1505 East High Street
Jefferson City, Missouri 65101
Telephone (573) 659-9078
Facsimile (573) 659-9079

GREDELL Engineering Resources, Inc.

Sikeston Board of Municipal Utilities
Sikeston Power Station
Bottom Ash Pond
Structural Stability Assessment

Prepared for:

Sikeston Board of Municipal Utilities

Sikeston Power Station
1551 West Wakefield Avenue
Sikeston, MO 63801

October 17, 2016

Sikeston Board of Municipal Utilities
Sikeston Power Station
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Structural Stability Assessment

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PROFESSIONAL ENGINEER'S CERTIFICATION

40 CFR 257.73(d) Periodic Structural Stability Assessments.

I, Thomas R. Gredell, P.E., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR 257.73(d)(3) that this structural stability assessment for the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond meets the requirements of 40 CFR 257.73(d) as found in federal regulation 40 CFR 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments and has been prepared using methods and procedures consistent with the professional standard of care and customary practice for engineering investigations of projects of this nature.

Name: Thomas R. Gredell, P.E.

Signature: Thomas R. Gredell

Date: 10-17-2016

Registration Number: PE-021137
State of Registration: Missouri

STATE OF MISSOURI
THOMAS R. GREDELL
NUMBER PE-021137
PROFESSIONAL ENGINEER

1.0 INTRODUCTION

In accordance with the scope of services outlined in the Sikeston Board of Municipal Utilities (SBMU) Work Order No. 4 dated August 02, 2016, GREDELL Engineering Resources, Inc. (Gredell Engineering) conducted an initial structural stability assessment for the SBMU Sikeston Power Station (SPS) Bottom Ash Pond, a coal combustion residual (CCR) surface impoundment. The purpose of this assessment was to determine if the Bottom Ash Pond was designed, constructed, operated, and maintained in a manner consistent with recognized and generally accepted good engineering practices under the Federal CCR rule, section (§) 40 CFR 257.73(d). This report describes Gredell Engineering's assessment for the Bottom Ash Pond and includes the required certification by a qualified professional engineer stating this structural stability assessment was conducted in accordance with §257.73(d).

1.1 40 CFR §257.73(d) Periodic Structural Stability Assessment

§257.73(d), which requires the initial structural stability assessment completed by Gredell Engineering, is provided for reference below.

(d)(1) The owner or operate of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

(d)(1)(i) Stable foundations and abutments;

(d)(1)(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

(d)(1)(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

(d)(1)(iv) Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

(d)(1)(v) A single spillway or combination of spillways configured as specified in paragraph (d)1(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section;

(d)(1)(v)(A) All spillways must be either: (1) of non-erodible construction and designed to carry sustained flows; or (2) Earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.;

(d)(1)(v)(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a: (1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or (2) 1000-year flood for a significant hazard potential CCR surface impoundment; or (3) 100-year flood for a low hazard potential CCR surface impoundment;

(d)(1)(vi) Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure;

(d)(1)(vii) For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body;

(d)(2) The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator unit must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken;

(d)(3) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment was conducted in accordance with the requirements of this section.

2.0 BOTTOM ASH POND DESCRIPTION

SPS is located west of the City of Sikeston, south of West Wakefield Avenue, and east of Route BB in Scott County, Missouri. The Bottom Ash Pond at SPS resides to the southeast of SPS, and directly south of SPS's coal pile and inactive Fly Ash Pond. The Bottom Ash Pond occupies approximately 61 acres with a minimum and consistent berm elevation of 322.3 feet. Based on an aerial survey conducted by Surdex Corporation on May 06, 2012, the Bottom Ash Pond has an approximate remaining capacity of 333 acre-feet (ac-ft) (14,500,000 cubic feet [ft^3]).

SPS and the Bottom Ash Pond are located at a transition between agricultural and urban areas. The Bottom Ash Pond is surrounded by agricultural, commercial, and residential areas. Residential areas are located approximately 150 feet east/southeast of the Bottom Ash Pond. Commercial areas are located approximately 700 feet south of the Bottom Ash Pond. The remaining area around the Bottom Ash Pond is agricultural land. There is City-owned property to the east, south, and west of the Bottom Ash Pond. See Appendix A, Figure 1 – Aerial View, for a depiction of the Bottom Ash Pond.

3.0 STRUCTURAL STABILITY ASSESSMENT

The Federal CCR Rule requires an initial and periodic structural stability assessment for existing CCR surface impoundments. Periodic structural stability assessments shall be conducted every five years. Structural stability assessments must document whether the design, construction, operation, and maintenance of the CCR surface impoundment is consistent with recognized and generally accepted good engineering practices.

3.1 Foundations and Abutments

The foundation soils for the Bottom Ash Pond consist of existing soils or fills compacted to support the finished construction of the Bottom Ash Pond. Topsoil and soil with unsuitable material was stripped to a minimum depth of 6 inches. The stripped surface was further excavated or filled to the desired grades. The foundation soils beneath the berms of the Bottom Ash Pond consist of silty sand (SM) and fine to medium course sand (SP) (Geotechnology 2011).

