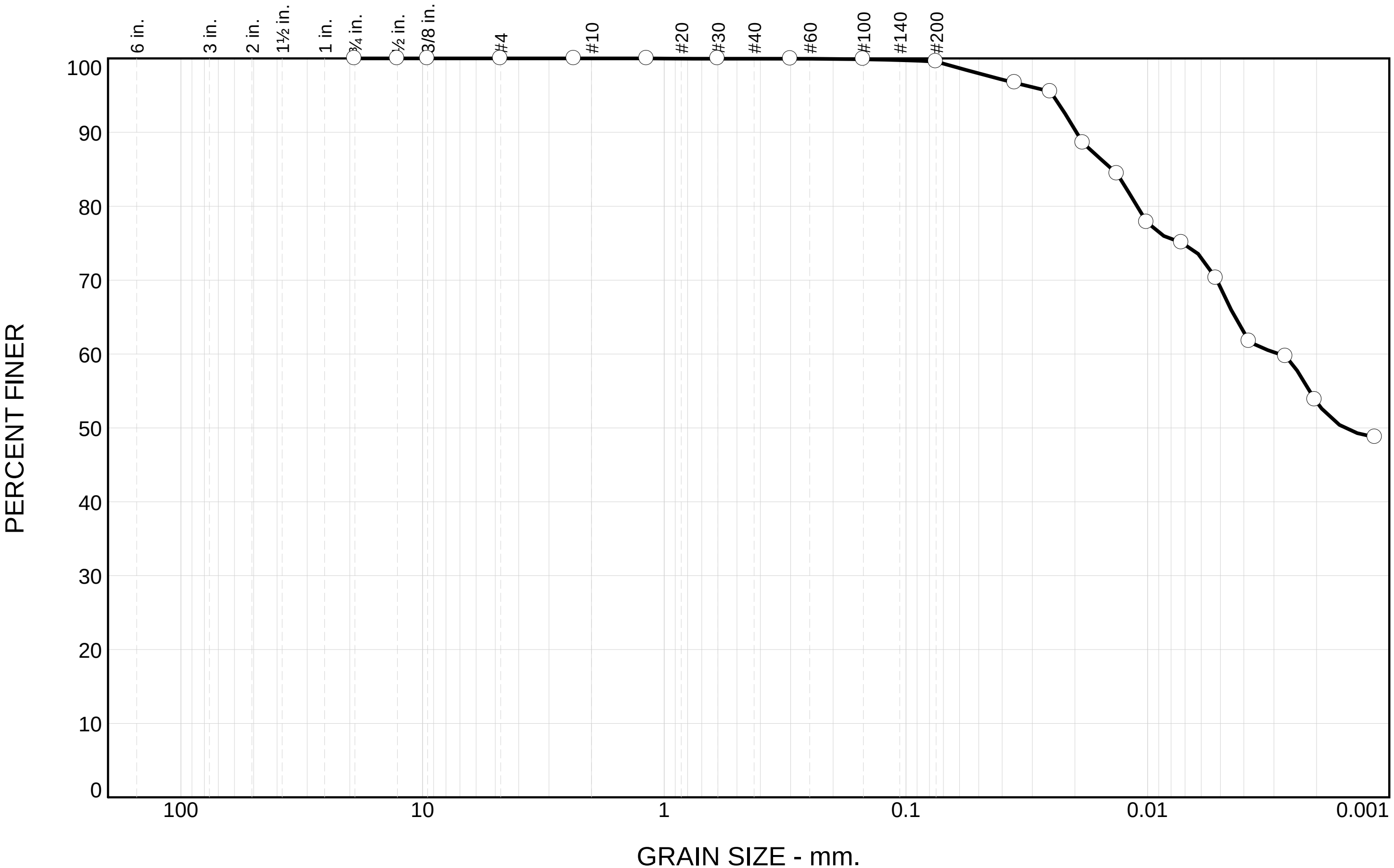
Sample No.: SS-6 **Source of Sample:** P-169 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-121

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.4	30.5	69.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	100.0		
#50	100.0		
#100	99.9		
#200	99.6		

* (no specification provided)

Material Description

CLAY (CH), grey-brown, high plastic, with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= CH AASHTO=

Coefficients

D_{85}= 0.0139 D_{60}= 0.0028 D_{50}= 0.0015
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Date Tested: 04-09-10 **Tested By:** J. Pruett

Remarks

Sample No.: ST-O **Source of Sample:** P-175 **Date Sampled:** 04-09-10
Location: **Elev./Depth:** 1
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-122

Ameren Missouri; Labadie Power Plant
Utility Waste Landfill, Detailed Site Investigation
Location P-175; Sample 1-3 feet
Hydraulic Conductivity

Soil Conditions	
Pre-test conditions	**Post-test Conditions**
Wet Density = 114.4 (lbs/ft^3)	Wet Density = 116.5 (lbs/ft^3)
% Moisture = 34.7%	% Moisture = 35.8%
Dry Density = 84.9 (lbs/ft^3)	Dry Density = 85.8 (lbs/ft^3)

Test Information	
a (cm^2)=	0.1969
L (cm)=	5.1016
A (cm^2)=	20.28856

Trial 1

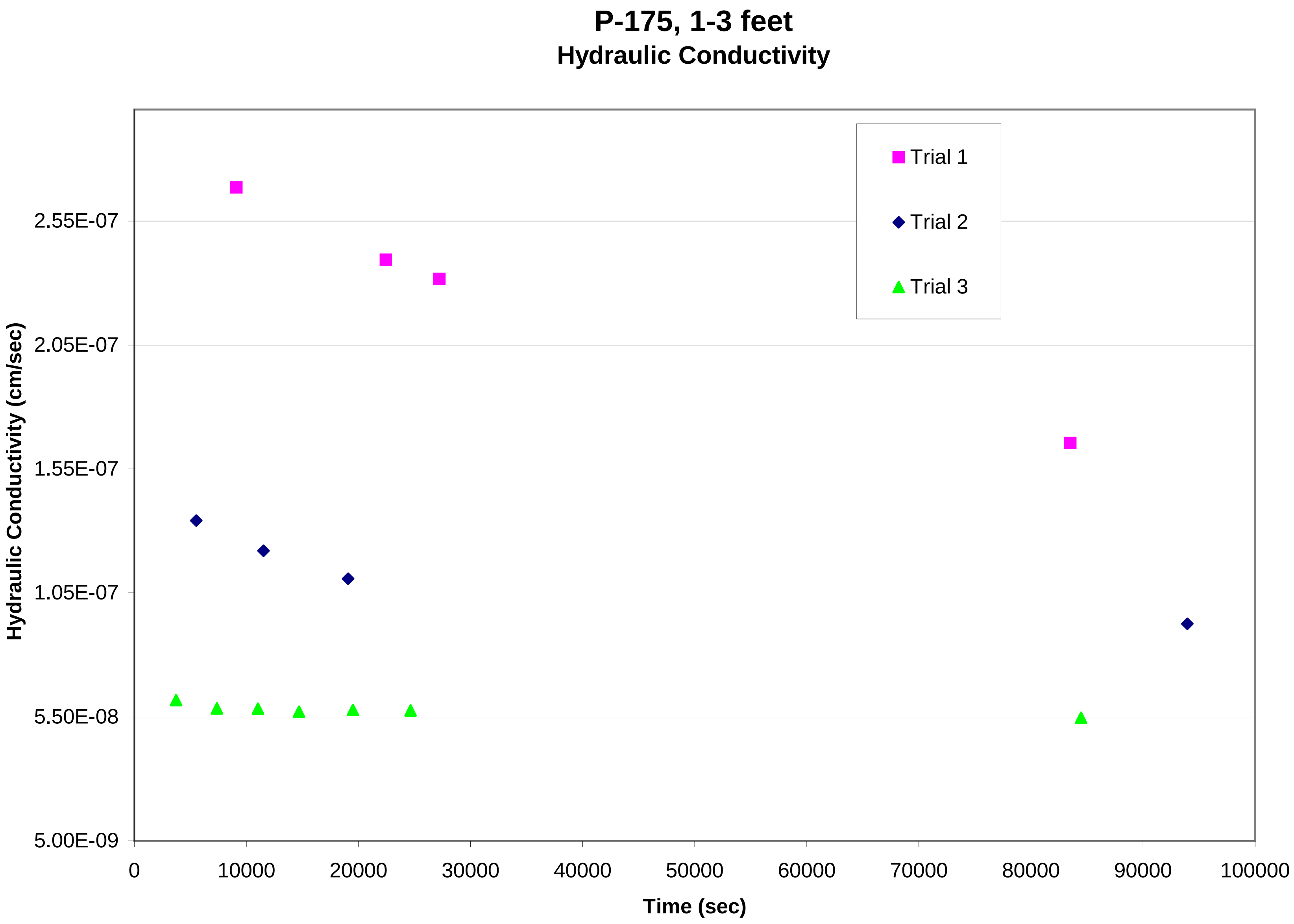
			Base Burette		Top Burette								
Date and Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (°C)	Weighted Average Temp. (°C)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Cumulative Time (sec)	Corrected Hydraulic Conductivity (cm/sec)
4/7/10 8:46	0	15.7	10.00	27.200	0.00	78.000	121.158	21.1					
4/7/10 11:18	9120	15.7	8.83	33.144	1.16	72.107	109.322	22.1	21.60	2.79E-07	0.9623875	9120	2.68E-07
4/7/10 15:00	22440	15.5	7.53	39.748	2.43	65.656	96.266	23.9	22.43	2.54E-07	0.9436516	22440	2.39E-07
4/7/10 16:20	27240	15.4	7.14	41.729	2.82	63.674	92.304	24.2	22.72	2.47E-07	0.9373554	27240	2.32E-07
4/8/10 7:58	83520	15.8	4.64	54.429	5.35	50.822	66.751	21.3	22.74	1.77E-07	0.9368572	83520	1.65E-07

Trial 2

			Base Burette		Top Burette								
Date and Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (°C)	Weighted Average Temp. (°C)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Cumulative Time (sec)	Corrected Hydraulic Conductivity (cm/sec)
4/8/10 9:19	0	15.9	10.00	27.200	0.00	78.000	121.158	21.1					
4/8/10 10:51	5520	15.7	9.64	29.029	0.37	76.120	117.450	22.1	21.60	1.39E-07	0.9623875	5520	1.34E-07
4/8/10 12:31	11520	15.9	9.32	30.654	0.71	74.393	114.097	23.9	22.33	1.29E-07	0.9459159	11520	1.22E-07
4/8/10 14:37	19080	15.9	8.98	32.382	1.07	72.564	110.541	24.2	23.01	1.19E-07	0.9309217	19080	1.11E-07
4/9/10 11:25	93960	16.2	6.33	45.844	3.80	58.696	83.210	21.3	22.80	9.90E-08	0.9354553	93960	9.26E-08

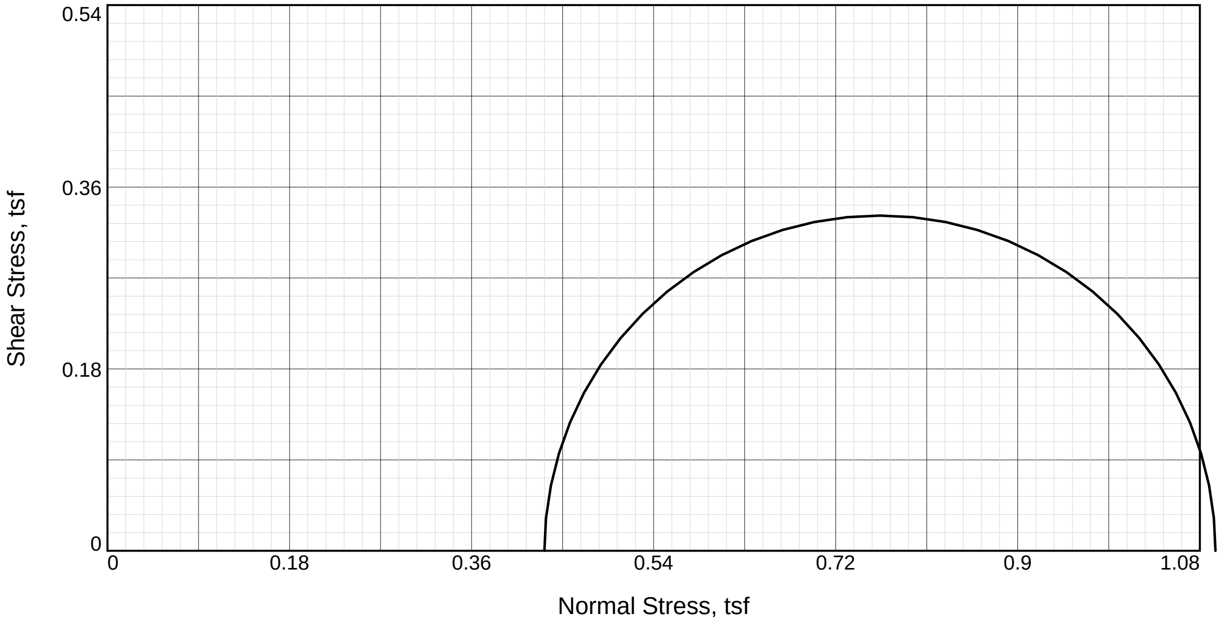
Trial 3

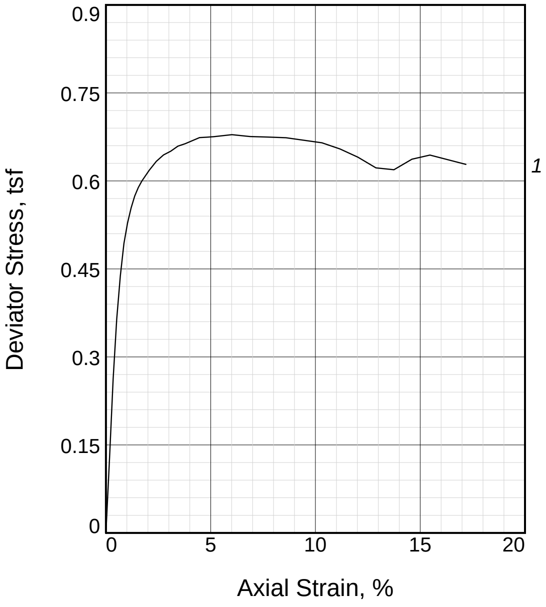
			Base Burette		Top Burette								
Date and Time	Elapsed Time (seconds)	Cell Burette Reading (ml)	Reading (ml)	Distance from Datum (cm)	Reading (ml)	Distance from Datum (cm)	Total Head Across Sample (cm of water)	Temperature (°C)	Weighted Average Temp. (°C)	Uncorrected Hydraulic Conductivity (cm/sec)	Correction Factor	Cumulative Time (sec)	Corrected Hydraulic Conductivity (cm/sec)
4/12/10 8:21	0	15.9	10.00	27.200	0.00	78.000	121.158	21.7					
4/12/10 9:23	3720	16.0	9.86	27.911	0.09	77.543	119.990	21.9	21.80	6.45E-08	0.9578233	3720	6.18E-08
4/12/10 10:24	7380	15.9	9.76	28.419	0.19	77.035	118.974	21.8	21.82	6.10E-08	0.9572598	7380	5.84E-08
4/12/10 11:25	11040	15.9	9.65	28.978	0.29	76.527	117.907	21.9	21.83	6.10E-08	0.9570701	11040	5.84E-08
4/12/10 12:26	14700	16.0	9.56	29.435	0.39	76.019	116.942	21.9	21.85	5.96E-08	0.9566924	14700	5.71E-08
4/12/10 13:46	19500	15.9	9.42	30.146	0.53	75.308	115.519	21.9	21.86	6.05E-08	0.9564120	19500	5.79E-08
4/12/10 15:12	24660	16.0	9.28	30.858	0.67	74.596	114.097	22.0	21.88	6.03E-08	0.9559953	24660	5.76E-08
4/13/10 7:49	84480	16.1	7.87	38.020	2.09	67.383	99.720	21.5	21.79	5.70E-08	0.9580938	84480	5.47E-08



Reitz & Jens, Inc. *Consulting Engineers*

Figure B-123





Sample No.		1
Initial	Water Content,	48.7
	Dry Density, pcf	71.6
	Saturation,	97.6
	Void Ratio	1.3373
	Diameter, in.	2.85
	Height, in.	5.82
At Test	Water Content,	48.7
	Dry Density, pcf	71.6
	Saturation,	97.6
	Void Ratio	1.3373
	Diameter, in.	2.85
	Height, in.	5.82
Strain rate, %/min.		0.83
Back Pressure, tsf		0.00
Cell Pressure, tsf		0.43
Fail. Stress, tsf		0.66
Ult. Stress, tsf		0.68
σ_1 Failure, tsf		1.10
σ_3 Failure, tsf		0.43

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CH), gray-brown, high plastic, with lignite and limonite

LL= 80 **PL=** 28 **PI=** 52

Assumed Specific Gravity= 2.68

Remarks:

Figure B-124

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-176 **Depth:** 7

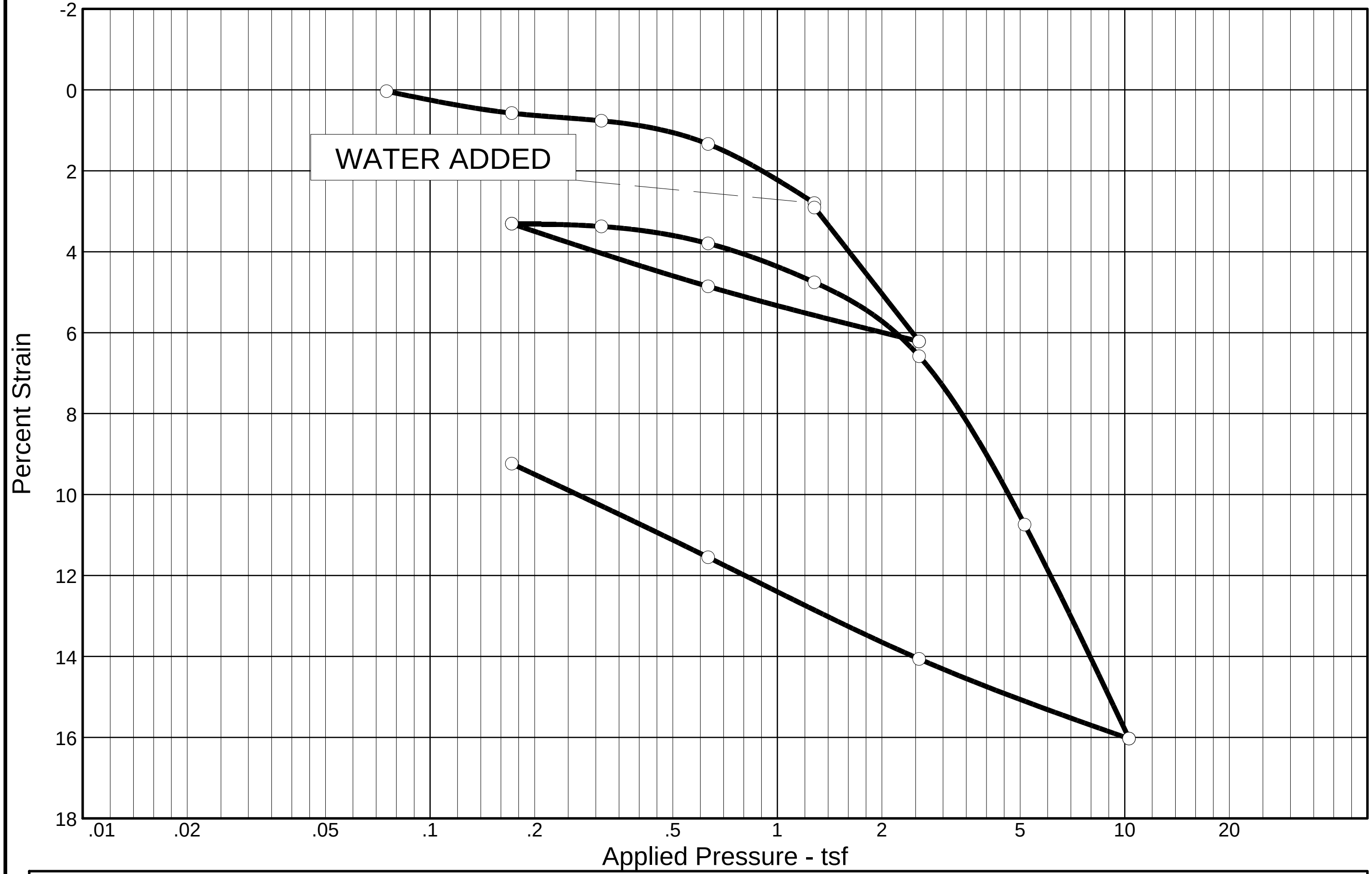
Sample Number: ST-3

Proj. No.: 2008012455 **Date:** 1-19-2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Pruett **Checked By:** K. Kocher

