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OFFICE OF MINES & MINERALS
LAND RECLAMATION DIVISION

PART IV

OPERATIONS PLAN

1) Proposed Operational Procedures and Methods for the Mine Over Its Projected Life

Describe the type and method of mining procedures and proposed engineering techniques to be employed in the operation of the proposed mine. Describe the major equipment to be employed and how such equipment will be used in the different aspects of the mining operation. Provide an estimation of the anticipated annual coal production and anticipated coal production by tonnage once the mine is at full operational capacity.

Sunrise Coal, LLC is proposing to develop and operate Bulldog Mine, an unplanned subsidence underground coal mine in Vermilion County, Illinois. The location of the proposed permit and shadow areas are shown on the enclosed maps. The Bulldog Mine will extract the Herrin No. 6 coal seam utilizing conventional room and pillar mining methods. A portal to the underground mine will be created by excavating a slope from the surface to the coal seam. Two air shafts will also be constructed to the underground mining operation.

The overall mining layout is shown on the *Shadow Area Map, Map S.* A room-and-pillar mining system with two walk-through super-sections is planned for extracting coal. Four continuous miners, battery haulage units, and dual-boom bolters will be used for the mining process. The primary equipment in the face area will be supported by other equipment such as supplementary bolters, personnel carriers, supply equipment, scoops and tractors.

Initial surface disturbance will involve removing and stockpiling topsoil in advance of sediment ponds, treatment ponds, a holding pond, and access road construction. After adequate topsoil has been removed, the sediment ponds and a holding pond will be built at the locations shown on the *Operations/Surface Drainage Control Map, Map D.*

Remaining topsoil will be removed from the surface area and placed in stockpiles prior to developing surface support facilities at the mine site. Sub-soil will be removed from the area as necessary to facilitate mine construction and development. Any stockpiled sub-soil will be segregated from topsoil stockpiles. Tractors/pull scrapers in combination with necessary support equipment will remove and stockpile the topsoil and sub-soil. Signs will be placed on the stockpiles to identify the material stored in the individual piles. Vegetation will be established on the stockpiles to help eliminate erosion caused by wind and water. The stockpiled soil materials will eventually be used to reclaim the area after completion of mining.

If necessary, consolidated overburden from the mine portal slopes will be drilled and blasted using conventional equipment. However, available borehole data indicates the compressive strength of all materials within 50 feet from the surface is low enough to cut with a continuous miner. No surface blasting activities will be employed within 50 vertical feet of the original ground surface for the development of the proposed mine slope or the two proposed air shafts. If it is later determined necessary to blast within 50 feet of the surface, a blasting plan will be submitted to the Department for approval prior to conducting any surface blasting activities within 50 feet of the surface.

As indicated in *Attachment III-2A2* from Part III of this application, the upper layers of consolidated overburden exhibit positive net neutralization potential. This material will be used to construct a road base for the mine access roads. Excess material excavated from the slope will

be hauled to the soil stockpile at the location shown on the *Operations/Surface Drainage Control Map, Map D.*

Various equipment including dozers, gob truck, motor grader and a water wagon will provide ongoing support of the surface facilities as necessary.

After the mine slope has been completed, the underground mining operation will begin extracting the Herrin No. 6 coal seam from the mine utilizing a continuous miner, shuttle cars and conveyor belts to mine and transport the coal to the preparation plant for processing. Roof control and support will be achieved in the mine with conventional roof bolters.

Two air shafts (intake and return) will be constructed during mine development. The shafts will be approximately 16 feet in diameter.

Within the shadow area, the Herrin No. 6 coal seam averages approximately 5.9 feet thick. The proposed pillar geometry can be found in Part IV 3)C)2)a) of this application. The operation expects a maximum extraction ratio of 52 percent. The mine is expected to produce approximately 500,000 to 600,000 tons of clean coal during the first year of operation then ramp up to approximately to 1,200,000 tons per year within five years.

2) Mining Operations Plan for the Proposed Permit Area

Describe the proposed mining operations plan for the permit area in terms of the mining sequence, the employment of facilities, establishment and maintenance of erosion control facilities, air pollution control facilities, coal storage, cleaning and loading areas, location and placement of topsoil, spoil, coal waste, or other storage facilities.

Sediment control and erosion will be controlled by the use of drainage ditches, two treatment ponds and three sediment ponds as illustrated on the *Operations/Surface Drainage Control Map, Map D.* Sediment Pond #1, Treatment Pond #1, and Treatment Pond #2 are sized to provide all the required sediment volume as shown in the Sediment Control Calculations. Sediment Ponds #2 and #3 will provide additional sediment storage, if needed, as they are in series with Treatment Ponds #1 and #2 respectively. At locations where it is not possible to pass runoff through a stilling basin, such as the back slopes and spoil from ditches and ponds, sediment control structures may include rip-rap, straw bales, and/or silt fence. The affected areas will be stabilized and seeded to minimize erosion.

Excavating the mine slope that will provide access to the coal seam will begin after drainage control is established. Other facilities will be constructed on an as needed basis during mine development.

Coal processing will be accomplished through the use of a washing plant utilizing heavy media separation. A conveyor belt will transport run-of-mine coal from underground to a raw coal stockpile. Radial stackers will be used to store both raw coal and clean coal at the locations shown on the *Operations/Surface Drainage Control Map, Map D.* The limits of the clay liner under the raw and clean coal pad will be clearly marked in the field as described in Part IV(6)(D) of this application. Conveyors will transport coarse refuse to refuse bins located adjacent to the Refuse Impoundment.

Coal from the clean coal stockpile will be loaded onto licensed trucks for highway haulage to various customers. The location of a potential rail loop is indicated on the *Operations/Surface*

***Drainage Control Map, Map D*, but is not being proposed to be constructed at this time. If the rail loop is proposed to be built in the future, Sunrise Coal will obtain the required regulatory approvals.**

Fugitive dust will be controlled by frequently watering the roads while they are used during dry, dusty periods. Some portions of the roads may be oiled and chipped periodically, or treated with approved dust suppressant chemicals in order to further control dust pollution.

Soil storage areas are shown on the enclosed *Operations/Surface Drainage Control Map, Map D.* Soil stockpiles will be vegetated to minimize wind and water erosion.

2) A) 1) Describe how each type of overburden (soil horizons, glacial drift and consolidated material) will be handled with regards to shaft excavations.

Topsoil will be placed in stockpiles and stored for future use. Glacial drift will be used as fill material for mine support facilities. Any excess glacial drift will be stockpiled for future use. Consolidated material from the excavation will be used for access road construction and to create a base for parking and material/equipment storage areas. Excess consolidated material will be placed in the excess consolidated material stockpile at the location shown on the *Operations/Surface Drainage Control Map, Map D.* The stockpiled material will be vegetated to protect the stored material from wind and water erosion.

2) A) 2) If toxic materials have been identified as occurring in the overburden, describe how these materials will be handled to insure proper disposal.

Fifteen unconsolidated strata layers exist in the overburden column near the location where the mine slope will be developed. One-hundred percent of the unconsolidated overburden materials exhibited an excess of tons calcium carbonate equivalent per 1000 tons of unconsolidated material.

Forty-eight consolidated strata layers were sampled in the overburden that exists above the Herrin No. 6 coal seam. Five under burden layers were sampled in the strata below the Herrin No. 6 coal seam.

Forty-four of the forty-eight consolidated overburden strata layers totaling 286.7 feet thick exhibit a weighted average of positive 107.00 tons calcium carbonate equivalent per 1000 tons of material. Only four of the forty-eight consolidated overburden strata layers negative tons calcium carbonate equivalent per 1000 tons of material. The negative calcium carbonate material totaling 26.6 feet thick exhibit a weighted average of negative 35.05 tons calcium carbonate equivalent per 1000 tons of material.

The layers of strata exhibiting negative net neutralization potential exist at depths greater than 285 feet below the surface. This material will be blended with the excavated overburden material that demonstrates positive net neutralization potential and used as a base to provide a solid foundation across the mine site. Considering the overall calcareous nature of the consolidated overburden, and the blending that will occur during the slope development process, special material handling techniques are not considered necessary in the interest of prevention of contamination of groundwater and surface water supplies.

2) B) 1) Locate on the operations map all soil horizon storage areas and/or root medium stockpiles. Identify each storage area as to its content.

Please refer to the *Operations/Surface Drainage Control Map, Map D* for the location of soil stockpiles. Should it become evident that additional soil horizon stockpiles are necessary, mine management will solicit field approval from the Office of Mines and Minerals, Land Reclamation Division field inspector. The stockpiles will be identified in the field with signs showing the type of soil material stored in each stockpile.

2) B) 2) Describe measures to be employed to prevent or minimize exposure of soil stockpiles to excessive water and wind erosion, unnecessary compaction and contamination by undesirable materials.

As soon as possible after completion of topsoil stockpiles, a vegetative cover will be established to control wind and water erosion. Mulch may be used instead of, or in addition to this vegetative cover if necessary to avoid excessive wind and water erosion.

To avoid unnecessary compaction and contamination by undesirable materials, an orderly stockpile construction procedure will be followed. This procedure may include moving the bulk of material during periods of desirable weather conditions, as well as making the fewest amount of passes practical over the stockpiles with soil transfer equipment during stockpile construction.

Refer to the response at Part V(1)(D)(2)(b) for the list of vegetation used for vegetative cover.

2) B) 3) Describe methods and treatment measures to be used on exposed areas where topsoil has been removed to prevent excess air and water pollution.

Topsoil will be removed only as far in advance of surface disturbance as necessary to support the mining operation. Provided there is sufficient time between topsoil removal and area utilization, the exposed soil areas will have the vegetation reestablished to prevent excess wind and water erosion.

2) C) The permit map and plans shall show the lands proposed to be affected within the proposed permit through the operation, according to the sequence of mining and reclamation and any change in a facility or feature to be caused by the proposed operations if the facility or feature was shown under 62 Ill. Adm. Code Sections 1783.24 through 1783.25.

Please refer to the maps provided in this permit application for all lands proposed to be affected.

2) D) Show on the permit map or other designated map each area of land for which a performance bond will be posted under 62 Ill. Adm. Code 1800.

A performance bond will be posted for essentially the entire surface permit area.

2) E) Mining Operations Plan for the Proposed Shadow Area

2) E) 1) Provide a map at a scale of 1 inch to 1,000 feet or other scales as approved by the Department identifying the limits of the proposed shadow area (area from which coal is proposed to be extracted by underground mining methods).

The proposed shadow area is shown on the enclosed *Shadow Area Map, Map S.*

2) E) 2) Within the limits of the proposed shadow area identify all areas projected to be mined, at a minimum, during the term of the permit showing the proposed size, sequence and yearly projections for the development of underground workings.

Areas to be mined are shown on the enclosed *Shadow Area Map, Map S.* Along with other points of interest, the map illustrates the location of the proposed boundaries of the shadow area, and sequence of yearly projections for the development of the underground coal reserves.

3) Subsidence Control Plan

3) A) General Requirements

3) A) 1) Within the permit, shadow and adjacent areas are there structures or renewable resource lands?
Yes __**X**__ No ______

If yes, on the shadow area map described in 2,E, above, or other designated map, provide survey information which identifies all structures and renewable resource lands. Include all topographic features at a maximum contour interval of 10 feet. Identify all surface and subsurface man made features within, passing through, or passing over the area in which underground mining operations are located or will be projected to be located. Such features shall include but are not limited to all buildings, facilities, roads, bridges, major electric transmission lines, pipelines, agricultural drainage tile fields, gas and oil wells and water wells.

If no, provide evidence and support documentation that no structures or renewable resource lands exist as a result of a survey conducted within these areas.

Several structures that will incur limited extraction ratios are identified on the *Shadow Area Map, Map S.* The structures that will be protected by limited extraction ratios include occupied dwellings, Norfolk Southern Railroad, the coal preparation plant, Sediment Pond #1, Sediment Pond #2, Sediment Pond #3, Treatment Pond #1, Treatment Pond #2, and the Holding Pond. The extraction ratio within the influence area of these structures will be limited to 50% or less to minimize potential unplanned subsidence. The influence area will be determined by using appropriate angles of draw for unconsolidated and consolidated overburden as indicated in Part IV 3)C)2)c).

There are no private water bodies (farm ponds) that exceed 20-acre feet in size within the shadow area.

There are seven proposed water bodies that will exceed 20-acre feet in volume within the surface permit area. These water bodies will include three sediment ponds, two treatment ponds, the Holding Pond, and the Refuse Impoundment as shown on the *Operations/Surface Drainage Control Map, Map D.* Surface structures proposed to be constructed in support of the underground mining operation will include the mine portal/slope and the preparation plant. No underground mining is proposed to occur under the refuse impoundment. The

extraction ratio within the influence area of all other water bodies and structures mentioned above will be limited to 50% to minimize potential unplanned subsidence.

3) A) 2) Within the proposed permit, shadow or adjacent areas does the applicant intend to adopt mining technologies which provide for planned subsidence in a predictable and controlled manner?
Yes _______ No __X__

If yes, provide information requested under "Planned Subsidence", Subsection B.

If no, provide information requested under "Subsidence Unplanned", Subsection C.

If the applicant intends to conduct both planned and unplanned subsidence mining operations both subsections B and C must be addressed.

3) A) 3) Provide geologic descriptions characterizing the thickness and lithology of the coal and overburden geological units throughout the shadow area. Provide stratigraphy test boring and core sampling log descriptions from the shadow area. Include the elevation and locations of the boring logs.

Please refer to the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012 in *Attachment IV-3A3*. Locations of the borings are shown on Figure 2.4 of the attachment and also on the *Shadow Area Map, Map S*.

3) B) Planned Subsidence

Not applicable, planned subsidence is not proposed for this mining permit.

3) B) 1) Provide a detailed description of the mining technology used to produce planned and predictable subsidence?

3) B) 2) Provide a description of factors (i.e. drift thickness variations, expected variations in extraction height, or presence of faults and their direction (strike & dip) in relation to mine panels, etc.) with supporting documentation which may influence the magnitude, extent and predictability of planned subsidence. Include data on predicted subsidence profiles and post-subsidence contours, including calculations on the predicted angle of draw. Provide a description of measures taken in the field to confirm the accuracy and reliability of predicted subsidence profiles.

3) B) 3) On a plan base map(s), at a map scale of 1 inch to 400 feet provide a map of underground workings which locates all areas where planned subsidence mining operations are to be conducted. Include detailed information in regard to the location,, length, width and height of projected panel development and extraction areas. Give typical percentage of coal removed in planned subsidence extraction areas.

3) B) 4) On the 1 inch to 400 feet plan base map(s) the information regarding the location of features required in Parts a-d below is to be provided in relation to areas of planned subsidence.

3) B) 4) a) Identify all topographic features at a maximum contour interval of 10 feet.

3) B) 4) b) Identify and label all impoundments with a storage capacity of 20 acre-feet or more, or bodies of water with a volume of 20 acre feet or more. In a written narrative provide information which assures compliance with the requirement of Title 62 Ill. Adm. Code 1817.121(d) to permit such proposed mining operations. If no such features exist provide a specific statement indicating such.

3) B) 4) c) Identify and label all public road right-of-ways and cemeteries located within 100 feet measured horizontally of surface areas of predicted planned subsidence. In a written narrative provide information which assures compliance with the requirements of Title 62 Ill. Adm. Code 1761.11 and 12 as may be necessary to permit planned subsidence mining operations within the prohibited area. If no such features exist provide a specific statement indicating such.

3) B) 4) d) Identify and label all occupied dwellings, public buildings and facilities, schools, churches, hospitals, community or institutional buildings, or public parks located within 300 feet measured horizontally of surface areas of predicted planned subsidence. If no such features exist provide a specific statement indicating such. If such features do exist include the following information as may be necessary:

3) B) 4) d) i) Provide a written narrative with support documentation which assures compliance with the requirements of Title 62 Ill. Adm. Code 1761.11 and 12 as may be necessary to permit planned subsidence mining operations within the prohibited area.

3) B) 4) d) ii) Provide a written narrative which assures compliance with the requirements of Title 62 Ill. Adm. Code 1817.121(d) as may be necessary to permit such proposed mining operations in relation to public buildings and facilities, schools, churches and hospitals.

3) B) 5) Describe the anticipated effects of planned subsidence.

3) B) 5) a) Using the predicted magnitude, extent of planned subsidence profiles, post-subsidence contours and angle of draw provided in response to 4,B, above, provide a list of all structures and facilities located within the projected area of influence of the planned subsidence. The list provided must correspond to each panel or extraction area to be mined by planned subsidence mining methods and must cross-reference with surface structures and feature map(s).

3) B) 5) b) Using the predicted magnitude, extent of planned subsidence profiles and post-subsidence contours provided in response to B, 2, above, locate and identify all areas of where surface subsidence impacts are projected to cause disruptions of surface drainage or drainage problems on a map(s) at a 1" to 400' scale.

3) B) 5) c) Describe any other anticipated effects of planned subsidence.

3) B) 6) Describe, if any, measures to be taken on the surface to prevent or minimize the effects of planned subsidence.

3) B) 7) Describe measures to be taken to mitigate or remedy any subsidence-related material damages.

3) B) 7) a) Provide a description of mitigation measures to be taken to repair or compensate the owners of structures or facilities which sustain material damage caused by subsidence, including but not limited to the following:

3) B) 7) a) 1) Compensate the owner of structures or facilities in the full amount of the diminution in value resulting from the subsidence.

3) B) 7) a) 2) Repair, restore, rehabilitate or replace damaged structures or facilities.

3) B) 7) a) 3) Compensation may be accomplished by the purchase prior to mining of a noncancelable premium prepaid insurance policy payable to the surface owner in the full amount of the possible material damage. Documentation of the purchase of such qualifying insurance must be provided.

3) B) 7) b) Provide a description of measures adopted to control and correct material damage resulting from subsidence caused to surface lands, to the extent technologically and economically feasible, by restoring the land to a condition capable of maintaining the value and reasonable foreseeable uses which it was capable of supporting before subsidence. Also provide descriptions of specific repair measures recommended to remedy anticipated material damages detailed in 7,a above.

3) B) 7) c) In conjunction with subsidence control plans to mitigate subsidence-related material damage to land and structures, provide a description of measures to be taken to determine the degree of material damage or diminution of value or reasonable foreseeable use of the surface.

3) C) Subsidence Unplanned (Maximize Mine Stability)

3) C) 1) Describe the method of coal removal which is designed consistent with known technology to maximize mine stability to prevent or minimize subsidence and subsidence related damage so that if subsidence does occur it cannot be considered planned subsidence.

The Bulldog Mine will utilize the room-and-pillar method of underground mining. Solid pillars of coal will be left intact for support, and coal pillar sizes are designed for long term stability of the mine itself and the overlying surface.

Please refer to the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve,* dated May 11, 2012 in *Attachment IV-3A3.*

3) C) 2) On the shadow area map(s) describe in 2,E, above, or other designated map show all areas where coal extraction as described above in 3,C,1 is to occur. Include the following detailed information:

3) C) 2) a) Provide the location of mains, submains and extraction panels giving geometric sizes, dimensions and orientation including lengths, widths, and extraction heights of each.

The proposed mine plan for operations at the Bulldog Mine utilizes the room-and-pillar method of mining. Average extraction height (coal seam thickness) is 5.9 ft.

Sunrise Coal, LLC contracted Marino Engineering Associates, Inc. (MEA) to do a study of the rock overburden, pillar and floor conditions in the shadow area of the Bulldog Mine. The report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve,* dated May 11, 2012 determined that the mine floor was the limiting factor in mine stability.

In the mains and submains, the typical mine plan will include the following geometry for square pillars:

Entry Width	=	**18 ft**
Pillar Width	=	**52 ft**
Extraction Ratio	=	**45%**
Center to Center	=	**70 ft**

In the production areas, the typical mine plan may include the following square pillar geometries resulting in a maximum extraction ratio of 52%:

Room Width	=	**18 ft**
Pillar Width	=	**42 ft**
Center to Center	=	**60 ft**

or

Room Width	=	**20 ft**
Pillar Width	=	**45 ft**
Center to Center	=	**65 ft**

The above mine plan conditions are based on the average geotechnical data and calculations provided in the MEA report dated May 11, 2012 which is located in *Attachment IV-3A3*. As additional data is collected and as the mine is developed, the above mine plan geometries may be altered to meet the safety factors using pillar and floor calculation methods provided in the MEA report.

Additional testing of the floor materials will be conducted periodically throughout the expansion of the mine. The testing may be plate load testing or other alternatively accepted testing techniques. The testing will be performed at intervals of approximately 10,000 feet as measured along mains and submains. If the direct observation of the floor materials begins to show signs of deterioration or failure, additional testing will be performed at intervals of approximately 5,000 feet. A report of said testing will be submitted to IDNR.

Sunrise Coal may, in the future, elect to perform two-staged mining as outlined in the attached report prepared by MEA titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve* dated May 11, 2012. The final extraction ratio will be determined based on additional testing and will be subject to IDNR approval.

As noted above, the mine layout will typically be in a square checkerboard configuration but can be any shape. The number of entries may vary in any given main or panel depending upon ventilation needs, overlying critical structures, coal uniformity, etc. Generally, more entries will be used on panels of greater lengths to aid in ventilation, while fewer entries with staggered crosscuts may be used to mine beneath a critical structure.

As indicated on the *Shadow Area Map, Map S*, occupied dwellings, the Norfolk Southern Railroad, the coal preparation plant, Sediment Pond #1, Sediment Pond #2, Sediment Pond #3, Treatment Pond #1, Treatment Pond #2, and the Holding Pond will be protected from subsidence by limiting coal extraction to 50% or less. There will be no coal extraction under the Refuse Impoundment. This reduced extraction will be maintained,

not only under the structure per se, but also everywhere the structure is within the zone of influence of the mining. This will be determined by an influence angle of 20°.

Using an influence angle of 20°, the extent of limited extraction beyond the protected feature is calculated below.

Based on the average depth to bottom of the coal from the attached MEA Report.

(tan20°) x 366 ft = 133 ft

Based on the maximum depth to the bottom of the coal from the attached MEA Report.

(tan20°) x 390 ft = 142 ft

From the above calculations, Sunrise will use a 150 ft offset for all structures requiring additional protection.

Please refer to the MEA report located in *Attachment IV-3A3* and the *Shadow Area Map, Map S.*

3) C) 2) b) Identify and label all impoundments with a storage capacity of 20 acre-feet or more, or bodies of water with a volume of 20 acre feet or more, public buildings and facilities, churches, schools and hospitals. In a written narrative provide information which assures compliance with the requirements of Title 62 Ill. Adm. Code 1817.121(d) as may be necessary to permit such proposed mining operations. If no such features exist provide a specific statement indicating such.

Several structures that will incur limited extraction ratios are identified on the *Shadow Area Map, Map S.* The structures that will be protected by limited extraction ratios include Norfolk Southern Railroad and several homes. The extraction ratio within the influence area of these structures will be limited to 50% or less to minimize potential unplanned subsidence.

There are no public buildings and facilities, churches, schools and hospitals located within or adjacent to the shadow area.

There are no gas/petro transmission lines or oil or gas wells in the shadow area.

There are no existing private water bodies (farm ponds) that exceed 20-acre feet in size within the shadow area.

There are seven proposed water bodies that will exceed 20-acre feet in volume within the surface permit area. These water bodies will include three sediment ponds, two treatment ponds, the holding pond and the refuse impoundment as shown on the *Operations/Surface Drainage Control Map, Map D.* Surface structures proposed to be constructed in support of the underground mining operation will include the mine portal/slope and the preparation plant. No underground mining is proposed to occur under the refuse impoundment. The extraction ratio within the influence area of all other water bodies and structures mentioned above will be limited to 50% to minimize potential unplanned subsidence.

3) C) 2) c) Provide calculations for the estimated potential angle of draw.

Based on past underground mining experience in the State of Illinois, an angle of 20° has been chosen for the damage limit for the Bulldog Mine.

The following calculation is based on the average depth to bottom of the coal from the Marino Engineering Associates, Inc. (MEA) report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, located in *Attachment IV-3A3*.

$$(\tan 20°) \times 366 \text{ ft} = 133 \text{ ft}$$

The following calculation is based on the maximum depth to the bottom of the coal from the attached MEA Report.

$$(\tan 20°) \times 390 \text{ ft} = 142 \text{ ft}$$

From the above calculations, Sunrise will use a 150 ft offset for all structures requiring additional protection.

3) C) 3) Provide information regarding proposed mining extraction geometries, including information on the dimensions of pillars, extraction widths of rooms, entries, and crosscuts, etc., for all mains, submains, panel entries and all development areas. Provide information regarding the highest extraction percentage for each of the mining geometries proposed by the operator, if variations are proposed. Information is to include specific details of the effects of any proposed second mining operations on final mining geometries and extraction percentages. Map(s) at a scale of 1 inch to 400 feet (other scales as approved by the Department) are to be provided representing all proposed extraction geometries, including any proposed second mining.

3) C) 3) a) Provide information regarding the design engineering of the various mining geometries proposed in 3,C,3 above in maximizing mine stability to prevent subsidence. Include the following:

The design engineering for determining the mining geometries is provided in the Marino Engineering Associates, Inc. (MEA) report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, located in *Attachment IV-3A3*. Mining configurations are shown on the *Shadow Area Map, Map S*.

In the mains and submains, the typical mine plan will include the following geometry for square pillars:

Entry Width	=	**18 ft**
Pillar Width	=	**52 ft**
Extraction Ratio	=	**45%**
Center to Center	=	**70 ft**

In the production areas, the typical mine plan may include the following square pillar geometries resulting in a maximum extraction ratio of 52%:

Room Width	=	**18 ft**
Pillar Width	=	**42 ft**
Center to Center	=	**60 ft**

or

Room Width	**=**	**20 ft**
Pillar Width	**=**	**45 ft**
Center to Center	**=**	**65 ft**

The above mine plan conditions are based on the average geotechnical data and calculations provided in the MEA report dated May 11, 2012. As additional data is collected and as the mine is developed, the above mine plan geometries may be altered to meet the safety factors using pillar and floor calculation methods provided in the MEA report.

3) C) 3) a) i) Detailed information regarding the specific methodology used to calculate mine stability with support documentation and design calculations.

Mine Stability calculations, including methodology and support documentation are provided in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012. The report is located in *Attachment IV-3A3.*

3) C) 3) a) ii) Data concerning actual coal strengths typical of the coal to be mined and as this information relates to pillar design and stability.

Coal strength data typical for the coal to be mined and stability calculations for the coal safety factor are in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012. The report is located in *Attachment IV-3A3.* This report provides the coal strength data and pillar strength calculations. This study determined that the floor conditions dictated the stability of the overburden as it related to surface subsidence.

3) C) 3) a) iii)Data regarding the strength and geotechnical characteristics of the actual mine floor and subfloor as it relates to mine design and stability. Information is to be included describing the thickness and lithology of the floor and subfloor units.

Data concerning floor strength and geotechnical characteristics, thickness, and lithology is included in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve.* The report is located in *Attachment IV-3A3.*

3) C) 4) Provide detailed descriptions of subsidence control measures that will be taken to prevent or minimize subsidence and subsidence-related damage which includes, but is not limited to the following:

3) C) 4) a) Backstowing or backfilling, include map locations;

No backstowing or backfilling is proposed within the shadow area.

3) C) 4) b) Leaving areas in which no coal is removed within the shadow area, including a description of the overlying area to be protected by solid coal blocks left in place. Identify any such areas by map locations;

Occupied dwellings and other sensitive surface features may be provided additional protection against subsidence. Protective measures could include: leaving solid blocks of coal larger than normal pillars, reducing mining width, and/or eliminating crosscuts. Mine areas in areas which require greater protection, will have no more than 50% extraction. Areas where the additional support will be provided will be determined by using an influence angle of 20° extended downward from the outline of the features which will be protected.

There are no gas/petro transmission lines or oil or gas wells above the shadow area.

3) C) 4) c) Surface measures taken to prevent material damage or lessening of the value of reasonably foreseeable uses of the surface;

No surface measures are proposed within the shadow area. In the event surface subsidence does occur which impairs the present land use, surface measures may be taken to minimize subsidence related damage. Such measures could include: provide positive drainage, provide road fill and ditch grading, drainage tile for subsurface drainage.

3) C) 4) d) Monitoring, if any, to determine the commencement and degree of subsidence so that other appropriate measures can be taken to prevent or reduce material damage. Include map locations of any proposed monitoring sites.

No monitoring of the surface or underground workings is proposed at this time. Monitoring will be on a case by case basis should any subsidence occur.

3) C) 5) Describe measures to be taken to mitigate or remedy any subsidence-related material damages.

3) C) 5) a) Provide a description of mitigation measures taken to repair or compensate the owners of structures or facilities which may be materially damaged by subsidence, including but, not limited to the following:

3) C) 5) a) i) Compensate the owner of structures or facilities in the full amount of diminution in value resulting from the subsidence.

3) C) 5) a) ii) Repair, restore, rehabilitate or replace damaged structures or facilities.

3) C) 5) a) iii)Compensation may be accomplished by the purchase prior to mining of a noncancelable premium prepaid insurance policy payable to the surface owner in the full amount of the possible material damage. Documentation of the purchase of such qualifying insurance must be provided.

The underground mining areas of the Bulldog Mine have been designed for long term stability and against unplanned subsidence areas. Damage to structures caused by subsidence is not planned or anticipated. However, should subsidence cause damage to a structure or facility, mitigation and/or remediation would be pursued by Sunrise Coal, LLC.

In the event that a surface owner or the company feels subsidence has damaged a structure, an independent consultant will be employed by the company to evaluate the damage and provide an assessment as to whether the damage was subsidence related. If the consultant determines that the damage is subsidence related, and both parties agree

with the assessment, Sunrise Coal, LLC will retain a competent contractor to inspect and assess any damages and estimate the cost of repair or replacement. The lower of the two estimates will be pursued as the appropriate mitigation and/or remediation of damages.

If repair of the structure is deemed the appropriate mitigation and/or remediation, Sunrise Coal, LLC will pay the cost of rehabilitating or restoring the structures to its pre-mining condition. If replacement is deemed the appropriate mitigation and/or remediation, Sunrise Coal, LLC will promptly pay the structure owner the replacement cost in accordance with the contractor's estimate.

In cases of documented unplanned subsidence where differences of opinion occur between the damaged party and Sunrise Coal, LLC, a qualified professional, mutually acceptable to both parties, will impartially assess the degree of material damage from mine subsidence and provide cost estimates for repair or replacement.

Sunrise Coal, LLC does not intend to purchase any structure prior to mining, nor will they pursue the option of purchasing non-cancelable insurance policies. However, Sunrise Coal, LLC reserves the right to mitigate and/or remedy subsidence damages using any or all available options.

3) C) 5) b) Provide a description of measures adopted to control and correct material damage resulting from subsidence caused to surface lands, to the extent technologically and economically feasible, by restoring the land to a condition capable of maintaining the value and reasonably foreseeable uses which it was capable of supporting before subsidence.

The underground mining areas of the Bulldog Mine have been designed for long term stability and against unplanned subsidence areas. Damage to surface lands caused by subsidence is not planned or anticipated. However, should surface subsidence occur, mitigation and/or remediation would be pursued by Sunrise Coal, LLC.

Regardless of the corrective measures employed to correct the surface subsidence, Sunrise Coal, LLC will restore the pre-mining land use capabilities of all affected surface lands to the extent technologically and economically feasible, and to the extent required by law.

Aerial photography showing topographic contours of the mine area will be used to determine pre-mining surface features. The aerial photography can be utilized to compare pre-mining contours to possible subsidence areas.

Upon proof that subsidence has caused damage to the pre-mining land use capabilities, Sunrise Coal, LLC will inspect the area for the effects on pre-mining drainage patterns and land use capabilities. Sunrise Coal, LLC will then develop a plan to restore the affected area to pre-mining land use condition to the extent economically and technologically feasible and required by law.

Also see the response to Part IV 3)C)5)a).

3) C) 5) c) In conjunction with the requirements to mitigate subsidence-related material damage to land, and structures provide a description of measures to be taken to determine the degree of material damage or diminution of value or reasonable foreseeable uses of the surface.

Underground mining areas of the Bulldog Mine have been designed for long term stability and are designated Unplanned Subsidence Areas. Damage to surface lands and structures caused by subsidence is not planned or anticipated. No pre-mining structure or area surveys are planned for the mining area.

Aerial photography showing topographic contours of the mine area will be used to determine pre-mining surface features. The aerial photography can be utilized to compare pre-mining contours to possible subsidence areas.

4) Existing Structures

4) A) Provide a description of each existing structure proposed to be used in connection with or to facilitate the surface coal mining and reclamation operations. The description shall include the following:

Not applicable, this mining operation does not propose using any existing structures.

4) A) 1) Locate the structure on the operations map or other designated map,

4) A) 2) provide plans of the structure detailing its current, pre-mining condition,

4) A) 3) provide approximate dates, beginning and completion for construction of the structure, and

4) A) 4) provide a showing that the structure meets the performance standards of either 62 Ill. Adm. Code Sections 1810 through 1828 or 62 Ill. Adm. Code Sections 280-300 (Interim Regulation Program). The showing shall monitor data or other substantiating evidence.

4) B) For each structure proposed to be modified or reconstructed for use in connection with or to facilitate the surface coal mining and reclamation operations a compliance plan is required which shall include the following:

Not applicable, this mining operation does not propose using any existing structures.

4) B) 1) Design specifications for reconstruction or modification of the structure to meet the design and performance standards of 62 Ill. Adm. Code Sections 1810 through 1828.

4) B) 2) A schedule for reconstruction or modification of the structure showing dates for beginning and completing interim steps as well as final reconstruction,

4) B) 3) provisions for monitoring the structure during and after modification to ensure that the performance standards of 62 Ill. Adm. Code Sections 1810 through 1828 are met, and

4) B) 4) a showing that the risk of harm of the environment or to public health or safety is not significant during the period of modification or reconstruction.

5) Support Facilities

5) A) Locate on a mining operations map each of the areas to be permitted for surface disturbance to facilitate the mining operation. Map shall include all support facilities including buildings, structures, conveyors, parking areas, coal preparation plants, yards, railroad spurs, on-site rail yards, each air pollution collection and control facility, each facility to be used to protect and enhance fish and wildlife and related environmental values, and each explosive storage and handling facility.

Please refer to the *Operations/Surface Drainage Control Map, Map D* for the location of all support facilities.

Details of the proposed sanitary wastewater treatment system at the mine are shown on *Map ST-1, Wastewater Treatment Facility Plan and Section.* The proposed sanitary wastewater treatment system will consist of septic tanks, a gravity collection system, pump station, and subsurface seepage system. The septic tanks for the Office/Bathhouse building and the Shop and Warehouse buildings will drain into the four (4) inch PVC gravity collection system which will flow to the pump station. The dosing pumps will pump the effluent to the seepage via a two (2) inch PVC force main. The seepage field will consist of a two (2) inch header pipe and six (6) rows of 1¼ inch perforated PVC drain pipe in deep wall trenches. The design parameters for the system are as follows:

1. **Estimated Wastewater Flow: 9,000 gal/day (300 employees @ 30 gal/day)**
2. **Seepage Rate: 1.0 gal/day/sq. ft.**
3. **Absorption Area: (9,000 gal/day)/(1.0 gal/day/sq. ft. = 9,000 sq. ft.**
4. **Minimum Width of Trench: 2 feet**
5. **Minimum Depth of Distribution Lines: 3.5 feet**
6. **Depth of Trenches: 12 feet**
7. **Length of Trenches: 95 feet**

There will be no surface discharge from this system and it will be permitted by the Vermilion County Health Department.

5) B) Indicate acreage of each type of facility within permit area such as: buildings, roads, railroads, parking areas, pavements, loading and unloading facilities, sanitary facilities, and undeveloped areas. (Summation of above areas should equal total support facility area.)

Facility	Acres
Mine Entries	**0.5**
Soil Storage	**47.5**
Sedimentation Ponds/Ditches	**38.5**
Access Roads	**7.1**
Office/Parking Areas	**4.2**
Equipment/Material Storage Areas	**13.5**
Coal Handling Facility	**25.6**
Coal Waste Facility	**61.8**
Other Support Area	**189.0**
Undisturbed-Area	**2.6**
Total Support Area	**390.3**

5) C) Transportation Facilities

5) C) 1) Provide a detailed description on mining operations map or other map and show location of the following:

5) C) 1) a) Proposed road(s), conveyor system(s), or rail system.

The location of all roads and conveyor systems is shown on the *Operations/Surface Drainage Control Map, Map D.* A rail system is not being proposed at this time, however a potential location of a rail loop is indicated on the *Operations/Surface Drainage Control Map, Map D.* A letter from Norfolk Southern Railway is included in *Attachment IV-5C1a*

5) C) 1) b) Related sediment control facilities.

Please refer to the *Operations/Surface Drainage Control Map, Map D,* hydrology calculations and surface drainage control narrative.

5) C) 1) c) Earth borrow locations and/or locations for deposition of excess excavation.

It is not anticipated that any earth borrow locations or locations for deposition of excess excavation will be required for the construction of the proposed roads and conveyors.

5) C) 2) Provide specifications and plan-profiles of existing gradeline, proposed road centerline, ditch flow lines, road cut, fill embankment, culvert, bridge and drainage structures. Provide typical cross sections where appropriate.

Please refer to the enclosed plan, profile and cross-section detail drawings for the listed items that are relevant to this mine site. Also, see the Culvert Design Calculations sheet in Part IV of this application.

5) C) 3) For all transportation facilities to be constructed, provide construction details for all sediment control facilities to be constructed to prevent additional contributions of suspended solids to streamflow or to runoff outside the permit area.

Runoff and/or sedimentation control facilities that may be constructed along roads will be minor centralized flow channels. Straw bale checks combined with vegetative ground cover may be used as necessary to control additional contributions of suspended solids.

Construction details for all other sediment control facilities are shown on the plan, profile and cross-section detail drawings included herein.

5) C) 4) Discuss the revegetation of ditch and borrow areas involved in construction.

Revegetation of areas disturbed for ditch construction will be planted and/or seeded to establish a diverse, effective and permanent vegetative ground cover. If necessary to aid seed germination and/or erosion control, the disturbed areas will also be mulched to enhance the revegetation efforts.

5) C) 5) Discuss the estimated life of each facility and how materials will be removed when the facility becomes inactive.

The anticipated maximum life of the transportation facilities is approximately 25 years based on current coal reserves, or as long as the mine is actively producing coal and there is sufficient refuse and slurry storage capacity. Reclamation of these facilities will be done concurrently with the general reclamation of the area, and in accordance with the approved reclamation plan as soon as practicable after it is no longer needed for mining and reclamation operations. Other support area reclamation will be completed within 12 months

following active use, which will vary according to each specific facility.

5) C) 6) Provide a report of appropriate geo-technical analysis where approval from the Department is required for alternative specifications or steep cut slopes under 62 Ill. Adm. Code 1817.150.

No alternative specifications or steep cut slopes are being proposed.

5) C) 7) Provide a description of measures to be taken to protect the inlet end of a ditch relief culvert, other than use of a rock headwall, and for alteration or relocation of a natural drainageway for approval by the Department under 62 Ill. Adm. Code 1817.150.

If necessary to aid in the function of culverts, the inlet end will be protected by a rock or grouted rip-rap headwall. No other culvert inlet protection is proposed.

6) Waste Material

To insure compliance with 62 Ill. Adm. Code 1817.41(a), and to demonstrate that dissolved contaminants are minimized in runoff from the refuse disposal area, Best Management Practices (BMP's) as specified in the June 2007 SIU study entitled, "Identification and Assessment of Best Management Practices in Illinois Mining Operations to Minimize Sulfate and Chloride Discharges" shall be implemented. Each BMP to be implemented from the cited study is identified and discussed in *Attachment IV-6.*

6) A) Identify the nature of all waste material including shaft excavation material and non-coal waste to be disposed of within the permit area. Give the net neutralization potential.

The nature of the coal processing waste material generated at this facility will include a coarse refuse waste stream and a fine slurry refuse waste stream. The coal waste by-product anticipated by the coal processing operation will consist of roof and floor out-of-seam dilution associated with loading the coal seam, and shales, coal partings and pyritic materials separated from the coal as it is screened, sized and processed through the coal processing plant. Material comprising the out-of-seam dilution will primarily be shales and/or underclays. Because of the type of rock, coal and minerals, net neutralization potentials of the out-of-seam dilution can be expected to range from the positive to negative side of the acid base scale. Refuse consisting of a combination of shales, shale partings and pyritic materials will generally exhibit negative net neutralization potential. Extremes of the negative net neutralization potentials can range from slightly less than negative to a maximum of approximately 35 tons calcium carbonate equivalent per 1000 tons of refuse material. *Attachment III-2A2* lists the net neutralization potential for the immediate roof and floor materials that will comprise the majority of breaker rock.

Acid-base accounting data contained in *Attachment III-2A2* indicate the overburden present at the location where the mine slopes will be constructed is generally positive in net neutralization potential. Only four of the overburden layers of strata, totaling less than twenty-seven feet thick, exhibit negative net neutralization potentials.

Fifteen unconsolidated strata layers exist in the overburden column near the location where the mine slope will be developed. One-hundred percent of the unconsolidated overburden materials exhibited an excess of tons calcium carbonate equivalent per 1000 tons of unconsolidated material.

Forty-eight consolidated strata layers were sampled in the overburden that exists above the Herrin No. 6 coal seam. Five underburden layers were sampled in the strata below the Herrin No. 6 coal seam.

Forty-four of the forty-eight consolidated overburden strata layers totaling 286.7 feet thick exhibit a weighted average of positive 107.00 tons calcium carbonate equivalent per 1000 tons of material.

The layers of strata exhibiting negative net neutralization potential are at depths greater than 285 feet from the surface. This material will be placed in the soil stockpile at the location shown on the *Operations/Surface Drainage Control Map, Map D.* The waste material will be blended with the excess consolidated overburden that demonstrates positive net neutralization potential. Considering the overall calcareous nature of the consolidated overburden, and the blending that will occur during the slope development process, special material handling techniques are not considered necessary in the interest of prevention of contamination of groundwater and surface water supplies.

Additional waste material will be generated from the roof and floor during normal underground mine development. During initial mine development this waste will be removed from underground and deposited with the gob/coarse refuse. After developing a few mine panels, the underground waste material from the roof and floor will remain underground and will be deposited in the abandoned crosscuts. All coarse and fine refuse material that is generated from the coal washing process in the preparation plant will be deposited in the Refuse Impoundment.

Non-coal waste will be hauled from the site by a licensed waste hauler.

6) B) Coal processing waste bank dams shall be designed to comply with requirements of 62 Ill. Adm. Code 1817.81 through 1817.84. For coal processing waste dams and embankments each plan shall comply with the requirements of MSHA, 30 CFR 77.216-1 and 77.216-2, and shall contain the results of a geo-technical investigation as prescribed under 62 Ill. Adm. Code 1784.16(e).

A report prepared by Patriot Engineering and Environmental, Inc. (Patriot), titled, *Engineering Evaluation & Construction Considerations Coal Refuse Impoundment No. 1* was previously submitted to MSHA. The document is dated June 7, 2012, updated September 20, 2013, and a portion of the report is included with this submittal as an attachment. The report contains soil testing data, soil boring analysis, monitoring well installation, groundwater analysis and preliminary design information. The report proposed a multiple phase design. MSHA has determined that only two (2) phases are to be completed initially with future consideration for further phases. Therefore, only a portion of the report is included for reference only in regard to site investigation information. MSHA issued comments in regard to the initial submittal.

A second design firm has been acquired to replace Patriot. Schnabel Engineering has prepared a report titled, *Responses to MSHA Comments dated October 8, 2015; Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundments No. 1; Allerton-Homer, Illinois* which is included. The report contains design specifications, drawings, analyses, additional soil testing data and information for the proposed Stages 1 and 2 in regard to the coarse refuse embankment. A second report *Responses to MSHA Comments Dated March 20, 2017, Proposed Stages 1 and 2, Bulldog Mine Refuse Impoundment No. 1, Allerton-Homer, Illinois*; is attached.

6) C) Indicate location of all areas in which such materials including shaft excavation material and non-coal waste (including those under Subtitle C of RCRA) are to be disposed of on the mining operations map. Indicate all streams, creeks, and surface water impoundments within such areas or which receive runoff from such areas. Provide acreage of disposal area and borrow areas. Indicate location of borrow area on mining operations map.

The refuse impoundment will receive coarse and fine refuse. Sub-soil from the mine shafts and mine slope excavation may be used as fill material to construct mine support facilities and suitable consolidated material will be used as a sub-base to construct access roads. Non-Coal waste material will not be disposed of on site and will be hauled from the site by a licensed waste hauler.

Treatment Pond #2 which will receive any discharge from the refuse impoundment, and Treatment Pond #1 which will receive runoff from the coal processing area. The Holding Pond will receive pumpage from the underground mine.

The refuse impoundment, mine support facilities, access roads and ponds are shown on the *Operations/Surface Drainage Control Map, Map D.* The locations of streams are shown on the *Hydrology Map, Map A.* Refuse disposal area acreage is included in the table at Part IV-5)B). No borrow areas are currently proposed for this site.

6) D) Provide construction details for all impoundments and structures to contain such waste material. Provide typical cross-sections of all proposed levees, dams and excavations.

Initially a report was prepared by Patriot Engineering and Environmental, Inc., titled, *Engineering Evaluation & Construction Considerations Coal Refuse Impoundment No. 1.* The report describes the soil drilling and analysis, monitoring well installation and sampling, clay liner, preliminary impoundment design and analysis for multiple phases of construction, and other information. The document was dated June 7, 2012, updated September 20, 2013, and was submitted to the Department and MSHA for review.

MSHA has indicated that only two phases of construction will be allowed initially and submitted a number of comments that included a request for additional soil testing for design. Therefore, another design firm was acquired by Sunrise Coal, Schnabel Engineering. Schnabel Engineering has completed the design and answered MSHA comments in two documents included in this submittal. Only a portion of the original Patriot report is being included for reference only. Specifically, boring locations, boring logs, soil profiles, soil analysis, monitoring well location, monitoring well logs, monitoring well readings, and water test results. The reason is that only those portions of the document were not included in the Schnabel Engineering reports but are referenced and is applicable to the design being evaluated by MSHA. The portions of the report not included and are not applicable are any reference to the multiple phases of construction. Initial site reconnaissance was performed by Patriot and is included as part of the submittal for reference only.

Refer to the report prepared by Schnabel Engineering titled, *Responses to MSHA Comments dated October 8, 2015; Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundment No. 1; Allerton-Homer, Illinois* dated September 22, 2016. The report is included under separate cover and has drawings, cross-sections and design details regarding the refuse impoundment design. The design maintains the impoundment slopes as previously designed. Also, refer to the report prepared by Schnabel Engineering titled, *Responses to MSHA Comments dated March 20, 2017;*

Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundments No. 1; Allerton-Homer, Illinois dated September 14, 2017. This report is also included as part of the permit submittal.

All vegetation, topsoil, roots, and soft sub-soil will be removed from the proposed Refuse Impoundment area. The soils will be stockpiled in accordance with applicable regulations.

The Refuse Impoundment will be a partially incised impoundment. After the topsoil is removed, approximately 24 feet of subsoil will be excavated. Clay soil from the excavation will be used to construct the embankment for the first phase of the Refuse Impoundment. Coarse refuse will be used to construct the embankment for the remaining phases. Before fill for the embankment is placed, a relatively impermeable soil liner will be constructed using the clayey soils encountered on site. The soils will be placed in 6-8 inch loose lifts and compacted until four (4) feet of clayey fill has been placed and compacted. The four (4) feet of clay fill should provide a liner with a permeability of approximately 1×10^{-7} cm/sec. If the in situ soils do not produce liner having a permeability of 1×10^{-7} cm/sec. or less, bentonite will be added to the soil to achieve the required permeability. The coarse refuse embankment is planned to be constructed utilizing 3H:1V side slopes eventually to an elevation of approximately 75 feet above the surrounding ground elevation. Coarse refuse will be hauled by trucks and/or scrapers and spread in layers not to exceed 1 foot in thickness. Compaction will be accomplished by vibratory action created by the trucks and/or scrapers and spreading equipment. The embankment will be constructed in a manner that will promote unimpeded surface water runoff.

The Schnabel Engineering report(s) has revised the refuse impoundment decant pipe design and replaced the blanket drain with a perimeter French drain for an internal drain system. Construction Specifications are contained in Appendix VI of the report and drawings are located in Appendix VII of the same report.

Engineering design details for Sediment Pond #1, Sediment Pond #2, Sediment Pond #3, the Holding Pond, Treatment Pond #1, and Treatment Pond #2 are shown in the pond design section in Part IV of this application. After excavation, a soil liner, identical to the Refuse Impoundment liner, will be constructed in each of these ponds using the excavated subsoil.

Construction details for the compacted clay liners under the raw coal, clean coal, and prep plant areas are illustrated on *Clean Coal, Raw Coal & Prep Plant Area Profile Section, Map PP-1.* These clay liners will be constructed in an identical manner as the clay liners under the sediment ponds, holding pond, treatment ponds, and refuse impoundment. The limits of the liner will be clearly marked in the field, in such a manner that it is obvious to mine personnel, contractors, and regulators where the outer edge of the liner is located. This outer edge could be marked with iron pins, flags, retaining walls, etc. In any case the markings shall be established in such a manner that they cannot be knocked down or inadvertently moved during operations. All affected mine personnel will be trained in the significance of the markers prior to the commencement of operations. In no case, shall stockpiled coal extend past the extents of the proposed liner. The exact dimension of each coal pile is not known at this time, but the liner will be constructed large enough to contain the piles within the maximum capacity of the coal storage area. Markers and concrete barriers will be utilized to ensure the coal is within the area that has been provided with a liner. The coal stackers have limited range, but dozers can be used to push coal outside the discharge radius. Therefore, a designated area will be determined as construction is completed to limit the area and extent of the raw coal and clean coal storage areas. These areas will have a clay liner prior to the discharge of coal from either stacker.

Assuming a stack height of 150 feet and a 35 degree angle of repose for bituminous coal, a radius of 214 feet would be required. Therefore, a radius of approximately 250 feet is shown. The area under the preparation plant will have a liner as shown on the attached drawing noted above. The clean coal pile is shown in a circle around the vertical stacker. The raw coal pile is a partial circle due to the location of the stacker near the preparation plant. It is likely a barrier wall or other device may be used to prevent raw coal from intruding onto the preparation plant.

Construction details for the compacted clay liners under the drainage ditches are illustrated on *Collector Ditches #1, #2, #3, #4, & #5 Profile & Cross Sections, Map P-4* and *Collector Ditches #6, #7, #8, & #9 Profile & Cross Sections, Map P-5.* These ditch liners will be constructed as per the liners in the above mentioned structures. However, instead of a compacted clay liner, the applicant may install an impermeable geomembrane liner with a minimum thickness of 60 mils in the drainage ditches.

A quality assurance/ quality control plan detailing the clay liner installation is included in *Attachment IV-6D.*

6) E) Indicate location and provide details for diversions as necessary to divert surface water around such areas on the mining operations map.

All surface water collector ditches are shown on the *Operations/Surface Drainage Control Map, Map D.* Collector ditch engineering designs and details are discussed in the responses to Part IV-7) Surface Drainage Control, and are shown on the plan, profile and cross-section detail drawings included herein.

6) F) Provide details of diversions or other devices designed to collect surface runoff from waste disposal sites and transport same to appropriate treatment facility.

Construction details for all other sediment control and treatment facilities, including collector ditches, are discussed in Part IV-7) Surface Drainage Control, and are shown on the profile and cross-section detail drawings included herein.

6) G) Provide details of such treatment facilities and identify points of discharge.

Construction details for all other sediment control and treatment facilities, including collector ditches, are discussed in Part IV-7) Surface Drainage Control, and are shown on the plan, profile and cross-section detail drawings included herein.

6) H) For disposal areas explain measures to be taken to avoid pollution of surface or groundwater due to leaching through levees or dams and through underlying soil.

Also, all structures which contain and/or convey waste or runoff from waste shall have a four (4) foot thick clay liner compacted to a minimum 95% of the maximum standard laboratory density with a permeability of a minimum of 1 X 10^{-7} cm/sec. An impermeable geomembrane liner with a thickness of 60 mils may be used under the drainage ditches in lieu of a four (4) foot compacted clay liner.

These measures will help prevent pollution of surface and groundwater due to leaching through levees or dams and through underlying soil.

6) I) Describe estimated life of each area.

The proposed Refuse Impoundment No.1 could be designed to Stage V to hold ±2,419 acre-feet or ±3,902,653 cubic yards of slurry. Current design is to Stage II until further testing and design allow for elevating the impoundment based on MSHA criteria. The estimated volume is ±440 acre-feet or 710,000 cubic yards of slurry up to the fines elevation.

Sunrise Coal, LLC estimates the wash plant at Bulldog will generate 0.14 cubic yards of slurry per clean ton of coal and will generate 0.16 cubic yards of coarse refuse per clean ton of coal.

The permit states that Sunrise Coal, LLC will produce 600,000 clean tons the first two years, 800,000 clean tons years three and four, and then it will average 1,200,000 clean tons after five years. This gives an annual estimate of clean tons as follows:

Year 1: 600,000
Year 2: 600,000
Year 3: 800,000
Year 4: 800,000
Year 5 to 25 1,200,000

To calculate the cubic yards of slurry produced in twenty-five years, the following applies: (0.14 c.y. slurry/clean ton)X(28,000,000 clean tons) = 3,920,000 c.y. of slurry in based on the coal reserves and projected annual production.

The current Stage II impoundment design is for 710,000 cubic yards of slurry. The estimated clean tons of coal would be 5,071,000 with an estimated 5.9 years of life based on the production schedule shown above. If a Stage V impoundment holds ±3,902,000 cubic yards of slurry, there would be approximately twenty-five years of life for slurry disposal.

To calculate the cubic yards of coarse refuse produced in twenty-five years, the following applies: (0.16 c.y. coarse/clean ton)X(28,000,000 clean tons) = 4,480,000 c.y. of coarse refuse.

The current Stage II impoundment design contains an estimated 290,000 cubic yards of coarse refuse embankment volume. The estimated clean tons to generate the coarse refuse is 1,812,500 with an estimated time frame of just less than 3 years. The total amount of coarse refuse that can be placed in a Stage V refuse impoundments is approximately 3,742,870 c.y., consisting of impoundment Stages II-V.

Obviously, additional coarse refuse storage areas will be needed to reach the maximum slurry storage (25 yr.) design of the mine. During coal processing coarse refuse and slurry are generated in the proportions shown above.

When additional storage areas are needed, Sunrise Coal, LLC will propose additional coarse refuse and slurry storage within the current proposed surface facilities. If necessary nearby offsite areas will be proposed. These areas usually occur within one mile of existing surface facilities.

6) J) Coal preparation:

6) J) 1) Give a general description of the coal processing operation at this facility.

The Bulldog Mine coal processing plant will utilize heavy media separation to process the coal. Run-of-mine coal will be transported from the underground mine to the plant via a

conveyor, where it will be stockpiled by a radial stacker. Clean coal from the plant will also be stockpiled though the use of a radial stacker. Impurities removed from the coal will exit the processing plant as either gob/coarse refuse or as fine coal slurry refuse. Coarse refuse will be transported to refuse bins located adjacent to the Refuse Impoundment. Slurry will be pumped to the Refuse Impoundment.

Coal from the clean coal stockpile will be loaded onto licensed trucks for highway haulage to various customers. The location of a potential rail loop is indicated on the *Operations/Surface Drainage Control Map, Map D*, but is not being proposed to be constructed at this time. If the rail loop is proposed to be built in the future, Sunrise Coal will obtain the required regulatory approvals.

Please refer to the *Operations/Surface Drainage Control Map, Map D* for the location of the coal processing plant and associated facilities.

6) J) 2) Describe the fresh water (makeup) and slurry circuits for this operation and indicate if a discharge occurs. If a discharge does occur, it should be included on Schedule A. If a discharge does not occur, a detailed description of how this will be accomplished must be submitted.

The underground water from the mine will be pumped to the Holding Pond. This water will be stored and used in coal processing on an as needed basis. It is believed that mixing of this water with other plant source water will dilute both sulfates and chlorides below allowable thresholds, given that other waters used at the plant are stormwater, and fresh water from the Georgetown municipal supply. Water in the Holding Pond will be circulated to the coal preparation plant for use in coal processing. If the water quality in the Holding Pond is tested and shown to exceed effluent sulfate and chloride levels, there will be no discharge of the pond unless mixing with other sources for dilution has occurred. Other sources for mixing can include water delivered from the municipal water supply, previously stored water from other ponds, active precipitation, and etc. Evacuating water from the Holding Pond will occur only when effluent limits can be achieved. Engineering design details regarding the Holding Pond are in *Attachment III-2D1a, Assessment of Alternatives for Minimal Environmental Degradation and Economic Benefit Analysis.*

It is anticipated that the coal processing plant will require approximately 200 gpm of water usage and the underground mine will require approximately 100 gpm of water usage. It is the intent of Sunrise Coal to collect and store runoff from precipitation events to use for plant operation. The location of this facility in East-Central Illinois farm country will require the operator to store water in the ponds to insure adequate water supply for operation. The watersheds in this area are characterized by mildly sloping land, and the agricultural fields are drained with subsurface tile systems.

An existing field drain pipe will pass through Sediment Pond #2. A divider berm will be constructed within the pond so that the drain tile can pass over the pond. The drain tile will require that a solid pipe replace the existing drain tile to allow water to pass through the tile without discharging into the pond. Water from the drainage tile will not enter into the Sediment Pond #2. A 6-inch discharge pipe from Sediment Pond #2 will discharge a portion of the run-off into the field drain pipe.

All the ponds will be storage ponds. Except for the Holding Pond, they have been designed with seven (7) to nine (9) feet of freeboard at normal pool elevations for this purpose. The operator intends to use the water in the treatment ponds, sediment ponds, and holding pond

as makeup water for coal processing. Water from the Refuse Impoundment will be recycled to the plant for use as well. This system will be basically a closed loop system as it is anticipated the ponds will discharge only during heavier rainfall events. Area farmers have indicated there is little flow in the drain tiles during the growing season when the crops are in the fields. So it is anticipated that water will be stored during the fall and winter for use through the growing season.

If at any time the quantity of water in the ponds becomes insufficient for full operation, Sunrise Coal will purchase water from the City of Georgetown. The City agrees to deliver up to a maximum of 300,000 gallons per day to Sunrise Coal for its first two years after the date on which all infrastructure is constructed and completed and Sunrise Coal is able to and requests the delivery of water from the City of Georgetown and thereafter up to a maximum of 500,000 gallons per day. The supply from the City of Georgetown is believed to be sufficient if for some reason adequate quantities of water necessary to maintain full production at the mine cannot be pumped from the ponds.

The water from Georgetown will be produced from the City's water treatment plant and shall meet all standards to be used as treated water. However, water from the city of Georgetown will not be used for any of Sunrise's potable water needs (eg., cooking, cleaning, washing, showering, drinking, etc.). Water from the City of Georgetown will only be used for production needs (eg., preparation plant, watering roads, etc.). Water will be obtained from the City of Homer for Sunrise's potable water needs.

Normal operating conditions will result in no discharge from the Refuse Impoundment. In the unlikely event the Refuse Impoundment does discharge, the discharged water will flow to Treatment Pond #2 and be re-circulated back to the preparation plant. Excess water contained in Treatment Pond #2 will be allowed to discharge to Sediment Pond #3. Water discharging from Sediment Pond #3 will be sampled and analyzed at an IEPA approved laboratory in accordance with the approved NPDES permit for this facility as will water discharging from Sediment Pond #2 and Sediment Pond #1.

6) J) 3) What safeguards are provided to prevent the discharge of slurry fines and untreated slurry water during emergency situations (e.g. power outages, mechanical equipment breakdown, plant shutdowns, etc.)? Also indicate where the slurry would go by gravity flow in the event of an emergency discharge, and the environmental impact this would have.

Clear water from the Refuse Impoundment will be pumped to the prep plant for make-up water and/or discharged to Treatment Pond #2. This will help to insure the water level in the Refuse Impoundment is drawn down thus providing surge volume in the impoundment in the event of a power failure or mechanical breakdown.

Should an unforeseen event occur, a discharge of slurry fines and untreated slurry water will be intercepted by Collector Ditch #7 and Collector Ditch #8 that direct surface water runoff to Treatment Pond #2 which discharges to Sediment Pond #3. Any slurry fines that may enter the surface drainage control system will be contained in Treatment Pond #2. Effluent water quality from Sediment Pond #3 will meet the requirements of the approved NPDES permit for this facility.

7) Surface Drainage Control

7) A) 1) Locate on the mining operations map or on a separate drainage map all proposed drainage control

systems. Show drainage patterns of all affected mining areas.

All proposed drainage control systems and drainage patterns of all affected mining areas are shown on the *Operations/Surface Drainage Control Map, Map D.*

When there is a discharge of treated water from the sediment ponds, it will be conveyed to Olive Branch, the downstream receiving stream, by existing agricultural drain tiles, drainage ditches, and field runoff as shown on the *Operations/Surface Drainage Control Map, Map D.* Olive Branch is located approximately one (1) mile north of the mine site. A profile and typical cross section of Olive Branch, as well as its location to the mine, are shown on *Map OB-1, Olive Branch Profile and Cross Section.*

Only a portion of the sediment pond run-off is directed to the agricultural drain tiles. Two drain tiles exist, one passes through and the other is adjacent to the Bulldog Mine site. The "west" drain tile is a 24-inch drain tile that enters the site from the south under road 800 North, passing under the haulage road and railroad, over Sediment Pond #2 and proceeds north toward Olive Branch. The "east" drain tile is an 18-inch drain tile that is along road 200 East and adjacent to Sediment Pond #1 and Sediment Pond #3 and proceeds north to Olive Branch.

Sediment Pond #1 will discharge into the drainage ditch along road 200 East at NPDES Outfall #3 and not into the drain tile. Sediment Pond #2 will discharge through the 6-inch discharge pipe into the "west" drain tile via NPDES Outfall #1. The remaining runoff will flow through the emergency spillway into the adjacent field. The watershed runoff contributing to Sediment Pond #1, Sediment Pond #2, and Sediment Pond #3 is shown on *Map W, Bulldog Mine, Watershed Map.* Sediment Pond #3 will discharge through a 4-inch discharge pipe into the "east" drain tile via NPDES Outfall #2. The remaining runoff will flow through the emergency spillway into the existing ditch along road 200 East.

Both drain tiles are part of the Union Drainage District No. 1, Vance and Sidell Township, Vermilion County Illinois. There is a "Mutual Drainage Agreement" for the "east" drain tile where a total of ten (10) different tracts totaling 550 acres that contribute runoff to the drain tile. The acreage attributed to the Refuse Impoundment, Collector Ditch #7, Collector Ditch #8, Collector Ditch #9, Treatment Pond #2 and Sediment Pond #3 are in the NE ¼ of Section 35 are part of that agreement. There are approximately 153 acres in that tract. Dividing the 153 acres by the total 550 acres (total) equals 0.278 or 27.8%. That is the percentage that Bulldog Mine can contribute from that tract. A field survey was conducted on the drain tile and it is estimated that the 18-inch drain tile is 9,530 feet long with a drop of 7.5 feet or a slope of 0.078% with a calculated discharge rate of 2.645 cu. ft. /sec. Taking the discharge rate (2.645) times the contribution allotment (0.278) equals 0.73 cu. ft. /sec. The amount of flow through the 4-inch discharge pipe from Sediment Pond #3 equals 0.55 cu. ft. /sec at a peak 100 year – 6 hour storm event.

The "west" drainage tile is a 24-inch pipe, 8,480 feet in length with a drop of 10.8 feet based on a survey conducted in the field. The discharge rate is calculated to be 7.311 cu. ft. /sec. Assuming a total of 650 acres contributes runoff to the drain tile, the amount contributed by the Bulldog Mine is 200 acres from the SW ¼ of Section 26 and SW ¼ of the SE ¼ of Section 26. Dividing the 200 acres by 650 acres equals 0.307 or 30.7% or 2.24 cu. ft. /sec that the mine can contribute from Sediment Pond #2. Sediment Pond #2 discharge flow through the 6-inch discharge pipe equals 1.72 cu. ft. /sec. at a peak 100 year – 6 hour storm event.

For determining the capacity of the drainage tiles that the Bulldog Mine will contribute to, the Hazen-Williams equation was used.

$V = kCR^{0.63}S^{0.54}$

V = velocity

k = "conversion" factor: 1.318 for units of ft/sec.

C = factor for relative roughness

R = hydraulic radius

S = slope of the energy line

$V = 1.318CR^{0.63}S^{0.54}$

$Q = \ 1.318\frac{\pi}{4}D^2C\left(\frac{D}{4}\right)^{0.63}S^{0.54}$

$Q(ft/s) = 0.432CD^{2.63}S^{0.54}$

The "East" drain tile is an 18-inch tile that is adjacent to Sediment Pond #1 and Sediment Pond #3 and runs north towards Olive Branch along County Road 200 East.

D = 1.5 ft.

C = 100

S = (7.5 ft.)/ (9530 ft.) = 0.078%

$Q = 0.432(100)(1.5)^{2.63}(0.00078)^{0.54} = 2.645\ cu.ft./sec.$

Contribution Allotment = (153 acres)/ (550 acres) = 27.8% of drain tile's capacity.

Mine's Allocation = (2.645 cu. ft. /sec.)(0.278) = 0.73 cu. ft. /sec.

The "West" drain tile is a 24-inch tile that enters the site from the south under road 800 North, passes over Sediment Pond 002, and proceeds north towards Olive Branch.

D = 2.0 ft.

C = 100

S = (10.8 ft.)/ (8,480 ft.) = 0.13%

$Q = 0.432(100)(2.0)^{2.63}(0.0013)^{0.54} = 7.31\ cu.ft./sec.$

Contribution Allotment = (200 acres)/ (650 acres) = 30.7% of drain tile's capacity.

Mine's Allocation = (7.31 cu. ft. /sec.)(0.307) = 2.24 cu. ft. /sec.

The discharge flow of each pond outlet into the drainage tile is limited to below the allocated portion of the tile and therefore, will not cause any downstream or upstream impacts.

7) A) 2) Will all surface drainage from the affected mining area be collected and treated prior to leaving the permit area?

Yes __X__ No ______

If yes, delineate how and where surface drainage will be collected and treated, and list permit numbers and type of permit that the drainage control systems are operated under. If above answer is no, explain how regulatory compliance will be achieved without treatment, i.e., address the requirements of Section 1817.46(e).

All affected area surface drainage from within the permit area will be collected and treated at the sediment ponds and treatment ponds before being discharged from the permit area. Please refer to the *Operations/Surface Drainage Control Map, Map D* for delineation of how and where surface drainage will be collected and directed to the ponds.

7) B) Will all surface drainage from unaffected areas be intercepted and diverted around the affected mining area?
Yes ______ No __X__
If no, please discuss.