The foundation soils where designed to be compacted in accordance with the construction specifications to a 95% maximum density at optimum moisture for silty sands and 70% relative density for sands prior to the construction of any features of the Bottom Ash Pond. The construction specifications may be found in the Sikeston Board of Municipal Utilities, Sikeston Power Station, Bottom Ash Pond, History of Construction, Appendix C – Historical Construction Specifications.

No deficiencies were found during the assessment of the foundations and abutments of the Bottom Ash Pond, therefore, no corrective measures are recommended.

3.2 Slope Protection

The Bottom Ash Pond has sufficient slope protection on the interior and exterior slopes to protect against various methods of erosion which may cause detrimental effects to the berms of the Bottom Ash Pond. The interior slopes of the bottom ash are protected from surface erosion and wave action by vegetative growth and rip-rap. Rip-rap was visible from the top of the berms to an observed water line elevation of 318.5 feet (as observed on October 5, 2016). Additionally, aerial photography obtained by Surdex Corporation on May 06, 2012 depicts rip-rap along the interior slopes to an observed water line elevation of 315 feet). The exterior slopes of the Bottom Ash Pond berms are protected from erosion by a thick, consistent grass vegetative cover.

No deficiencies were found during the assessment of the slope protection measures for the Bottom Ash Pond, therefore, no corrective measures are recommended.

3.3 Berm Stability

The berms of the Bottom Ash Pond were constructed on top of the prepared foundation soils. The berm fill material consists of fine sands and silty sands (SP and SM) (Geotechnology 2011). The berm fill materials were designed to be placed and compacted in accordance with the construction specifications to 70 percent relative density. The berms were constructed with 2 horizontal to 1 vertical slopes (2H:1V). The design finished top elevation of the berms was 322 feet. A recent aerial topographic survey shows that the berm has a consistent elevation that ranges between 322.3 and 322.6.

A global stability evaluation was conducted by Geotechnology in 2011 on the Bottom Ash Pond berms provide information on the stability of the berms for decision making purposes. The evaluation included four borings in the berms of the Bottom Ash Pond. The standard penetration tests for the borings equates to an average N value of 22 which correlates to a medium-dense compaction for the berm material. An N value of 22 indicates the berms were mechanically compacted during construction.

The global stability evaluation, assessed a range of loading conditions in the Bottom Ash Pond. The evaluation was conducted for steady state seepage at normal pool (elevation 317 feet), steady state seepage at maximum pool (elevation 321.5 feet), and pseudo-static conductions for seismic loading (elevation 317 feet). The calculated factors of safety for each condition were determined to be 2.1 (steady state, normal pool) and 1.5 (steady state, maximum pool), and 1.3 (pseudo-static, normal pool) (Geotechnology 2011). A factor of safety less than 1 would indicate an unstable condition in the berms.

Based on the available geotechnical data and analyses of the Bottom Ash Pond, it is determined the dikes of the Bottom Ash Pond were mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. Additionally, no evidence has been found or observed that leads Gredell Engineering to believe the specifications were not followed.

A visual inspection of the berms of the Bottom Ash Pond identified an area of saturated soil along the northern berm of the Bottom Ash Pond and west of the Fly Ash Pond. The area was previously identified by SPS personnel as an area of persistent wet conditions from rainfall due to the lack of drainage along the toe of the slope of the Bottom Ash Pond. The wet ground conditions were observed to begin approximately midway on the exterior slope of the berm (approximate elevation of 314 feet) and continued to the toe of the exterior slope of the berm. The type of grass vegetation was visually observed to change along a horizontal line along the exterior slope of the berm that generally matched the beginning of the wet conditions. Simple manual field techniques were also used to confirm the observations of wet conditions.

Due to the lack of recent precipitation, the saturated condition of the soil may be the result of seepage through the northern berm from the Bottom Ash Pond. However, no visible flow was observed and stability analysis of critical sections of Bottom Ash Pond berms by others reportedly exceed the minimum Factors of Safety required by the CCR rule.

Based on the observations and rationale described above, the wet, saturated soil condition is identified as a deficiency under the rule. Consistent with recognized and generally accepted good engineering practices, it is recommended corrective measures be undertaken by SBMU to further evaluate the potential seepage through the northern berm of the Bottom Ash Pond. The evaluation should recommend appropriate corrective measures to stabilize and/or repair the northern berm of the Bottom Ash Pond. At a minimum, corrective measures should be taken to improve the conditions for future routine maintenance (i.e., mowing) and observation.

3.4 Maximum Vegetation Height Requirement

As stated above, §257.73(d)(1)(iv) requires the vegetated slopes of berms and surrounding areas to not exceed six inches above the vegetated slope of the berm. §257.73(d)(1)(iv) was remanded with vacatur by the United States Court of Appeals for the District of Columbia Circuit on June 14, 2016. Therefore, the Bottom Ash Pond is no longer subject the maximum vegetation height requirement stipulated in §257.73(d)(1)(iv).