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
1	0.08	5.24		11	0.63	0.02	0.001				
2	0.17	4.86		12	1.28	0.01	0.001				
3	0.31	0.16		13	2.56	0.01	0.003				
4	0.63	0.07		14	5.15	0.01	0.006				
5	1.28	0.01	0.003	15	10.29	0.01	0.009				
6	1.28	0.93		16	2.56	0.01					
7	2.56	0.01	0.005	17	0.63	0.00					
8	0.63	0.02		18	0.17	0.00					
9	0.17	0.01									
10	0.31	0.02	0.000								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
94.0 %	38.3 %	80.0	80	52	2.68		1.69	0.37	0.07		0.1	1.092

MATERIAL DESCRIPTION	USCS	AASHTO
Becoming gray, with tan sandy clayey silt seam, and laminations of tan sandy silt, silty clay and silty sand		

Project No. 2008012455 **Client:** Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source: B-176 **Sample No.:** ST-3 **Elev./Depth:** 7

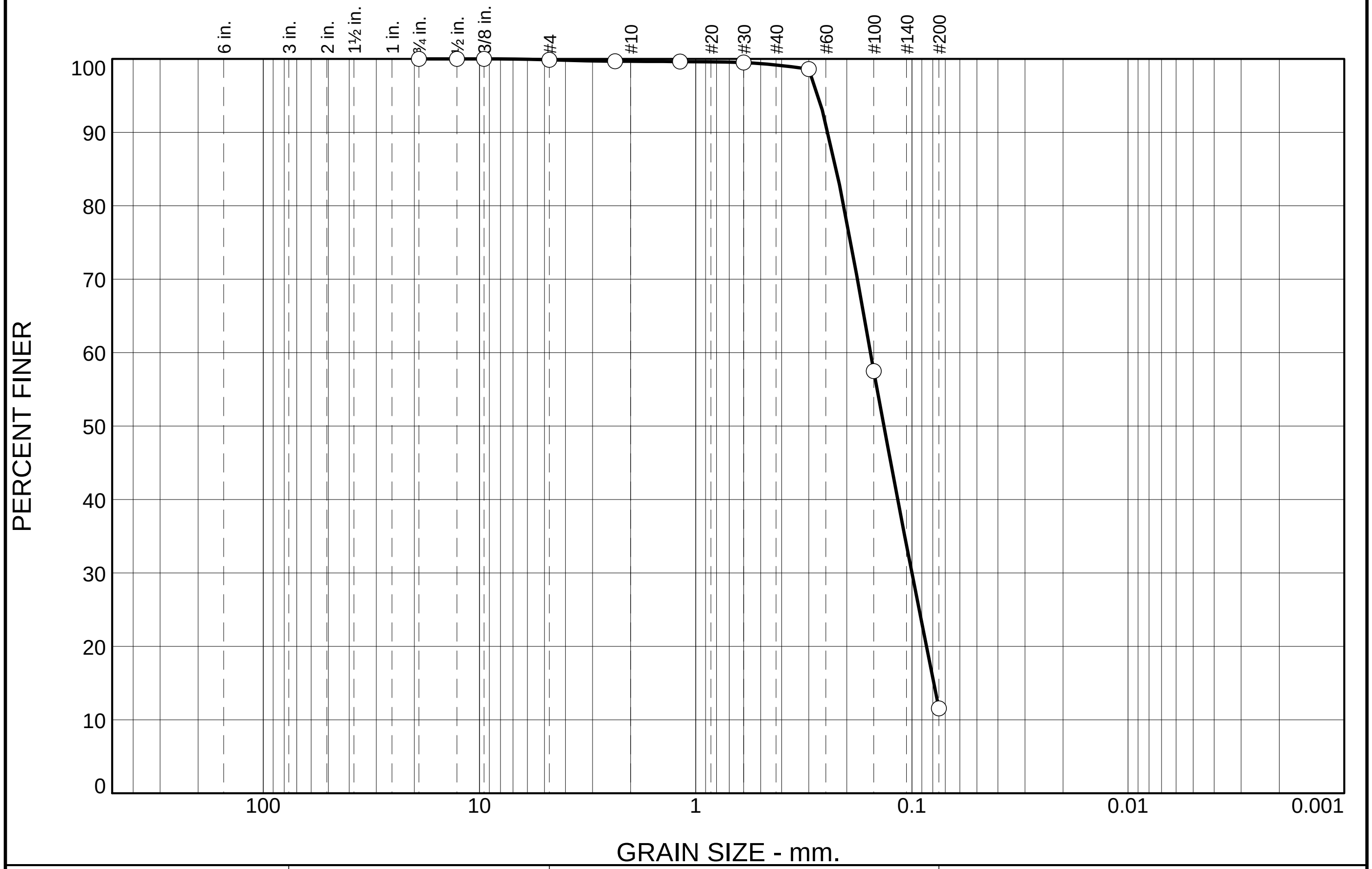
Remarks:

Assumed specific gravity

REITZ & JENS, INC.
CONSULTING ENGINEERS

Figure B-125

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.2	0.5	87.6	11.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.9		
#8	99.7		
#16	99.6		
#30	99.5		
#50	98.6		
#100	57.5		
#200	11.6		

* (no specification provided)

Material Description

SAND (SP-SM), tannish gray, dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2239 D_{60}= 0.1554 D_{50}= 0.1347

D_{30}= 0.0999 D_{15}= 0.0791 D_{10}=

C_u= C_c=

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

Sample No.: SS-7 **Source of Sample:** B-176 **Date Sampled:** 1-19-2010

Location: **Elev./Depth:** 23.5

Checked By: K. Kocher **Title:** Engineer

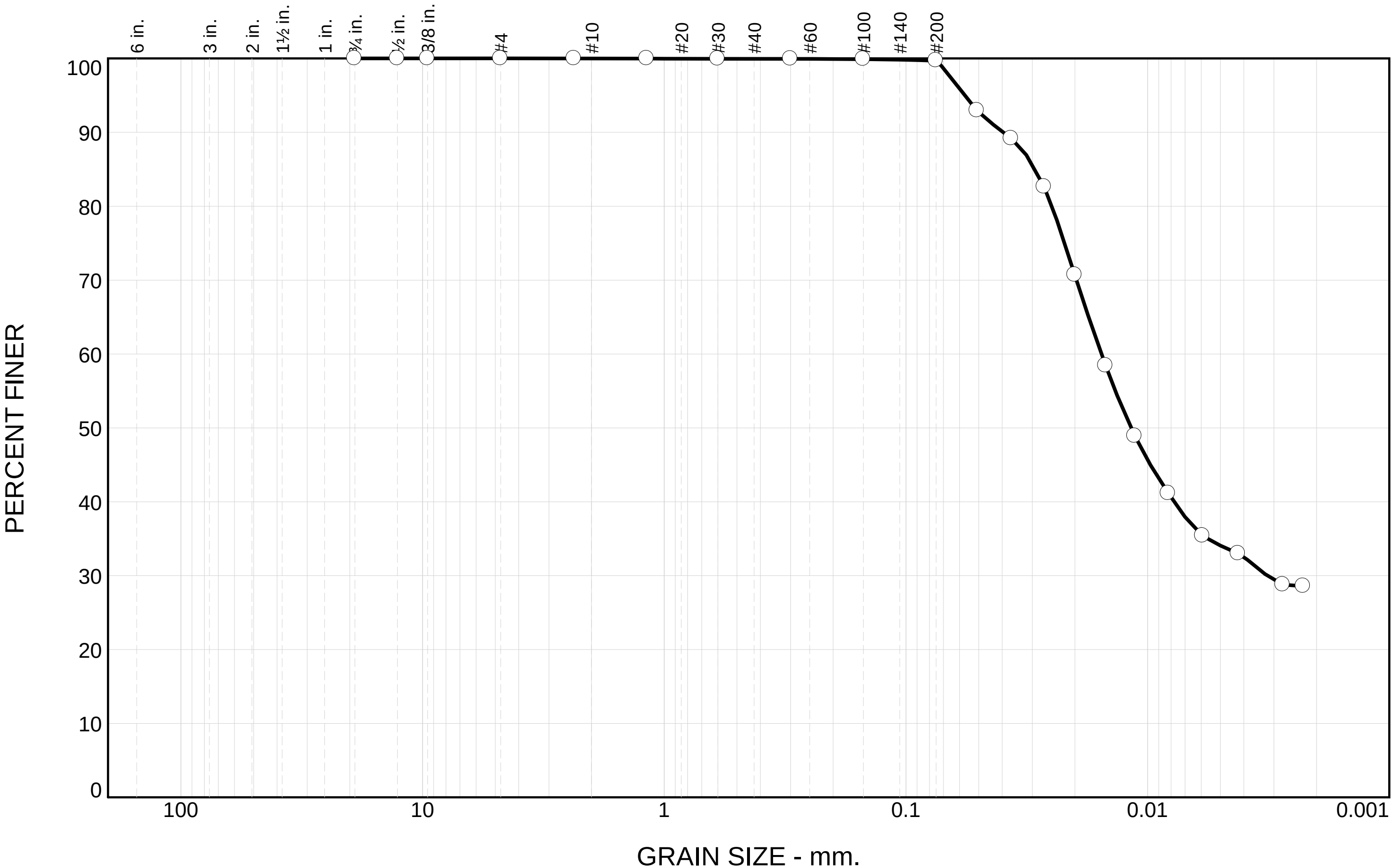
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-126

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.3	65.6	34.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	100.0		
#50	99.9		
#100	99.9		
#200	99.7		

* (no specification provided)

Material Description

Clayey SILT (ML), grey and brown

Atterberg Limits (ASTM D 4318)

PL= 26 LL= 68 PI= 42

Classification

USCS= CH AASHTO=

Coefficients

D_{85}= 0.0291 D_{60}= 0.0155 D_{50}= 0.0117
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Date Tested: 04-15-10 **Tested By:** J. Pruett

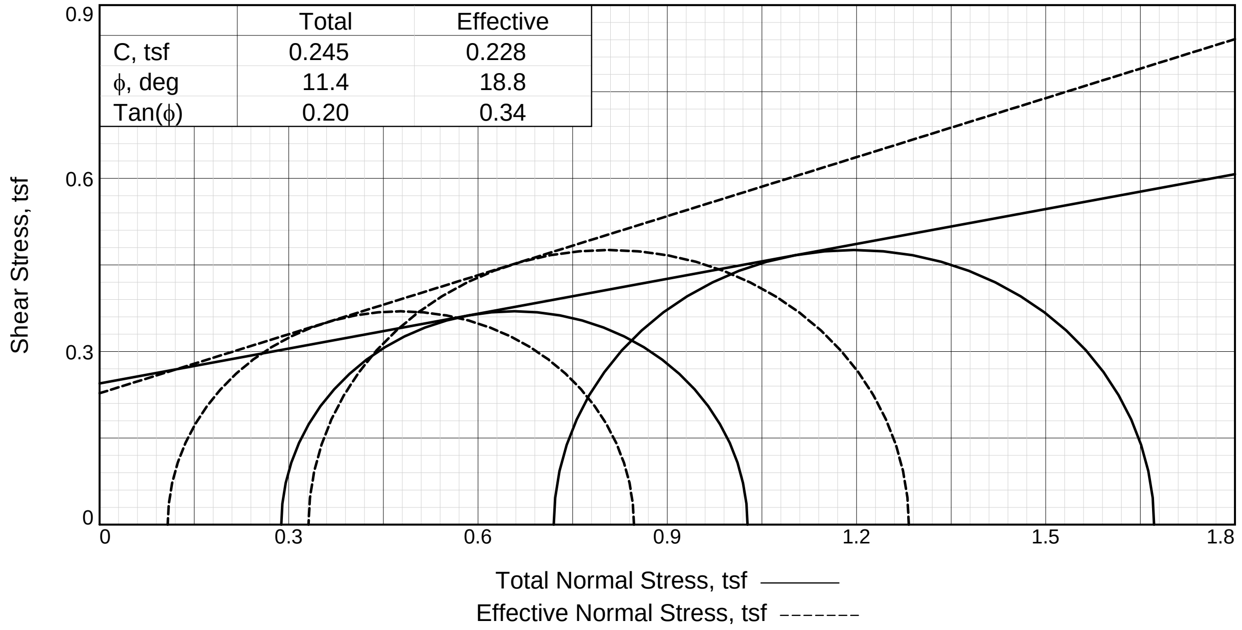
Remarks

Sample No.: ST-O **Source of Sample:** P-177 **Date Sampled:** 4/13/10
Location: **Elev./Depth:** 2
Checked By: K. Kocher **Title:** Engineer

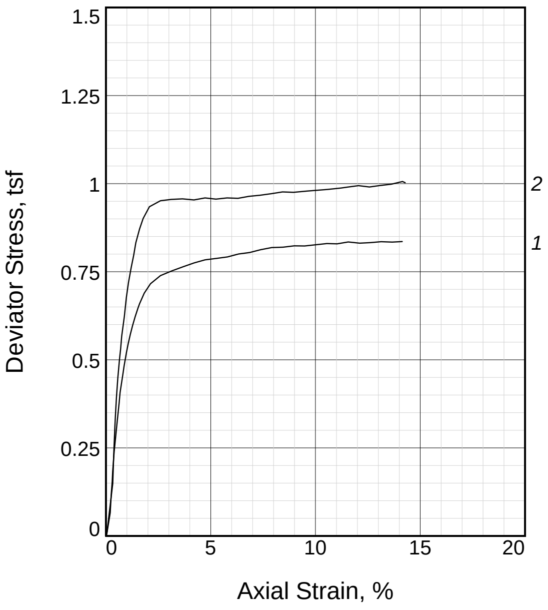
REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-127



	Total	Effective
C, tsf	0.245	0.228
ϕ, deg	11.4	18.8
Tan(ϕ)	0.20	0.34



	Sample No.	1	2
Initial	Water Content,	35.0	32.2
	Dry Density, pcf	83.9	84.4
	Saturation,	94.5	87.8
	Void Ratio	0.9932	0.9830
	Diameter, in.	2.02	2.01
	Height, in.	4.03	4.03
At Test	Water Content,	35.2	35.0
	Dry Density, pcf	86.0	86.4
	Saturation,	100.0	100.0
	Void Ratio	0.9445	0.9375
	Diameter, in.	2.01	2.00
	Height, in.	4.00	4.00
	Strain rate, %/min.	0.25	0.25
	Back Pressure, tsf	3.96	3.96
	Cell Pressure, tsf	4.25	4.68
	Fail. Stress, tsf	0.74	0.95
	Total Pore Pr., tsf	4.14	4.35
	Ult. Stress, tsf	0.84	1.00
	Total Pore Pr., tsf	4.04	4.38
	$\bar{\sigma}_1$ Failure, tsf	0.85	1.28
	$\bar{\sigma}_3$ Failure, tsf	0.11	0.33

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: CLAY (CH), grey and brown, high plastic, silty clay lenses and small pockets

Assumed Specific Gravity= 2.68

Remarks:

Figure B-128

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: P-177 **Depth:** 2

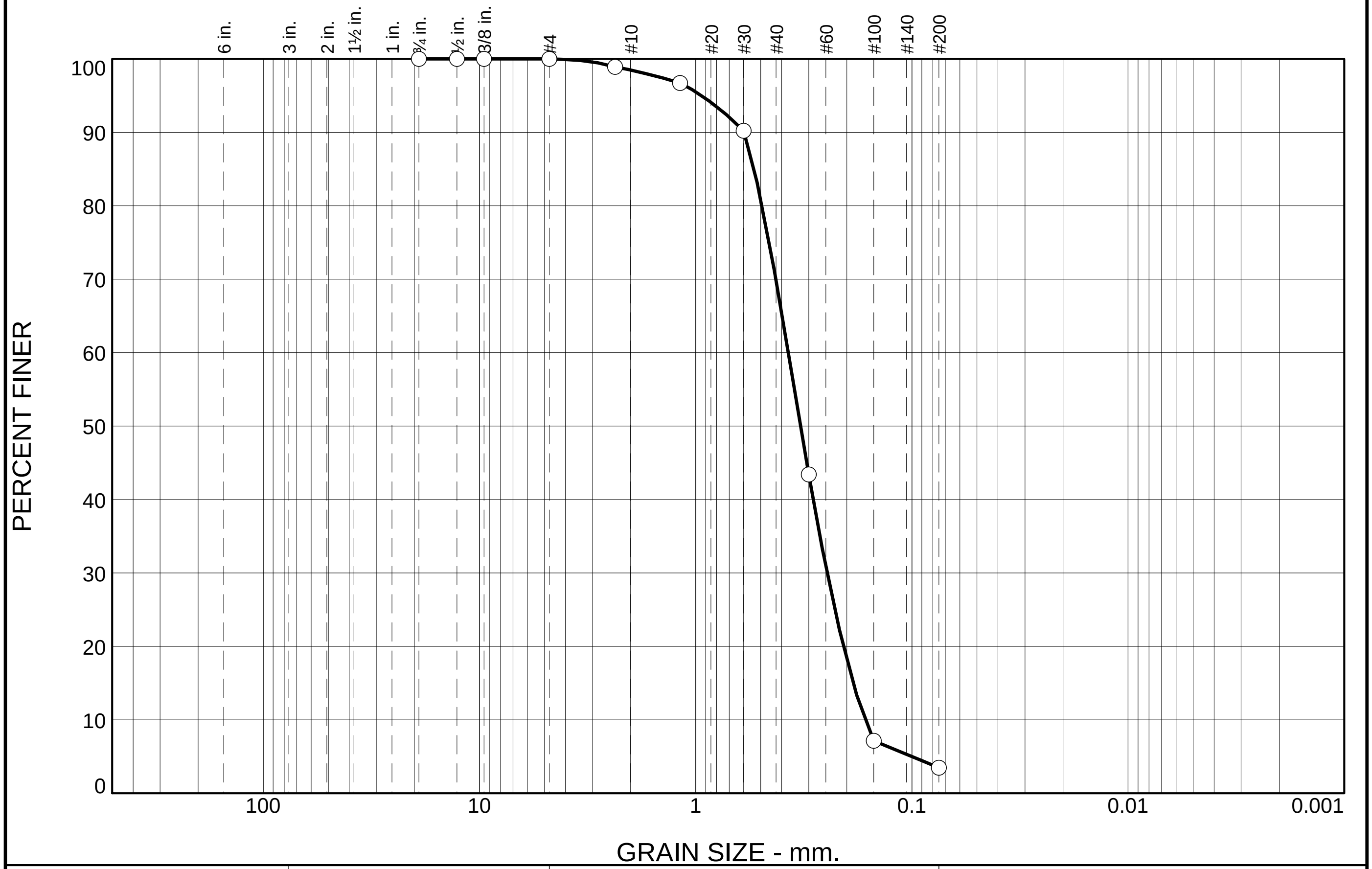
Sample Number: ST-O

Proj. No.: 2008012455 **Date:** 4/13/10

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Fouse

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.5	28.6	66.4	3.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	98.9		
#16	96.7		
#30	90.2		
#50	43.4		
#100	7.2		
#200	3.5		