Drainage from unaffected areas to the south, east, and west of the permit area is a combination of natural surface flow and flow through drain tiles in agricultural fields. The drainage tiles collect surface runoff from the east, south and west of the affected mining area. This water will pass through without being intercepted or diverted, but will not be adversely affected. Drainage ditches along the roads 100 East, 200 East and 800 North will intercept offsite run off and divert water around the majority of the affected acreage. Collection ditches exist around the perimeter of the affected acreage to prevent runoff from the mine site, except from sediment ponds. Therefore, it is expected that with the combination of the drainage tiles, drainage ditches, and flow patterns, that the surface runoff from unaffected areas will be directed away from contact with the affected acreage.

7) C) Describe the timing in which all construction of the sediment ponds and surface drainage control structures will be complete. Include a discussion of the vegetation stabilization of these structures.

Initial surface disturbance will involve removing topsoil for the construction of the holding pond, treatment ponds, and sediment ponds. After the topsoil is removed, the ponds will be constructed. Then construction of the slope will commence. The remaining drainage control structures will be constructed as the roads, refuse area, and plant areas are constructed. The roads will be constructed with the material from the slope construction.

The ponds and surface drainage control structures will be vegetated after construction using the following seed mixture:

Fescue	**20 lbs./ac.**
Orchard Grass	**10 lbs./ac.**
Cover Crop	**15 lbs./ac.**

7) D) Overland Flow Diversions

For all diversions of overland flow, shallow groundwater flow, and ephemeral streams which divert surface water around the mining area, and all collection drains that transport affected area runoff into water-treatment facilities, provide the following:

7) D) 1) Typical cross sections bottom width, side slopes and depth.

Please refer *Collector Ditches #1, #2, #3, #4, & #5 Profile & Cross Sections, Map P-4* and *Collector Ditches #6, #7, #8, & #9 Profile & Cross Sections, Map P-5.*

7) D) 2) Proposed flow line slopes.

Please refer to *Collector Ditches #1, #2, #3, #4, & #5 Profile & Cross Sections, Map P-4* and *Collector Ditches #6, #7, #8, & #9 Profile & Cross Sections, Map P-5.*

7) D) 3) Runoff and diversion capacity calculations.

The ditch calculations for Collector Ditches #1 through #4 and #8 are based on a 10 year-24 hour rainfall event to comply with the requirements of Illinois Administrative Code Section 1817.43.

The ditch calculations for Collector Ditches #5, #6, #7 and #9 are based on a 100 year-6 hour rainfall event to comply with the requirements of Illinois Administrative Code Section 1817.84. Interim Collector Ditches 7 and 9 can be utilized for each toe during the construction of each phase for the refuse impoundment. The design used for the final ditch will be utilized for each interim ditch which will be adequate since the final design is used for a larger surface area than any intermittent phase. The alternative is to construct Collector Ditch 7 and 9 in the proposed final location and allow run-off to be collected during each phase of construction. In either case, surface runoff from the toe of the impoundment will flow across areas that are lined including the collector ditches. All runoff from the construction of the impoundment will be intercepted by the collector ditches and will be associated with lined areas.

All the ditches are vegetated channels. Following is the design summary for the various ditches. Also included in this application are the SEDCAD Version 4 software printouts of the computations for the designs.

DESIGN SUMMARY

For Collector Ditch #1, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Sta. 0+00 to 21+66

Drainage area	**= 13.8 acres**
10 yr.-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 77**
Topography	**= short grass**
Q	**= 12.0 cfs**
Velocity	**= 0.5 to 1.1 fps**

For Collector Ditch #2, Segments 1 2, 3, 4, and 5, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 10+50

Drainage area	**= 29.5 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 89**
Topography	**= gravel surface areas**
Q	**= 61.2 cfs**
Velocity	**= 1.0 to 1.9 fps**

Ditch Segment 2, Sta. 11+00 to 13+50

Drainage area	**= 3.8 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Numbers	**= 82**
Topography	**= short grass**
Q	**= 67.2 cfs**
Velocity	**= 1.1 to 1.9 fps**

Ditch Segment 3, Sta. 13+50 to 35+00

Drainage area	**= 2.9 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 82**
Topography	**= short grass**
Q	**= 71.9 cfs**
Velocity	**= 1.1 to 2.0 fps**

Ditch Segment 4, Sta. 35+00 to 51+50

Drainage area	**= 6.6 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 79**
Topography	**= short grass**
Q	**= 81.6 cfs**
Velocity	**= 1.1 to 2.0 fps**

Ditch Segment 5, Sta. 51+50 to 64+70

Drainage area	**= 3.4 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 79**
Topography	**= short grass**
Q	**= 85.5 cfs**
Velocity	**= 1.1 to 2.0 fps**

For Collector Ditch #3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 10+66

Drainage area	**= 4.1 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 77**
Topography	**= short grass**
Q	**= 6.0 cfs**
Velocity	**= 0.3 to 0.8 fps**

For Collector Ditch #4, Segments 1, 2 the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 10+60

Drainage area	**= 19.3 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Numbers	**= 85, 77**
Topography	**= gravel surface areas, short grass**
Q	**= 28.6 cfs**
Velocity	**= 0.9 to 1.8 fps**

Ditch Segment 2, Sta. 10+60 to 18+93

Drainage area	**= 1.6 acres**
10 yr-24 hr. rainfall	**= 4.26 inches**
Curve Number	**= 77**
Topography	**= short grass**
Q	**= 32.0 cfs**
Velocity	**= 0.7 to 1.4 fps**

For Collector Ditch #5, Segments 1 2, 3, and 4, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 5+00

Drainage area	**= 1.6 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Numbers	**= 77**
Topography	**= short grass**
Q	**= 6.4 cfs**
Velocity	**= 0.4 to 0.9 fps**

Ditch Segment 2, Sta. 5+00 to 13+00

Drainage area	= 2.4 acres
100 yr-6 hr. rainfall	= 4.96 inches
Curve Number	= 77
Topography	= short grass
Q	= 15.9 cfs
Velocity	= 0.6 to 1.3 fps

Ditch Segment 3, Sta. 13+00 to 20+85

Drainage area	= 7.7 acres
10 yr-24 hr. rainfall	= 4.96 inches
Curve Number	= 89
Topography	= gravel surface areas, raw coal pile
Q	= 54.2 cfs
Velocity	= 1.2 to 2.3 fps

Ditch Segment 4, Sta. 21+75 to 26+43

Drainage area	= 3.4 acres
10 yr-24 hr. rainfall	= 4.96 inches
Curve Number	= 89
Topography	= gravel surface areas
Q	= 71.1 cfs
Velocity	= 1.5 to 2.6 fps

For Collector Ditch #6, Segments 1 through 5, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 7+00

Drainage area	= 13.5 acres
100 yr-6 hr. rainfall	= 4.96 inches
Curve Number	= 89
Topography	= gravel surface areas
Q	= 52.2 cfs
Velocity	= 1.0 to 1.8 fps

Ditch Segment 2, Sta. 7+00 to 13+60

Drainage area	= 19.8 acres
100 yr-6 hr. rainfall	= 4.96 inches
Curve Number	= 89
Topography	= gravel surface areas clean coal pile
Q	= 118.0 cfs
Velocity	= 1.6 to 2.7 fps

Ditch Segment 3, Sta. 14+00 to 25+50

Drainage area	= 6.8 acres
100 yr-6 hr. rainfall	= 4.96 inches
Curve Number	= 89
Topography	= gravel surface areas
Q	= 140.0 cfs
Velocity	= 1.7 to 2.8 fps

<u>Ditch Segment 4, Sta. 25+50 to 41+10</u>	
Drainage area	**= 5.5 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Number	**= 89**
Topography	**= gravel**
Q	**= 165.6 cfs**
Velocity	**= 1.9 to 3.0 fps**

<u>Ditch Segment 5, Sta. 41+60 to 48+25</u>	
Drainage area	**= 17.7 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Number	**= 79**
Topography	**= short grass soil piles, short grass**
areas	
Q	**= 205.6 cfs**
Velocity	**= 2.1 to 3.3 fps**

For Collector Ditch #7, Segments 1, 2 and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

<u>Ditch Segment 1, Sta. 0+00 to 0+50</u>	
Drainage area	**= 0.5 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Number	**= 89**
Topography	**= gravel surface areas**
Q	**= 2.5 cfs**
Velocity	**= 0.2 to 0.6 fps**

<u>Ditch Segment 2, Sta. 1+40 to 21+00</u>	
Drainage area	**= 3.5 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Number	**= 89**
Topography	**= gravel area**
Q	**= 19.9 cfs**
Velocity	**= 0.6 to 1.3 fps**

<u>Ditch Segment 3, Sta. 21+00 to 30+34</u>	
Drainage area	**= 23.9 acres**
100 yr-6 hr. rainfall	**= 4.96 inches**
Curve Number	**= 77, 86**
Topography	**= short grass, coarse refuse**
Q	**= 118.7 cfs**
Velocity	**= 1.8 to 3.0 fps**

For Collector Ditch #8, Segments 1, 2 and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment #1, Sta. 0+00 to 12+50

Drainage area	= 5.9 acres
100 yr 24 hr rainfall	= 4.26 inches
Curve Number	= 77
Topography	= short grass
Q	= 12.7 cfs
Velocity	= 0.4 to 0.9 fps

Ditch Segment 2, Sta. 12+50 to 25+50

Drainage area	= 5.8 acres
100 yr24 hr rainfall	= 4.26 inches
Curve Number	= 77
Topography	= short grass
Q	= 25.3 cfs
Velocity	= 0.6 to 1.2 fps

Ditch Segment 3, Sta. 25+50 to 48+81

Drainage area	= 9.5 acres
100 yr 24 hr rainfall	= 4.26 inches
Curve Number	= 77
Topography	= short grass
Q	= 45.8 cfs
Velocity	= 0.8 to 1.6 fps

For Collector Ditch #9, Segments 1, 2, and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to12+00

Drainage area	= 28.4 acres
100 yr-6 hr rainfall	= 4.96 inches
Curve Number	= 77, 86
Topography	= short grass, coarse refuse
Q	= 127.4 cfs
Velocity	= 1.6 to 2.7 fps

Ditch Segment 2, Sta. 12+00 to 22+50

Drainage area	= 16.1 acres
100 yr-6 hr rainfall	= 4.96 inches
Curve Number	= 77, 86
Topography	= short grass, coarse refuse
Q	= 191.8 cfs
Velocity	= 2.1 to 3.0 fps

Ditch Segment 3, Sta. 22+50 to 40+40	
Drainage area	**= 20.2 acres**
100 yr-6 hr rainfall	**= 4.96 inches**
Curve Number	**= 77, 86**
Topography	**= short grass, coarse refuse**
Q	**= 284.6 cfs**
Velocity	**= 2.6 to 3.8 fps**

7) D) 4) Details of proposed erosion and sediment control measures to be employed.

For permanent diversion also include:

7) D) 5) Watershed limits upstream from the diversions.

There are no permanent diversions.

7) D) 6) Plan profile drawings of the proposed diversion showing existing gradeline, proposed diversion bottom gradeline and water surface at design storm.

There are no permanent diversions.

7) E) Sediment pond Design:

Please refer to the pond design section in Part IV of this application and the following maps:

- ***Sediment Pond #1 and Holding Pond Plan, Profile & Cross Sections, Map P-1***
- ***Sediment Pond #2 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Sediment Pond #3 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) F) 1) Discuss the design basis for the sediment pond(s) calculations.

Sediment Pond Design

Sediment Pond #1, Treatment Pond #1, ~~and~~ Treatment Pond #2, and Sediment Pond #2 will be used for sediment control. These ponds are located downstream of the mine operation areas which allows the impoundments to collect all runoff from the mine operations for treatment before discharging. All the ponds are incised but will have a 3-4 feet embankment dam constructed of clay material from the proposed pond excavations. The minimum width of the top of dam is 10 feet for these impoundments. The locations of the ponds are shown on the *Operations/Surface Drainage Control Map, Map D* and are described below:

- **Sediment Pond #1 is located in the northeastern most portion of the permit area north of Road 800 North and west of Road 200 East. This impoundment will receive runoff from the soil stockpiles. Collector Ditches #3 and #4 will direct drainage to this pond.**
- **Treatment Pond #1 is located in the northwest portion of the permit area between Haul Roads #1 and #2. This impoundment will receive runoff from coal storage areas, a portion of the office/bath house, haul road, gravel areas and soil stockpiles. Collector Ditches #5 and #6 will direct drainage to this pond.**
- **Treatment Pond #2 is located in the southeast portion of the permit area. This impoundment will receive runoff from soil stockpiles and the Refuse Impoundment. Collector Ditches #7 and #8 will direct drainage to this pond.**

- **Sediment Pond #2 receives runoff from the haulroad, grass areas and railroad loop via Collector Ditch #1 and parking area, office/bath house, supply yard, haulage road, and gravel areas as directed by Collector Ditch #2.**

Sediment Pond Construction:

- **Sediment Pond #1 will be an incised impoundment. The principal spillway will be grass lined open channel four (4) feet in width. The sediment pond will be a temporary impoundment.**
- **Treatment Pond #1 will be an incised impoundment. The pond will receive surface runoff from the mine operation areas including pumpage from the mine. The spillway will be a 4 feet wide grass lined open channel spillway. Collector Ditches #5 and #6 will direct drainage to this pond. This pond will be a permanent impoundment.**
- **Treatment Pond #2 will be an incised impoundment. The pond will receive surface runoff from soil stockpiles and the Refuse Impoundment. The spillway will be a 10 feet wide grass lined open channel spillway. Collector Ditches #7, #8, and #9 will direct drainage to this pond. This pond will be a permanent impoundment.**
- **Sediment Pond #2 will be an incised impoundment. The principal spillway will be a 6-inch pipe which will flow into the existing 24-inch drain tile. The emergency spillway is a 16 feet wide grass lined open channel spillway. There is a dividing wall in the pond with two (2) 36-inch pipes to allow for flow equalization, for the purpose of allowing the existing 24-inch drain tile to cross over the pond. Collector Ditch #1 and Ditch #2 will direct drainage to this pond. This pond will be a permanent impoundment.**

Sediment storage:

Calculations for each watershed were performed to estimate sediment loads to the ponds. A factor of 0.1 ac-ft of sediment per acre of affected drainage area was used to estimate the sediment storage volumes required for each impoundment.

Drainage areas:

The watershed areas were determined from available topographic mapping and mapping prepared from field surveys performed by the applicant.

Precipitation runoff:

The designs are based on the precipitation expected from a 10 year, 24 hour, Type II distribution storm. Using Illinois State Water Survey Bulletin 70, this precipitation generates 4.26 inches of rainfall.

The overflow structures were designed based on the expected precipitation from a 100 year – 6 hour, Type II distribution storm. Using Illinois State Water Survey Bulletin 70, this precipitation event generates 4.96 inches of rainfall. SEDCAD 4 analyses demonstrating that the spillways can safely discharge a 100 year – 6 hour precipitation event is included herewith.

Expected runoff was determined using the commercially available software known as SEDCAD Version 4. This software is used by the Office of Surface Mining in 24 states.

Sediment volume:

Sediment volumes were determined by summing the expected storm runoff volume with estimated mine pumpage and adding the volume necessary for the sediment storage. Mine pumping is estimated at 0.44 ac-ft per day (100 gallons per minute). This value is determined from previous mine applications and in field experience from this region. The required Sediment storage volume is determined using the soil loss factor of 0.1 ac-ft per acre per year of affected drainage area. Multiplying this factor by the affected drainage area to size the impoundment has been accepted by the Department for previous submittals. Ponds are designed for a 10 hour detention time for the summed storm runoff and mine pumpage. Comparing this volume with the volume at pool elevation will determine the years of available storage in the pond.

Spillway sizing: Spillways were sized to accommodate the expected discharge as determined from the above referenced SEDCAD Version 4 software.

Submit calculations used in spillway designs and determination of inflow volume and pond volume.

Please refer to the pond design section within Part IV of this application.

7) F) 2) Submit a typical section of the embankment(s), details of the principal and emergency spillways and a plan view of each pond at a scale of 1 inch = 200 ft. or larger showing pond bottom contours and points of inflow.

Please refer to the following drawings for the pond plan views and details:

- ***Sediment Pond #1 and Holding Pond Plan, Profile & Cross Sections, Map P-1***
- ***Sediment Pond #2 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Sediment Pond #3 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) F) 3) For all sedimentation ponds provide design information showing compliance with the requirements of 62 Ill. Adm. Code 1817.46. Each plan shall, at minimum, comply with the requirements of MSHA, 30 CFR 77.216-1 and 77.216-2.

Please refer to the pond design section within Part IV of this application.

7) G) If sediment removal becomes necessary, explain how the sediment will be removed, where it will be disposed of, and what disposal methods will be used.

If sediment removal becomes necessary for continuation of adequate pond performance, sediment will be removed utilizing a small dredge, a dragline or other excavation equipment designed to effectively remove sedimentation. The large surface area and depth of the ponds would easily accommodate using a small dredge to remove sediment buildup, deposit the sediment in an approved location, and effectively restore the pond volume to its original size. A small dredge could easily be mobilized and placed quickly into operation should the need arise.

Sediment removed from the pond will be deposited in the Refuse Impoundment.

7) H) Will pH adjustment be necessary on any of the discharges in order to meet the applicable State and Federal Standards?

Yes ______ No **X**

If yes, a discussion of the situation is necessary, along with a detailed basis of design. The basis should include a detailed description of the proposed treatment facilities, process flow diagrams, and design calculations.

7) I) Does a perennial or intermittent stream occur within the proposed permit area?
Yes _______ No __X__

If yes, is an exception to the 100 foot buffer zone being requested or is a stream diversion being proposed. For exception to the 100 foot buffer zone, indicate how compliance with Section 1817.57 will be assured. For a stream diversion, complete Part V 6) of the application form.

7) J) Permanent and Temporary Impoundments, Ponds, Banks, Dams and Embankments

7) J) 1) All temporary and permanent impoundments must meet the requirements of 62 Ill. Adm. Code 1817.49. Will the mining operation involve the construction of any impoundments other than those waste retention?
Yes __X__ No _______

If yes, Include the following information:

7) J) 1) a) Locate on mining operations map all impoundments, dam locations, and watershed limits, indicate which impoundments are proposed to be permanent and complete Part V 3)D) of the application.

All impoundments, dam locations, and watershed limits are illustrated on the enclosed maps. No permanent impoundments are proposed for this mine site.

7) J) 1) b) Provide construction and maintenance details of dams, spillways, seepage control measures, and erosion control measures for inlets and outlets. Employ maps and cross sections where necessary. Where design plans for proposed structures are not provided, submit a certification statement providing a schedule for submission of detailed design plans for each structure.

Please refer to the pond design section within Part IV of this application. Also, refer to the following drawings for the pond plan views and details:

- ***Sediment Pond #1 and Holding Pond Plan, Profile & Cross Sections, Map P-1***
- ***Sediment Pond #2 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Sediment Pond #3 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) J) 2) Describe proposed reclamation plans for each structure, including a time table and plans for removal and disposal of material. Each plan shall:

7) J) 2) a) Be prepared by or under the direction of, and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified, licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 2) b) contain a description, map, and cross-section of the structure and its location,

Please refer to the *Operations/Surface Drainage Control Map, Map D.*

7) J) 2) c) contain preliminary hydrologic and geologic information required to assess the hydrologic impact of the structure,

The holding pond, sediment ponds, and treatment ponds are incised impoundments with low profile (3-4 feet high) embankments that will be constructed of clay materials from the pond excavations. No bedrock or aquifers will be disturbed so there will be no hydrologic impact.

The Refuse Impoundment is partially incised. The first phase embankment will be constructed with clay soil from the excavation. The remaining phases of the embankment will be constructed of coarse refuse. No bedrock or aquifers will be disturbed so there will be no hydrologic impact.

7) J) 2) d) if underground mining has occurred, the plan shall contain a survey describing the potential effect on the structure from subsidence of the subsurface strata resulting from the post underground mining operations,

There is no planned subsidence at this mine. The extraction ratio within the influence area of the impoundments will be limited to 50% or less. The pillar sizes are larger than the minimum required to help insure adequate stability. There is also a considerable limestone layer between the mine and the impoundment which will provide for stability. It should be noted that no underground mining will occur beneath the Refuse Impoundment as no mining will take place in the permit area south of Road 800 North.

7) J) 2) e) for structures where the detailed design plans are not submitted to the Department with the general plan, the plan shall contain a certification statement which includes a schedule setting forth the dates that detailed design plans are to be submitted. For these structures, the detailed design plans must be submitted to the Department and approved in writing prior to the beginning of construction.

7) J) 3) For each structure that meets or exceeds the size or other criteria of MSHA, 30 CFR 77.216(a), the detailed design plan shall:

7) J) 3) a) Be prepared by or under the direction of and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified, licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 3) b) include any design and construction requirements for the structure, including any required geo-technical information,

Please refer to a report prepared by Patriot Engineering and Environmental, Inc., titled, *Engineering Evaluation & Construction Considerations Coal Refuse Impoundment No. 1.* The document is dated June 7, 2012, updated September 20, 2013, and a portion of the report is included with this submittal under separate cover. The report contains the initial soil testing, soil boring logs, location maps, monitoring well installation,

groundwater analysis, and field tests for the refuse impoundment design. The information is included as *Attachment IV-7)J).*

Refer to the report prepared by Schnabel Engineering, titled *Reponses to MSHA Comments dated October 8, 2015; Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundment No. 1; Allerton-Homer, Illinois,* dated September 22, 2016. The report includes construction specifications, drawings, geotechnical analysis, and other analyses for impoundment design and installation as currently proposed. A second report has been prepared based on MSHA comments titled *Responses to MSHA Comments dated March 20, 2017, Proposed Stages 1 and 2, Bulldog Mine Refuse Impoundment No. 1, Allerton-Homer, Illinois,* dated September 14, 2017.

7) J) 3) c) describe the operation and maintenance requirements for each structure, and

The Refuse Impoundment will be operated as part of a closed circuit system as the water from the pond will be pumped backed to the prep plant for make-up. If there is a discharge, it will report to Treatment Pond #2 and it will also be pumped back to the plant. As for maintenance, particular attention will be given to potential seepage, keeping the spillway free of debris, and erosion of embankment areas and side slopes.

7) J) 3) d) describe the timetable and plans for removal of each structure if appropriate.

When permanent cessation of the mining operation occurs, removal of the Refuse Impoundment will be part of the final reclamation. The 24 inch diameter spillway pipe will be grouted shut with cement grout and the riprap lined spillway discharge ditch will be removed. Toxicity testing will be performed to determine the net neutralization potential of the waste material. An appropriate quantity of lime will be incorporated into the surface of the slurry before covering the waste material with 4 feet of non-toxic, non-combustible soil materials.

7) J) 4) For each structure that does not meet the size or other criteria of MSHA, 30 CFR 77.216(a), the detailed plan shall:

7) J) 4) a) Be prepared by or under the direction of and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 4) b) include any design and construction requirements for the structure, including any required geo-technical information,

Design and construction requirements for the structures are included in the pond design section within Part IV of this application.

7) J) 4) c) describe the operation and maintenance requirements for each structure, and

Operation of the ponds will consist of effluent monitoring and frequent inspection by qualified personnel as required by regulation. Particular attention will be given to potential seepage, trash removal from spillway areas, and erosion of embankment areas and side slopes.

7) J) 4) d) describe the timetable and plans for removal of each structure if appropriate.

When a pond is no longer needed it will be drained, backfilled, topsoiled, and seeded in accordance with the reclamation plan.

7) K) If any of the following questions are answered yes, a permit may be needed from Illinois Department of Natural Resources, Office of Water Resource Management.

7) K) 1) Will the mining operation involve the construction of any levees, dikes, haul roads or other similar structures or the placement of any fill along or in the flood plain of any stream serving a drainage area of ten (10) square miles or greater at the point of construction?
Yes ______ No __**X**__

7) K) 2) Will the mining operation involve any relocation or diversion of or any construction activity in, over, under or along the banks of any stream serving a drainage area of ten (10) square miles or greater at the point of construction?
Yes ______ No __**X**__

7) K) 3) Is there any urban development (residential, commercial or industrial uses) in the areas immediately surrounding the mining operation?
Yes ______ No __**X**__
(If yes, please re-answer questions 1 and 2 above applying a one (1) square mile drainage area limit.)

7) K) 4) Will the mining operation involve the construction, major modification, or removal of any dam which in the event of failure would have probability for loss of life or additional economic loss in excess of that which would occur downstream of the dam in the absence of the dam?
Yes ______ No __**X**__

7) K) 5) Will the mining operation involve the construction, major modification, or removal of any dam 25 feet or more in height?
Yes __**X**__ No ______

7) K) 6) Will the mining operation involve construction, major modification, or removal of any dam which would have an impounding capacity of 50 acre feet or more?
Yes __**X**__ No ______

8) Provide a plan detailing fugitive dust control practices to be employed during proposed surface coal mining and reclamation operations as required under 62 Ill. Adm. Code 1817.95.

The mine site supervisor will monitor weather and wind conditions, and will be responsible for taking necessary action to control fugitive dust.

Exposed surface areas will be protected and stabilized to effectively control erosion and air pollution during site preparation, and mining and reclamation operations. Water trucks will be used when necessary to control fugitive dust on all heavily traveled areas during dry or dusty periods. All roads or other heavily traveled areas will be surfaced with a durable non-toxic material.

Measures used to control fugitive dust at the coal handling site will include using water spray bars

at the coal conveyor transfer points, frequent road watering during dry dusty conditions, and if necessary spraying water on the coal stockpiles.

POND DESIGN

Design of the treatment ponds and sediment ponds was discussed previously in Part IV. A calculation report for the actual pond sizing follows, as well as the printout from the storm routing for the pond, which was developed from the SEDCAD Version 4 software. Table #1 summarizes the pond design as well as answers questions in Part IV relative to embankment height, storage volume, etc. Table #2 summarizes the pond design for the treatment ponds and holding pond that are not NPDES discharge ponds but necessary for holding water for treatment prior to discharge to the sediment ponds.

TABLE #1

NPDES	Total Drainage Area (Acres)	Total Disturbed Drainage Area (Acres)	Total Calculated Inflow from Design Storm (AC-FT)	Pumpage Volume If Applicable (AC-FT)	Sediment Storage Volume (AC-FT)	Total Volume Below Primary Spillway (AC-FT)	Total Volume Below Emergency Spillway (AC-FT)
Sediment Pond #1	36.2	36.2	9.4	0	3.62	26.8	26.8
Sediment Pond #2	201.2	201.2	38.5	0	20.1	102.8	130.3
Sediment Pond #3	152.4	152.4	34.1	0	15.2	20.2	39.0

Notes:

1) **All ponds are incised with no embankment.**
2) **Sediment Pond #1 – open channel spillway and no emergency spillway.**
3) **Sediment Pond #2 – straight pipe spillway and open channel emergency spillway.**
4) **Sediment Pond #3 – straight pipe spillway and open channel emergency spillway.**

TABLE #2

Non-NPDES	Total Drainage Area (Acres)	Total Disturbed Drainage Area (Acres)	Total Calculated Inflow from Design Storm (AC-FT)	Pumpage Volume If Applicable (AC-FT)	Sediment Storage Volume (AC-FT)	Total Volume Below Primary Spillway (AC-FT)	Total Volume Below Emergency Spillway (AC-FT)
Treatment Pond #1	117.9	117.9	24.1	0.44	12.2	130.0	130.0
Treatment Pond #2	145.3	145.3	31.7	0	14.5	75.2	75.2
Holding Pond	1.9	1.9	3.3	2.65	2.85	19.8	19.8

Notes:

1) **Treatment Pond #1 – open channel spillway to Sediment Pond #2.**
2) **Treatment Pond #2 – open channel spillway to Sediment Pond #3.**
3) **Holding Pond – open channel spillway to Sediment Pond #1.**

SEDIMENT CONTROL CALCULATIONS

Treatment Pond #1
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 117.9 acres
Top of dam elevation = 678.0
Principal spillway elevation = 671.0
Pumping = 0.44 ac-ft (100 gpm from preparation plant runoff)
Runoff = 24.1 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

[(24.1) + (0.44)] (10/24) + (0.1)(117.9) = 22.0 ac-ft
Volume at pool elevation 671.0 = 130.0 ac-ft

Treatment Pond #2
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 145.3 acres
Top of dam elevation = 683.0
Principal spillway elevation = 674.0
Mine pumping = 0.0 ac-ft
Runoff = 31.7 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

[(31.7) + (0)] (10/24) + (0.1)(145.3) = 27.7 ac-ft
Volume at pool elevation 674.0 = 75.2 ac-ft

Holding Pond
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 1.9 acres
Top of dam elevation = 681.0
Principal spillway elevation = 678.0
Pumping = 2.65 ac-ft (600 gpm from underground pumpage)
Runoff = 0.6 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

Sediment Pond #3 is taking in runoff from the pond acres and Treatment Pond #2. Treatment Pond #2 is taking in the remaining runoff. The sediment control calculation for Sediment Pond #3 is determined by the total runoff, but only 2.4 ac-ft needs to be considered.

[(0.6) + (2.65)] (10/24) + (0.1)(1.9) = 1.5 ac-ft
Volume at pool elevation 678.0 = 19.8 ac-ft

Sediment Pond #1
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 36.2 acres (Holding Pond accepts 1.9 acres and 3.3 ac-ft)
Top of dam elevation = 679.0
Principal spillway elevation = ~~673.0~~ 676.0
Mine pumping = 0.0 ac-ft
Runoff = 6.8 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

[(6.8) + (0)] (10/24) + (0.1)(36.2) = 6.5 ac-ft
Volume at pool elevation 676.0 ft = 26.8 ac-ft

Sediment Pond #2
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 201.2 acres (Treatment Pond #1 accepts 117.9 acres)
Top of dam elevation = 678.0
Principal spillway elevation = 670.0
Mine pumping = 0.0 ac-ft
Runoff = 38.5 ac-ft from SEDCAD Version 4 program
(Treatment Pond #1 accepts 24.1 ac-ft)
Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

Sediment Pond #2 is taking in sediment from Collector Ditch #1 and #2. Treatment Pond #1 is taking in the remaining runoff. The sediment control calculation for Sediment Pond #2 is determined by the total runoff, but only 14.4 ac-ft needs to be considered.

[(38.5) + (0)] (10/24) + (0.1)(201.2)= 36.2 ac-ft
Volume at pool elevation 670.0 = 102.8 ac-ft

Sediment Pond #3
Estimate 0.1 ac-ft of sediment per acre of affected drainage area
Drainage area = 152.4 acres (Treatment Pond #2 accepts 145.3 acres)
Top of dam elevation = 683.0
Principal spillway elevation = 673.5
Mine pumping = 0.0 ac-ft
Runoff = 34.1 ac-ft from SEDCAD Version 4 program
(Treatment Pond #2 accepts 31.7 ac-ft)
Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

Sediment Pond #3 is taking in runoff from the pond acres and Treatment Pond #2. Treatment Pond #2 is taking in the remaining runoff. The sediment control calculation for Sediment Pond #3 is determined by the total runoff, but only 2.4 ac-ft needs to be considered.

[(34.1) + (0)] (10/24) + (0.1)(152.4) = 29.4 ac-ft
Volume at pool elevation 673.5 = 20.2 ac-ft

Please note that Sediment Pond #1, Sediment Pond #2, Sediment Pond #3, Treatment Pond #1, Treatment Pond #2, and Holding Pond are sized to provide all the required sediment volume as shown in these Sediment Control Calculations. Sediment Ponds #2 and #3 will provide additional sediment storage, if needed, as they are in series with Treatment Ponds #1 and #2 respectively.

CULVERT DESIGN CALCULATIONS

The following summarizes the design of the pipe culverts to be installed as part of the mining operation within the permit area.

The following table summarizes the design for the various culverts. Culvert sizing was done using SEDCAD Version 4 software. Culvert locations are indicated on the *Operations/Surface Drainage Control Map, Map D.* Details on the collector ditches are shown on *Collector Ditches #1, #2, #3, #4, & #5 Profile & Cross Sections, Map P-4* and *Collector Ditches #6, #7, #8, & #9 Profile & Cross Sections, Map P-5.* Details on the haul roads are shown on *Haul Roads #1, #2, #3 & #4 Plan, Profile & Cross Sections, Map HR-1.*

Culvert Location/Number	Total Design Flow (CFS)	Design Headwater Depth (FT)	Culvert Size
Collector Ditch #2 Sta. 10+50 to 11+00 (1)	61.2	5.5	36"
Collector Ditch #5 Sta. 20+85 to 21+75	54.2	4.7	42"
Collector Ditch #6 Sta. 13+60 to 14+00	118.0	4.7	2 (two) - 42"
Collector Ditch #6 Sta. 41+10 to 41+60	165.6	5.9	2 (two) - 42"
Treatment Pond #1 Spillway Ditch Sta. 3+90 to 4+40	102.0	7.9	42"
Collector Ditch #7 Sta. 0+50 to 1+40	2.5	3.1	10"

NOTE:

1) **Culvert under the haul road to be designed using 10 year – 6 hour storm. Utilized 10 year – 24 hour storm due to culvert in drainage ditch utilizing the same storm design criteria. Evaluated design using 10 year – 6 hour storm. Both storm criteria yield a 36 inch culvert.**

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-5C1a

NORFOLK SOUTHERN CORPORATION PROPOSED
RAIL DEVELOPMENT

NORFOLK SOUTHERN
Industrial Development Department
7021 Hall Street
Saint Louis, MO 63147
Email: jacob.weir@nscorp.com

Jacob W. Weir
Industrial Development Manager
Phone: (314) 679-1880
Fax: (314) 679-1884

February 20, 2014

Mr. Scott Fowler
Illinois Department of Natural Resources
Office of Mines and Minerals
Land Reclamation Division
One Natural Resources Way
Springfield, Illinois 62702-1271

Re: Bulldog Mine
UCMP-1 Permit Application No. 429
Norfolk Southern Corporation Proposed Rail Development

Dear Mr. Fowler,

Norfolk Southern Railway has been working with Sunrise Coal, LLC concerning rail transportation for the above referenced project. Norfolk Southern Railway intends to facilitate the connection of our main line track just south of County Highway Route 8 to a lead track serving the proposed Bulldog mine site near the intersection of County Road 800N/100E – Vermilion County, Illinois. Attached is a general location map, detailing the above.

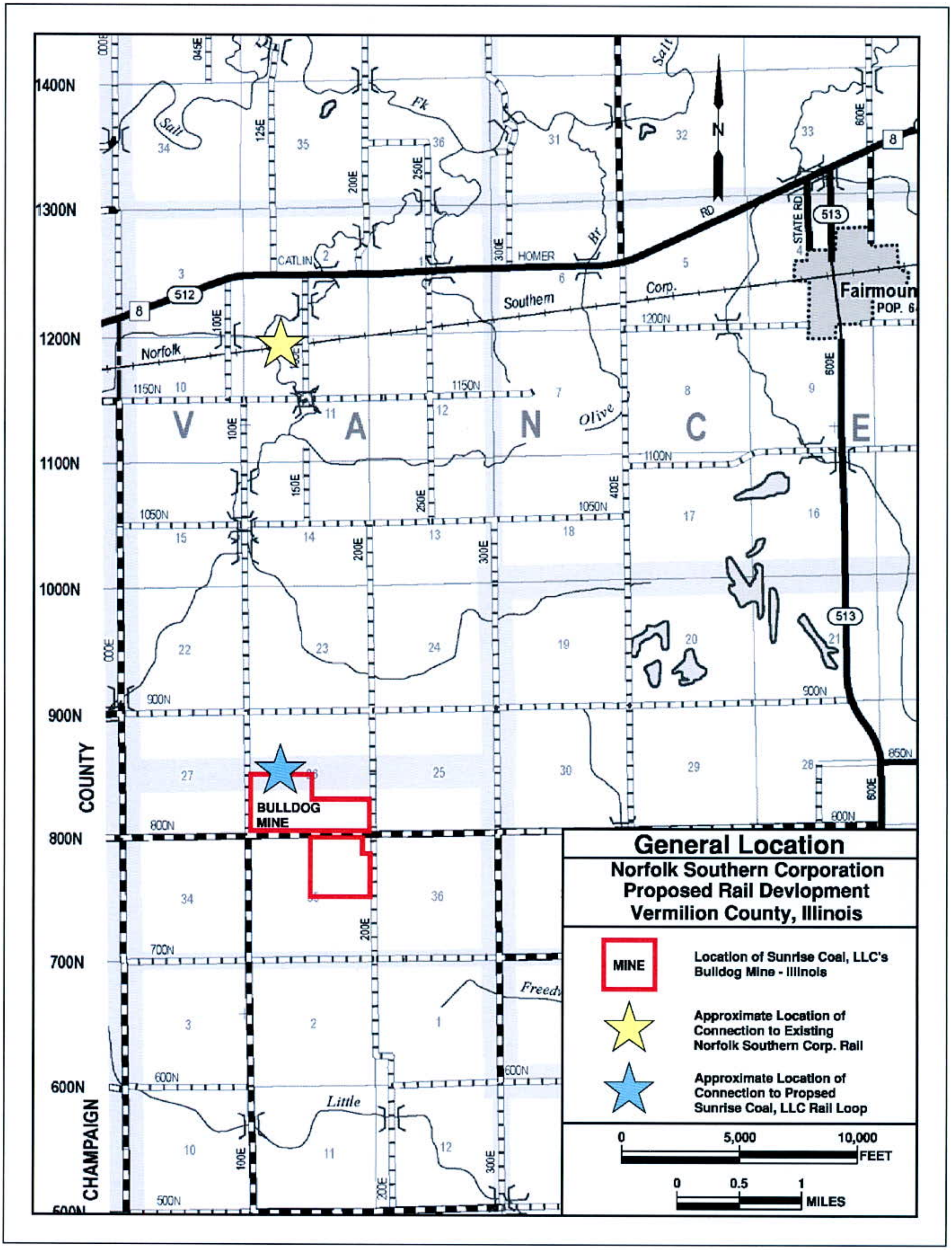
This letter is intended to notify the Illinois Department of Natural Resources that Norfolk Southern Railway supports the project and intends to support Sunrise Coal, LLC in ensuring successful completion of the project. Our company has worked with Sunrise Coal to develop a conceptual track design that will provide access from the main line to the proposed mine.

If you have any questions concerning this letter, please feel free to contact me.

Sincerely,

Jake Weir

Jacob Weir


General Location
Norfolk Southern Corporation
Proposed Rail Devlopment
Vermilion County, Illinois
MINE
Location of Sunrise Coal, LLC's Bulldog Mine - Illinois
Approximate Location of Connection to Existing Norfolk Southern Corp. Rail
Approximate Location of Connection to Propsed Sunrise Coal, LLC Rail Loop
0
5,000
10,000
FEET
0
0.5
1
MILES
BULLDOG MINE
V A N C E
CHAMPAIGN COUNTY
Fairmount
Norfolk
Southern
Corp.
CATLIN
HOMER
RD
1400N
1300N
1200N
1100N
1000N
900N
800N
700N
600N
1150N
1050N
1100N
850N
500N
100E
125E
150E
200E
250E
300E
400E
600E
STATE RD
512
513
8
Salt
Fk
Olive
Br
Little
N

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-6

"BEST MANAGEMENT PRACTICES" TO MINIMIZE DISSOLVED CONTAMINANTS IN RUNOFF FROM REFUSE DISPOSAL AREAS

"Best Management Practices" To Minimize Dissolved Contaminants In Runoff From Refuse Disposal Areas

The SIU study entitled, "Identification and Assessment of Best Management Practices in Illinois Mining Operations to Minimize Sulfate and Chloride Discharges" discusses several Best Management Practices (BMP's) that may be used at mine sites to reduce the amount of sulfate and chloride present in mine discharges. As noted in the study, not all BMP's listed can be implemented at all mines due to site-specific conditions. However, Sunrise Coal intends to implement as many BMP's as practical to insure that their refuse disposal area does not unduly contaminate the mine's effluent discharges.

As noted in the SIU study, sulfide minerals such as pyrite and marcasite will oxidize in the presence of oxygen and water to form highly acidic, sulfate-rich discharges. Controlling water and/or oxygen access to the sulfide minerals will help to control the amount of sulfates generated. However, in contrast to sulfates that are generated from oxidation, chlorides are naturally present within the coal. Fragmenting the coal during mining and processing procedures leads to the liberation of chlorides into mine drainage. Sulfate and chloride discharges are independent from one another; however both may occur due to the presence of both sulfide minerals and chlorides in Illinois coal.

In order to reduce the sulfate and chloride discharges, Sunrise Coal intends to implement the following BMP's listed in the SIU study for their refuse impoundment.

- Systematic Covering of Older Coarse Refuse - Fresh coarse refuse material typically does not generate a significant amount of sulfates for a period of 3 to 12 months. Sunrise Coal will systematically cover older coarse refuse material with fresh coarse refuse material in order to prevent oxidation and thereby reducing the amount of sulfates generated.

- Compaction of Coarse Refuse Material - The coarse refuse material will be transported via conveyor from the preparation plant to the refuse bins located adjacent to the refuse impoundment. The coarse refuse material will then be hauled by trucks and spread by tracked dozers in layers not to exceed 2 feet in thickness. Compaction of the coarse refuse material will be accomplished by the vibratory action created by the equipment hauling and spreading the refuse material.

- Minimize Long-Term End-Dumping - End-dumped and un-compacted coarse refuse piles will acidify and generate sulfates more rapidly than compacted coarse refuse. Sunrise Coal will avoid long-term, end-dumping of coarse refuse. Coarse refuse material will instead be compacted as described in the above bullet labeled "Compaction of Coarse Refuse Material."

- Alkaline Amendments for Coarse Refuse Material - Any coarse refuse material that does become acid before being compacted and covered will be treated with an alkaline amendment, such as lime, in order to restore non-acidic conditions. Mine management will routinely monitor the coarse refuse material for the formation of acid salts. If acid salts are present, pH test strips or a pH metering device will be used to verify the acidity

"Best Management Practices" To Minimize Dissolved Contaminants In Runoff From Refuse Disposal Areas

level of the coarse refuse material. An appropriate amount of lime to restore non-acidic conditions will then be incorporated into the refuse material before any fresh refuse material is added. Additionally, alkaline amendments may be added as a preventative measure to minimize or delay the initiation of acid generation. This would be beneficial in areas that have not recently been covered with fresh coarse refuse material.

Upon completion of refuse disposal in this impoundment, toxicity testing will be performed and the appropriate amount of alkaline amendment will then be incorporated into the surface of the refuse material. If necessary, based on the toxicity testing, the alkaline amendment may be added over 2 to 3 seasons in order to develop a non-acid producing weathered coarse refuse surface zone. After all of the alkaline amendment has been added, the impoundment will be covered with 4 feet of non-toxic, non-combustible soil material.

- <u>Alkaline Recharge Trenches (ART)</u> - The establishment of ART infiltration zones in out-slope runoff and erosion control channels can intercept and counteract the acid seep pathways that can develop on side slopes and toes of coarse refuse disposal areas. Considering all of the previously mentioned measures that will be used to control sulfate containing acid mine drainage, Sunrise Coal does not anticipate a need to construct ARTs. However, the refuse impoundment will be monitored closely, and if the need arises ARTs will be installed as necessary.

- <u>Maintain Adequate Water Depth</u> - During active disposal of slurry, Sunrise Coal will maintain an adequate water depth within the refuse impoundment to maximize retention time allowing, differential separation of slurry constituents based on their particle size and specific gravity. This practice will help minimize "black water" return and the downstream scour and transport of fine grained pyrite.

- <u>Sequential Movement of Discharge Point</u> - Sunrise Coal will routinely move the discharge point of the pipe where slurry enters the impoundment in order to obtain a better slurry distribution and to maximize the available storage capacity. The practice will minimize the exposure of unsaturated coarse grained pyrite.

- <u>Alkaline Amendments for Fine Refuse Material</u> - After all of the fine refuse generated by coal processing has been disposed of in the impoundment, toxicity testing will be performed to determine the net neutralization potential of the waste material. An appropriate amount of alkaline amendment, such as lime, will then be incorporated into the surface of the slurry material. If necessary, the alkaline amendment may be added over 2 to 3 seasons. After all required alkaline amendment has been added, the impoundment will be covered with 4 feet of non-toxic non combustible soil materials.

"Best Management Practices" To Minimize Dissolved Contaminants In Runoff From Refuse Disposal Areas

- Neutralization of Acid/Sulfate Run Off and Water Management - Normal operating conditions will result in no discharge from the Refuse Impoundment. In the unlikely event that the Refuse Impoundment does discharge, the discharged water will flow to Treatment Pond #2 and be re-circulated back to the preparation plant. Excess water contained in Treatment Pond #2 will be allowed to discharge to Sediment Pond #3. Taking the previously mentioned BMP's into consideration, it is not anticipated that any acid drainage from the mine's refuse pile will have a negative effect on Sediment Pond #3. However, the water quality of Treatment Pond #2 and Sediment Pond #3 will be routinely monitored, and if the need arises, the acid run off from the gob/coarse refuse pile will be neutralized with the proper alkaline amendment. This will help to ensure that any effluent discharge leaving the mine site will be in full compliance with all water monitoring requirements.

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-3A3

ROOF OVERBURDEN, PILLAR AND FLOOR CONDITIONS FOR THE ALLERTON COAL RESERVE

AND

ANALYTICAL DATA COLLECTION DOCUMENTATION

ROOF OVERBURDEN, PILLAR AND FLOOR CONDITIONS FOR THE ALLERTON COAL RESERVE

VERMILION COUNTY, IL

Prepared for: Mr. Sam Elder
Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Prepared by: Gennaro G. Marino, Ph.D., P.E.
Abdolreza Osouli, Ph.D.

Date: May 11, 2012

MARINO ENGINEERING ASSOCIATES, INC.
1101 EAST COLORADO AVENUE
URBANA, ILLINOIS 61801
217-384-2288

May 11, 2012

MEA is a leading expert in mine subsidence engineering. With over 31 years of experience, MEA's staff has provided services across the full scope of mine subsidence engineering, including significant work in research, site subsidence studies, mine stability design and failure analyses, prediction of subsidence displacement and damage potential, subsidence damage evaluation, repair design, and mine grouting design and monitoring. Being foremost in this field, MEA staff have authored over 70 publications on related topics and have worked in coal fields across the U.S.

MEA has also been hired by mining companies and others to provide consulting services on active or new operations for both room-and-pillar and longwall mining in addition to low to high extraction old works. These services are included in those listed above. Because of the amount of coal mining related work MEA has done, it has designed and developed a cross-hole radar to detect mine voids for cases where mining may exist.

Having worked extensively on old coal mines and both low and high extraction active mines, MEA is uniquely qualified and separates itself from other geotechnical and mining engineering companies across the U.S. MEA also has expertise in a full scope of services in geotechnical and pavement engineering, as well as construction material testing and monitoring.

May 11, 2012

-PREFACE-

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May 11, 2012

1.0 INTRODUCTION

At the request of the Sunrise Coal Company, Inc., MEA has conducted a geotechnical investigation of the allowable pillar strength and bearing capacity of the mine floor and in turn the allowable extraction conditions for the Allerton Reserve which is located between Homer and Allerton in Vermilion County, IL (see Figure 1.1).

The scope of work for this project included the sampling and testing of the coal and floor materials to determine their composition and engineering properties. This data was used to assess the range of floor profile conditions and representative rock mechanics properties of the various floor materials. Laboratory testing was performed by both Mr. E. Sprouls, P.E., and MEA. The vast majority of the retrieved core was logged by C. Hutchison. Using the lab data and geologic hole conditions, the floor stratigraphy was determined and analyzed for bearing strength across the application area. Because the dominant mode of long term instability is the mine floor, the analysis in this report focuses on this mechanism of failure. The pillar strength was also checked herein. It should be noted that roof stability in rooms is not discussed in this report. Because the mine depth will be greater than 245 ft room-roof, collapse resulting in surface subsidence is not expected.

In the following section, the coal and floor geology across the coal reserve is discussed. In Section 3, rock mechanics properties of the coal and floor are summarized. Then using the data discussed in Sections 2 and 3, the allowable floor bearing strength across the reserve is analyzed in Section 4. In Section 5, a similar analysis is performed for the coal pillar. Using the allowable capacities in Sections 5 and 6, the critical stability design requirements across the reserve are given in Section

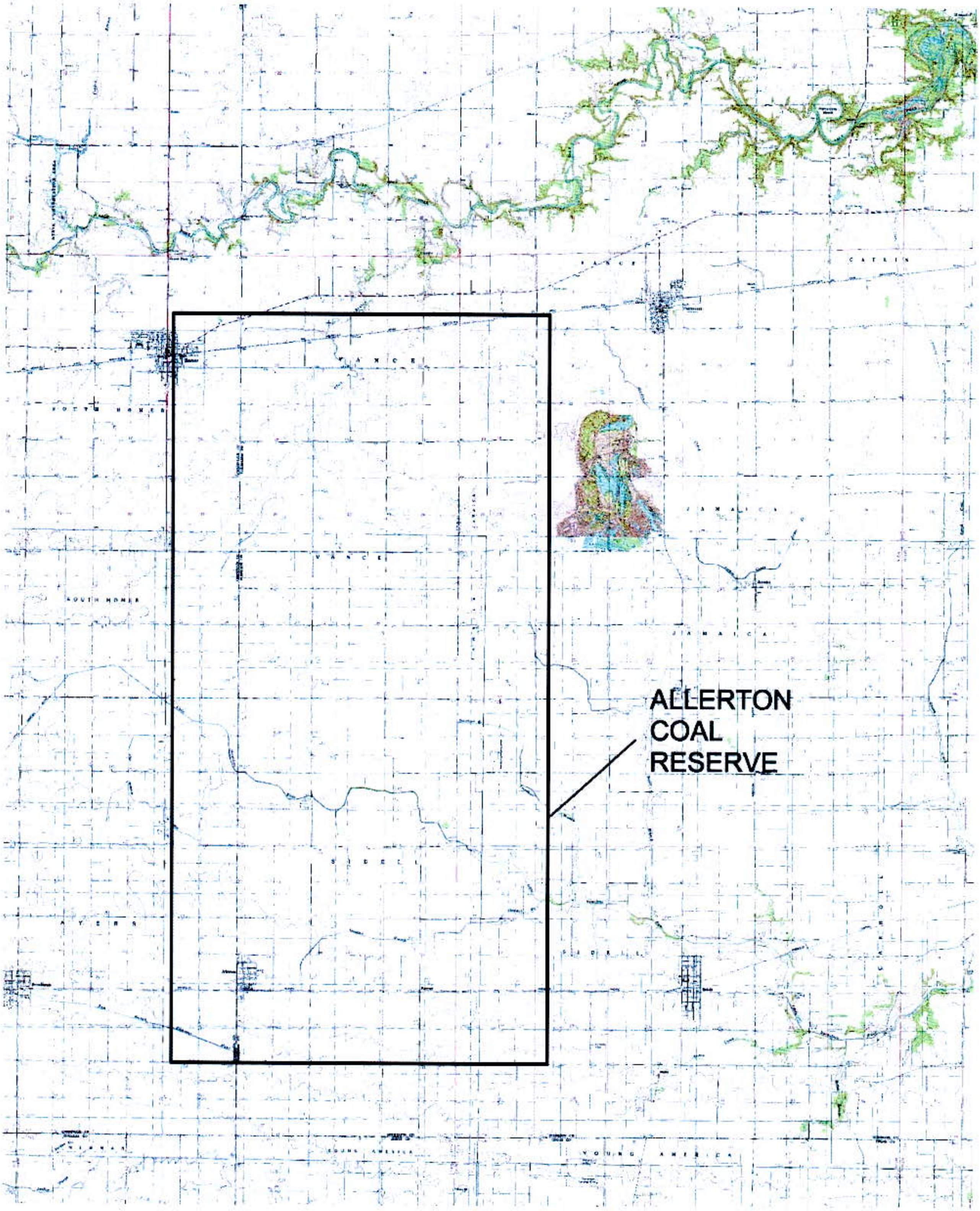


FIGURE 1.1 LOCATION OF ALLERTON COAL RESERVE

7. The following sections consist of the summary and conclusions of this investigation (Section 8) and the references (Section 9). A comprehensive table with the available floor information on a hole to hole basis is provided in Appendix A. Swell test results and associated particle size distributions from lab tests run on the immediate fine-grained floor material are given in Appendix B.

2.0 COAL AND FLOOR GEOLOGY

2.1 Regional Geology

The Allerton Coal Reserve is associated with the Illinois Basin. The Basin (formed from layers of rocks) includes all of the central and southern parts of the state (see Figure 2.1). Regional arches, shelves, and dome-like features are present in the Illinois Basin. Structure within the basin is shown in Figure 2.2 and consists mostly of anticlines and synclines which are typically wide and gentle, with dips of 1 to 2 percent. As can be seen in Figures 2.1 and 2.2, the site is situated between the LaSalle Anticline Belt to the west and the Marshall Syncline to the east. No significant faults are present in the project area. Along the LaSalle Anticline, however, strata dip is on the order of 20 percent. The deepest part of the basin sediment is present at the southeastern end of the state where most of the formations thicken. In most places the regional dip of the formations are extremely gentle at 10 to 30 feet/mile.

The Pennsylvanian system is the youngest large bedrock system in the Illinois Basin. Within the Pennsylvanian System is the Carbondale Formation which contains four major coal members. These coal seams make up 92 percent of the coal in the Pennsylvanian System. Units (or coal measures) of the Carbondale Formation extend over wide areas. Abrupt lateral changes exist, however, where sandstone occupies erosion channels. Figure 2.3 shows a generalized geologic column.

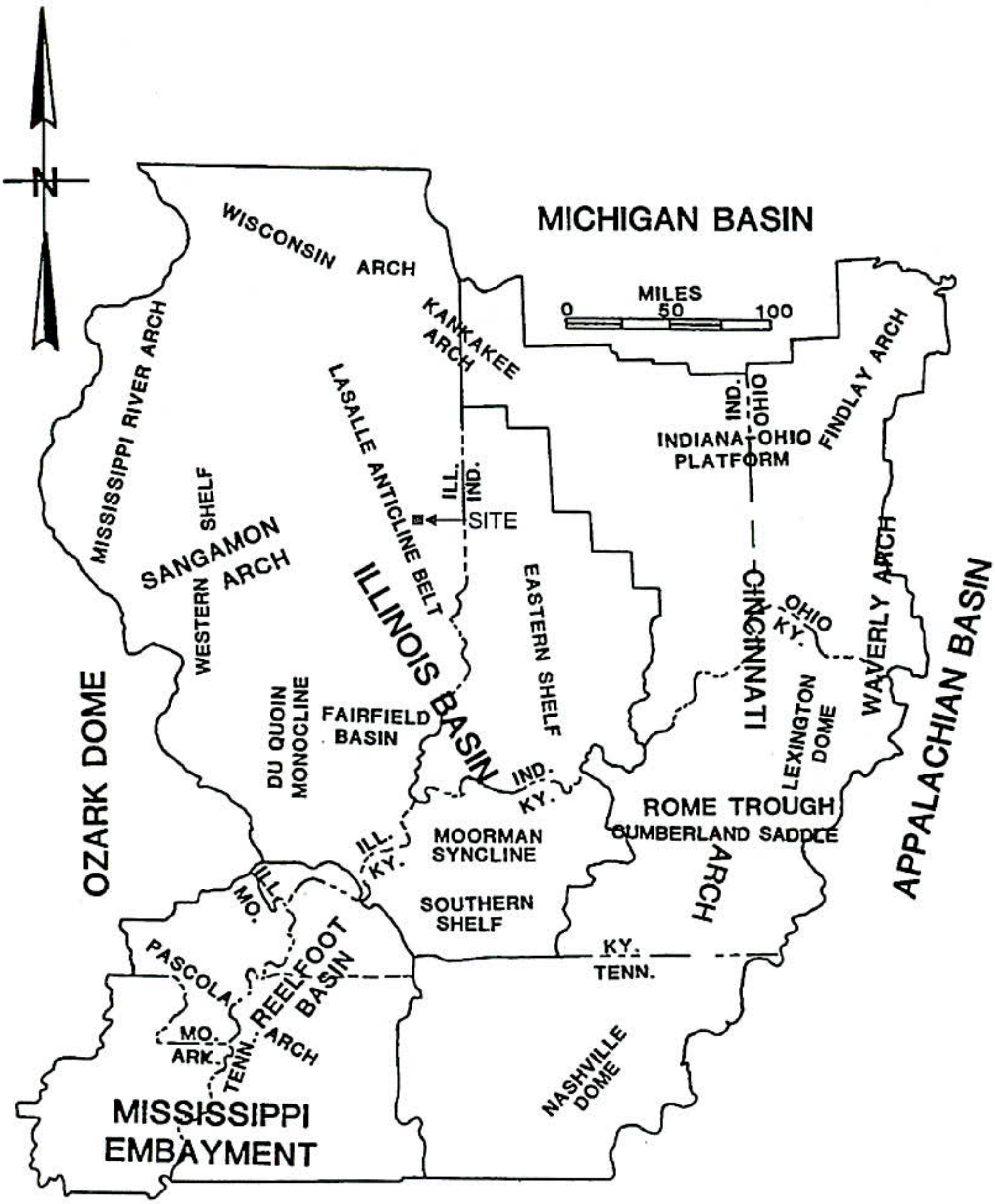


FIGURE 2.1 STRUCTURAL FEATURES OF THE EASTERN INTERIOR REGION (SPECK, 1979)

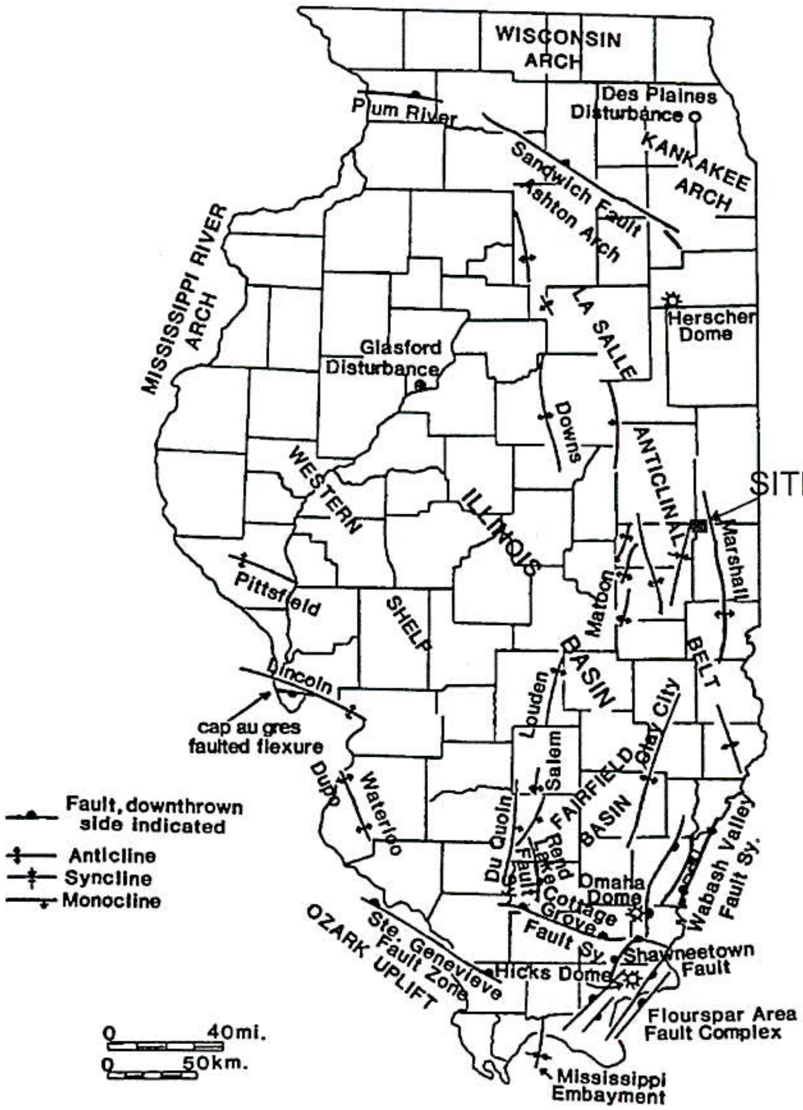


FIGURE 2.2 STRUCTURAL FEATURES WITHIN THE ILLINOIS BASIN (KRAUSSE, ET AL., 1979)

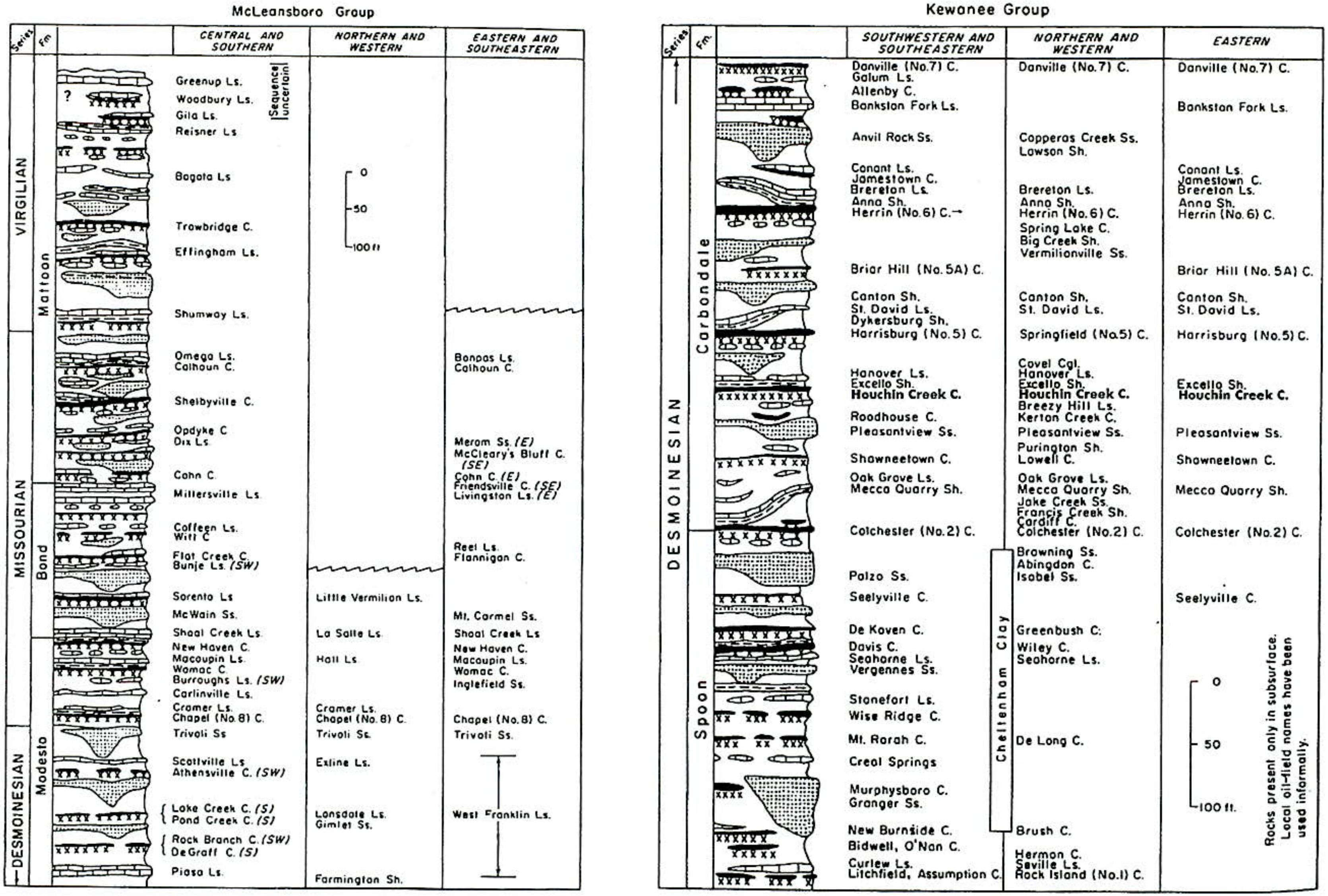


FIGURE 2.3 GENERALIZED GEOLOGIC COLUMN (Kosanke, et al., 1960)

The coal measures have been deposited in cyclothems[1] and consist of mostly clastic rocks[2]. Therefore, vertical lithologic changes are common. The coal measure rocks are primarily sandstone, siltstone, claystone and shale which make up 90 to 95 percent of the formation while less than 2 percent is comprised of coal, underclay and limestone. More than fifty cyclothems have been discerned in the Illinois Basin.

Across the state this seam is deeper than 1000 ft in the Fairfield Basin (see Figure 2.2). However, Herrin No. 6 occurs at depths of typically 330 to 380 ft below ground surface on the project site. On the periphery of the Basin outcrops of the Herrin and other coal seams can be found. The Herrin No. 6 Coal is named after Herrin, Illinois where the coal was extensively mined by 1912 (Willman, et al., 1975). Coal seam thicknesses are typically up to 8 ft and are relatively constant over large parts of a region.

The dip of the Herrin No. 6 seam across the reserve investigated very generally dips to the east toward the Marshall Syncline (see Figure 2.2). This dip is roughly 6-20 ft/mile across the application area.

The bedrock surface is covered by varying thickness of glacial deposits from the Quaternary period. Glaciation covers most of Illinois with deposits typically up to 50 ft thick and over 200 ft in thickness in buried bedrock valleys. Sediments of the Wisconsinian stage predominantly exist in the northeast to east central Illinois. Illinoisian glacial deposits cover 90 percent of Illinois, and are extensive in the west and to the south of the limit to the Wisconsin movement. These Illinoisian and Wisconsinian

[1] Cyclothems are a series of beds deposited during a sedimentary cycle of the type that prevailed during the Pennsylvanian Period. Nonmarine sediments, often including bituminous coal, commonly occur in the lower half of a cyclothem, while marine sediments in the upper half. Most cyclothems are incomplete.

[2] Clastic rock means a sedimentary rock composed principally of fragments derived from pre-existing rocks and transported mechanically to their own places of deposition; eg. sandstone, shale.

deposits are covered with widespread Wisconsin loess. Pre-Illinoisian deposits are irregularly distributed and of unknown extent in Illinois. The soil cover above the reserve area typically ranges from 20 ft to 85 ft.

2.2 Subsurface Investigation Program

The locations of the borings drilled in and around the Allerton Coal Reserve are shown in Figure 2.4. A total of 44 borings are shown. The logging of the coal measures geology to this point had been performed by Mr. C. Hutchison, Sunrise Coal, LLC. All of the holes were drilled by Sunrise Coal, LLC except SA-29, SA-31, SA-39, SA-42, SA-88, SA-89, SA-91, SA-92, and SA-93, which were drilled by Magnum Drilling Services of Evansville, Indiana. SA-2, SA-4, and SA-5 were drilled in November 2009. SA-12 to SA-63 were drilled from April 14, 2010 to December 9, 2010. SA-67 to SA-97 were drilled from June 15, 2011 to October 28, 2011. Of the holes drilled by Magnum Drilling Services, SA-29, SA-31, SA-39, and SA-42 were drilled May to June 2010 and SA-88, SA-89, SA-91, SA-92, and SA-93 were drilled in October 2011.