3.5 Spillway Design and Capacity

Discharge from the Bottom Ash Pond is through a concrete stop-log structure with dimensions of 6 feet wide, 11 feet long, and 8.5 feet deep with a top elevation of 322.53 feet (the active spillway). The active spillway is not currently operated with stop-logs. The discharge structure outlet is a single, 10-inch carbon fiber pipe which discharges Bottom Ash Pond effluent into the Process Waste Pond. The discharge pipe inlet and outlet invert elevations are 314.53 feet and 304.97 feet, respectively. The discharge pipe is routed from the discharge structure to a control valve with an invert elevation of approximately 306.3 feet. The distance from the discharge structure to the control valve is approximately 80 feet and the slope of the discharge pipe is approximately 10.3%. From the control valve, the discharge pipe is routed to the Process Waste Pond over a distance of approximately 1,820 feet with a slope of approximately 0.07%. Average daily and monthly maximum flow rates from the Bottom Ash Pond to the Process Waste Pond are 1.22 and 2.13 million gallons per day (MGD), respectively, as identified in SBMU's NPDES permit process flow diagram.

The Bottom Ash Pond also has a second overflow structure constructed of a concrete inlet with a 30-inch corrugated metal discharge pipe through the berm separating the Bottom Ash Pond from the inactive Fly Ash Pond. The discharge of the overflow structure is into the inactive Fly Ash Pond. The overflow structure is inoperable due to excess CCR deposits in the inactive Fly Ash Pond obstructing the discharge end of the 30-inch pipe.

The hazard potential classification for the Bottom Ash Pond was determined by modeling a worst-case probable scenario breach of the Bottom Ash Pond Berms and its resulting flood waters impact on the surrounding land using HydroCAD. Based on the HydroCAD model, the Bottom Ash Pond at SPS was classified as Significant. As stated above, §257.73(d)(1)(v)(B)(2) requires the inflow design flood for CCR surface impoundments with significant hazard potential classifications to be the 1,000 year flood (Gredell Engineering Resources, 2016a). The 1,000-year flood is the volume of runoff generated by the 1,000 year rainfall event for a given location. The 1,000 year, 24 hour rainfall event was modeled to determine if the existing Bottom Ash Pond and its associated discharge structures are negatively impacted by the discharge from the Bottom Ash Pond. From the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2, the 1,000-year, 24-hour precipitation event for Sikeston, Missouri is 12 inches of rainfall.

The peak discharge from the combined process wastewaters and the 1,000-year flood was determined to be 967 cubic feet per second (CFS) with a total influent volume of 2,622,500 ft^3 (19.6 MG). The maximum water elevation in the Bottom Ash Pond from the combined influents was determined to be 320.3 feet, 1.7 feet below the top of the Bottom Ash Pond berms (elevation 322 feet). The current capacity of the Bottom Ash pond with 61 acres area and 1.7 feet of storage is approximately 4,517,000 ft^3. The peak discharge from the Bottom Ash Pond during the 1,000-year inflow design flood was determined to be 1.78 CFS (1.15 MGD). Therefore, the Bottom Ash Pond active spillway has adequate hydrologic and hydraulic capacity to manage flow during and following the peak discharge from the inflow design flood, as required by §257.73(d)(1)(v) (Gredell Engineering Resources, 2016b).

No deficiencies were found during the assessment of active spillway of the Bottom Ash Pond. The emergency spillway between the Bottom Ash Pond and the Fly Ash Pond was found to be deficient due to excess fly ash at the discharge of the 30-inch corrugated metal pipe impeding the flow path of water from the Bottom Ash Pond. Consistent with recognized and generally accepted good engineering practices, it is recommended corrective measures be taken to either remove the accumulated CCR from the discharge end of the overflow structure, or construct an alternate overflow structure capable of adequately managing flow during and following the peak discharge from the design flood event.

3.6 Structural Integrity of Hydraulic Structures

As stated above, §257.73(d)(1)(vi) requires the structural integrity of hydraulic structures passing through or beneath a CCR surface impoundment to be maintained in a manner to prevent conditions which negatively affect the operation of the hydraulic structure.

3.6.1 Identified Hydraulic Structures

The Bottom Ash Pond has multiple hydraulic structures pass through the berms and one hydraulic structure passing beneath the CCR surface impoundment. Hydraulic structures passing through the berms of the Bottom Ash Pond Include:

- Overflow Structure: 30-inch corrugated metal pipe passing through the northern berm between the Bottom Ash Pond and the Fly Ash Pond (approximate 318.25 feet invert elevation).
- Active Discharge Structure: 10-inch carbon fiber pipe passing through the northern berm of the Bottom Ash Pond, discharging into the Process Waste Pond (approximate 314.5 feet invert elevation).
- Makeup Water Inlet: 8-inch iron pipe passing through the northern berm of the Bottom Ash Pond from the Fly Ash Pond (approximate 321.5 feet invert elevation).