* (no specification provided)

Material Description

SAND (SP), tan and gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.5368 D_{60}= 0.3727 D_{50}= 0.3274
D_{30}= 0.2466 D_{15}= 0.1871 D_{10}= 0.1648
C_u= 2.26 C_c= 0.99

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

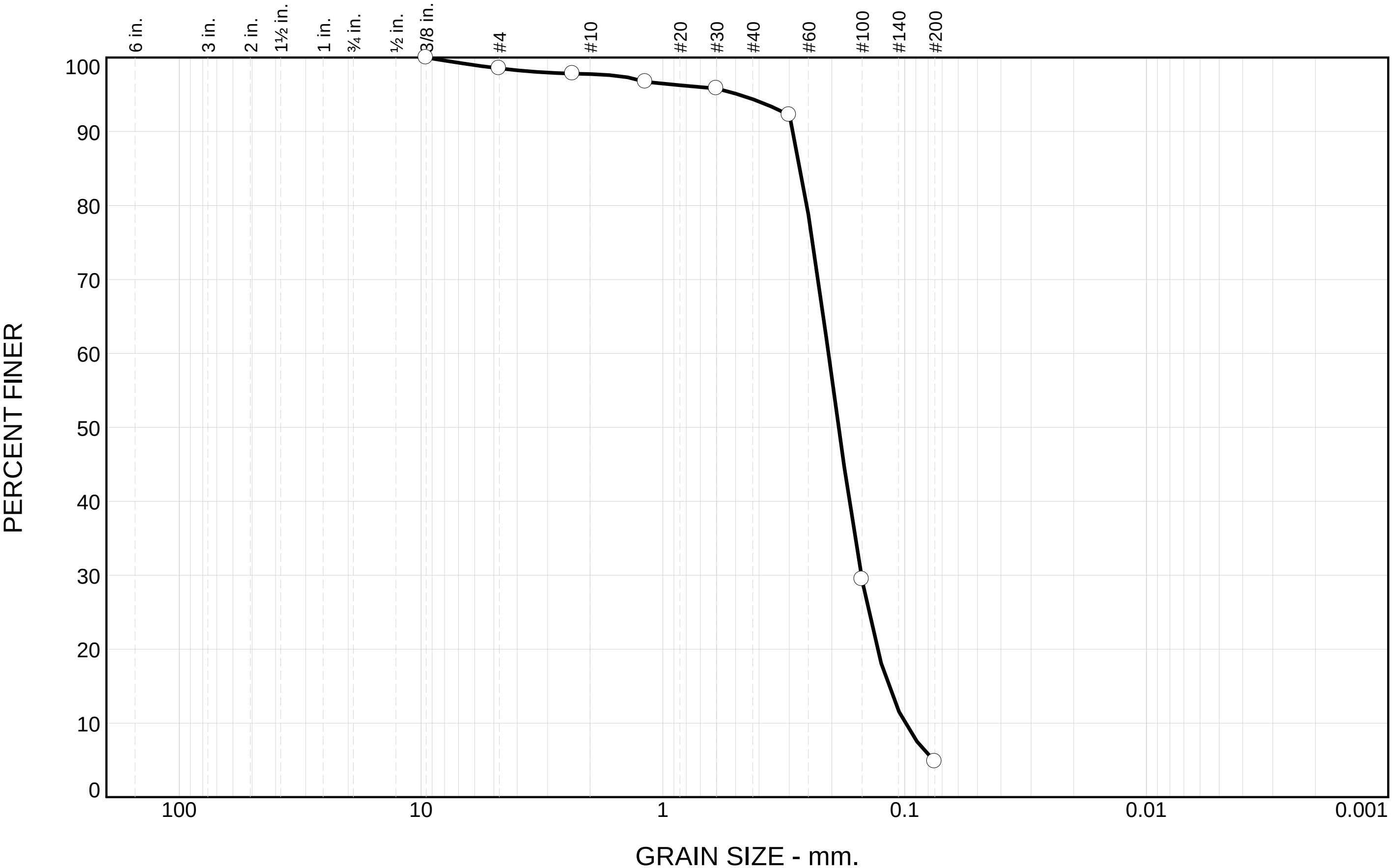
Sample No.: SS-7 **Source of Sample:** B-188 **Date Sampled:** 11-09-2009
Location: **Elev./Depth:** 23.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-129

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.5	0.7	3.4	89.6	4.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.5		
#8	97.8		
#16	96.7		
#30	95.8		
#50	92.2		
#100	29.4		
#200	4.8		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.2693 D_{60}= 0.2065 D_{50}= 0.1875
D_{30}= 0.1511 D_{15}= 0.1165 D_{10}= 0.0997
C_u= 2.07 C_c= 1.11

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

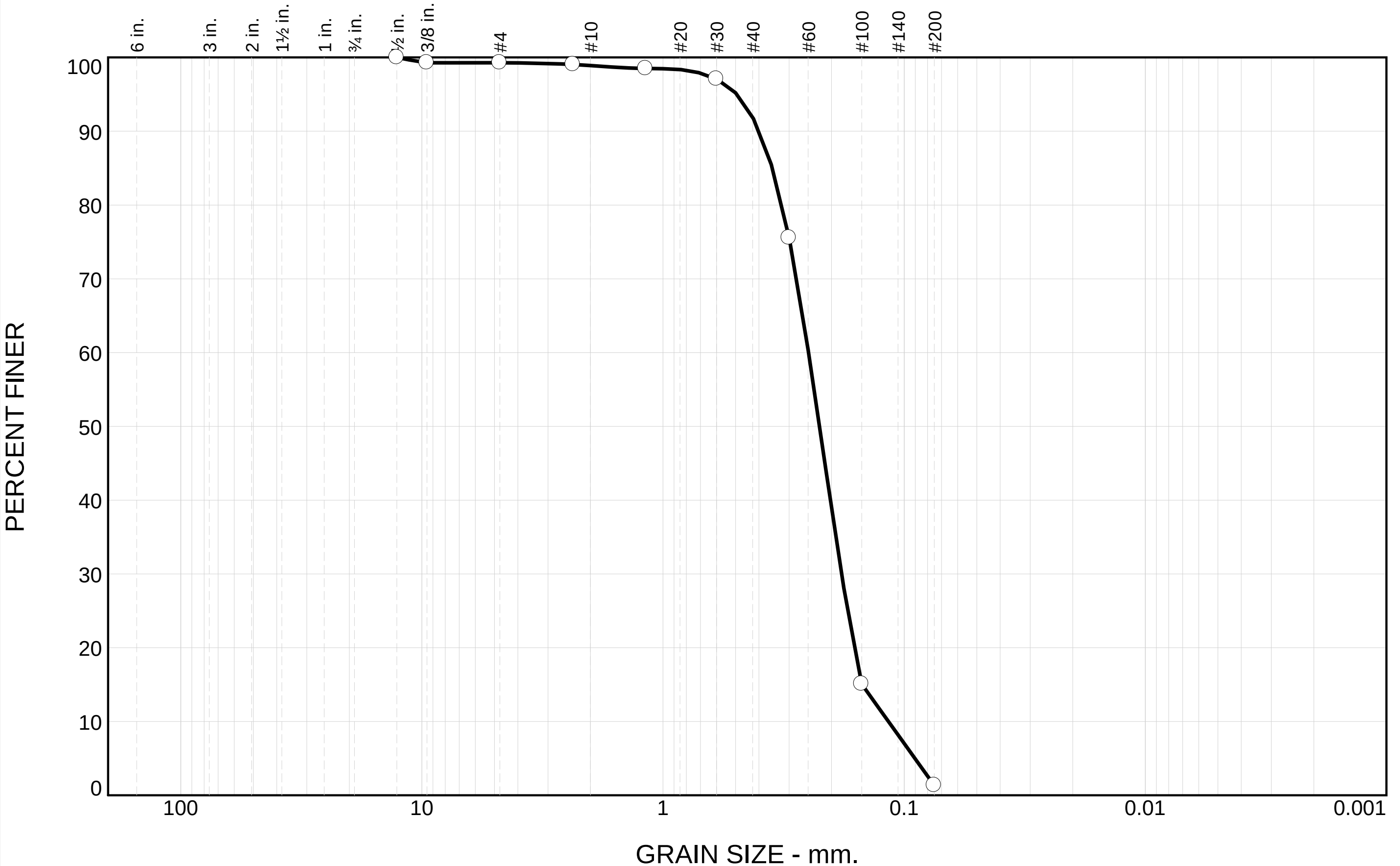
Sample No.: SS-4 **Source of Sample:** P-193 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-130

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	0.4	7.0	90.6	1.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	99.3		
#4	99.3		
#8	99.1		
#16	98.5		
#30	97.1		
#50	75.5		
#100	15.1		
#200	1.3		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3521 D_{60}= 0.2491 D_{50}= 0.2243
D_{30}= 0.1818 D_{15}= 0.1495 D_{10}= 0.1162
C_u= 2.14 C_c= 1.14

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

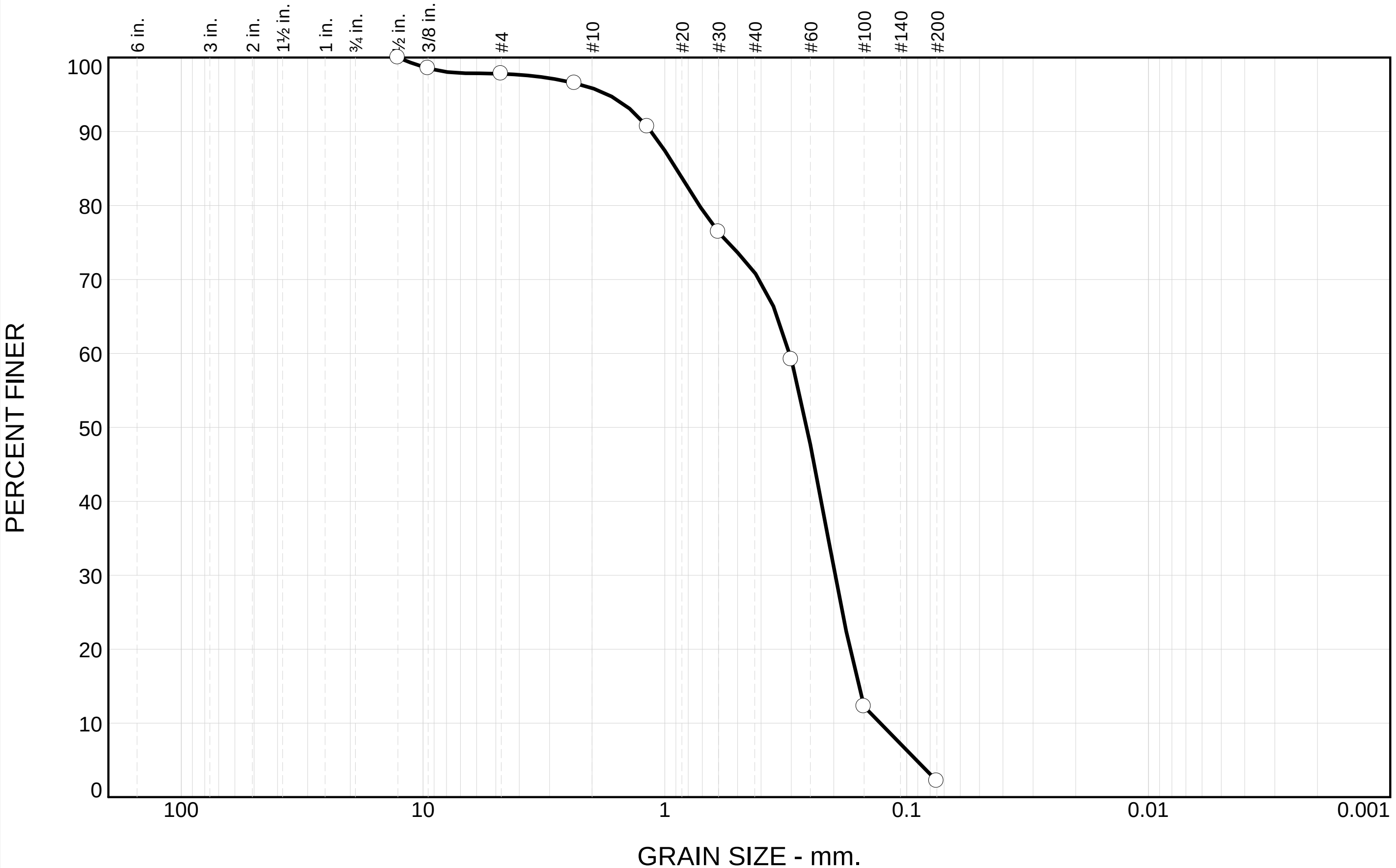
Sample No.: SS-5 **Source of Sample:** P-193 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: J. Crose **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-131

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.2	1.9	25.0	68.7	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	98.5		
#4	97.8		
#8	96.5		
#16	90.7		
#30	76.4		
#50	59.2		
#100	12.2		
#200	2.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.8973 D_{60}= 0.3048 D_{50}= 0.2585
D_{30}= 0.1975 D_{15}= 0.1580 D_{10}= 0.1285
C_u= 2.37 C_c= 1.00

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

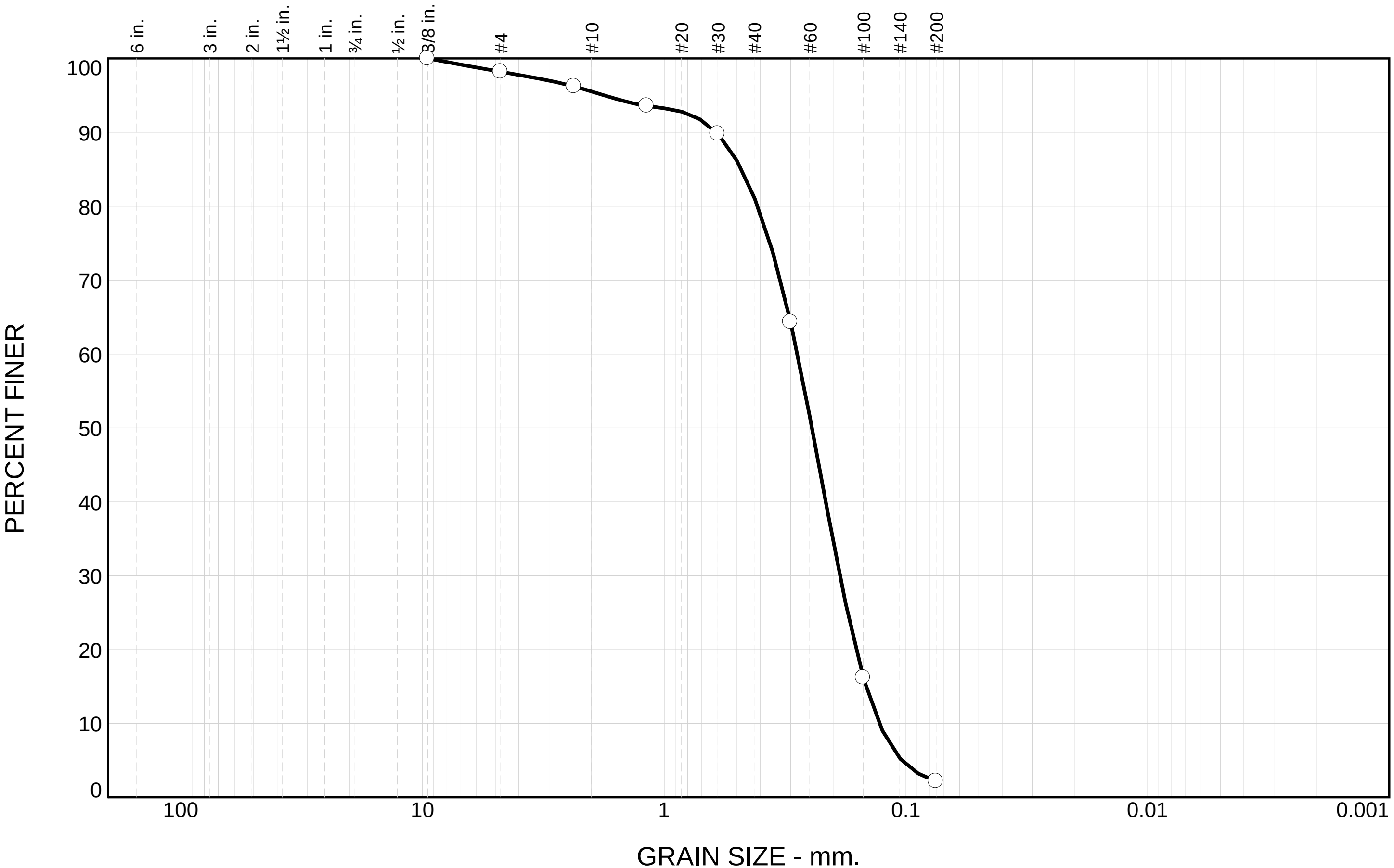
Sample No.: SS-6 **Source of Sample:** P-193 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K.Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-132

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	2.7	14.2	79.1	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.2		
#8	96.2		
#16	93.6		
#30	89.8		
#50	64.3		
#100	16.2		
#200	2.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.4787 D_{60}= 0.2811 D_{50}= 0.2448
D_{30}= 0.1875 D_{15}= 0.1464 D_{10}= 0.1290
C_u= 2.18 C_c= 0.97