To provide a better understanding of the floor conditions, a few of the holes were relogged and analyzed further by MEA. Rock mechanics testing of floor material were conducted by Mr. E. Sprouls, P.E. and MEA.

The core was logged for recovery length (rate of recovery), fractures, lithology, hardness, and other pertinent details. Also, on some of the core, Rock Quality Designation (RQD), Recovery rates, and Rock hardness were determined by Sunrise drillers. In the later holes cored, the hardness was based on the AASHTO Classification System. The AASHTO rock hardness classification is given in Table 2.1.

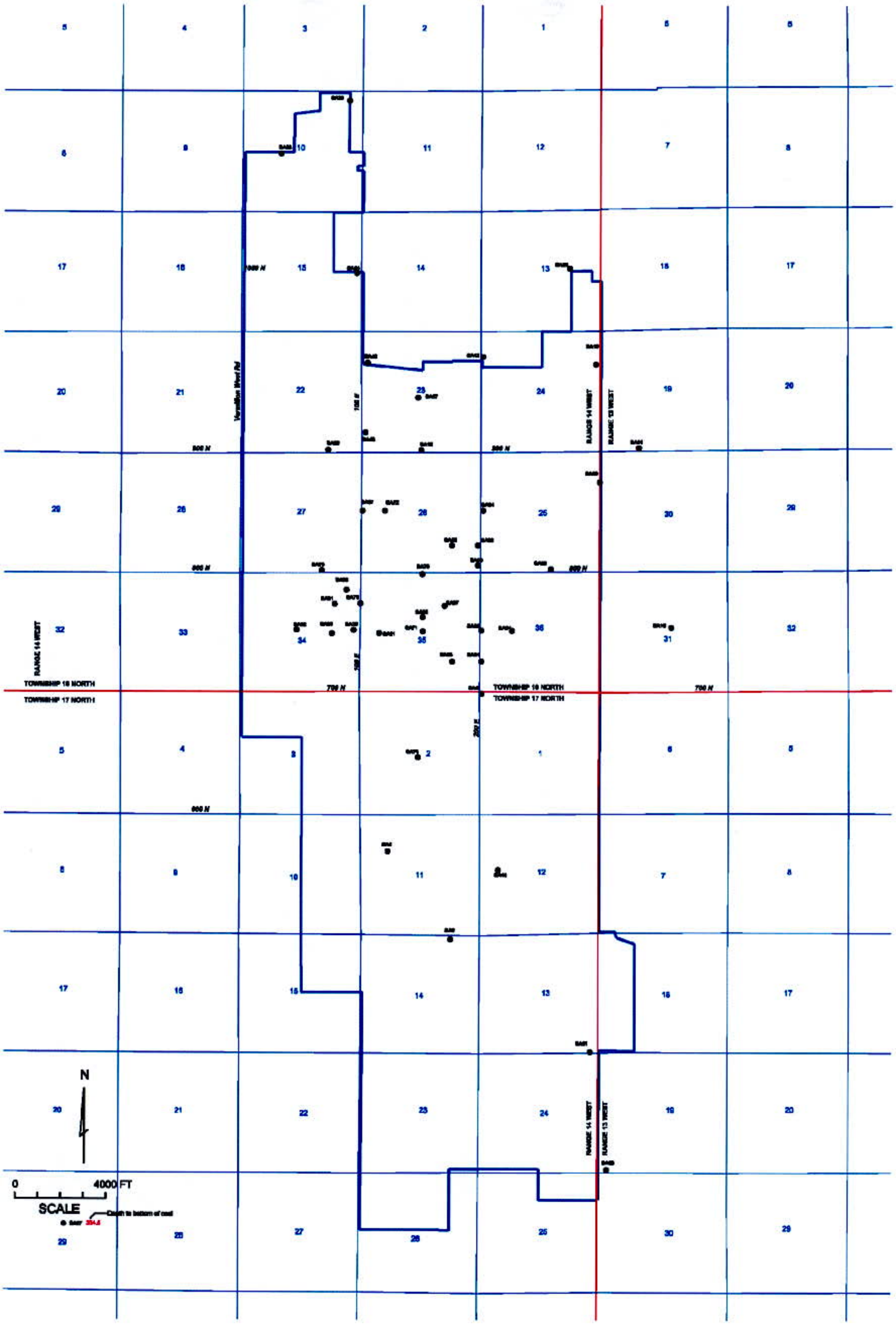


FIGURE 2.4 BORING LOCATION PLAN

TABLE 2.1 AASHTO ROCK HARDNESS CLASSIFICATION[1]

Very Hard	Cannot be scratched by knife or sharp pick. Breaking of hand specimens requires several hard blows of the geologists pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimen.
Moderately Hard	Can be scratched by knife or pick. Gouges or grooves to 6 mm (0.25 inch) deep can be excavated by hand blow or point of geologists pick. Hand specimens can be detached by moderate blows.
Medium	Can be grooved or gouged 2 mm (0.05 inch) deep by firm point. Can be excavated in small chips to pieces about 25 mm (1 inch) maximum size by hard blows of the point of a geologists pick.
Soft	Can be gouged or grooved readily by knife or pick. Can be excavated in fragments from chips to several inches in size by moderate blows of a pick point. Small, thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken by finger pressure. Can be scratched readily by fingernail.

[1] Manual on Subsurface Investigation, Published by the American Association of State Highway and Transportation Officials, Washington, D.C., 1998.

2.3 Rock Classification

In order to determine the actual floor bearing conditions across the site, it was necessary to determine in the lab the detailed makeup of the various floor strata and their relevant characteristics. Because of the moisture sensitivity of the immediate floor, the most significant rock descriptions made in the lab were of rock plasticity and durability.

Classification, as it relates to rock plasticity and durability of the clastic floor material is difficult, if not impossible, to ascertain from mere visual or brief tactile inspection. These characteristics can only be estimated based on visual and textual observations on the slaked rock after submersion. Also, rock type adjustments can be made based on representative samples tested for Atterberg Limits or based on the estimated Liquid Limit of the rock in a moisture softened state. The Liquid Limit boundaries given in Table 2.2 denote changes in rock type are based on equivalent increments of residual strength as it empirically relates to the Liquid Limit (Marino and Osouli, 2012). This relationship is shown in Figure 2.5. It is important to note that depending upon the actual fine-grained rock type, there is a considerable difference in the resulting shear strength at confining pressures expected below the pillar. With no discernible difference in appearance, the shear strength for a silty mudstone is 2 to 3 times that for floor material classified as a claystone.

Floor durability observations were made on submersed floor samples. These observations were used to determine the DuroIndex of the submerged samples (Marino and Osouli, 2012). These durability classifications are given in Table 2.3.

Using the above criteria, the floor core was reclassified. Field logs were modified by MEA based on laboratory rock classification of the floor materials for Borings SA-57,

TABLE 2.2 ROCK CLASSIFICATION BASED ON ROCK PLASTICITY

	LIQUID LIMIT
SILTSTONE/SANDY SHALE	28%
SILTY MUDSTONE/SILTY SHALE	29 to 40%
MUDSTONE/SILTY CLAYEY SHALE	>40 to 50%
CLAYSTONE/CLAYEY SHALE	>50 to 100%
FINE GRAINED CLAYSTONE	>100%

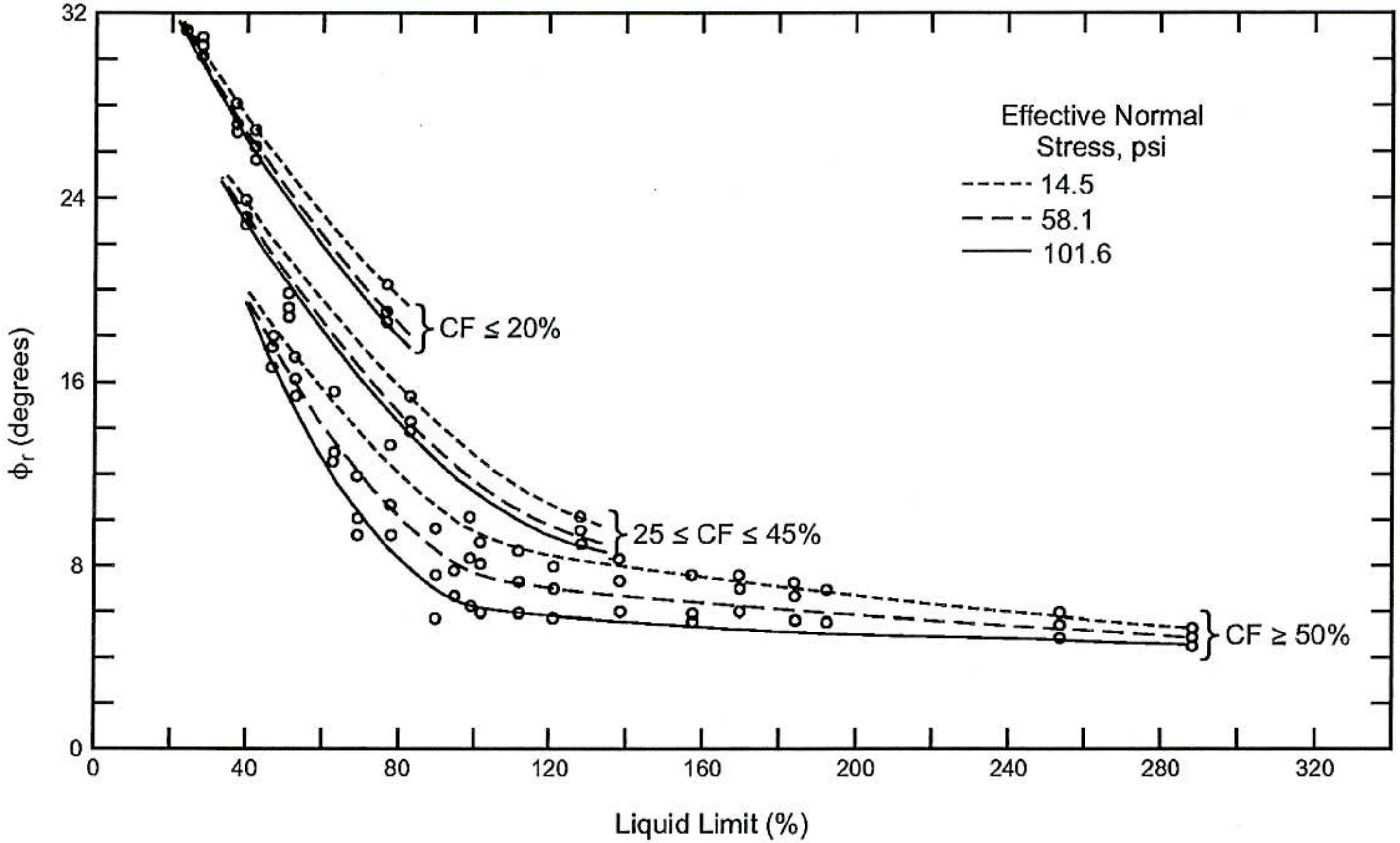


FIGURE 2.5 RESIDUAL FRICTION ANGLE VERSUS LIQUID LIMIT FOR VARIOUS SOILS AND ROCKS (Terzaghi, Peck and Mesri, 1996)

TABLE 2.3 DUROINDEX CLASSIFICATION

Very Non-durable (V.N.D.) - rapid complete disintegration in water within 15 minutes

Non-Durable (N.D.) - complete disintegration in water for 24 hrs or more

Moderately Non-Durable (mod. N.D.) - fragmental breakdown in water with only trace of sample less than fine gravel size for 24 hrs or more

Slightly Non-Durable (sli. N.D.) - separation along partings (this may be found to exist in the rock core which exhibits fissile cracking resulting in core discs some as thin as 0.02 ft or less) or full-body cracking resulting in sound particles, all greater than fine gravel size in 24 hrs or more

Durable (D) - remains intact and sound upon submersion with only 1-2% of the entire sample broken down in 24 hrs or more

Notes:

1. Submersion of coarse gravel-sized or greater rock samples in water but no greater than 1 inch thick of 2-4 in. diameter rock core.
2. This classification testing is done from just exposing rock to soaking. The rock specimen should be placed in the bowl of water where the vertical axis of the core is horizontal (or the plane of deposition is made vertical).
3. Particles are judged to be sound, if they are difficult to break between fingers.
4. Trace is defined as up to 10% by weight of the whole sample.

SA-67, SA-70, SA-71, SA-74 to SA-75, SA-78, SA-81, SA-85 to SA-86, SA-89, and SA-91 to SA-93. Based on this data and core logs provided to MEA, rock classification at the remaining holes was approximated. To assess the hole to hole classification, a detailed spreadsheet depicting all the available data was prepared and is provided in Appendix A. Moreover, to clarify floor material descriptions there was extensive communication with Mr. C. Hutchison.

2.4 Herrin No. 6 Coal

From borings drilled to date, the depth to the Herrin No. 6 Coal ranged from 318 ft to 383 ft (typically from 344 to 377 ft). Much of the project area contains 5 to 7 ft of coal. However, in the northern half of the application area, the coal appears to be on average about 1 ft thicker than the southern half.

2.5 Floor Profile

Based on the boring and laboratory information available, the floor stratigraphy across the reserve was analyzed. This is an important assessment as it is directly related to determining the actual allowable floor bearing. In comparing the variation in floor support across a reserve, the floor capacity for the most resistant floor conditions can be 2 times or more than the least resistant. Therefore, the most cost effective means to support the proposed room and pillar mine is to accommodate the important variations in the floor geology. Conventional design methods, however, assume some arbitrary "average" floor condition which results in under-designed and over-designed areas and therefore areas of both active and abandoned works from more significantly exposed to pillar punching.

The coal measures relative to this floor study are below the Herrin No. 6 Coal. A general geologic column showing the various geologic names of the rock beds is shown in Figure 2.3. Over much of the application area, the most immediate floor material consists of a gray mudstone to silty mudstone (MS-$MS) as defined in Table 2.2 based on rock plasticity testing. Changes in gradation or rock plasticity laterally or with depth are impossible to discriminate from visual and brief textural characteristics. But, based on more detailed laboratory testing, it was found that the range in rock plasticity was relatively limited. All of these fine-grained rocks were found to be non-durable and weak.

The depth of this fine-grained rock unit is more typically 2 to 10 ft but can more locally reach 13 ft or more. These fine-grained rocks, in addition to being significantly moisture sensitive (i.e. non-durable), are weak even when fresh. Also present in the unit are intermittent beds of limited thickness of mainly limestone, shale, and carbonaceous shale. In most instances, these rocks were found to be durable and of higher strengths, but significantly less in quantity and thickness.

The weak fine-grained floor rock is soft to medium hard which is locally found to be slickensided with a varying amount of limestone nodules. Based on the rock cores retrieved to date and discussions with C. Hutchison, the slickensided zones appear isolated/localized. The presence of slickensides significantly reduces the field strength of even fresh fine-grained rocks.

In addition to assessing the geotechnical properties of the most immediate fine-grained rock layers, it is important to classify and determine the depth and thickness of the first resistant (durable) rock zone as this layer(s) can restrict shearing in the floor and consequently increase the overall bearing capacity. Furthermore, a sufficiently thick durable zone will mitigate the deterioration of underlying non-durable materials. A durable rock zone was identified as a rock layer(s) which has a cumulative thickness of greater than about 2 ft and is of sufficient laboratory tested durability. In other words, floor materials which make up the durable zone do not lose significant strength when exposed to moisture under nominal vertical pressure in the room and under the pillar.

It is important to note that the estimates of the geologic-geotechnical conditions are based on the available data given in this report. Because in certain areas of the reserve the data is either absent or scarce, these conditions can only be speculated. It appears, however, there is sufficient information to approximate the range of floor conditions present.

The first resistant floor strata appears to be essentially a limestone, silty shale or sandstone unit. The deeper sandstone unit may be only locally relevant when the shallower limestone or shale units were not present. The limestone and shale units appear to be most prevalent in the central and southern areas, respectively, of the application area.

The limestone unit, below the MS-$MS, basically consists of a hard, light gray to gray limestone which can contain silty to sandy facies interbedded or intercalculated with some medium to moderately hard silty shale. The individual limestone beds are typically 0.5 to 2.5 ft in this unit. Although there are alternate beds of limestone and shale in places, the unit generally becomes more shaley with depth. The unit thickness is typically 2 to 4 ft when mudstone to silty mudstone underlies this unit. Where the MS-$MS is not present, interbeds of mainly gray silty shale followed by fine-grained sandstone exists below the limestone unit. With these materials present, the total thickness of resistant strata can reach more than 8 ft.

In other areas across the reserve, the most immediate resistant floor unit below the No. 6 Coal is basically a gray, medium to moderately hard, silty shale which can also be sandy in places This unit can be present immediately beneath the coal to a depth of about 7 ft where it is overlain with MS-$MS. Also, the carbonaceous zone which is below the limestone unit appears present, at least in places, within the shale unit, but is slightly shallower.

Where the limestone or shale resistant units are not present, the mudstone-silty mudstone extends to deeper depths below the No. 6 Coal. This would result in the lower gray, moderately hard, fine-grained sandstone unit being the most immediate resistant material. Obviously, given the MS-$MS thickness, this is the worst floor bearing condition.

3.0 GEOTECHNICAL PROPERTIES OF THE HERRIN NO. 6 COAL AND MINE FLOOR

3.1 Scope

The Herrin Coal was tested for uniaxial compression strength. More importantly, however, rock mechanics testing was performed on the floor core in order to assess the appropriate bearing conditions across the reserve. This testing included the determination of moisture contents (MC) (ASTM D-2216) with depth, slake durability (SD) (ASTM D-4644), DuroIndex (DI) (followed the specifications outlined in Table 2.3), Atterberg Limits (ASTM D-4318), swell characteristics (in general, in compliance with ASTM D-4546 except for loading sequence to accommodate the maximum swell pressure through free well phase), clay fraction (CF) (ASTM D-1140), indirect tensile strengths (ITS) (ASTM D-3967), point load strengths (PLS) (ASTM D-5731) and uniaxial compression strengths (UCS) (ASTM D-2938). All the ITS and some of the MC, Atterberg Limits and UCS tests were conducted by Mr. E. Sprouls from November to December, 2009 for SA-2, SA-4, and SA-5; from April 2010 to January 2011 for SA-12 to SA-63; and from June to November, 2011 for SA-67 to SA-97. All other tests were conducted by MEA. Of these tests, MC, AL, DI, and PLS tests were conducted from July 2011 to January 2012 except the tests on samples of SA-57 which were conducted from October to November 2010. Swell tests and clay fracture tests were conducted from January to April 2012. All the laboratory data, except the swell related data was compiled in a summary table on a per hole basis and are given in Appendix A. The swell related data is provided in Appendix B.

3.2 Herrin Coal Strengths

The Herrin Coal was tested for uniaxial compression by Mr. E. Sprouls. The strength results are provided in Table 3.1. The UCS of coal samples ranged from 548 psi to 6,856 psi and averaged 2,094 psi for 71 samples tested.

3.3 Floor Properties

The moisture content, Atterberg Limits, unconfined compression strength, clay fraction, indirect tensile strengths, and point load strengths for each floor rock unit are summarized in Table 3.2.

The most prominent fine-grained rocks in the immediate floor are silty mudstone to mudstone. The Liquid Limit for these fine-grained rocks ranges from 31% to 52% with an average of 41%, indicating the unit description of mudstone to silty mudstone (MS-$MS) based on Table 2.2. Within one standard deviation, the liquid limit and plasticity index for this fine-grained unit only range from 36% to 46% and 16% to 27% respectively, across the application area. The moisture contents in MS-$MS range from 1.5% to 12.9% with an average of 6.1% (see Table 3.2). Obviously MC in the range of 1% to about 4% were mainly limestone nodules in the MS-$MS. Removing these tests, the average MC becomes 6.4%. The mudstone to silty mudstone rocks have an average unconfined compression strength of about 1,465 psi. The strength appeared greater in core described as containing more than 50% limestone nodules. The only two indirect tensile strengths show an average strength value of 250 psi for silty mudstone. This strength was consistent with the average axial PLS of 52 psi when considering the ITS being 5 times the PLS. This strength ratio was found to be the best fit for the silty shale roof.

TABLE 3.1 HERRIN NO. 6 COAL UNIAXIAL COMPRESSIVE STRENGTHS

E. SPROULS TESTS RESULTS

Hole #	Run #	Depth (ft.)	Strength[1.] (psi)
SA-4	4	354.00	2175
SA-4	4	355.80	1593
SA-4	4	357.50	1693
SA-5		345.00	1697
SA-5		347.00	1069
SA-5		349.00	976
SA-5		351.00	6856
SA-12	3	356.70	1905
SA-12	3	358.70	1664
SA-12	3	361.20	1259
SA-16	4	377.90	1785
SA-16	4	379.90	3130
SA-16	4	382.00	1429
SA-19	3	354.00	2210
SA-19	3	357.00	1482
SA-19	3	359.50	1973
SA-20		363.00	2925
SA-20		365.20	1586
SA-20		367.50	1530
SA-26	4	368.00	2684
SA-26	4	370.70	630
SA-26	4	373.50	2153
SA-29	4	382.80	3045
SA-29	4	384.20	2507
SA-29	4	356.50	1501
SA-30	3	366.80	1919
SA-30	3	368.80	2748
SA-30	3	370.70	1941
SA-31	2	346.20	2847
SA-31	2	348.20	2075
SA-31	3	349.90	963
SA-33	3	372.00	3364
SA-33	3	374.30	2181
SA-33	3	376.70	3421
SA-39		321.00	1537
SA-39		323.00	2309
SA-39		325.00	1530

Hole #	Run #	Depth (ft.)	Strength[1.] (psi)
SA-40		333.60	2733
SA-40		335.60	3265
SA-40		337.60	2705
SA-42	3	350.20	2394
SA-42	3	352.00	864
SA-42	3	354.00	1041
SA-43	4	356.70	2387
SA-43	4	360.10	1352
SA-43	4	361.50	2036
SA-46	3	368.50	2118
SA-46	3	370.50	2082
SA-46	3	372.60	2868
SA-54	3	334.20	1523
SA-54	3	336.40	1584
SA-54	3	338.60	548
SA-61		373.20	2749
SA-61		374.60	1310
SA-61		376.00	2885
SA-63	2	328.20	4030
SA-63	2	330.20	2783
SA-63	2	332.20	2380
SA-72	2	357.00	1969
SA-72	2	359.50	667
SA-72	2	362.00	1664
SA-94	1	367.50	2620
SA-94	2	370.00	1296
SA-94	2	373.00	1756
SA-96	3	365.50	3010
SA-96	3	367.50	1967
SA-96	4	370.50	1487
SA-96	4	371.50	2276
SA-97	3	376.00	1655
SA-97	3	378.30	2323
SA-97	3	381.00	2027

[1.] Coal Strengths are for an L/D equal to one.

TABLE 3.2 PHYSICAL AND ENGINEERING PROPERTIES FOR VARIOUS FLOOR ROCK TYPES

Rock Unit	Liquid Limit (%)	Plasticity Index (%)	Clay Fraction[3.] (%)	Unconfined Compression Strength (psi)	RQD (%)	Indirect Tensile Strength (psi)	Point Load Strength (psi)		Natural Moisture Content (%)
							Dia.	Axial	
Mudstone to Silty Mudstone	41 31-52 (28)	21.7 10.5-32 (28)	29.2 27.5-30 (3)	1465.2 258-3436 (10)	52[1.] 0-83 (6)	248.5 201-296 (2)	4.4 <0.6-21.2 (11)	52.2 22.3-107.1 (6)	6.1 1.5-12.9 (323)
Limestone	-	-	-	3083 398-8608 (7)	-[2.]	680 (1)	-	10.9 (1)	3.9 0.9-6.4 (31)
Shale	-	-	-	2530.3 322-6374 (6)	67[2.] 39-83 (7)	-	20.5 6.3-34.7 (2)	235.2 (1)	4.9 3.0-8.3 (42)
Sandstone	-	-	-	-	76[2.] 69-83 (2)	-	-	-	5.0 2.1-7.4 (10)

[1.] RQD values are given for core runs which contain 90% or more of the MS-$MS unit
[2] RQD values for core runs for all floor materials. The holes which contain 30% or more of this unit were considered
[3.] Clay defined by particle sizes no more than 0.002 mm

Notes:
41 – average
31-52 – range
(28) – number of measurements

Rocks were also tested in stronger, durable zones logged as limestone, nodular limestone, silty to sandy shale with lenses of sandstone and sandstone (see Table 3.2). The average MC for limestone and shale units were 3.9% and 4.9%, respectively. For both the limestone and shale floor materials there are some higher moisture contents than expected (see Table 3.2). These moistures are the result of the presence of argillaceous or clay content in some of the selected samples. The uniaxial compressive strength (UCS) for the limestone ranges from 398 to 8,608 psi (ave. 3,083 psi). The UCS ranged from 322 to 6,374 psi and averaged 2,530 psi for the floor shales. These floor shales were clayey, silty and sandy, and carbonaceous in places. Where the shale unit has clayey material, the UCS is 4 to 5 times less than sandy shales. Similar strength variation exists in the limestone which can contain fine-grained intercalations. The limestone and shale units were determined to be resistant layers, except where clayey non-durable materials were present. Rocks with significant clay or argillaceous content are not sufficiently resistant or durable and were not considered as such in floor stability analyses.

For the sandstone unit, the measured moisture contents ranged from 2.1% to 7.4% with an average of 5.0%. Again, the higher water contents most likely represent argillaceous facies.

The rock fracturing in the floor was also summarized. RQD[3] was measured by the driller for some of the borings provided in this report (see Table 3.2). For core runs which were in the floor, the reported RQD ranged from 0 to 98% with an average of

[3] The Rock Quality Designation (RQD) is the percent of the total length of sound rock core which is of a length of 4 in. or more bounded by natural fractures (not core breaks) of the core run, or some identified core length (Deere, 1989)

73%. The value of 0 was recorded in two holes (SA-84 and SA-85) where the MS-$MS floor core was described as soft to very soft containing significant broken zones. In core runs with more than 90% of the mudstone-silty mudstone unit, the average RQD was 52% (6 holes) with a range of 0 (next lowest 71%) to 83%. Excluding the hole with zero RQD, the average becomes 78%.

3.4 Floor Swell Properties

Much of the fine-grained floor material which is present beneath the Herrin No. 6 Coal of the project site has a severe range in mechanical properties once the coal is mined out. With little confinement and exposure to moisture, such as in mine rooms, these fine-grained rocks can have egregious swell potential and consequently reduce to a soil-like consistency. Also, in floor areas with little confinement, such as in mine rooms where expansive rocks are exposed to moisture (i.e., pooling mine water), a significant suction pressure can result. This suction in effect, in addition to rock fractures, causes moisture penetration and, consequently, can result in fairly rapid rock softening. However, with confinement such as beneath the coal pillar core, these floor materials can remain fairly intact.

From our experience in investigating the floor in a number of abandoned coal mines in the Illinois Coal Basin, these non-durable fine-grained rocks can exhibit the complete range from the fully softened to intact phase. Figure 3.1 is an example of the dramatic difference of the immediate floor moisture profiles taken in the room and below the pillar. These borings were drilled in abandoned workings in the No. 6 Coal Seam where pooled water was present on the mine floor in Vermilion County, IL.

To quantify the swell potential with applied pressure, two one-dimensional tests were performed on the floor MS-$MS in a consolidometer. The results of these tests are summarized in Table 3.3 with the swell related data given in Appendix B. Also, both swell pressure versus strain curves have been superimposed and depicted in Figure 3.2. It should be noted that each load decrement was sustained until the latter stages of secondary (or tertiary) swell before reducing the load. As can be seen in Figure 3.2, swell pressures at zero vertical strain can be higher than 500 psi with free swell strains estimated up to about 31%. Although these deformation characteristics are fairly dramatic from an engineering perspective, only nominal change in the rock's consistency (i.e. nominal straining) occurs with fairly significant reduction in load (see Figure 3.2). This has been quantified on Table 3.3 by the stress (σ_{smc}) at the point of maximum curvature of the vertical swell pressure versus vertical swell strain plot. This stress point for both samples tested was 35 and 40 psi at only 2 and 3% swell strain, respectively. For the tested rocks, the liquid limit was near the overall average for the reserve at 40% and 41% with the clay fraction at 30%. Therefore, these swell test results should be most representative of the floor materials across the mine application area. The most significant differences were related to initial dry density and moisture content which could explain why the swell pressure for the sample from Boring SA89 appears higher (see Table 3.3 and Figure 3.2).

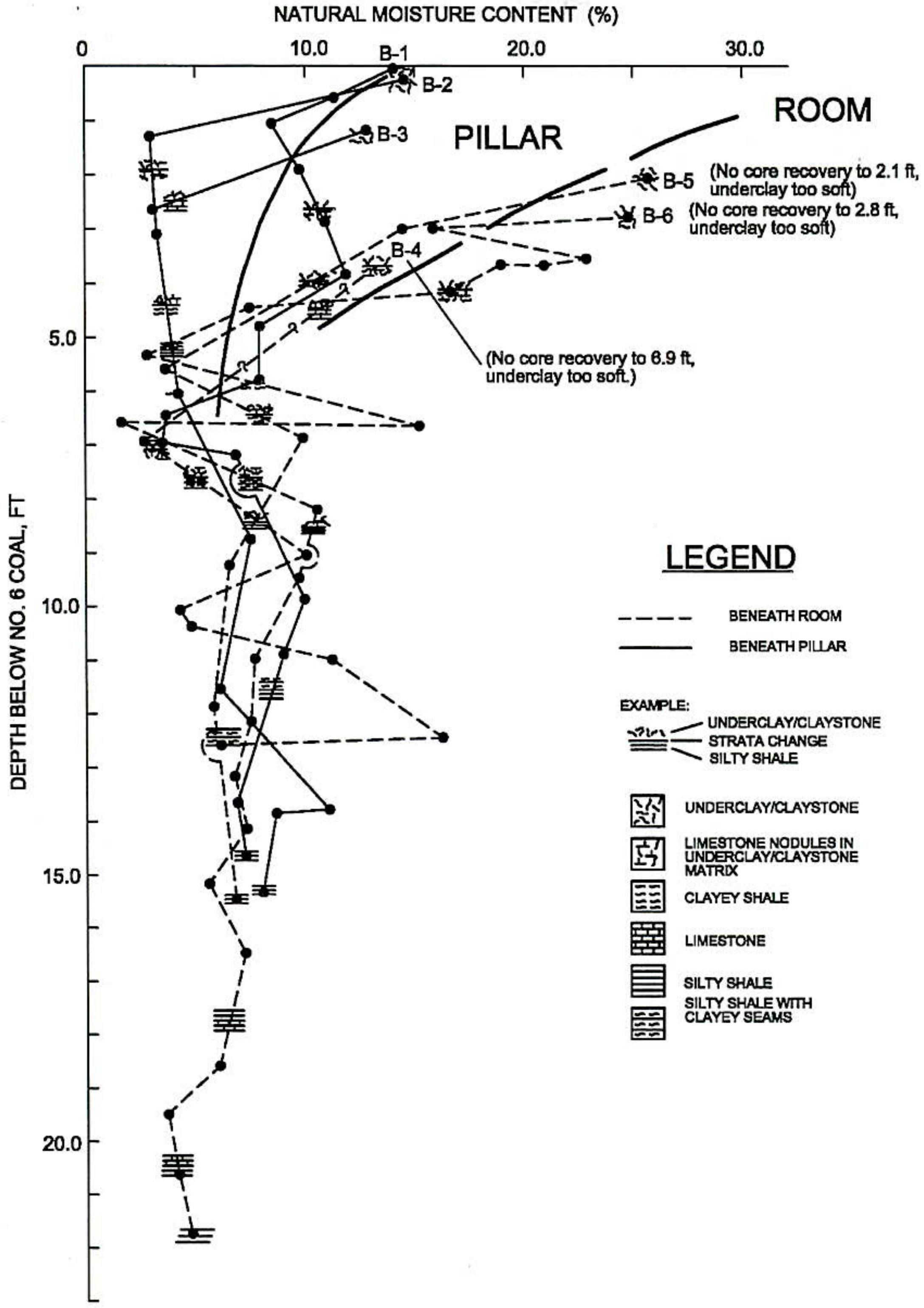


FIGURE 3.1 MOISTURE CONTENT PROFILES FOR FLOOR STRATA BENEATH PILLARS AND ROOMS FOR MINE IN NO. 6 COAL SEAM NEAR DANVILLE, ILLINOIS (MARINO, ET AL., 1982, AND MARINO AND DEVINE, 1985)

TABLE 3.3 ONE-DIMENSIONAL SWELL TEST ON INTACT FLOOR SAMPLES

Sample	LL (%)	PI (%)	CF (%)	MC_i (%)	DD_i (pcf)	σ_{smax} (psi)	σ_{smc} (psi)	ε_{smax} (%)
SA-75, 383.8 ft	40	23	30	5.3	141.3	525	40	21
SA-89, 391.6 ft	41	23	30	4.3	149.0	>350	35	31

Definitions:

CF = percent clay fraction where clay particles are defined by particle sizes of 0.002 mm or less

DD_i = Dry Density

σ_{smax} = swell pressure at zerio strain

σ_{smc} = low strain swell pressure at point of maximum curvature of vertical swell pressure versus strain

ε_{smax} = maximum swelling strain at nominal pressure

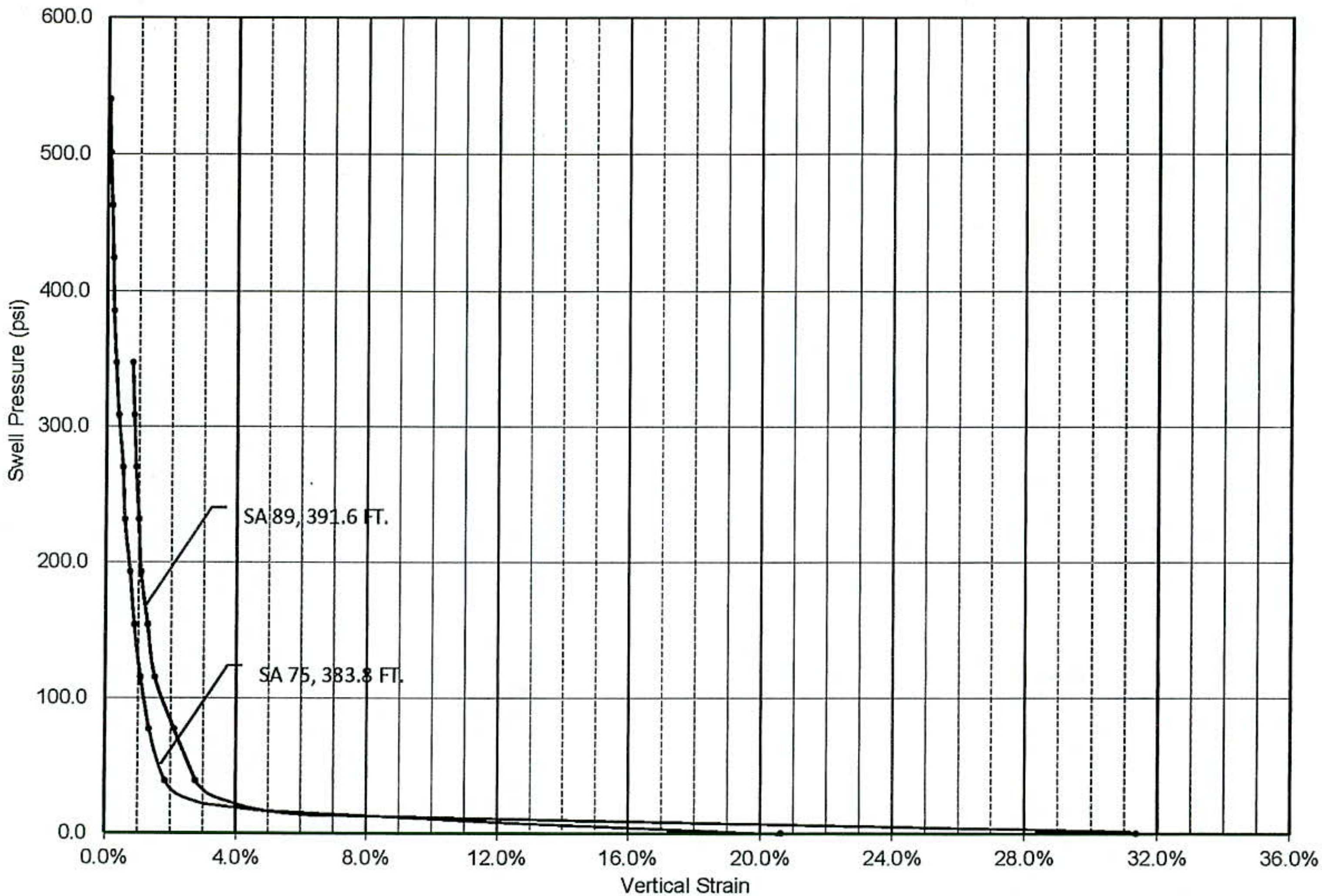


FIGURE 3.2 SWELL PRESSURE VERSUS VERTICAL STRAIN CURVES FOR THE MUDSTONE-SILTY MUDSTONE FLOOR

4.0 MINE STABILITY ANALYSIS

Surface subsidence is caused by subjacent mine instability. There are three modes of mine instability which are prominent in the Illinois Coal Basin. These are roof collapse above the rooms, pillar crushing, and floor bearing failure.[4] These failure modes are conceptually depicted in Figure 4.1. Therefore, in this report an evaluation of the long-term stability considering these various failure modes of the proposed subjacent mining was performed. Sag subsidence can result from any of the above three failure modes. Because of the depth of the coal reserve, however, pit subsidence from room-roof collapse is not expected. Bauer and Hunt, 1981, have reported that pit events have not been observed over abandoned mines at depth greater than 165 ft.

Small sag events result when the upward progression of subsidence from room-roof collapse breaches the bedrock surface. However, if the rock overburden is sufficiently thick, the upward progression is "choked off" by the bulking effect of the subjacent collapsed rubblized roof materials. In a study of active coal mines across the US, Molinda, et al. found that 71% of roof falls occurred in room intersections. Whittaker and Reddish, 1989, modeled the roof caving process for a mine room intersection to determine the maximum height of caving where:

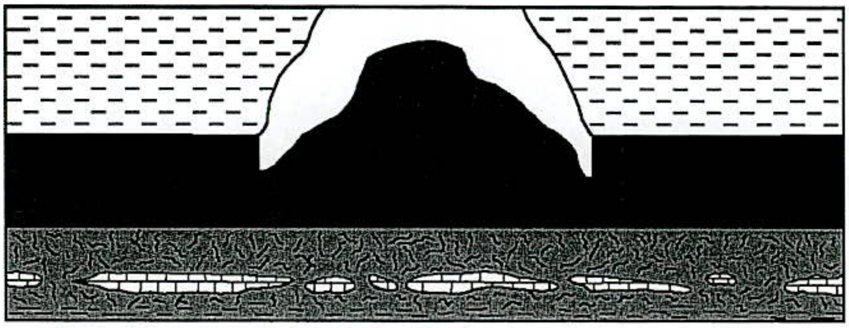
$$z=\frac{4}{(k-1)\pi D^2}\{2W_rM^2\cot\varphi+MW_r^2\} \qquad (4.1)$$

where: z = ultimate caving height

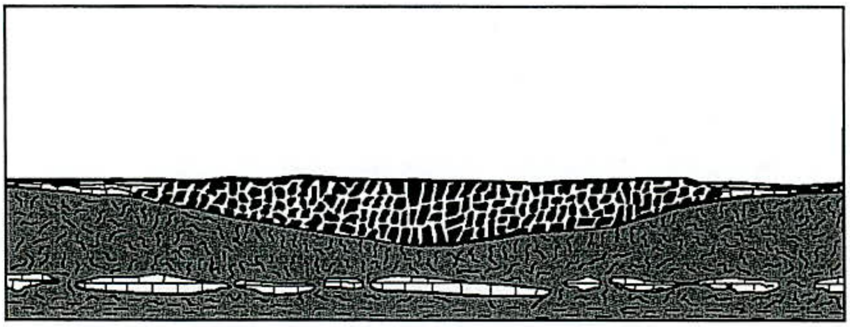
k = bulking factor, assumed at 1.5 for silty shale

D = diameter of collapse-chimney, assumed equal to W_r

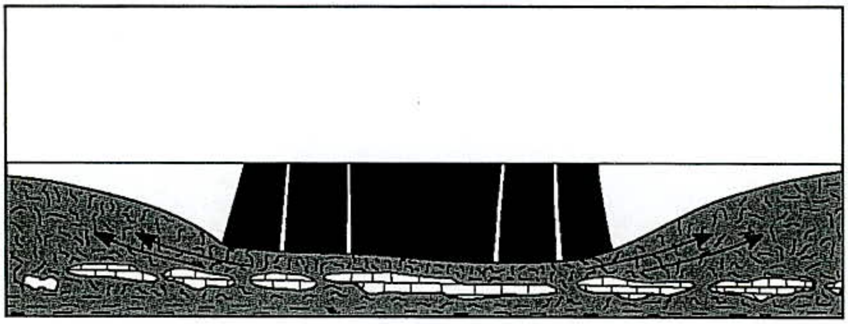
[4] Bearing failures ("roof squeezes") in the mine roof can also result when the immediate roof contains a sufficient amount of weak material. In fact, mine plans have been modified to address this mine stability issue. For example, this ground control problem was reported in the western portion of the Appalachian Coal Field (i.e. eastern Ohio) where a significant amount of claystone was found above the Pittsburgh Coal No. 8 Seam (Paul and Plein, 1935). It should be noted, however, that this is not a common bearing condition found in the area of the project site.



ROOF FAILURE ABOVE ROOM



PILLAR CRUSHING



PILLAR PUNCHING

FIGURE 4.1 SKETCHES OF THE THREE PRINCIPAL MODES OF FAILURE OF ROOM-AND-PILLAR MINE WORKINGS WHICH CAN RESULT IN SURFACE SUBSIDENCE

W_r = width of mine rooms, ft

M = excavated height of mine rooms, assumed equal to 6.5 ft

φ = angle of repose of caved rock within mine rooms adjoining collapse area. The angle of repose of the fallen roof material is assumed to equal 30°.

Note Equation (4.1) cannot be used if an overlying aquifer would be breached during the caving process. This would add a downward groundwater flow to the caved materials and therefore exacerbate the problem.

Considering the limit of the upward propagation of subsidence based only on bulking of the cave material, the height of caving is given below using Equation 4.1 with different room width, W_r:

W_r = 18 ft, z = 37 ft

W_r = 20 ft, z = 35 ft

W_r = 25 ft, z = 31 ft

Note, z increases with decreasing W_r because the spread of rubble in the room is a function of extraction height and does not increase with room width. Since the rock cover above the No. 6 Coal is at least 200 ft based on the project borings, Equation 4.1 indicates that bulking of caved material will alone preclude surface subsidence from this mechanism of failure. Therefore, room-roof stability does not play a role in the potential for surface subsidence.

5.0 PILLAR STRENGTH ANALYSIS

The capacity of the proposed coal pillars for Allerton Reserve is assessed using the Mark- Bieniawski pillar strength relationship (Mark, 1999):

$$S_p = S_1(0.64+0.54W_p/H_p-0.18\left(W_p^2/L_p H_p\right)) \tag{5.1}$$

where:
- S_p = pillar strength
- W_p = pillar width
- L_p = pillar length
- H_p = pillar height
- S_1 = in situ coal cube strength - 900 psi is assumed based on Mark (1990). Based on Mark and Barton (1997), the laboratory tests measure the intact coal strength that is apparently irrelevant to the in situ strength.

This pillar strength equation and use of 900 psi cube strength are the industry standards and are used in both the ARMPS and LA model programs.

The vertical pressure exerted by the overburden on these pillars can be determined from the tributary pressure, $\sigma_{pt,}$ where:

$$\sigma_{pt}=\frac{WD_s(S)+WD_{rx}(RX)}{1-e} \tag{5.2}$$

where:
- σ_{pt} = tributary pressure in psi
- WD_s = average wet density of the soil cover = 135 pcf
- S = soil cover thickness
- WD_{rx} = average wet density of the rock cover = 165 pcf
- RX = rock cover thickness
- e = extraction ratio

Therefore, the safety or stability factor, SF, becomes for first mining conditions:

$$SF = \frac{S_p}{\sigma_{pt}} \qquad (5.3)$$

For a long-term stability a factor of safety of 2.0 is recommended.

Using the above equations and considering a safety factor of 2.0, the allowable extraction ratio on a hole to hole basis assuming square pillars and 18 ft and 20 ft wide rooms is provided in Tables 5.1 and 5.2, respectively.

TABLE 5.1 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH FOR SQUARE PILLARS AND 18 FT WIDE ROOM USING PILLAR STRENGTH CRITERIA

SECTION/BOREHOLE	OVERBURDEN SOIL THICKNESS, FT	OVERBURDEN ROCK THICKNESS, FT	DEPTH OF COAL, FT	THICKNESS OF COAL, FT	VERTICAL OVERBURDEN STRESS[1], PSI	STRESS IN PILLAR, PSI	ALLOWABLE COAL PILLAR STRENGTH[2], PSI	PILLAR WIDTH, FT	EXTRACTION RATIO
	S	Rx	D_{coal}	t_{coal}	σ_v	S_{tp}	S_{pa}	W_P	e
SA4	52	302	354	3.93	395	1244	1245	23.2	0.68
SA5	74	271	345	6.75	380	990	991	29.3	0.62
SA12	43	314	357	6.17	400	1049	1051	29.1	0.62
SA16	113	265	378	4.77	410	1172	1172	26.0	0.65
SA19	34	320	354	5.87	398	1067	1068	28.3	0.63
SA20	50	312	362	5.96	405	1065	1069	28.9	0.62
SA26	32	335	367	6.61	414	1040	1041	30.8	0.60
SA29	80	303	383	4.6	422	1204	1207	26.1	0.65
SA30	35	332	367	3.85	413	1281	1283	23.6	0.68
SA31	28	318	346	4.2	391	1206	1206	23.8	0.68
SA33	41	331	372	5.22	418	1142	1142	27.5	0.63
SA39	95	224	319	6.25	346	976	975	26.5	0.65
SA40	32	301	333	5.53	375	1060	1061	26.4	0.65
SA42	38	312	350	6.2	393	1037	1040	28.8	0.62
SA43	35	321	356	6.53	401	1026	1032	30.0	0.61
SA46	156	211	367	6.28	388	1028	1028	28.7	0.62
SA54	55	279	334	6.45	371	996	996	28.2	0.63
SA61	126	247	373	4.48	401	1189	1190	25.0	0.66
SA63	119	209	328	5.22	351	1052	1052	24.6	0.67
SA72	43	314	357	6.43	400	1034	1035	29.6	0.61
SA94	57	310	367	6.22	409	1055	1058	29.7	0.61
SA96	23	342	365	6.90	414	1024	1025	31.4	0.60
SA97	51	324	375	6.35	419	1063	1063	30.4	0.61

Notes:

1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using Mark-Bieniawski (1999) pillar strength formula. Safety factor of 2 was assumed. Pillars assumed to be square. Coal strength of 900 psi assumed.

TABLE 5.2 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH FOR SQUARE PILLARS AND 20 FT WIDE ROOM USING PILLAR STRENGTH CRITERIA

SECTION/BOREHOLE	OVERBURDEN SOIL THICKNESS, FT	OVERBURDEN ROCK THICKNESS, FT	DEPTH OF COAL, FT	THICKNESS OF COAL, FT	VERTICAL OVERBURDEN STRESS[1], PSI	STRESS IN PILLAR, PSI	ALLOWABLE COAL PILLAR STRENGTH[2], PSI	PILLAR WIDTH, FT	EXTRACTION RATIO
	S	Rx	D_{coal}	t_{coal}	σ_v	S_{tp}	S_{pa}	W_P	e
SA4	52	302	354	3.93	395	1300	1300	24.6	0.70
SA5	74	271	345	6.75	380	991	991	32.5	0.62
SA12	43	314	357	6.17	400	1051	1051	32.2	0.62
SA16	113	265	378	4.77	410	1172	1172	28.9	0.65
SA19	34	320	354	5.87	398	1068	1068	31.4	0.63
SA20	50	312	362	5.96	405	1069	1069	32.0	0.62
SA26	32	335	367	6.61	414	1041	1041	34.2	0.60
SA29	80	303	383	4.6	422	1207	1207	28.9	0.65
SA30	35	332	367	3.85	413	1283	1283	26.2	0.68
SA31	28	318	346	4.2	391	1259	1259	25.2	0.69
SA33	41	331	372	5.22	418	1142	1142	30.6	0.63
SA39	95	224	319	6.25	346	975	975	29.5	0.64
SA40	32	301	333	5.53	375	1061	1061	29.3	0.65
SA42	38	312	350	6.2	393	1081	1081	30.3	0.64
SA43	35	321	356	6.53	401	1071	1071	31.5	0.63
SA46	156	211	367	6.28	388	1028	1028	31.9	0.62
SA54	55	279	334	6.45	371	996	996	31.3	0.63
SA61	126	247	373	4.48	401	1190	1190	27.7	0.66
SA63	119	209	328	5.22	351	1052	1052	27.4	0.67
SA72	43	314	357	6.43	400	1035	1035	32.9	0.61
SA94	57	310	367	6.22	409	1058	1058	32.9	0.61
SA96	23	342	365	6.90	414	1065	1065	33.1	0.61
SA97	51	324	375	6.35	419	1106	1106	32.1	0.62

Notes:

1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using Mark-Bieniawski (1999) pillar strength formula. Safety factor of 2 was assumed. Pillars assumed to be square. Coal strength of 900 psi assumed.

6.0 FLOOR BEARING CAPACITY ANALYSIS

6.1 Introduction

The methodology used to analyze the floor bearing capacity is described in Marino and Osouli, 2012. The most relevant information to the design of the mine floor has been provided, however, herein.

The geotechnical analysis given herein considered the influence of softening in order to determine the allowable bearing capacity of the No. 6 Coal mine floor. Given the pressure versus swelling strain characteristics discussed in Section 3.4, the geotechnical properties of the floor fine-grained rock will correspondingly vary because of the confining pressure changes from under the mine room to pillar. Under soaking with little to no confining pressures, the floor materials can soften to soil-like consistency. Consequently, the conventional equations used to determine floor bearing capacity are not very accurate, as they assume uniform material properties.

The inherent limitations of other methods to estimate the floor bearing strength, which results from their assumptions are as follows: 1) assume one or two homogenous layers; 2) assume layers are frictionless cohesive materials; and 3) use Mohr-Coulomb failure criterion. Plate strength tests also have shortcomings as the ultimate bearing load is affected by 1) the rate of loading or strain; 2) only the immediate floor is sheared zone below the plate; 3) an accentuated effect of fairly thin harder zones or lenses, or nodules within the zone of shearing; and 4) uncertainty about long-term strength parameter values.

In addition to the above, the use of the Vesic-Speck Method (Speck, 1979), which is used in the Illinois Basin also has shortcomings. This method estimates the floor bearing strength from floor moisture. No consideration is made for moisture increase when the floor becomes wet and softened. As can be seen in Figure 3.1, the floor moisture clearly increases over time. Furthermore, the assessment of the thickness of the weak floor based on the moisture profile seems entirely arbitrary.

In order to model the behavior of the floor under pillar induced stress, extensive FEM analyses had been performed. Because of the swelling and softening properties of the MS-$MS unit, the model construction considered the floor with fully softened, partially softened and unsoftened zones (see Figure 6.1).

The analysis of the mine floor bearing capacity includes the use of numerical analysis where the material stiffness and strength can be selected in locations anticipated to have different ranges in confining stress. The ultimate bearing capacity was then determined by making a correction for these material changes based on results from 2-dimensional FEM analysis to the capacity calculated from well-established bearing equations. The FEM adjustment or correction was taken as the ratio for the softened to unsoftened average peak pillar stress for certain pillar to room width ratios, W_p/W_r, and floor conditions.

To model the floor profile conditions, the following factors had to be evaluated:

- The immediate floor thickness of the non-durable, weak, fine-grained rock.
- Representative material properties of the immediate, non-durable, weak floor profile.
- The thickness of the underlying durable, bearing resistant zone.
- Representative material properties of the bearing resistant zone.

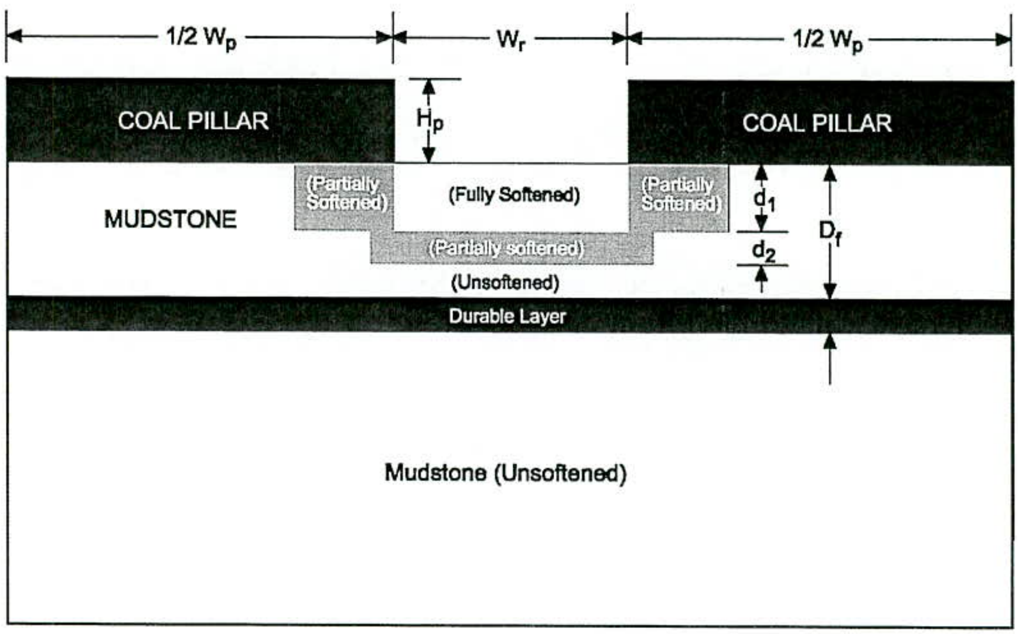


FIGURE 6.1 PILLAR - FLOOR MODEL GEOMETRY SHOWING SOFTENED, PARTIALLY SOFTENED, UNSOFTENED AND DURABLE (RESISTANT) ZONES.

- Representative material properties of the underlying weak, fine-grained rock of unlimited extent.

The thickness or depth of the non-durable weak floor, D_f, was established for each project boring where sufficient data was available. Thickness was determined by the depth to the first resistant bearing layer. The most immediate bearing resistant zone in the mine floor was defined by about 2 ft or greater of durable rock. The rock was considered durable if it had an overall DuroIndex rating of slightly non-durable to durable.

6.2 Material Properties

The FEM analysis results used in this investigation assumed the immediate, non-durable, weak floor material to be a mudstone with the following characteristics:

Ave. Liquid Limit:	44%
Ave. Plasticity Index:	25%
Ave. Clay Fraction:	28%
Ave. Natural Moisture Content:	7.0%

The immediate non-durable floor in the Allerton Reserve has the following properties:

Ave. Liquid Limit:	41%
Ave. Plasticity Index:	21.7%
Ave. Clay Fraction:	29%
Ave. Natural Moisture Content:	6.1%

As can be seen from comparing the above characteristics, the modeled material is more plastic than at the project site. Also, based on the swell tests performed, the average pressure of MS-$MS unit at the maximum swell stress-strain curvature (σ_{smc}) is less (i.e. 38 psi compared to 50 psi). Therefore, it would be expected that the softening potential would be less and overall strength would be greater than the assumed model properties.

Another material analysis which was performed was to determine the weighted average fully softened friction angle (Skempton, 1977, Terzaghi, et. al., 1996). This friction angle was determined on a hole to hole basis for the immediate MS-$MS unit (see Appendix A). The fully softened friction angle was assumed based on the liquid limit and the presence and intensity of slickensides. Where abundant slickensides were present, the friction angle was reduced to the residual value. The friction angles assumed for the various beds within the mudstone-silty mudstone unit are provided in Table 6.1. From the available borehole and laboratory data, the overall MS-$MS unit average friction angle is 27°. This weighted average friction angle for modeled case was between 26° and 27° and therefore lower than for the Allerton Reserve. Therefore, based on the above, the use of the analysis results provided in Marino and Osouli, 2012 should be conservative for floor design for the Allerton Reserve.

Consolidated-drained triaxial tests were run on various fine-grained floor samples of the modeled reserve. Each sample was allowed to swell by inundating it in water under a slight back pressure. The changes in length of the sample were noted against time to study the swelling of the material. Because these were indurated fine-grained rocks, this stage took a considerable amount of time to complete. Once the sample reached the latter stages of secondary swell, it was sheared under drained triaxial loading conditions by applying a vertical load. Based on these tests, an unsoftened

TABLE 6.1 FULLY SOFTENED FRICTION ANGLES ASSUMED FOR BEDS IN THE MUDSTONE-SILTY MUDSTONE UNIT

Unit	Friction Angle
SILTY MUDSTONE	
SLI $MS, FREQ SLK	25
CB, $MS, DISC SLKS	26
$MS, DISC SLKS	26
$MS , OCC SLK	27
V.$MS, DISC SLKS	27
SLI $MS DISC SLKS	27
$MS	28
SLI, $MS	28
$MS w/20% LS NOD	28
MUDSTONE TO SILTY MUDSTONE	
MS-$MS, MANY DISC SLKS	23
MS-$MS, SLKS	23
MS-$MS, DISC SLKS	25
$MS-MS, DISC SLKS	25
CB, MS-$MS, DISC SLKS	25
MS-$MS, OCC SLKS	26.5
$MS-MS, OCC SLKS	26.5
MS-$MS, FEW SLKS	26.5
MS-$MS, SM DISC SLKS	26.5
MS-$MS, FEW, SM, DISC SLKS	27.5
MS-$MS	27.5
CB, MS-$MS	27.5
MUDSTONE TO SILTY MUDSTONE W/ LS	
MS-$MS w/ NOD?, SLKS throughout	23
MS-$MS, trace LS NOD, Several SLKS	23
MS-$MS, w/ 10% LS NOD, DISC SLKS	25
MS-$MS, trace LS NOD, OCC SLKS	26.5
MS-$MS, w/ LS NOD, DISC SLKS	27.5
MS-$MS, 10% LS NOD	27.5
MS-$MS, w/30% LS NOD	27.5
MS-$MS w/ 40% LS NOD	29
MS-$MS w/ LS NOD, sparse DISK SLKS	30
MS-$MS w/ 50% LS NOD	30
MS-$MS w/ LS NOD	32.5
MUDSTONE	
MS-DISC SLKS	26
MS	27
LIMESTONE	
LS	35
LS NOD at base	35
NOD LS	35
NOD LS, MAS	35
SHALE	
Sandy SH	28
CB SH	28

friction angle of 29° and cohesion of 109 psi were assumed in the FEM model for the mudstone (see Figure 6.2).

As can be seen in Figure 6.2, there is a significant difference in the strength of the fully softened (remolded) and the intact phases of the rock material despite both phases being subjected to confining pressures of up to 500 psi. The p-q[5] diagram in Figure 6.2 also shows a consistent trend of increased triaxial strength for intact samples with a decrease in rock plasticity. Also, the difference in rate of increase and magnitude of the modulus with confining pressure between the fully softened reconstituted and intact samples are shown in Figure 6.3.

The stiffer and stronger fine-grained intact floor rocks compared to compacted samples of the same material is essentially due to aggregation of clay particles over geologic time. In fact, it is interesting to note that the method of sample preparation affected the Liquid Limit with the pulverized samples having a Liquid Limit 2 to 4% higher than the air slaked samples thus indicating additional breakdown of aggregated particles resulted when the floor rock was pulverized and then soaked. The effect of particle aggregation could also be seen, at least in part, with the increase in the Liquid Limit with the number of slake cycles the sample had undergone.

Based on the D_f data at the boring locations, the depth of weak, non-durable rock, varies across the reserve from 0 to 13 ft or more. The shallowest durable beds appear to exist in the southern and central parts of the application area. Depth to the resistant zone in these areas seem to be less than 4 ft. The resistant zones encountered were units described as limestone, shale or sandstone and are also

[5] p-q diagram is a scheme for plotting the state of stress at a point by plotting $(\sigma_1-\sigma_3)/2$ versus $(\sigma_1+\sigma_3)/2$

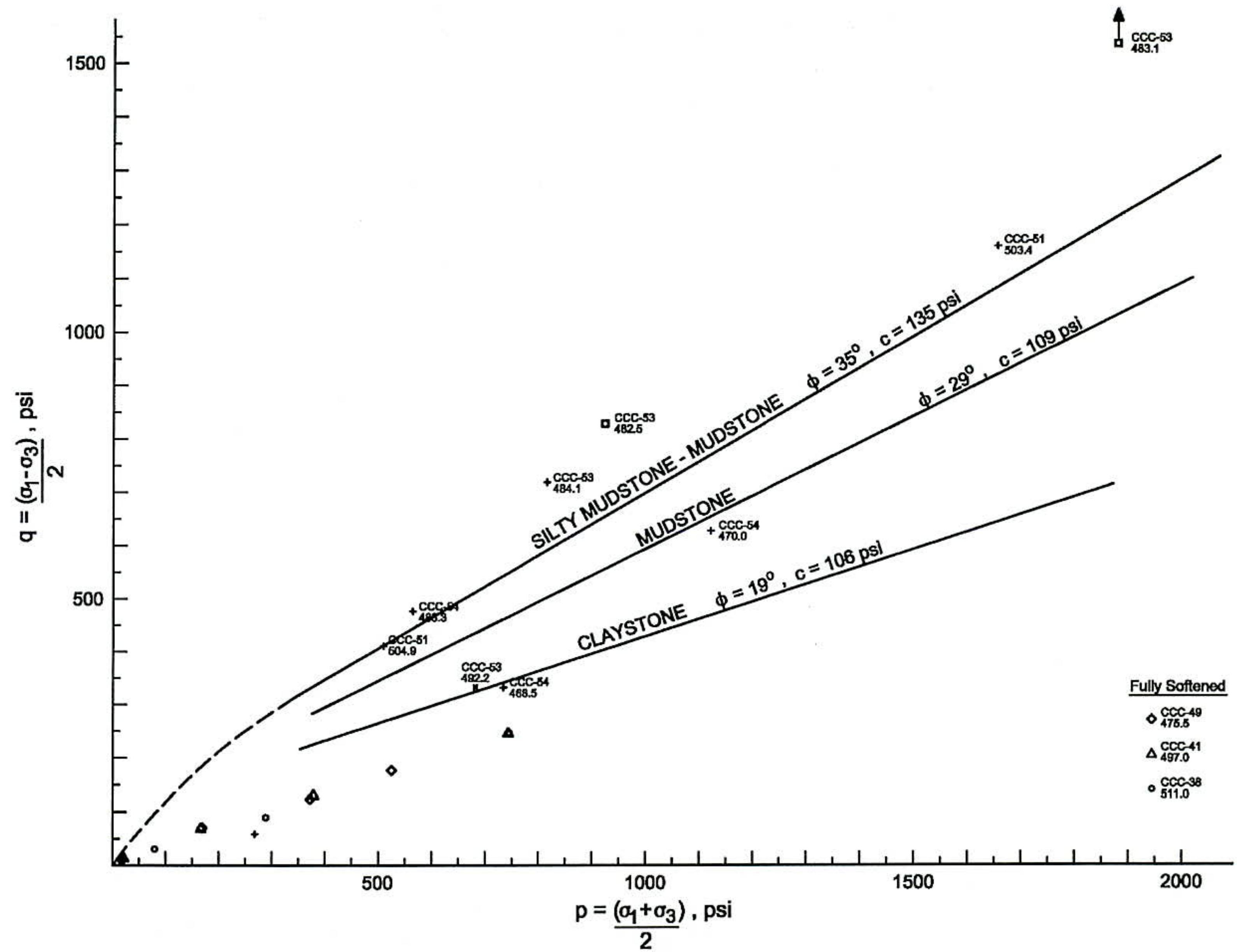
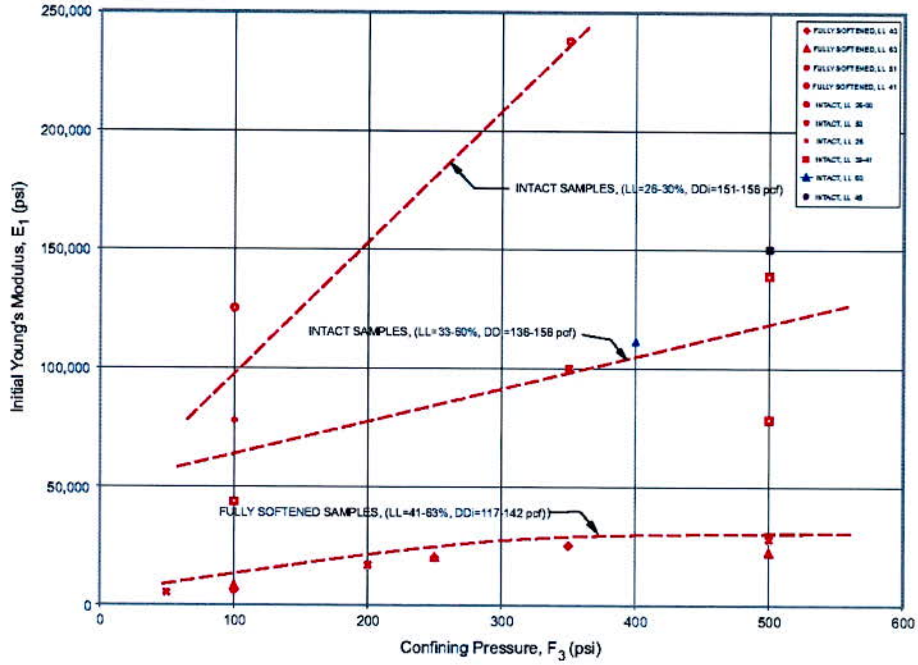


FIGURE 6.2 SOAKED FULLY-SOFTENED COMPARED TO INTACT (CONSOLIDATED-DRAINED) TRIAXIAL TEST RESULTS ON FINE-GRAINED FLOOR SAMPLES



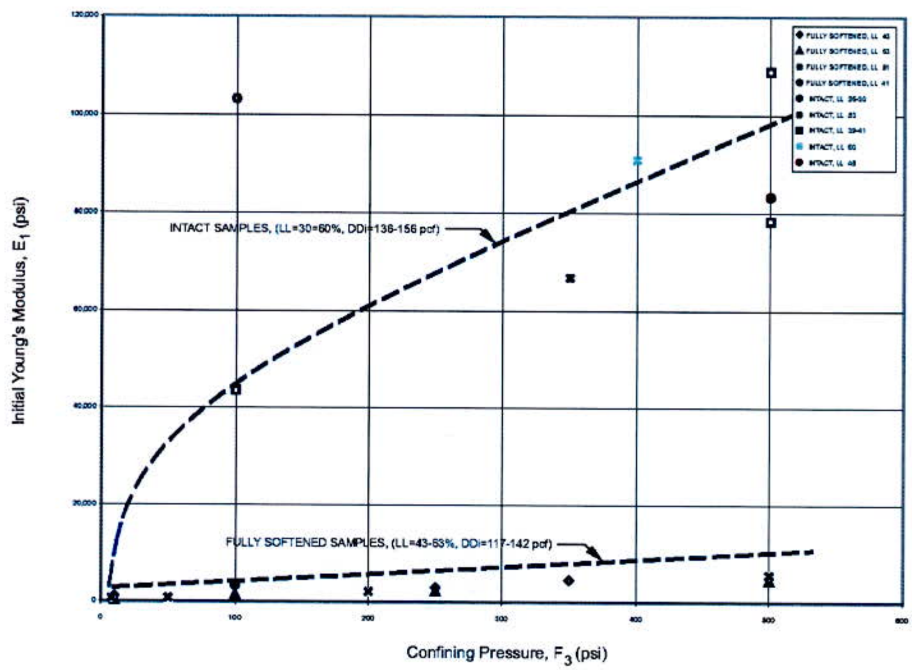


FIGURE 6.3 EFFECT OF CONFINING PRESSURE ON INITIAL AND OVERALL YOUNG'S MODULUS FOR FINE-GRAINED FLOOR MATERIALS

discussed in Section 2. In the northern part of the application area, little data is available.