Multiple hydraulic structures are buried on top of, or along the interior of, the Bottom Ash Pond, but do not pass completely through the berms. The following pipes are laid in concrete lined pipe trenches up the exterior slopes, then along and across the top of the berms to the interior of the Bottom Ash Pond. Once within the interior of the Bottom Ash Pond, the pipes are either re-buried or lay above grade. All pipes through the berms, with the exception of the Bottom Ash Pond's active spillway and inoperable overflow structure, are located above the normal water level of the Bottom Ash Pond (approximate elevation 318.5 feet).

- Bottom Ash Transport Water Inlet: estimated 8 to 10-inch iron pipe (the end of the pipe was physically inaccessible for direct measurement);
- Plant Operations Wastewater Inlet: 12-inch iron pipe;
- Pipe Trench Sump Discharge Pipe: 4-inch PVC pipe;
- Former Transport Water Inlets: Dual, 3-inch iron pipes;

The Bottom Ash Pond was constructed with dual, 2,140-foot long culverts passing beneath the compacted clay liner to convey stormwater from the eastern side to the western side of the Bottom Ash Pond. The stormwater culverts were located in the same location and along the same trajectory as the original Compress Road, which was removed during the construction of the Bottom Ash Pond. The purpose of the dual stormwater culverts is to maintain the gravity flow of off-site stormwater (originating on the east side of the Bottom Ash Pond) to the west side of the Bottom Ash Pond, eventually discharging into Ditch #4. The stormwater culverts were constructed as continuously reinforced concrete box culverts with inside dimensions of 5 feet tall by 8 feet wide for approximately 2,090 feet measured from inlet on the east to discharge on the west. The remaining 50 feet of the stormwater culverts are constructed of oval corrugated metal arch-pipe with approximate inside dimensions of 4 feet tall by 6.5 feet wide. The inlet and discharge elevations are 301.9 feet and 297.7 feet, respectively.

3.6.2 Structural Integrity of Identified Hydraulic Structures

A visual inspection was conducted of each hydraulic structure passing through or beneath the berms of the Bottom Ash Pond, where visible, for structural integrity, significant deterioration and deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively impact the operation of the hydraulic structure. The results of the visual inspection are described below.

- Overflow Structure: The concrete headwall of the overflow structure was in good condition with no visual signs of deterioration. The iron shear gate and inlet of the 30-inch corrugated metal pipe appeared to be in good condition with no visual signs of deterioration. The discharge of the 30-inch corrugated metal pipe was not identified due to excessive CCR accumulation that buried the discharge end in the inactive the Fly Ash Pond. The excessive CCR accumulation that negates the functionality of the overflow structure. The inoperable overflow structure is not determined to be a deficiency because the active discharge structure adequately manages flow during and following the peak discharge from the design flood event (the 1,000-year flood).
- Active Discharge Structure: The concrete discharge structure serving the 10-inch carbon fiber discharge pipe appeared in good condition with no visual signs of deterioration. The inlet of the 10-inch discharge pipe was beneath the water surface and therefore, not directly observed. The control valve serving the discharge was observed to be in good condition and was reported to have been recently operated per plant personnel. The discharge of the 10-inch carbon fiber pipe is moderately deteriorated. The deterioration does not compromise the operation of the discharge pipe.
- Makeup Water Inlet: The 8-inch iron pipe passing through the northern berm of the Bottom Ash Pond from the Fly Ash Pond appeared in good condition with no visual signs of deterioration. The inlet and discharge ends of the pipe showed no signs of deterioration and the inlet valves were observed and reported to be in operating condition.
- Bottom Ash Transport Water Inlet: The bottom ash transport pipe was estimated at 8 to 10-inches in diameter. An exact determination was not possible because the inlet discharge end of the pipe is inaccessible. The bottom ash transport water pipe is located below grade after rising from within the concrete lined pipe trench. The transport pipe appeared to be in good condition within the concrete lined pipe trench and at its discharge location in the Bottom Ash Pond. The concrete lined pipe trench did not appear to show any signs of significant deterioration.
- Plant Operations Wastewater Inlet: The plant operations wastewater 12-inch iron inlet pipe was observed to be in good condition within the concrete lined pipe trench. The plant

operations wastewater inlet pipe is located below grade after rising from within the concrete lined pipe trench. The discharge end of the pipe was showed signs of slight deterioration due to corrosion. The deterioration of the discharge end of the pipe does not compromise the operation of the inlet pipe.

- Pipe Trench Sump Discharge Pipe: The pipe trench sump discharge pipe (a 4-inch PVC pipe that runs along the top of the Bottom Ash Pond berm) was observed to be in good condition with no signs of deterioration. The PVC pipe is not located below grade at any point along its path within the boundary of the CCR Surface Impoundment.
- Dual Former Transport Water Inlets: The two former transport water inlet (3-inch) iron pipes are not located below grade at any point along their path, and therefore, were not evaluated as part of this initial structural stability assessment.