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

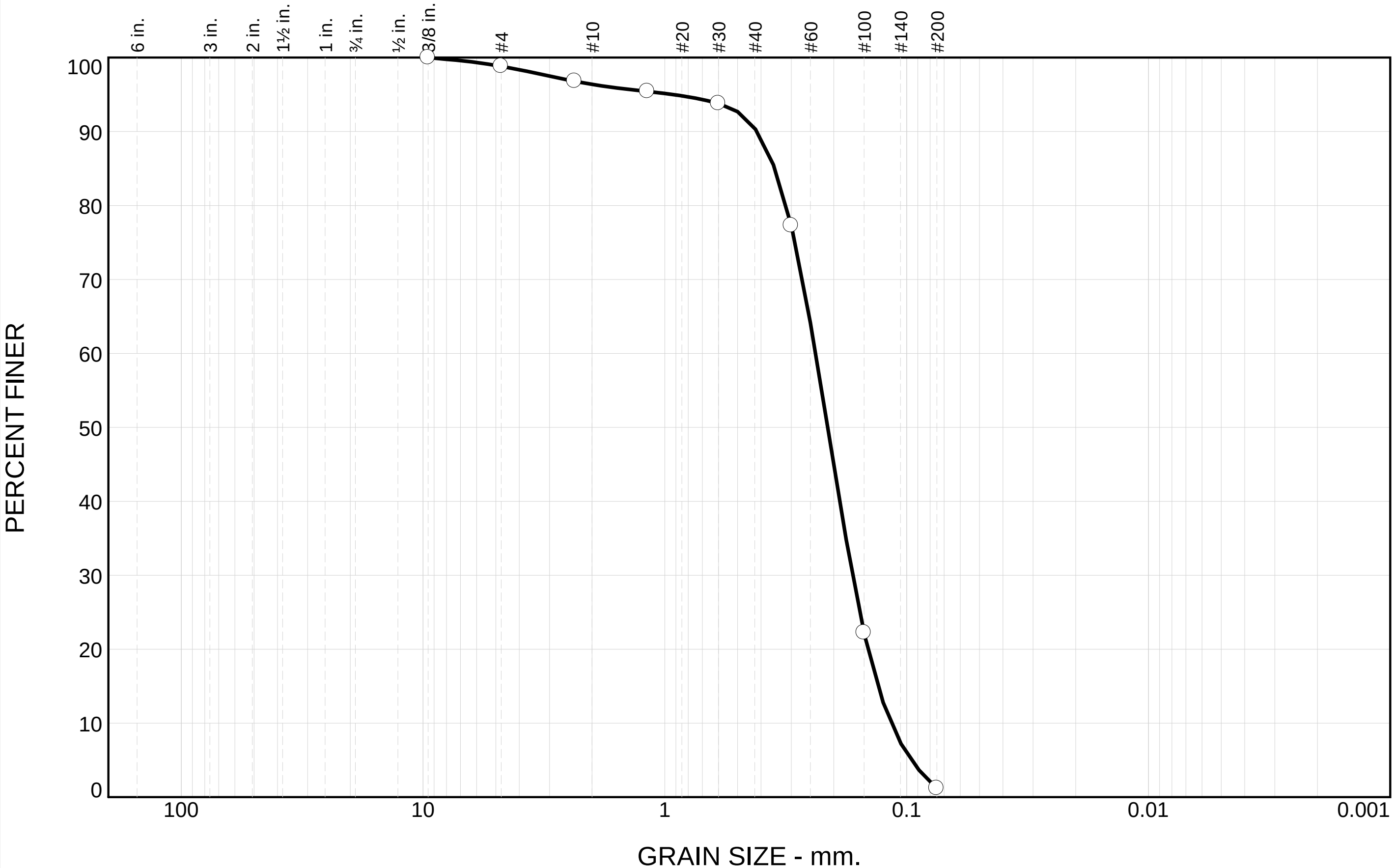
Sample No.: SS-4 **Source of Sample:** P-197 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-133

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.2	2.4	6.0	89.2	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.8		
#8	96.8		
#16	95.4		
#30	93.8		
#50	77.3		
#100	22.2		
#200	1.2		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3510 D_{60}= 0.2379 D_{50}= 0.2120
D_{30}= 0.1674 D_{15}= 0.1315 D_{10}= 0.1160
C_u= 2.05 C_c= 1.02

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

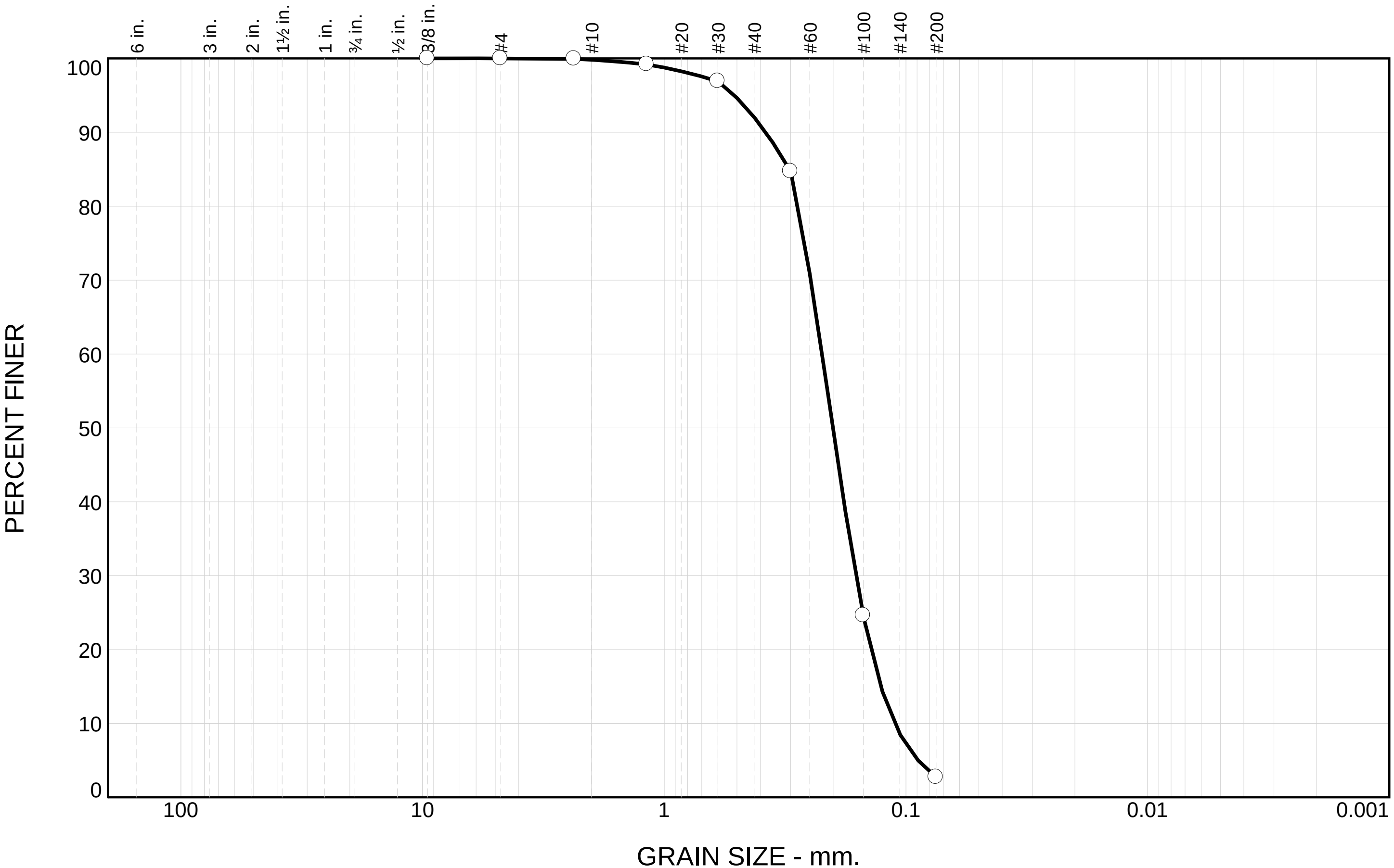
Sample No.: SS-5 **Source of Sample:** P-197 **Date Sampled:**
Location: **Elev./Depth:** 30
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-134

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	7.7	89.4	2.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	100.0		
#8	99.9		
#16	99.2		
#30	96.9		
#50	84.7		
#100	24.6		
#200	2.7		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.3035 D_{60}= 0.2222 D_{50}= 0.2005
D_{30}= 0.1610 D_{15}= 0.1270 D_{10}= 0.1114
C_u= 2.00 C_c= 1.05

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

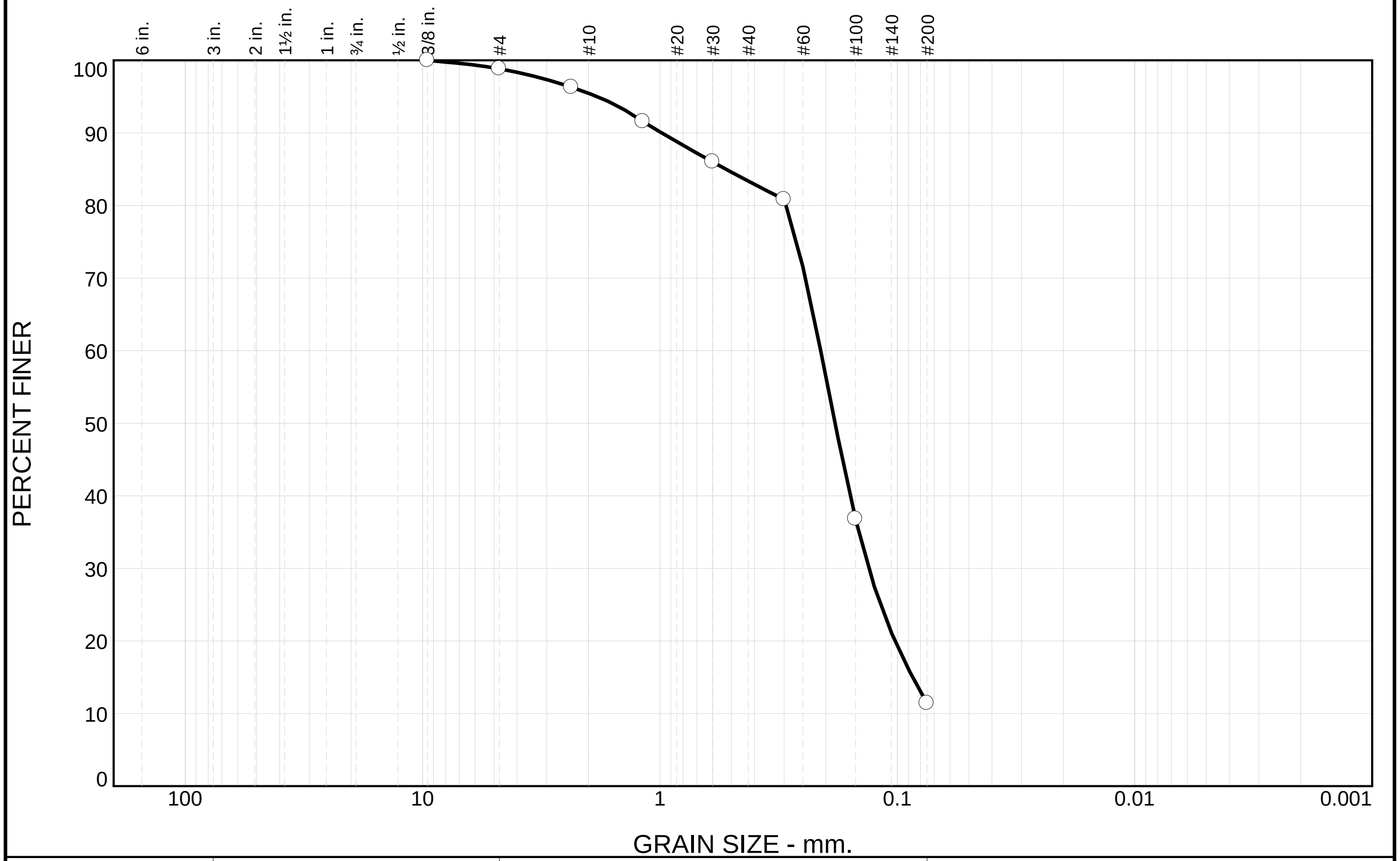
Sample No.: SS-6 **Source of Sample:** P-197 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-135

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.2	3.3	12.1	72.0	11.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	98.8		
#8	96.3		
#16	91.6		
#30	86.0		
#50	80.8		
#100	36.8		
#200	11.4		

* (no specification provided)

Material Description

SAND (SP-SM), with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.5268 D_{60}= 0.2103 D_{50}= 0.1830
D_{30}= 0.1320 D_{15}= 0.0862 D_{10}=
C_u= C_c=

Date Tested: 01-14-10 **Tested By:** J. Crose

Remarks

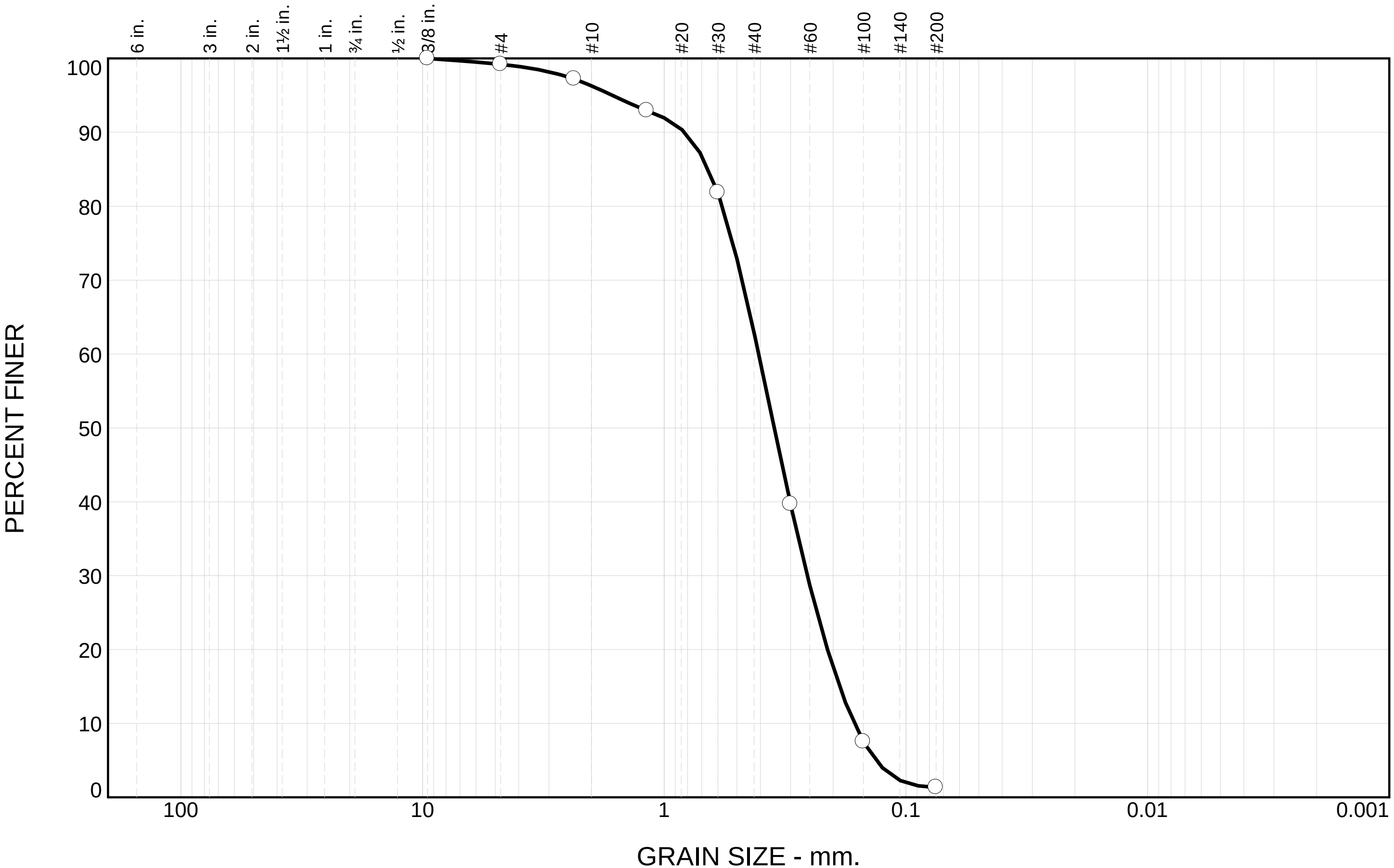
Sample No.: SS-4 **Source of Sample:** P-199 **Date Sampled:**
Location: **Elev./Depth:** 25
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-136

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	2.9	33.4	61.6	1.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.2		
#8	97.2		
#16	92.9		
#30	81.8		
#50	39.7		
#100	7.5		
#200	1.3		

* (no specification provided)

Material Description

SAND (SP)

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.6558 D_{60}= 0.4066 D_{50}= 0.3506
D_{30}= 0.2557 D_{15}= 0.1882 D_{10}= 0.1637
C_u= 2.48 C_c= 0.98

Date Tested: 01-14-10 **Tested By:** J. Crose

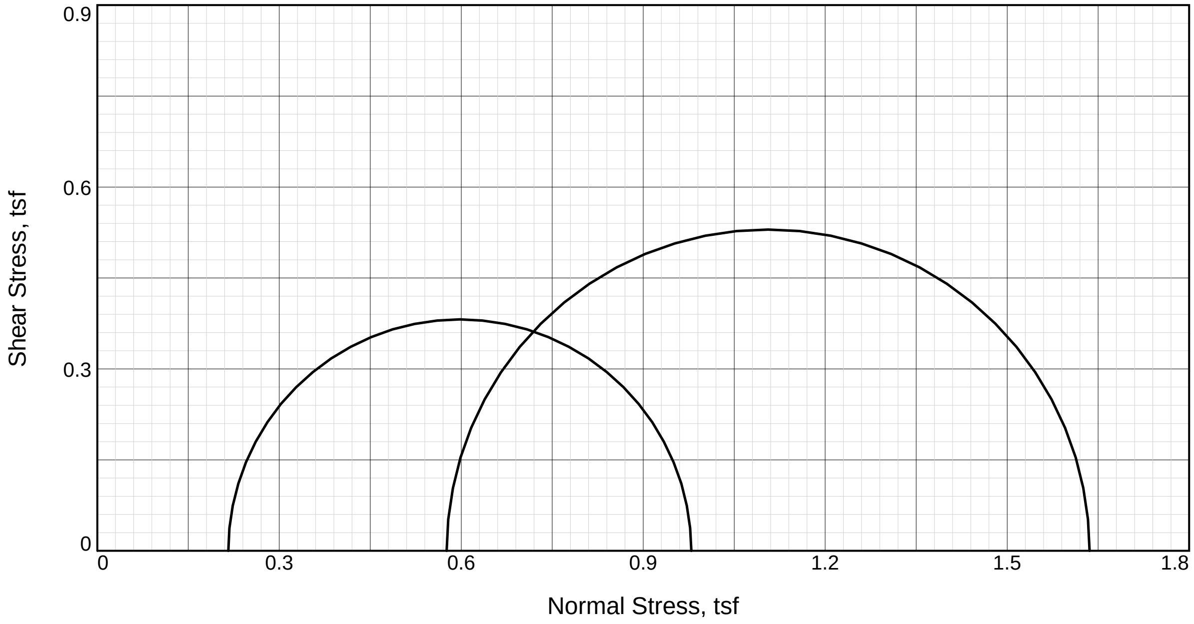
Remarks

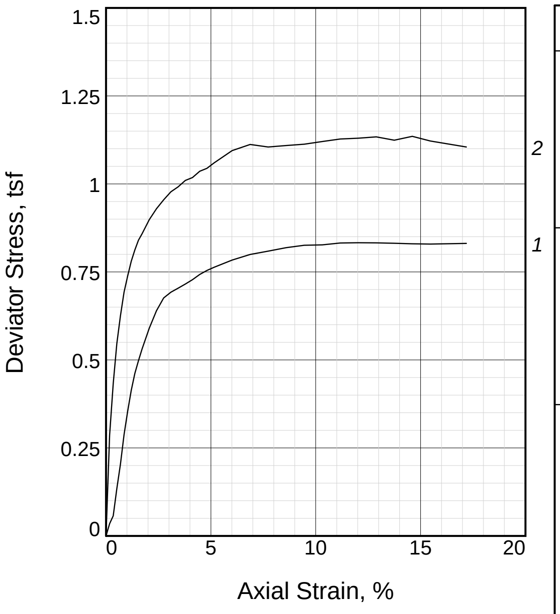
Sample No.: SS-6 **Source of Sample:** P-199 **Date Sampled:**
Location: **Elev./Depth:** 35
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie UWL DSI