Based on the triaxial testing summarized above, the mudstone was assumed in the modeling to have a rock density of 135 pcf with the following strength properties presented in Table 6.2.

In the numerical model, the Young's Modulus for the various mudstone stages was determined according to its overall value and its relationship with confining pressure as shown in Figure 6.3. Also, in order to incorporate the reduction in strength from peak to residual condition, strain softening model elements were used in the numerical analysis to reach a residual state.

Several resistant units were considered in the modeling. These were a carbonaceous zone, siltstone-sandstone and silty limestone. Their associated properties assumed in the FEM analysis are given in Table 6.3. Rock densities were taken at 100 pcf for the carbonaceous zone and 150 pcf for the other resistant materials. The initial Young's Modulus for both the siltstone-sandstone and silty limestone and for the No. 5 carbonaceous zone were assumed to be 1.5×10^5 psi and 1.0×10^5 psi, respectively. The increase in modulus with confining pressure assumed in the floor model for these rocks was extrapolated for siltstone from the triaxial data. Strain softening elements were also used for the durable rock layers as well as for the fine-grained materials.

TABLE 6.2 STRENGTH PROPERTIES OF MUDSTONE

MUDSTONE	FRICTION ANGLE		COHESION	
	Peak	Residual	Peak	Residual
Fully Softened	25•	19•	0	0
Partially Softened	29•	19•	50 psi	0
Unsoftened	29•	19•	109 psi	0

TABLE 6.3 ASSUMED STRENGTH PROPERTIES FOR DIFFERENT MATERIALS

	FRICTION ANGLE		COHESION	
	Peak	Residual	Peak	Residual
No. 5 CARBONACEOUS ZONE	16•	16•	1,650 psi	0
SILTSTONE-SANDSTONE	35•	35•	2,910 psi	0
SILTY LIMESTONE	35•	35•	3,810 psi	0

6.3 FEM Model Geometry and Loading Conditions

The effect of floor softening on the ultimate bearing capacity of coal mine floor was evaluated using a 2-dimensional numerical analysis. The FEM analysis was carried out with SMAP-2D which has the versatile ability to simulate geotechnical and structural problems. As shown in Figure 6.1, the 2-dimensional numerical model consists of a room and two half-width coal pillars, with a floor of softened and unsoftened mudstone which may include a durable, resistant layer. This room-and-pillar configuration was taken to allow passive wedge development across the centerline of the entry, as well as to eliminate other boundary condition effects with modeling. Also, the numerical model contained two half-width coal pillars based on the assumption of symmetric behavior of mudstone underlying the coal pillar. Plane strain behavior was assumed for the numerical model and a symmetric mesh about vertical centerline was used. The vertical boundaries at the centerlines of two coal pillars are horizontally constrained. The bottom horizontal boundary which is located around 2.5 times of opening width below the room was constrained in the vertical direction as shown in Figure 6.4.

The analysis considered a room width, W_r, equal to 20 ft and pillar width, W_p, based on pillar to room width ratios, W_p/W_r, of 1, 2, 3, 4, 5, and 6. Assuming 20 ft room width provides slightly less bearing resistance than for 18 ft and is therefore conservative if smaller room widths are considered. The height of the pillar was taken as 8 ft. The depth of model below the coal mine was equal to 50 ft which is around 2.5 times of width of the excavation.

FEM analyses were performed on both softened and unsoftened floor cases. In the room, the immediate mine floor is assumed to become fully softened and to reach a

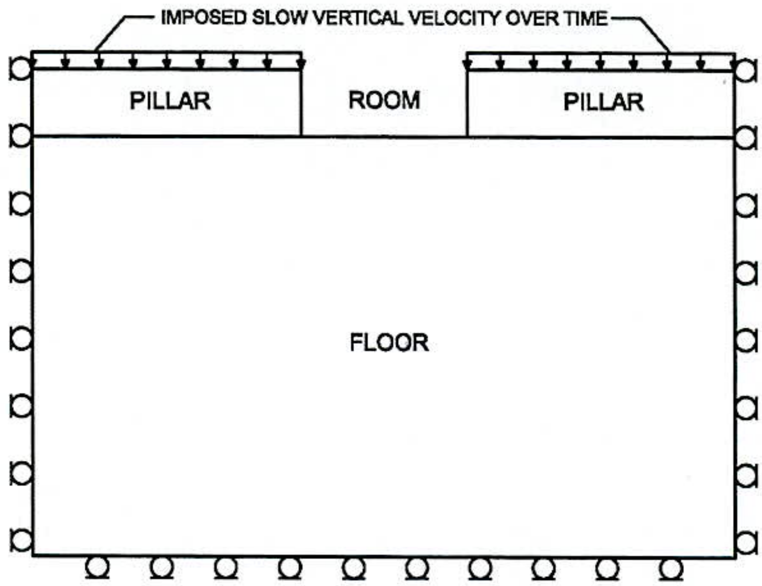


FIGURE 6.4 FLOOR LOADING AND BOUNDARY CONDITIONS ASSUMED IN THE FEM ANALYSIS

depth of one half of room width based on Marino and Choi, 1999. Also, at the same depth as the fully softened zone, a 10 ft wide partially softened zone adjacent to the softened zone and under the pillar were assumed. A partially softened zone was taken under the pillar because of the significant drop of confining pressure below the pillar perimeter (see Figure 6.1). A 5 ft partially softened zone was also placed below the fully-softened material below the room in the FEM model. The effect of floor softening was then studied by comparing the ultimate bearing stress for both softened and unsoftened profile cases.

In the modeling, the rock type, depth, D_f, and thickness, T, of the bearing resistant durable layer were varied. The durable layer was assumed not to be softened and restricted the depth of floor softening to the depth of the durable layer. Taking into consideration the range of floor conditions, the ultimate bearing pressure was determined for certain D_f/W_p and W_p/W_r ratios.

In the FEM analyses, all floor materials are considered homogeneous, isotropic, and non-linear with elasto-plastic characteristics. Elements used to simulate material behavior in the engineering model in SMAP have non-linear, elasto-plastic, as well as strain-softening properties. The engineering model requires peak and residual shear strength and can simulate the gradual strain softening to residual condition after failure (peak). The engineering model can also simulate the non-linear relationship between modulus and confining pressure for both loading and unloading conditions. In addition to being more representative of the actual material properties, use of this type of element allows for a more definitive load-displacement failure to be determined compared to the ever increasing bearing load obtained with displacement when merely using an elasto-plastic element. The coal pillars were considered to be elastic in the model having a relatively stiff modulus in order to simulate rigid body behavior during settlement.

The coal mine was assumed to be located 500 ft below a horizontal ground surface, and the overburden stress is applied on the top of the coal layer to simulate the overburden load. To account for these pre-mine geostatic stresses, the numerical model had to be stabilized before extraction. During the stage of initial stabilization, the overburden pressure of 555 psi (which is equivalent to about 500 ft of cover) was applied incrementally in order for the model to reach the geostatic conditions and to reduce the dynamic loading effect. The assumed initial state of stress is expected to have little effect on the modeling results.

The mine entry was sequentially excavated after the overburden loading on top of the numerical model was stabilized. During the sequential coal extraction, the two coal pillars were constrained from vertical settlement in order to prevent uneven initial settlement of coal pillars during the coal extraction stage. After coal extraction, the tops of pillars were vertically displaced downward by applying a very slow velocity so that significant dynamic forces were not generated in the elements. This loading condition is analogous to a plate load test. During the imposed constant rate of settlement, the average vertical stress in elements across the coal pillar was calculated with vertical displacement of the pillar. From the plot of average pillar stress versus displacement, the ultimate bearing strength of the mine floor was determined.

Before carrying out a detailed analysis, a careful study for determining mesh configuration was done. Numerous testing runs had to be executed to study the stability of the mesh and to see if the FEM model converged to the right solution. This was done mainly by changing the element size and determining the element size at which less than 5% change in the results occurred upon changing the element size. Moreover, analyses of the computed trends as discussed in Section 6.4 are reasonable, which also validates the results obtained. Once the proper mesh configuration was determined, the numerical analysis was carried out for different durable layer types, thicknesses and depths for the softened condition. It is important to point out that some of these cases were run several times to check mesh stability. In addition to the listed cases, additional analysis was done using the same meshes for the unsoftened floor material case (with no resistant zone). Computer runs were done for durable rock type; carbonaceous shale, siltstone/sandstone and limestone units. For each rock unit, the analysis was done for different combinations of durable rock thickness (T) and depths (D_f). In addition to the above, other FEM runs were done for no durable layer for both softened and unsoftened cases. Some of the investigated cases, especially for pillar to room width ratios greater than 3, required intensive computing resources and took computation trial times as long as 3 weeks to finish.

6.4 FEM Analyses Results

To investigate the effect of durable layer type, thickness and depth on floor stability, a series of plots were constructed using the data obtained from the FEM. The plots show the relationship between the pillar to room width ratio (W_p/W_r) and the bearing capacity ratio (C_s). The bearing capacity ratio (or the correction for softening and the presence of durable layer) is defined as the ratio of the maximum mobilized floor strength for the softened condition with a durable layer to the unsoftened maximum mobilized floor strength without a durable layer.

Figure 6.5 shows the effect of floor softening on the floor resistance where no durable zone is present. Even at a high W_p/W_r ratio of 6, the bearing capacity ratio only reaches 0.91.

Figures 6.6a through 6.6d show the plots for durable carbonaceous zone layer cases. These figures show that at W_p/W_r ratio equal to 1, the thickness and depth of the durable layer has no effect on the bearing capacity ratio. It is interesting to note that the C_s value for the no durable layer case and all durable layer cases was found to be the same and equal to about 0.28. The only exception was the case when D_f was 5 ft; in this case the C_s value was determined to be 0.5 at W_p/W_r equals to 1. Figure 6.6 shows that for D_f equal to or greater than 15 ft and for T values of 2 to 3 feet there is little increase ranging from 2 to 10% in C_s values when compared to the case of nondurable floor. On the other hand, for D_f of 10 ft or less, the increase in C_s values ranges from 10 to 60%. At D_f of 20 ft, the plots for T values of 2 and 3 ft coincided perfectly showing that at such depth the variation in thickness from 2 to 3 ft has no effect on C_s value.

A similar finite element analysis was done for the siltstone/sandstone durable zone and the results are presented in Figures 6.7a and 6.7b. The analysis was done for two durable zone thicknesses of 2 and 6 ft for W_p/W_r values ranging from 1 to 4. For a durable layer thickness of 2 ft, the beneficial effect of the durable zone vanishes at a depth of 12 ft and greater. Changing the durable layer thickness from 2 ft to 6 ft caused appreciable increase in C_s values.

Finally the analysis was done for a 2 ft thick limestone durable layer located at 3 different depths of 10, 14 and 18 ft. The analysis shows that at D_f of 10 ft, the C_s value is 6% higher than the C_s value for no durable layer case. For D_f values of 12 and

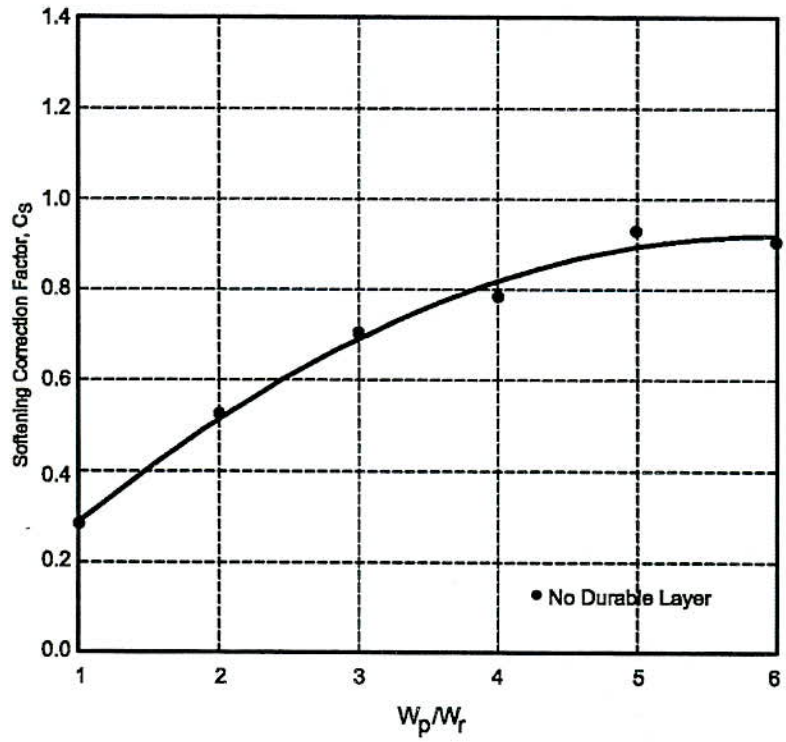


FIGURE 6.5 THE EFFECT OF FLOOR SOFTENING WITH NO DURABLE ZONE ON THE BEARING CAPACITY RATIO (C_S)

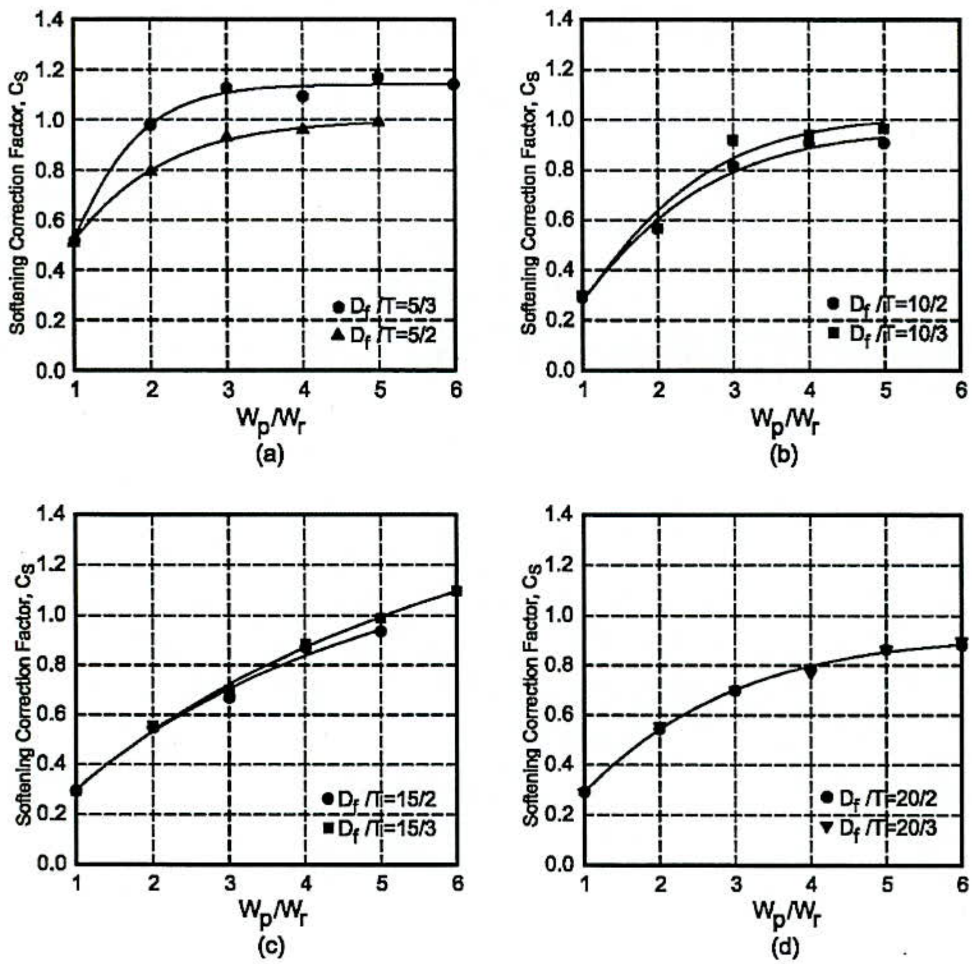


FIGURE 6.6 VARIATION OF C_S WITH W_p/W_r FOR DIFFERENT DEPTHS AND THICKNESSES OF THE DURABLE CARBONACEOUS ZONES

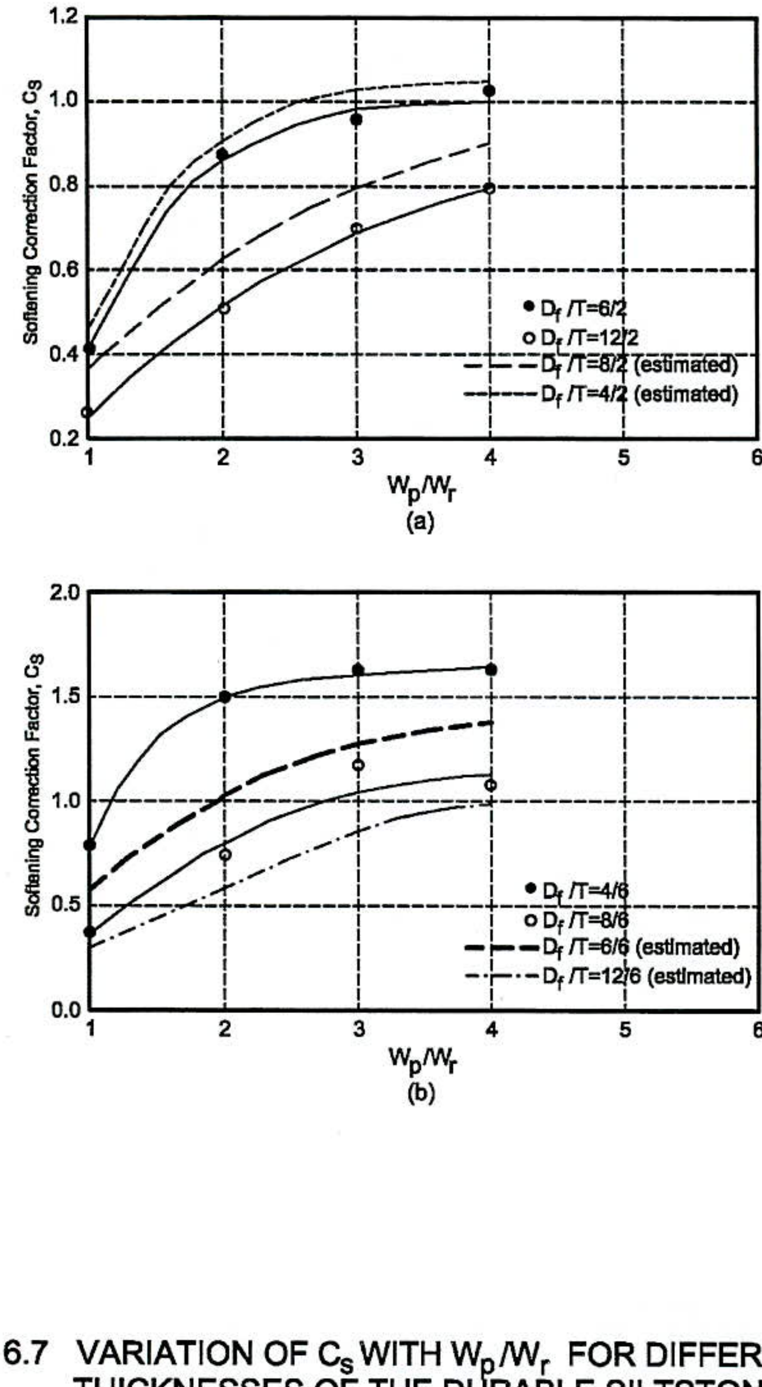


FIGURE 6.7 VARIATION OF C_s WITH W_p/W_r FOR DIFFERENT DEPTHS AND THICKNESSES OF THE DURABLE SILTSTONE/SANDSTONE ZONES

greater, a durable limestone layer of 2 ft did not seem to improve C_s values at the same W_p/W_r and was roughly the same as that of the no durable layer case. The results of the analysis are presented in Figure 6.8.

Using the results obtained from the finite element analysis it was possible to develop a series of best fit curves that describe the relationships between W_p/W_r and C_s for different combinations of durable layer thicknesses, rock types and depths. As can be seen from the previous plots these curves nicely fit the analysis results. Developing these curves is critical for determining the extraction ratios for different combination of durable zones types, thicknesses and depths. This is described in detail in Section 6.6 which covers the floor design analysis.

6.5 Operation Bearing Strength Assessment

The above laboratory strength and FEM parameters assessment do not include insitu effects or a comparison with actual failure capacities. In order to calibrate bearing capacity assessments discussed above, a reduction factor, R, should be applied for the rock mass condition.

Operational strength assessment for fine grained mine floors have been discussed in Ganow (1975) and Speck (1979). Ganow (1975) compared uniaxial compression strength of fine grained floor material of fissure versus intact samples and estimated R to be in the range of 0.35 for "underclays" and 0.6 for "shale". The reduction factor was also determined by Speck (1979) by comparing triaxial strengths and plate load tests performed on the Illinois Coal Basin floor. Speck (1979) determined for "underclay" that 0.15 to 0.22 and 0.43 were appropriate for R value in two different mine sites. It should be noted the lower R range was in an Illinois Basin mine which

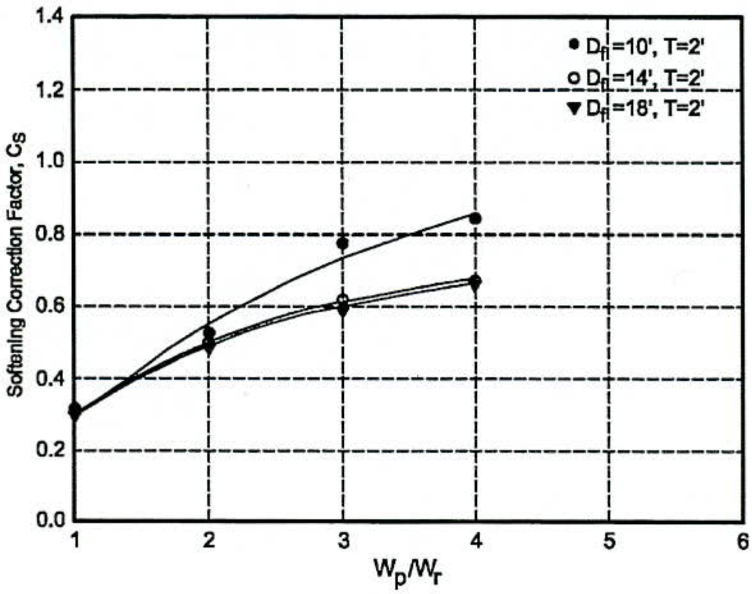


FIGURE 6.8 VARIATION OF C_S WITH W_p/W_r FOR TWO FT THICK SILTY LIMESTONE LAYER LOCATED AT DIFFERENT DEPTHS

reportedly contained 'highly fissured underclay' floor. For "claystone" the R value of 0.6 was determined. Another method to evaluate the rock mass strength was developed by Hoek-Brown (1980) and modified by different researchers (Hoek, Kaiser and Bawden, 1993; Hoek and Korzulovic, 2001; Hoek et al., 2002). Using the 2002 version of Hoek-Brown failure criterion and the characteristics of non-slickensided mudstone floor, R was determined to be between 0.63 to 0.89.

Based on the reported reduction factors and considering an essentially non-slickensided mudstone floor, a reduction factor of 0.4 is estimated for the project site. There were two holes (SA-84 and SA-85) which have been reported to have highly fractured MS-$MS with an RQD of zero. Of the holes which were drilled to sufficient depth and where RQD measurements were not taken, SA-34 appears to have encountered a fairly broken MS-$MS unit and therefore is assumed to have a low RQD value. For these three low RQD holes, R was reduced to 0.25.

6.6 Floor Design Analysis

Because of the weak floor conditions throughout the reserve, the size of the pillars and thus the allowable extraction ratio can be controlled by the allowable floor bearing capacity. The procedure used to determine the floor bearing capacity for this project site is provided below.

1. The overburden vertical stress (σ_v) is determined using the following equation:

$$\sigma_v = WD_s(S) + WD_{rx}(RX) \tag{6.1}$$

where: WD_s = average wet density of the soil cover = 135 pcf

S = soil cover thickness

WD_{rx} = average wet density of the rock cover = 165 pcf

RX = thickness of rock layer above top of coal

2. Pillar stress (σ_{tp}) is determined using the following tributary pressure equation:

$$\sigma_{tp}=\frac{\sigma_v}{(1\text{-}e)} \tag{6.2}$$

where: e = extraction ratio for a checkboard pattern

$$= 1\text{-}\frac{W_p^2}{(W_p+W_r)^2}$$

3. The softening correction factor (C_s) is determined using the plots presented in Figures 6.5 to 6.8.

4. For the chosen W_p, the ultimate bearing capacity (q_u) is determined using Prandtl bearing capacity equation for a semi-half space (Vesic, 1975):

$$q_u=cN_c\delta_{sc}+0.5WDW_PN_\gamma\delta_{S\gamma} \tag{6.3}$$

where: c = cohesion

N_c = bearing capacity factor

δ_{sc} = shape correction factor = $1+W_p/L_pN_c$

WD = wet density

N_γ = bearing capacity factor

$\delta_{s\gamma}$ = shape correction factor = $1\text{-}0.4(W_p/L_p)$

This equation considers the shape factors for a square pillar (i.e. δ_{sc} =1.59 and $\delta_{s\gamma}$ = 0.6). Using appropriate material values for mudstone (□ = 29°, c = 109 psi) and the project site, the Prandtl is summarized to:

$$q_u\ (\text{psi})= 4828+0.47\ (W_p) \tag{6.4}$$

where: W_p is in inches

5. The allowable bearing capacity (q_a) is determined using the following equation considering field reduction factor of 0.4 and a safety factor of 2:

$$q_a = 0.2\ C_s q_u \tag{6.5a}$$

For the localized condition of a highly fractured MS-$MS, R is assumed a 0.25. This accordingly reduces the above equation to:

$$q_a = 0.125\ C_s q_u \tag{6.5b}$$

The calculated allowable floor bearing, on a hole to hole basis assuming square pillars and a room width of 18 ft and 20 ft are provided in Tables 6.4 and 6.5, respectively.

As noted above in this section, the resistant zones and depths across the reserve are somewhat different than those modeled to obtain C_s values. Using the available C_s relationships provided in Figures 6.4 to 6.7, conservative C_s assumptions were made where project conditions are not represented. For example, the weaker carbonaceous zone C_s correlation was used for the stronger limestone unit at shallower depths as no such correlation was available for the limestone (see Figure 6.6a). Another example was the use of the siltstone-sandstone plot for the shallow limestone unit (see Figure 6.7a). The C_s correlation used to determine q_a for the floor conditions of each hole is noted in Tables 6.4 and 6.5.

As can be seen in Table 6.4, the allowable extraction ratios calculated for the known floor conditions range from 33 to 58%. This represents a difference in allowable floor support capacity of 1.6 times the weakest (not including where nominal to small D_f exist where it would be even higher). The lower extraction ratios (i.e. 33-38%) are related to highly fractured weak immediate floor conditions. Based on review of the

TABLE 6.4 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH ASSUMING SQUARE PILLARS AND 18 FT WIDE ROOM USING BORE HOLE DATA

BOREHOLE	OVERBURDEN SOIL THICKNESS (ft)	OVERBURDEN ROCK THICKNESS (ft)	DEPTH OF COAL (ft)	THICKNESS OF COAL (ft)	DURABLE ROCK TYPE	VERTICAL OVERBURDEN STRESS[1] (psi)	THICKNESS OF DURABLE LAYER (ft)	RATIO OF PILLAR TO ROOM WIDTH	THICKNESS OF NON-DURABLE LAYER (ft)	BEARING CAPACITY CORRECTION FACTOR	ULTIMATE BEARING CAPACITY[2] (psi)	STRESS IN PILLAR (psi)	ALLOWABLE BEARING CAPACITY[3] (psi)	ROOM WIDTH (ft)	PILLAR WIDTH (ft)	EXTRACTION	REMARKS
	S	Rx	D_{coal}	t_{coal}		σ_v	T	W_p/W_r	D_f	C_s	q_u	S_{tp}	q_a	W_r	W_p	e	
SA-2	150	232	382	6.20	NOD LS	406	5.62	1.89	2.45	0.98	5020	950	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-25	48	323	371	5.58	S SH	415	4.37	1.89	5	0.98	5020	971	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-34	24	344	368	5.71	$S - LS	417	3.15	3.72	3.84	1.04	5206	671	677	18	67	0.38	Fig6.7a, Df/T=4/2 used
SA-53	76	242	318	6.00	S SH (1.25') - SS	349	18.15	2.11	6.9	0.76	5043	757	766	18	38	0.54	Fig6.7b, Df/T=8/6 used
SA-57	35	300	335	6.09	CB $ SH (0.35') - S SH	377	2.62	2.11	5.1	0.82	5043	818	827	18	38	0.54	Fig6.6a, Df/T=5/2 used
SA-58	25	322	347	6.32	LS	393	2.58	1.94	2.92	0.9	5026	900	905	18	35	0.56	Fig6.7a, Df/T=4/2 used[5]
SA-63	119	209	328	5.22	$ SH	351	2.13	2.00	3.45	0.8	5031	790	805	18	36	0.56	Fig6.6a, Df/T=5/2 used
SA-67	28	331	359	6.16	LS (0.45') - $S(2.45')-LS(1.6')	406	4.5	1.89	2.99	0.98	5020	949	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-70	61	311	372	5.02	NOD LS	414	1.76	1.89	2.24	0.98	5020	968	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-71	47	329	376	6.72	LS (0.75') - $ SH	421	3.25	1.94	5.68	0.99	5026	966	995	18	35	0.56	Fig6.6a, Df/T=5/3 used
SA-74	61	286	347	6.25	L SH (0.37') - $ SH	385	5.05	1.83	3.63	0.94	5015	919	943	18	33	0.58	Fig6.6a, Df/T=5/3 used
SA-75	30	342	372	7.00	LS	419	1.65	2.06	1.82	0.92	5037	927	927	18	37	0.55	Fig6.7a, Df/T=4/2 used[5]
SA-78	34	338	372	6.20	S LS (0.64') - $ SH	419	3.65	2.11	3.36	0.91	5043	911	918	18	38	0.54	Fig6.7a, Df/T=4/2 used
SA-81	38	333	371	6.80	NOD LS	417	2.25	2.33	3	0.85	5065	851	861	18	42	0.51	Fig6.6a, Df/T=5/2 used[6]
SA-84	119	258	377	3.18	NOD LS	407	2.4	4.06	4.37	0.97	5240	632	635	18	73	0.36	Fig6.6a, Df/T=5/2 used[6]
SA-85 [7]	49	314	363	5.8	NOD LS	405	2	4.56	10	0.9	5291	603	595	18	82	0.33	Fig6.8 used
SA-86	64	319	383	6.70	LS (0.5') - $ SH	426	3.3	1.94	5.35	0.99	5026	976	995	18	35	0.56	Fig6.6a, Df/T=5/3 used
SA-88	31	336	367	6.35	SS	414	2.3	3.11	12.45	0.72	5144	722	741	18	56	0.43	Fig6.7a, Df/T=12/2 used
SA-89	44	336	380	5.50	LS (0.55') - $ SH	426	2.3	2.83	7.7	0.77	5116	779	788	18	51	0.45	Fig6.6b, Df/T=10/2 used
SA-91	26	344	370	7.20	Coal (1.4') - S SH (1.75') - SS(4.95')	419	13.1	1.89	5.4	0.98	5020	980	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-92 [4]	33	319	352	6.70	LS (0.7') - $ SH (1') - LS (0.25')	396	1.95	2.61	6.7	0.75	5093	757	764	18	47	0.48	Fig6.6b, Df/T=10/2 used
SA-93	33	320	353	6.60	LS (0.5') - $ SH	397	4.05	1.89	4.35	0.98	5020	929	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-96	23	342	365	6.90	LS(1.95')-S SH(0.55')	414	5.9	1.89	5.6	0.98	5020	967	984	18	34	0.57	Fig6.6a, Df/T=5/3 used

Notes:
1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using $4828.4+0.47{*}W_p$. W_p in inches for considering softening effect.
3. Calculated using $q_a=0.2C_sq_u$ except for SA-34, SA-84, and SA-85 where $q_a=0.125C_sq_u$ was used.
4. The soil cover depth was not reported in the log and assumed based on hole SA-93 log.
5. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable siltstone/sandstone zone.
6. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable carbonaceous zone.
7. Durable layer was not encountered down to termination depth which was at 9.47-ft of the floor. A 2ft thick durable nodular limestone was assumed at a depth of 10-ft. The C_s value of 0.9 was estimated since there was not any C_s data available for Wp/Wr of greater than 4.

MEA

TABLE 6.5 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH ASSUMING SQUARE PILLARS AND 20 FT WIDE ROOM USING BORE HOLE DATA

BOREHOLE	OVERBURDEN SOIL THICKNESS (ft)	OVERBURDEN ROCK THICKNESS (ft)	DEPTH OF COAL (ft)	THICKNESS OF COAL (ft)	DURABLE ROCK TYPE	VERTICAL OVERBURDEN STRESS[1] (psi)	THICKNESS OF DURABLE LAYER (ft)	RATIO OF PILLAR TO ROOM WIDTH	THICKNESS OF NON-DURABLE LAYER (ft)	BEARING CAPACITY CORRECTION FACTOR	ULTIMATE BEARING CAPACITY[2] (psi)	STRESS IN PILLAR (psi)	ALLOWABLE BEARING CAPACITY[3] (psi)	ROOM WIDTH (ft)	PILLAR WIDTH (ft)	EXTRACTION	REMARKS
	S	Rx	D_{coal}	t_{coal}		σ_v	T	W_p/W_r	D_f	C_s	q_u	s_{tp}	q_a	W_r	W_p	e	
SA-2	150	232	382	6.20	NOD LS	406	5.62	1.85	2.45	0.96	5037	964	967	20	37	0.58	Fig6.6a, Df/T=5/3 used[6]
SA-25	48	323	371	5.58	S SH	415	4.37	1.90	5	0.98	5043	967	988	20	38	0.57	Fig6.6a, Df/T=5/3 used
SA-34	24	344	368	5.71	$S - LS	417	3.15	3.75	3.84	1.05	5251	669	689	20	75	0.38	Fig6.7a, Df/T=4/2 used
SA-53	76	242	318	6.00	S SH (1.25') - SS	349	18.15	2.10	6.9	0.76	5065	760	770	20	42	0.54	Fig6.7b, Df/T=8/6 used
SA-57	35	300	335	6.09	CB $ SH (0.35') - S SH	377	2.62	2.10	5.1	0.82	5065	821	831	20	42	0.54	Fig6.6a, Df/T=5/2 used
SA-58	25	322	347	6.32	LS	393	2.58	1.95	2.92	0.90	5048	899	909	20	39	0.56	Fig6.7a, Df/T=4/2 used[5]
SA-63	119	209	328	5.22	$ SH	351	2.13	2.00	3.45	0.80	5054	790	809	20	40	0.56	Fig6.6a, Df/T=5/2 used
SA-67	28	331	359	6.16	LS (0.45') - $S(2.45')-LS(1.6')	406	4.5	1.90	2.99	0.98	5043	946	988	20	38	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-70	61	311	372	5.02	NOD LS	414	1.76	1.90	2.24	0.98	5043	964	988	20	38	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-71	47	329	376	6.72	LS (0.75') - $ SH	421	3.25	1.95	5.68	0.99	5048	965	1000	20	39	0.56	Fig6.6a, Df/T=5/3 used
SA-74	61	286	347	6.25	L SH (0.37') - $ SH	385	5.05	1.80	3.63	0.93	5031	931	936	20	36	0.59	Fig6.6a, Df/T=5/3 used
SA-75	30	342	372	7.00	LS	419	1.65	2.05	1.82	0.92	5060	929	931	20	41	0.55	Fig6.7a, Df/T=4/2 used[5]
SA-78	34	338	372	6.20	S LS (0.64') - $ SH	419	3.65	2.10	3.36	0.91	5065	914	922	20	42	0.54	Fig6.7a, Df/T=4/2 used
SA-81	38	333	371	6.80	NOD LS	417	2.25	2.30	3	0.85	5088	859	865	20	46	0.51	Fig6.6a, Df/T=5/2 used[6]
SA-84	119	258	377	3.18	NOD LS	407	2.4	4.00	4.37	0.97	5280	636	640	20	80	0.36	Fig6.6a, Df/T=5/2 used[6]
SA-85 [7]	49	314	363	5.8	NOD LS	405	2	4.75	10	0.91	5364	594	610	20	95	0.32	Fig6.8 used
SA-86	64	319	383	6.70	LS (0.5') - $ SH	426	3.3	1.95	5.35	0.99	5048	975	1000	20	39	0.58	Fig6.6a, Df/T=5/3 used
SA-88	31	336	367	6.35	SS	414	2.3	3.10	12.45	0.72	5178	723	746	20	62	0.43	Fig6.7a, Df/T=12/2 used
SA-89	44	336	380	5.50	LS (0.55') - $ SH	426	2.3	2.85	7.7	0.77	5150	777	793	20	57	0.45	Fig6.6b, Df/T=10/2 used
SA-91	26	344	370	7.20	Coal (1.4') - S SH (1.75') - SS(4.95')	419	13.1	1.90	5.4	0.98	5043	976	988	20	38	0.57	Fig6.6a, Df/T=5/3 used
SA-92 [4]	33	319	352	6.70	LS (0.7') - $ SH (1') - LS (0.25')	396	1.95	2.65	6.7	0.75	5127	751	769	20	53	0.47	Fig6.6b, Df/T=10/2 used
SA-93	33	320	353	6.60	LS (0.5') - $ SH	397	4.05	1.85	4.35	0.96	5037	942	967	20	37	0.58	Fig6.6a, Df/T=5/3 used
SA-96	23	342	365	6.90	LS(1.95')-S SH(0.55')	414	5.9	1.90	5.6	0.98	5043	963	988	20	38	0.57	Fig6.6a, Df/T=5/3 used

Notes:
1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using $4828.4+0.47{*}W_p$, W_p in inches for considering softening effect.
3. Calculated using $q_a=0.2C_sq_u$ except for SA-34, SA-84, and SA-85 where $q_a=0.125C_sq_u$ was used.
4. The soil cover depth was not reported in the log and assumed based on hole SA-93 log.
5. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable siltstone/sandstone zone.
6. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable carbonaceous zone.
7. Durable layer was not encountered down to termination depth which was at 9.47-ft of the floor. A 2ft thick durable nodular limestone was assumed at a depth of 10-ft. The C_s value of 0.9 was estimated since there was not any C_s data available for Wp/Wr of greater than 4.

available data, these areas appear relatively isolated. Excluding these fracture areas, the calculated ratio ranged from 42 to 58% at the boreholes.

Table 6.5 shows the allowable extraction ratios for the known floor conditions assuming a 20 ft room width range from 32 to 59%. Excluding the localized fracture areas, the calculated extraction ratio range from 43 to 59% at the boreholes.

As reflected in Tables 6.4 and 6.5, there is considerable variation in the allowable extraction ratios (e_a) with corresponding changes in the floor conditions, as discussed above, across the application area. In determining e_a, conservative assumptions were made including:

- Using established bearing capacity relationship for mudstone. Based on the Allerton floor testing, the weak immediate floor is less plastic than mudstone and overall classifies as a slightly silty mudstone (or mudstone-silty mudstone). It is expected that the triaxial strength of this less plastic rock would be greater than for the mudstone.
- Less plastic floor will also tend to result in a more limited softening effect under the perimeter of the pillar.
- In determining the softening correction factor (C_s), thicker weak floor were assumed in places. This was done because bearing capacity relationships had not been established for thinner layers (e.g. D_f < 4-5 ft) of non-durable floor on top of the first resistant layer.
- In places, the durable layer was assumed to be of weaker materials. No established relationships for C_s have been generated for the stronger durable layer at the project depths.

- Resistant or durable layer depths were not extrapolated between C_s correlation lines. Depths were taken to the nearest but deeper C_s vs. W_p/W_r curve.

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7.0 PILLAR-FLOOR STABILITY MINE DESIGN REQUIREMENTS

7.1 Allowable Coal Extraction

In Sections 5 and 6, the allowable coal extraction across the reserve has been calculated based on the pillar and floor strength, respectively. The floor stability condition is controlling the allowable extraction in this reserve assuming square pillars with a room width of 16-20 ft. It should be noted, however, where resistant floor is immediately below the No. 6 Coal, or just below, the floor capacity would clearly exceed the pillar strengths. The vast majority of the extraction area is between 40% to 55% extraction. The main area of lowest extraction where D_f was the deepest was estimated at 40-45%.

As discussed in Section 6.6, it is believed that these calculated allowable extraction ratios for floor stability are conservative. No triaxial strength testing was performed for the long term stability analysis at the time of issuing this report. Therefore, having assumed strength characteristics for a more plastic rock would underestimate the softened bearing capacity. Also, adjustments on the ultimate floor bearing capacity for softening effects, as discussed in Section 6.6, were overestimated. Therefore, with appropriate triaxial strength testing and more site specific FEM analyses, a better estimation and potentially improved allowable extraction can be achieved.

7.2 Design Extraction Ratios

Based on the available data provided in this report, to achieve long-term stability across the application area (excluding significantly fractured floor areas), an average e_a of 52% would be recommended. The extraction ratio may change across the reserve due to variation in geologic conditions. Further geotechnical investigation and testing data will be provided where typical site conditions are not encountered. One fairly localized fractured floor area was identified in the middle portion of the application area where the recommended extraction would be on the order of 35%[6]. Given the restricted extraction in this area, it may be cost effective to place the slope bottom coal in this area.

Because of the variable floor conditions, the proposed Sunrise Mine is most adaptable to a two-staged mining process. This room-and-pillar process would include initial mining at the expected minimum uniform extraction ratio. The second stage mining can be done by corner fendering or slabbing the stage-one pillars upon retreat. A schematic of this is depicted in Figure 7.1.

The final or second stage extraction would depend on the site specific floor conditions. Because the spacing of the project borings is too widely spaced to accurately assess the site specific conditions (e.g. the continuity of the rock beds in the floor), in-mine floor sampling is recommended if greater than the nominal floor bearing capacity is assumed. Further, in-mine drilling and sampling is recommended to determine the weak floor condition and first bearing resistant zone. The location of these holes and determination of the floor conditions should be made by a qualified independent geotechnical engineer.

This more efficient mine design will typically result in an increase of 5 to 10% higher extraction using the 2 staged mining process. Upward to 58% has been estimated using stability analysis results provided herein.

[6] Except for the area mentioned above, extensive, slickensided or fractured conditions in the immediate floor are assumed to be too localized to substantially affect the resulting bearing capacity. If this is found to be otherwise the case (e.g. found in areas greater than 100 ft wide) from the in-mine floor sampling, an adjustment in floor design may be required.

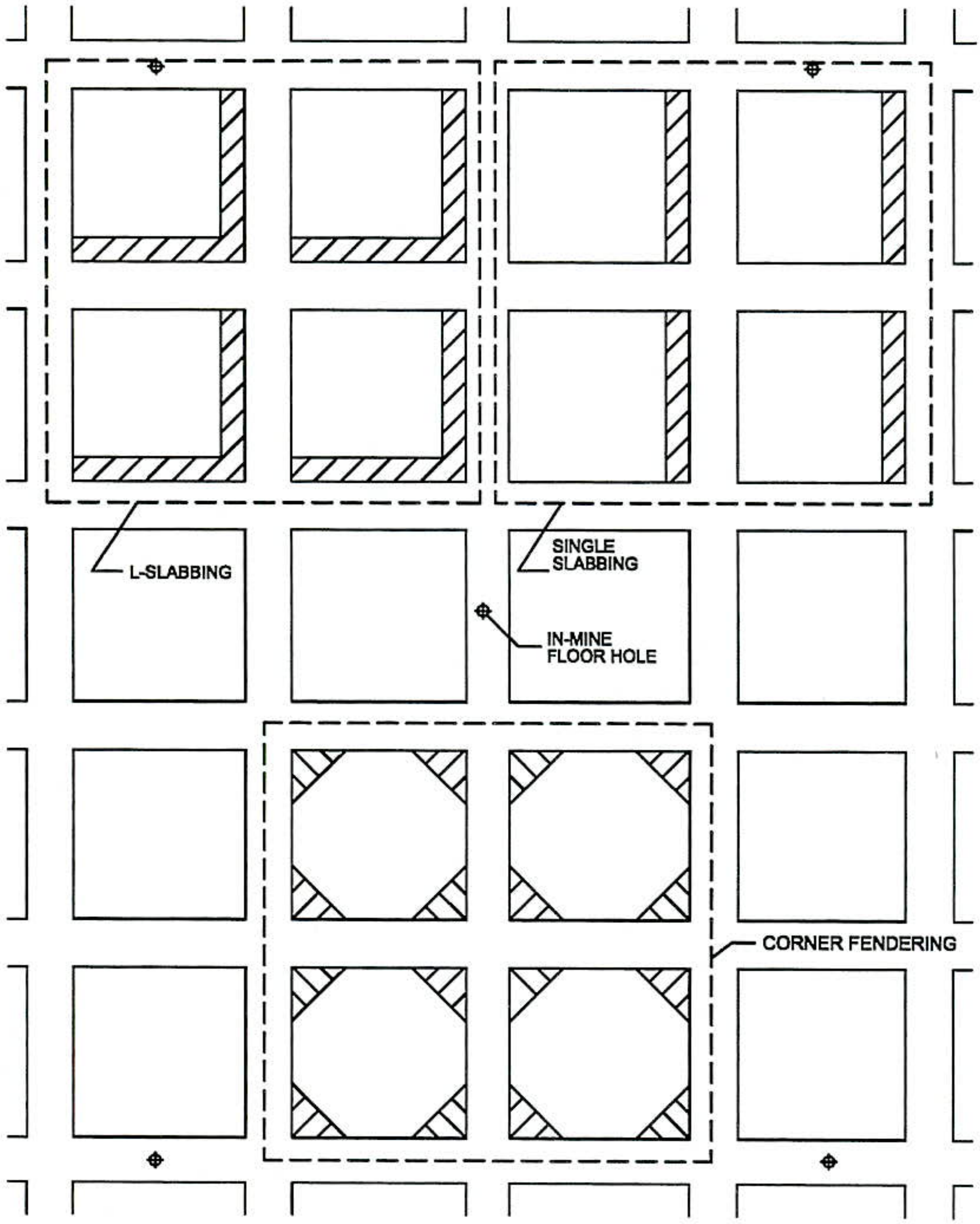

FIGURE 7.1 SCHEMATIC OF SECOND STAGE ROOM-AND-PILLAR MINING AFTER IN-MINE FLOOR EVALUATION

Consequently, there is a significant advantage to two-staged mining as final room widths, W_{r2} can be reasonably expanded with little concern for subsidence related to room collapse upon abandonment in deeper mines. Moreover, this same methodology can be used for other coal mines at this depth or greater where no surface subsidence is a requirement.

Figure 7.2 includes a graph (shown to the left) depicting the relationship comparing square pillar widths (W_p) (which controls floor and pillar stability) for one-time mining, (W_{p1}), and that after two staged mining (W_{p2}) for different extraction ratios. Extraction ratio contours are for both stage-one (e_1) and stage-two mining (e_2). As can be seen from this plot, there is a significant fundamental advantage to two staged mining in obtaining greater overall coal extraction without sacrificing surface subsidence potential. For example, for the same extraction ratio of 50% W_{p1} = 43 ft vs W_{p2} = 72 ft with final cut of rooms to 30 ft wide. This is in addition to less required permanent roof support.

The second graph to the right in Figure 7.2 depicts what initial mining configuration is required, assuming a stage-one mine room width (W_{r1}) of 18 ft, and a constant center-to-center spacing (c/c) for the targeted final extraction ratio and pillar room width after stage-two mining. This graph will be very helpful to establish initial mining configurations while considering the final layout after stage-two mining. Going across to the left graph, the extraction ratio can be determined for the same square pillar width if one time mining is done. For example, say 72 ft squares and 30 ft rooms, or an extraction ratio of 50%, are targeted as above, the initial extraction will be 32% assuming 18 ft rooms and 84 ft pillars. As you can see from these correlations, after the

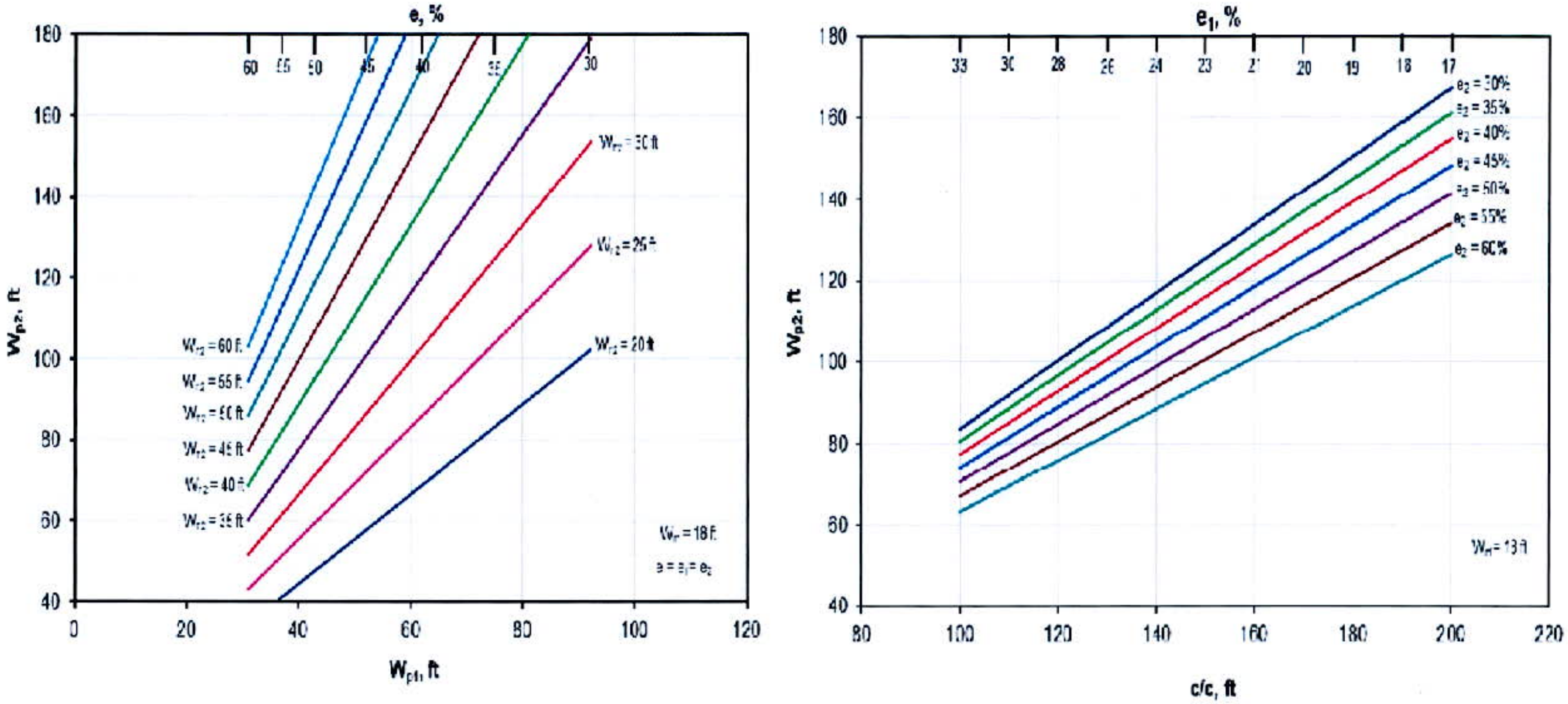

FIGURE 7.2 TWO STAGED MINING ROOM-AND-PILLAR RELATIONSHIPS (ASSUMING SQUARE PILLARS AND "L" SLABBING)

mine is opened, it would be prudent to perform this mining as soon as practical to optimize the mine plan for second staged mining upon retreat.

7.3 Roadway Stability

Roadway stability in the form of severe rutting and muddy conditions may be present in mine floor areas which are exposed to significant traffic and moisture. These roadway conditions can be mitigated by providing drainage away from areas of concern, installing gravel with possibly a geofabric/grid reinforced base, or possibly the use of cement stabilization. Leaving a coal floor may be another option.

8.0 SUMMARY AND CONCLUSIONS

At the request of Sunrise Coal Co., Marino Engineering Associates, Inc. (MEA) has performed a mine stability analysis for a proposed room-and-pillar mine in the Herrin No. 6 Coal in Vermilion County, Illinois. The coal reserve is located just south of Oakwood, IL and is called the Allerton Reserve herein.

The Herrin Coal in the Allerton Reserve ranges in depth from typically 344 to 377 ft, but can be as shallow as 318 ft. Within the permit application area the coal ranges from typically 5 to 7 ft and is generally thicker to the north.

The No. 6 Coal was cored throughout the reserve. In the analyses performed herein, information from a total of 44 core holes were used. The continuous coring in these holes was commenced in the roof and overburden and continued into the floor of the No. 6 Coal.

Recovery rates were recorded and RQD measurements were taken in some of the cored holes. Select core was tested for moisture content, indirect tensile strength, point load strength, uniaxial compressive strength, rock durability, rock plasticity, and rock swell.

Because surface subsidence must be prevented in the application area, the design focus is on long-term stability of the proposed room-and-pillar workings. Mine roof, pillar and floor conditions were assessed across the application area. As discussed in Section 4 of this report, room-roof collapse should not result in surface subsidence. Even if a room collapse occurred, the proposed mine would be too deep and the rock overburden would be too thick for the collapse to affect the ground surface. Therefore, for the purposes of this analysis, a room-roof stability analysis was not performed.

Pillar strengths across the application area were also calculated. Considering long-term stability, allowable extraction ratios were determined at the hole locations assuming square pillars and a room width of 18 ft. Allowable extraction ratios ranging from 60% to 68% were determined. See Section 5.

As expected, the most controlling component of mine support exists in the floor. Therefore, based on the information and design methodology presented herein, the long-term support capacity of the floor was less than that for the coal pillar, and thus was the support element which restricted the extraction across the application area. See Section 7.1.

In determining the floor support across the application area, a detailed analysis was performed of the engineering geological conditions. A key factor in assessing floor support is determining the depth of the weaker non-durable immediate floor material immediately above the first resistant durable zone. Across the permit application area, the thickness of this non-durable material appears to be essentially non-existent to depths possibly greater than 13 ft (typically in the 2 to 10 ft range). The most immediate resistant zone was also variable, ranging from a limestone, shale or sandstone unit. See Section 2.5.

The engineering properties of an immediate non-durable floor material also play a key role in the ultimate support capacity of the floor. Based on the rock plasticity (i.e. liquid limit determinations) the non-durable floor material was found to be fairly consistent across the application area and overall classify as a slightly silty mudstone or mudstone-silty mudstone (MS-$MS). From our experience, depending upon the rock plasticity, the triaxial strength can vary up to about 3 times the lowest.

Another key factor in assessing the floor bearing capacity, which should not be ignored, is the rock fracturing. The amount of in place fracturing in the rock determines the rock mass strength. The fracturing condition alone can affect the ultimate strength of the floor by up to 200% or more. Based on the known fracturing conditions across the reserve, the rock mass strength was assessed to be 40% of the intact rock strength except in a localized extensively fractured area. In this area, the field reduction factor was taken at 25%. See Section 6.5.

For long stability, as well as while the mine is active, floor softening should be considered. In this regard, the Vesic-Speck Method (Speck, 1979), which is used in the Illinois Basin has its shortcomings. This method estimates the floor bearing strength based on moisture content of fresh rock. No consideration is made for moisture increase when the floor becomes wet and softened, nor is there any adjustment for variations in fracturing or slickensides. Furthermore, the assessment of the thickness of the weak floor based on the moisture profile seems entirely arbitrary.

The methodology used to analyze the bearing capacity of the softened floor condition is discussed primarily in Sections 6.3 to 6.6. Corrections to the bearing capacity equation have been established for softening, fracturing, and depth and thickness of a durable zone for various pillar to room ratios. The softening correction was developed for a mudstone floor with or without a durable zone. Therefore, employing this correction factor should be conservative as the floor at the project site is less plastic. Moreover, the presence of a durable zone was underestimated.

Considering the softened floor condition and the available data, allowable extraction ratios calculated across the application area ranged from about 40 to 58% except where highly fractured floor was encountered. The extraction assessed in much of the application area ranged from 45 to 55%. The fractured floor area appears to be fairly localized and would restrict coal extraction to about 35%. To design for long-term stability, an average extraction ratio of 52% is recommended. This rate may change across the reserve based on further geotechnical testing and presence of localized fractured zones. With greater exposure to unplanned subsidence, a higher uniform extraction can be used. See Section 7.2.

Given the variability of the floor support conditions, the permit application area is more adaptable to a two-staged mining process. This would be the most cost effective process consisting of an initial development at a lower extraction followed by a second stage of mining upon retreat. During stage two, the rooms would be widened according to the floor strength. The floor strengths in an area would be determined after stage one by in-mine coring and index testing of the floor.

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APPENDIX A

HOLE SUMMARY TABLE INCLUDING ROCK MECHANICS TESTING RESULTS ON FLOOR

Attachment IV-3A3

HOLE SUMMARY OF FLOOR CONDITIONS AND PROPERTIES

DRAFT 4/2/12

Boring Name	Recovery (%)	RQD (%)	Top Depth (ft)	Material Description (MEA)	Thickness (ft)	Friction Angle	Weighted Ave. Friction Angle	Resistance	Slake Index	Slake Index Depth (ft)	MC (%)	MC Depth (ft)	PL	AL Depth (ft)	UCS/T (psi)	UCS Depth (ft)	Size corrected Point Load Index (psi)	Point Load Depth (ft)	Point Load Depth Above Floor (ft)	Type
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				

MEA

SA02-101434	07	1	363.4	376	MUDSTONE - SILTY MUDSTONE, ESC SLKS
					EOB
	'08	10	357.5	[illegible]	#1 COAL
			358.1	[illegible]	CARBONACEOUS SHALE
			358.3	[illegible]	MUDSTONE - SILTY MUDSTONE
			359.8	[illegible]	[illegible] SILTY MUDSTONE
			361.4	[illegible]	NODULAR LIMESTONE
			361.66	[illegible]	MUDSTONE
			361.95	[illegible]	LIMESTONE
			362.95	[illegible]	SILTY SHALE
			363.3	[illegible]	CARBONACEOUS COAL / SHALE
			[illegible]	[illegible]	SILTY MUDSTONE
			377.7	[illegible]	SANDSTONE
SA03-101434	'08	09	377.8	[illegible]	EOB
	09	17	367.43	[illegible]	#1 COAL
			367.66	[illegible]	CARBONACEOUS SHALE
			367.8	[illegible]	[illegible]
			376	[illegible]	NODULAR LIMESTONE
			379.65	[illegible]	MUDSTONE - SILTY MUDSTONE, ESC SLKS
			380.88	[illegible]	LIMESTONE
			381	[illegible]	MUDSTONE - SILTY MUDSTONE
SA04-101435	09	17			EOB
	'08	16	368.1	[illegible]	#1 COAL
			370	[illegible]	V. SILTY MUDSTONE, ESC SLKS
			370.8	[illegible]	SILTY MUDSTONE with 20% LIMESTONE NODULES
			377.6	[illegible]	LIMESTONE
			379.55	[illegible]	SANDY SHALE
			380.1	[illegible]	CARBONACEOUS SHALE
			380.75	[illegible]	COALY SHALE
			380.44	[illegible]	SANDY SHALE
SA06-101434	'08	29	383.5	[illegible]	EOB
			375.24	[illegible]	#1 COAL
			381.58	[illegible]	SILTY MUDSTONE, ESC SLK
			[illegible]	[illegible]	[illegible]
			384.26	[illegible]	LIMESTONE
			384.75	[illegible]	MUDSTONE - SILTY MUDSTONE
			386.6	[illegible]	LIMESTONE
			387.2	[illegible]	MUDSTONE - SILTY MUDSTONE
SA07-101435	'08	7	388	[illegible]	EOB

Definitions

$ = silty	FIS = fissile	PLT = [illegible]
ANG = angular	FOS = fossils or fossiliferous	PR = poorly
ARG = argillaceous	FRAC'D = fractured	PTS = parts
BND = banded	FRAG'S = fragments	PYR = pyritized, pyrite
BDPL = bedding plane	FREQ = frequent	ROH = rough
BK = black	GY = grey	SH = shale
BN = brown	HD = hard	SID = siderite
BOT = bottom	INBD = interbeds	SLI = slight
CALC = calcareous	INCL = inclusions	SLK = slickensided or slickensides
CR = [illegible]	IN PLS = in places	SM = small
CL = [illegible]	LAM = laminations	SMS = [illegible]
CO = coal	LN = lenses	SO = soft
CONC = concretion	LS = limestone	STKS = streaks
DISC = discontinuous	MAS = massive	T. = trace
DK = dark	MBD = medium bedded	THBD = thin bedded
DR = drill hole without sampling	MIC = micaceous	V. = very
EL = electric log	MOD = moderately	VAL = [illegible]
EVY = every	NO = no data	WK = weak
F. = fine	NOD = nodule	

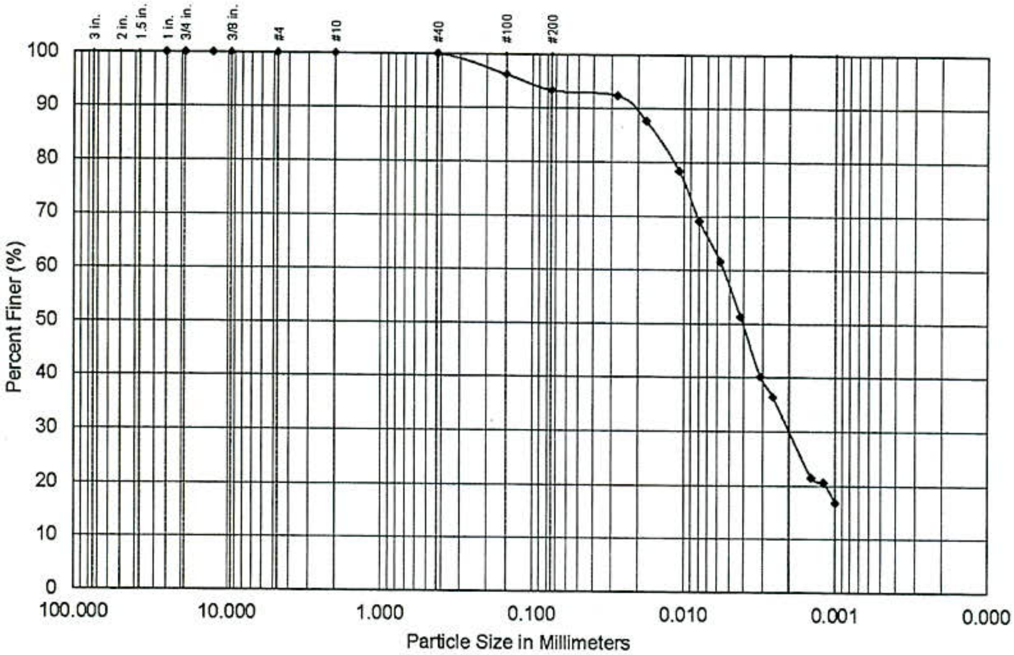
May 11, 2012

APPENDIX B

ONE DIMENSIONAL SWELL TEST DATA

MEA
Soil and Rock
Mechanics
Laboratory

Particle Size Distribution Report



CRS	Fine	CRS	Med.	Fine	Silt	Clay	Colloids
% Gravels		% Sands			% Fines		

Sieve Size	Sieve Opening(mm)	Pecent Retained	Percent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00100	83.21	16.79
Hydrometer	0.00119	79.48	20.52
Hydrometer	0.00143	78.55	21.45
Hydrometer	0.00257	63.62	36.38
Hydrometer	0.00311	59.89	40.11
Hydrometer	0.00422	48.70	51.30
Hydrometer	0.00574	38.44	61.56
Hydrometer	0.00791	30.98	69.02
Hydrometer	0.01076	21.65	78.35
Hydrometer	0.01780	12.32	87.68
Hydrometer	0.02747	7.66	92.34
200	0.08	6.73	93.27
100	0.15	3.82	96.18
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion
MUDSTONE - SILTY
MUDSTONE

Atterberg Limits

LL= 39.8%
PL= 16.9%
PI= 22.9%

Classification

USCS: CL:
AASHTO:

Remarks

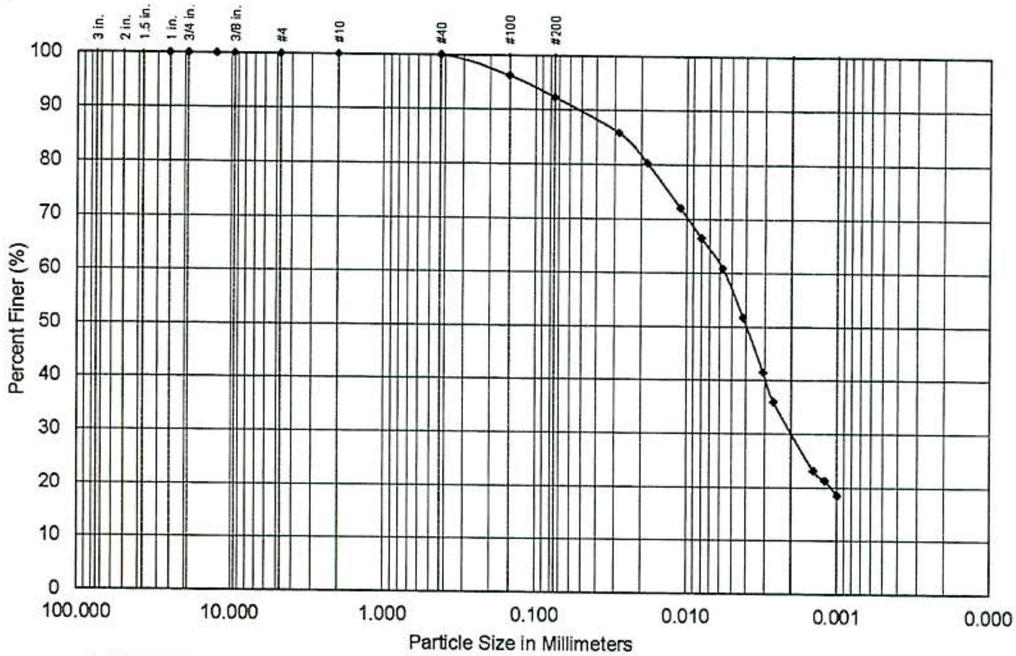
Sieve Method
ASTM D 422,
hydrometer and sieve
analysis on portion passing
#10 sieve , (section 7.0)

Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.
Sample ID: SA-75
Depth: 383.8'
Checked by: B.P.U.