A visual inspection of the dual stormwater culverts located beneath the compacted clay liner of the Bottom Ash Pond was conducted via remote video operations. Each stormwater culvert was inspected independently. A complete inspection of the southern stormwater culvert was accomplished. However, approximately 300 feet of the northern stormwater culvert was not able to be directly inspected. Sediments within the northern stormwater culvert prevented the direct inspection of the stormwater culvert between approximately 1,600 and 1,900 feet (as measured from the inlet using the remote video equipment). The remote video capabilities of the inspection equipment allowed for an indirect visual inspection of the 300 feet by zooming the video camera. The observed condition of this section of the northern stormwater culvert were observed to be consistent with the remainder of the stormwater culvert, which is discussed below.

The continuously reinforced concrete box culvert sections of the stormwater culverts were observed to be in good condition. All surfaces of the concrete sections of the stormwater culverts were visible from the inlet of each culvert to approximately 1,200 feet into the culverts. From 1,200 feet to 2,090 feet, the bottom of the continuously reinforced concrete box culverts was obscured by sediment deposits with a maximum estimated thickness of 6-inches in depth. Recurring normal concrete shrinkage cracking in the top of both stormwater culverts was observed at regular intervals. No apparent separation or displacement of the concrete was observed. Minor seepage and calcification were observed at each crack. Cracking along the exterior vertical walls of the concrete box culvert was observed, but infrequent. Where cracking was present in the vertical walls, seepage and calcification were present. No deterioration was observed along the bottom of the concrete sections of the stormwater culverts where it was visible and not obscured by sediments. Debris was identified in the concrete sections of the stormwater culvert in the form of random individual rip-rap stones and tires. The observed minor shrinkage cracking of the concrete sections of the stormwater culvert do not negatively affect the structural integrity nor the operation of the hydraulic structures. The sediment within the concrete section of the stormwater culverts has a slight negative impact on the operation of the hydraulic structure by reducing the hydraulic capacity and flow velocity within the stormwater culverts. However, the percentage of the total cross sectional area of the stormwater culverts is less than 10% for the reinforced concrete box culvert sections. The flat topography surrounding the Bottom Ash Pond will not result in inundation of the Bottom Ash Pond due to the slightly reduced capacity of the structure. However, the sediment in the stormwater culverts is identified as a deficiency to be addressed in the future.

The final 50 feet (2,090 to 2,140 feet) of each stormwater culvert is constructed of corrugated metal pipe. The northern stormwater culvert appears to be in good condition with minimal deterioration. The southern stormwater culvert appears to be in good condition except for two locations where seams near the top of the corrugated metal pipe have separated. The bituminous lining of both the corrugated metal culverts is deteriorating and is in danger of no longer functioning properly. The bottom of both corrugated metal pipe culverts is obscured by sediments approximately 6- to 10-inches thick. The sediment within the metal pipe section of the stormwater culverts has a slight negative impact on the operation of the hydraulic structure by reducing the hydraulic capacity and flow velocity within the stormwater culverts. However, the percentage of the total cross sectional area of the stormwater culverts is less than 25% for the corrugated metal arch-pipe sections. The flat topography surrounding the Bottom Ash Pond will not result in inundation of the Bottom Ash Pond due to the slightly reduced capacity of the structure. However, the sediment in the stormwater culverts is identified as a deficiency to be addressed in the future. The separated seams of the southern stormwater culvert are also identified as a deficiency.

A factor in the sedimentation of the stormwater culverts is believed to be that the bottom elevation of the grassed lined channel downstream of the discharge of the stormwater culverts was observed to be higher than the invert discharge elevation of the stormwater culverts. The elevation of the grass lined channel reduces the velocity of water discharging from the stormwater culverts, resulting in sedimentation within the culverts. The elevation of the bottom of the grass lined channel negatively impacts the operation of the stormwater culverts by reducing the discharge velocity of stormwater from the stormwater culverts. Therefore, the elevation of the bottom of the grass lined channel is identified as a deficiency.

Consistent with recognized and generally accepted good engineering practices, it is recommended corrective measures be taken to address the deficiencies identified in the hydraulic structures passing through or beneath the berms of the Bottom Ash Pond. The identified deficiencies and recommended corrective measures are as follows:

- It is recommended corrective measures be taken to lower the grade of the grass lined channel by a minimum of 100 feet to a depth of at least 1 foot below the discharge elevation of the stormwater culverts to allow complete discharge of the stormwater culverts following a rainfall event. The excavation of the channel will also provide a sediment trap for the deposition of sediments in the stormwater flow.
- Remove the sediment and debris (rip-rap stones and tires) from within both stormwater culverts located beneath the Bottom Ash Pond.