Project No: 2008012455 **Figure** B-137





	Sample No.	1	2
Initial	Water Content,	33.9	34.5
	Dry Density, pcf	85.3	85.9
	Saturation,	94.4	97.5
	Void Ratio	0.9611	0.9481
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
At Test	Water Content,	33.9	34.5
	Dry Density, pcf	85.3	85.9
	Saturation,	94.4	97.5
	Void Ratio	0.9611	0.9481
	Diameter, in.	2.85	2.85
	Height, in.	5.82	5.82
	Strain rate, %/min.	0.83	0.83
	Back Pressure, tsf	0.00	0.00
	Cell Pressure, tsf	0.22	0.58
	Fail. Stress, tsf	0.76	1.06
	Ult. Stress, tsf	0.83	1.06
	σ_1 Failure, tsf	0.98	1.64
	σ_3 Failure, tsf	0.22	0.58

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: CLAY (CH), gray-brown, high plastic, with traces of lignite and limonite

LL= 86 **PL=** 30 **PI=** 56

Assumed Specific Gravity= 2.68

Remarks:

Figure B-138

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

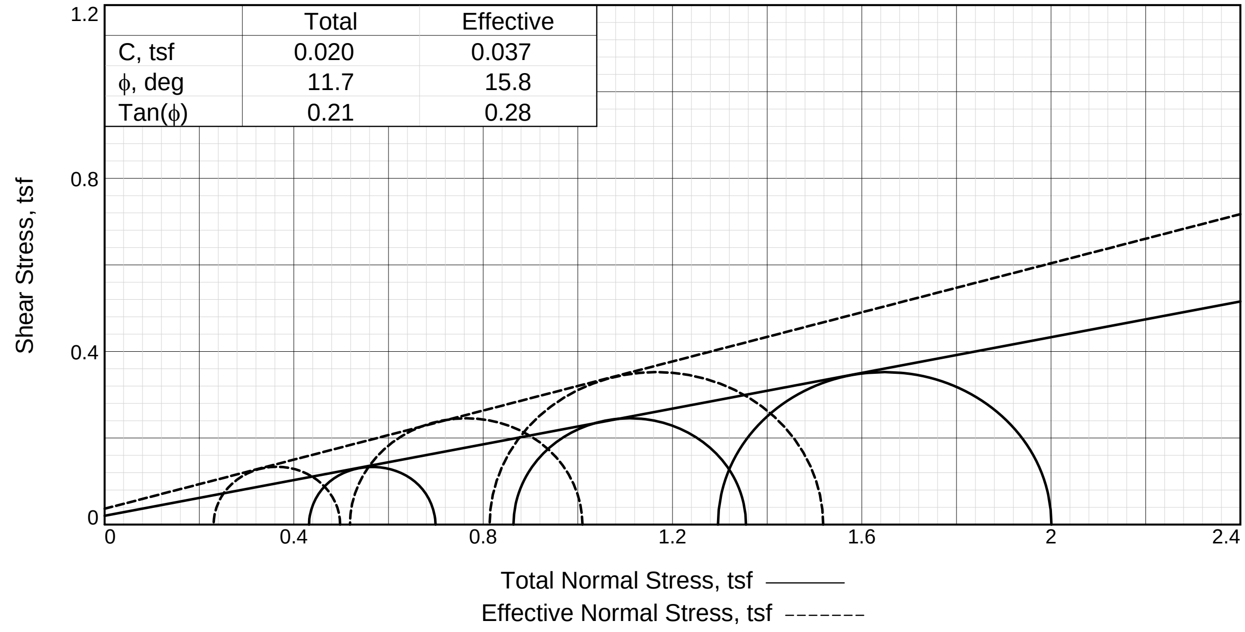
Source of Sample: B-200 **Depth:** 3

Sample Number: ST-2

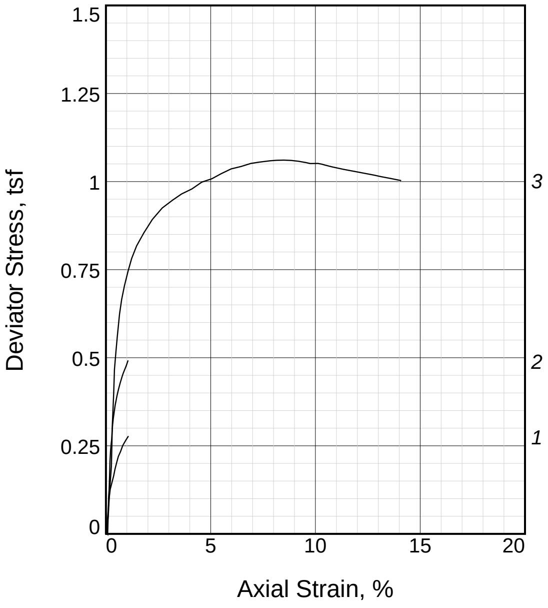
Proj. No.: 2008012455 **Date:** 1-18-2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: J. Pruett **Checked By:** K. Kocher



	Total	Effective
C, tsf	0.020	0.037
ϕ, deg	11.7	15.8
Tan(ϕ)	0.21	0.28



Sample No.		1	2	3
Initial	Water Content,	59.3	59.3	59.3
	Dry Density, pcf	64.9	64.9	64.9
	Saturation,	100.8	100.8	100.8
	Void Ratio	1.5761	1.5761	1.5761
	Diameter, in.	1.99	1.99	1.99
	Height, in.	5.00	5.00	5.00
At Test	Water Content,	52.4	48.3	45.0
	Dry Density, pcf	69.6	72.9	75.8
	Saturation,	100.0	100.0	100.0
	Void Ratio	1.4042	1.2939	1.2063
	Diameter, in.	1.94	1.92	1.91
	Height, in.	4.89	4.76	4.65
Strain rate, %/min.		0.02	0.02	0.02
Back Pressure, tsf		3.96	4.32	5.04
Cell Pressure, tsf		4.39	5.18	6.34
Fail. Stress, tsf		0.27	0.49	0.70
Total Pore Pr., tsf		4.16	4.67	5.52
Ult. Stress, tsf				
Total Pore Pr., tsf				
$\bar{\sigma}_1$ Failure, tsf		0.50	1.01	1.52
$\bar{\sigma}_3$ Failure, tsf		0.23	0.52	0.81

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: CLAY (CH), gray, high plastic, with fine sand and silt lenses, trace lignite, abundant

LL= 62 **PL=** 21 **PI=** 41

Assumed Specific Gravity= 2.68

Remarks:

Figure B-139

Client: Ameren Missouri

Project: Labadie Power Plant UWL DSI

Source of Sample: B-200 **Depth:** 10

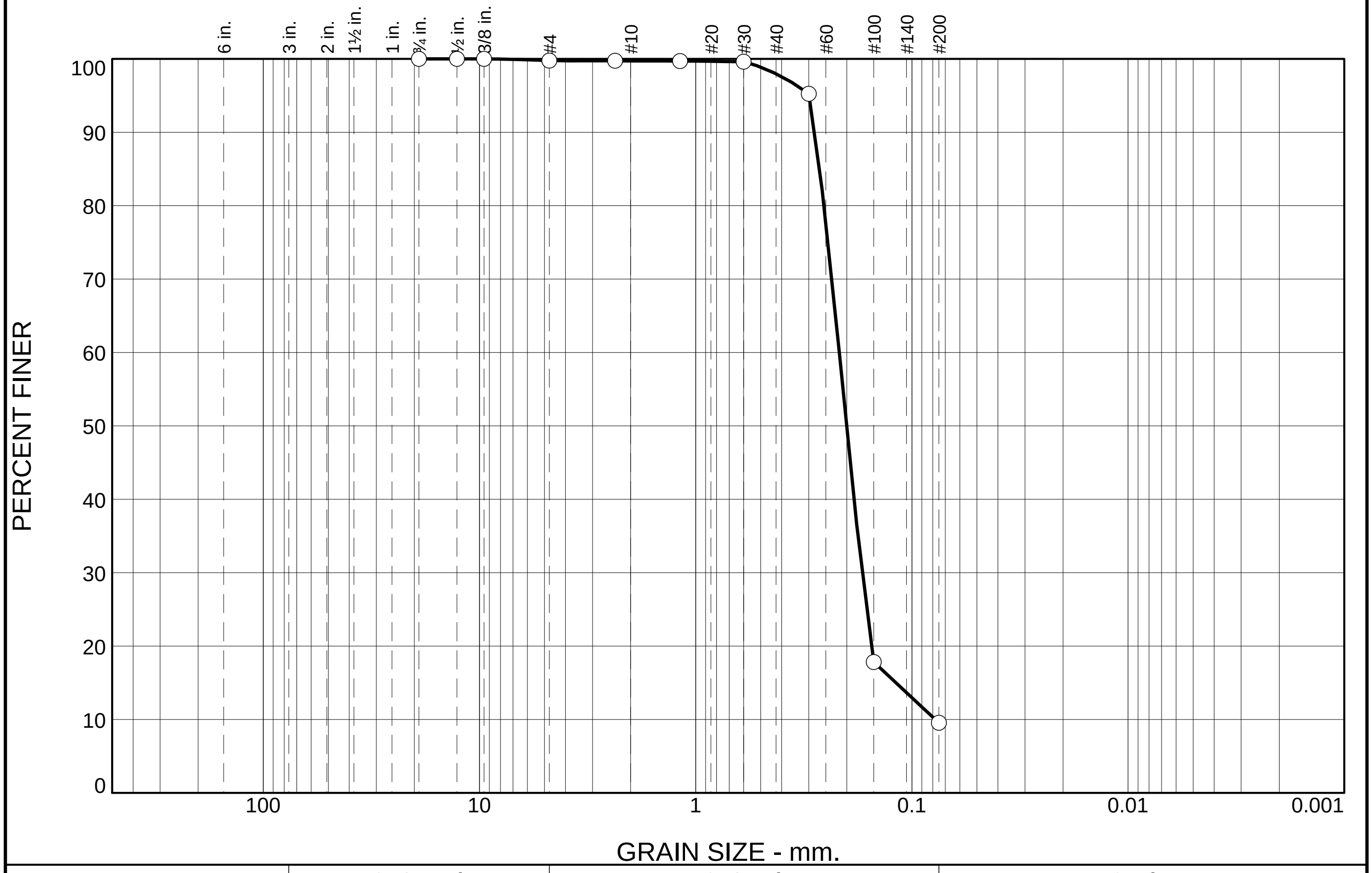
Sample Number: ST-5

Proj. No.: 2008012455 **Date:** 1/18/2010

REITZ & JENS, INC.
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Fouse

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.1	1.7	88.4	9.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	99.8		
#8	99.7		
#16	99.7		
#30	99.6		
#50	95.3		
#100	17.8		
#200	9.6		

* (no specification provided)

Material Description

SAND (SP-SM), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.2672 D_{60}= 0.2166 D_{50}= 0.2005
D_{30}= 0.1701 D_{15}= 0.1183 D_{10}= 0.0778
C_u= 2.78 C_c= 1.72

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

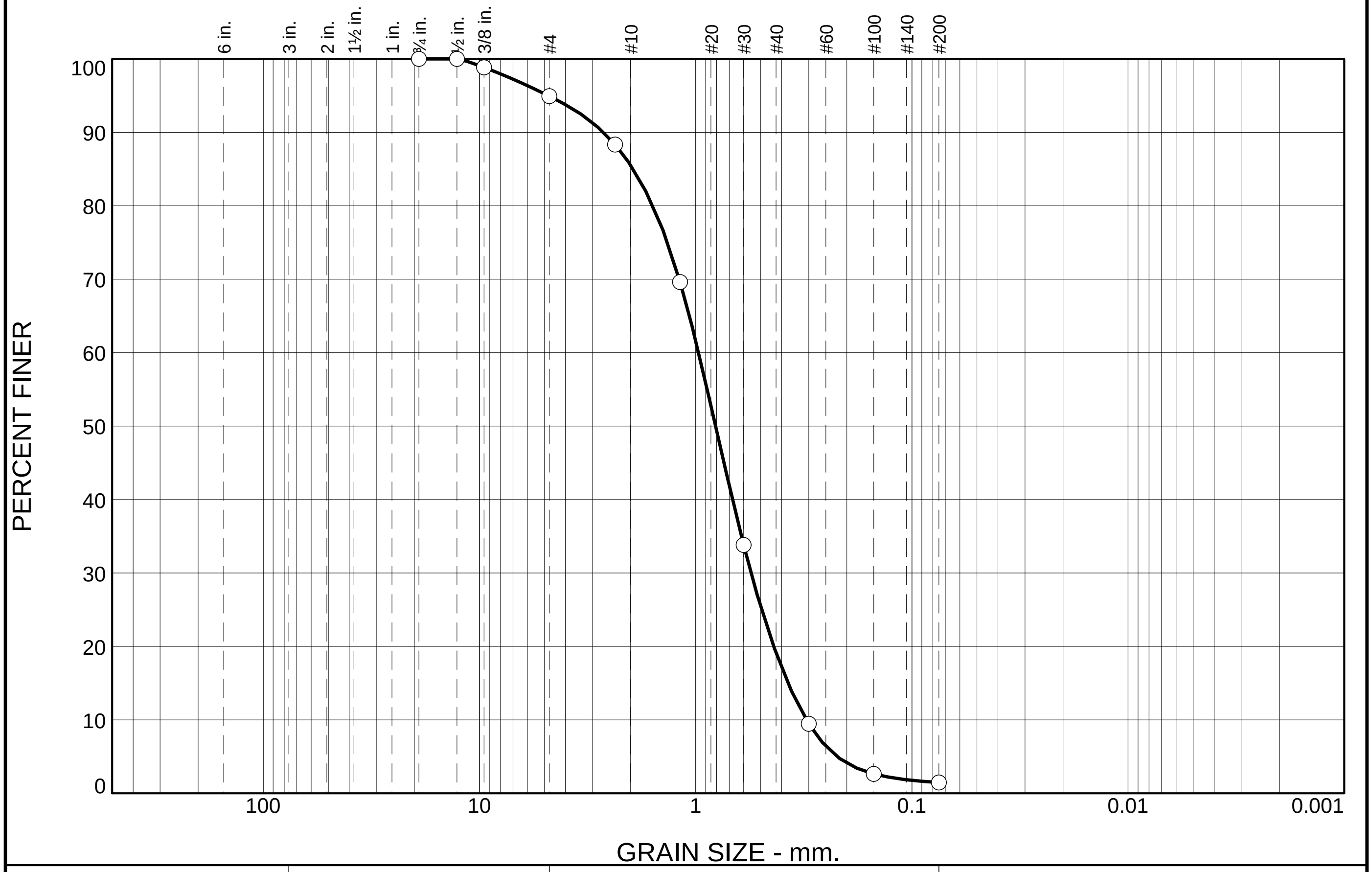
Sample No.: SS-7 **Source of Sample:** B-200 **Date Sampled:** 1-18-2010
Location: **Elev./Depth:** 18.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-140

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.1	9.3	66.5	17.6	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	98.9		
#4	94.9		
#8	88.3		
#16	69.6		
#30	33.8		
#50	9.5		
#100	2.7		
#200	1.5		

* (no specification provided)

Material Description

SAND (SP), gray, loose

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 1.9447 D_{60}= 0.9695 D_{50}= 0.8084
D_{30}= 0.5544 D_{15}= 0.3741 D_{10}= 0.3077
C_u= 3.15 C_c= 1.03

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

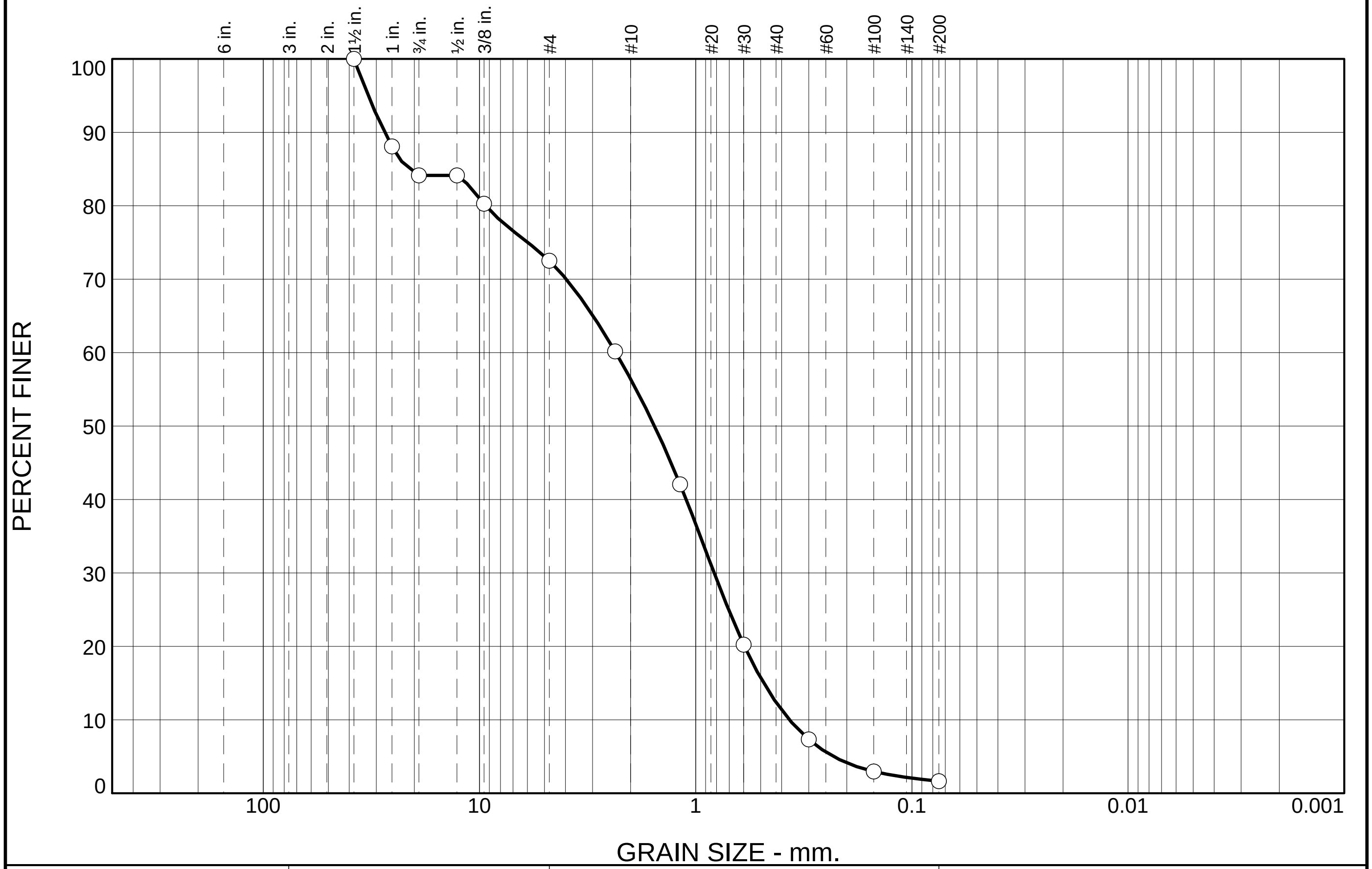
Sample No.: SS-10 **Source of Sample:** B-200 **Date Sampled:** 1-18-2010
Location: **Elev./Depth:** 33.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-141

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	15.9	11.6	16.1	44.0	10.8	1.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	88.1		
3/4	84.1		
1/2	84.1		
3/8	80.3		
#4	72.5		
#8	60.2		
#16	42.1		
#30	20.2		
#50	7.3		
#100	3.0		
#200	1.6		

* (no specification provided)