MEA
Soil and Rock
Mechanics
Laboratory

Particle Size Distribution Report



CRS	Fine	CRS	Med.	Fine	Silt	Clay	Colloids
% Gravels		% Sands			% Fines		

Sieve Size	Sieve Opening(mm)	Pecent Retained	Percent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00099	81.55	18.45
Hydrometer	0.00120	78.79	21.21
Hydrometer	0.00143	76.94	23.06
Hydrometer	0.00263	64.03	35.97
Hydrometer	0.00308	58.49	41.51
Hydrometer	0.00419	48.35	51.65
Hydrometer	0.00574	39.13	60.87
Hydrometer	0.00796	33.59	66.41
Hydrometer	0.01101	28.06	71.94
Hydrometer	0.01834	19.76	80.24
Hydrometer	0.02822	14.22	85.78
200	0.08	7.77	92.23
100	0.15	3.81	96.19
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion
SLIGHTLY SILTY MUDSTONE

Atterberg Limits

LL= 41.0%
PL= 18.3%
PI= 22.7%

Classification

USCS: CL
AASHTO:

Remarks

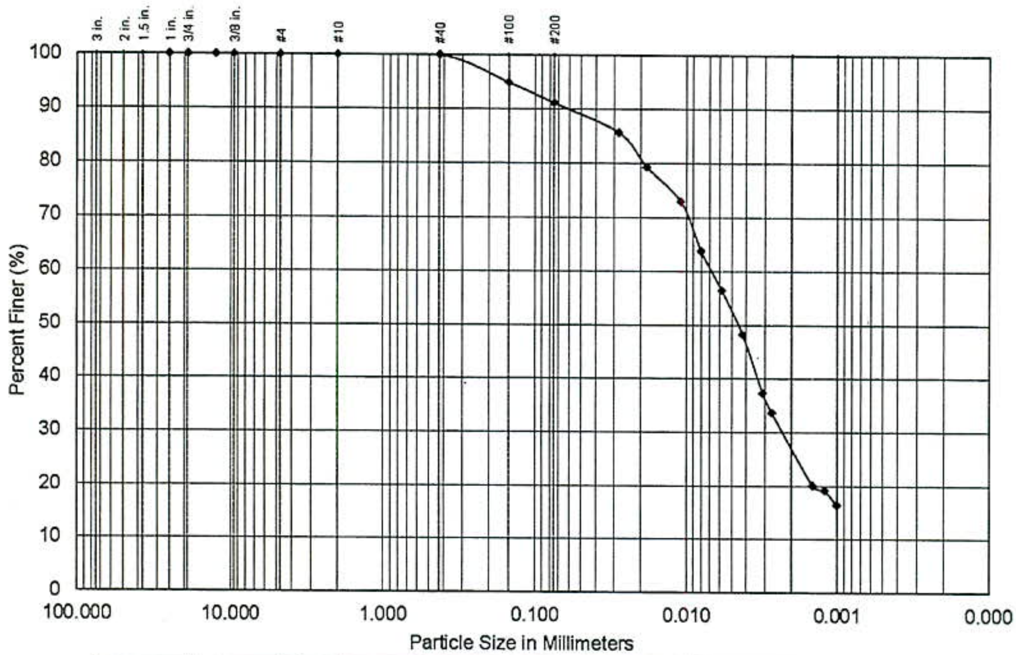
Sieve Method
ASTM D 422, hydrometer and sieve analysis on portion passing #10 sieve , (section 7.0)

Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.
Sample ID: SA-89
Depth: 391.15'
Checked by: B.P.U.

MEA
Soil and Rock
Mechanics
Laboratory

Particle Size Distribution Report



CRS	Fine	CRS	Med.	Fine	Silt	Clay	Colloids
% Gravels		% Sands			% Fines		

Sieve Size	Sieve Opening(mm)	Pecent Retained	Percent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00101	83.60	16.40
Hydrometer	0.00121	80.87	19.13
Hydrometer	0.00145	79.96	20.04
Hydrometer	0.00271	66.30	33.70
Hydrometer	0.00312	62.65	37.35
Hydrometer	0.00424	51.72	48.28
Hydrometer	0.00592	43.53	56.47
Hydrometer	0.00798	36.24	63.76
Hydrometer	0.01087	27.13	72.87
Hydrometer	0.01826	20.75	79.25
Hydrometer	0.02795	14.38	85.62
200	0.08	8.91	91.09
100	0.15	5.12	94.88
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion
MUDSTONE

Atterberg Limits

LL= 41.0%
PL= 20.0%
PI= 21.0%

Classification

USCS: CL
AASHTO:

Remarks

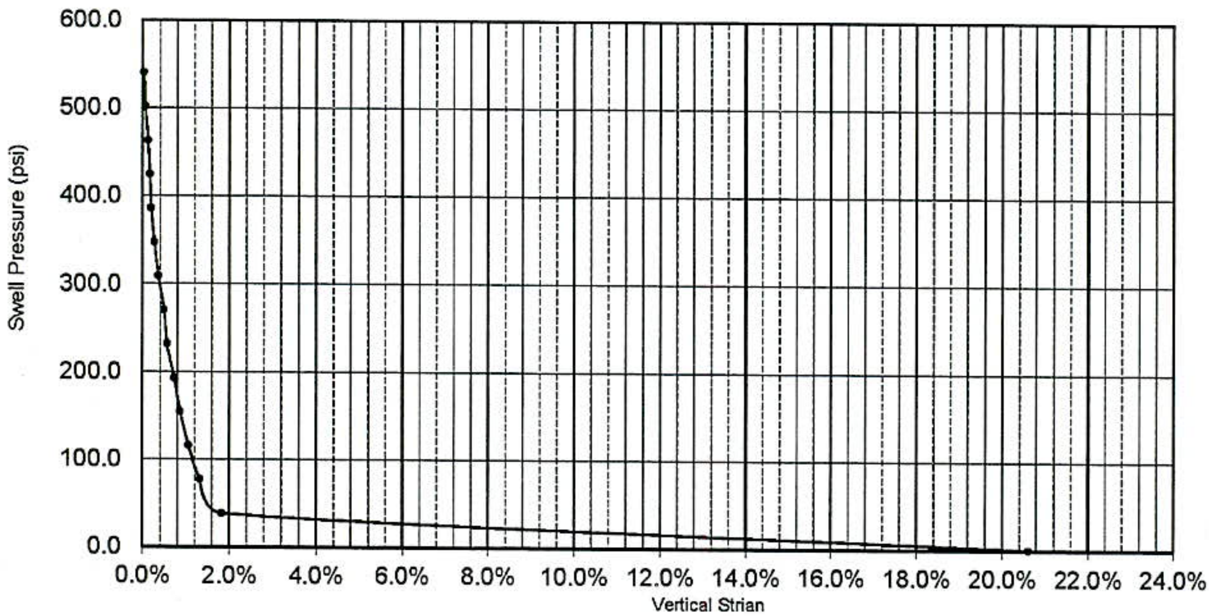
Sieve Method
ASTM D 422, hydrometer and sieve analysis on portion passing #10 sieve , (section 7.0)

Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.

Sample ID: SA-93
Depth: 362.3'
Checked by: B.P.U.

SOIL AND ROCK MECHANICS LABORATORY



Note: Final Sample Height for calculating free swell vertical strain estimated for 1,000 years.

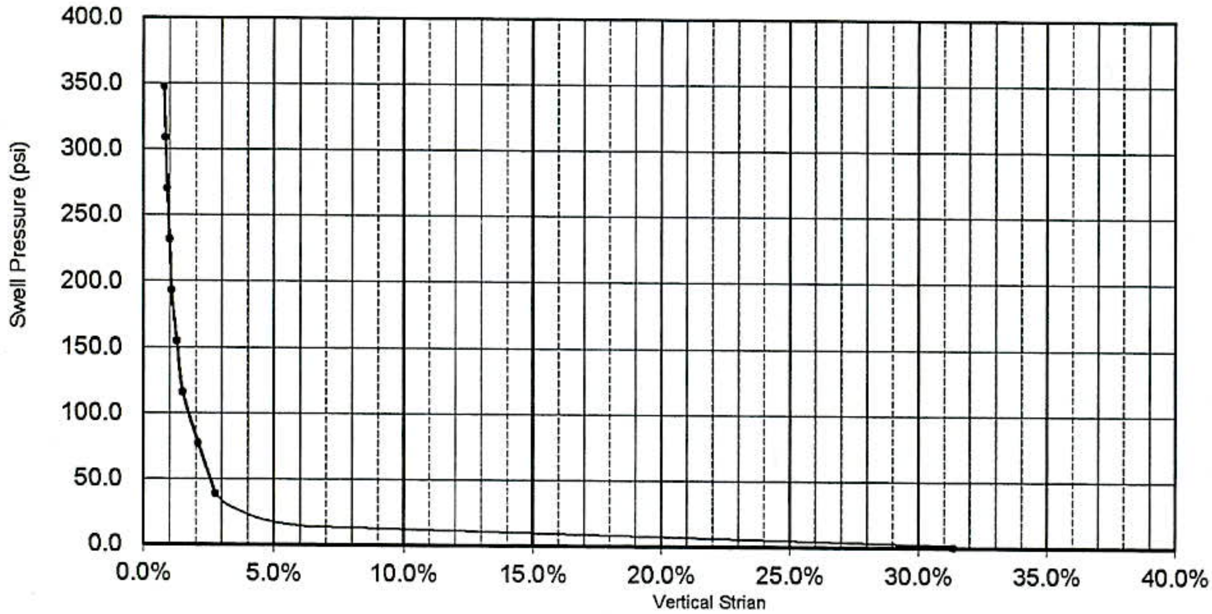
SWELL TEST RESULTS

Sample Identification :	SA-75
Sample Depth :	383.8'
Sample Classification :	MUDSTONE - SILTY MUDSTONE
USCS :	CL
Liquid Limit :	39.8%
Plasticity Index :	22.9%
Dry Density, pcf(before test) :	141.3
Dry Density, pcf(after test) :	120.0

	Before test :	After Test :
Moisture Content :	5.3%	9.5%
Void Ratio :	0.19	0.40
Saturation :	74.5%	85.0%
Specific Gravity :	2.7 (est.)	

Project: Allerton Reserve		Date: 25-Jan-12

SOIL AND ROCK MECHANICS LABORATORY



Note: Final Sample Height for calculating free swell vertical strain estimated for 1,000 years.

SWELL TEST RESULTS

Sample Identification :	SA-89
Sample Depth :	391.6'
Sample Classification :	SLIGHTLY SILTY MUDSTONE
USCS :	CL
Liquid Limit :	41.0%
Plasticity Index :	22.7%
Dry Density, pcf(before test) :	149.0
Dry Density, pcf(after test) :	111.5

	Before test :	After Test :
Moisture Content :	4.3%	9.9%
Void Ratio :	0.13	0.28
Saturation :	89.7%	102.3%
Specific Gravity :	2.7 (est.)	

Project: Allerton Reserve		Date: 6-Feb-12

MARINO ENGINEERING ASSOCIATES, INC.

06/05/14

Pursuant to requirements given in IDNR Land Reclamation Division Memorandum No. 2012-4 dated 7/23/12, MEA is providing the following information for Permit No. 429-The Building Mine.

1. *The names of the persons or organizations that collected the data [indicted if the data was collected by company personnel or a consultant, and if by a consultant the name of the consultant firm];*

The core samples were collected by Sunrise coal and delivered to MEA soil and rock mechanics laboratory.

2. *The names of the persons or organizations that analyzed the data;*

The rock mechanics test data was analyzed by Dr. G.G. Marino, P.E. and Dr. A. Osouli, P.E.

3. *The dates of the collection of the data;*

The core samples were collected by Sunrise. Sunrise will provide this information.

4. *The dates of the analysis of the data;*

Dates that testing was performed were:

Start Date	**Finish Date**
27 Oct. 10	6 Nov. 10
2 Jul. 11	6 Jul. 11
31 Aug. 11	1 Nov. 11
4 Nov. 11	8 Dec. 11
2 Jan. 12	30 Apr. 12

5. *A description of the methodology used to collect the data [indicted grab, composite, etc.]; and*

   Core samples were provided by Sunrise Coal Co.

6. *A description of the methodology used to analyze the data [i.e., ASTM standard]*

   The following tests and corresponding ASTM were conducted on the rock core:

Test	ASTM Ref.
Moisture Content	ASTM D-2216
Atterberg Limits	ASTM D-4318
DuroIndex	(no ASTM)
Slake Durability	ASTM D-4644
Point Load	ASTM D-5731
USCS	ASTM D-2487
Grain Size Analysis (Hydro.)	ASTM D-1140
Splitting Tensile Strength	ASTM D-3967
Unconfined Compression	ASTM D-2938
One Dimensional Swell	ASTM D-4546

LICENSED PROFESSIONAL ENGINEER
GENNARO G.
MARINO
062-042500
STATE OF ILLINOIS
6/5/14

Gennaro G. Marino, Ph.D., P.E., D.GE

MEA

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-6D

QUALITY ASSURANCE/QUALITY CONTROL PLAN
FOR CLAY LINER INSTALLATION

QUALITY ASSURANCE/QUALITY CONTROL PLAN
SUNRISE COAL, LLC
BULLDOG MINE
CLAY LINER INSTALLATION

Purpose

The purpose of this plan is to establish the process necessary to ensure a clay liner is constructed in all structures used for waste disposal, storage of materials containing contaminants, and /or conveyance and containment of runoff from waste or other materials containing contaminants at Bulldog Mine in Vermilion County, Illinois. The liner shall be a minimum of four (4) feet in thickness and have a permeability of $1X10^{-7}$ cm/sec. or less. The structures which shall have liners shall be, but not necessary limited to, the following:

1. Refuse Impoundment (Slurry Pond)
2. Treatment Pond #1
3. Treatment Pond #2
4. Raw and clean coal storage areas
5. All drainage control structures (ditches) connecting such structures
6. Sediment Pond #1
7. Sediment Pond #2
8. Sediment Pond #3
9. Holding Pond

Scope

This plan provides the work necessary to construct a minimum four (4) foot thick clay liner to meet the required permeability in all structures where required. The clayey soils encountered at this site will be used to provide adequate liner material under the structures. Should the in situ soils not produce a liner having a permeability of $1X10^{-7}$ cm/sec. or less, bentonite shall be added to the soil to achieve the required permeability.

Liner Specifications

At the locations where a liner is to be installed, the topsoil shall be stripped to a depth of 8-12 inches. All roots shall be grubbed and the area shall be graded to the design elevations. Any soft, spongy, or otherwise unsuitable soil encountered shall be excavated and replaced with adequate clayey soil. The soil subgrade shall be scarified to a depth of approximately four (4) inches with a construction disk. Preparation of the area to receive the liner and placement of the fill shall be performed using tractors, backhoes, dozers, pans and/or graders.

After scarifying, four (4) inches of clayey fill soil shall be placed and compacted to 95% of the maximum standard laboratory dry density as determined by ASTM Method of Test D-698. Moisture content of the fill soils shall range within two (2) percent below and three (3) percent above optimum moisture content. Compaction shall be achieved using a sheepsfoot roller to

QUALITY ASSURANCE/QUALITY CONTROL PLAN
SUNRISE COAL, LLC
BULLDOG MINE
CLAY LINER INSTALLATION

compact the lift. Compaction shall be determined by ASTM Method of Test D6938 (Nuclear Density).

Additional fill shall be placed in 6-8 inch loose lifts, each lift being compacted and tested as stated above, until four (4) feet of clayey fill has been placed and properly compacted.

At least one (1) test shall be taken for every 7,500 cubic yards of material placed. The tests shall be taken on a grid pattern to insure that all liner areas will be tested. If tests indicate the proper compaction has not been achieved, the area will be re-processed and re-tested until it is acceptable. The limits of the area to be re-processed shall be delineated by performing additional tests on the areas immediately adjacent to the failed test area until samples that meet the compaction requirement are obtained.

After the liner is in place, thin walled Shelby tube samples shall be taken and the permeability determined by ASTM Method of Test D5084. At least one (1) test shall be taken for every 7,500 cubic yards of material placed. The tests shall be taken on a grid pattern to insure that all liner areas are tested. If any tests indicate the liner does not meet the permeability of $1X10^{-7}$ cm/sec, the area shall be re-processed and re-tested until it is acceptable. The limits of the area to be re-processed shall be delineated by performing additional tests on the areas immediately adjacent to the failed test area until samples that meet the permeability requirement are obtained.

Sunrise Coal
Bulldog Mine - Permit #429
Holding Pond - Sediment Pond #1

100yr - 6hr Storm

Top of Dam Elev = 679.0

Pool Elev = 676.0

Peak Elev =677.9

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

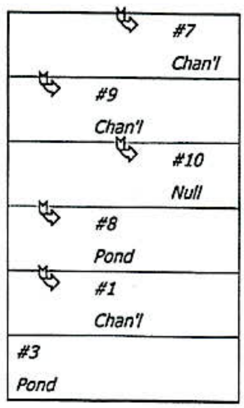
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	4.960 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#3	0.000	0.000	Collector Ditch #3, Sta 0+00 to 10+66 (Sediment Pond #1).
Pond	#3	==>	End	0.000	0.000	Sediment Pond #1.
Channel	#7	==>	#9	0.000	0.000	Collector Ditch #4, Sta 0+00 to 10+60.
Pond	#8	==>	#3	0.000	0.000	Underground Pumpage Holding Pond.
Channel	#9	==>	#3	0.000	0.000	Collector ditch #4, Sta 10+60 to 18+93 (Sediment Pond #1).
Null	#10	==>	#8	0.000	0.000	MINE PUMPAGE-Use Acres to input 2.65 ac-ft



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#7		19.300	19.300	49.44	3.96
#9		1.600	20.900	55.82	4.30
#10		9.450	9.450	48.60	3.18
#8	In	1.900	11.350	58.78	3.93
	Out			33.40	3.93
#1		4.100	4.100	10.83	0.72
#3	In	9.300	45.650	140.05	11.58
	Out			61.29	11.58

Structure Detail:

Structure #7 (Vegetated Channel)

Collector Ditch #4, Sta 0+00 to 10+60.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	49.44 cfs		49.44 cfs	
Depth:	2.26 ft	2.56 ft	3.44 ft	3.74 ft
Top Width:	15.02 ft	16.22 ft	19.78 ft	20.98 ft
Velocity:	2.08 fps		1.11 fps	
X-Section Area:	23.72 sq ft		44.40 sq ft	
Hydraulic Radius:	1.474 ft		2.074 ft	
Froude Number:	0.29		0.13	
Roughness Coefficient:	0.0414		0.0973	

Structure #9 (Vegetated Channel)

Collector ditch #4, Sta 10+60 to 18+93 (Sediment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	55.82 cfs		55.82 cfs	
Depth:	2.37 ft	2.67 ft	3.56 ft	3.86 ft
Top Width:	15.46 ft	16.66 ft	20.25 ft	21.45 ft
Velocity:	2.20 fps		1.19 fps	
X-Section Area:	25.39 sq ft		46.77 sq ft	
Hydraulic Radius:	1.531 ft		2.132 ft	
Froude Number:	0.30		0.14	
Roughness Coefficient:	0.0402		0.0925	

Structure #10 (Null)

MINE PUMPAGE-Use Acres to input 2.65 ac-ft

Structure #8 (Pond)

Underground Pumpage Holding Pond.

Pond Inputs:

Initial Pool Elev:	678.00 ft
Initial Pool:	19.82 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
678.00	50.00	3.00:1	3.00:1	10.00

Pond Results:

Peak Elevation:	679.20 ft
Dewater Time:	0.38 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
657.90	0.000	0.000	0.000	
658.00	0.600	0.020	0.000	
658.40	0.613	0.263	0.000	
658.90	0.630	0.573	0.000	
659.40	0.647	0.893	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
659.90	0.664	1.221	0.000		
660.40	0.682	1.557	0.000		
660.90	0.699	1.902	0.000		
661.40	0.717	2.256	0.000		
661.90	0.735	2.620	0.000		
662.40	0.754	2.992	0.000		
662.90	0.772	3.373	0.000		
663.40	0.791	3.764	0.000		
663.90	0.810	4.165	0.000		
664.40	0.829	4.574	0.000		
664.90	0.849	4.994	0.000		
665.40	0.869	5.423	0.000		
665.90	0.889	5.863	0.000		
666.40	0.909	6.312	0.000		
666.90	0.929	6.771	0.000		
667.40	0.950	7.241	0.000		
667.90	0.971	7.721	0.000		
668.40	0.992	8.212	0.000		
668.90	1.013	8.713	0.000		
669.40	1.034	9.225	0.000		
669.90	1.056	9.747	0.000		
670.40	1.078	10.281	0.000		
670.90	1.100	10.826	0.000		
671.40	1.123	11.381	0.000		
671.90	1.145	11.948	0.000		
672.40	1.168	12.527	0.000		
672.90	1.191	13.117	0.000		
673.40	1.215	13.718	0.000		
673.90	1.238	14.332	0.000		
674.40	1.262	14.957	0.000		
674.90	1.286	15.594	0.000		
675.40	1.310	16.243	0.000		
675.90	1.335	16.904	0.000		
676.40	1.359	17.578	0.000		
676.90	1.384	18.264	0.000		
677.40	1.410	18.962	0.000		
677.90	1.435	19.673	0.000		
678.00	1.440	19.817	0.000		Spillway #1
678.40	1.477	20.400	7.548	7.40	
678.90	1.524	21.151	16.982	1.30	
679.20	1.553	21.617	33.403	0.45	Peak Stage

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
679.40	1.572	21.925	44.235	
679.90	1.621	22.723	79.824	
680.40	1.670	23.545	126.733	
680.90	1.720	24.393	186.713	
681.00	1.730	24.565	200.237	

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
657.90	0.000	0.000
658.00	0.000	0.000
658.40	0.000	0.000
658.90	0.000	0.000
659.40	0.000	0.000
659.90	0.000	0.000
660.40	0.000	0.000
660.90	0.000	0.000
661.40	0.000	0.000
661.90	0.000	0.000
662.40	0.000	0.000
662.90	0.000	0.000
663.40	0.000	0.000
663.90	0.000	0.000
664.40	0.000	0.000
664.90	0.000	0.000
665.40	0.000	0.000
665.90	0.000	0.000
666.40	0.000	0.000
666.90	0.000	0.000
667.40	0.000	0.000
667.90	0.000	0.000
668.40	0.000	0.000
668.90	0.000	0.000
669.40	0.000	0.000
669.90	0.000	0.000
670.40	0.000	0.000
670.90	0.000	0.000
671.40	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
671.90	0.000	0.000
672.40	0.000	0.000
672.90	0.000	0.000
673.40	0.000	0.000
673.90	0.000	0.000
674.40	0.000	0.000
674.90	0.000	0.000
675.40	0.000	0.000
675.90	0.000	0.000
676.40	0.000	0.000
676.90	0.000	0.000
677.40	0.000	0.000
677.90	0.000	0.000
678.00	0.000	0.000
678.40	7.548	7.548
678.90	16.982	16.982
679.40	44.235	44.235
679.90	79.824	79.824
680.40	126.733	126.733
680.90	186.713	186.713
681.00	200.237	200.237

Structure #1 (Vegetated Channel)

Collector Ditch #3, Sta 0+00 to 10+66 (Sediment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.3	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	10.83 cfs		10.83 cfs	
Depth:	1.08 ft	1.38 ft	1.97 ft	2.27 ft
Top Width:	10.34 ft	11.54 ft	13.90 ft	15.10 ft
Velocity:	1.22 fps		0.55 fps	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
X-Section Area:	8.86 sq ft		19.64 sq ft	
Hydraulic Radius:	0.817 ft		1.324 ft	
Froude Number:	0.23		0.08	
Roughness Coefficient:	0.0583		0.1783	

Structure #3 (Pond)

Sediment Pond #1.

Pond Inputs:

Initial Pool Elev:	676.00 ft
Initial Pool:	26.76 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
676.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	677.94 ft
Dewater Time:	0.73 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
657.90	0.000	0.000	0.000	
658.00	1.110	0.037	0.000	
658.40	1.125	0.484	0.000	
658.90	1.143	1.051	0.000	
659.40	1.162	1.627	0.000	
659.90	1.181	2.213	0.000	
660.40	1.200	2.808	0.000	
660.90	1.219	3.413	0.000	
661.40	1.239	4.028	0.000	
661.90	1.258	4.652	0.000	
662.40	1.278	5.286	0.000	
662.90	1.297	5.929	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
663.40	1.317	6.583	0.000		
663.90	1.338	7.247	0.000		
664.40	1.358	7.921	0.000		
664.90	1.378	8.605	0.000		
665.40	1.399	9.299	0.000		
665.90	1.419	10.003	0.000		
666.40	1.440	10.718	0.000		
666.90	1.461	11.444	0.000		
667.40	1.483	12.180	0.000		
667.90	1.504	12.926	0.000		
668.40	1.525	13.684	0.000		
668.90	1.547	14.452	0.000		
669.40	1.569	15.231	0.000		
669.90	1.591	16.020	0.000		
670.40	1.613	16.821	0.000		
670.90	1.635	17.633	0.000		
671.40	1.657	18.456	0.000		
671.90	1.680	19.291	0.000		
672.40	1.703	20.136	0.000		
672.90	1.725	20.993	0.000		
673.00	1.730	21.166	0.000		
673.40	1.765	21.865	0.000		
673.90	1.809	22.758	0.000		
674.40	1.854	23.674	0.000		
674.90	1.899	24.612	0.000		
675.40	1.945	25.573	0.000		
675.90	1.991	26.557	0.000		
676.00	2.000	26.756	0.000		Spillway #1
676.40	2.038	27.564	5.444	12.85	
676.90	2.085	28.595	12.249	1.85	
677.40	2.133	29.649	30.717	1.75	
677.90	2.181	30.728	58.495	0.90	
677.94	2.185	30.809	61.292	0.20	Peak Stage
678.40	2.230	31.831	96.334		
678.90	2.280	32.958	145.344		
679.00	2.290	33.187	156.562		

<u>Detailed Discharge Table</u>

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
657.90	0.000	0.000
658.00	0.000	0.000
658.40	0.000	0.000
658.90	0.000	0.000
659.40	0.000	0.000
659.90	0.000	0.000
660.40	0.000	0.000
660.90	0.000	0.000
661.40	0.000	0.000
661.90	0.000	0.000
662.40	0.000	0.000
662.90	0.000	0.000
663.40	0.000	0.000
663.90	0.000	0.000
664.40	0.000	0.000
664.90	0.000	0.000
665.40	0.000	0.000
665.90	0.000	0.000
666.40	0.000	0.000
666.90	0.000	0.000
667.40	0.000	0.000
667.90	0.000	0.000
668.40	0.000	0.000
668.90	0.000	0.000
669.40	0.000	0.000
669.90	0.000	0.000
670.40	0.000	0.000
670.90	0.000	0.000
671.40	0.000	0.000
671.90	0.000	0.000
672.40	0.000	0.000
672.90	0.000	0.000
673.00	0.000	0.000
673.40	0.000	0.000
673.90	0.000	0.000
674.40	0.000	0.000
674.90	0.000	0.000
675.40	0.000	0.000
675.90	0.000	0.000
676.00	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
676.40	5.444	5.444
676.90	12.249	12.249
677.40	30.717	30.717
677.90	58.495	58.495
678.40	96.334	96.334
678.90	145.344	145.344
679.00	156.562	156.562

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#7	1	1.400	0.178	0.000	0.000	77.000	M	3.63	0.245
	2	10.500	0.455	0.000	0.000	77.000	M	20.08	1.805
	3	3.600	0.038	0.000	0.000	85.000	M	16.84	0.996
	4	2.400	0.051	0.000	0.000	85.000	M	11.23	0.664
	5	1.400	0.157	0.000	0.000	77.000	M	3.70	0.245
	Σ	**19.300**						**49.44**	**3.956**
#9	1	1.600	0.020	0.000	0.000	77.000	M	6.38	0.344
	Σ	**20.900**						**55.82**	**4.300**
#10	1	9.450	0.003	0.000	0.000	92.000	F	48.60	3.181
	Σ	**9.450**						**48.60**	**3.181**
#8	1	1.900	0.003	0.000	0.000	98.000	F	10.18	0.746
	Σ	**11.350**						**58.78**	**3.927**
#1	1	4.100	0.164	0.000	0.000	77.000	M	10.83	0.719
	Σ	**4.100**						**10.83**	**0.719**
#3	1	2.600	0.003	0.000	0.000	98.000	F	13.93	1.021
	2	1.800	0.071	0.000	0.000	77.000	M	7.17	0.387
	3	3.600	0.026	0.000	0.000	85.000	M	16.84	0.996
	4	1.300	0.164	0.000	0.000	77.000	M	3.43	0.228
	Σ	**45.650**						**140.05**	**11.579**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	5.21	56.00	1,075.00	1.820	0.164
#1	**1**	**Time of Concentration:**					**0.164**
#3	1	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#3	**1**	**Time of Concentration:**					**0.003**
#3	2	3. Short grass pasture	9.19	57.00	620.00	2.420	0.071
#3	**2**	**Time of Concentration:**					**0.071**
#3	3	5. Nearly bare and untilled, and alluvial valley fans	15.20	57.00	375.00	3.890	0.026
#3	**3**	**Time of Concentration:**					**0.026**
#3	4	3. Short grass pasture	1.65	10.00	605.00	1.020	0.164
#3	**4**	**Time of Concentration:**					**0.164**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	3. Short grass pasture	4.80	54.00	1,125.00	1.750	0.178
#7	**1**	**Time of Concentration:**					**0.178**
#7	2	3. Short grass pasture	0.60	6.00	1,000.00	0.610	0.455
#7	**2**	**Time of Concentration:**					**0.455**
#7	3	5. Nearly bare and untilled, and alluvial valley fans	11.49	54.00	470.00	3.380	0.038
#7	**3**	**Time of Concentration:**					**0.038**
#7	4	5. Nearly bare and untilled, and alluvial valley fans	9.65	55.00	570.00	3.100	0.051
#7	**4**	**Time of Concentration:**					**0.051**
#7	5	3. Short grass pasture	1.08	5.00	465.00	0.820	0.157
#7	**5**	**Time of Concentration:**					**0.157**
#8	1	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#8	**1**	**Time of Concentration:**					**0.003**
#9	1	3. Short grass pasture	3.00	3.00	100.00	1.380	0.020
#9	**1**	**Time of Concentration:**					**0.020**
#10	1	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#10	**1**	**Time of Concentration:**					**0.003**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #1 to Sediment #2

10yr - 24hr Storm

Top of Dam Elev = 678.5

Pool Elev = 670.0

Peak Elev = 675.7

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

General Information

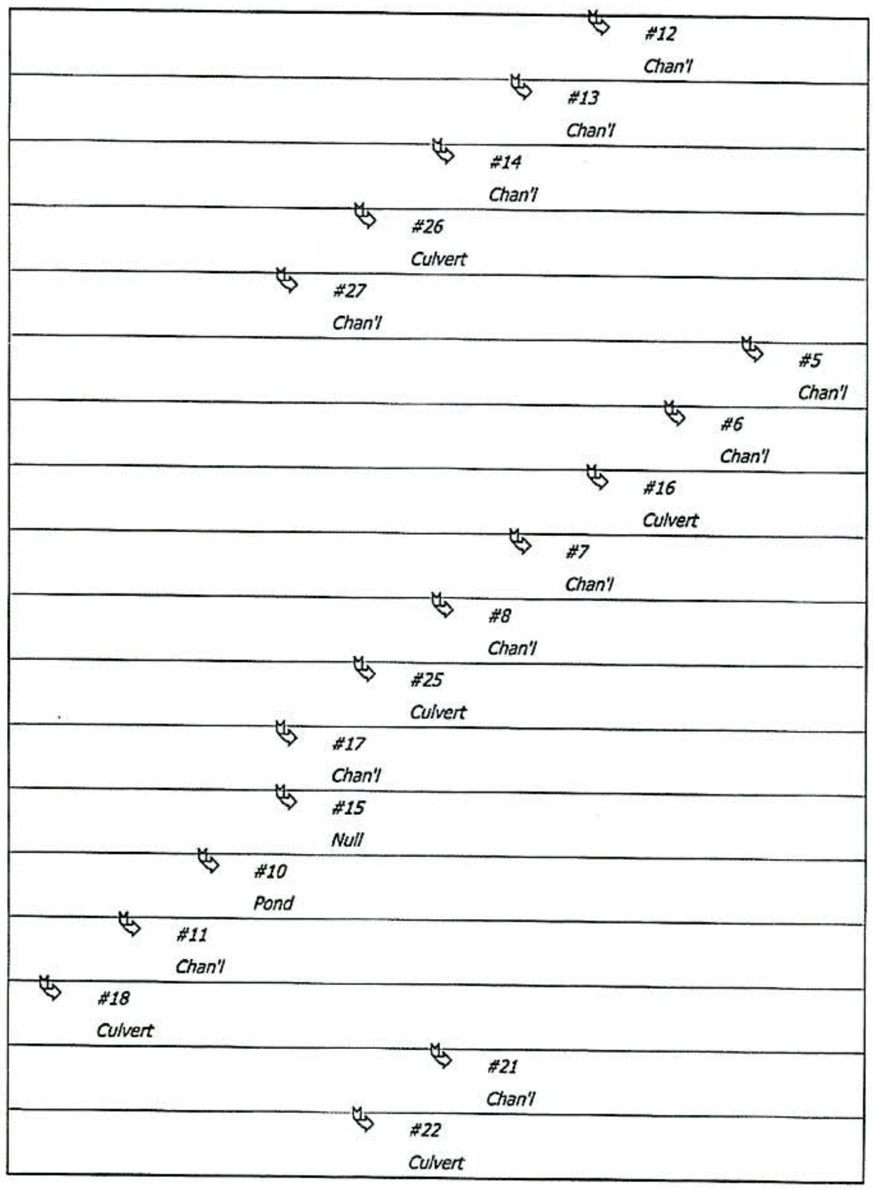
Storm Information:

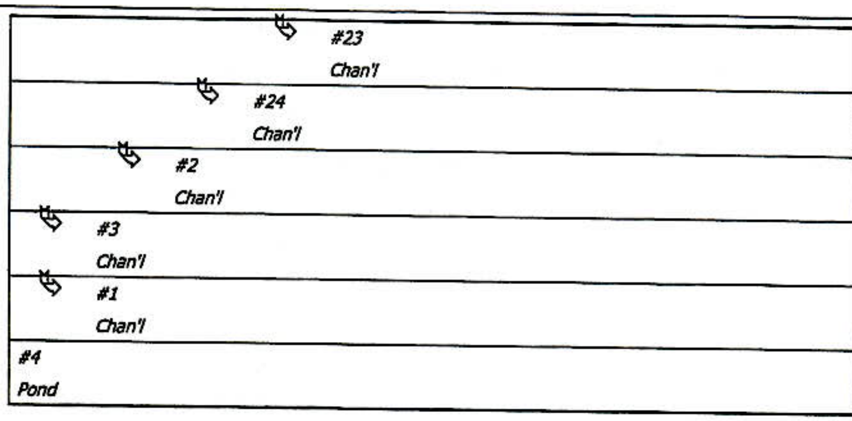
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	4.260 inches

Structure Networking:

Type	Stru #	(flows Into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#4	0.000	0.000	Collector Ditch #1, Sta 0+00 to 21+66 (Sediment Pond #2).
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #2, Sta 35+00 to 51+50.
Channel	#3	==>	#4	0.000	0.000	Collector Ditch #2, Sta 51+50 to 64+70 (Sediment Pond #2).
Pond	#4	==>	End	0.000	0.000	Sediment Pond #2.
Channel	#5	==>	#6	0.000	0.000	Collector Ditch #6, Sta 0+00 to 7+00.
Channel	#6	==>	#16	0.000	0.000	Collector Ditch #6, Sta 7+00 to 13+60 (Culvert under Haul Road #2).
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #6, Sta 14+00 (Culvert under Haul Road #2) to 25+50.
Channel	#8	==>	#25	0.000	0.000	Collector Ditch #6, Sta 25+50 to 41+10.
Pond	#10	==>	#11	0.000	0.000	Treatment Pond #1.
Channel	#11	==>	#18	0.000	0.000	Spillway Ditch to Sediment Pond #2, Sta 0+00 to 3+90 (Culvert under Haul Road #2)
Channel	#12	==>	#13	0.000	0.000	Collector Ditch #5, Sta 0+00 to 5+00.
Channel	#13	==>	#14	0.000	0.000	Collector Ditch #5, Sta 5+00 to 13+00.
Channel	#14	==>	#26	0.000	0.000	Collector Ditch #5, Sta 13+00 to 20+85 (Culvert Under Haul Road #1 and Rail Road).
Null	#15	==>	#10	0.000	0.000	Plant Runoff Pumpage
Culvert	#16	==>	#7	0.000	0.000	Culvert under Haul Road #2, Collector Ditch #6, Sta 13+60 to 14+00.
Channel	#17	==>	#10	0.000	0.000	Collector Ditch #6, Sta 41+60 to 48+25 (Treatment Pond #1).
Culvert	#18	==>	#4	0.000	0.000	Spillway Ditch to Sediment Pond #2, Culvert under Haul Road #2, Sta 3+90 to 4+40 (Sediment Pond #2)
Channel	#21	==>	#22	0.000	0.000	Collector Ditch #2, Sta 0+00 to 10+50.
Culvert	#22	==>	#23	0.000	0.000	Culvert Under Entrance, Collector Ditch #2, Sta 10+50 to 11+00.
Channel	#23	==>	#24	0.000	0.000	Collector Ditch #2, Sta 11+00 to 13+50.
Channel	#24	==>	#2	0.000	0.000	Collector Ditch #2, Sta 13+50 to 35+00.
Culvert	#25	==>	#17	0.000	0.000	Culvert Under Rail Road, Collector Dtich #6, Sta. 41+10 to 41+60.

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#26	==>	#27	0.000	0.000	Culvert Under Haul Road #1 and Rail Road, Collector Ditch #5 Sta 20+85 to 21+75.
Channel	#27	==>	#10	0.000	0.000	Collector Ditch #5, Sta 21+75 to 26+43 (Treatment Pond #1).




#23
Chan'l
#24
Chan'l
#2
Chan'l
#3
Chan'l
#1
Chan'l
#4
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#12		1.600	1.600	3.45	0.27
#13		2.400	4.000	8.63	0.67
#14		7.700	11.700	31.00	2.64
#26		0.000	11.700	31.00	2.64
#27		3.400	15.100	40.88	3.51
#5		13.500	13.500	30.74	2.99
#6		19.800	33.300	69.81	7.29
#16		0.000	33.300	69.81	7.29
#7		6.800	40.100	82.86	8.70
#8		5.500	45.600	97.87	10.05
#25		0.000	45.600	97.87	10.05
#17		17.700	63.300	120.77	12.63
#15		1.320	1.320	4.29	0.44
#10	In	38.200	117.920	231.42	24.07
	Out			48.58	23.98
#11		0.000	117.920	48.58	23.98
#18		0.000	117.920	48.58	23.98
#21		29.500	29.500	61.20	6.09
#22		0.000	29.500	61.20	6.09
#23		3.800	33.300	67.16	6.70
#24		2.900	36.200	71.92	7.29
#2		6.600	42.800	81.60	8.26
#3		3.400	46.200	85.46	8.75
#1		13.800	13.800	11.98	1.85
#4	In	23.300	201.220	138.92	38.45
	Out			8.06	9.65

Structure Detail:

Structure #12 (Vegetated Channel)

Collector Ditch #5, Sta 0+00 to 5+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	3.45 cfs		3.45 cfs	
Depth:	0.72 ft	1.02 ft	1.51 ft	1.81 ft
Top Width:	8.88 ft	10.08 ft	12.04 ft	13.24 ft
Velocity:	0.64 fps		0.25 fps	
X-Section Area:	5.36 sq ft		13.62 sq ft	
Hydraulic Radius:	0.581 ft		1.068 ft	
Froude Number:	0.15		0.04	
Roughness Coefficient:	0.0787		0.3007	

Structure #13 (Vegetated Channel)

Collector Ditch #5, Sta 5+00 to 13+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	8.63 cfs		8.63 cfs	
Depth:	1.06 ft	1.36 ft	1.98 ft	2.28 ft
Top Width:	10.22 ft	11.42 ft	13.92 ft	15.12 ft
Velocity:	1.01 fps		0.44 fps	
X-Section Area:	8.57 sq ft		19.71 sq ft	
Hydraulic Radius:	0.799 ft		1.327 ft	
Froude Number:	0.19		0.06	
Roughness Coefficient:	0.0623		0.2011	

Structure #14 (Vegetated Channel)

Collector Ditch #5, Sta 13+00 to 20+85 (Culvert Under Haul Road #1 and Rail Road).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	31.00 cfs		31.00 cfs	
Depth:	1.59 ft	1.89 ft	2.62 ft	2.92 ft
Top Width:	14.38 ft	15.58 ft	18.49 ft	19.69 ft
Velocity:	1.74 fps		0.89 fps	
X-Section Area:	17.83 sq ft		34.73 sq ft	
Hydraulic Radius:	1.179 ft		1.760 ft	
Froude Number:	0.28		0.11	
Roughness Coefficient:	0.0468		0.1192	

Structure #26 (Culvert)

Culvert Under Haul Road #1 and Rail Road, Collector Ditch #5 Sta 20+85 to 21+75.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.24	0.0150	4.70	0.00	0.90

Culvert Results:

Design Discharge = 31.00 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure #27 (Vegetated Channel)

Collector Ditch #5, Sta 21+75 to 26+43 (Treatment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	40.88 cfs		40.88 cfs	
Depth:	1.79 ft	2.09 ft	2.84 ft	3.14 ft
Top Width:	15.14 ft	16.34 ft	19.37 ft	20.57 ft
Velocity:	1.98 fps		1.05 fps	
X-Section Area:	20.67 sq ft		38.91 sq ft	
Hydraulic Radius:	1.293 ft		1.878 ft	
Froude Number:	0.30		0.13	
Roughness Coefficient:	0.0438		0.1057	

Structure #5 (Vegetated Channel)

Collector Ditch #6, Sta 0+00 to 7+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	30.74 cfs		30.74 cfs	
Depth:	1.83 ft	2.13 ft	3.02 ft	3.32 ft
Top Width:	15.30 ft	16.50 ft	20.09 ft	21.29 ft
Velocity:	1.45 fps		0.72 fps	
X-Section Area:	21.26 sq ft		42.44 sq ft	
Hydraulic Radius:	1.316 ft		1.973 ft	
Froude Number:	0.22		0.09	
Roughness Coefficient:	0.0479		0.1253	

<u>*Structure #6 (Vegetated Channel)*</u>

Collector Ditch #6, Sta 7+00 to 13+60 (Culvert under Haul Road #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	69.81 cfs		69.81 cfs	
Depth:	2.54 ft	2.84 ft	3.82 ft	4.12 ft
Top Width:	18.17 ft	19.37 ft	23.30 ft	24.50 ft
Velocity:	2.10 fps		1.17 fps	
X-Section Area:	33.26 sq ft		59.84 sq ft	
Hydraulic Radius:	1.717 ft		2.384 ft	
Froude Number:	0.27		0.13	
Roughness Coefficient:	0.0394		0.0883	

<u>*Structure #16 (Culvert)*</u>

Culvert under Haul Road #2, Collector Ditch #6, Sta 13+60 to 14+00.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	0.15	0.0140	4.70	0.00	0.90

Culvert Results:

Design Discharge = 69.81 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #7 (Vegetated Channel)

Collector Ditch #6, Sta 14+00 (Culvert under Haul Road #2) to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	82.86 cfs		82.86 cfs	
Depth:	2.51 ft	2.81 ft	3.76 ft	4.06 ft
Top Width:	20.04 ft	21.24 ft	25.04 ft	26.24 ft
Velocity:	2.20 fps		1.26 fps	
X-Section Area:	37.68 sq ft		65.87 sq ft	
Hydraulic Radius:	1.776 ft		2.457 ft	
Froude Number:	0.28		0.14	
Roughness Coefficient:	0.0385		0.0835	

Structure #8 (Vegetated Channel)

Collector Ditch #6, Sta 25+50 to 41+10.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	97.87 cfs		97.87 cfs	
Depth:	2.68 ft	2.98 ft	3.94 ft	4.24 ft
Top Width:	20.74 ft	21.94 ft	25.78 ft	26.98 ft
Velocity:	2.37 fps		1.39 fps	
X-Section Area:	41.25 sq ft		70.57 sq ft	
Hydraulic Radius:	1.875 ft		2.553 ft	
Froude Number:	0.30		0.15	
Roughness Coefficient:	0.0370		0.0777	

Structure #25 (Culvert)

Culvert Under Rail Road, Collector Dtich #6, Sta. 41+10 to 41+60.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.15	0.0150	5.90	0.00	0.90

Culvert Results:

Design Discharge = 97.87 cfs

Minimum pipe diameter: 1 - 45 inch pipe(s) required

Structure #17 (Vegetated Channel)

Collector Ditch #6, Sta 41+60 to 48+25 (Treatment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	120.77 cfs		120.77 cfs	
Depth:	2.92 ft	3.22 ft	4.19 ft	4.49 ft

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Top Width:	21.68 ft	22.88 ft	26.77 ft	27.97 ft
Velocity:	2.61 fps		1.57 fps	
X-Section Area:	46.27 sq ft		77.06 sq ft	
Hydraulic Radius:	2.006 ft		2.681 ft	
Froude Number:	0.31		0.16	
Roughness Coefficient:	0.0352		0.0710	

<u>Structure #15 (Null)</u>

Plant Runoff Pumpage

<u>Structure #10 (Pond)</u>

Treatment Pond #1.

Pond Inputs:

Initial Pool Elev:	671.00 ft
Initial Pool:	129.99 ac-ft

<u>Emergency Spillway</u>

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
671.00	20.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	672.83 ft
Dewater Time:	0.89 days

Dewatering time is calculated from peak stage to lowest spillway

<u>Elevation-Capacity-Discharge Table</u>

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
644.90	0.000	0.000	0.000	
645.00	3.820	0.127	0.000	
645.40	3.853	1.662	0.000	
645.90	3.895	3.599	0.000	
646.40	3.937	5.557	0.000	
646.90	3.979	7.536	0.000	
647.40	4.021	9.535	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
647.90	4.063	11.556	0.000	
648.40	4.106	13.599	0.000	
648.90	4.149	15.663	0.000	
649.40	4.192	17.748	0.000	
649.90	4.236	19.855	0.000	
650.40	4.279	21.983	0.000	
650.90	4.323	24.134	0.000	
651.40	4.367	26.307	0.000	
651.90	4.411	28.501	0.000	
652.40	4.456	30.718	0.000	
652.90	4.501	32.957	0.000	
653.40	4.546	35.218	0.000	
653.90	4.591	37.503	0.000	
654.40	4.636	39.809	0.000	
654.90	4.682	42.139	0.000	
655.40	4.728	44.491	0.000	
655.90	4.774	46.866	0.000	
656.40	4.820	49.265	0.000	
656.90	4.866	51.686	0.000	
657.40	4.913	54.131	0.000	
657.90	4.960	56.599	0.000	
658.40	5.007	59.091	0.000	
658.90	5.055	61.607	0.000	
659.40	5.102	64.146	0.000	
659.90	5.150	66.709	0.000	
660.40	5.198	69.296	0.000	
660.90	5.247	71.907	0.000	
661.40	5.295	74.543	0.000	
661.90	5.344	77.202	0.000	
662.40	5.393	79.887	0.000	
662.90	5.442	82.595	0.000	
663.40	5.491	85.329	0.000	
663.90	5.541	88.087	0.000	
664.40	5.591	90.870	0.000	
664.90	5.641	93.678	0.000	
665.40	5.691	96.511	0.000	
665.90	5.742	99.369	0.000	
666.40	5.793	102.253	0.000	
666.90	5.844	105.162	0.000	
667.40	5.895	108.096	0.000	
667.90	5.946	111.056	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
668.40	5.998	114.042	0.000		
668.90	6.050	117.054	0.000		
669.40	6.102	120.092	0.000		
669.90	6.154	123.156	0.000		
670.40	6.207	126.246	0.000		
670.90	6.259	129.363	0.000		
671.00	6.270	129.989	0.000		Spillway #1
671.40	6.332	132.510	4.611	6.61*	
671.90	6.410	135.695	10.375	8.15	
672.40	6.489	138.920	26.689	4.55	
672.83	6.556	141.722	48.582	2.10	Peak Stage
672.90	6.567	142.184	52.187		
673.40	6.647	145.487	87.901		
673.90	6.727	148.831	134.607		
674.40	6.807	152.214	193.164		
674.90	6.888	155.638	264.351		
675.40	6.969	159.102	348.885		
675.90	7.051	162.607	447.425		
676.40	7.133	166.154	560.584		
676.90	7.216	169.741	688.939		
677.40	7.299	173.370	833.032		
677.90	7.383	177.041	993.381		
678.00	7.400	177.779	1,027.445		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
644.90	0.000	0.000
645.00	0.000	0.000
645.40	0.000	0.000
645.90	0.000	0.000
646.40	0.000	0.000
646.90	0.000	0.000
647.40	0.000	0.000
647.90	0.000	0.000
648.40	0.000	0.000
648.90	0.000	0.000
649.40	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
649.90	0.000	0.000
650.40	0.000	0.000
650.90	0.000	0.000
651.40	0.000	0.000
651.90	0.000	0.000
652.40	0.000	0.000
652.90	0.000	0.000
653.40	0.000	0.000
653.90	0.000	0.000
654.40	0.000	0.000
654.90	0.000	0.000
655.40	0.000	0.000
655.90	0.000	0.000
656.40	0.000	0.000
656.90	0.000	0.000
657.40	0.000	0.000
657.90	0.000	0.000
658.40	0.000	0.000
658.90	0.000	0.000
659.40	0.000	0.000
659.90	0.000	0.000
660.40	0.000	0.000
660.90	0.000	0.000
661.40	0.000	0.000
661.90	0.000	0.000
662.40	0.000	0.000
662.90	0.000	0.000
663.40	0.000	0.000
663.90	0.000	0.000
664.40	0.000	0.000
664.90	0.000	0.000
665.40	0.000	0.000
665.90	0.000	0.000
666.40	0.000	0.000
666.90	0.000	0.000
667.40	0.000	0.000
667.90	0.000	0.000
668.40	0.000	0.000
668.90	0.000	0.000
669.40	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
669.90	0.000	0.000
670.40	0.000	0.000
670.90	0.000	0.000
671.00	0.000	0.000
671.40	4.611	4.611
671.90	10.375	10.375
672.40	26.689	26.689
672.90	52.187	52.187
673.40	87.901	87.901
673.90	134.607	134.607
674.40	193.164	193.164
674.90	264.351	264.351
675.40	348.885	348.885
675.90	447.425	447.425
676.40	560.584	560.584
676.90	688.939	688.939
677.40	833.032	833.032
677.90	993.381	993.381
678.00	1,027.445	1,027.445

Structure #11 (Vegetated Channel)

Spillway Ditch to Sediment Pond #2, Sta 0+00 to 3+90 (Culvert under Haul Road #2)

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	3.0:1	3.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	48.58 cfs		48.58 cfs	
Depth:	2.26 ft	2.56 ft	3.38 ft	3.68 ft
Top Width:	17.55 ft	19.35 ft	24.30 ft	26.10 ft
Velocity:	2.00 fps		1.01 fps	
X-Section Area:	24.33 sq ft		47.89 sq ft	
Hydraulic Radius:	1.331 ft		1.885 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.30		0.13	
Roughness Coefficient:	0.0433		0.1075	

Structure #18 (Culvert)

Spillway Ditch to Sediment Pond #2, Culvert under Haul Road #2, Sta 3+90 to 4+40 (Sediment Pond #2)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.23	0.0140	7.90	0.00	0.90

Culvert Results:

Design Discharge = 48.58 cfs

Minimum pipe diameter: 1 - 30 inch pipe(s) required

Structure #21 (Vegetated Channel)

Collector Ditch #2, Sta 0+00 to 10+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	61.20 cfs		61.20 cfs	
Depth:	2.82 ft	3.12 ft	4.24 ft	4.54 ft
Top Width:	17.30 ft	18.50 ft	22.96 ft	24.16 ft
Velocity:	1.86 fps		1.00 fps	
X-Section Area:	32.91 sq ft		61.39 sq ft	
Hydraulic Radius:	1.766 ft		2.460 ft	
Froude Number:	0.24		0.11	
Roughness Coefficient:	0.0405		0.0943	

Structure #22 (Culvert)

Culvert Under Entrance, Collector Ditch #2, Sta 10+50 to 11+00.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.12	0.0140	5.50	0.00	0.90

Culvert Results:

Design Discharge = 61.20 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Structure #23 (Vegetated Channel)

Collector Ditch #2, Sta 11+00 to 13+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	67.16 cfs		67.16 cfs	
Depth:	2.93 ft	3.23 ft	4.35 ft	4.65 ft
Top Width:	17.71 ft	18.91 ft	23.39 ft	24.59 ft
Velocity:	1.94 fps		1.05 fps	
X-Section Area:	34.70 sq ft		63.90 sq ft	
Hydraulic Radius:	1.818 ft		2.511 ft	
Froude Number:	0.24		0.11	
Roughness Coefficient:	0.0397		0.0907	

Structure #24 (Vegetated Channel)

Collector Ditch #2, Sta 13+50 to 35+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	71.92 cfs		71.92 cfs	
Depth:	2.74 ft	3.04 ft	4.12 ft	4.42 ft
Top Width:	18.97 ft	20.17 ft	24.49 ft	25.69 ft
Velocity:	1.95 fps		1.07 fps	
X-Section Area:	36.97 sq ft		66.95 sq ft	
Hydraulic Radius:	1.825 ft		2.533 ft	
Froude Number:	0.25		0.11	
Roughness Coefficient:	0.0396		0.0893	

Structure #2 (Vegetated Channel)

Collector Ditch #2, Sta 35+00 to 51+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	81.60 cfs		81.60 cfs	
Depth:	2.66 ft	2.96 ft	4.01 ft	4.31 ft
Top Width:	20.64 ft	21.84 ft	26.03 ft	27.23 ft
Velocity:	2.00 fps		1.13 fps	
X-Section Area:	40.77 sq ft		72.18 sq ft	
Hydraulic Radius:	1.862 ft		2.585 ft	
Froude Number:	0.25		0.12	
Roughness Coefficient:	0.0390		0.0860	

Structure #3 (Vegetated Channel)

Collector Ditch #2, Sta 51+50 to 64+70 (Sediment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	85.46 cfs		85.46 cfs	
Depth:	2.53 ft	2.83 ft	3.83 ft	4.13 ft
Top Width:	22.11 ft	23.31 ft	27.34 ft	28.54 ft
Velocity:	1.98 fps		1.13 fps	
X-Section Area:	43.10 sq ft		75.43 sq ft	
Hydraulic Radius:	1.850 ft		2.588 ft	
Froude Number:	0.25		0.12	
Roughness Coefficient:	0.0392		0.0858	

Structure #1 (Vegetated Channel)

Collector Ditch #1, Sta 0+00 to 21+66 (Sediment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.98 cfs		11.98 cfs	
Depth:	1.09 ft	1.39 ft	2.01 ft	2.31 ft
Top Width:	12.35 ft	13.55 ft	16.03 ft	17.23 ft
Velocity:	1.08 fps		0.50 fps	
X-Section Area:	11.06 sq ft		24.11 sq ft	
Hydraulic Radius:	0.860 ft		1.420 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.20		0.07	
Roughness Coefficient:	0.0596		0.1816	

Structure #4 (Pond)

Sediment Pond #2.