- Repair the separated seams of the corrugated metal pipe section in the southern stormwater culvert.

Generally accepted good engineering practices for surface impoundments typically include secondary discharge structures or spillways in the event a surface impoundment's active spillway is deemed inoperable. Accordingly, it is recommended corrective measures be taken to remove the obstructions to the discharge end of the pipe in the inactive Fly Ash Pond to render it operative. Alternatively, design and install a broad crested weir emergency spillway in the Bottom Ash Pond berm at least 100 feet west of the inoperable structure.

3.7 Downstream Inundation and Sudden Drawdown

As stated above, §257.73(d)(1)(vii) requires the structural integrity of the CCR unit must be maintained during low pool of the adjacent water body or sudden drawdown of the adjacent water body. The Bottom Ash Pond berms are not subject to inundation by an adjacent water body. Therefore, the structural integrity of the Bottom Ash Pond was not assessed for low pool or sudden drawdown of an adjacent water body.

3.8 Miscellaneous Assessed Site Features

Various site features which are present in or near the Bottom Ash Pond were assessed for their impact on the structural stability of the Bottom Ash Pond. Various identified site features are as follows:

- Three electrical manholes were identified along the northern berm of the Bottom Ash Pond. The manholes are reported by SBMU personnel to support the original power supply that powered the original scrubber sludge pump station located in the northeast corner of the Bottom Ash Pond. The electrical manholes and the associated electrical conduit run parallel to the centerline of the berm, do not pass through the berm and therefore are not found to be detrimental to the structural integrity of the Bottom Ash Pond Berms.
- Three 10-inch iron pipes were identified along the interior of the eastern berm of the Bottom Ash Pond. The iron pipes do not penetrate the berms of Bottom Ash Pond. SPS personnel identified the pipes as former aeration lines. The pipes observed were laid on the bottom of the Bottom Ash Pond, as reported by SPS personnel. The aeration lines were connected with a header pipe that ran along the inside of the northern half of the east berm. The aeration system was operated during the early years of operation to treat odors, but have not been used in recent years and are not anticipated to be used in the future.
- A pit was observed in the deposited CCR materials in the southwest portion of the Bottom Ash Pond. The pit was 50 to 80 feet in horizontal dimension, approximately 10+/- feet deep and at least 20 feet inward of the Bottom Ash Pond berms. The pit was identified

by SPS personnel as an excavation used to obtain a quantity of CCR materials for off-site testing for potential beneficial use. The pit was not backfilled and had vegetation growing around the perimeter.

4.0 RECOMMENDED CORRECTIVE MEASURES SUMMARY

As stated above, §257.73(d)(2) pertaining to CCR surface impoundments states each periodic assessment must identify any structural stability deficiencies associated with the CCR surface impoundment and recommend corrective measures. A summary of the identified deficiencies and recommended corrective measures are provided below:

- An area of wet/saturated soil was identified along the exterior of the northern berm of the Bottom Ash Pond and west of the Fly Ash Pond. The wet area was observed from the toe of the exterior slope up the berm to an approximate elevation of 314 feet. Due to a lack of recent precipitation and other observations made in the field, the wet/saturated condition of the soil may be an indication of seepage from the Bottom Ash Pond through this portion of north berm. Therefore, Gredell Engineering has identified this condition as a CCR rule deficiency.

  Gredell Engineering recommends further investigation of the wet area along the northern berm of the Bottom Ash Pond. If the wet area is confirmed to be caused by seepage from the Bottom Ash Pond, corrective measures will be necessary to remediate this condition. An evaluation should be made that recommends appropriate corrective measures to stabilize and/or repair the northern berm of the Bottom Ash Pond. At a minimum, corrective measures should be taken to improve the conditions of the berm for future routine maintenance (i.e., mowing) and observation.

- The bottom elevation of the grass lined channel downstream of the discharge of the stormwater culverts underneath the Bottom Ash Pond was observed to be higher than the invert discharge elevation of the stormwater culverts. The elevation of the grass lined channel reduces the velocity of water discharging from the stormwater culverts, resulting in sedimentation within the culverts. The elevation of the bottom of the grass lined channel negatively impacts the operation of the stormwater culverts by reducing the discharge total flow and velocity of stormwater from the culverts. Therefore, the elevation of the bottom of the grass lined channel is identified as a CCR rule deficiency.

  The recommended corrective measure is to lower the elevation of the bottom of the grass lined channel by at least 1-foot below the elevation of the stormwater culverts for a minimum of 100 feet downstream of the discharge end of the culverts. This will allow complete discharge of the stormwater culverts following a rainfall event. The excavation of the channel will also provide a sediment trap for the deposition of future sediments in the stormwater flow.