Material Description

SAND and GRAVEL (SP), gray, loose

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 21.2314 D_{60}= 2.3412 D_{50}= 1.5493
D_{30}= 0.8206 D_{15}= 0.4845 D_{10}= 0.3683
C_u= 6.36 C_c= 0.78

Date Tested: 02-17-10 **Tested By:** J. Pruett

Remarks

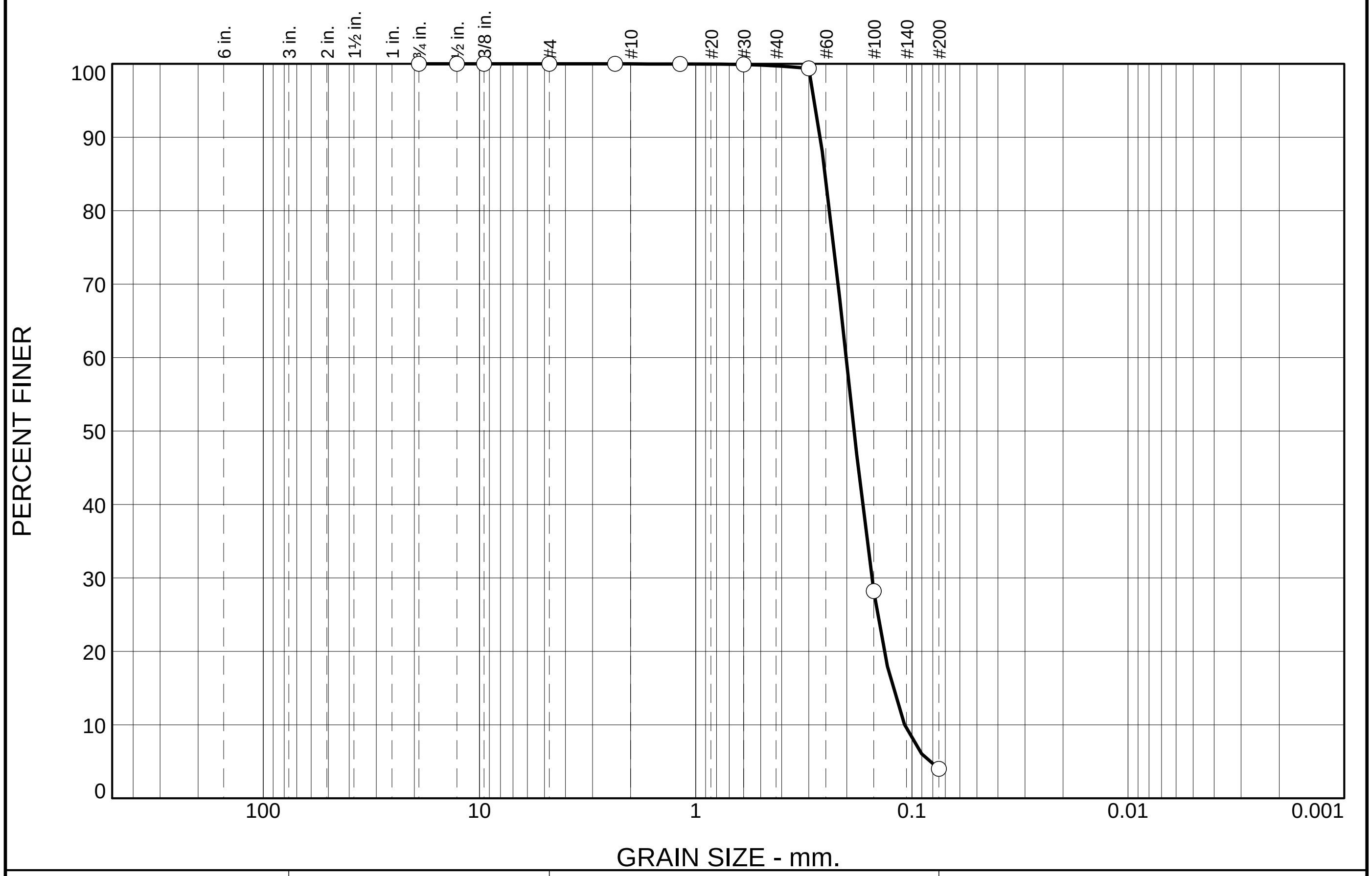
Sample No.: SS-13 **Source of Sample:** B-200 **Date Sampled:** 1-18-2010
Location: **Elev./Depth:** 48.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-142

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	95.7	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	100.0		
#8	100.0		
#16	100.0		
#30	99.9		
#50	99.4		
#100	28.2		
#200	4.0		

* (no specification provided)

Material Description

SAND (SP), tan, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP AASHTO=

Coefficients

D_{85}= 0.2517 D_{60}= 0.2016 D_{50}= 0.1851
D_{30}= 0.1531 D_{15}= 0.1227 D_{10}= 0.1079
C_u= 1.87 C_c= 1.08

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

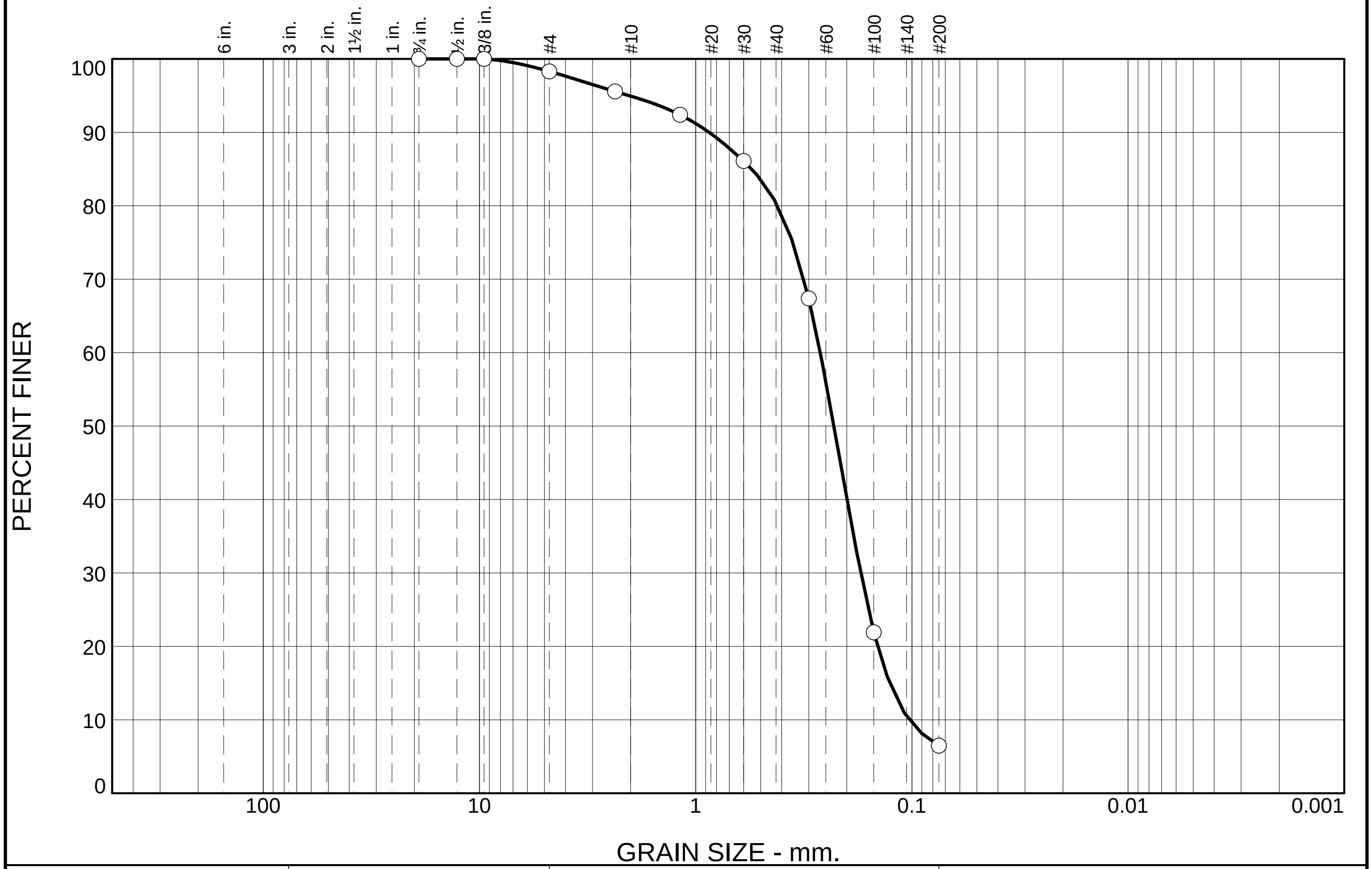
Sample No.: SS-5 **Source of Sample:** B-202 **Date Sampled:** 1-18-2010
Location: **Elev./Depth:** 13.5
Checked By: K. Kocher **Title:** Engineer

Reitz & Jens, Inc.
Consulting Engineers

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-143

Particle Size Distribution Report - ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	3.4	14.5	73.9	6.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.3		
#8	95.6		
#16	92.4		
#30	86.1		
#50	67.4		
#100	21.9		
#200	6.5		

* (no specification provided)

Material Description

SAND (SP-SM), gray, medium-dense

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS= SP-SM AASHTO=

Coefficients

D_{85}= 0.5503 D_{60}= 0.2652 D_{50}= 0.2294
D_{30}= 0.1725 D_{15}= 0.1267 D_{10}= 0.1028
C_u= 2.58 C_c= 1.09

Date Tested: 02-03-10 **Tested By:** J. Crose

Remarks

Sample No.: SS-8 **Source of Sample:** B-202 **Date Sampled:** 1-19-2010
Location: **Elev./Depth:** 28.5
Checked By: K. Kocher **Title:** Engineer

REITZ & JENS, INC.
CONSULTING ENGINEERS

Client: Ameren Missouri
Project: Labadie Power Plant UWL DSI

Project No: 2008012455 **Figure** B-144

Appendix C

INDIVIDUAL CONE PENETRATION TEST LOGS AND DATA SUMMARIES

LEGEND

KEY TO SOIL SYMBOLS

Symbol	Description
≋	Organic Material
▨	Clay
▨	Silty Clay to Clay
▥	Clayey Silt to Silty Clay
▥	Sandy Silt to Clayey Silt
▥	Silty Sand to Sandy Silt
░	Sand to Silty Sand
░	Sand
▓	Gravelly Sand to Sand

│ qc = Cone Tip Pressure, tons/sq. ft.

│ fs = Skin Friction, tons/sq. ft.

│ Rf = Friction ratio (fs/qc) in %

│ u2 = Porewater Pressure, psi

│ N60 = Calculated Equivalent N-value, blows/foot, (Standard Penetration Test)

│ Su = Calculated Undrained Shear Strength, ksf

│ Phi = Friction Angle, degrees

Notes:

1. Borings were made on February 1 thru February 6, 2010 by Terra Drill, Inc. using 1.5” diameter cone pentrometer with pore pressure measurements (CPTu) owned and operated by Reitz & Jens. Borings were backfilled the same day with Bentonite chips.
2. Borings were located by Reitz & Jens, and were staked after drilling. Borings elevations were later surveyed with respect to the existing structure. “Foundation Depth” noted on the log is based on the survey and provided plans.
3. Borings were logged in the field by Reitz & Jens Geological Engineer, who monitored and conducted all CPT related work.
4. Soil classification and equivalent N_{60} were based upon Robertson 1986[1].
5. Undrained shear strength (Su) is based on Lunne, Robertson, Powell (1997)[2]. Internal friction Angle (Phi or Ø) is based on Bowles (1996)[3].
6. Stratification lines shown on the log represent approximate soil boundaries; actual changes in strata may be gradual.

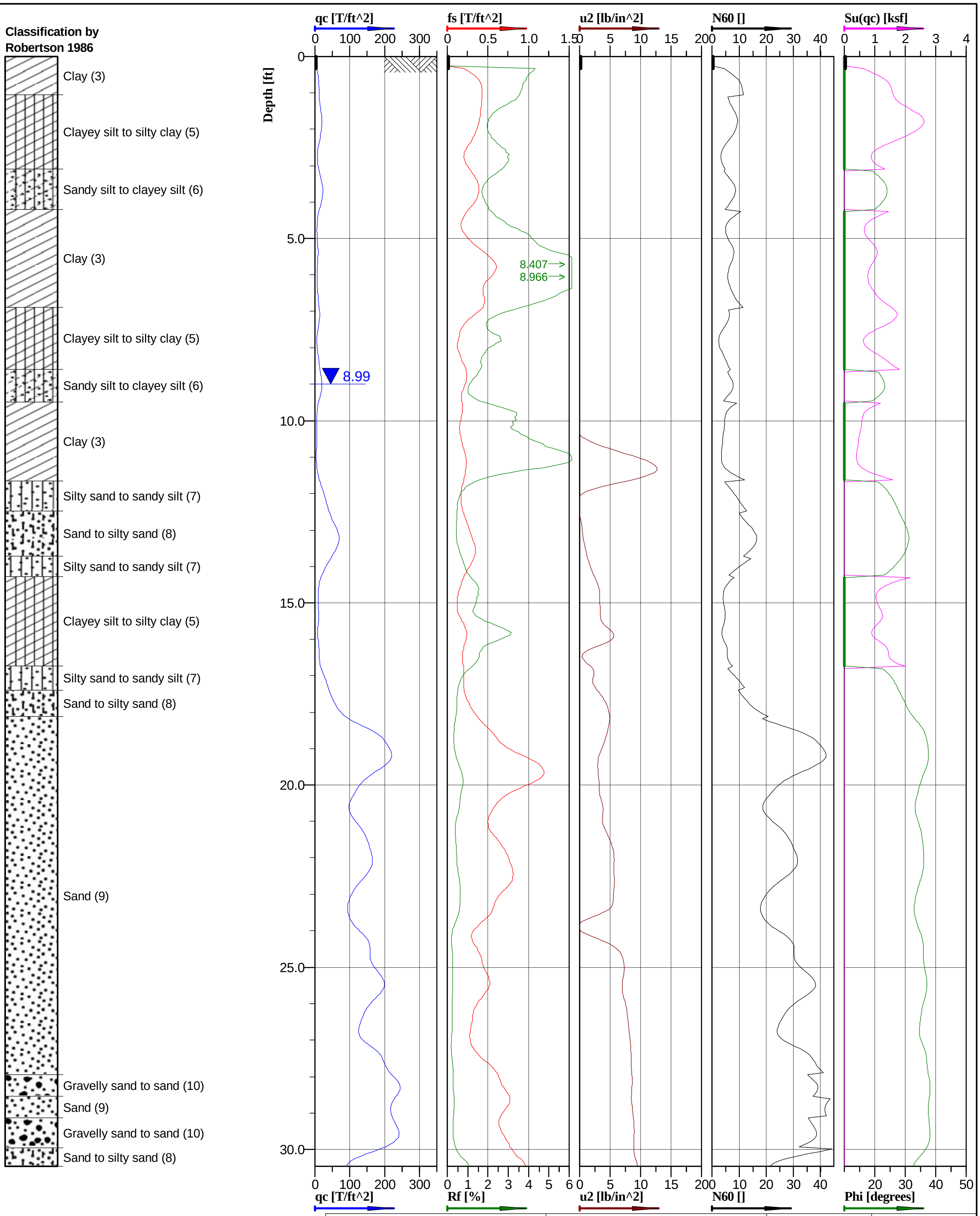
---

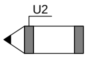
[1] Robertson et al. (1986) *Use of piezometer cone data.* Proceedings of the ASCE Specialty Conference: In Situ 86: Use of In Situ Tests in Geotechnical Engineering. ASCE 1986

[2] Lunne, T. Robertson, P.K. and Powell, J.J.M. (1997) Cone Penetration Testing in Geotechnical Practice, Published by Blackie Academic & Professional.

[3] Bowles, Joseph E. (1996) Foundation Analysis and Design. McGraw-Hill. 5th ed. Page 180.

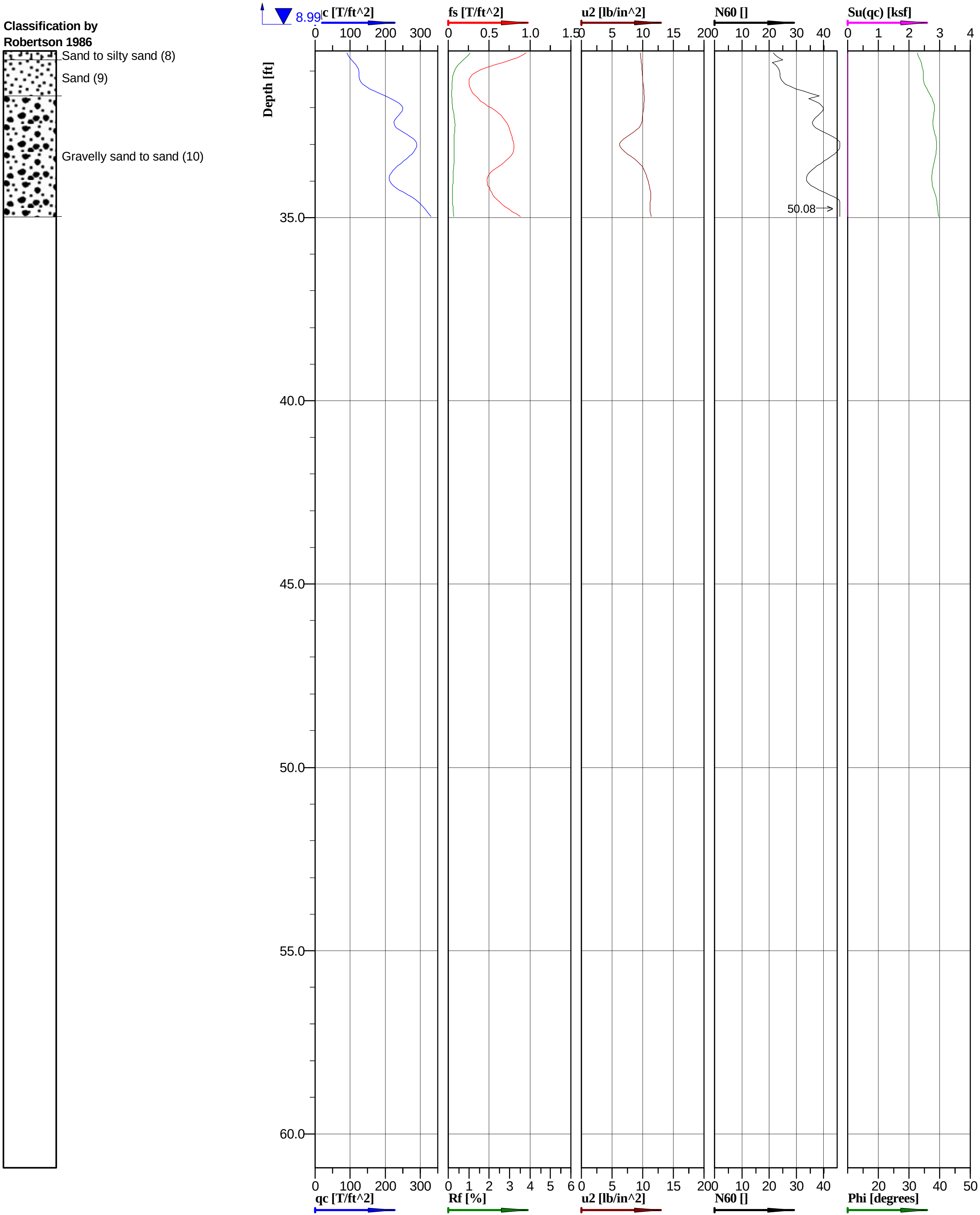
Figure 2-0

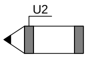




Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO
Position: X: 727863.35 ft, Y: 996087.43 ft
Ground level: 468.60
Test no: C-11
Project ID: 2008012455
Client: Ameren Missouri
Date: 10/28/2009
Scale: 1 : 44
Project: Labadie Power Plant UWL DSI
Page: 1
Fig: C-1
File: Labadie C-011.cpd