Pond Inputs:

Initial Pool Elev:	670.00 ft
Initial Pool:	102.83 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
6.00	50.00	0.50	0.0140	670.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
675.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	675.70 ft
Dewater Time:	18.69 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
641.00	0.000	0.000	0.000	
641.50	0.579	0.097	0.000	
642.00	2.316	0.772	0.000	
642.50	2.384	1.947	0.000	
643.00	2.452	3.156	0.000	
643.50	2.508	4.396	0.000	
644.00	2.565	5.664	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
644.50	2.615	6.959	0.000	
645.00	2.666	8.279	0.000	
645.50	2.711	9.623	0.000	
646.00	2.756	10.990	0.000	
646.50	2.799	12.379	0.000	
647.00	2.842	13.789	0.000	
647.50	2.884	15.221	0.000	
648.00	2.927	16.673	0.000	
648.50	2.969	18.147	0.000	
649.00	3.011	19.642	0.000	
649.50	3.054	21.159	0.000	
650.00	3.097	22.696	0.000	
650.50	3.140	24.255	0.000	
651.00	3.183	25.836	0.000	
651.50	3.226	27.438	0.000	
652.00	3.269	29.062	0.000	
652.50	3.312	30.707	0.000	
653.00	3.356	32.374	0.000	
653.50	3.399	34.063	0.000	
654.00	3.443	35.774	0.000	
654.50	3.488	37.507	0.000	
655.00	3.533	39.262	0.000	
655.50	3.577	41.039	0.000	
656.00	3.622	42.839	0.000	
656.50	3.667	44.661	0.000	
657.00	3.712	46.506	0.000	
657.50	3.757	48.373	0.000	
658.00	3.803	50.264	0.000	
658.50	3.849	52.177	0.000	
659.00	3.896	54.113	0.000	
659.50	3.942	56.072	0.000	
660.00	3.988	58.055	0.000	
660.50	4.034	60.060	0.000	
661.00	4.081	62.089	0.000	
661.50	4.128	64.141	0.000	
662.00	4.175	66.217	0.000	
662.50	4.222	68.316	0.000	
663.00	4.270	70.440	0.000	
663.50	4.318	72.587	0.000	
664.00	4.366	74.757	0.000	
664.50	4.414	76.953	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
665.00	4.463	79.172	0.000		
665.50	4.513	81.416	0.000		
666.00	4.563	83.685	0.000		
666.50	4.616	85.979	0.000		
667.00	4.669	88.301	0.000		
667.50	4.725	90.649	0.000		
668.00	4.782	93.026	0.000		
668.50	4.842	95.432	0.000		
669.00	4.902	97.868	0.000		
669.50	4.967	100.335	0.000		
670.00	5.032	102.835	0.000		Spillway #1
670.50	5.108	105.370	0.322	95.28*	
671.00	5.184	107.943	0.548	56.77*	
671.50	5.275	110.557	0.687	46.05*	
672.00	5.366	113.217	0.800	40.24*	
672.50	5.469	115.926	0.913	35.91*	
673.00	5.573	118.687	1.025	32.57*	
673.50	5.684	121.501	1.124	30.30*	
674.00	5.797	124.371	1.195	29.06*	
674.50	5.937	127.304	1.266	28.04*	
675.00	6.078	130.308	1.337	27.18*	Spillway #2
675.50	6.207	133.379	2.291	16.22*	
675.70	6.261	134.665	8.062	10.85	Peak Stage
676.00	6.338	136.516	16.371		
676.50	6.437	139.709	37.196		
677.00	6.537	142.953	66.827		
677.50	6.616	146.241	106.881		
678.00	6.695	149.569	158.281		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
641.00	0.000	0.000	0.000
641.50	0.000	0.000	0.000
642.00	0.000	0.000	0.000
642.50	0.000	0.000	0.000
643.00	0.000	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
643.50	0.000	0.000	0.000
644.00	0.000	0.000	0.000
644.50	0.000	0.000	0.000
645.00	0.000	0.000	0.000
645.50	0.000	0.000	0.000
646.00	0.000	0.000	0.000
646.50	0.000	0.000	0.000
647.00	0.000	0.000	0.000
647.50	0.000	0.000	0.000
648.00	0.000	0.000	0.000
648.50	0.000	0.000	0.000
649.00	0.000	0.000	0.000
649.50	0.000	0.000	0.000
650.00	0.000	0.000	0.000
650.50	0.000	0.000	0.000
651.00	0.000	0.000	0.000
651.50	0.000	0.000	0.000
652.00	0.000	0.000	0.000
652.50	0.000	0.000	0.000
653.00	0.000	0.000	0.000
653.50	0.000	0.000	0.000
654.00	0.000	0.000	0.000
654.50	0.000	0.000	0.000
655.00	0.000	0.000	0.000
655.50	0.000	0.000	0.000
656.00	0.000	0.000	0.000
656.50	0.000	0.000	0.000
657.00	0.000	0.000	0.000
657.50	0.000	0.000	0.000
658.00	0.000	0.000	0.000
658.50	0.000	0.000	0.000
659.00	0.000	0.000	0.000
659.50	0.000	0.000	0.000
660.00	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.00	0.000	0.000	0.000
661.50	0.000	0.000	0.000
662.00	0.000	0.000	0.000
662.50	0.000	0.000	0.000
663.00	0.000	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
663.50	0.000	0.000	0.000
664.00	0.000	0.000	0.000
664.50	0.000	0.000	0.000
665.00	0.000	0.000	0.000
665.50	0.000	0.000	0.000
666.00	0.000	0.000	0.000
666.50	0.000	0.000	0.000
667.00	0.000	0.000	0.000
667.50	0.000	0.000	0.000
668.00	0.000	0.000	0.000
668.50	0.000	0.000	0.000
669.00	0.000	0.000	0.000
669.50	0.000	0.000	0.000
670.00	0.000	0.000	0.000
670.50	(3)>0.322	0.000	0.322
671.00	(5)>0.548	0.000	0.548
671.50	(6)>0.687	0.000	0.687
672.00	(6)>0.800	0.000	0.800
672.50	(6)>0.913	0.000	0.913
673.00	(6)>1.025	0.000	1.025
673.50	(6)>1.124	0.000	1.124
674.00	(6)>1.195	0.000	1.195
674.50	(6)>1.266	0.000	1.266
675.00	(6)>1.337	0.000	1.337
675.50	(6)>1.408	0.883	2.291
676.00	(6)>1.479	14.892	16.371
676.50	(6)>1.550	35.646	37.196
677.00	(6)>1.615	65.212	66.827
677.50	(6)>1.667	105.214	106.881
678.00	(6)>1.719	156.562	158.281

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#12	1	0.800	0.013	0.000	0.000	77.000	M	1.73	0.134
	2	0.800	0.013	0.000	0.000	77.000	M	1.73	0.134
	Σ	**1.600**						**3.45**	**0.268**
#13	1	1.500	0.068	0.000	0.000	77.000	M	3.24	0.252
	2	0.900	0.067	0.000	0.000	77.000	M	1.94	0.151
	Σ	**4.000**						**8.63**	**0.671**
#14	1	3.800	0.101	0.000	0.000	89.000	F	11.04	0.971
	2	3.900	0.023	0.000	0.000	89.000	M	11.33	0.996
	Σ	**11.700**						**31.00**	**2.637**
#26	Σ	**11.700**						**31.00**	**2.637**
#27	1	3.400	0.082	0.000	0.000	89.000	M	9.88	0.868
	Σ	**15.100**						**40.88**	**3.506**
#5	1	4.300	0.039	0.000	0.000	89.000	M	12.49	1.098
	2	9.200	0.193	0.000	0.000	89.000	M	18.90	1.889
	Σ	**13.500**						**30.74**	**2.987**
#6	1	6.200	0.527	0.000	0.000	89.000	M	9.58	1.264
	2	4.500	0.039	0.000	0.000	89.000	M	13.07	1.149
	3	9.100	0.164	0.000	0.000	89.000	M	19.25	1.890
	Σ	**33.300**						**69.81**	**7.291**
#16	Σ	**33.300**						**69.81**	**7.291**
#7	1	5.500	0.160	0.000	0.000	89.000	M	11.63	1.143
	2	1.300	0.454	0.000	0.000	89.000	M	2.15	0.264
	Σ	**40.100**						**82.86**	**8.698**
#8	1	4.400	0.045	0.000	0.000	89.000	M	12.78	1.124
	2	1.100	0.176	0.000	0.000	89.000	M	2.31	0.227
	Σ	**45.600**						**97.87**	**10.049**
#25	Σ	**45.600**						**97.87**	**10.049**
#17	1	17.700	0.247	0.000	0.000	79.000	M	25.27	2.580
	Σ	**63.300**						**120.77**	**12.629**
#15	1	1.320	0.027	0.000	0.000	98.000	M	4.29	0.442
	Σ	**1.320**						**4.29**	**0.442**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	15.800	0.334	0.000	0.000	86.000	M	26.35	2.932
	2	5.100	0.148	0.000	0.000	86.000	M	9.96	0.961
	3	6.200	0.320	0.000	0.000	86.000	M	10.43	1.149
	4	6.700	0.282	0.000	0.000	79.000	M	9.21	0.972
	5	4.400	0.012	0.000	0.000	98.000	F	14.29	1.475
	Σ	**117.920**						**231.42**	**24.066**
#11	Σ	**117.920**						**48.58**	**23.981**
#18	Σ	**117.920**						**48.58**	**23.981**
#21	1	19.500	0.173	0.000	0.000	89.000	M	41.01	4.042
	2	2.600	0.216	0.000	0.000	89.000	M	5.23	0.532
	3	7.400	0.197	0.000	0.000	89.000	M	15.11	1.514
	Σ	**29.500**						**61.20**	**6.089**
#22	Σ	**29.500**						**61.20**	**6.089**
#23	1	3.800	0.212	0.000	0.000	82.000	M	6.24	0.614
	Σ	**33.300**						**67.16**	**6.703**
#24	1	2.900	0.057	0.000	0.000	82.000	M	7.21	0.586
	Σ	**36.200**						**71.92**	**7.289**
#2	1	3.600	0.154	0.000	0.000	79.000	M	5.61	0.530
	2	3.000	0.169	0.000	0.000	79.000	M	4.66	0.442
	Σ	**42.800**						**81.60**	**8.261**
#3	1	3.400	0.323	0.000	0.000	79.000	M	4.47	0.493
	Σ	**46.200**						**85.46**	**8.753**
#1	1	13.800	0.696	0.000	0.000	77.000	M	11.98	1.848
	Σ	**13.800**						**11.98**	**1.848**
#4	1	17.100	0.727	0.000	0.000	71.000	M	10.84	1.788
	2	6.200	0.011	0.000	0.000	98.000	F	20.13	2.078
	Σ	**201.220**						**138.92**	**38.448**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	0.59	9.00	1,530.00	0.610	0.696
#1	**1**	**Time of Concentration:**					**0.696**
#2	1	4. Cultivated, straight row	0.33	10.00	3,000.00	0.510	1.633

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	**1**	**Time of Concentration:**					**0.154**
#2	2	4. Cultivated, straight row	0.38	15.00	4,000.00	0.540	2.057
#2	**2**	**Time of Concentration:**					**0.169**
#3	1	4. Cultivated, straight row	0.29	10.00	3,400.00	0.480	1.967
#3	**1**	**Time of Concentration:**					**0.323**
#4	1	3. Short grass pasture	0.49	7.00	1,440.00	0.550	0.727
#4	**1**	**Time of Concentration:**					**0.727**
#4	2	9. Small streams flowing bankfull	0.42	1.00	239.00	5.820	0.011
#4	**2**	**Time of Concentration:**					**0.011**
#5	1	7. Paved area and small upland gullies	0.50	1.00	200.00	1.420	0.039
#5	**1**	**Time of Concentration:**					**0.039**
#5	2	7. Paved area and small upland gullies	0.17	1.00	579.00	0.830	0.193
#5	**2**	**Time of Concentration:**					**0.193**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	0.22	2.00	892.06	0.470	0.527
#6	**1**	**Time of Concentration:**					**0.527**
#6	2	7. Paved area and small upland gullies	0.50	1.00	200.00	1.420	0.039
#6	**2**	**Time of Concentration:**					**0.039**
#6	3	7. Paved area and small upland gullies	0.30	2.00	657.03	1.110	0.164
#6	**3**	**Time of Concentration:**					**0.164**
#7	1	7. Paved area and small upland gullies	0.41	3.00	740.00	1.280	0.160
#7	**1**	**Time of Concentration:**					**0.160**
#7	2	7. Paved area and small upland gullies	0.29	5.00	1,750.08	1.070	0.454
#7	**2**	**Time of Concentration:**					**0.454**
#8	1	7. Paved area and small upland gullies	1.32	5.00	380.02	2.300	0.045
#8	**1**	**Time of Concentration:**					**0.045**
#8	2	7. Paved area and small upland gullies	0.29	2.00	684.46	1.080	0.176
#8	**2**	**Time of Concentration:**					**0.176**
#10	1	3. Short grass pasture	1.63	20.00	1,230.00	1.020	0.334
#10	**1**	**Time of Concentration:**					**0.334**
#10	2	3. Short grass pasture	1.11	5.00	450.00	0.840	0.148
#10	**2**	**Time of Concentration:**					**0.148**
#10	3	3. Short grass pasture	0.67	5.00	750.00	0.650	0.320
#10	**3**	**Time of Concentration:**					**0.320**
#10	4	3. Short grass pasture	2.40	30.00	1,250.00	1.230	0.282
#10	**4**	**Time of Concentration:**					**0.282**
#10	5	9. Small streams flowing bankfull	0.40	1.00	250.06	5.690	0.012

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#10	**5**	**Time of Concentration:**					**0.012**
#12	1	3. Short grass pasture	27.00	54.00	200.00	4.150	0.013
#12	**1**	**Time of Concentration:**					**0.013**
#12	2	3. Short grass pasture	27.00	54.00	200.00	4.150	0.013
#12	**2**	**Time of Concentration:**					**0.013**
#13	1	3. Short grass pasture	9.17	55.00	600.00	2.420	0.068
#13	**1**	**Time of Concentration:**					**0.068**
#13	2	3. Short grass pasture	1.89	5.00	265.00	1.090	0.067
#13	**2**	**Time of Concentration:**					**0.067**
#14	1	7. Paved area and small upland gullies	1.06	8.00	755.00	2.070	0.101
#14	**1**	**Time of Concentration:**					**0.101**
#14	2	5. Nearly bare and untilled, and alluvial valley fans	16.67	57.50	345.00	4.080	0.023
#14	**2**	**Time of Concentration:**					**0.023**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	1.00	100.00	1.000	0.027
#15	**1**	**Time of Concentration:**					**0.027**
#17	1	3. Short grass pasture	2.61	30.00	1,150.08	1.290	0.247
#17	**1**	**Time of Concentration:**					**0.247**
#21	1	7. Paved area and small upland gullies	0.61	6.00	980.00	1.570	0.173
#21	**1**	**Time of Concentration:**					**0.173**
#21	2	7. Paved area and small upland gullies	0.33	3.00	903.00	1.160	0.216
#21	**2**	**Time of Concentration:**					**0.216**
#21	3	7. Paved area and small upland gullies	0.35	3.00	847.00	1.190	0.197
#21	**3**	**Time of Concentration:**					**0.197**
#23	1	3. Short grass pasture	1.10	7.00	635.00	0.830	0.212
#23	**1**	**Time of Concentration:**					**0.212**
#24	1	3. Short grass pasture	1.82	4.00	220.00	1.070	0.057
#24	**1**	**Time of Concentration:**					**0.057**
#27	1	7. Paved area and small upland gullies	0.77	4.00	520.02	1.760	0.082
#27	**1**	**Time of Concentration:**					**0.082**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #1 to Sediment #2

100yr - 6hr Storm

Top of Dam Elev = 678.5

Pool Elev = 670.0

Peak Elev = 676.3

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

General Information

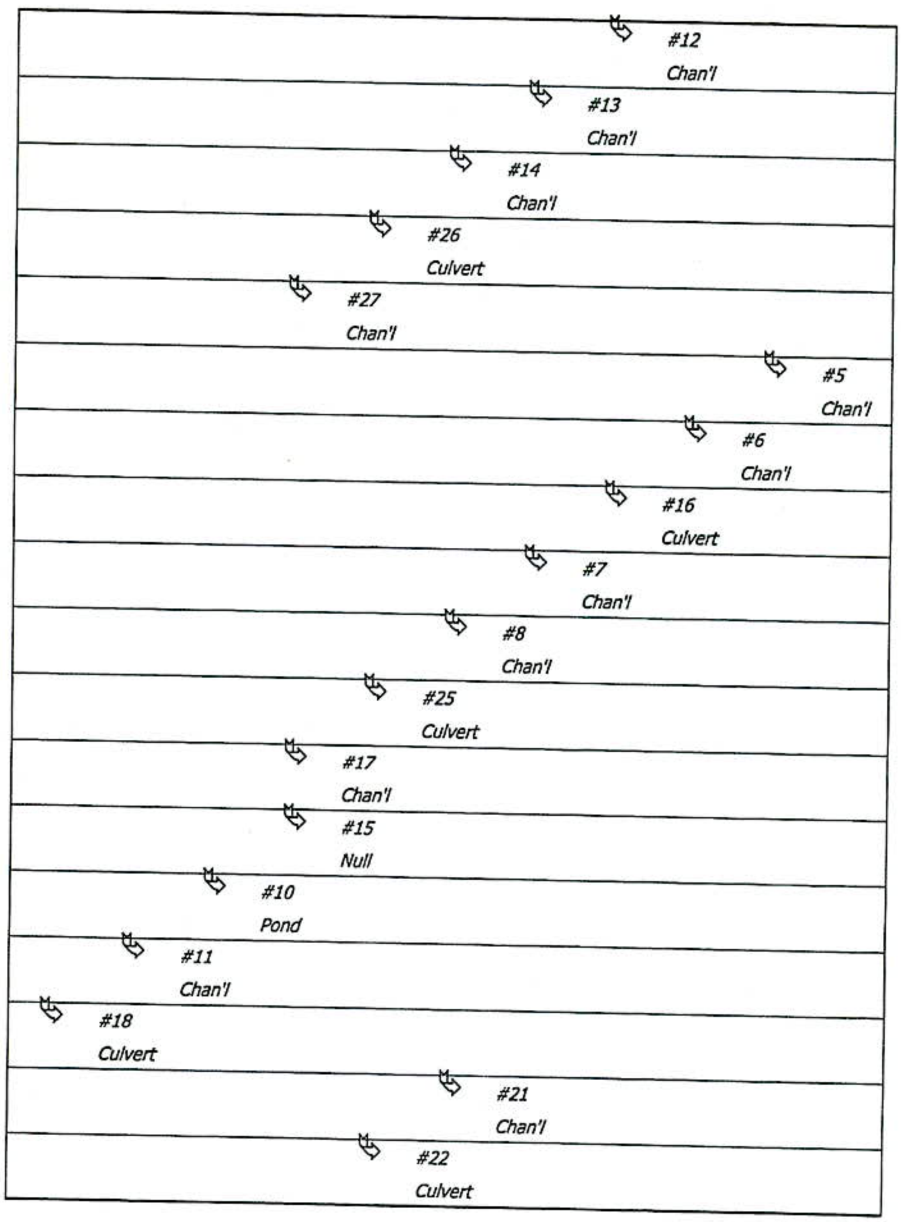
Storm Information:

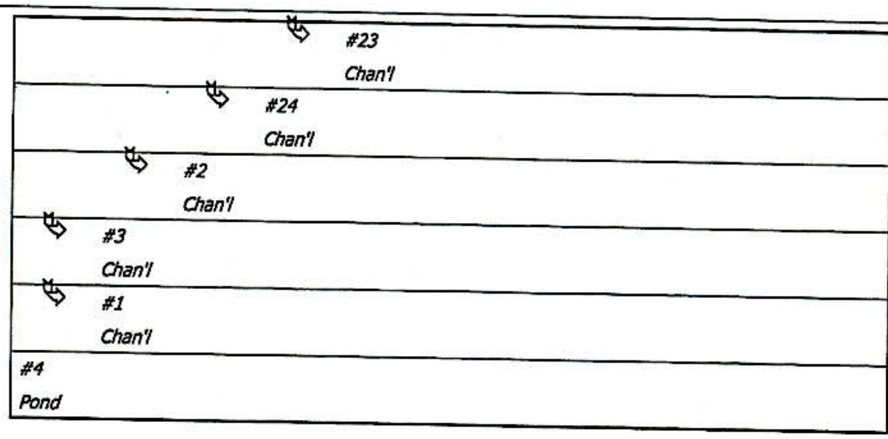
Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	4.960 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#4	0.000	0.000	Collector Ditch #1, Sta 0+00 to 21+66 (Sediment Pond #2).
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #2, Sta 35+00 to 51+50.
Channel	#3	==>	#4	0.000	0.000	Collector Ditch #2, Sta 51+50 to 64+70 (Sediment Pond #2).
Pond	#4	==>	End	0.000	0.000	Sediment Pond #2.
Channel	#5	==>	#6	0.000	0.000	Collector Ditch #6, Sta 0+00 to 7+00.
Channel	#6	==>	#16	0.000	0.000	Collector Ditch #6, Sta 7+00 to 13+60 (Culvert under Haul Road #2).
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #6, Sta 14+00 (Culvert under Haul Road #2) to 25+50.
Channel	#8	==>	#25	0.000	0.000	Collector Ditch #6, Sta 25+50 to 41+10.
Pond	#10	==>	#11	0.000	0.000	Treatment Pond #1.
Channel	#11	==>	#18	0.000	0.000	Spillway Ditch to Sediment Pond #2, Sta 0+00 to 3+90 (Culvert under Haul Road #2)
Channel	#12 •	==>	#13	0.000	0.000	Collector Ditch #5, Sta 0+00 to 5+00.
Channel	#13	==>	#14	0.000	0.000	Collector Ditch #5, Sta 5+00 to 13+00.
Channel	#14	==>	#26	0.000	0.000	Collector Ditch #5, Sta 13+00 to 20+85 (Culvert Under Haul Road #1 and Rail Road).
Null	#15	==>	#10	0.000	0.000	Plant Runoff Pumpage
Culvert	#16	==>	#7	0.000	0.000	Culvert under Haul Road #2, Collector Ditch #6, Sta 13+60 to 14+00.
Channel	#17	==>	#10	0.000	0.000	Collector Ditch #6, Sta 41+60 to 48+25 (Treatment Pond #1).
Culvert	#18	==>	#4	0.000	0.000	Spillway Ditch to Sediment Pond #2, Culvert under Haul Road #2, Sta 3+90 to 4+40 (Sediment Pond #2)
Channel	#21	==>	#22	0.000	0.000	Collector Ditch #2, Sta 0+00 to 10+50.
Culvert	#22	==>	#23	0.000	0.000	Culvert Under Entrance, Collector Ditch #2, Sta 10+50 to 11+00.
Channel	#23	==>	#24	0.000	0.000	Collector Ditch #2, Sta 11+00 to 13+50.
Channel	#24	==>	#2	0.000	0.000	Collector Ditch #2, Sta 13+50 to 35+00.
Culvert	#25	==>	#17	0.000	0.000	Culvert Under Rail Road, Collector Dtich #6, Sta. 41+10 to 41+60.

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#26	==>	#27	0.000	0.000	Culvert Under Haul Road #1 and Rail Road, Collector Ditch #5 Sta 20+85 to 21+75.
Channel	#27	==>	#10	0.000	0.000	Collector Ditch #5, Sta 21+75 to 26+43 (Treatment Pond #1).




#23
Chan'l
#24
Chan'l
#2
Chan'l
#3
Chan'l
#1
Chan'l
#4
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#12		1.600	1.600	6.38	0.34
#13		2.400	4.000	15.94	0.86
#14		7.700	11.700	54.17	3.25
#26		0.000	11.700	54.17	3.25
#27		3.400	15.100	71.05	4.30
#5		13.500	13.500	52.22	3.63
#6		19.800	33.300	118.01	8.87
#16		0.000	33.300	118.01	8.87
#7		6.800	40.100	140.00	10.58
#8		5.500	45.600	165.61	12.22
#25		0.000	45.600	165.61	12.22
#17		17.700	63.300	205.57	15.50
#15		1.320	1.320	7.07	0.52
#10	In	38.200	117.920	393.70	29.50
	Out			101.97	29.49
#11		0.000	117.920	101.97	29.49
#18		0.000	117.920	101.97	29.49
#21		29.500	29.500	103.79	7.41
#22		0.000	29.500	103.79	7.41
#23		3.800	33.300	114.18	8.18
#24		2.900	36.200	122.47	8.91
#2		6.600	42.800	139.66	10.15
#3		3.400	46.200	146.21	10.78
#1		13.800	13.800	21.02	2.37
#4	In	23.300	201.220	239.78	47.44
	Out			28.03	20.17

Structure Detail:

Structure #12 (Vegetated Channel)

Collector Ditch #5, Sta 0+00 to 5+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	6.38 cfs		6.38 cfs	
Depth:	0.93 ft	1.23 ft	1.81 ft	2.11 ft
Top Width:	9.72 ft	10.92 ft	13.24 ft	14.44 ft
Velocity:	0.87 fps		0.37 fps	
X-Section Area:	7.32 sq ft		17.43 sq ft	
Hydraulic Radius:	0.720 ft		1.236 ft	
Froude Number:	0.18		0.06	
Roughness Coefficient:	0.0672		0.2295	

Structure #13 (Vegetated Channel)

Collector Ditch #5, Sta 5+00 to 13+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	15.94 cfs		15.94 cfs	
Depth:	1.36 ft	1.66 ft	2.37 ft	2.67 ft
Top Width:	11.44 ft	12.64 ft	15.46 ft	16.66 ft
Velocity:	1.34 fps		0.63 fps	
X-Section Area:	11.86 sq ft		25.38 sq ft	
Hydraulic Radius:	0.982 ft		1.531 ft	
Froude Number:	0.23		0.09	
Roughness Coefficient:	0.0536		0.1543	

<u>*Structure #14 (Vegetated Channel)*</u>

Collector Ditch #5, Sta 13+00 to 20+85 (Culvert Under Haul Road #1 and Rail Road).

Trapezoidal Vegetated Channel Inputs:

<u>Material: Grass mixture</u>

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	54.17 cfs		54.17 cfs	
Depth:	2.00 ft	2.30 ft	3.08 ft	3.38 ft
Top Width:	16.01 ft	17.21 ft	20.34 ft	21.54 ft
Velocity:	2.25 fps		1.24 fps	
X-Section Area:	24.05 sq ft		43.71 sq ft	
Hydraulic Radius:	1.418 ft		2.006 ft	
Froude Number:	0.32		0.15	
Roughness Coefficient:	0.0409		0.0936	

<u>*Structure #26 (Culvert)*</u>

Culvert Under Haul Road #1 and Rail Road, Collector Ditch #5 Sta 20+85 to 21+75.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.24	0.0150	4.70	0.00	0.90

Culvert Results:

Design Discharge = 54.17 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #27 (Vegetated Channel)

Collector Ditch #5, Sta 21+75 to 26+43 (Treatment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	71.05 cfs		71.05 cfs	
Depth:	2.24 ft	2.54 ft	3.34 ft	3.64 ft
Top Width:	16.94 ft	18.14 ft	21.34 ft	22.54 ft
Velocity:	2.55 fps		1.45 fps	
X-Section Area:	27.89 sq ft		48.94 sq ft	
Hydraulic Radius:	1.549 ft		2.136 ft	
Froude Number:	0.35		0.17	
Roughness Coefficient:	0.0383		0.0834	

Structure #5 (Vegetated Channel)

Collector Ditch #6, Sta 0+00 to 7+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	52.22 cfs		52.22 cfs	
Depth:	2.26 ft	2.56 ft	3.52 ft	3.82 ft
Top Width:	17.05 ft	18.25 ft	22.08 ft	23.28 ft
Velocity:	1.84 fps		0.99 fps	
X-Section Area:	28.35 sq ft		52.94 sq ft	
Hydraulic Radius:	1.564 ft		2.230 ft	
Froude Number:	0.25		0.11	
Roughness Coefficient:	0.0422		0.0999	

Structure #6 (Vegetated Channel)

Collector Ditch #6, Sta 7+00 to 13+60 (Culvert under Haul Road #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	118.01 cfs		118.01 cfs	
Depth:	3.13 ft	3.43 ft	4.43 ft	4.73 ft
Top Width:	20.51 ft	21.71 ft	25.74 ft	26.94 ft
Velocity:	2.65 fps		1.58 fps	
X-Section Area:	44.57 sq ft		74.79 sq ft	
Hydraulic Radius:	2.027 ft		2.687 ft	
Froude Number:	0.32		0.16	
Roughness Coefficient:	0.0349		0.0707	

Structure #16 (Culvert)

Culvert under Haul Road #2, Collector Ditch #6, Sta 13+60 to 14+00.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	0.15	0.0140	4.70	0.00	0.90

Culvert Results:

Design Discharge = 118.01 cfs

Minimum pipe diameter: 1 - 84 inch pipe(s) required

Structure #7 (Vegetated Channel)

Collector Ditch #6, Sta 14+00 (Culvert under Haul Road #2) to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	140.00 cfs		140.00 cfs	
Depth:	3.10 ft	3.40 ft	4.37 ft	4.67 ft
Top Width:	22.40 ft	23.60 ft	27.49 ft	28.69 ft
Velocity:	2.79 fps		1.71 fps	
X-Section Area:	50.20 sq ft		81.97 sq ft	
Hydraulic Radius:	2.104 ft		2.773 ft	
Froude Number:	0.33		0.17	
Roughness Coefficient:	0.0340		0.0667	

Structure #8 (Vegetated Channel)

Collector Ditch #6, Sta 25+50 to 41+10.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	165.61 cfs		165.61 cfs	
Depth:	3.31 ft	3.61 ft	4.59 ft	4.89 ft
Top Width:	23.25 ft	24.45 ft	28.35 ft	29.55 ft
Velocity:	3.01 fps		1.88 fps	
X-Section Area:	55.08 sq ft		87.98 sq ft	
Hydraulic Radius:	2.220 ft		2.883 ft	
Froude Number:	0.34		0.19	
Roughness Coefficient:	0.0327		0.0621	

Structure #25 (Culvert)

Culvert Under Rail Road, Collector Dtich #6, Sta. 41+10 to 41+60.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.15	0.0150	5.90	0.00	0.90

Culvert Results:

Design Discharge = 165.61 cfs

Minimum pipe diameter: 1 - 84 inch pipe(s) required

Structure #17 (Vegetated Channel)

Collector Ditch #6, Sta 41+60 to 48+25 (Treatment Pond #1).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	205.57 cfs		205.57 cfs	
Depth:	3.61 ft	3.91 ft	4.88 ft	5.18 ft

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Top Width:	24.44 ft	25.64 ft	29.52 ft	30.72 ft
Velocity:	3.31 fps		2.13 fps	
X-Section Area:	62.14 sq ft		96.39 sq ft	
Hydraulic Radius:	2.377 ft		3.029 ft	
Froude Number:	0.37		0.21	
Roughness Coefficient:	0.0311		0.0566	

Structure #15 (Null)

Plant Runoff Pumpage

Structure #10 (Pond)

Treatment Pond #1.

Pond Inputs:

Initial Pool Elev:	671.00 ft
Initial Pool:	129.99 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
671.00	20.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	673.55 ft
Dewater Time:	0.73 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
644.90	0.000	0.000	0.000	
645.00	3.820	0.127	0.000	
645.40	3.853	1.662	0.000	
645.90	3.895	3.599	0.000	
646.40	3.937	5.557	0.000	
646.90	3.979	7.536	0.000	
647.40	4.021	9.535	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
647.90	4.063	11.556	0.000	
648.40	4.106	13.599	0.000	
648.90	4.149	15.663	0.000	
649.40	4.192	17.748	0.000	
649.90	4.236	19.855	0.000	
650.40	4.279	21.983	0.000	
650.90	4.323	24.134	0.000	
651.40	4.367	26.307	0.000	
651.90	4.411	28.501	0.000	
652.40	4.456	30.718	0.000	
652.90	4.501	32.957	0.000	
653.40	4.546	35.218	0.000	
653.90	4.591	37.503	0.000	
654.40	4.636	39.809	0.000	
654.90	4.682	42.139	0.000	
655.40	4.728	44.491	0.000	
655.90	4.774	46.866	0.000	
656.40	4.820	49.265	0.000	
656.90	4.866	51.686	0.000	
657.40	4.913	54.131	0.000	
657.90	4.960	56.599	0.000	
658.40	5.007	59.091	0.000	
658.90	5.055	61.607	0.000	
659.40	5.102	64.146	0.000	
659.90	5.150	66.709	0.000	
660.40	5.198	69.296	0.000	
660.90	5.247	71.907	0.000	
661.40	5.295	74.543	0.000	
661.90	5.344	77.202	0.000	
662.40	5.393	79.887	0.000	
662.90	5.442	82.595	0.000	
663.40	5.491	85.329	0.000	
663.90	5.541	88.087	0.000	
664.40	5.591	90.870	0.000	
664.90	5.641	93.678	0.000	
665.40	5.691	96.511	0.000	
665.90	5.742	99.369	0.000	
666.40	5.793	102.253	0.000	
666.90	5.844	105.162	0.000	
667.40	5.895	108.096	0.000	
667.90	5.946	111.056	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
668.40	5.998	114.042	0.000		
668.90	6.050	117.054	0.000		
669.40	6.102	120.092	0.000		
669.90	6.154	123.156	0.000		
670.40	6.207	126.246	0.000		
670.90	6.259	129.363	0.000		
671.00	6.270	129.989	0.000		Spillway #1
671.40	6.332	132.510	4.611	6.61*	
671.90	6.410	135.695	10.375	5.45	
672.40	6.489	138.920	26.689	2.25	
672.90	6.567	142.184	52.187	1.55	
673.40	6.647	145.487	87.901	1.20	
673.55	6.671	146.495	101.972	0.50	Peak Stage
673.90	6.727	148.831	134.607		
674.40	6.807	152.214	193.164		
674.90	6.888	155.638	264.351		
675.40	6.969	159.102	348.885		
675.90	7.051	162.607	447.425		
676.40	7.133	166.154	560.584		
676.90	7.216	169.741	688.939		
677.40	7.299	173.370	833.032		
677.90	7.383	177.041	993.381		
678.00	7.400	177.779	1,027.445		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
644.90	0.000	0.000
645.00	0.000	0.000
645.40	0.000	0.000
645.90	0.000	0.000
646.40	0.000	0.000
646.90	0.000	0.000
647.40	0.000	0.000
647.90	0.000	0.000
648.40	0.000	0.000
648.90	0.000	0.000
649.40	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
649.90	0.000	0.000
650.40	0.000	0.000
650.90	0.000	0.000
651.40	0.000	0.000
651.90	0.000	0.000
652.40	0.000	0.000
652.90	0.000	0.000
653.40	0.000	0.000
653.90	0.000	0.000
654.40	0.000	0.000
654.90	0.000	0.000
655.40	0.000	0.000
655.90	0.000	0.000
656.40	0.000	0.000
656.90	0.000	0.000
657.40	0.000	0.000
657.90	0.000	0.000
658.40	0.000	0.000
658.90	0.000	0.000
659.40	0.000	0.000
659.90	0.000	0.000
660.40	0.000	0.000
660.90	0.000	0.000
661.40	0.000	0.000
661.90	0.000	0.000
662.40	0.000	0.000
662.90	0.000	0.000
663.40	0.000	0.000
663.90	0.000	0.000
664.40	0.000	0.000
664.90	0.000	0.000
665.40	0.000	0.000
665.90	0.000	0.000
666.40	0.000	0.000
666.90	0.000	0.000
667.40	0.000	0.000
667.90	0.000	0.000
668.40	0.000	0.000
668.90	0.000	0.000
669.40	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
669.90	0.000	0.000
670.40	0.000	0.000
670.90	0.000	0.000
671.00	0.000	0.000
671.40	4.611	4.611
671.90	10.375	10.375
672.40	26.689	26.689
672.90	52.187	52.187
673.40	87.901	87.901
673.90	134.607	134.607
674.40	193.164	193.164
674.90	264.351	264.351
675.40	348.885	348.885
675.90	447.425	447.425
676.40	560.584	560.584
676.90	688.939	688.939
677.40	833.032	833.032
677.90	993.381	993.381
678.00	1,027.445	1,027.445

Structure #11 (Vegetated Channel)

Spillway Ditch to Sediment Pond #2, Sta 0+00 to 3+90 (Culvert under Haul Road #2)

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
4.00	3.0:1	3.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	101.97 cfs		101.97 cfs	
Depth:	2.93 ft	3.23 ft	4.08 ft	4.38 ft
Top Width:	21.56 ft	23.36 ft	28.49 ft	30.29 ft
Velocity:	2.73 fps		1.54 fps	
X-Section Area:	37.41 sq ft		66.31 sq ft	
Hydraulic Radius:	1.662 ft		2.224 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.36		0.18	
Roughness Coefficient:	0.0368		0.0792	

Structure #18 (Culvert)

Spillway Ditch to Sediment Pond #2, Culvert under Haul Road #2, Sta 3+90 to 4+40 (Sediment Pond #2)

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.23	0.0140	7.90	0.00	0.90

Culvert Results:

Design Discharge = 101.97 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #21 (Vegetated Channel)

Collector Ditch #2, Sta 0+00 to 10+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	103.79 cfs		103.79 cfs	
Depth:	3.45 ft	3.75 ft	4.89 ft	5.19 ft
Top Width:	19.80 ft	21.00 ft	25.56 ft	26.76 ft
Velocity:	2.33 fps		1.34 fps	
X-Section Area:	44.50 sq ft		77.19 sq ft	
Hydraulic Radius:	2.077 ft		2.769 ft	
Froude Number:	0.27		0.14	
Roughness Coefficient:	0.0360		0.0757	

Structure #22 (Culvert)

Culvert Under Entrance, Collector Ditch #2, Sta 10+50 to 11+00.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.12	0.0140	5.50	0.00	0.90

Culvert Results:

Design Discharge = 103.79 cfs

Minimum pipe diameter: 1 - 54 inch pipe(s) required

Structure #23 (Vegetated Channel)

Collector Ditch #2, Sta 11+00 to 13+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	114.18 cfs		114.18 cfs	
Depth:	3.57 ft	3.87 ft	5.02 ft	5.32 ft
Top Width:	20.30 ft	21.50 ft	26.07 ft	27.27 ft
Velocity:	2.43 fps		1.42 fps	
X-Section Area:	47.01 sq ft		80.46 sq ft	
Hydraulic Radius:	2.138 ft		2.829 ft	
Froude Number:	0.28		0.14	
Roughness Coefficient:	0.0353		0.0728	

Structure #24 (Vegetated Channel)

Collector Ditch #2, Sta 13+50 to 35+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	122.47 cfs		122.47 cfs	
Depth:	3.38 ft	3.68 ft	4.78 ft	5.08 ft
Top Width:	21.51 ft	22.71 ft	27.14 ft	28.34 ft
Velocity:	2.46 fps		1.46 fps	
X-Section Area:	49.82 sq ft		84.04 sq ft	
Hydraulic Radius:	2.157 ft		2.859 ft	
Froude Number:	0.28		0.15	
Roughness Coefficient:	0.0350		0.0713	

Structure #2 (Vegetated Channel)

Collector Ditch #2, Sta 35+00 to 51+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	139.66 cfs		139.66 cfs	
Depth:	3.30 ft	3.60 ft	4.67 ft	4.97 ft
Top Width:	23.20 ft	24.40 ft	28.70 ft	29.90 ft
Velocity:	2.55 fps		1.54 fps	
X-Section Area:	54.78 sq ft		90.43 sq ft	
Hydraulic Radius:	2.213 ft		2.926 ft	
Froude Number:	0.29		0.15	
Roughness Coefficient:	0.0344		0.0684	

Structure #3 (Vegetated Channel)

Collector Ditch #2, Sta 51+50 to 64+70 (Sediment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
12.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	146.21 cfs		146.21 cfs	
Depth:	3.15 ft	3.45 ft	4.48 ft	4.78 ft
Top Width:	24.58 ft	25.78 ft	29.94 ft	31.14 ft
Velocity:	2.54 fps		1.55 fps	
X-Section Area:	57.55 sq ft		94.05 sq ft	
Hydraulic Radius:	2.207 ft		2.934 ft	
Froude Number:	0.29		0.15	
Roughness Coefficient:	0.0344		0.0680	

Structure #1 (Vegetated Channel)

Collector Ditch #1, Sta 0+00 to 21+66 (Sediment Pond #2).

Parabolic Vegetated Channel Inputs:

Material: Grass mixture

Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	21.02 cfs		21.02 cfs	
Depth:	2.12 ft	2.42 ft	3.06 ft	3.36 ft
Top Width:	8.48 ft	9.06 ft	12.25 ft	12.83 ft
Velocity:	1.75 fps		0.84 fps	
X-Section Area:	12.00 sq ft		25.00 sq ft	
Hydraulic Radius:	1.212 ft		1.750 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.26		0.10	
Roughness Coefficient:	0.0463		0.1234	

Structure #4 (Pond)

Sediment Pond #2.

Pond Inputs:

Initial Pool Elev:	670.00 ft
Initial Pool:	102.83 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
6.00	50.00	0.50	0.0140	670.00	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
675.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	676.28 ft
Dewater Time:	19.27 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
641.00	0.000	0.000	0.000	
641.50	0.579	0.097	0.000	
642.00	2.316	0.772	0.000	
642.50	2.384	1.947	0.000	
643.00	2.452	3.156	0.000	
643.50	2.508	4.396	0.000	
644.00	2.565	5.664	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
644.50	2.615	6.959	0.000	
645.00	2.666	8.279	0.000	
645.50	2.711	9.623	0.000	
646.00	2.756	10.990	0.000	
646.50	2.799	12.379	0.000	
647.00	2.842	13.789	0.000	
647.50	2.884	15.221	0.000	
648.00	2.927	16.673	0.000	
648.50	2.969	18.147	0.000	
649.00	3.011	19.642	0.000	
649.50	3.054	21.159	0.000	
650.00	3.097	22.696	0.000	
650.50	3.140	24.255	0.000	
651.00	3.183	25.836	0.000	
651.50	3.226	27.438	0.000	
652.00	3.269	29.062	0.000	
652.50	3.312	30.707	0.000	
653.00	3.356	32.374	0.000	
653.50	3.399	34.063	0.000	
654.00	3.443	35.774	0.000	
654.50	3.488	37.507	0.000	
655.00	3.533	39.262	0.000	
655.50	3.577	41.039	0.000	
656.00	3.622	42.839	0.000	
656.50	3.667	44.661	0.000	
657.00	3.712	46.506	0.000	
657.50	3.757	48.373	0.000	
658.00	3.803	50.264	0.000	
658.50	3.849	52.177	0.000	
659.00	3.896	54.113	0.000	
659.50	3.942	56.072	0.000	
660.00	3.988	58.055	0.000	
660.50	4.034	60.060	0.000	
661.00	4.081	62.089	0.000	
661.50	4.128	64.141	0.000	
662.00	4.175	66.217	0.000	
662.50	4.222	68.316	0.000	
663.00	4.270	70.440	0.000	
663.50	4.318	72.587	0.000	
664.00	4.366	74.757	0.000	
664.50	4.414	76.953	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
665.00	4.463	79.172	0.000		
665.50	4.513	81.416	0.000		
666.00	4.563	83.685	0.000		
666.50	4.616	85.979	0.000		
667.00	4.669	88.301	0.000		
667.50	4.725	90.649	0.000		
668.00	4.782	93.026	0.000		
668.50	4.842	95.432	0.000		
669.00	4.902	97.868	0.000		
669.50	4.967	100.335	0.000		
670.00	5.032	102.835	0.000		Spillway #1
670.50	5.108	105.370	0.322	95.28*	
671.00	5.184	107.943	0.548	56.77*	
671.50	5.275	110.557	0.687	46.05*	
672.00	5.366	113.217	0.800	40.24*	
672.50	5.469	115.926	0.913	35.91*	
673.00	5.573	118.687	1.025	32.57*	
673.50	5.684	121.501	1.124	30.30*	
674.00	5.797	124.371	1.195	29.06*	
674.50	5.937	127.304	1.266	28.04*	
675.00	6.078	130.308	1.337	27.18*	Spillway #2
675.50	6.207	133.379	2.291	25.25	
676.00	6.338	136.516	16.371	12.80	
676.28	6.387	138.303	28.029	2.95	Peak Stage
676.50	6.437	139.709	37.196		
677.00	6.537	142.953	66.827		
677.50	6.616	146.241	106.881		
678.00	6.695	149.569	158.281		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
641.00	0.000	0.000	0.000
641.50	0.000	0.000	0.000
642.00	0.000	0.000	0.000
642.50	0.000	0.000	0.000
643.00	0.000	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
643.50	0.000	0.000	0.000
644.00	0.000	0.000	0.000
644.50	0.000	0.000	0.000
645.00	0.000	0.000	0.000
645.50	0.000	0.000	0.000
646.00	0.000	0.000	0.000
646.50	0.000	0.000	0.000
647.00	0.000	0.000	0.000
647.50	0.000	0.000	0.000
648.00	0.000	0.000	0.000
648.50	0.000	0.000	0.000
649.00	0.000	0.000	0.000
649.50	0.000	0.000	0.000
650.00	0.000	0.000	0.000
650.50	0.000	0.000	0.000
651.00	0.000	0.000	0.000
651.50	0.000	0.000	0.000
652.00	0.000	0.000	0.000
652.50	0.000	0.000	0.000
653.00	0.000	0.000	0.000
653.50	0.000	0.000	0.000
654.00	0.000	0.000	0.000
654.50	0.000	0.000	0.000
655.00	0.000	0.000	0.000
655.50	0.000	0.000	0.000
656.00	0.000	0.000	0.000
656.50	0.000	0.000	0.000
657.00	0.000	0.000	0.000
657.50	0.000	0.000	0.000
658.00	0.000	0.000	0.000
658.50	0.000	0.000	0.000
659.00	0.000	0.000	0.000
659.50	0.000	0.000	0.000
660.00	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.00	0.000	0.000	0.000
661.50	0.000	0.000	0.000
662.00	0.000	0.000	0.000
662.50	0.000	0.000	0.000
663.00	0.000	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
663.50	0.000	0.000	0.000
664.00	0.000	0.000	0.000
664.50	0.000	0.000	0.000
665.00	0.000	0.000	0.000
665.50	0.000	0.000	0.000
666.00	0.000	0.000	0.000
666.50	0.000	0.000	0.000
667.00	0.000	0.000	0.000
667.50	0.000	0.000	0.000
668.00	0.000	0.000	0.000
668.50	0.000	0.000	0.000
669.00	0.000	0.000	0.000
669.50	0.000	0.000	0.000
670.00	0.000	0.000	0.000
670.50	(3)>0.322	0.000	0.322
671.00	(5)>0.548	0.000	0.548
671.50	(6)>0.687	0.000	0.687
672.00	(6)>0.800	0.000	0.800
672.50	(6)>0.913	0.000	0.913
673.00	(6)>1.025	0.000	1.025
673.50	(6)>1.124	0.000	1.124
674.00	(6)>1.195	0.000	1.195
674.50	(6)>1.266	0.000	1.266
675.00	(6)>1.337	0.000	1.337
675.50	(6)>1.408	0.883	2.291
676.00	(6)>1.479	14.892	16.371
676.50	(6)>1.550	35.646	37.196
677.00	(6)>1.615	65.212	66.827
677.50	(6)>1.667	105.214	106.881
678.00	(6)>1.719	156.562	158.281

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#12	1	0.800	0.013	0.000	0.000	77.000	M	3.19	0.172
	2	0.800	0.013	0.000	0.000	77.000	M	3.19	0.172
	Σ	**1.600**						**6.38**	**0.344**
#13	1	1.500	0.068	0.000	0.000	77.000	M	5.98	0.323
	2	0.900	0.067	0.000	0.000	77.000	M	3.59	0.194
	Σ	**4.000**						**15.94**	**0.860**
#14	1	3.800	0.101	0.000	0.000	89.000	F	18.87	1.179
	2	3.900	0.023	0.000	0.000	89.000	M	19.36	1.210
	Σ	**11.700**						**54.17**	**3.249**
#26	Σ	**11.700**						**54.17**	**3.249**
#27	1	3.400	0.082	0.000	0.000	89.000	M	16.88	1.055
	Σ	**15.100**						**71.05**	**4.304**
#5	1	4.300	0.039	0.000	0.000	89.000	M	21.35	1.334
	2	9.200	0.193	0.000	0.000	89.000	M	32.05	2.299
	Σ	**13.500**						**52.22**	**3.633**
#6	1	6.200	0.527	0.000	0.000	89.000	M	15.99	1.538
	2	4.500	0.039	0.000	0.000	89.000	M	22.34	1.396
	3	9.100	0.164	0.000	0.000	89.000	M	32.66	2.301
	Σ	**33.300**						**118.01**	**8.868**
#16	Σ	**33.300**						**118.01**	**8.868**
#7	1	5.500	0.160	0.000	0.000	89.000	M	19.74	1.391
	2	1.300	0.454	0.000	0.000	89.000	M	3.59	0.322
	Σ	**40.100**						**140.00**	**10.581**
#8	1	4.400	0.045	0.000	0.000	89.000	M	21.85	1.365
	2	1.100	0.176	0.000	0.000	89.000	M	3.91	0.277
	Σ	**45.600**						**165.61**	**12.223**
#25	Σ	**45.600**						**165.61**	**12.223**
#17	1	17.700	0.247	0.000	0.000	79.000	M	45.06	3.281
	Σ	**63.300**						**205.57**	**15.504**
#15	1	1.320	0.027	0.000	0.000	98.000	M	7.07	0.518
	Σ	**1.320**						**7.07**	**0.518**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	15.800	0.334	0.000	0.000	86.000	M	44.84	3.614
	2	5.100	0.148	0.000	0.000	86.000	M	17.14	1.184
	3	6.200	0.320	0.000	0.000	86.000	M	17.77	1.416
	4	6.700	0.282	0.000	0.000	79.000	M	16.39	1.236
	5	4.400	0.012	0.000	0.000	98.000	F	23.58	1.728
	Σ	**117.920**						**393.70**	**29.504**
#11	Σ	**117.920**						**101.97**	**29.492**
#18	Σ	**117.920**						**101.97**	**29.492**
#21	1	19.500	0.173	0.000	0.000	89.000	M	69.58	4.920
	2	2.600	0.216	0.000	0.000	89.000	M	8.86	0.648
	3	7.400	0.197	0.000	0.000	89.000	M	25.63	1.843
	Σ	**29.500**						**103.79**	**7.411**
#22	Σ	**29.500**						**103.79**	**7.411**
#23	1	3.800	0.212	0.000	0.000	82.000	M	10.96	0.770
	Σ	**33.300**						**114.18**	**8.181**
#24	1	2.900	0.057	0.000	0.000	82.000	M	12.85	0.733
	Σ	**36.200**						**122.47**	**8.914**
#2	1	3.600	0.154	0.000	0.000	79.000	M	10.08	0.675
	2	3.000	0.169	0.000	0.000	79.000	M	8.37	0.562
	Σ	**42.800**						**139.66**	**10.150**
#3	1	3.400	0.323	0.000	0.000	79.000	M	7.95	0.626
	Σ	**46.200**						**146.21**	**10.777**
#1	1	13.800	0.696	0.000	0.000	77.000	M	21.02	2.372
	Σ	**13.800**						**21.02**	**2.372**
#4	1	17.100	0.727	0.000	0.000	71.000	M	19.95	2.369
	2	6.200	0.011	0.000	0.000	98.000	F	33.22	2.435
	Σ	**201.220**						**239.78**	**47.444**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	0.59	9.00	1,530.00	0.610	0.696
#1	**1**	**Time of Concentration:**					**0.696**
#2	1	4. Cultivated, straight row	0.33	10.00	3,000.00	0.510	1.633

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	**1**	**Time of Concentration:**					**0.154**
#2	2	4. Cultivated, straight row	0.38	15.00	4,000.00	0.540	2.057
#2	**2**	**Time of Concentration:**					**0.169**
#3	1	4. Cultivated, straight row	0.29	10.00	3,400.00	0.480	1.967
#3	**1**	**Time of Concentration:**					**0.323**
#4	1	3. Short grass pasture	0.49	7.00	1,440.00	0.550	0.727
#4	**1**	**Time of Concentration:**					**0.727**
#4	2	9. Small streams flowing bankfull	0.42	1.00	239.00	5.820	0.011
#4	**2**	**Time of Concentration:**					**0.011**
#5	1	7. Paved area and small upland gullies	0.50	1.00	200.00	1.420	0.039
#5	**1**	**Time of Concentration:**					**0.039**
#5	2	7. Paved area and small upland gullies	0.17	1.00	579.00	0.830	0.193
#5	**2**	**Time of Concentration:**					**0.193**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	0.22	2.00	892.06	0.470	0.527
#6	**1**	**Time of Concentration:**					**0.527**
#6	2	7. Paved area and small upland gullies	0.50	1.00	200.00	1.420	0.039
#6	**2**	**Time of Concentration:**					**0.039**
#6	3	7. Paved area and small upland gullies	0.30	2.00	657.03	1.110	0.164
#6	**3**	**Time of Concentration:**					**0.164**
#7	1	7. Paved area and small upland gullies	0.41	3.00	740.00	1.280	0.160
#7	**1**	**Time of Concentration:**					**0.160**
#7	2	7. Paved area and small upland gullies	0.29	5.00	1,750.08	1.070	0.454
#7	**2**	**Time of Concentration:**					**0.454**
#8	1	7. Paved area and small upland gullies	1.32	5.00	380.00	2.300	0.045
#8	**1**	**Time of Concentration:**					**0.045**
#8	2	7. Paved area and small upland gullies	0.29	2.00	684.46	1.080	0.176
#8	**2**	**Time of Concentration:**					**0.176**
#10	1	3. Short grass pasture	1.63	20.00	1,230.00	1.020	0.334
#10	**1**	**Time of Concentration:**					**0.334**
#10	2	3. Short grass pasture	1.11	5.00	450.00	0.840	0.148
#10	**2**	**Time of Concentration:**					**0.148**
#10	3	3. Short grass pasture	0.67	5.00	750.00	0.650	0.320
#10	**3**	**Time of Concentration:**					**0.320**
#10	4	3. Short grass pasture	2.40	30.00	1,250.00	1.230	0.282
#10	**4**	**Time of Concentration:**					**0.282**
#10	5	9. Small streams flowing bankfull	0.40	1.00	250.00	5.690	0.012

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#10	**5**	**Time of Concentration:**					**0.012**
#12	1	3. Short grass pasture	27.00	54.00	199.99	4.150	0.013
#12	**1**	**Time of Concentration:**					**0.013**
#12	2	3. Short grass pasture	27.00	54.00	200.00	4.150	0.013
#12	**2**	**Time of Concentration:**					**0.013**
#13	1	3. Short grass pasture	9.17	55.00	600.00	2.420	0.068
#13	**1**	**Time of Concentration:**					**0.068**
#13	2	3. Short grass pasture	1.89	5.00	265.00	1.090	0.067
#13	**2**	**Time of Concentration:**					**0.067**
#14	1	7. Paved area and small upland gullies	1.06	8.00	755.00	2.070	0.101
#14	**1**	**Time of Concentration:**					**0.101**
#14	2	5. Nearly bare and untilled, and alluvial valley fans	16.67	57.50	345.00	4.080	0.023
#14	**2**	**Time of Concentration:**					**0.023**
#15	1	5. Nearly bare and untilled, and alluvial valley fans	1.00	1.00	100.00	1.000	0.027
#15	**1**	**Time of Concentration:**					**0.027**
#17	1	3. Short grass pasture	2.61	30.00	1,150.08	1.290	0.247
#17	**1**	**Time of Concentration:**					**0.247**
#21	1	7. Paved area and small upland gullies	0.61	6.00	980.00	1.570	0.173
#21	**1**	**Time of Concentration:**					**0.173**
#21	2	7. Paved area and small upland gullies	0.33	3.00	903.07	1.160	0.216
#21	**2**	**Time of Concentration:**					**0.216**
#21	3	7. Paved area and small upland gullies	0.35	3.00	847.00	1.190	0.197
#21	**3**	**Time of Concentration:**					**0.197**
#23	1	3. Short grass pasture	1.10	7.00	635.00	0.830	0.212
#23	**1**	**Time of Concentration:**					**0.212**
#24	1	3. Short grass pasture	1.82	4.00	220.00	1.070	0.057
#24	**1**	**Time of Concentration:**					**0.057**
#27	1	7. Paved area and small upland gullies	0.77	4.00	520.00	1.760	0.082
#27	**1**	**Time of Concentration:**					**0.082**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #2 to Sediment #3

10yr - 24hr Storm

Top of Dam Elev = 683.0

Pool Elev = 673.5

Peak Elev = 680.34

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

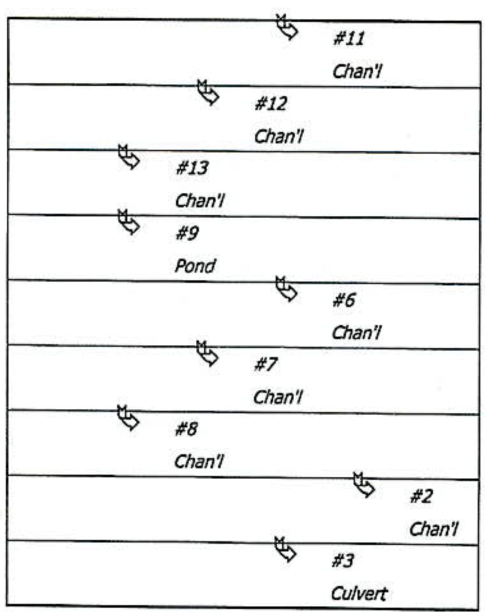
General Information

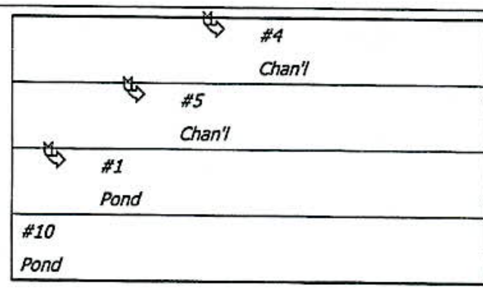
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	4.260 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#10	0.000	0.000	Treatment Pond #2.
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).
Culvert	#3	==>	#4	0.000	0.000	Culvert under Entrance, Sta 0+50 to 1+40.
Channel	#4	==>	#5	0.000	0.000	Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.
Channel	#5	==>	#1	0.000	0.000	Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).
Channel	#6	==>	#7	0.000	0.000	Collector Ditch #8, Sta 0+00 to 12+50.
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #8, Sta 12+50 to 25+50.
Channel	#8	==>	#1	0.000	0.000	Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).
Pond	#9	==>	#1	0.000	0.000	Refuse Impoundment.
Pond	#10	==>	End	0.000	0.000	Sediment Pond #3.
Channel	#11	==>	#12	0.000	0.000	Collector Ditch #9, Sta 0+00 to 12+00.
Channel	#12	==>	#13	0.000	0.000	Colllector Ditch #9, Sta 12+00 to 22+50.
Channel	#13	==>	#1	0.000	0.000	Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).




#4
Chan'l
#5
Chan'l
#1
Pond
#10
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#11		17.100	17.100	44.40	3.70
#12		10.100	27.200	69.88	5.80
#13		14.500	41.700	107.11	8.90
#9	In	40.300	40.300	130.86	13.51
	Out			0.80	2.41
#6		5.900	5.900	12.73	0.99
#7		5.800	11.700	25.25	1.96
#8		9.500	21.200	45.75	3.56
#2		0.500	0.500	1.45	0.13
#3		0.000	0.500	1.45	0.13
#4		3.500	4.000	11.62	1.02
#5		16.900	20.900	52.11	4.51
#1	In	21.200	145.300	261.60	24.52
	Out			55.45	24.27
#10	In	7.100	152.400	74.52	26.65
	Out			8.05	7.81

Structure Detail:

Structure #11 (Vegetated Channel)

Collector Ditch #9, Sta 0+00 to 12+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	44.40 cfs		44.40 cfs	
Depth:	1.94 ft	2.24 ft	3.13 ft	3.43 ft
Top Width:	17.77 ft	18.97 ft	22.54 ft	23.74 ft
Velocity:	1.65 fps		0.87 fps	
X-Section Area:	26.98 sq ft		50.98 sq ft	
Hydraulic Radius:	1.444 ft		2.123 ft	
Froude Number:	0.24		0.10	
Roughness Coefficient:	0.0448		0.1094	

Structure #12 (Vegetated Channel)

Colllector Ditch #9, Sta 12+00 to 22+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	69.88 cfs		69.88 cfs	
Depth:	2.34 ft	2.64 ft	3.58 ft	3.88 ft
Top Width:	19.36 ft	20.56 ft	24.31 ft	25.51 ft
Velocity:	2.03 fps		1.14 fps	
X-Section Area:	34.37 sq ft		61.38 sq ft	
Hydraulic Radius:	1.679 ft		2.361 ft	
Froude Number:	0.27		0.13	
Roughness Coefficient:	0.0401		0.0899	

Structure #13 (Vegetated Channel)

Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	107.11 cfs		107.11 cfs	
Depth:	2.78 ft	3.08 ft	4.05 ft	4.35 ft
Top Width:	21.13 ft	22.33 ft	26.20 ft	27.40 ft
Velocity:	2.47 fps		1.46 fps	
X-Section Area:	43.32 sq ft		73.28 sq ft	
Hydraulic Radius:	1.930 ft		2.607 ft	
Froude Number:	0.30		0.15	
Roughness Coefficient:	0.0362		0.0748	

Structure #9 (Pond)

Refuse Impoundment.

Pond Inputs:

Initial Pool Elev:	750.00 ft
Initial Pool:	2047.36 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
24.00	500.00	17.50	0.0190	750.00	0.50	0.00

Pond Results:

Peak Elevation:	750.30 ft
Dewater Time:	9.04 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
662.40	0.000	0.000	0.000	
662.50	8.820	0.294	0.000	
663.40	9.042	8.332	0.000	
664.40	9.292	17.498	0.000	
665.40	9.545	26.917	0.000	
666.40	9.802	36.590	0.000	
667.40	10.062	46.521	0.000	
668.40	10.325	56.714	0.000	
669.40	10.592	67.173	0.000	
670.40	10.862	77.900	0.000	
671.40	11.136	88.899	0.000	
672.40	11.413	100.173	0.000	
673.40	11.694	111.726	0.000	
673.50	11.722	112.897	0.000	
674.40	11.978	123.561	0.000	
675.40	12.265	135.682	0.000	
676.40	12.555	148.092	0.000	
677.40	12.849	160.794	0.000	
678.40	13.147	173.792	0.000	
679.40	13.448	187.089	0.000	
680.00	13.630	195.212	0.000	
680.40	13.748	200.688	0.000	
681.40	14.043	214.583	0.000	
682.40	14.342	228.776	0.000	
683.40	14.645	243.269	0.000	
684.40	14.950	258.066	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
685.40	15.258	273.170	0.000	
686.40	15.570	288.584	0.000	
687.40	15.885	304.311	0.000	
688.40	16.203	320.355	0.000	
689.40	16.524	336.718	0.000	
690.40	16.848	353.404	0.000	
691.40	17.175	370.415	0.000	
692.40	17.506	387.756	0.000	
693.40	17.840	405.428	0.000	
694.40	18.177	423.436	0.000	
695.40	18.516	441.782	0.000	
696.40	18.860	460.470	0.000	
697.40	19.206	479.503	0.000	
698.40	19.555	498.883	0.000	
699.40	19.908	518.614	0.000	
700.40	20.264	538.700	0.000	
701.40	20.622	559.143	0.000	
702.40	20.984	579.946	0.000	
703.40	21.350	601.113	0.000	
704.40	21.718	622.646	0.000	
705.40	22.090	644.550	0.000	
706.40	22.464	666.827	0.000	
707.40	22.842	689.479	0.000	
708.40	23.223	712.511	0.000	
709.40	23.607	735.926	0.000	
710.40	23.994	759.726	0.000	
711.40	24.385	783.916	0.000	
712.40	24.778	808.497	0.000	
713.40	25.175	833.473	0.000	
714.40	25.575	858.847	0.000	
715.40	25.978	884.623	0.000	
716.40	26.384	910.804	0.000	
717.40	26.793	937.392	0.000	
718.40	27.205	964.391	0.000	
719.40	27.621	991.804	0.000	
720.40	28.040	1,019.634	0.000	
721.40	28.462	1,047.884	0.000	
722.40	28.887	1,076.558	0.000	
723.40	29.315	1,105.659	0.000	
724.40	29.746	1,135.189	0.000	
725.40	30.181	1,165.152	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
726.40	30.618	1,195.551	0.000		
727.40	31.059	1,226.390	0.000		
728.40	31.503	1,257.671	0.000		
729.40	31.950	1,289.397	0.000		
730.40	32.400	1,321.572	0.000		
731.40	32.854	1,354.199	0.000		
732.40	33.310	1,387.281	0.000		
733.40	33.770	1,420.821	0.000		
734.40	34.233	1,454.822	0.000		
735.40	34.699	1,489.287	0.000		
736.40	35.168	1,524.220	0.000		
737.40	35.640	1,559.624	0.000		
738.40	36.116	1,595.502	0.000		
739.40	36.594	1,631.857	0.000		
740.40	37.076	1,668.692	0.000		
741.40	37.561	1,706.010	0.000		
742.40	38.049	1,743.815	0.000		
743.40	38.540	1,782.109	0.000		
744.40	39.034	1,820.896	0.000		
745.40	39.532	1,860.179	0.000		
746.40	40.033	1,899.961	0.000		
747.40	40.536	1,940.245	0.000		
748.40	41.043	1,981.034	0.000		
749.40	41.553	2,022.333	0.000		
750.00	41.861	2,047.356	0.000		Spillway #1
750.30	42.016	2060.044	0.803	25.95	Peak Stage
750.40	42.067	2,064.142	1.063		
751.40	42.583	2,106.467	6.942		
752.40	43.102	2,149.309	15.350		
753.40	43.625	2,192.673	21.862		
754.40	44.151	2,236.560	26.884		
755.40	44.680	2,280.976	31.093		
756.40	45.212	2,325.921	34.806		
757.40	45.747	2,371.401	38.151		
758.00	46.070	2,398.946	40.025		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
662.40	0.000	0.000
662.50	0.000	0.000
663.40	0.000	0.000
664.40	0.000	0.000
665.40	0.000	0.000
666.40	0.000	0.000
667.40	0.000	0.000
668.40	0.000	0.000
669.40	0.000	0.000
670.40	0.000	0.000
671.40	0.000	0.000
672.40	0.000	0.000
673.40	0.000	0.000
673.50	0.000	0.000
674.40	0.000	0.000
675.40	0.000	0.000
676.40	0.000	0.000
677.40	0.000	0.000
678.40	0.000	0.000
679.40	0.000	0.000
680.00	0.000	0.000
680.40	0.000	0.000
681.40	0.000	0.000
682.40	0.000	0.000
683.40	0.000	0.000
684.40	0.000	0.000
685.40	0.000	0.000
686.40	0.000	0.000
687.40	0.000	0.000
688.40	0.000	0.000
689.40	0.000	0.000
690.40	0.000	0.000
691.40	0.000	0.000
692.40	0.000	0.000
693.40	0.000	0.000
694.40	0.000	0.000
695.40	0.000	0.000
696.40	0.000	0.000
697.40	0.000	0.000
698.40	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
699.40	0.000	0.000
700.40	0.000	0.000
701.40	0.000	0.000
702.40	0.000	0.000
703.40	0.000	0.000
704.40	0.000	0.000
705.40	0.000	0.000
706.40	0.000	0.000
707.40	0.000	0.000
708.40	0.000	0.000
709.40	0.000	0.000
710.40	0.000	0.000
711.40	0.000	0.000
712.40	0.000	0.000
713.40	0.000	0.000
714.40	0.000	0.000
715.40	0.000	0.000
716.40	0.000	0.000
717.40	0.000	0.000
718.40	0.000	0.000
719.40	0.000	0.000
720.40	0.000	0.000
721.40	0.000	0.000
722.40	0.000	0.000
723.40	0.000	0.000
724.40	0.000	0.000
725.40	0.000	0.000
726.40	0.000	0.000
727.40	0.000	0.000
728.40	0.000	0.000
729.40	0.000	0.000
730.40	0.000	0.000
731.40	0.000	0.000
732.40	0.000	0.000
733.40	0.000	0.000
734.40	0.000	0.000
735.40	0.000	0.000
736.40	0.000	0.000
737.40	0.000	0.000
738.40	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
739.40	0.000	0.000
740.40	0.000	0.000
741.40	0.000	0.000
742.40	0.000	0.000
743.40	0.000	0.000
744.40	0.000	0.000
745.40	0.000	0.000
746.40	0.000	0.000
747.40	0.000	0.000
748.40	0.000	0.000
749.40	0.000	0.000
750.00	0.000	0.000
750.40	(3)>1.063	1.063
751.40	(3)>6.942	6.942
752.40	(4)>15.350	15.350
753.40	(5)>21.862	21.862
754.40	(5)>26.884	26.884
755.40	(5)>31.093	31.093
756.40	(5)>34.806	34.806
757.40	(5)>38.151	38.151
758.00	(5)>40.025	40.025

Structure #6 (Vegetated Channel)

Collector Ditch #8, Sta 0+00 to 12+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	12.73 cfs		12.73 cfs	
Depth:	1.52 ft	1.82 ft	2.74 ft	3.04 ft
Top Width:	12.08 ft	13.28 ft	16.94 ft	18.14 ft
Velocity:	0.93 fps		0.41 fps	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
X-Section Area:	13.74 sq ft		31.39 sq ft	
Hydraulic Radius:	1.074 ft		1.721 ft	
Froude Number:	0.15		0.05	
Roughness Coefficient:	0.0584		0.1826	

Structure #7 (Vegetated Channel)

Collector Ditch #8, Sta 12+50 to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	25.25 cfs		25.25 cfs	
Depth:	1.80 ft	2.10 ft	3.06 ft	3.36 ft
Top Width:	15.19 ft	16.39 ft	20.22 ft	21.42 ft
Velocity:	1.21 fps		0.59 fps	
X-Section Area:	20.85 sq ft		43.13 sq ft	
Hydraulic Radius:	1.300 ft		1.990 ft	
Froude Number:	0.18		0.07	
Roughness Coefficient:	0.0508		0.1395	

Structure #8 (Vegetated Channel)

Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	45.75 cfs		45.75 cfs	
Depth:	2.29 ft	2.59 ft	3.63 ft	3.93 ft
Top Width:	17.16 ft	18.36 ft	22.50 ft	23.70 ft
Velocity:	1.59 fps		0.83 fps	
X-Section Area:	28.79 sq ft		55.30 sq ft	
Hydraulic Radius:	1.579 ft		2.284 ft	
Froude Number:	0.22		0.09	
Roughness Coefficient:	0.0440		0.1082	

Structure #2 (Vegetated Channel)

Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	1.45 cfs		1.45 cfs	
Depth:	0.82 ft	1.12 ft	1.70 ft	2.00 ft
Top Width:	5.26 ft	6.46 ft	8.80 ft	10.00 ft
Velocity:	0.49 fps		0.16 fps	
X-Section Area:	2.96 sq ft		9.18 sq ft	
Hydraulic Radius:	0.525 ft		0.956 ft	
Froude Number:	0.12		0.03	
Roughness Coefficient:	0.0883		0.4085	

Structure #3 (Culvert)

Culvert under Entrance, Sta 0+50 to 1+40.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.20	0.0140	3.10	0.00	0.90

Culvert Results:

Design Discharge = 1.45 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Structure #4 (Vegetated Channel)

Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.62 cfs		11.62 cfs	
Depth:	1.12 ft	1.42 ft	2.08 ft	2.38 ft
Top Width:	12.48 ft	13.68 ft	16.31 ft	17.51 ft
Velocity:	1.01 fps		0.46 fps	
X-Section Area:	11.46 sq ft		25.26 sq ft	
Hydraulic Radius:	0.881 ft		1.461 ft	
Froude Number:	0.19		0.07	
Roughness Coefficient:	0.0603		0.1864	

Structure #5 (Vegetated Channel)

Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	52.11 cfs		52.11 cfs	
Depth:	2.08 ft	2.38 ft	3.22 ft	3.52 ft
Top Width:	16.32 ft	17.52 ft	20.90 ft	22.10 ft
Velocity:	2.06 fps		1.12 fps	
X-Section Area:	25.29 sq ft		46.60 sq ft	
Hydraulic Radius:	1.462 ft		2.078 ft	
Froude Number:	0.29		0.13	
Roughness Coefficient:	0.0416		0.0970	

Structure #1 (Pond)

Treatment Pond #2.

Pond Inputs:

Initial Pool Elev:	674.00 ft
Initial Pool:	75.24 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
674.00	50.00	3.00:1	3.00:1	10.00

Pond Results:

Peak Elevation:	675.51 ft
Dewater Time:	0.33 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.90	0.000	0.000	0.000		
661.00	5.070	0.169	0.000		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
661.90	5.164	4.774	0.000		
662.90	5.269	9.991	0.000		
663.90	5.376	15.313	0.000		
664.90	5.483	20.743	0.000		
665.90	5.592	26.280	0.000		
666.90	5.701	31.926	0.000		
667.90	5.812	37.683	0.000		
668.90	5.924	43.551	0.000		
669.90	6.036	49.531	0.000		
670.90	6.150	55.624	0.000		
671.90	6.265	61.832	0.000		
672.90	6.381	68.155	0.000		
673.90	6.498	74.595	0.000		
674.00	6.510	75.245	0.000		Spillway #1
674.90	6.707	81.193	16.982	4.24*	
675.51	6.844	85.366	55.451	3.70	Peak Stage
675.90	6.929	88.010	79.824		
676.90	7.155	95.052	186.713		
677.90	7.384	102.321	352.261		
678.90	7.617	109.821	578.051		
679.90	7.854	117.556	868.644		
680.90	8.094	125.530	1,228.779		
681.90	8.338	133.745	1,662.836		
682.90	8.585	142.206	2,125.495		
683.00	8.610	143.066	2,174.872		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.90	0.000	0.000
661.00	0.000	0.000
661.90	0.000	0.000
662.90	0.000	0.000
663.90	0.000	0.000
664.90	0.000	0.000
665.90	0.000	0.000
666.90	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
667.90	0.000	0.000
668.90	0.000	0.000
669.90	0.000	0.000
670.90	0.000	0.000
671.90	0.000	0.000
672.90	0.000	0.000
673.90	0.000	0.000
674.00	0.000	0.000
674.90	16.982	16.982
675.90	79.824	79.824
676.90	186.713	186.713
677.90	352.261	352.261
678.90	578.051	578.051
679.90	868.644	868.644
680.90	1,228.779	1,228.779
681.90	1,662.836	1,662.836
682.90	2,125.495	2,125.495
683.00	2,174.872	2,174.872

Structure #10 (Pond)

Sediment Pond #3.