- The build-up of sediment and debris observed within the concrete and corrugated metal pipe sections of the stormwater culverts underneath the Bottom Ash Pond creates a negative impact on the operation of the hydraulic structures by reducing the hydraulic capacity and velocity within the stormwater culverts. The sediment within the metal pipe section of the stormwater culverts reduces the hydraulic capacity and flow velocity within the stormwater culverts. However, the percentage reduction of the total cross sectional area of the stormwater culverts is 25% or less. It is noted that the flat topography surrounding the Bottom Ash Pond will likely result in all surrounding onsite and offsite stormwater conveyances being full during a significant flood event. As such, the reduced capacity of the stormwater culverts is not expected to result in the upstream inundation of the Bottom Ash Pond due to the reduced capacity of the structure. Nevertheless, Gredell Engineering has identified the build-up of sediment and debris in the stormwater culverts as a CCR rule deficiency.

Gredell Engineering recommends corrective measures be taken to remove the sediment and debris (individual rip-rap stones and tires) from within both stormwater culverts located beneath the Bottom Ash Pond.

- The southern stormwater culvert appears to be in good condition except for two locations where seams near the top of the corrugated metal pipe have been damaged and separated. The bituminous lining of both the corrugated metal culverts is cracking and deteriorating and could no longer function properly. Therefore, the separated seams of the southern stormwater culvert are identified as a CCR rule deficiency.

  Gredell Engineering recommends repair of the separated seams of the corrugated metal pipe section in the southern stormwater culvert.

Although not identified as a CCR rule deficiency, generally accepted engineering practices for surface impoundments typically include secondary discharge structures or spillways to be used in cases of excessive flow or in the event a surface impoundment's active spillway is rendered inoperable. Currently, the Bottom Ash Pond has one, operable discharge structure. The overflow structure between the Bottom Ash Pond and the Fly Ash Pond is currently inoperable due to excess CCR accumulation at the discharge of the 30-inch corrugated metal pipe, impeding the flow of water from the Bottom Ash Pond. The inoperable overflow structure was not determined to be a deficiency because Gredell Engineering's hydrologic and hydraulic evaluation determined that the one discharge structure adequately manages the anticipated flow during, and following, the peak discharge from the design flood event (the 1,000-year flood). However, consistent with generally accepted engineering practices, it is recommended that measures be taken to either: 1) render the existing secondary overflow structure operable (this would involve removing the obstructions to the discharge end of the pipe in the inactive Fly Ash Pond); or 2) to construct an alternative, secondary overflow structure (an alternate, secondary overflow structure could be the installation of a broad crested weir spillway in the Bottom Ash Pond berm at least 100 feet west of the inoperable structure).

5.0 MISCELLANEOUS REQUIREMENTS

Section 257.73(g) states that SBMU must comply with:

- The recordkeeping requirements specified in 257.105(f);
- The notification requirements specified in 257.106(f); and,
- The Internet requirements specified in 257.107(f).

6.0 REFERENCES

Geotechnology Inc., 2011. "Global Stability Evaluation Fly Ash and Bottom Ash Ponds Sikeston Power Station Sikeston, Missouri."

Gredell Engineering Resources, Inc., 2016a. "Sikeston Board of Municipal Utilities Sikeston Power Station Bottom Ash Pond Hazard Potential Classification Assessment."

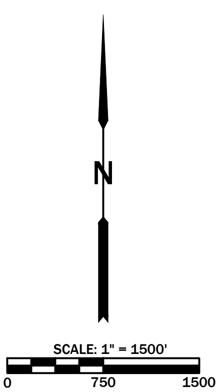
Gredell Engineering Resources, Inc., 2016b. "Sikeston Board of Municipal Utilities Sikeston Power Station Bottom Ash Pond Inflow Design Flood Control System Plan."

Gredell Engineering Resources, Inc., 2016c. "Sikeston Board of Municipal Utilities Sikeston Power Station Bottom Ash Pond History of Construction."

Sikeston Board of Municipal Utilities, 2015. "Sikeston Power Station Missouri State Operating Permit, MO-0095575."