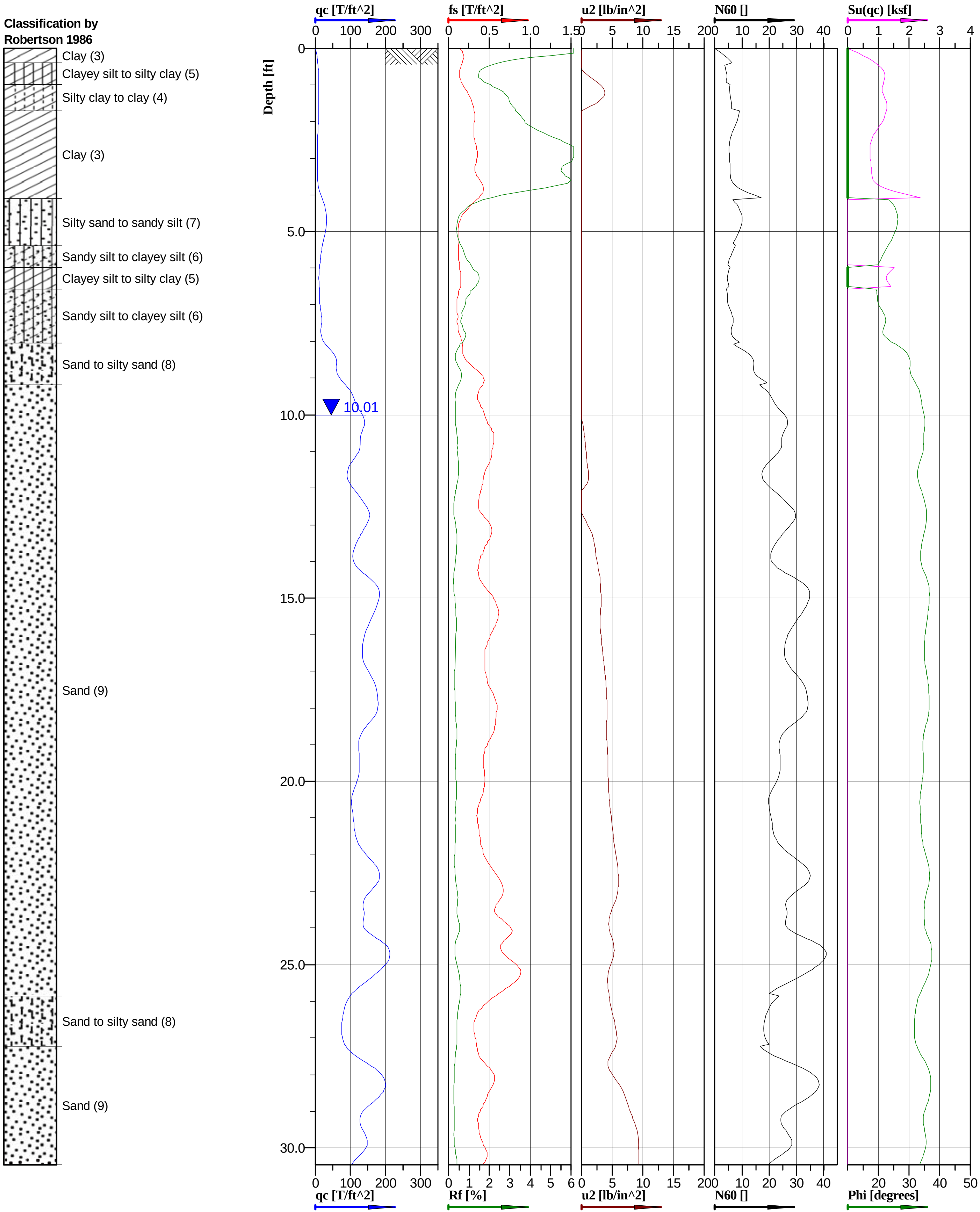


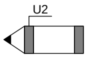
Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO	Position: X: 727863.35 ft, Y: 996087.43 ft	Ground level: 468.60	Test no: C-11
Project ID: 2008012455	Client: Ameren Missouri	Date: 10/28/2009	Scale: 1 : 44
Project: Labadie Power Plant UWL DSI		Page: 2	Fig: C-1
		File: Labadie C-011.cpd	

Client: Ameren Missouri
Project name: Labadie Power Plant UWL DSI
Test no.: C-11
Test date: 10/28/2009
Location: Labadie MO
File name: Labadie C-011.cpd

				CPT-Pro Calculated Values								Reitz and Jens Calculated Values				
Depth [ft]	Corrected point resistance [MPa]	Corrected local friction [MPa]	Pore pressure behind cone [lb/in^2]	Soil Type	SPT Energy Ratio N60 [bpf]	Undrained shear strength [ksf]	Total overburden stress [MPa]	Effective total overburden stress [MPa]	R&J Phi Angle [degrees]	Relative density [%]	Unit weight [g/cm^3]	Corrected N60 [bpf]	Unit Weight [pcf]	Total Overburden [ksf]	Effective Overburden [ksf]	Es (OCR=4) [ksf]
1.25	1.136	0.031	-7.0122	Clayey silt to silty clay (5)	7.2	1.572	0.007	0.007			1.82	7.2	114	0.15	0.15	943
3.75	1.142	0.026	-6.2796	Clay (3)	6.0	0.924	0.021	0.021	22.3		1.82	6.0	114	0.44	0.44	277
6.25	0.832	0.04	-6.2008	Clayey silt to silty clay (5)	6.9	1.111	0.034	0.034			1.8	6.9	112	0.71	0.71	667
8.75	1.034	0.017	-4.6857	Clay (3)	5.3	0.952	0.048	0.047	22.0		1.82	5.3	114	1.00	0.98	286
11.25	1.296	0.018	4.0202	Sand to silty sand (8)	6.3	0.599	0.061	0.054	25.3	49	1.82	4.0	114	1.27	1.12	108
13.75	3.66	0.023	1.5868	Clayey silt to silty clay (5)	10.5	1.318	0.075	0.061	28.9	58	1.9	10.5	119	1.56	1.27	791
16.25	1.627	0.018	2.9491	Sand to silty sand (8)	6.3	1.258	0.089	0.067	26.0	47	1.86	4.0	116	1.85	1.39	135
18.75	14.028	0.066	3.8734	Sand (9)	28.8		0.103	0.074	34.8	78	1.98	14.4	124	2.14	1.54	1167
21.25	12.808	0.064	4.4935	Sand (9)	25.6		0.118	0.081	34.9	77	1.99	12.8	124	2.45	1.68	1066
23.75	12.257	0.048	4.447	Sand (9)	24.5		0.133	0.088	34.6	74	1.99	12.3	124	2.77	1.83	1020
26.25	15.667	0.037	7.7328	Sand (9)	31.3		0.148	0.095	36.0	80	1.99	15.7	124	3.08	1.98	1303
28.75	21.364	0.065	8.6803	Sand to silty sand (8)	38.8		0.163	0.103	37.7	88	2.02	24.8	126	3.39	2.14	1777
31.25	15.678	0.055	9.8124	Gravelly sand to sand (10)	30.4		0.178	0.11	35.7	77	1.99	20.7	124	3.70	2.29	1304
33.75	25.194	0.064	9.5982	Gravelly sand to sand (10)	42.0		0.193	0.117	38.5	91	2.04	28.6	127	4.01	2.43	2096

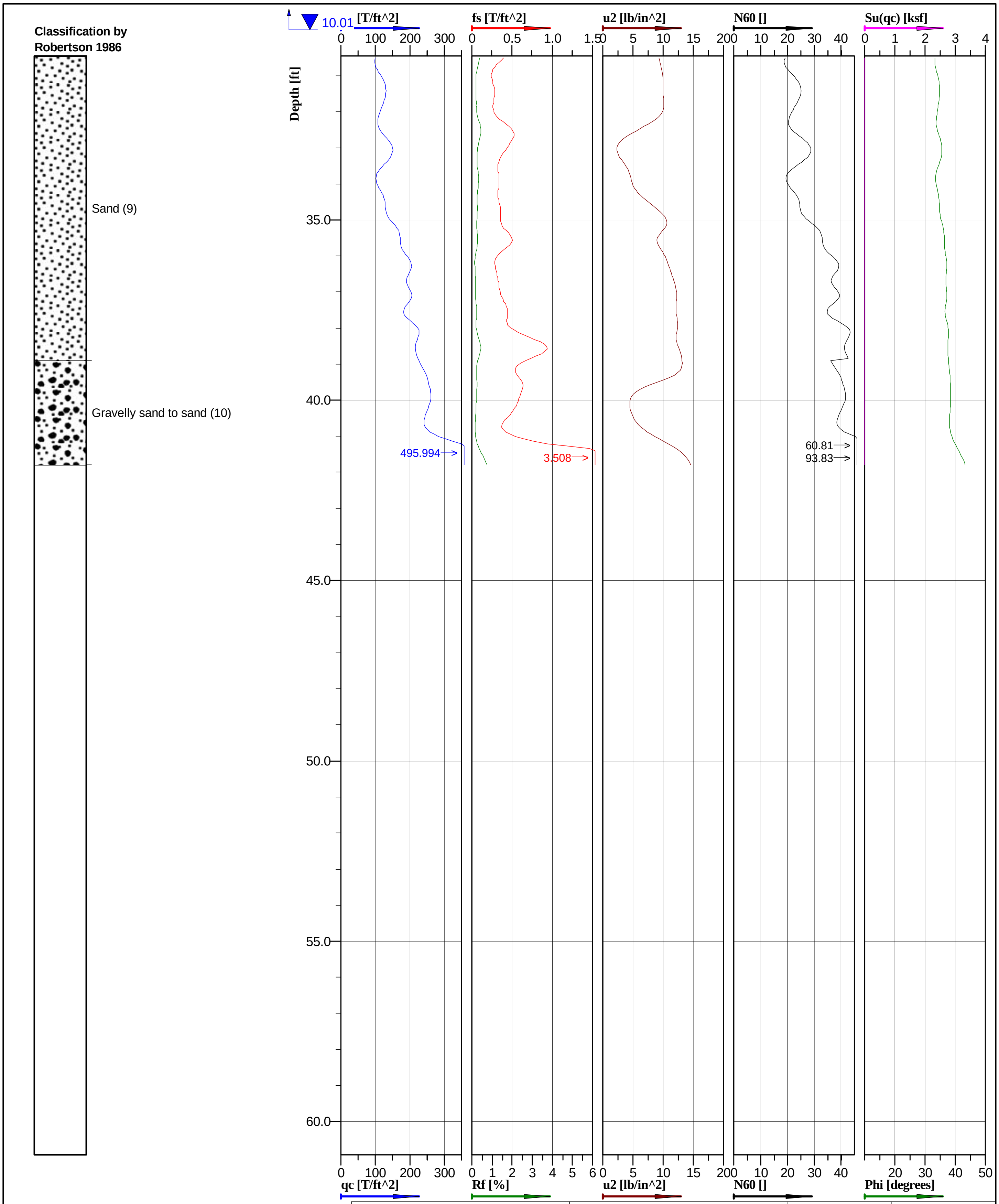


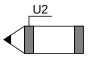


REITZ & JENS, INC.
CONSULTING ENGINEERS

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO
Position: X: 728453.51 ft, Y: 996064.70 ft
Ground level: 468.11
Test no: C-13
Project ID: 2008012455
Client: Ameren Missouri
Date: 10/28/2009
Scale: 1 : 44
Project: Labadie Power Plant UWL DSI
Page: 1
Fig: C-2
Confirmation sounding adjacent to B-13
File: Labadie C-013.cpd





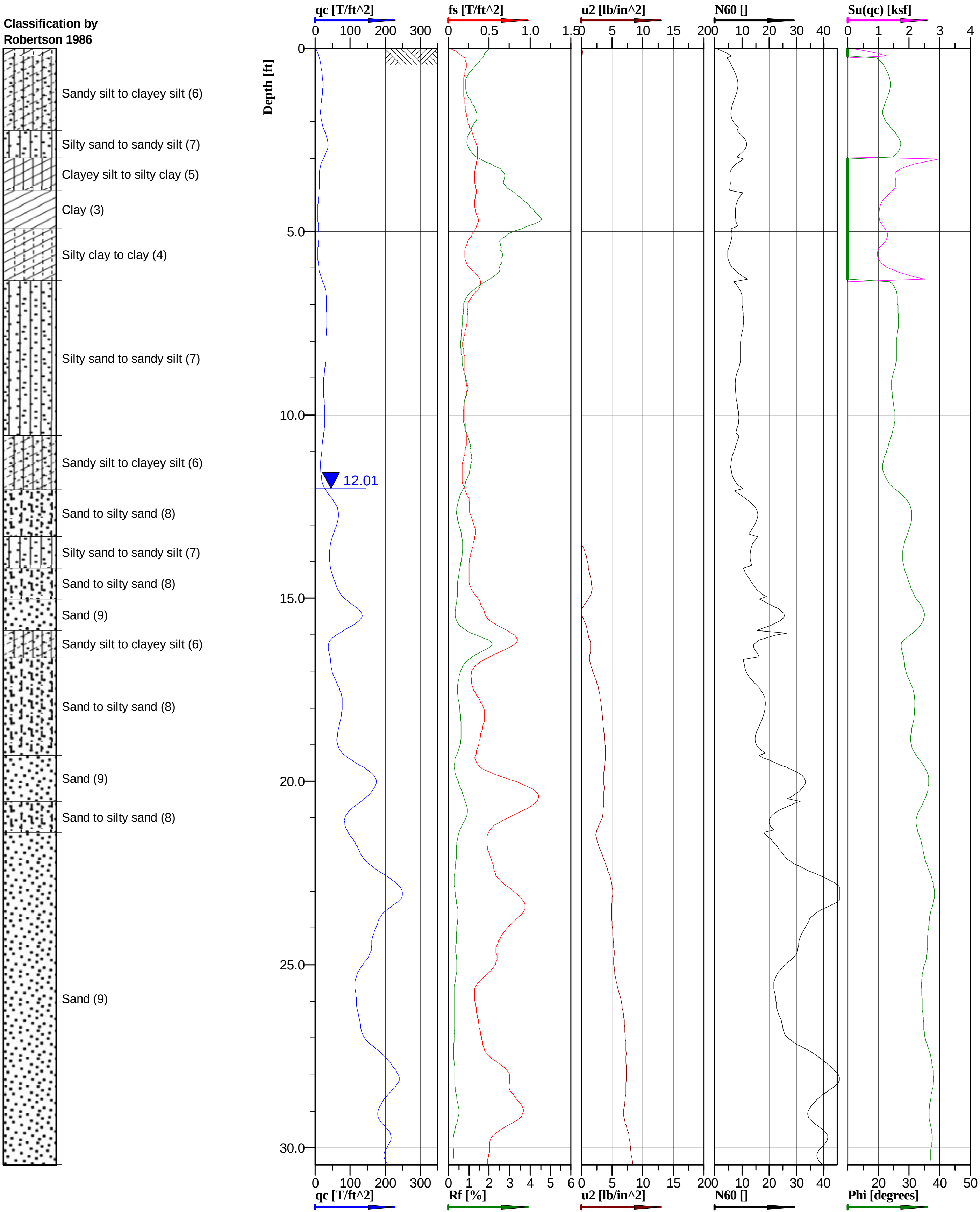
Reitz & Jens, Inc.
Consulting Engineers

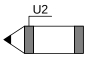
Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO	Position: X: 728453.51 ft, Y: 996064.70 ft	Ground level: 468.11	Test no: C-13
Project ID: 2008012455	Client: Ameren Missouri	Date: 10/28/2009	Scale: 1 : 44
Project: Labadie Power Plant UWL DSI		Page: 2	Fig: C-2
Confirmation sounding adjacent to B-13		File: Labadie C-013.cpd	

Client: Ameren Missouri
Project name: Labadie Power Plant UWL DSI
Test no.: C-13
Test date: 10/28/2009
Location: Labadie MO
File name: Labadie C-013.cpd