Pond Inputs:

Initial Pool Elev:	673.50 ft
Initial Pool:	20.16 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
4.00	50.00	0.50	0.0140	673.50	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
680.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	680.34 ft

Dewater Time:	32.07 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.40	0.000	0.000	0.000		
660.50	0.940	0.031	0.000		
661.40	1.013	0.910	0.000		
662.40	1.097	1.964	0.000		
663.40	1.184	3.104	0.000		
664.40	1.274	4.333	0.000		
665.40	1.368	5.653	0.000		
666.40	1.465	7.069	0.000		
667.40	1.566	8.584	0.000		
668.40	1.669	10.201	0.000		
669.40	1.776	11.924	0.000		
670.40	1.887	13.755	0.000		
671.40	2.001	15.698	0.000		
672.40	2.118	17.757	0.000		
673.40	2.238	19.935	0.000		
673.50	2.250	20.159	0.000		Spillway #1
674.40	2.416	22.258	0.144	177.00*	
675.40	2.608	24.770	0.216	140.65*	
676.40	2.806	27.476	0.289	113.47*	
677.40	3.012	30.384	0.361	97.46*	
678.40	3.225	33.503	0.434	87.01*	
679.40	3.446	36.838	0.506	79.73*	
680.00	3.582	38.946	0.550	46.41*	Spillway #2
680.34	3.660	40.182	8.052	26.15	Peak Stage
680.40	3.674	40.397	9.355		
681.40	3.909	44.188	31.338		
682.40	4.151	48.217	96.984		
683.00	4.300	50.752	157.230		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.40	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.40	0.000	0.000	0.000
662.40	0.000	0.000	0.000
663.40	0.000	0.000	0.000
664.40	0.000	0.000	0.000
665.40	0.000	0.000	0.000
666.40	0.000	0.000	0.000
667.40	0.000	0.000	0.000
668.40	0.000	0.000	0.000
669.40	0.000	0.000	0.000
670.40	0.000	0.000	0.000
671.40	0.000	0.000	0.000
672.40	0.000	0.000	0.000
673.40	0.000	0.000	0.000
673.50	0.000	0.000	0.000
674.40	(1)>0.144	0.000	0.144
675.40	(2)>0.216	0.000	0.216
676.40	(3)>0.289	0.000	0.289
677.40	(4)>0.361	0.000	0.361
678.40	(4)>0.434	0.000	0.434
679.40	(5)>0.506	0.000	0.506
680.00	(5)>0.550	0.000	0.550
680.40	(6)>0.579	8.777	9.355
681.40	(6)>0.621	30.717	31.338
682.40	(6)>0.650	96.334	96.984
683.00	(6)>0.668	156.562	157.230

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#11	1	4.100	0.015	0.000	0.000	77.000	M	8.85	0.688
	2	7.800	0.025	0.000	0.000	86.000	M	21.33	1.807
	3	5.200	0.095	0.000	0.000	86.000	M	14.22	1.205
	Σ	**17.100**						**44.40**	**3.701**
#12	1	3.700	0.015	0.000	0.000	77.000	M	7.98	0.621
	2	6.400	0.025	0.000	0.000	86.000	M	17.50	1.483
	Σ	**27.200**						**69.88**	**5.805**
#13	1	10.300	0.025	0.000	0.000	86.000	M	28.17	2.387
	2	4.200	0.014	0.000	0.000	77.000	M	9.06	0.705
	Σ	**41.700**						**107.11**	**8.897**
#9	1	40.300	0.003	0.000	0.000	98.000	F	130.86	13.507
	Σ	**40.300**						**130.86**	**13.507**
#6	1	5.900	0.015	0.000	0.000	77.000	M	12.73	0.991
	Σ	**5.900**						**12.73**	**0.991**
#7	1	5.800	0.015	0.000	0.000	77.000	M	12.52	0.974
	Σ	**11.700**						**25.25**	**1.965**
#8	1	8.500	0.014	0.000	0.000	77.000	M	18.34	1.427
	2	1.000	0.102	0.000	0.000	77.000	M	2.16	0.168
	Σ	**21.200**						**45.75**	**3.560**
#2	1	0.500	0.006	0.000	0.000	89.000	F	1.45	0.127
	Σ	**0.500**						**1.45**	**0.127**
#3	Σ	**0.500**						**1.45**	**0.127**
#4	1	3.500	0.004	0.000	0.000	89.000	F	10.17	0.894
	Σ	**4.000**						**11.62**	**1.021**
#5	1	5.400	0.120	0.000	0.000	86.000	M	14.77	1.251
	2	1.300	0.008	0.000	0.000	77.000	M	2.81	0.218
	3	6.600	0.005	0.000	0.000	86.000	M	18.05	1.529
	4	3.600	0.141	0.000	0.000	77.000	M	5.22	0.492
	Σ	**20.900**						**52.11**	**4.511**
#1	1	11.700	0.032	0.000	0.000	77.000	M	25.25	1.965
	2	9.500	0.003	0.000	0.000	98.000	F	30.85	3.184
	Σ	**145.300**						**261.60**	**24.524**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	7.100	0.003	0.000	0.000	98.000	F	23.05	2.380
	Σ	**152.400**						**74.52**	**26.647**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	18.75	75.00	400.00	3.460	0.032
#1	**1**	**Time of Concentration:**					**0.032**
#1	2	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#1	**2**	**Time of Concentration:**					**0.003**
#2	1	7. Paved area and small upland gullies	11.76	20.00	170.00	6.900	0.006
#2	**1**	**Time of Concentration:**					**0.006**
#4	1	7. Paved area and small upland gullies	8.00	8.00	100.00	5.690	0.004
#4	**1**	**Time of Concentration:**					**0.004**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.68	75.00	1,122.01	2.580	0.120
#5	**1**	**Time of Concentration:**					**0.120**
#5	2	3. Short grass pasture	36.67	55.00	150.00	4.840	0.008
#5	**2**	**Time of Concentration:**					**0.008**
#5	3	5. Nearly bare and untilled, and alluvial valley fans	50.00	75.00	150.00	7.070	0.005
#5	**3**	**Time of Concentration:**					**0.005**
#5	4	3. Short grass pasture	1.70	9.00	530.00	1.040	0.141
#5	**4**	**Time of Concentration:**					**0.141**
#6	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#6	**1**	**Time of Concentration:**					**0.015**
#7	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#7	**1**	**Time of Concentration:**					**0.015**
#8	1	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#8	**1**	**Time of Concentration:**					**0.014**
#8	2	3. Short grass pasture	1.43	5.00	350.00	0.950	0.102
#8	**2**	**Time of Concentration:**					**0.102**
#9	1	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#9	**1**	**Time of Concentration:**					**0.003**
#10	1	4. Cultivated, straight row	0.15	2.00	1,300.00	0.350	1.031
#10	**1**	**Time of Concentration:**					**0.003**
#11	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#11	**1**	**Time of Concentration:**					**0.015**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#11	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#11	**2**	**Time of Concentration:**					**0.025**
#11	3	5. Nearly bare and untilled, and alluvial valley fans	7.81	75.00	960.00	2.790	0.095
#11	**3**	**Time of Concentration:**					**0.095**
#12	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#12	**1**	**Time of Concentration:**					**0.015**
#12	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#12	**2**	**Time of Concentration:**					**0.025**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#13	**1**	**Time of Concentration:**					**0.025**
#13	2	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#13	**2**	**Time of Concentration:**					**0.014**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #2 to Sediment #3

100yr - 6hr Storm

Top of Dam Elev = 683.0

Pool Elev = 673.5

Peak Elev = 680.89

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

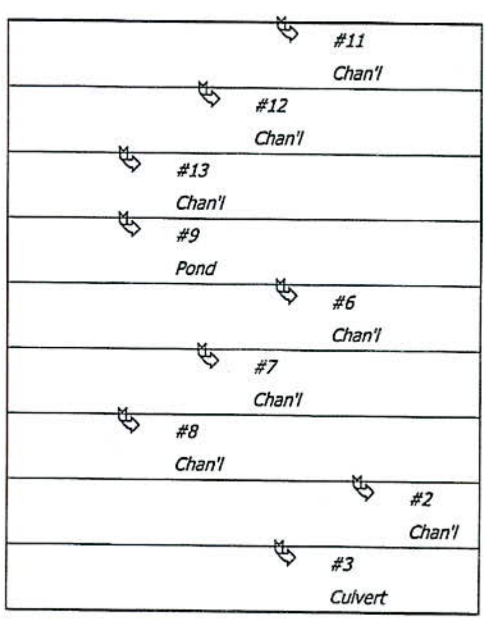
General Information

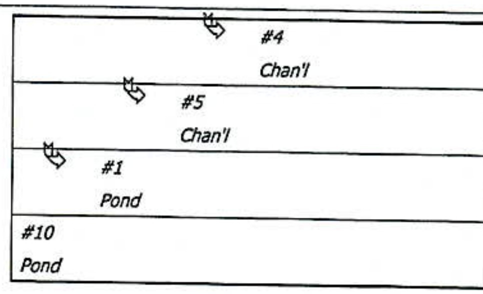
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	4.960 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#10	0.000	0.000	Treatment Pond #2.
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).
Culvert	#3	==>	#4	0.000	0.000	Culvert under Entrance, Sta 0+50 to 1+40.
Channel	#4	==>	#5	0.000	0.000	Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.
Channel	#5	==>	#1	0.000	0.000	Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).
Channel	#6	==>	#7	0.000	0.000	Collector Ditch #8, Sta 0+00 to 12+50.
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #8, Sta 12+50 to 25+50.
Channel	#8	==>	#1	0.000	0.000	Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).
Pond	#9	==>	#1	0.000	0.000	Refuse Impoundment.
Pond	#10	==>	End	0.000	0.000	Sediment Pond #3.
Channel	#11	==>	#12	0.000	0.000	Collector Ditch #9, Sta 0+00 to 12+00.
Channel	#12	==>	#13	0.000	0.000	Colllector Ditch #9, Sta 12+00 to 22+50.
Channel	#13	==>	#1	0.000	0.000	Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).




#4
Chan'l
#5
Chan'l
#1
Pond
#10
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#11		17.100	17.100	78.14	4.59
#12		10.100	27.200	123.31	7.20
#13		14.500	41.700	189.01	11.04
#9	In	40.300	40.300	215.95	15.82
	Out			0.99	3.45
#6		5.900	5.900	23.52	1.27
#7		5.800	11.700	46.63	2.52
#8		9.500	21.200	84.50	4.56
#2		0.500	0.500	2.48	0.16
#3		0.000	0.500	2.48	0.16
#4		3.500	4.000	19.86	1.24
#5		16.900	20.900	90.84	5.57
#1	In	21.200	145.300	462.58	30.86
	Out			117.86	30.58
#10	In	7.100	152.400	145.43	33.37
	Out			20.07	14.52

Structure Detail:

Structure #11 (Vegetated Channel)

Collector Ditch #9, Sta 0+00 to 12+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	78.14 cfs		78.14 cfs	
Depth:	2.45 ft	2.75 ft	3.70 ft	4.00 ft
Top Width:	19.80 ft	21.00 ft	24.78 ft	25.98 ft
Velocity:	2.14 fps		1.22 fps	
X-Section Area:	36.51 sq ft		64.28 sq ft	
Hydraulic Radius:	1.742 ft		2.423 ft	
Froude Number:	0.28		0.13	
Roughness Coefficient:	0.0390		0.0856	

Structure #12 (Vegetated Channel)

Colllector Ditch #9, Sta 12+00 to 22+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	123.31 cfs		123.31 cfs	
Depth:	2.95 ft	3.25 ft	4.22 ft	4.52 ft
Top Width:	21.78 ft	22.98 ft	26.87 ft	28.07 ft
Velocity:	2.63 fps		1.59 fps	
X-Section Area:	46.82 sq ft		77.73 sq ft	
Hydraulic Radius:	2.020 ft		2.694 ft	
Froude Number:	0.32		0.16	
Roughness Coefficient:	0.0350		0.0704	

Structure #13 (Vegetated Channel)

Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	189.01 cfs		189.01 cfs	
Depth:	3.49 ft	3.79 ft	4.76 ft	5.06 ft
Top Width:	23.96 ft	25.16 ft	29.06 ft	30.26 ft
Velocity:	3.19 fps		2.03 fps	
X-Section Area:	59.28 sq ft		93.03 sq ft	
Hydraulic Radius:	2.315 ft		2.972 ft	
Froude Number:	0.36		0.20	
Roughness Coefficient:	0.0317		0.0587	

Structure #9 (Pond)

Refuse Impoundment.

Pond Inputs:

Initial Pool Elev:	750.00 ft
Initial Pool:	2047.35 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
24.00	500.00	17.50	0.0190	750.00	0.50	0.00

Pond Results:

Peak Elevation:	750.37 ft
Dewater Time:	9.79 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
662.40	0.000	0.000	0.000	
662.50	8.820	0.294	0.000	
663.40	9.042	8.332	0.000	
664.40	9.292	17.498	0.000	
665.40	9.545	26.917	0.000	
666.40	9.802	36.590	0.000	
667.40	10.062	46.521	0.000	
668.40	10.325	56.714	0.000	
669.40	10.592	67.172	0.000	
670.40	10.862	77.899	0.000	
671.40	11.136	88.898	0.000	
672.40	11.413	100.172	0.000	
673.40	11.693	111.725	0.000	
674.40	11.977	123.560	0.000	
675.40	12.265	135.681	0.000	
676.40	12.555	148.091	0.000	
677.40	12.849	160.793	0.000	
678.40	13.147	173.791	0.000	
679.40	13.448	187.088	0.000	
680.00	13.630	195.211	0.000	
680.40	13.748	200.687	0.000	
681.40	14.043	214.582	0.000	
682.40	14.342	228.775	0.000	
683.40	14.645	243.268	0.000	
684.40	14.950	258.065	0.000	
685.40	15.258	273.169	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
686.40	15.570	288.583	0.000	
687.40	15.885	304.310	0.000	
688.40	16.203	320.354	0.000	
689.40	16.524	336.717	0.000	
690.40	16.848	353.402	0.000	
691.40	17.175	370.414	0.000	
692.40	17.506	387.754	0.000	
693.40	17.840	405.427	0.000	
694.40	18.177	423.435	0.000	
695.40	18.516	441.781	0.000	
696.40	18.860	460.469	0.000	
697.40	19.206	479.501	0.000	
698.40	19.555	498.882	0.000	
699.40	19.908	518.613	0.000	
700.40	20.264	538.699	0.000	
701.40	20.622	559.141	0.000	
702.40	20.984	579.945	0.000	
703.40	21.350	601.111	0.000	
704.40	21.718	622.645	0.000	
705.40	22.090	644.549	0.000	
706.40	22.464	666.825	0.000	
707.40	22.842	689.478	0.000	
708.40	23.223	712.510	0.000	
709.40	23.607	735.925	0.000	
710.40	23.994	759.725	0.000	
711.40	24.385	783.914	0.000	
712.40	24.778	808.495	0.000	
713.40	25.175	833.472	0.000	
714.40	25.575	858.846	0.000	
715.40	25.978	884.622	0.000	
716.40	26.384	910.802	0.000	
717.40	26.793	937.390	0.000	
718.40	27.205	964.389	0.000	
719.40	27.621	991.802	0.000	
720.40	28.040	1,019.633	0.000	
721.40	28.462	1,047.883	0.000	
722.40	28.887	1,076.557	0.000	
723.40	29.315	1,105.657	0.000	
724.40	29.746	1,135.188	0.000	
725.40	30.181	1,165.151	0.000	
726.40	30.618	1,195.550	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
727.40	31.059	1,226.389	0.000		
728.40	31.503	1,257.669	0.000		
729.40	31.950	1,289.396	0.000		
730.40	32.400	1,321.571	0.000		
731.40	32.854	1,354.198	0.000		
732.40	33.310	1,387.279	0.000		
733.40	33.770	1,420.819	0.000		
734.40	34.233	1,454.820	0.000		
735.40	34.699	1,489.286	0.000		
736.40	35.168	1,524.219	0.000		
737.40	35.640	1,559.623	0.000		
738.40	36.116	1,595.501	0.000		
739.40	36.594	1,631.855	0.000		
740.40	37.076	1,668.690	0.000		
741.40	37.561	1,706.009	0.000		
742.40	38.049	1,743.813	0.000		
743.40	38.540	1,782.107	0.000		
744.40	39.034	1,820.894	0.000		
745.40	39.532	1,860.177	0.000		
746.40	40.033	1,899.959	0.000		
747.40	40.536	1,940.244	0.000		
748.40	41.043	1,981.033	0.000		
749.40	41.553	2,022.331	0.000		
750.00	41.861	2,047.354	0.000		Spillway #1
750.37	42.052	2062.923	0.986	43.95	Peak Stage
750.40	42.067	2,064.141	1.063		
751.40	42.583	2,106.465	6.942		
752.40	43.102	2,149.308	15.350		
753.40	43.625	2,192.671	21.862		
754.40	44.151	2,236.559	26.884		
755.40	44.680	2,280.974	31.093		
756.40	45.212	2,325.920	34.806		
757.40	45.747	2,371.400	38.151		
758.00	46.070	2,398.945	40.025		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
662.40	0.000	0.000
662.50	0.000	0.000
663.40	0.000	0.000
664.40	0.000	0.000
665.40	0.000	0.000
666.40	0.000	0.000
667.40	0.000	0.000
668.40	0.000	0.000
669.40	0.000	0.000
670.40	0.000	0.000
671.40	0.000	0.000
672.40	0.000	0.000
673.40	0.000	0.000
674.40	0.000	0.000
675.40	0.000	0.000
676.40	0.000	0.000
677.40	0.000	0.000
678.40	0.000	0.000
679.40	0.000	0.000
680.00	0.000	0.000
680.40	0.000	0.000
681.40	0.000	0.000
682.40	0.000	0.000
683.40	0.000	0.000
684.40	0.000	0.000
685.40	0.000	0.000
686.40	0.000	0.000
687.40	0.000	0.000
688.40	0.000	0.000
689.40	0.000	0.000
690.40	0.000	0.000
691.40	0.000	0.000
692.40	0.000	0.000
693.40	0.000	0.000
694.40	0.000	0.000
695.40	0.000	0.000
696.40	0.000	0.000
697.40	0.000	0.000
698.40	0.000	0.000
699.40	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
700.40	0.000	0.000
701.40	0.000	0.000
702.40	0.000	0.000
703.40	0.000	0.000
704.40	0.000	0.000
705.40	0.000	0.000
706.40	0.000	0.000
707.40	0.000	0.000
708.40	0.000	0.000
709.40	0.000	0.000
710.40	0.000	0.000
711.40	0.000	0.000
712.40	0.000	0.000
713.40	0.000	0.000
714.40	0.000	0.000
715.40	0.000	0.000
716.40	0.000	0.000
717.40	0.000	0.000
718.40	0.000	0.000
719.40	0.000	0.000
720.40	0.000	0.000
721.40	0.000	0.000
722.40	0.000	0.000
723.40	0.000	0.000
724.40	0.000	0.000
725.40	0.000	0.000
726.40	0.000	0.000
727.40	0.000	0.000
728.40	0.000	0.000
729.40	0.000	0.000
730.40	0.000	0.000
731.40	0.000	0.000
732.40	0.000	0.000
733.40	0.000	0.000
734.40	0.000	0.000
735.40	0.000	0.000
736.40	0.000	0.000
737.40	0.000	0.000
738.40	0.000	0.000
739.40	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
740.40	0.000	0.000
741.40	0.000	0.000
742.40	0.000	0.000
743.40	0.000	0.000
744.40	0.000	0.000
745.40	0.000	0.000
746.40	0.000	0.000
747.40	0.000	0.000
748.40	0.000	0.000
749.40	0.000	0.000
750.00	0.000	0.000
750.40	(3)>1.063	1.063
751.40	(3)>6.942	6.942
752.40	(4)>15.350	15.350
753.40	(5)>21.862	21.862
754.40	(5)>26.884	26.884
755.40	(5)>31.093	31.093
756.40	(5)>34.806	34.806
757.40	(5)>38.151	38.151
758.00	(5)>40.025	40.025

Structure #6 (Vegetated Channel)

Collector Ditch #8, Sta 0+00 to 12+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	23.52 cfs		23.52 cfs	
Depth:	1.95 ft	2.25 ft	3.25 ft	3.55 ft
Top Width:	13.78 ft	14.98 ft	19.02 ft	20.22 ft
Velocity:	1.22 fps		0.58 fps	
X-Section Area:	19.24 sq ft		40.70 sq ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Hydraulic Radius:	1.309 ft		1.980 ft	
Froude Number:	0.18		0.07	
Roughness Coefficient:	0.0505		0.1408	

Structure #7 (Vegetated Channel)

Collector Ditch #8, Sta 12+50 to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	46.63 cfs		46.63 cfs	
Depth:	2.31 ft	2.61 ft	3.65 ft	3.95 ft
Top Width:	17.23 ft	18.43 ft	22.58 ft	23.78 ft
Velocity:	1.60 fps		0.84 fps	
X-Section Area:	29.10 sq ft		55.75 sq ft	
Hydraulic Radius:	1.589 ft		2.294 ft	
Froude Number:	0.22		0.09	
Roughness Coefficient:	0.0438		0.1073	

Structure #8 (Vegetated Channel)

Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	84.50 cfs		84.50 cfs	
Depth:	2.92 ft	3.22 ft	4.31 ft	4.61 ft
Top Width:	19.68 ft	20.88 ft	25.25 ft	26.45 ft
Velocity:	2.09 fps		1.18 fps	
X-Section Area:	40.43 sq ft		71.70 sq ft	
Hydraulic Radius:	1.920 ft		2.628 ft	
Froude Number:	0.26		0.12	
Roughness Coefficient:	0.0381		0.0834	

Structure #2 (Vegetated Channel)

Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	2.48 cfs		2.48 cfs	
Depth:	1.00 ft	1.30 ft	1.96 ft	2.26 ft
Top Width:	6.01 ft	7.21 ft	9.84 ft	11.04 ft
Velocity:	0.62 fps		0.21 fps	
X-Section Area:	4.01 sq ft		11.60 sq ft	
Hydraulic Radius:	0.619 ft		1.078 ft	
Froude Number:	0.13		0.03	
Roughness Coefficient:	0.0782		0.3272	

Structure #3 (Culvert)

Culvert under Entrance, Sta 0+50 to 1+40.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.20	0.0140	3.10	0.00	0.90

Culvert Results:

Design Discharge = 2.48 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #4 (Vegetated Channel)

Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	19.86 cfs		19.86 cfs	
Depth:	1.40 ft	1.70 ft	2.43 ft	2.73 ft
Top Width:	13.60 ft	14.80 ft	17.74 ft	18.94 ft
Velocity:	1.31 fps		0.63 fps	
X-Section Area:	15.12 sq ft		31.32 sq ft	
Hydraulic Radius:	1.060 ft		1.658 ft	
Froude Number:	0.22		0.08	
Roughness Coefficient:	0.0527		0.1472	

Structure #5 (Vegetated Channel)

Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	90.84 cfs		90.84 cfs	
Depth:	2.60 ft	2.90 ft	3.78 ft	4.08 ft
Top Width:	18.40 ft	19.60 ft	23.12 ft	24.32 ft
Velocity:	2.65 fps		1.54 fps	
X-Section Area:	34.32 sq ft		58.84 sq ft	
Hydraulic Radius:	1.749 ft		2.362 ft	
Froude Number:	0.34		0.17	
Roughness Coefficient:	0.0365		0.0765	

Structure #1 (Pond)

Treatment Pond #2.

Pond Inputs:

Initial Pool Elev:	674.00 ft
Initial Pool:	75.24 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
674.00	50.00	3.00:1	3.00:1	10.00

Pond Results:

Peak Elevation:	676.26 ft
Dewater Time:	0.34 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.90	0.000	0.000	0.000		
661.00	5.070	0.169	0.000		
661.90	5.164	4.774	0.000		
662.90	5.269	9.991	0.000		
663.90	5.376	15.313	0.000		
664.90	5.483	20.743	0.000		
665.90	5.592	26.280	0.000		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
666.90	5.701	31.926	0.000		
667.90	5.812	37.683	0.000		
668.90	5.924	43.551	0.000		
669.90	6.036	49.531	0.000		
670.90	6.150	55.624	0.000		
671.90	6.265	61.832	0.000		
672.90	6.381	68.155	0.000		
673.90	6.498	74.595	0.000		
674.00	6.510	75.245	0.000		Spillway #1
674.90	6.707	81.193	16.982	4.24*	
675.90	6.929	88.010	79.824	3.05	
676.26	7.011	90.516	117.864	0.95	Peak Stage
676.90	7.155	95.052	186.713		
677.90	7.384	102.321	352.261		
678.90	7.617	109.821	578.051		
679.90	7.854	117.556	868.644		
680.90	8.094	125.530	1,228.779		
681.90	8.338	133.745	1,662.836		
682.90	8.585	142.206	2,125.495		
683.00	8.610	143.066	2,174.872		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.90	0.000	0.000
661.00	0.000	0.000
661.90	0.000	0.000
662.90	0.000	0.000
663.90	0.000	0.000
664.90	0.000	0.000
665.90	0.000	0.000
666.90	0.000	0.000
667.90	0.000	0.000
668.90	0.000	0.000
669.90	0.000	0.000
670.90	0.000	0.000
671.90	0.000	0.000
672.90	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
673.90	0.000	0.000
674.00	0.000	0.000
674.90	16.982	16.982
675.90	79.824	79.824
676.90	186.713	186.713
677.90	352.261	352.261
678.90	578.051	578.051
679.90	868.644	868.644
680.90	1,228.779	1,228.779
681.90	1,662.836	1,662.836
682.90	2,125.495	2,125.495
683.00	2,174.872	2,174.872

Structure #10 (Pond)

Sediment Pond #3.

Pond Inputs:

Initial Pool Elev:	673.50 ft
Initial Pool:	20.16 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
4.00	50.00	0.50	0.0140	673.50	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
680.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	680.89 ft
Dewater Time:	31.20 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.40	0.000	0.000	0.000		
660.50	0.940	0.031	0.000		
661.40	1.013	0.910	0.000		
662.40	1.097	1.964	0.000		
663.40	1.184	3.104	0.000		
664.40	1.274	4.333	0.000		
665.40	1.368	5.653	0.000		
666.40	1.465	7.069	0.000		
667.40	1.566	8.584	0.000		
668.40	1.669	10.201	0.000		
669.40	1.776	11.924	0.000		
670.40	1.887	13.755	0.000		
671.40	2.001	15.698	0.000		
672.40	2.118	17.757	0.000		
673.40	2.238	19.935	0.000		
673.50	2.250	20.159	0.000		Spillway #1
674.40	2.416	22.258	0.144	177.00*	
675.40	2.608	24.770	0.216	140.65*	
676.40	2.806	27.476	0.289	113.47*	
677.40	3.012	30.384	0.361	97.46*	
678.40	3.225	33.503	0.434	87.01*	
679.40	3.446	36.838	0.506	79.73*	
680.00	3.582	38.946	0.550	46.41*	Spillway #2
680.40	3.674	40.397	9.355	1.88*	
680.89	3.789	42.244	20.069	5.30	Peak Stage
681.40	3.909	44.188	31.338		
682.40	4.151	48.217	96.984		
683.00	4.300	50.752	157.230		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.40	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.40	0.000	0.000	0.000
662.40	0.000	0.000	0.000
663.40	0.000	0.000	0.000

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
664.40	0.000	0.000	0.000
665.40	0.000	0.000	0.000
666.40	0.000	0.000	0.000
667.40	0.000	0.000	0.000
668.40	0.000	0.000	0.000
669.40	0.000	0.000	0.000
670.40	0.000	0.000	0.000
671.40	0.000	0.000	0.000
672.40	0.000	0.000	0.000
673.40	0.000	0.000	0.000
673.50	0.000	0.000	0.000
674.40	(1)>0.144	0.000	0.144
675.40	(2)>0.216	0.000	0.216
676.40	(3)>0.289	0.000	0.289
677.40	(4)>0.361	0.000	0.361
678.40	(4)>0.434	0.000	0.434
679.40	(5)>0.506	0.000	0.506
680.00	(5)>0.550	0.000	0.550
680.40	(6)>0.579	8.777	9.355
681.40	(6)>0.621	30.717	31.338
682.40	(6)>0.650	96.334	96.984
683.00	(6)>0.668	156.562	157.230

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#11	1	4.100	0.015	0.000	0.000	77.000	M	16.34	0.882
	2	7.800	0.025	0.000	0.000	86.000	M	37.08	2.222
	3	5.200	0.095	0.000	0.000	86.000	M	24.72	1.482
	Σ	**17.100**						**78.14**	**4.586**
#12	1	3.700	0.015	0.000	0.000	77.000	M	14.75	0.796
	2	6.400	0.025	0.000	0.000	86.000	M	30.42	1.824
	Σ	**27.200**						**123.31**	**7.205**
#13	1	10.300	0.025	0.000	0.000	86.000	M	48.96	2.935
	2	4.200	0.014	0.000	0.000	77.000	M	16.74	0.903
	Σ	**41.700**						**189.01**	**11.043**
#9	1	40.300	0.003	0.000	0.000	98.000	F	215.95	15.825
	Σ	**40.300**						**215.95**	**15.825**
#6	1	5.900	0.015	0.000	0.000	77.000	M	23.52	1.269
	Σ	**5.900**						**23.52**	**1.269**
#7	1	5.800	0.015	0.000	0.000	77.000	M	23.12	1.247
	Σ	**11.700**						**46.63**	**2.516**
#8	1	8.500	0.014	0.000	0.000	77.000	M	33.88	1.828
	2	1.000	0.102	0.000	0.000	77.000	M	3.99	0.215
	Σ	**21.200**						**84.50**	**4.558**
#2	1	0.500	0.006	0.000	0.000	89.000	F	2.48	0.155
	Σ	**0.500**						**2.48**	**0.155**
#3	Σ	**0.500**						**2.48**	**0.155**
#4	1	3.500	0.004	0.000	0.000	89.000	F	17.38	1.086
	Σ	**4.000**						**19.86**	**1.241**
#5	1	5.400	0.120	0.000	0.000	86.000	M	25.67	1.539
	2	1.300	0.006	0.000	0.000	77.000	M	5.18	0.280
	3	6.600	0.005	0.000	0.000	86.000	M	31.37	1.881
	4	3.600	0.141	0.000	0.000	77.000	M	9.51	0.631
	Σ	**20.900**						**90.84**	**5.571**
#1	1	11.700	0.032	0.000	0.000	77.000	M	46.63	2.516
	2	9.500	0.003	0.000	0.000	98.000	F	50.91	3.730
	Σ	**145.300**						**462.58**	**30.864**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#10	1	7.100	0.003	0.000	0.000	98.000	F	38.04	2.788
	Σ	**152.400**						**145.43**	**33.371**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	18.75	75.00	400.00	3.460	0.032
#1	**1**	**Time of Concentration:**					**0.032**
#1	2	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#1	**2**	**Time of Concentration:**					**0.003**
#2	1	7. Paved area and small upland gullies	11.76	20.00	170.00	6.900	0.006
#2	**1**	**Time of Concentration:**					**0.006**
#4	1	7. Paved area and small upland gullies	8.00	8.00	100.00	5.690	0.004
#4	**1**	**Time of Concentration:**					**0.004**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.68	75.00	1,122.01	2.580	0.120
#5	**1**	**Time of Concentration:**					**0.120**
#5	2	5. Nearly bare and untilled, and alluvial valley fans	36.67	55.00	150.00	6.050	0.006
#5	**2**	**Time of Concentration:**					**0.006**
#5	3	5. Nearly bare and untilled, and alluvial valley fans	50.00	75.00	150.00	7.070	0.005
#5	**3**	**Time of Concentration:**					**0.005**
#5	4	3. Short grass pasture	1.70	9.00	530.00	1.040	0.141
#5	**4**	**Time of Concentration:**					**0.141**
#6	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#6	**1**	**Time of Concentration:**					**0.015**
#7	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#7	**1**	**Time of Concentration:**					**0.015**
#8	1	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#8	**1**	**Time of Concentration:**					**0.014**
#8	2	3. Short grass pasture	1.43	5.00	350.00	0.950	0.102
#8	**2**	**Time of Concentration:**					**0.102**
#9	1	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#9	**1**	**Time of Concentration:**					**0.003**
#10	1	4. Cultivated, straight row	0.15	2.00	1,300.00	0.350	1.031
#10	**1**	**Time of Concentration:**					**0.003**
#11	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#11	**1**	**Time of Concentration:**					**0.015**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#11	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#11	**2**	**Time of Concentration:**					**0.025**
#11	3	5. Nearly bare and untilled, and alluvial valley fans	7.81	75.00	960.00	2.790	0.095
#11	**3**	**Time of Concentration:**					**0.095**
#12	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#12	**1**	**Time of Concentration:**					**0.015**
#12	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#12	**2**	**Time of Concentration:**					**0.025**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#13	**1**	**Time of Concentration:**					**0.025**
#13	2	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#13	**2**	**Time of Concentration:**					**0.014**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #2 to Sediment #3
Capped Refuse Impoundment

10yr - 24hr Storm

Top of Dam Elev = 683.0

Pool Elev = 673.5

Peak Elev = 680.7

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

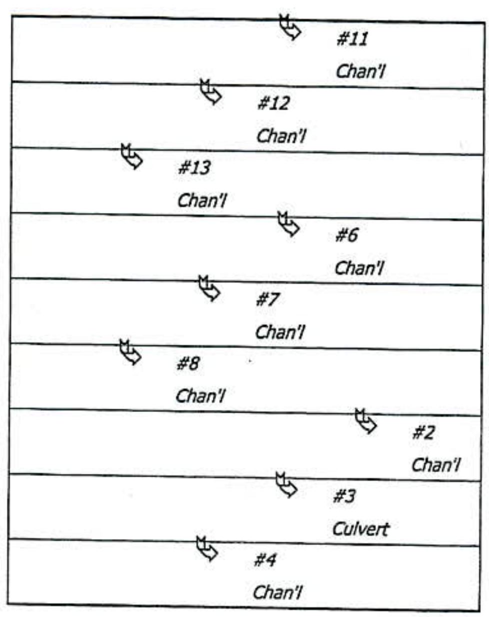
General Information

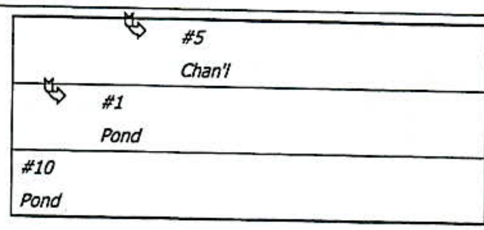
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	4.260 Inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#10	0.000	0.000	Treatment Pond #2.
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).
Culvert	#3	==>	#4	0.000	0.000	Culvert under Entrance, Sta 0+50 to 1+40.
Channel	#4	==>	#5	0.000	0.000	Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.
Channel	#5	==>	#1	0.000	0.000	Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).
Channel	#6	==>	#7	0.000	0.000	Collector Ditch #8, Sta 0+00 to 12+50.
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #8, Sta 12+50 to 25+50.
Channel	#8	==>	#1	0.000	0.000	Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).
Pond	#10	==>	End	0.000	0.000	Sediment Pond #3.
Channel	#11	==>	#12	0.000	0.000	Collector Ditch #9, Sta 0+00 to 12+00.
Channel	#12	==>	#13	0.000	0.000	Colllector Ditch #9, Sta 12+00 to 22+50.
Channel	#13	==>	#1	0.000	0.000	Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).




#5
Chan'l
#1
Pond
#10
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#11		28.400	28.400	72.80	6.19
#12		16.100	44.500	109.53	9.43
#13		20.200	64.700	162.35	13.84
#6		5.900	5.900	12.73	0.99
#7		5.800	11.700	25.25	1.96
#8		9.500	21.200	45.75	3.56
#2		0.500	0.500	1.45	0.13
#3		0.000	0.500	1.45	0.13
#4		3.500	4.000	11.62	1.02
#5		23.900	27.900	68.28	6.00
#1	In	31.500	145.300	367.38	31.68
	Out			97.46	31.67
#10	In	7.100	152.400	111.93	34.05
	Out			16.06	15.67

Structure Detail:

Structure #11 (Vegetated Channel)

Collector Ditch #9, Sta 0+00 to 12+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	72.80 cfs		72.80 cfs	
Depth:	2.38 ft	2.68 ft	3.62 ft	3.92 ft
Top Width:	19.52 ft	20.72 ft	24.48 ft	25.68 ft
Velocity:	2.07 fps		1.17 fps	
X-Section Area:	35.13 sq ft		62.43 sq ft	
Hydraulic Radius:	1.702 ft		2.383 ft	
Froude Number:	0.27		0.13	
Roughness Coefficient:	0.0397		0.0883	

Structure #12 (Vegetated Channel)

Colllector Ditch #9, Sta 12+00 to 22+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	109.53 cfs		109.53 cfs	
Depth:	2.81 ft	3.11 ft	4.08 ft	4.38 ft
Top Width:	21.24 ft	22.44 ft	26.30 ft	27.50 ft
Velocity:	2.50 fps		1.48 fps	
X-Section Area:	43.87 sq ft		73.98 sq ft	
Hydraulic Radius:	1.944 ft		2.621 ft	
Froude Number:	0.31		0.16	
Roughness Coefficient:	0.0360		0.0741	

Structure #13 (Vegetated Channel)

Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	162.35 cfs		162.35 cfs	
Depth:	3.29 ft	3.59 ft	4.56 ft	4.86 ft
Top Width:	23.15 ft	24.35 ft	28.25 ft	29.45 ft
Velocity:	2.98 fps		1.86 fps	
X-Section Area:	54.48 sq ft		87.24 sq ft	
Hydraulic Radius:	2.206 ft		2.870 ft	
Froude Number:	0.34		0.19	
Roughness Coefficient:	0.0328		0.0626	

Structure #6 (Vegetated Channel)

Collector Ditch #8, Sta 0+00 to 12+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	12.73 cfs		12.73 cfs	
Depth:	1.52 ft	1.82 ft	2.74 ft	3.04 ft
Top Width:	12.08 ft	13.28 ft	16.94 ft	18.14 ft
Velocity:	0.93 fps		0.41 fps	
X-Section Area:	13.74 sq ft		31.39 sq ft	
Hydraulic Radius:	1.074 ft		1.721 ft	
Froude Number:	0.15		0.05	
Roughness Coefficient:	0.0584		0.1826	

Structure #7 (Vegetated Channel)

Collector Ditch #8, Sta 12+50 to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	25.25 cfs		25.25 cfs	
Depth:	1.80 ft	2.10 ft	3.06 ft	3.36 ft
Top Width:	15.19 ft	16.39 ft	20.22 ft	21.42 ft
Velocity:	1.21 fps		0.59 fps	
X-Section Area:	20.85 sq ft		43.13 sq ft	
Hydraulic Radius:	1.300 ft		1.990 ft	
Froude Number:	0.18		0.07	
Roughness Coefficient:	0.0508		0.1395	

Structure #8 (Vegetated Channel)

Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	45.75 cfs		45.75 cfs	
Depth:	2.29 ft	2.59 ft	3.63 ft	3.93 ft
Top Width:	17.16 ft	18.36 ft	22.50 ft	23.70 ft
Velocity:	1.59 fps		0.83 fps	
X-Section Area:	28.79 sq ft		55.30 sq ft	
Hydraulic Radius:	1.579 ft		2.284 ft	
Froude Number:	0.22		0.09	
Roughness Coefficient:	0.0440		0.1082	

Structure #2 (Vegetated Channel)

Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	1.45 cfs		1.45 cfs	
Depth:	0.82 ft	1.12 ft	1.70 ft	2.00 ft
Top Width:	5.26 ft	6.46 ft	8.80 ft	10.00 ft
Velocity:	0.49 fps		0.16 fps	
X-Section Area:	2.96 sq ft		9.18 sq ft	
Hydraulic Radius:	0.525 ft		0.956 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.12		0.03	
Roughness Coefficient:	0.0883		0.4085	

Structure #3 (Culvert)

Culvert under Entrance, Sta 0+50 to 1+40.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.20	0.0140	2.60	0.00	0.90

Culvert Results:

Design Discharge = 1.45 cfs

Minimum pipe diameter: 1 - 8 inch pipe(s) required

Structure #4 (Vegetated Channel)

Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.62 cfs		11.62 cfs	
Depth:	1.12 ft	1.42 ft	2.08 ft	2.38 ft
Top Width:	12.48 ft	13.68 ft	16.31 ft	17.51 ft
Velocity:	1.01 fps		0.46 fps	
X-Section Area:	11.46 sq ft		25.26 sq ft	
Hydraulic Radius:	0.881 ft		1.461 ft	
Froude Number:	0.19		0.07	
Roughness Coefficient:	0.0603		0.1864	

Structure #5 (Vegetated Channel)

Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	68.28 cfs		68.28 cfs	
Depth:	2.32 ft	2.62 ft	3.48 ft	3.78 ft
Top Width:	17.28 ft	18.48 ft	21.94 ft	23.14 ft
Velocity:	2.33 fps		1.31 fps	
X-Section Area:	29.31 sq ft		52.17 sq ft	
Hydraulic Radius:	1.595 ft		2.212 ft	
Froude Number:	0.32		0.15	
Roughness Coefficient:	0.0390		0.0864	

Structure #1 (Pond)

Treatment Pond #2.

Pond Inputs:

Initial Pool Elev:	674.00 ft
Initial Pool:	75.24 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
674.00	50.00	3.00:1	3.00:1	10.00

Pond Results:

Peak Elevation:	676.07 ft
Dewater Time:	0.38 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.90	0.000	0.000	0.000		
661.00	5.070	0.169	0.000		
661.90	5.164	4.774	0.000		
662.90	5.269	9.991	0.000		
663.90	5.376	15.313	0.000		
664.90	5.483	20.743	0.000		
665.90	5.592	26.280	0.000		
666.90	5.701	31.926	0.000		
667.90	5.812	37.683	0.000		
668.90	5.924	43.551	0.000		
669.90	6.036	49.531	0.000		
670.90	6.150	55.624	0.000		
671.90	6.265	61.832	0.000		
672.90	6.381	68.155	0.000		
673.90	6.498	74.595	0.000		
674.00	6.510	75.245	0.000		Spillway #1
674.90	6.707	81.193	16.982	4.24*	
675.90	6.929	88.010	79.824	4.20	
676.07	6.968	89.172	97.462	0.65	Peak Stage
676.90	7.155	95.052	186.713		
677.90	7.384	102.321	352.261		
678.90	7.617	109.821	578.051		
679.90	7.854	117.556	868.644		
680.90	8.094	125.530	1,228.779		
681.90	8.338	133.745	1,662.836		
682.90	8.585	142.206	2,125.495		
683.00	8.610	143.066	2,174.872		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.90	0.000	0.000
661.00	0.000	0.000
661.90	0.000	0.000
662.90	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
663.90	0.000	0.000
664.90	0.000	0.000
665.90	0.000	0.000
666.90	0.000	0.000
667.90	0.000	0.000
668.90	0.000	0.000
669.90	0.000	0.000
670.90	0.000	0.000
671.90	0.000	0.000
672.90	0.000	0.000
673.90	0.000	0.000
674.00	0.000	0.000
674.90	16.982	16.982
675.90	79.824	79.824
676.90	186.713	186.713
677.90	352.261	352.261
678.90	578.051	578.051
679.90	868.644	868.644
680.90	1,228.779	1,228.779
681.90	1,662.836	1,662.836
682.90	2,125.495	2,125.495
683.00	2,174.872	2,174.872

Structure #10 (Pond)

Sediment Pond #3.

Pond Inputs:

Initial Pool Elev:	673.50 ft
Initial Pool:	20.16 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
4.00	50.00	0.50	0.0140	673.50	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
680.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

Peak Elevation:	680.71 ft
Dewater Time:	31.76 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.40	0.000	0.000	0.000		
660.50	0.940	0.031	0.000		
661.40	1.013	0.910	0.000		
662.40	1.097	1.964	0.000		
663.40	1.184	3.104	0.000		
664.40	1.274	4.333	0.000		
665.40	1.368	5.653	0.000		
666.40	1.465	7.069	0.000		
667.40	1.566	8.584	0.000		
668.40	1.669	10.201	0.000		
669.40	1.776	11.924	0.000		
670.40	1.887	13.755	0.000		
671.40	2.001	15.698	0.000		
672.40	2.118	17.757	0.000		
673.40	2.238	19.935	0.000		
673.50	2.250	20.159	0.000		Spillway #1
674.40	2.416	22.258	0.144	177.00*	
675.40	2.608	24.770	0.216	140.65*	
676.40	2.806	27.476	0.289	113.47*	
677.40	3.012	30.384	0.361	97.46*	
678.40	3.225	33.503	0.434	87.01*	
679.40	3.446	36.838	0.506	79.73*	
680.00	3.582	38.946	0.550	46.41*	Spillway #2
680.40	3.674	40.397	9.355	13.15	
680.71	3.747	41.554	16.065	7.30	Peak Stage
681.40	3.909	44.188	31.338		
682.40	4.151	48.217	96.984		
683.00	4.300	50.752	157.230		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.40	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.40	0.000	0.000	0.000
662.40	0.000	0.000	0.000
663.40	0.000	0.000	0.000
664.40	0.000	0.000	0.000
665.40	0.000	0.000	0.000
666.40	0.000	0.000	0.000
667.40	0.000	0.000	0.000
668.40	0.000	0.000	0.000
669.40	0.000	0.000	0.000
670.40	0.000	0.000	0.000
671.40	0.000	0.000	0.000
672.40	0.000	0.000	0.000
673.40	0.000	0.000	0.000
673.50	0.000	0.000	0.000
674.40	(1)>0.144	0.000	0.144
675.40	(2)>0.216	0.000	0.216
676.40	(3)>0.289	0.000	0.289
677.40	(4)>0.361	0.000	0.361
678.40	(4)>0.434	0.000	0.434
679.40	(5)>0.506	0.000	0.506
680.00	(5)>0.550	0.000	0.550
680.40	(6)>0.579	8.777	9.355
681.40	(6)>0.621	30.717	31.338
682.40	(6)>0.650	96.334	96.984
683.00	(6)>0.668	156.562	157.230

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#11	1	4.100	0.015	0.000	0.000	77.000	M	8.85	0.688
	2	7.800	0.025	0.000	0.000	86.000	M	21.33	1.807
	3	5.200	0.095	0.000	0.000	86.000	M	14.22	1.205
	4	2.900	0.138	0.000	0.000	86.000	M	5.66	0.546
	5	8.400	0.101	0.000	0.000	86.000	M	22.97	1.946
	Σ	**28.400**						**72.80**	**6.193**
#12	1	3.700	0.015	0.000	0.000	77.000	M	7.98	0.621
	2	6.400	0.025	0.000	0.000	86.000	M	17.50	1.483
	3	6.000	0.146	0.000	0.000	86.000	M	11.72	1.131
	Σ	**44.500**						**109.53**	**9.428**
#13	1	10.300	0.025	0.000	0.000	86.000	M	28.17	2.387
	2	4.200	0.014	0.000	0.000	77.000	M	9.06	0.705
	3	5.700	0.074	0.000	0.000	86.000	M	15.59	1.321
	Σ	**64.700**						**162.35**	**13.841**
#6	1	5.900	0.015	0.000	0.000	77.000	M	12.73	0.991
	Σ	**5.900**						**12.73**	**0.991**
#7	1	5.800	0.015	0.000	0.000	77.000	M	12.52	0.974
	Σ	**11.700**						**25.25**	**1.965**
#8	1	8.500	0.014	0.000	0.000	77.000	M	18.34	1.427
	2	1.000	0.102	0.000	0.000	77.000	M	2.16	0.168
	Σ	**21.200**						**45.75**	**3.560**
#2	1	0.500	0.006	0.000	0.000	89.000	F	1.45	0.127
	Σ	**0.500**						**1.45**	**0.127**
#3	Σ	**0.500**						**1.45**	**0.127**
#4	1	3.500	0.004	0.000	0.000	89.000	F	10.17	0.894
	Σ	**4.000**						**11.62**	**1.021**
#5	1	5.400	0.120	0.000	0.000	86.000	M	14.77	1.251
	2	1.300	0.008	0.000	0.000	77.000	M	2.81	0.218
	3	6.600	0.005	0.000	0.000	86.000	M	18.05	1.529
	4	3.600	0.141	0.000	0.000	77.000	M	5.22	0.492
	5	2.900	0.213	0.000	0.000	86.000	M	5.39	0.538
	6	4.100	0.091	0.000	0.000	86.000	M	11.21	0.950
	Σ	**27.900**						**68.28**	**5.998**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	11.700	0.025	0.000	0.000	86.000	M	32.00	2.711
	2	9.500	0.003	0.000	0.000	98.000	F	30.85	3.184
	3	10.300	0.089	0.000	0.000	86.000	M	28.17	2.387
	Σ	**145.300**						**367.38**	**31.681**
#10	1	7.100	0.003	0.000	0.000	98.000	F	23.05	2.380
	Σ	**152.400**						**111.93**	**34.053**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#1	**1**	**Time of Concentration:**					**0.025**
#1	2	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#1	**2**	**Time of Concentration:**					**0.003**
#1	3	5. Nearly bare and untilled, and alluvial valley fans	8.45	79.00	935.02	2.900	0.089
#1	**3**	**Time of Concentration:**					**0.089**
#2	1	7. Paved area and small upland gullies	11.76	20.00	170.00	6.900	0.006
#2	**1**	**Time of Concentration:**					**0.006**
#4	1	7. Paved area and small upland gullies	8.00	8.00	100.00	5.690	0.004
#4	**1**	**Time of Concentration:**					**0.004**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.68	75.00	1,122.01	2.580	0.120
#5	**1**	**Time of Concentration:**					**0.120**
#5	2	3. Short grass pasture	36.67	55.00	150.00	4.840	0.008
#5	**2**	**Time of Concentration:**					**0.008**
#5	3	5. Nearly bare and untilled, and alluvial valley fans	50.00	75.00	150.00	7.070	0.005
#5	**3**	**Time of Concentration:**					**0.005**
#5	4	3. Short grass pasture	1.70	9.00	530.00	1.040	0.141
#5	**4**	**Time of Concentration:**					**0.141**
#5	5	5. Nearly bare and untilled, and alluvial valley fans	4.74	79.00	1,667.01	2.170	0.213
#5	**5**	**Time of Concentration:**					**0.213**
#5	6	5. Nearly bare and untilled, and alluvial valley fans	8.32	79.00	950.02	2.880	0.091
#5	**6**	**Time of Concentration:**					**0.091**
#6	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#6	**1**	**Time of Concentration:**					**0.015**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#7	**1**	**Time of Concentration:**					**0.015**
#8	1	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#8	**1**	**Time of Concentration:**					**0.014**
#8	2	3. Short grass pasture	1.43	5.00	350.00	0.950	0.102
#8	**2**	**Time of Concentration:**					**0.102**
#10	1	4. Cultivated, straight row	0.15	2.00	1,300.00	0.350	1.031
#10	**1**	**Time of Concentration:**					**0.003**
#11	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#11	**1**	**Time of Concentration:**					**0.015**
#11	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#11	**2**	**Time of Concentration:**					**0.025**
#11	3	5. Nearly bare and untilled, and alluvial valley fans	7.81	75.00	960.00	2.790	0.095
#11	**3**	**Time of Concentration:**					**0.095**
#11	4	5. Nearly bare and untilled, and alluvial valley fans	6.32	79.00	1,249.99	2.510	0.138
#11	**4**	**Time of Concentration:**					**0.138**
#11	5	5. Nearly bare and untilled, and alluvial valley fans	7.74	79.00	1,020.01	2.780	0.101
#11	**5**	**Time of Concentration:**					**0.101**
#12	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#12	**1**	**Time of Concentration:**					**0.015**
#12	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#12	**2**	**Time of Concentration:**					**0.025**
#12	3	5. Nearly bare and untilled, and alluvial valley fans	6.08	79.00	1,300.00	2.460	0.146
#12	**3**	**Time of Concentration:**					**0.146**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#13	**1**	**Time of Concentration:**					**0.025**
#13	2	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#13	**2**	**Time of Concentration:**					**0.014**
#13	3	5. Nearly bare and untilled, and alluvial valley fans	9.52	79.00	830.00	3.080	0.074
#13	**3**	**Time of Concentration:**					**0.074**

Sunrise Coal
Bulldog Mine - Permit #429
Treatment #2 to Sediment #3
Capped Refuse Impoundment

100 yr-6 hr Storm

Top of Dam Elev = 683.0

Pool Elev = 673.5

Peak Elev = 681.8

Midwest Reclamation Resources, Inc.
1023 North 14th Street
Murphysboro, IL

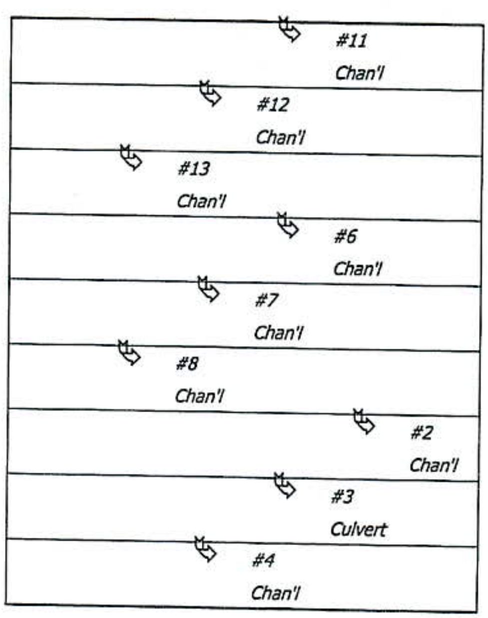
General Information

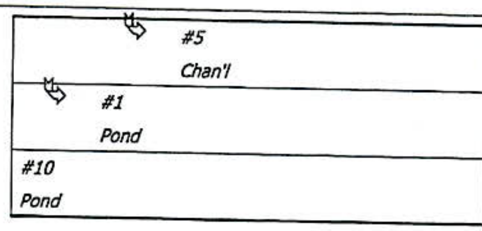
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	4.960 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#10	0.000	0.000	Treatment Pond #2.
Channel	#2	==>	#3	0.000	0.000	Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).
Culvert	#3	==>	#4	0.000	0.000	Culvert under Entrance, Sta 0+50 to 1+40.
Channel	#4	==>	#5	0.000	0.000	Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.
Channel	#5	==>	#1	0.000	0.000	Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).
Channel	#6	==>	#7	0.000	0.000	Collector Ditch #8, Sta 0+00 to 12+50.
Channel	#7	==>	#8	0.000	0.000	Collector Ditch #8, Sta 12+50 to 25+50.
Channel	#8	==>	#1	0.000	0.000	Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).
Pond	#10	==>	End	0.000	0.000	Sediment Pond #3.
Channel	#11	==>	#12	0.000	0.000	Collector Ditch #9, Sta 0+00 to 12+00.
Channel	#12	==>	#13	0.000	0.000	Colllector Ditch #9, Sta 12+00 to 22+50.
Channel	#13	==>	#1	0.000	0.000	Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).




#5
Chan'l
#1
Pond
#10
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#11		28.400	28.400	127.39	7.65
#12		16.100	44.500	191.83	11.67
#13		20.200	64.700	284.63	17.13
#6		5.900	5.900	23.52	1.27
#7		5.800	11.700	46.63	2.52
#8		9.500	21.200	84.50	4.56
#2		0.500	0.500	2.48	0.16
#3		0.000	0.500	2.48	0.16
#4		3.500	4.000	19.86	1.24
#5		23.900	27.900	118.74	7.40
#1	In	31.500	145.300	643.36	39.09
	Out			205.05	39.09
#10	In	7.100	152.400	223.98	41.87
	Out			57.15	24.10

Structure Detail:

Structure #11 (Vegetated Channel)

Collector Ditch #9, Sta 0+00 to 12+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	127.39 cfs		127.39 cfs	
Depth:	2.98 ft	3.28 ft	4.26 ft	4.56 ft
Top Width:	21.94 ft	23.14 ft	27.02 ft	28.22 ft
Velocity:	2.67 fps		1.62 fps	
X-Section Area:	47.65 sq ft		78.78 sq ft	
Hydraulic Radius:	2.041 ft		2.714 ft	
Froude Number:	0.32		0.17	
Roughness Coefficient:	0.0347		0.0694	

Structure #12 (Vegetated Channel)

Colllector Ditch #9, Sta 12+00 to 22+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	191.83 cfs		191.83 cfs	
Depth:	3.51 ft	3.81 ft	4.78 ft	5.08 ft
Top Width:	24.05 ft	25.25 ft	29.14 ft	30.34 ft
Velocity:	3.21 fps		2.05 fps	
X-Section Area:	59.79 sq ft		93.61 sq ft	
Hydraulic Radius:	2.326 ft		2.982 ft	
Froude Number:	0.36		0.20	
Roughness Coefficient:	0.0316		0.0583	

Structure #13 (Vegetated Channel)

Collector Ditch #9, Sta 22+50 to 40+40 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
10.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	284.63 cfs		284.63 cfs	
Depth:	4.10 ft	4.40 ft	5.35 ft	5.65 ft
Top Width:	26.39 ft	27.59 ft	31.39 ft	32.59 ft
Velocity:	3.82 fps		2.57 fps	
X-Section Area:	74.56 sq ft		110.68 sq ft	
Hydraulic Radius:	2.632 ft		3.263 ft	
Froude Number:	0.40		0.24	
Roughness Coefficient:	0.0288		0.0494	

Structure #6 (Vegetated Channel)

Collector Ditch #8, Sta 0+00 to 12+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
6.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	23.52 cfs		23.52 cfs	
Depth:	1.95 ft	2.25 ft	3.25 ft	3.55 ft
Top Width:	13.78 ft	14.98 ft	19.02 ft	20.22 ft
Velocity:	1.22 fps		0.58 fps	
X-Section Area:	19.24 sq ft		40.70 sq ft	
Hydraulic Radius:	1.309 ft		1.980 ft	
Froude Number:	0.18		0.07	
Roughness Coefficient:	0.0505		0.1408	

Structure #7 (Vegetated Channel)

Collector Ditch #8, Sta 12+50 to 25+50.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	46.63 cfs		46.63 cfs	
Depth:	2.31 ft	2.61 ft	3.65 ft	3.95 ft
Top Width:	17.23 ft	18.43 ft	22.58 ft	23.78 ft
Velocity:	1.60 fps		0.84 fps	
X-Section Area:	29.10 sq ft		55.75 sq ft	
Hydraulic Radius:	1.589 ft		2.294 ft	
Froude Number:	0.22		0.09	
Roughness Coefficient:	0.0438		0.1073	

Structure #8 (Vegetated Channel)

Collector Ditch #8, Sta 25+50 to 48+81 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.1	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	84.50 cfs		84.50 cfs	
Depth:	2.92 ft	3.22 ft	4.31 ft	4.61 ft
Top Width:	19.68 ft	20.88 ft	25.25 ft	26.45 ft
Velocity:	2.09 fps		1.18 fps	
X-Section Area:	40.43 sq ft		71.70 sq ft	
Hydraulic Radius:	1.920 ft		2.628 ft	
Froude Number:	0.26		0.12	
Roughness Coefficient:	0.0381		0.0834	

Structure #2 (Vegetated Channel)

Collector Ditch #7, Sta 0+00 to 0+50 (Culvert under Entrance).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	2.48 cfs		2.48 cfs	
Depth:	1.00 ft	1.30 ft	1.96 ft	2.26 ft
Top Width:	6.01 ft	7.21 ft	9.84 ft	11.04 ft
Velocity:	0.62 fps		0.21 fps	
X-Section Area:	4.01 sq ft		11.60 sq ft	
Hydraulic Radius:	0.619 ft		1.078 ft	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Froude Number:	0.13		0.03	
Roughness Coefficient:	0.0782		0.3272	

Structure #3 (Culvert)

Culvert under Entrance, Sta 0+50 to 1+40.

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
90.00	0.20	0.0140	3.10	0.00	0.90

Culvert Results:

Design Discharge = 2.48 cfs

Minimum pipe diameter: 1 - 10 inch pipe(s) required

Structure #4 (Vegetated Channel)

Collector Ditch #7, Sta 1+40 (Culvert under Entrance) to 21+00.

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	19.86 cfs		19.86 cfs	
Depth:	1.40 ft	1.70 ft	2.43 ft	2.73 ft
Top Width:	13.60 ft	14.80 ft	17.74 ft	18.94 ft
Velocity:	1.31 fps		0.63 fps	
X-Section Area:	15.12 sq ft		31.32 sq ft	
Hydraulic Radius:	1.060 ft		1.658 ft	
Froude Number:	0.22		0.08	
Roughness Coefficient:	0.0527		0.1472	

Structure #5 (Vegetated Channel)

Collector Ditch #7, Sta 21+00 to 30+34 (Treatment Pond #2).

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
8.00	2.0:1	2.0:1	0.2	D, B	0.30			5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	118.74 cfs		118.74 cfs	
Depth:	2.89 ft	3.19 ft	4.08 ft	4.38 ft
Top Width:	19.56 ft	20.76 ft	24.32 ft	25.52 ft
Velocity:	2.98 fps		1.80 fps	
X-Section Area:	39.82 sq ft		65.91 sq ft	
Hydraulic Radius:	1.903 ft		2.512 ft	
Froude Number:	0.37		0.19	
Roughness Coefficient:	0.0343		0.0683	

Structure #1 (Pond)

Treatment Pond #2.

Pond Inputs:

Initial Pool Elev:	674.00 ft
Initial Pool:	75.24 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
674.00	50.00	3.00:1	3.00:1	10.00

Pond Results:

Peak Elevation:	677.01 ft
Dewater Time:	1.62 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.90	0.000	0.000	0.000		
661.00	5.070	0.169	0.000		
661.90	5.164	4.774	0.000		
662.90	5.269	9.991	0.000		
663.90	5.376	15.313	0.000		
664.90	5.483	20.743	0.000		
665.90	5.592	26.280	0.000		
666.90	5.701	31.926	0.000		
667.90	5.812	37.683	0.000		
668.90	5.924	43.551	0.000		
669.90	6.036	49.531	0.000		
670.90	6.150	55.624	0.000		
671.90	6.265	61.832	0.000		
672.90	6.381	68.155	0.000		
673.90	6.498	74.595	0.000		
674.00	6.510	75.245	0.000		Spillway #1
674.90	6.707	81.193	16.982	34.45	
675.90	6.929	88.010	79.824	2.75	
676.90	7.155	95.052	186.713	1.40	
677.01	7.182	95.857	205.050	0.20	Peak Stage
677.90	7.384	102.321	352.261		
678.90	7.617	109.821	578.051		
679.90	7.854	117.556	868.644		
680.90	8.094	125.530	1,228.779		
681.90	8.338	133.745	1,662.836		
682.90	8.585	142.206	2,125.495		
683.00	8.610	143.066	2,174.872		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.90	0.000	0.000
661.00	0.000	0.000
661.90	0.000	0.000
662.90	0.000	0.000
663.90	0.000	0.000
664.90	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
665.90	0.000	0.000
666.90	0.000	0.000
667.90	0.000	0.000
668.90	0.000	0.000
669.90	0.000	0.000
670.90	0.000	0.000
671.90	0.000	0.000
672.90	0.000	0.000
673.90	0.000	0.000
674.00	0.000	0.000
674.90	16.982	16.982
675.90	79.824	79.824
676.90	186.713	186.713
677.90	352.261	352.261
678.90	578.051	578.051
679.90	868.644	868.644
680.90	1,228.779	1,228.779
681.90	1,662.836	1,662.836
682.90	2,125.495	2,125.495
683.00	2,174.872	2,174.872

Structure #10 (Pond)

Sediment Pond #3.