APPENDIX A

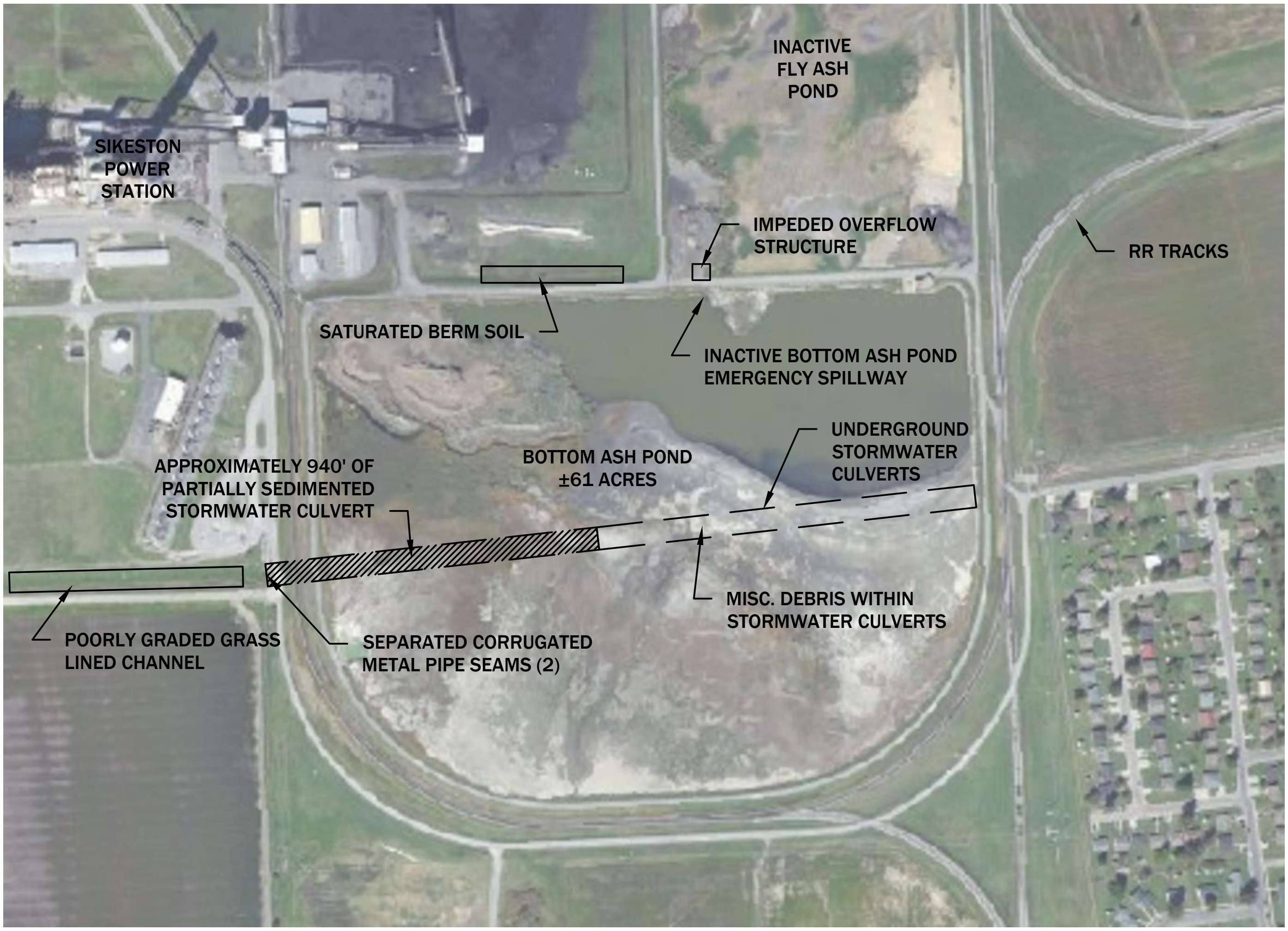
Figures

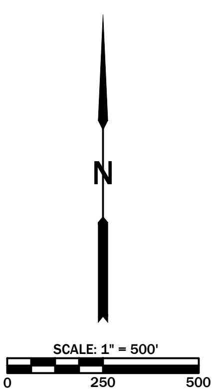


STRUCTURAL STABILITY ASSESSMENT BOTTOM ASH POND SIKESTON POWER STATION	**GREDELL Engineering Resources, Inc.** ENVIRONMENTAL ENGINEERING LAND - AIR - WATER 1505 East High Street Telephone: (573) 659-9078 Jefferson City, Missouri Facsimile: (573) 659-9079 MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

FIGURE 1 - AERIAL VIEW				
	DATE 10/2016	SCALE AS NOTED	PROJECT NAME SIKESTON	REVISION
	DRAWN AJK	APPROVED TG	FILE NAME STRUC STAB ASSMNT	SHEET # 1 OF 1

M:\Share\CADDFiles\SIKESTON\POND CLOSURE\STRUC STAB ASSMNT.dwg, FIGURE 1 - AERIAL VIEW, 10/14/2016 2:02:05 PM





STRUCTURAL STABILITY ASSESSMENT
BOTTOM ASH POND
SIKESTON POWER STATION

GREDELL Engineering Resources, Inc.

ENVIRONMENTAL ENGINEERING LAND - AIR - WATER

1505 East High Street
Jefferson City, Missouri
Telephone: (573) 659-9078
Facsimile: (573) 659-9079

MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

FIGURE 2 - BOTTOM ASH POND
IDENTIFIED DEFICIENCIES

DATE	SCALE	PROJECT NAME	REVISION
10/2016	AS NOTED	SIKESTON	
DRAWN	APPROVED	FILE NAME	SHEET #
AJK	TG	STRUC STAB ASSMNT	1 OF 1

M:\Share\CADDFiles\SIKESTON\POND CLOSURE\STRUC STAB ASSMNT.dwg, FIGURE 2 - BOTTOM ASH POND IDENTIFIED DEFICIENCIES, 10/14/2016 2:02:06 PM