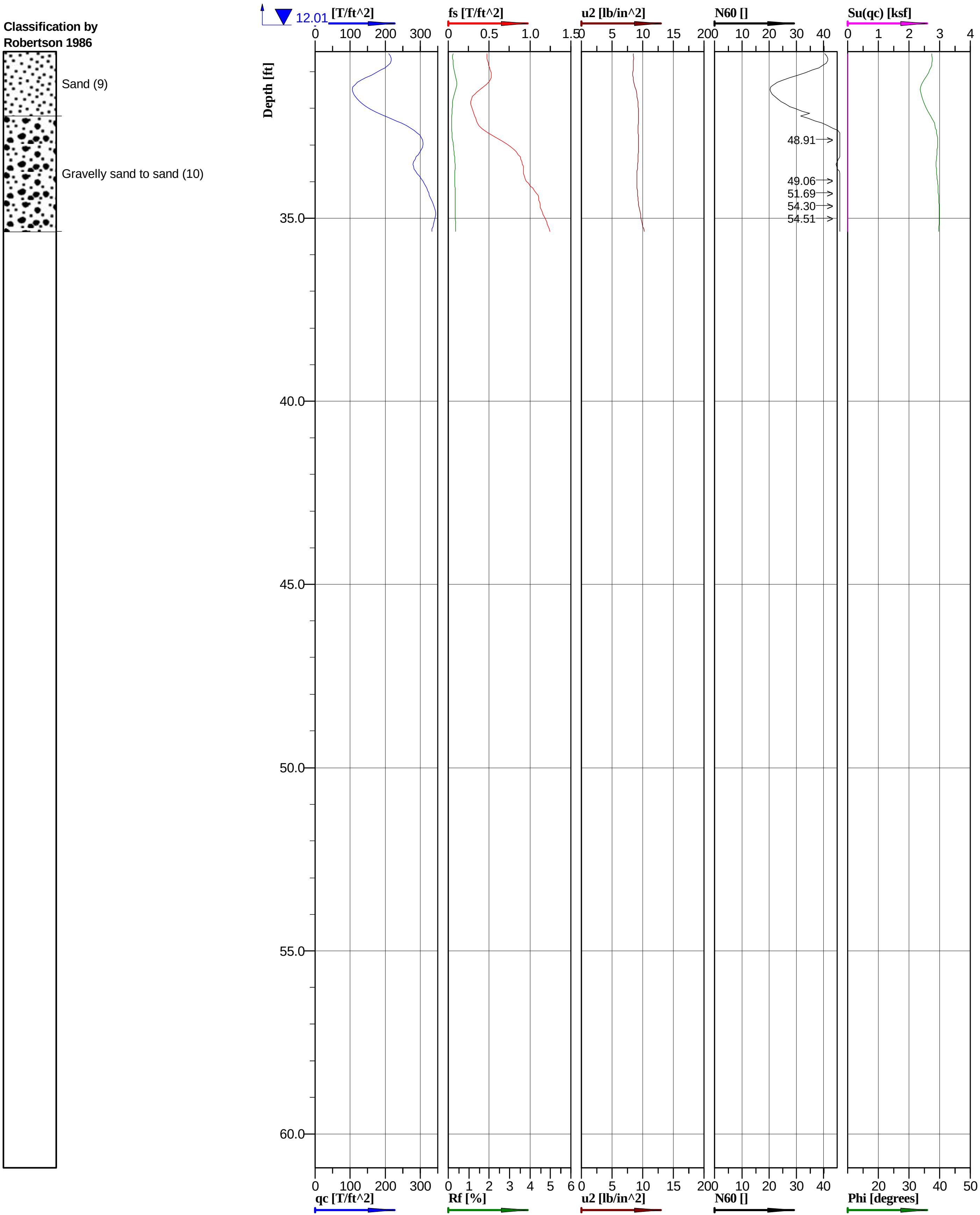
				CPT-Pro Calculated Values								Reitz and Jens Calculated Values				
Depth	Corrected point resistance	Corrected local friction	Pore pressure behind cone	Soil Type	SPT Energy Ratio N60	Undrained shear strength	Total overburden stress	Effective total overburden str	R&J Phi Angle	Relative density	Unit weight	Corrected N60	Unit Weight	Total Overburden	Effective Overburden	Es (OCR=4)
[ft]	[MPa]	[MPa]	[lb/in^2]		[bpf]	[ksf]	[MPa]	[MPa]	[degrees]	[%]	[g/cm^3]	[bpf]	[pcf]	[ksf]	[ksf]	[ksf]
1.25	0.724	0.023	-0.2251	Clay (3)	5.6	0.999	0.007	0.007			1.77	5.6	111	0.15	0.15	300
3.75	1.487	0.028	-3.2628	Silty sand to sandy silt (7)	7.9	0.978	0.02	0.02	25.5		1.82	5.0	114	0.42	0.42	124
6.25	1.44	0.012	-1.9881	Sandy silt to clayey silt (6)	5.8	1.35	0.034	0.034	21.6		1.84	5.8	115	0.71	0.71	120
8.75	6.585	0.028	-2.0836	Sand (9)	15.1		0.048	0.048	29.7	68	1.93	7.5	120	1.00	1.00	548
11.25	11.458	0.045	0.3838	Sand (9)	22.9		0.063	0.059	34.3	78	1.98	11.5	124	1.31	1.23	953
13.75	13.488	0.042	2.035	Sand (9)	27.0		0.078	0.066	35.2	81	1.99	13.5	124	1.62	1.37	1122
16.25	14.709	0.049	3.4183	Sand (9)	29.4		0.092	0.073	35.7	82	1.99	14.7	124	1.91	1.52	1224
18.75	13.79	0.049	4.1731	Sand (9)	27.6		0.107	0.081	35.3	79	1.99	13.8	124	2.23	1.68	1147
21.25	11.975	0.04	5.0704	Sand (9)	23.9		0.122	0.088	34.5	74	1.99	12.0	124	2.54	1.83	996
23.75	16.046	0.064	5.2203	Sand (9)	32.1		0.137	0.095	36.1	81	1.99	16.0	124	2.85	1.98	1335
26.25	10.354	0.049	4.916	Sand (9)	22.7		0.152	0.102	33.5	66	1.96	11.4	122	3.16	2.12	861
28.75	15.144	0.043	7.2196	Sand (9)	30.3		0.167	0.109	35.8	77	1.99	15.1	124	3.47	2.27	1260
31.25	11.152	0.032	9.3155	Sand (9)	22.3		0.182	0.117	34.2	68	1.99	11.1	124	3.79	2.43	928
33.75	12.148	0.036	5.3593	Sand (9)	24.3		0.196	0.124	34.6	69	1.99	12.1	124	4.08	2.58	1011
36.25	17.845	0.036	10.9131	Sand (9)	35.7		0.211	0.131	36.7	80	1.99	17.8	124	4.39	2.72	1485
38.75	21.989	0.06	10.9403	Gravelly sand to sand (10)	40.3		0.226	0.138	37.8	85	2.02	27.4	126	4.70	2.87	1829
41.25	34.05	0.129	8.6089	Gravelly sand to sand (10)	56.7		0.239	0.145	39.6	95	2.04	38.6	127	4.97	3.02	2833

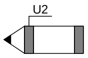




Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO	Position: X: 727587.86 ft, Y: 995796.00 ft	Ground level: 469.49	Test no: C-16
Project ID: 2008012455	Client: Ameren Missouri	Date: 10/23/2009	Scale: 1 : 44
Project: Labadie Power Plant UWL DSI		Page: 1	Fig: C-3
		File: Labadie C-016.cpd	



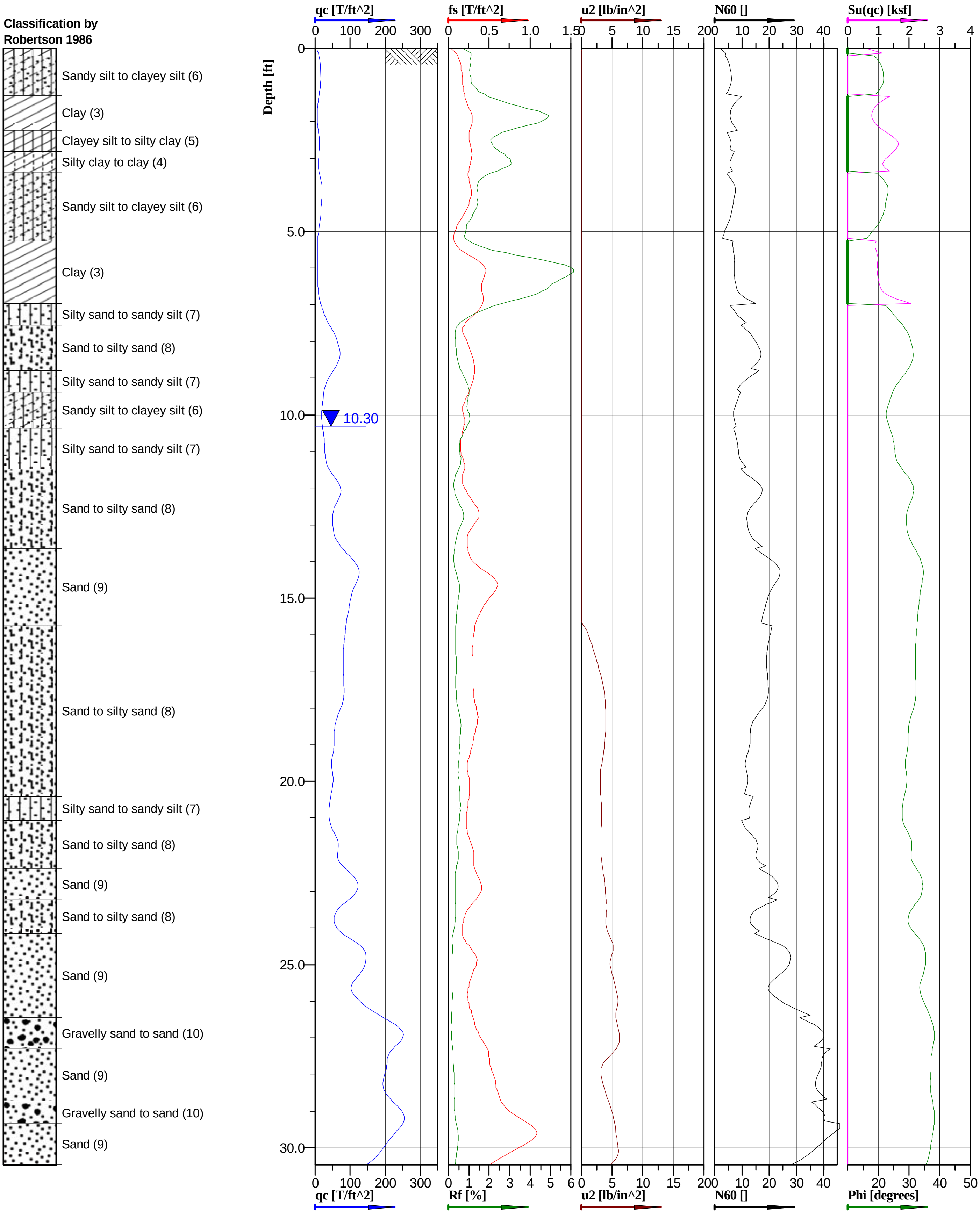


Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

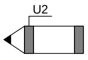
Location: Labadie, MO	Position: X: 727587.86 ft, Y: 995796.00 ft	Ground level: 469.49	Test no: C-16
Project ID: 2008012455	Client: Ameren Missouri	Date: 10/23/2009	Scale: 1 : 44
Project: Labadie Power Plant UWL DSI		Page: 2	Fig: C-3
		File: Labadie C-016.cpd	

Client: Ameren Missouri
Project name: Labadie Power Plant UWL DSI
Test no.: C-16
Test date: 10/23/2009
Location: Labadie MO
File name: Labadie C-016.cpd

				CPT-Pro Calculated Values								Reitz and Jens Calculated Values				
Depth	Corrected point resistance	Corrected local friction	Pore pressure behind cone	Soil Type	SPT Energy Ratio N60	Undrained shear strength	Total overburden stress	Effective total overburden str	R&J Phi Angle	Relative density	Unit weight	Corrected N60	Unit Weight	Total Overburden	Effective Overburden	Es (OCR=4)
[ft]	[MPa]	[MPa]	[lb/in^2]		[bpf]	[ksf]	[MPa]	[MPa]	[degrees]	[%]	[g/cm^3]	[bpf]	[pcf]	[ksf]	[ksf]	[ksf]
1.25	1.833	0.02	-0.7678	Silty sand to sandy silt (7)	7.2	0.737	0.007	0.007	23.1		1.83	4.6	114	0.15	0.15	153
3.75	1.428	0.032	-1.3414	Silty clay to clay (4)	7.9	1.432	0.021	0.021	26.5		1.83	7.9	114	0.44	0.44	716
6.25	1.934	0.026	-1.9854	Silty sand to sandy silt (7)	8.1	1.328	0.035	0.035	26.0		1.86	5.2	116	0.73	0.73	161
8.75	2.651	0.019	-2.7264	Silty sand to sandy silt (7)	8.9		0.049	0.049	25.4		1.89	5.7	118	1.02	1.02	221
11.25	2.539	0.02	-3.4778	Sand to silty sand (8)	8.4		0.063	0.062	24.5	50	1.87	5.4	117	1.31	1.29	211
13.75	5.252	0.027	-0.3621	Sand (9)	14.2		0.077	0.071	29.6	56	1.92	7.1	120	1.60	1.48	437
16.25	6.94	0.047	1.2901	Sand to silty sand (8)	17.3		0.091	0.078	30.8	62	1.93	11.0	120	1.89	1.62	577
18.75	8.773	0.041	3.5499	Sand (9)	19.9		0.105	0.085	32.4	64	1.95	9.9	122	2.18	1.77	730
21.25	12.19	0.068	3.3554	Sand (9)	25.9		0.12	0.092	34.5	73	1.97	13.0	123	2.50	1.91	1014
23.75	18.365	0.069	5.0401	Sand (9)	36.7		0.135	0.099	36.8	84	2	18.4	125	2.81	2.06	1528
26.25	12.858	0.038	6.533	Sand (9)	25.7		0.15	0.106	34.9	73	1.99	12.9	124	3.12	2.20	1070
28.75	19.984	0.069	7.3311	Sand (9)	40.0		0.165	0.114	37.3	85	2	20.0	125	3.43	2.37	1663
31.25	16.981	0.04	8.7446	Gravelly sand to sand (10)	32.8		0.18	0.121	36.3	78	2	22.3	125	3.74	2.52	1413
33.75	29.621	0.087	9.2581	Gravelly sand to sand (10)	49.4		0.195	0.128	39.3	94	2.04	33.6	127	4.06	2.66	2464
36.25	32.293	0.117	9.9953	Gravelly sand to sand (10)	53.8		0.203	0.133	39.7	97	2.04	36.6	127	4.22	2.77	2687

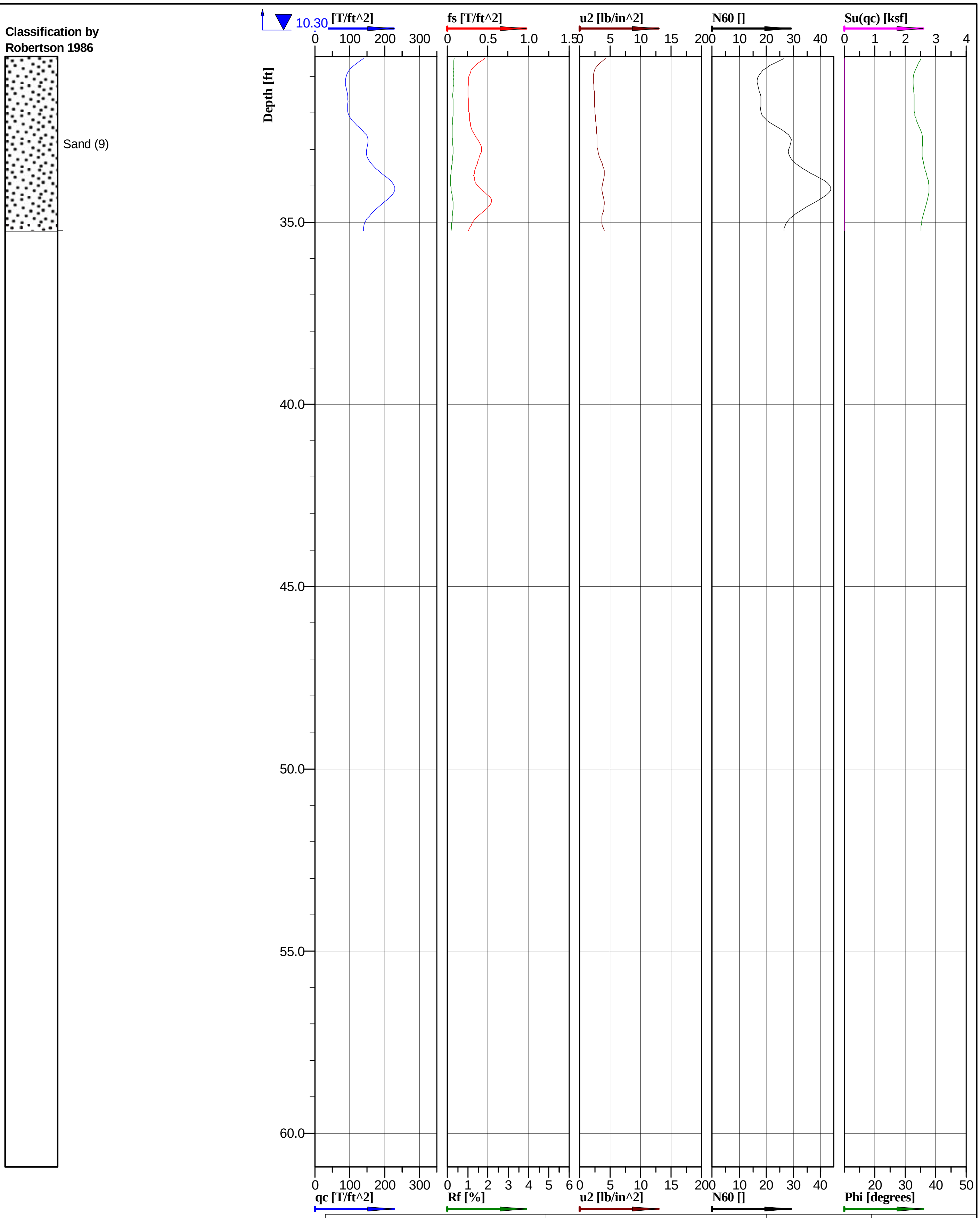


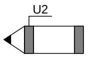
REITZ & JENS, INC.
CONSULTING ENGINEERS



Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO
Position: X: 728155.09 ft, Y: 995781.82 ft
Ground level: 468.01
Test no: C-18
Project ID: 2008012455
Client: Ameren Missouri
Date: 10/28/2009
Scale: 1 : 44
Project: Labadie Power Plant UWL DSI
Page: 1
Fig: C-4
File: Labadie C-018.cpd





REITZ & JENS, INC.
CONSULTING ENGINEERS

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie, MO
Position: X: 728155.09 ft, Y: 995781.82 ft
Ground level: 468.01
Test no: C-18
Project ID: 2008012455
Client: Ameren Missouri
Date: 10/28/2009
Scale: 1 : 44
Project: Labadie Power Plant UWL DSI
Page: 2
Fig: C-4
File: Labadie C-018.cpd

Client: Ameren Missouri
Project name: Labadie Power Plant UWL DSI
Test no.: C-18
Test date: 10/28/2009
Location: Labadie MO
File name: Labadie C-018.cpd

				CPT-Pro Calculated Values								Reitz and Jens Calculated Values				
Depth [ft]	Corrected point resistance [MPa]	Corrected local friction [MPa]	Pore pressure behind cone [lb/in^2]	Soil Type	SPT Energy Ratio N60 [bpf]	Undrained shear strength [ksf]	Total overburden stress [MPa]	Effective total overburden str [MPa]	R&J Phi Angle [degrees]	Relative density [%]	Unit weight [g/cm^3]	Corrected N60 [bpf]	Unit Weight [pcf]	Total Overburden [ksf]	Effective Overburden [ksf]	Es (OCR=4) (ksf)
1.25	1.018	0.019	-2.0188	Clayey silt to silty clay (5)	5.8	1.066	0.007	0.007	20.7		1.82	5.8	114	0.15	0.15	640
3.75	1.339	0.022	-4.5879	Sandy silt to clayey silt (6)	6.1	1.384	0.021	0.021	21.3		1.84	6.1	115	0.44	0.44	111
6.25	1.237	0.03	-5.0259	Sand to silty sand (8)	7.8	1.093	0.034	0.034	23.1	52	1.81	5.0	113	0.71	0.71	103
8.75	4.209	0.024	-2.7613	Sandy silt to clayey silt (6)	12.0		0.048	0.048	27.6	63	1.9	12.0	119	1.00	1.00	350
11.25	3.935	0.019	-4.55	Sand to silty sand (8)	11.2		0.062	0.059	27.2	58	1.9	7.1	119	1.29	1.23	327
13.75	8.21	0.036	-3.2647	Sand (9)	17.6		0.077	0.066	32.0	65	1.97	8.8	123	1.60	1.37	683
16.25	8.197	0.032	1.0366	Sand to silty sand (8)	19.2		0.091	0.073	32.4	66	1.95	12.3	122	1.89	1.52	682
18.75	5.697	0.029	3.6581	Sand to silty sand (8)	14.2		0.106	0.08	30.1	54	1.94	9.1	121	2.20	1.66	474
21.25	5.348	0.025	3.2302	Sand (9)	13.9		0.12	0.087	29.6	53	1.93	6.9	120	2.50	1.81	445
23.75	9.678	0.027	4.2775	Sand (9)	20.5		0.135	0.094	33.1	65	1.97	10.2	123	2.81	1.96	805
26.25	16.638	0.032	5.5778	Sand (9)	30.8		0.15	0.101	36.1	80	2.01	15.4	125	3.12	2.10	1384
28.75	20.758	0.071	4.5801	Sand (9)	39.7		0.165	0.109	37.5	87	2	19.9	125	3.43	2.27	1727
31.25	11.053	0.034	3.1383	Sand (9)	22.1		0.18	0.116	34.0	67	1.99	11.1	124	3.74	2.41	920
33.75	16.94	0.038	3.5473	Sand (9)	33.9		0.195	0.123	36.4	79	2	16.9	125	4.06	2.56	1409
36.25	13.434	0.027	3.8208	Sand (9)	26.9		0.203	0.127	35.2	72	1.99	13.4	124	4.22	2.64	1118