Pond Inputs:

Initial Pool Elev:	673.50 ft
Initial Pool:	20.16 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
4.00	50.00	0.50	0.0140	673.50	0.90	0.00

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
680.00	10.00	3.00:1	3.00:1	4.00

Pond Results:

	Peak Elevation:	681.79 ft
	Dewater Time:	31.69 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
660.40	0.000	0.000	0.000		
660.50	0.940	0.031	0.000		
661.40	1.013	0.910	0.000		
662.40	1.097	1.964	0.000		
663.40	1.184	3.104	0.000		
664.40	1.274	4.333	0.000		
665.40	1.368	5.653	0.000		
666.40	1.465	7.069	0.000		
667.40	1.566	8.584	0.000		
668.40	1.669	10.201	0.000		
669.40	1.776	11.924	0.000		
670.40	1.887	13.755	0.000		
671.40	2.001	15.698	0.000		
672.40	2.118	17.757	0.000		
673.40	2.238	19.935	0.000		
673.50	2.250	20.159	0.000		Spillway #1
674.40	2.416	22.258	0.144	177.00*	
675.40	2.608	24.770	0.216	140.65*	
676.40	2.806	27.476	0.289	113.47*	
677.40	3.012	30.384	0.361	97.46*	
678.40	3.225	33.503	0.434	87.01*	
679.40	3.446	36.838	0.506	79.73*	
680.00	3.582	38.946	0.550	46.41*	Spillway #2
680.40	3.674	40.397	9.355	11.90	
681.40	3.909	44.188	31.338	5.35	
681.79	4.006	45.772	57.154	1.65	Peak Stage
682.40	4.151	48.217	96.984		
683.00	4.300	50.752	157.230		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
660.40	0.000	0.000	0.000
660.50	0.000	0.000	0.000
661.40	0.000	0.000	0.000
662.40	0.000	0.000	0.000
663.40	0.000	0.000	0.000
664.40	0.000	0.000	0.000
665.40	0.000	0.000	0.000
666.40	0.000	0.000	0.000
667.40	0.000	0.000	0.000
668.40	0.000	0.000	0.000
669.40	0.000	0.000	0.000
670.40	0.000	0.000	0.000
671.40	0.000	0.000	0.000
672.40	0.000	0.000	0.000
673.40	0.000	0.000	0.000
673.50	0.000	0.000	0.000
674.40	(1)>0.144	0.000	0.144
675.40	(2)>0.216	0.000	0.216
676.40	(3)>0.289	0.000	0.289
677.40	(4)>0.361	0.000	0.361
678.40	(4)>0.434	0.000	0.434
679.40	(5)>0.506	0.000	0.506
680.00	(5)>0.550	0.000	0.550
680.40	(6)>0.579	8.777	9.355
681.40	(6)>0.621	30.717	31.338
682.40	(6)>0.650	96.334	96.984
683.00	(6)>0.668	156.562	157.230

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#11	1	4.100	0.015	0.000	0.000	77.000	M	16.34	0.882
	2	7.800	0.025	0.000	0.000	86.000	M	37.08	2.222
	3	5.200	0.095	0.000	0.000	86.000	M	24.72	1.482
	4	2.900	0.138	0.000	0.000	86.000	M	9.75	0.674
	5	8.400	0.101	0.000	0.000	86.000	M	39.93	2.393
	Σ	**28.400**						**127.39**	**7.653**
#12	1	3.700	0.015	0.000	0.000	77.000	M	14.75	0.796
	2	6.400	0.025	0.000	0.000	86.000	M	30.42	1.824
	3	6.000	0.146	0.000	0.000	86.000	M	20.17	1.394
	Σ	**44.500**						**191.83**	**11.665**
#13	1	10.300	0.025	0.000	0.000	86.000	M	48.96	2.935
	2	4.200	0.014	0.000	0.000	77.000	M	16.74	0.903
	3	5.700	0.074	0.000	0.000	86.000	M	27.10	1.624
	Σ	**64.700**						**284.63**	**17.127**
#6	1	5.900	0.015	0.000	0.000	77.000	M	23.52	1.269
	Σ	**5.900**						**23.52**	**1.269**
#7	1	5.800	0.015	0.000	0.000	77.000	M	23.12	1.247
	Σ	**11.700**						**46.63**	**2.516**
#8	1	8.500	0.014	0.000	0.000	77.000	M	33.88	1.828
	2	1.000	0.102	0.000	0.000	77.000	M	3.99	0.215
	Σ	**21.200**						**84.50**	**4.558**
#2	1	0.500	0.006	0.000	0.000	89.000	F	2.48	0.155
	Σ	**0.500**						**2.48**	**0.155**
#3	Σ	**0.500**						**2.48**	**0.155**
#4	1	3.500	0.004	0.000	0.000	89.000	F	17.38	1.086
	Σ	**4.000**						**19.86**	**1.241**
#5	1	5.400	0.120	0.000	0.000	86.000	M	25.67	1.539
	2	1.300	0.008	0.000	0.000	77.000	M	5.18	0.280
	3	6.600	0.005	0.000	0.000	86.000	M	31.37	1.881
	4	3.600	0.141	0.000	0.000	77.000	M	9.51	0.631
	5	2.900	0.213	0.000	0.000	86.000	M	9.26	0.663
	6	4.100	0.091	0.000	0.000	86.000	M	19.49	1.168
	Σ	**27.900**						**118.74**	**7.402**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	11.700	0.025	0.000	0.000	86.000	M	55.62	3.334
	2	9.500	0.003	0.000	0.000	98.000	F	50.91	3.730
	3	10.300	0.089	0.000	0.000	86.000	M	48.96	2.935
	Σ	**145.300**						**643.36**	**39.086**
#10	1	7.100	0.003	0.000	0.000	98.000	F	38.04	2.788
	Σ	**152.400**						**223.98**	**41.874**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#1	**1**	**Time of Concentration:**					**0.025**
#1	2	9. Small streams flowing bankfull	1.00	1.00	100.00	9.000	0.003
#1	**2**	**Time of Concentration:**					**0.003**
#1	3	5. Nearly bare and untilled, and alluvial valley fans	8.45	79.00	935.02	2.900	0.089
#1	**3**	**Time of Concentration:**					**0.089**
#2	1	7. Paved area and small upland gullies	11.76	20.00	170.00	6.900	0.006
#2	**1**	**Time of Concentration:**					**0.006**
#4	1	7. Paved area and small upland gullies	8.00	8.00	100.00	5.690	0.004
#4	**1**	**Time of Concentration:**					**0.004**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	6.68	75.00	1,122.01	2.580	0.120
#5	**1**	**Time of Concentration:**					**0.120**
#5	2	3. Short grass pasture	36.67	55.00	150.00	4.840	0.008
#5	**2**	**Time of Concentration:**					**0.008**
#5	3	5. Nearly bare and untilled, and alluvial valley fans	50.00	75.00	150.00	7.070	0.005
#5	**3**	**Time of Concentration:**					**0.005**
#5	4	3. Short grass pasture	1.70	9.00	530.00	1.040	0.141
#5	**4**	**Time of Concentration:**					**0.141**
#5	5	5. Nearly bare and untilled, and alluvial valley fans	4.74	79.00	1,667.01	2.170	0.213
#5	**5**	**Time of Concentration:**					**0.213**
#5	6	5. Nearly bare and untilled, and alluvial valley fans	8.32	79.00	950.02	2.880	0.091
#5	**6**	**Time of Concentration:**					**0.091**
#6	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#6	**1**	**Time of Concentration:**					**0.015**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#7	**1**	**Time of Concentration:**					**0.015**
#8	1	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#8	**1**	**Time of Concentration:**					**0.014**
#8	2	3. Short grass pasture	1.43	5.00	350.00	0.950	0.102
#8	**2**	**Time of Concentration:**					**0.102**
#10	1	4. Cultivated, straight row	0.15	2.00	1,300.00	0.350	1.031
#10	**1**	**Time of Concentration:**					**0.003**
#11	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#11	**1**	**Time of Concentration:**					**0.015**
#11	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#11	**2**	**Time of Concentration:**					**0.025**
#11	3	5. Nearly bare and untilled, and alluvial valley fans	7.81	75.00	960.00	2.790	0.095
#11	**3**	**Time of Concentration:**					**0.095**
#11	4	5. Nearly bare and untilled, and alluvial valley fans	6.32	79.00	1,249.99	2.510	0.138
#11	**4**	**Time of Concentration:**					**0.138**
#11	5	5. Nearly bare and untilled, and alluvial valley fans	7.74	79.00	1,020.01	2.780	0.101
#11	**5**	**Time of Concentration:**					**0.101**
#12	1	3. Short grass pasture	20.00	40.00	200.00	3.570	0.015
#12	**1**	**Time of Concentration:**					**0.015**
#12	2	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#12	**2**	**Time of Concentration:**					**0.025**
#12	3	5. Nearly bare and untilled, and alluvial valley fans	6.08	79.00	1,300.00	2.460	0.146
#12	**3**	**Time of Concentration:**					**0.146**
#13	1	5. Nearly bare and untilled, and alluvial valley fans	18.75	75.00	400.00	4.330	0.025
#13	**1**	**Time of Concentration:**					**0.025**
#13	2	3. Short grass pasture	22.50	45.00	200.00	3.790	0.014
#13	**2**	**Time of Concentration:**					**0.014**
#13	3	5. Nearly bare and untilled, and alluvial valley fans	9.52	79.00	830.00	3.080	0.074
#13	**3**	**Time of Concentration:**					**0.074**

Culvert Under Haul Road 2 - Ditch 6 1360'-1400'

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
40.00	0.15	0.0140	4.70	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 59.00 cfs

Maximum Headwater = 4.70 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
0.47	2.69	**3.00**	3.14
0.94	7.32	**8.69**	9.32
1.41	11.74	**14.56**	15.93
1.88	15.63	**19.87**	22.02
2.35	19.20	**24.63**	27.50
2.82	26.25	**29.13**	32.47
3.29	33.66	**38.45**	40.63
3.76	42.73	**47.75**	50.72
4.23	50.01	**57.26**	61.16
4.70	56.04	**69.93**	75.77
5.17	61.01	**77.92**	86.30
5.64	65.60	**84.55**	94.22
6.11	69.89	**90.70**	101.47
6.58	73.93	**96.45**	108.24
7.05	77.77	**101.88**	114.61

Culverts under Rail Road - Ditch 6 4110'-4160'

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
50.00	0.15	0.0150	5.90	0.00	0.90

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 83.00 cfs

Maximum Headwater = 5.90 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
0.59	3.93	**4.48**	4.73
1.18	9.63	**11.79**	12.83
1.77	14.58	**18.55**	20.55
2.36	19.37	**24.41**	27.32
2.95	28.43	**32.26**	33.82
3.54	37.68	**43.69**	46.35
4.13	47.26	**55.46**	59.36
4.72	55.04	**68.76**	74.75
5.31	61.85	**79.13**	87.39
5.90	67.96	**88.00**	98.28
6.49	73.18	**95.37**	106.98
7.08	78.00	**102.22**	115.00
7.67	82.55	**108.63**	122.51
8.26	86.86	**114.69**	129.55
8.85	90.96	**120.44**	136.27

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-7)A)

MUTUAL DRAINAGE AGREEMENT

MEMORANDUM

TO: SCOTT K. FOWLER
SUPERVISOR
LAND RECLAMATION DIVISION
ILLINOIS DEPARTMENT OF NATURAL RESOURCES

FROM: JACKSON KELLY, PLLC

DATE: JUNE ___, 2015

RE: BULLDOG MINE
MODIFICATION TO PERMIT APPLICATION NO. 429
RESPONSE TO MODIFICATION REQUEST NOS. 51(a) AND 54(a)

We have reviewed relevant portions of the Bulldog Mine Permit Application Number 429 (the "Application"), certain title related documents, and applicable Illinois law in response to Modification to Permit No. 429 request numbers 51(a) and 54(a) (the "Modification Requests") set forth in your letter dated March 20, 2015. Permit Application Number 429 was submitted to the Illinois Department of Natural Resources by Sunrise Coal, LLC ("Sunrise") to obtain an Illinois Surface Coal Mining and Reclamation Act permit for the Bulldog Mine, a proposed underground mining operation in Vermillion County, Illinois. The Modification Requests seek information and/or documentation confirming the right of Sunrise to use existing drainage tiles to support its proposed freshwater makeup plan and sediment control design in connection with the Bulldog Mine as set forth in Part IV(6)(J)(2) and Part IV(7)(D) and (E) of the Application. Based on our review of the applicable law and the title related documents attached hereto, Sunrise has secured the rights necessary to conduct such operations.

Sunrise intends to conduct surface operations in support of the Bulldog Mine on two tracts of land in Vermillion County, Illinois, described as follows (the "Surface Property"):

Tract 1:

The Southeast Quarter of the Southeast Quarter of Section 26, Township 18 North, Range 14 West, of the 2nd P.M., situated in Vermillion County, Illinois.

ALSO

The Northeast Quarter of Section 35, Township 18 North, Range 14 West, of the 2nd P.M., EXCEPT the North 701.0 feet of even width of the East 381.9 feet of the even width of said Northeast Quarter, ALSO EXCEPTING the South 20 feet of the North 721.0 feet of even width of the East 381.9 feet of even width of said Northeast Quarter, situated in Vermillion County, Illinois.

Tract 2:

The Southwest Quarter of Section Twenty-six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermillion County, Illinois and the Southwest Quarter of the Southeast Quarter of Section Twenty-six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermillion County, Illinois. Containing 200 acres, more or less.

As shown on Map D to the Application, there is a drainage tile running north and south along the East side of Tract 1 of the Surface Property (the "Tract 1 Drain") and a drainage tile running north and south through Tract 2 of the Surface Property (the "Tract 2 Drain"). As set forth in Part IV(6)(J)(2) of the Application, Sunrise proposes to collect and store water from the Tract 2 Drain in the Northwest corner of Tract 2 of the Surface Property for use as freshwater makeup in support of its mine operations. As set forth in Part IV(7)(D) and (E) of the Application, overflows from collected and treated surface runoff are designed to discharge into the Tract 1 Drain and the Tract 2 Drain. As explained herein, such plans and designs are well within Sunrise's rights under the Drainage Agreement, the Illinois Drainage Code, and applicable common law.

Sunrise acquired fee simple title to Tract 1 of the Surface Property by Warranty Deed dated November 17, 2011 from Nancy Ann Ready (the "Ready Deed"). A copy of the Ready

Deed and a copy of Sunrise's title insurance policy on Tract 1 of the Surface Property are attached hereto as Exhibit "A". The rights to the Tract 1 Drain are governed by a Mutual Drainage Agreement dated August 2, 1982, attached hereto as Exhibit "B" (the "Drainage Agreement"). Tract 1 of the Surface Property is described in the Drainage Agreement as Tract 3 and Tract 4. Sunrise is party to the Drainage Agreement by virtue of acquiring title to Tract 1 of the Surface Property pursuant to the Ready Deed. Under the Drainage Agreement, Sunrise may use the Tract 1 Drain to drain surface runoff from Tract 1 of the Surface Property. Paragraph 1 of the Drainage Agreement states that "[t]he drain shall be for the sole and exclusive benefit of the lands hereinafter described...," which includes Tract 1 of the Surface Property. Sunrise cannot, however, discharge surface runoff from Tract 2 into the Tract 1 Drain. *See* Paragraph 2 of the Drainage Agreement. Based on the revised Map D of the modified permit, all of the water that will be discharged into the Tract 1 Drain is runoff from the surface of Tract 1 of the Surface Property. Accordingly, Sunrise's surface runoff plans with regard to Tract 1 of the Surface Property are well within its rights under the Drainage Agreement and applicable law.

Sunrise may also use the Tract 2 Drain to drain surface runoff from Tract 2 of the Surface Property. Sunrise acquired fee simple title to the surface of Tract 2 of the Surface Property by Warranty Deed from Kizer Family Farms, L.P., dated December 30, 2011 (the "Kizer Deed"). A copy of the Kizer Deed and a copy of Sunrise's title insurance policy on Tract 2 of the Surface Property are attached hereto as Exhibit "C". Tract 2 of the Surface Property lies within a drainage district and the rights to use the Tract 2 Drain are governed by the provisions of the Illinois Drainage Code applicable to drainage districts. 70 ILCS 605/3, *et seq*. As shown by the drainage district map attached hereto as Exhibit "D" and the tax statements attached hereto as Exhibit "E", Tracts 1 and 2 of the Surface Property lies within Union Drainage District #1 in

Vance and Sidell Township, Vermillion County, Illinois.[1] The rights of landowners within a drainage district are subject to the provisions of the statute authorizing the construction of the drainage system, where they take advantage of such drainage facilities. *See Union Drainage Dist. No. 6 of Towns of Bourbonnais and Manteno v. Manteno Limestone Co., et al.*, 341 Ill. App. 353, 93 N.E.2d 500 (Ill. App. 2d) (citing *Turley v. Arnold*, 384 Ill. 158, 51 N.E.2d 176). The Illinois Drainage Code provides that "[d]rainage districts may be formed to construct, maintain or repair drains or levees or to engage in other drainage or levee work for agricultural, sanitary or mining purposes." Further, "[a] landowner within any drainage district has the right to use the ditches and drains of the district as outlets for any drains, either open or covered, which he may desire to construct for the more complete drainage of his own land..." 70 ILCS 605/3-1; 12-1.

The *Manteno Limestone* case is instructive. In that case, the trial court enjoined the Manteno Limestone Company from permitting any percolating water from its quarry from entering the drains of the Union Drainage District No. 6. The Illinois Court of Appeals reversed the trial court, noting that "[t]he purpose of the [Illinois Drainage Code] is to effectuate drainage for agricultural, sanitary and mining purposes, and it is immaterial whether the water entering the tiles comes from an above ground mining operation or from an underground shaft, for in both instances the drainage problem is substantially the same. *Manteno Limeston*, 341 Ill. App. at 503-504.[2] Sunrise also has the right under the common law to collect and store the surface water on Tract 2 in accordance with its freshwater makeup plan. "An owner of land owns the surface

[1] While the analysis applicable to Tract 2 with regard to the drainage district also applies to Tract 1, the rights to use the Tract 1 Drain are governed solely by the Drainage Agreement. *See* 70 ILCS 605/2-8.
[2] Notably, the appellate court further postulated that in the event the tiles become inadequate to carry the load because of increased volume of water from the quarry, it is the duty of the commissioners of the drainage district to proceed under the statute to construct a drainage system adequate to meet the needs of the district. *Manteno Limestone*, 341 Ill. App. at 367.

water by the same title that he or she owns the land itself, and an owner has the right to collect and appropriate it to his or her own use without liability to others." 36 Ill. Law and Prac. Waters § 3 (citing *Eberle v. Greene*, 18 Ill.2d 322, 163 N.E.2d 822 (1960). Accordingly, Sunrise's surface runoff and freshwater makeup plans are well within its rights under applicable law.

11-09897
BARBARA [illegible]
[illegible]
12/19/2011 11:38:33AM

VERMILION COUNTY TAX
$1937.00

STATE OF ILLINOIS
DEC.15.11
REAL ESTATE TRANSFER TAX
DEPARTMENT OF REVENUE
REAL ESTATE TRANSFER TAX
03874.00
0000502655
FP351002

186374 (*This space for Recorder's use*)

WARRANTY DEED

THIS INDENTURE WITNESSETH that the **Nancy Ann Ready, an unmarried adult,** of Dallas County, in the State of Texas, for and in consideration of $10.00 and other good and valuable consideration, in hand paid, **CONVEYS AND WARRANTS** to **Sunrise Coal, LLC, an Indiana limited liability company duly admitted to do business in the State of Illinois,** the following-described Real Estate situated in Vermilion County, Illinois, to-wit:

> The Southeast Quarter of the Southeast Quarter of Section 26, Township 18 North, Range 14 West of the 2nd P.M., situated in Vermilion County, Illinois.
>
> ALSO, the Northeast Quarter of Section 35, Township 18 North, Range 14 West of the 2nd P.M., EXCEPT the North 701.0 feet of even width of the East 381.9 feet of even width of said Northeast Quarter, ALSO EXCEPT the South 20 feet of the North 721.0 feet of even width of the East 381.9 feet of even width of said Northeast Quarter, situated in Vermilion County, Illinois.

(the "Real Estate"), hereby releasing and waiving all rights under and by virtue of the Homestead Exemption Laws of the State of Illinois.

Subject to all existing and recorded roadways.

EXHIBIT
A

Memoranda

1. The Grantor has paid to the Grantee an amount equal to the real estate taxes and assessments that are a lien upon the Real Estate to the date of delivery of this deed. Therefore the Grantee shall pay all real estate taxes and assessments due and payable after this date.

2. The Grantor shall deliver to the Grantee full and complete possession of the Real Estate, and improvements thereon, on the date of the recordation of this Warranty Deed; provided, however, that the Grantor shall have the right to enter upon the Real Estate after such date of recordation in order to harvest the agricultural crop growing on the Real Estate on such date of recordation.

In Witness Whereof, Nancy Ann Ready hereunto has set her hand and seal, this 17th day of November 2011.

Nancy Ann Ready

STATE OF TEXAS)
) SS:
COUNTY OF DALLAS)

I, the undersigned, a notary public in and for said County, in the State aforesaid, do hereby certify that Nancy Ann Ready, personally known to me to be the person whose name is subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that she signed, sealed, and delivered the said instrument as her free and voluntary act, for the uses and purposes therein set forth including the release and waiver of the right of homestead.

Given under my hand and notarial seal this 17 day of November A.D. 2011.

(seal)

ALMA P GARCIA
Notary Public
State of Texas
Comm. Expires 03/30/2015

Notary Public

Please mail future tax bills to Sunrise Coal, LLC, 1183 East Canvasback Drive, Terre Haute, Indiana 47802.

Please return recorded instrument to Ms. Jamalyn N. Sarver, Property Manager, Sunrise Coal, LLC 1183 East Canvasback Drive, Terre Haute, Indiana 47802.

This Warranty Deed was prepared on behalf of the Grantee by John Rowe of The Rowe Law Firm, LLC, 1418 N 1000 W, Linton, Indiana 47441.

Chicago Title Insurance Company

POLICY NO.: IL2169-46-186396¹..50-2011.72306-84977906

OWNER'S POLICY OF TITLE INSURANCE

Issued by

Chicago Title Insurance Company

Any notice of claim and any other notice or statement in writing required to be given the Company under this Policy must be given to the Company at the address shown in Section 18 of the Conditions.

COVERED RISKS

SUBJECT TO THE EXCLUSIONS FROM COVERAGE, THE EXCEPTIONS FROM COVERAGE CONTAINED IN SCHEDULE B, AND THE CONDITIONS, CHICAGO TITLE INSURANCE COMPANY, a Nebraska corporation (the "Company") insures, as of Date of Policy and, to the extent stated in Covered Risks 9 and 10, after Date of Policy, against loss or damage, not exceeding the Amount of Insurance, sustained or incurred by the Insured by reason of:

1. *Title being vested other than as stated in Schedule A.*
2. *Any defect in or lien or encumbrance on the Title. This Covered Risk includes but is not limited to insurance against loss from*
   (a) *A defect in the Title caused by*
      (i) *forgery, fraud, undue influence, duress, incompetency, incapacity, or impersonation;*
      (ii) *failure of any person or Entity to have authorized a transfer or conveyance;*
      (iii) *a document affecting Title not properly created, executed, witnessed, sealed, acknowledged, notarized, or delivered;*
      (iv) *failure to perform those acts necessary to create a document by electronic means authorized by law;*
      (v) *a document executed under a falsified, expired, or otherwise invalid power of attorney;*
      (vi) *a document not properly filed, recorded, or indexed in the Public Records including failure to perform those acts by electronic means authorized by law; or*
      (vii) *a defective judicial or administrative proceeding.*
   (b) *The lien of real estate taxes or assessments imposed on the Title by a governmental authority due or payable, but unpaid.*
   (c) *Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land. The term "encroachment" includes encroachments of existing improvements located on the Land onto adjoining land, and encroachments onto the Land of existing improvements located on adjoining land.*
3. *Unmarketable Title.*
4. *No right of access to and from the Land.*
5. *The violation or enforcement of any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to*
   (a) *the occupancy, use, or enjoyment of the Land;*
   (b) *the character, dimensions, or location of any improvement erected on the Land;*
   (c) *the subdivision of land; or*
   (d) *environmental protection*

   if a notice, describing any part of the Land, is recorded in the Public Records setting forth the violation or intention to enforce, but only to the extent of the violation or enforcement referred to in that notice.
6. *An enforcement action based on the exercise of a governmental police power not covered by Covered Risk 5 if a notice of the enforcement action, describing any part of the Land, is recorded in the Public Records, but only to the extent of the enforcement referred to in that notice.*
7. *The exercise of the rights of eminent domain if a notice of the exercise, describing any part of the Land, is recorded in the Public Records.*
8. *Any taking by a governmental body that has occurred and is binding on the rights of a purchaser for value without Knowledge.*
9. *Title being vested other than as stated Schedule A or being defective*
   (a) *as a result of the avoidance in whole or in part, or from a court order providing an alternative remedy, of a transfer of all or any part of the title to or any interest in the Land occurring prior to the transaction vesting Title as shown in Schedule A because that prior transfer constituted a fraudulent or preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws; or*
   (b) *because the instrument of transfer vesting Title as shown in Schedule A constitutes a preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws by reason of the failure of its recording in the Public Records*
      (i) *to be timely, or*
      (ii) *to impart notice of its existence to a purchaser for value or to a judgment or lien creditor.*

10. Any defect in or lien or encumbrance on the Title or other matter included in Covered Risks 1 through 9 that has been created or attached or has been filed or recorded in the Public Records subsequent to Date of Policy and prior to the recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

The Company will also pay the costs, attorneys' fees, and expenses incurred in defense of any matter insured against by this Policy, but only to the extent provided in the Conditions.

IN WITNESS WHEREOF, CHICAGO TITLE INSURANCE COMPANY has caused this policy to be signed and sealed by its duly authorized officers.

CHICAGO TITLE INSURANCE COMPANY

SEAL

Countersigned: ______________
Authorized Signatory

IL2169 186396*..50
Vermilion County Title, Inc.
112 North Vermilion Street
Danville, IL 61832
Tel: (217) 442-0510
Fax: (217) 431-8225

OFFICE FILE NUMBER
186396

ALTA OWNERS POLICY-2006
CHICAGO TITLE INSURANCE COMPANY
SCHEDULE A

POLICY NUMBER	DATE OF POLICY	AMOUNT OF INSURANCE
72306 - 84977906	12/15/11 11:38 a.m.	$3,873,600.00

1. Name of Insured:
   Sunrise Coal, LLC

2. The estate or interest in the Land which is covered by this policy is a Fee Simple.

3. Title to the estate or interest in the Land is vested in the Insured.

4. The Land herein described is encumbered by the following Mortgage or trust deed, and assignments:
   None

and the Mortgages or trust deeds, if any, shown in Schedule B hereof.

5. The Land referred to in this policy is described as follows:
   The Southeast Quarter of the Southeast Quarter of Section 26, Township 18 North Range 14 West of the 2nd P.M., situated in Vermilion County, Illinois.

   ALSO

   See Continuation Sheet

VERMILION COUNTY TITLE, INC.
NAME OF AGENT

(217) 442-0510
PHONE NUMBER

MAILING ADDRESS	CITY	STATE	ZIP
112 NORTH VERMILION ST.	DANVILLE	IL	61832

SCHEDULE A
ALTA Loan/Owners

This Policy valid only if Schedule B is attached.

(07/07 DisplaySoft 25-WIN-1-IL-OwnAWithNoLoanInfo_2006)

ADDED PAGE
CHICAGO TITLE INSURANCE COMPANY
(Schedule A-5 Continued)

File Number 186396

Policy Number 72306 -- 84977906

The Northeast Quarter of Section 35, Township 18 North Range 14 West of the 2nd P.M., EXCEPT the North 701.0 feet of even width of the East 381.9 feet of even width of said Northeast Quarter, ALSO EXCEPTING the South 20 feet of the North 721.0 feet of even width of the East 381.9 feet of even width of said Northeast Quarter, situated in Vermilion County, Illinois.

VERMILION COUNTY
TITLE, INC.
NAME OF AGENT

(217) 442-0510
PHONE NUMBER

112 NORTH VERMILION ST.	DANVILLE	IL	61832
MAILING ADDRESS	CITY	STATE	ZIP

ALTA OWNERS POLICY-2006
CHICAGO TITLE INSURANCE COMPANY
SCHEDULE B

File Number 186396
Policy Number: 72306 - 84977906
Owners

EXCEPTIONS FROM COVERAGE

This policy does not insure against loss or damage, and the Company will not pay costs, attorneys' fees or expenses, which arise by reason of:

General Exceptions:

(1) Rights or claims of parties in possession not shown by the public records.

(2) Any encroachment, encumbrance, violation, variation or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land.

(3) Easements, or claims of easements, not shown by the public records.

(4) Any lien, or right to a lien, for services, labor, or material heretofore or hereafter furnished, imposed by law and not shown by the public records.

(5) Taxes or special assessments which are not shown as existing liens by the public records.

Special Exceptions: The Mortgage, if any, referred to in Item 4 of Schedule A.

1. General Real Estate Taxes for the year 2011 are not yet due and payable.
P.I.N. No.: 25-35-200-005-0021 - SDLL 0362A
P.I.N. No.: 25-26-400-003-0021 - SDLL 0345
P.I.N. No.: 25-35-700-001-7100 - SDLL 038052F (MINERALS ONLY) (Affects property in question located in Section 35 and other property)
P.I.N. No.: 25-26-701-003-7100 - SDLL 038052C (MINERALS ONLY) (Affects SE1/4 SE1/4 26-18-14)

2. Memorandum of Agreement concerning the lease of coal in and under the property in question by and between Nancy A. Ready (Lessor) and Sunrise Coal LLC (Lessee), recorded December 10, 2009 as Document No. 09-11197.

3. Mortgage, Leasehold Mortgage, Security Agreement, Assignment of Rents and Leases, Assignment of Production, Financing Statement, Fixture Filing and As-Extracted Collateral Filing (Illinois) dated April 12, 2011 and recorded April 21, 2011, as Document No. 11-03149,

See Continuation Sheet

VERMILION COUNTY TITLE, INC.
NAME OF AGENT

(217) 442-0510
PHONE NUMBER

112 NORTH VERMILION ST.	DANVILLE	IL	61832
MAILING ADDRESS	CITY	STATE	ZIP

SCHEDULE B
Owner's Form

Schedule B of this Policy consists of pages.

ADDED PAGE
CHICAGO TITLE INSURANCE COMPANY
(Schedule B Continued)

File Number 186396
Policy Number 72306 -- 84977906

and as UCC No. 11-U00011 made by Sunrise Coal, LLC, an Indiana limited liability company to PNC Bank, National Association, to secure an indebtedness in the maximum principal amount of $70,000,000.00.

4. Rights of the public, the State of Illinois, the county, the township and the municipality in and to that part of the premises in question taken, used, or dedicated for roads or highways.

5. Rights of way for drainage ditches, drain tiles, feeders, laterals, and underground pipes, if any.

END SCHEDULE B

VERMILION COUNTY TITLE, INC.
NAME OF AGENT

(217) 442-0510
PHONE NUMBER

112 NORTH VERMILION ST.	DANVILLE	IL	61832
MAILING ADDRESS	CITY	STATE	ZIP

(07/07 DisplaySoft 25-WIN-1-IL-OwnBCont_2006)

A D D E D   P A G E
CHICAGO TITLE INSURANCE COMPANY
(Schedule B Signature Page)

File Number 186396
Policy Number 72306 - 84977906

Countersigned

Authorized Signatory

VERMILION COUNTY
TITLE, INC.
NAME OF AGENT

(217) 442-0510
PHONE NUMBER

112 NORTH VERMILION ST.
MAILING ADDRESS

DANVILLE
CITY

IL
STATE

61832
ZIP

(03/08 DisplaySoft 25-WIN-IL-OWNSCONTSIGN_2006)

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy, and the Company will not pay loss or damage, costs, attorneys' fees, or expenses that arise by reason of:

1. (a) Any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
   (i) the occupancy, use, or enjoyment of the Land;
   (ii) the character, dimensions or location of any improvement erected on the Land;
   (iii) the subdivision of land; or
   (iv) environmental protection;

   or the effect of any violation of these laws, ordinances, or governmental regulations. This Exclusion 1(a) does not modify or limit the coverage provided under Covered Risk 5.

   (b) Any governmental police power. This Exclusion 1(b) does not modify or limit the coverage provided under Covered Risk 6.
2. Rights of eminent domain. This Exclusion does not modify or limit the coverage provided under Covered Risk 7 or 8.
3. Defects, liens, encumbrances, adverse claims, or other matters:
   (a) created, suffered, assumed, or agreed to by the Insured Claimant;
   (b) not Known to the Company, not recorded in the Public Records at Date of Policy, but Known to the Insured Claimant and not disclosed in writing to the Company by the Insured Claimant prior to the date the Insured Claimant became an Insured under this policy;
   (c) resulting in no loss or damage to the Insured Claimant;
   (d) attaching or created subsequent to Date of Policy (however, this does not modify or limit the coverage provided under Covered Risk 9 and 10); or
   (e) resulting in loss or damage that would not have been sustained if the Insured Claimant had paid value for the Title.
4. Any claim, by reason of the operation of federal bankruptcy, state insolvency, or similar creditors' rights laws, that the transaction vesting the Title as shown in Schedule A, is
   (a) a fraudulent conveyance or fraudulent transfer; or
   (b) a preferential transfer for any reason not stated in Covered Risk 9 of this policy.
5. Any lien on the Title for real estate taxes or assessments imposed by governmental authority and created or attaching between Date of Policy and the date of recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

CONDITIONS

1. DEFINITION OF TERMS

The following terms when used in this policy mean:

(a) "Amount of Insurance": The amount stated in Schedule A, as may be increased or decreased by endorsement to this policy, increased by Section 8(b), or decreased by Sections 10 and 11 of these Conditions.

(b) "Date of Policy": The date designated as "Date of Policy" in Schedule A.

(c) "Entity": A corporation, partnership, trust, limited liability company, or other similar legal entity.

(d) "Insured": The Insured named in Schedule A.

(i) The term "Insured" also includes

(A) successors to the Title of the Insured by operation of law as distinguished from purchase, including heirs, devisees, survivors, personal representatives, or next of kin;

(B) successors to an Insured by dissolution, merger, consolidation, distribution, or reorganization;

(C) successors to an Insured by its conversion to another kind of Entity;

(D) a grantee of an Insured under a deed delivered without payment of actual valuable consideration conveying the Title

(1) if the stock, shares, memberships, or other equity interests of the grantee are wholly-owned by the named Insured,

(2) if the grantee wholly owns the named Insured,

(3) if the grantee is wholly-owned by an affiliated Entity of the named Insured, provided the affiliated Entity and the named Insured are both wholly-owned by the same person or Entity, or

(4) if the grantee is a trustee or beneficiary of a trust created by a written instrument established by the Insured named in Schedule A for estate planning purposes.

(ii) With regard to (A), (B), (C), and (D) reserving, however, all rights and defenses as to any successor that the Company would have had against any predecessor Insured.

(e) "Insured Claimant": An Insured claiming loss or damage.

(f) "Knowledge" or "Known": Actual knowledge, not constructive knowledge or notice that may be imputed to an Insured by reason of the Public Records or any other records that impart constructive notice of matters affecting the Title.

(g) "Land": The land described in Schedule A, and affixed improvements that by law constitute real property. The term "Land" does not include any property beyond the lines of the area described in Schedule A, nor any right, title, interest, estate, or easement in abutting streets, roads, avenues, alleys, lanes, ways, or waterways, but this does not modify or limit the extent that a right of access to and from the Land is insured by this policy.

(h) "Mortgage": Mortgage, deed of trust, trust deed, or other security instrument, including one evidenced by electronic means authorized by law.

(i) "Public Records": Records established under state statutes at Date of Policy for the purpose of imparting constructive notice of matters relating to real property to purchasers for value and without Knowledge. With respect to Covered Risk 5(d), "Public Records" shall also include environmental protection liens filed in the records of the clerk of the United States District Court for the district where the Land is located.

(j) "Title": The estate or interest described in Schedule A.

(k) "Unmarketable Title": Title affected by an alleged or apparent matter that would permit a prospective purchaser or lessee of the Title or lender on the Title to be released from the obligation to purchase, lease, or lend if there is a contractual condition requiring the delivery of marketable title.

2. CONTINUATION OF INSURANCE

The coverage of this policy shall continue in force as of Date of Policy in favor of an Insured, but only so long as the Insured retains an estate or interest in the Land, or holds an obligation secured by a purchase money Mortgage given by a purchaser from the Insured, or only so long as the Insured shall have liability by reason of warranties in any transfer or conveyance of the Title. This policy shall not continue in force in favor of any purchaser from the Insured of either (i) an estate or interest in the Land, or (ii) an obligation secured by a purchase money Mortgage given to the Insured.

3. NOTICE OF CLAIM TO BE GIVEN BY INSURED CLAIMANT

The Insured shall notify the Company promptly in writing (i) in case of any litigation as set forth in Section 5(a) of these Conditions, (ii) in case Knowledge shall come to an Insured hereunder of any claim of title or interest that is adverse to the Title, as insured, and that might cause loss or damage for which the Company may be liable by virtue of this policy, or (iii) if the Title, as insured, is rejected as Unmarketable Title. If the Company is prejudiced by the failure of the Insured Claimant to provide prompt notice, the Company's liability to the Insured Claimant under the policy shall be reduced to the extent of the prejudice.

4. PROOF OF LOSS

In the event the Company is unable to determine the amount of loss or damage, the Company may, at its option, require as a condition of payment that the Insured Claimant furnish a signed proof of loss. The proof of loss must describe the defect, lien, encumbrance, or other matter insured against by this policy that constitutes the basis of loss or damage and shall state, to the extent possible, the basis of calculating the amount of the loss or damage.

5. DEFENSE AND PROSECUTION OF ACTIONS

(a) Upon written request by the Insured, and subject to the options contained in Section 7 of these Conditions, the Company, at its own cost and without unreasonable delay, shall provide for the defense of an Insured in litigation in which any third party asserts a claim covered by this policy adverse to the Insured. This obligation is limited to only those stated causes of action alleging matters insured against by this policy. The Company shall have the right to select counsel of its choice (subject to the right of the Insured to object for reasonable cause) to represent the Insured as to those stated causes of action. It shall not be liable for and will not pay the fees of any other counsel. The Company will not pay any fees, costs, or expenses incurred by the Insured in the defense of those causes of action that allege matters not insured against by this policy.

(b) The Company shall have the right, in addition to the options contained in Section 7 of these Conditions, at its own cost, to institute and prosecute any action or proceeding or to do any other act that in its opinion may be necessary or desirable to establish the Title, as insured, or to prevent or reduce loss or damage to the Insured. The Company may take any appropriate action under the terms of this policy, whether or not it shall be liable to the Insured. The exercise of these rights shall not be an admission of liability or waiver of any provision of this policy. If the Company exercises its rights under this subsection, it must do so diligently.

(c) Whenever the Company brings an action or asserts a defense as required or permitted by this policy, the Company may pursue the litigation to a final determination by a court of competent jurisdiction, and it expressly reserves the right, in its sole discretion, to appeal from any adverse judgment or order.

6. DUTY OF INSURED CLAIMANT TO COOPERATE

(a) In all cases where this policy permits or requires the Company to prosecute or provide for the defense of any action or proceeding and any appeals, the Insured shall secure to the Company the right to so prosecute or provide defense in the action or proceeding, including the right to use, at its option, the name of the Insured for this purpose. Whenever requested by the Company, the Insured, at the Company's expense, shall give the Company all reasonable aid (i) in securing evidence, obtaining witnesses, prosecuting or defending the action or proceeding, or effecting settlement, and (ii) in any other lawful act that in the opinion of the Company may be necessary or desirable to establish the Title or any other matter as insured. If the Company is prejudiced by the failure of the Insured to furnish the required cooperation, the Company's obligations to the Insured under the policy shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation, with regard to the matter or matters requiring such cooperation.

(b) The Company may reasonably require the Insured Claimant to submit to examination under oath by any authorized representative of the Company and to produce for examination, inspection, and copying, at such reasonable times and places as may be designated by the authorized representative of the Company, all records, in whatever medium maintained, including books, ledgers, checks, memoranda, correspondence, reports, e-mails, disks, tapes, and videos whether bearing a date before or after Date of Policy, that reasonably pertain to the loss or damage. Further, if requested by any authorized representative of the Company, the Insured Claimant shall grant its permission, in writing, for any authorized representative of the Company to examine, inspect, and copy all of these records in the custody or control of a third party that reasonably pertain to the loss or damage. All information designated as confidential by the Insured Claimant provided to the Company pursuant to this Section shall not be disclosed to others unless, in the reasonable judgment of the Company, it is necessary in the administration of the claim. Failure of the Insured Claimant to submit for examination under oath, produce any reasonably requested information, or grant permission to secure reasonably necessary information from third parties as required in this subsection, unless prohibited by law or governmental regulation, shall terminate any liability of the Company under this policy as to that claim.

7. OPTIONS TO PAY OR OTHERWISE SETTLE CLAIMS; TERMINATION OF LIABILITY

In case of a claim under this policy, the Company shall have the following additional options:

(a) To Pay or Tender Payment of the Amount of Insurance.

To pay or tender payment of the Amount of Insurance under this policy together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment or tender of payment and that the Company is obligated to pay.

Upon the exercise by the Company of this option, all liability and obligations of the Company to the Insured under this policy, other than to make the payment required in this subsection, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

(b) To Pay or Otherwise Settle With Parties Other Than the Insured or With the Insured Claimant.

(i) To pay or otherwise settle with other parties for or in the name of an Insured Claimant any claim insured against under this policy. In addition, the Company will pay any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay; or

(ii) To pay or otherwise settle with the Insured Claimant the loss or damage provided for under this policy, together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay.

Upon the exercise by the Company of either of the options provided for in subsections (b)(i) or (ii), the Company's obligations to the Insured under this policy for the claimed loss or damage, other than the payments required to be made, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

8. DETERMINATION AND EXTENT OF LIABILITY

This policy is a contract of indemnity against actual monetary loss or damage sustained or incurred by the Insured Claimant who has suffered loss or damage by reason of matters insured against by this policy.

(a) The extent of liability of the Company for loss or damage under this policy shall not exceed the lesser of

(i) the Amount of Insurance; or

(ii) the difference between the value of the Title as insured and the value of the Title subject to the risk insured against by this policy.

(b) If the Company pursues its rights under Section 5 of these Conditions and is unsuccessful in establishing the Title, as insured,

(i) the Amount of Insurance shall be increased by 10%, and

(ii) the Insured Claimant shall have the right to have the loss or damage determined either as of the date the claim was made by the Insured Claimant or as of the date it is settled and paid.

(c) In addition to the extent of liability under (a) and (b), the Company will also pay those costs, attorneys' fees, and expenses incurred in accordance with Sections 5 and 7 of these Conditions.

9. LIMITATION OF LIABILITY

(a) If the Company establishes the Title, or removes the alleged defect, lien or encumbrance, or cures the lack of a right of access to or from the Land, or cures the claim of Unmarketable Title, all as insured, in a reasonably diligent manner by any method, including litigation and the completion of any appeals, it shall have fully performed its obligations with respect to that matter and shall not be liable for any loss or damage caused to the Insured.

(b) In the event of any litigation, including litigation by the Company or with the Company's consent, the Company shall have no liability for loss or damage until there has been a final determination by a court of competent jurisdiction, and disposition of all appeals, adverse to the Title, as insured.

(c) The Company shall not be liable for loss or damage to the Insured for liability voluntarily assumed by the Insured in settling any claim or suit without the prior written consent of the Company.

10. REDUCTION OF INSURANCE; REDUCTION OR TERMINATION OF LIABILITY

All payments under this policy, except payments made for costs, attorneys' fees, and expenses, shall reduce the Amount of Insurance by the amount of the payment.

11. LIABILITY NONCUMULATIVE

The Amount of Insurance shall be reduced by any amount the Company pays under any policy insuring a Mortgage to which exception is taken in Schedule B or to which the Insured has agreed, assumed, or taken subject, or which is executed by an Insured after Date of Policy and which is a charge or lien on the Title, and the amount so paid shall be deemed a payment to the Insured under this policy.

12. PAYMENT OF LOSS

When liability and the extent of loss or damage have been definitely fixed in accordance with these Conditions, the payment shall be made within 30 days.

13. RIGHTS OF RECOVERY UPON PAYMENT OR SETTLEMENT

(a) Whenever the Company shall have settled and paid a claim under this policy, it shall be subrogated and entitled to the rights of the Insured Claimant in the Title and all other rights and remedies in respect to the claim that the Insured Claimant has against any person or property, to the extent of the amount of any loss, costs, attorneys' fees, and expenses paid by the Company. If requested by the Company, the Insured Claimant shall execute documents to evidence the transfer to the Company of these rights and remedies. The Insured Claimant shall permit the Company to sue, compromise, or settle in the name of the Insured Claimant and to use the name of the Insured Claimant in any transaction or litigation involving these rights and remedies.

If a payment on account of a claim does not fully cover the loss of the Insured Claimant, the Company shall defer the exercise of its right to recover until after the Insured Claimant shall have recovered its loss.

(b) The Company's right of subrogation includes the rights of the Insured to indemnities, guaranties, other policies of insurance, or bonds, notwithstanding any terms or conditions contained in those instruments that address subrogation rights.

14. ARBITRATION

Either the Company or the Insured may demand that the claim or controversy shall be submitted to arbitration pursuant to the Title Insurance Arbitration Rules of the American Land Title Association ("Rules"). Except as provided in the Rules, there shall be no joinder or consolidation with claims or controversies of other persons. Arbitrable matters may include, but are not limited to, any controversy or claim between the Company and the Insured arising out of or relating to this policy, any service in connection with its issuance or the breach of a policy provision, or to any other controversy or claim arising out of the transaction giving rise to this policy. All arbitrable matters when the Amount of Insurance is $2,000,000 or less shall be arbitrated at the option of either the Company or the Insured. All arbitrable matters when the Amount of Insurance is in excess of $2,000,000 shall be arbitrated only when agreed to by both the Company and the Insured. Arbitration pursuant to this policy and under the Rules shall be binding upon the parties. Judgment upon the award rendered by the Arbitrator(s) may be entered in any court of competent jurisdiction.

15. LIABILITY LIMITED TO THIS POLICY; POLICY ENTIRE CONTRACT

(a) This policy together with all endorsements, if any, attached to it by the Company is the entire policy and contract between the Insured and the Company. In interpreting any provision of this policy, this policy shall be construed as a whole.

(b) Any claim of loss or damage that arises out of the status of the Title or by any action asserting such claim shall be restricted to this policy.

(c) Any amendment of or endorsement to this policy must be in writing and authenticated by an authorized person, or expressly incorporated by Schedule A of this policy.

(d) Each endorsement to this policy issued at any time is made a part of this policy and is subject to all of its terms and provisions. Except as the endorsement expressly states, it does not (i) modify any of the terms and provisions of the policy, (ii) modify any prior endorsement, (iii) extend the Date of Policy, or (iv) increase the Amount of Insurance.

16. SEVERABILITY

In the event any provision of this policy, in whole or in part, is held invalid or unenforceable under applicable law, the policy shall be deemed not to include that provision or such part held to be invalid, but all other provisions shall remain in full force and effect.

17. CHOICE OF LAW; FORUM

(a) Choice of Law: The Insured acknowledges the Company has underwritten the risks covered by this policy and determined the premium charged therefore in reliance upon the law affecting interests in real property and applicable to the interpretation, rights, remedies, or enforcement of policies of title insurance of the jurisdiction where the Land is located.

Therefore, the court or an arbitrator shall apply the law of the jurisdiction where the Land is located to determine the validity of claims against the Title that are adverse to the Insured and to interpret and enforce the terms of this policy. In neither case shall the court or arbitrator apply its conflicts of law principles to determine the applicable law.

(b) Choice of Forum: Any litigation or other proceeding brought by the Insured against the Company must be filed only in a state or federal court within the United States of America or its territories having appropriate jurisdiction.

18. NOTICES, WHERE SENT

Any notice of claim and any other notice or statement in writing required to be given to the Company under this policy must be given to the Company at Chicago Title Insurance Company, Attn: Claims Department, P. O. Box 45023, Jacksonville, Florida 32232-5023.

MUTUAL DRAINAGE AGREEMENT

THIS AGREEMENT Made and entered into as of this 2 day of August 1982, by and between the undersigned Parties,

WITNESSETH:

WHEREAS, each of the undersigned owners represent to be the owner or owners of the real estate described above their respective signatures with authority to convey the easements and impose the restrictive covenants on the use of said real estate as set forth in this Agreement;

WHEREAS, Williams Drainage Company has contracted to construct an eighteen-inch tile drain to provide a drainage outlet for the lands of the undersigned owners, and the undersigned owners agree that said tile drain shall be for the mutual and exclusive benefit of the lands hereinafter described;

NOW THEREFORE, the Parties jointly and mutually agre as follows:

1. Williams Drainage Company has been employed by the Parties to this Agreement to construct an eighteen-inch covered tile drain suitable for farm drainage of the lands hereinafter described from a point near the Southeast corner of Section 35, Township 18 North, Range 14 West of the Second P. M. in Vermilion County, Illinois, and thence North along a line near the East line of Sections 35 and 26 of said Township and Range, and thence across Section 23 of said Township and Range to an outlet into the open ditch in said Section 23, and the undersigned owners agree that said tile drain shall be for the mutual and exclusive benefit of the lands hereinafter described.

EXHIBIT

B

NOW THEREFORE, the Parties hereto jointly and mutually agree as follows:

1. Williams Drainage Company has been employed to construct said eighteen-inch covered drain tile across the lands of the Parties hereto in the manner hereinabove described. The drain shall be for the sole and exclusive benefit of the lands hereinafter described above the signatures of the owners who are Parties to this Agreement.

2. Without the written consent of the owners of all of the lands hereinafter described, no other lands except the lands hereinafter described shall be connected to said drainage tile either directly or indirectly by connection of existing tile drains or by construction of additional drain tile in the future.

3. Williams Drainage Company joins in this Agreement and agrees to construct said eighteen-inch tile drain for the total sum of Sixty-Three Thousand Seven Hundred Forty-Five Dollars ($63,745.00), and the undersigned owners agree that upon completion of said construction, they will pay to Williams Drainage Company that portion of said total cost that is set forth following the legal description of their land hereinafter described, and said payment shall be in full of said Parties' liability to the Williams Drainage Company for the construction of said drain.

4. The cost of any repairs required to said tile drain in the future shall be shared by the owners of the upper lands benefited by said repairs, and the cost of said repairs shall be a charge against said lands in proportion to the number of acres benefited.

5. Each tract of land hereinafter described shall have an easement appurtenant over all of the other lands hereinafter described to the extent reasonably necessary to

inspect said tile drain and to make any repairs required. Any damage to crops shall be a charge and apportioned against those upper lands benefited by any repairs.

6. As a covenant running with each tract of land hereinafter described, any owner of any of said lands that causes or permits the connection of any tile drain to said eighteen-inch tile drain including a connection within the area of any township road right-of-way which connection will permit the drainage of any lands other than those hereinafter described shall be liable for the cost of requiring the disconnection of said tile drains, including court costs and reasonable attorneys' fees.

IN WITNESS WHEREOF, the Parties have hereunto executed this Agreement as of the date and year first above written.

(All of the following described real estate is in Township 18 North, Range 14 West of the 2nd P. M., in Vermilion County, Illinois.)

Tract 1: Approximately 80 acres described as the East Half of the Northeast Quarter of Section 26.

Portion of cost for Tract 1: $ 9,272.00

Signature(s) of Owner(s) of Tract 1:

Robert Allen ______________________

______________________ ______________________

Tract 2: The East 60 acres of the North Half of the Northeast Quarter of Section 26.

Portion of cost for Tract 2: $ 6,954.00

Signature(s) of Owner(s) of Tract 2:

Virginia M. Davis ______________________

[illegible] ______________________

Tract 3: Approximately 40 acres described as the Southeast Quarter of the Southeast Quarter of Section 26.

Portion of cost for Tract 3: $ 4,636.00

Signature(s) of Owner(s) of Tract 3:

Nancy Ready
By Gordon Warters

Tract 4: Approximately 160 acres described as the Northeast Quarter of Section 35.

Portion of cost for Tract 4: $ 18,544.00

Signature(s) of Owner(s) of Tract 4:

Gordon T. Warters

Mayo Warters

Tract 5: Approximately 80 acres described as the North Half of the Southeast Quarter of Section 35.

Portion of cost for Tract 5: $ 9,272.00

Signature(s) of Owner(s) of Tract 5:

Joan F. Allen

Tract 6: The South 20 acres of the North Half of the North Half of the Southwest Quarter of Section 35.

Portion of cost for Tract 6: $ 2,318.00

Signature(s) of Owner(s) of Tract 6:

Vona Summers

Tract 7: The Northeast forty acres of the South 120 acres of the Southwest Quarter of Section 35.

Portion of cost for Tract 7: $ 4,636.00

Signature(s) of Owner(s) of Tract 7:

Blanche M. Summers by Joan G. Easton

by Craig S. Easton

Tract 8: The Northeast 10 acres in the Southeast Quarter of the Southeast Quarter of Section 35.

Portion of cost for Tract 8: $ 1,159.00

Signature(s) of Owner(s) of Tract 8:

Walter Freeman

Tract 9: Approximately 40 acres described as the Northwest Quarter of the Southwest Quarter of Section 36.

Portion of cost for Tract 9: $ 4,636.00

Signature(s) of Owner(s) of Tract 9:

Kathryn Dohme

Tract 10: Approximately 20 acres described as the South Half of the Southwest Quarter of the Northwest Quarter of Section 36.

Portion of cost for Tract 10: $ 2,318.00

Signature(s) of Owner(s) of Tract 10:

Gorgon Freeman
By Richard Freeman
Attorney in Fact

WILLIAMS DRAINAGE COMPANY

By David Dodd

11-10450

PREPARED BY:

R. Lee Allen
SORLING NORTHRUP
Attorneys
1 N. Old State Capitol Plaza
Suite 200
P.O. Box 5131
Springfield, IL 62705

VERMILION COUNTY TAX
2500.00

STATE OF ILLINOIS
STATE TAX
DEC.30.11
REAL ESTATE TRANSFER TAX
0000002718
REAL ESTATE TRANSFER TAX
0500000
FP351002

WARRANTY DEED

The Grantor, KIZER FAMILY FARMS, L.P., an Illinois Limited Partnership, by C. Scott Kizer, President of Kizer Management, Inc., its General Partner, for and in consideration of Two or More Dollars in hand paid, hereby CONVEYS and WARRANTS to Grantee, SUNRISE COAL, LLC, an Indiana Limited Liability Company, duly admitted to do business in the State of Indiana the real estate described on **Exhibit** A attached hereto, excepting and reserving unto the Grantor all of the rights, title, and interest in and to the coal and other minerals underlying said real estate.

This deed is subject to easements and restrictions of record, rights of the public in and to any portion of the premises within the boundaries of the public road, and rights of way for drainage ditches, drain tiles, feeders, laterals, and underground pipes, if any, to real estate taxes and special assessments for 2011 and subsequent years which Grantee assumes and agrees to pay and to the rights of the current farm tenant.

Situated in the County of Vermilion in the State of Illinois, hereby releasing and waiving all right under and by virtue of the Homestead Exemption Laws of this State.

Dated this 30th day of December, 2011.

KIZER FAMILY FARMS, L.P., an Illinois Limited Partnership

By: Kizer Management, Inc., Its General Partner

By: C. Scott Kizer
C. Scott Kizer, President

{S0802256.4 12/21/2011 EBC EBC}

EXHIBIT
C

STATE OF ______)
) SS.
COUNTY OF ______)

I, the undersigned, a Notary Public in and for said County and State aforesaid, DO HEREBY CERTIFY that C. SCOTT KIZER, President of Kizer Management, Inc., personally known to me to be the same person whose name is subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that he signed, sealed, and delivered the said instrument as his free and voluntary act, for the uses and purposes therein set forth.

Given under my hand and official seal, this ______ day of December, 2011.

OFFICIAL SEAL
R. LEE ALLEN
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 1-10-2015

____
Notary Public

GRANTEE:

Sunrise Coal, LLC
1183 E. Canvasback Drive
Terra Haute, IN 47802

RETURN DEED TO:

Sunrise Coal, LLC
1183 E. Canvasback Drive
Terra Haute, IN 47802

TAX BILL TO:

Sunrise Coal, LLC
1183 E. Canvasback Drive
Terra Haute, IN 47802

EXHIBIT A

The Southwest Quarter of Section Twenty-Six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermilion County, Illinois and the Southwest Quarter of the Southeast Quarter of Section Twenty-Six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermilion County, Illinois. Containing 200 acres, more or less.

Tax Identification Nos.: 25-26-300-001-0011 and 25-26-400-002-0021

First American Title

Owner's Policy of Title Insurance

ISSUED BY

First American Title Insurance Company

Owner's Policy

POLICY NUMBER

5011400- 208018

Any notice of claim and any other notice or statement in writing required to be given to the Company under this policy must be given to the Company at the address shown in Section 18 of the Conditions.

COVERED RISKS

SUBJECT TO THE EXCLUSIONS FROM COVERAGE, THE EXCEPTIONS FROM COVERAGE CONTAINED IN SCHEDULE B, AND THE CONDITIONS, **FIRST AMERICAN TITLE INSURANCE COMPANY**, a California corporation (the "Company") insures, as of Date of Policy and, to the extent stated in Covered Risks 9 and 10, after Date of Policy, against loss or damage, not exceeding the Amount of Insurance, sustained or incurred by the Insured by reason of:

1. Title being vested other than as stated in Schedule A.
2. Any defect in or lien or encumbrance on the Title. This Covered Risk includes but is not limited to insurance against loss from
   (a) A defect in the Title caused by
      (i) forgery, fraud, undue influence, duress, incompetency, incapacity, or impersonation;
      (ii) failure of any person or Entity to have authorized a transfer or conveyance;
      (iii) a document affecting Title not properly created, executed, witnessed, sealed, acknowledged, notarized, or delivered;
      (iv) failure to perform those acts necessary to create a document by electronic means authorized by law;
      (v) a document executed under a falsified, expired, or otherwise invalid power of attorney;
      (vi) a document not properly filed, recorded, or indexed in the Public Records including failure to perform those acts by electronic means authorized by law; or
      (vii) a defective judicial or administrative proceeding.
   (b) The lien of real estate taxes or assessments imposed on the Title by a governmental authority due or payable, but unpaid.
   (c) Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land. The term "encroachment" includes encroachments of existing improvements located on the Land onto adjoining land, and encroachments onto the Land of existing improvements located on adjoining land.
3. Unmarketable Title.
4. No right of access to and from the Land.

(Covered Risks Continued on Page 2)

In Witness Whereof, First American Title Insurance Company has caused its corporate name to be hereunto affixed by its authorized officers as of Date of Policy shown in Schedule A.

First American Title Insurance Company

FIRST AMERICAN TITLE INSURANCE COMPANY INCORPORATED SEPTEMBER 24, 1968 CALIFORNIA

Dennis J. Gilmore
President

Timothy Kemp
Secretary

HUFFMAN ABSTRACT & TITLE
48 N. VERMILION ST.
DANVILLE, IL 61832

(This Policy is valid only when Schedules A and B are attached)

COVERED RISKS (Continued)

5. The violation or enforcement of any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
   (a) the occupancy, use, or enjoyment of the Land;
   (b) the character, dimensions, or location of any improvement erected on the Land;
   (c) the subdivision of land; or
   (d) environmental protection

   if a notice, describing any part of the Land, is recorded in the Public Records setting forth the violation or intention to enforce, but only to the extent of the violation or enforcement referred to in that notice.
6. An enforcement action based on the exercise of a governmental police power not covered by Covered Risk 5 if a notice of the enforcement action, describing any part of the Land, is recorded in the Public Records, but only to the extent of the enforcement referred to in that notice.
7. The exercise of the rights of eminent domain if a notice of the exercise, describing any part of the Land, is recorded in the Public Records.
8. Any taking by a governmental body that has occurred and is binding on the rights of a purchaser for value without Knowledge.
9. Title being vested other than as stated in Schedule A or being defective

   (a) as a result of the avoidance in whole or in part, or from a court order providing an alternative remedy, of a transfer of all or any part of the title to or any interest in the Land occurring prior to the transaction vesting Title as shown in Schedule A because that prior transfer constituted a fraudulent or preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws; or

   (b) because the instrument of transfer vesting Title as shown in Schedule A constitutes a preferential transfer under federal bankruptcy, state insolvency, or similar creditors' rights laws by reason of the failure of its recording in the Public Records
      (i) to be timely, or
      (ii) to impart notice of its existence to a purchaser for value or to a judgment or lien creditor.
10. Any defect in or lien or encumbrance on the Title or other matter included in Covered Risks 1 through 9 that has been created or attached or has been filed or recorded in the Public Records subsequent to Date of Policy and prior to the recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

The Company will also pay the costs, attorneys' fees, and expenses incurred in defense of any matter insured against by this Policy, but only to the extent provided in the Conditions.

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy, and the Company will not pay loss or damage, costs, attorneys' fees, or expenses that arise by reason of:

1. (a) Any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting,regulating, prohibiting, or relating to
      (i) the occupancy, use, or enjoyment of the Land;
      (ii) the character, dimensions, or location of any improvement erected on the Land;
      (iii) the subdivision of land; or
      (iv) environmental protection;

      or the effect of any violation of these laws, ordinances, or governmental regulations. This Exclusion 1(a) does not modify or limit the coverage provided under Covered Risk 5.
   (b) Any governmental police power. This Exclusion 1(b) does not modify or limit the coverage provided under Covered Risk 6.
2. Rights of eminent domain. This Exclusion does not modify or limit the coverage provided under Covered Risk 7 or 8.
3. Defects, liens, encumbrances, adverse claims, or other matters
   (a) created, suffered, assumed, or agreed to by the Insured Claimant;
   (b) not Known to the Company, not recorded in the Public Records at Date of Policy, but Known to the Insured Claimant and not disclosed in writing to the Company by the Insured Claimant prior to the date the Insured Claimant became an Insured under this policy.
   (c) resulting in no loss or damage to the Insured Claimant;
   (d) attaching or created subsequent to Date of Policy (however, this does not modify or limit the coverage provided under Covered Risk 9 and 10); or
   (e) resulting in loss or damage that would not have been sustained if the Insured Claimant had paid value for the Title.
4. Any claim, by reason of the operation of federal bankruptcy, state insolvency, or similar creditors' rights laws, that the transaction vesting the Title as shown in Schedule A, is
   (a) a fraudulent conveyance or fraudulent transfer; or
   (b) a preferential transfer for any reason not stated in Covered Risk 9 of this policy.
5. Any lien on the Title for real estate taxes or assessments imposed by governmental authority and created or attaching between Date of Policy and the date of recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

CONDITIONS

1. **DEFINITION OF TERMS**

The following terms when used in this policy mean:

(a) "Amount of Insurance": The amount stated in Schedule A, as may be increased or decreased by endorsement to this policy, increased by Section 8(b), or decreased by Sections 10 and 11 of these Conditions.

(b) "Date of Policy": The date designated as "Date of Policy" in Schedule A.

(c) "Entity": A corporation, partnership, trust, limited liability company, or other similar legal entity.

(d) "Insured": The Insured named in Schedule A.

(i) The term "Insured" also includes

(A) successors to the Title of the Insured by operation of law as distinguished from purchase, including heirs, devisees, survivors, personal representatives, or next of kin;

(B) successors to an Insured by dissolution, merger, consolidation, distribution, or reorganization;

(C) successors to an Insured by its conversion to another kind of Entity;

(D) a grantee of an Insured under a deed delivered without payment of actual valuable consideration conveying the Title

(1) if the stock, shares, memberships, or other equity interests of the grantee are wholly-owned by the named Insured,

(2) if the grantee wholly owns the named Insured,

(3) if the grantee is wholly-owned by an affiliated Entity of the named Insured, provided the affiliated Entity and the named Insured are both wholly-owned by the same person or Entity, or

(4) if the grantee is a trustee or beneficiary of a trust created by a written instrument established by the Insured named in Schedule A for estate planning purposes.

(ii) With regard to (A), (B), (C), and (D) reserving, however, all rights and defenses as to any successor that the Company would have had against any predecessor Insured.

(e) "Insured Claimant": An Insured claiming loss or damage.

(f) "Knowledge" or "Known": Actual knowledge, not constructive knowledge or notice that may be imputed to an Insured by reason of the Public Records or any other records that impart constructive notice of matters affecting the Title.

(g) Land": The land described in Schedule A, and affixed improvements that by law constitute real property. The term "Land" does not include any property beyond the lines of the area described in Schedule A, nor any right, title, interest, estate, or easement in abutting streets, roads, avenues, alleys, lanes, ways, or waterways, but this does not modify or limit the extent that a right of access to and from the Land is insured by this policy.

(h) "Mortgage": Mortgage, deed of trust, trust deed, or other security instrument, including one evidenced by electronic means authorized by law.

(i) "Public Records": Records established under state statutes at Date of Policy for the purpose of imparting constructive notice of matters relating to real property to purchasers for value and without Knowledge. With respect to Covered Risk 5(d), "Public Records" shall also include environmental protection liens filed in the records of the clerk of the United States District Court for the district where the Land is located.

(j) "Title": The estate or interest described in Schedule A.

(k) "Unmarketable Title": Title affected by an alleged or apparent matter that would permit a prospective purchaser or lessee of the Title or lender on the Title to be released from the obligation to purchase, lease, or lend if there is a contractual condition requiring the delivery of marketable title.

2. **CONTINUATION OF INSURANCE**

The coverage of this policy shall continue in force as of Date of Policy in favor of an Insured, but only so long as the Insured retains an estate or interest in the Land, or holds an obligation secured by a purchase money Mortgage given by a purchaser from the Insured, or only so long as the Insured shall have liability by reason of warranties in any transfer or conveyance of the Title. This policy shall not continue in force in favor of any purchaser from the Insured of either (i) an estate or interest in the Land, or (ii) an obligation secured by a purchase money Mortgage given to the Insured.

3. **NOTICE OF CLAIM TO BE GIVEN BY INSURED CLAIMANT**

The Insured shall notify the Company promptly in writing (i) in case of any litigation as set forth in Section 5(a) of these Conditions, (ii) in case Knowledge shall come to an Insured hereunder of any claim of title or interest that is adverse to the Title, as insured, and that might cause loss or damage for which the Company may be liable by virtue of this policy, or (iii) if the Title, as insured, is rejected as Unmarketable Title. If the Company is prejudiced by the failure of the Insured Claimant to provide prompt notice, the Company's liability to the Insured Claimant under the policy shall be reduced to the extent of the prejudice.

4. **PROOF OF LOSS**

In the event the Company is unable to determine the amount of loss or damage, the Company may, at its option, require as a condition of payment that the Insured Claimant furnish a signed proof of loss. The proof of loss must describe the defect, lien, encumbrance, or other matter insured against by this policy that constitutes the basis of loss or damage and shall state, to the extent possible, the basis of calculating the amount of the loss or damage.

5. **DEFENSE AND PROSECUTION OF ACTIONS**

(a) Upon written request by the Insured, and subject to the options contained in Section 7 of these Conditions, the Company, at its own cost and without unreasonable delay, shall provide for the defense of an Insured in litigation in which any third party asserts a claim covered by this policy adverse to the Insured. This obligation is limited to only those stated causes of action alleging matters insured against by this policy. The Company shall have the right to select counsel of its choice (subject to the right of the Insured to object for reasonable cause) to represent the Insured as to those stated causes of action. It shall not be liable for and will not pay the fees of any other counsel. The Company will not pay any fees, costs, or expenses incurred by the Insured in the defense of those causes of action that allege matters not insured against by this policy.

(b) The Company shall have the right, in addition to the options contained in Section 7 of these Conditions, at its own cost, to institute and prosecute any action or proceeding or to do any other act that in its opinion may be necessary or desirable to establish the Title, as insured, or to prevent or reduce loss or damage to the Insured. The Company may take any appropriate action under the terms of this policy, whether or not it shall be liable to the Insured. The exercise of these rights shall not be an admission of liability or waiver of any provision of this policy. If the Company exercises its rights under this subsection, it must do so diligently.

(c) Whenever the Company brings an action or asserts a defense as required or permitted by this policy, the Company may pursue the litigation to a final determination by a court of competent jurisdiction, and it expressly reserves the right, in its sole discretion, to appeal any adverse judgment or order.

6. DUTY OF INSURED CLAIMANT TO COOPERATE

(a) In all cases where this policy permits or requires the Company to prosecute or provide for the defense of any action or proceeding and any appeals, the Insured shall secure to the Company the right to so prosecute or provide defense in the action or proceeding, including the right to use, at its option, the name of the Insured for this purpose. Whenever requested by the Company, the Insured, at the Company's expense, shall give the Company all reasonable aid (i) in securing evidence, obtaining witnesses, prosecuting or defending the action or proceeding, or effecting settlement, and (ii) in any other lawful act that in the opinion of the Company may be necessary or desirable to establish the Title or any other matter as insured. If the Company is prejudiced by the failure of the Insured to furnish the required cooperation, the Company's obligations to the Insured under the policy shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation, with regard to the matter or matters requiring such cooperation.

(b) The Company may reasonably require the Insured Claimant to submit to examination under oath by any authorized representative of the Company and to produce for examination, inspection, and copying, at such reasonable times and places as may be designated by the authorized representative of the Company, all records, in whatever medium maintained, including books, ledgers, checks, memoranda, correspondence, reports, e-mails, disks, tapes, and videos whether bearing a date before or after Date of Policy, that reasonably pertain to the loss or damage. Further, if requested by any authorized representative of the Company, the Insured Claimant shall grant its permission, in writing, for any authorized representative of the Company to examine, inspect, and copy all of these records in the custody or control of a third party that reasonably pertain to the loss or damage. All information designated as confidential by the Insured Claimant provided to the Company pursuant to this Section shall not be disclosed to others unless, in the reasonable judgment of the Company, it is necessary in the administration of the claim. Failure of the Insured Claimant to submit for examination under oath, produce any reasonably requested information, or grant permission to secure reasonably necessary information from third parties as required in this subsection, unless prohibited by law or governmental regulation, shall terminate any liability of the Company under this policy as to that claim.

7. OPTIONS TO PAY OR OTHERWISE SETTLE CLAIMS; TERMINATION OF LIABILITY

In case of a claim under this policy, the Company shall have the following additional options:

(a) To Pay or Tender Payment of the Amount of Insurance.
To pay or tender payment of the Amount of Insurance under this policy together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment or tender of payment and that the Company is obligated to pay.

Upon the exercise by the Company of this option, all liability and obligations of the Company to the Insured under this policy, other than to make the payment required in this subsection, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

(b) To Pay or Otherwise Settle With Parties Other Than the Insured or With the Insured Claimant.

(i) To pay or otherwise settle with other parties for or in the name of an Insured Claimant any claim insured against under this policy. In addition, the Company will pay any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay; or

(ii) To pay or otherwise settle with the Insured Claimant the loss or damage provided for under this policy, together with any costs, attorneys' fees, and expenses incurred by the Insured Claimant that were authorized by the Company up to the time of payment and that the Company is obligated to pay.

(iii) Upon the exercise by the Company of either of the options provided for in subsections (b)(i) or (ii), the Company's obligations to the Insured under this policy for the claimed loss or damage, other than the payments required to be made, shall terminate, including any liability or obligation to defend, prosecute, or continue any litigation.

8. DETERMINATION AND EXTENT OF LIABILITY

This policy is a contract of indemnity against actual monetary loss or damage sustained or incurred by the Insured Claimant who has suffered loss or damage by reason of matters insured against by this policy.

(a) The extent of liability of the Company for loss or damage under this policy shall not exceed the lesser of

(i) the Amount of Insurance; or

(ii) the difference between the value of the Title as insured and the value of the Title subject to the risk insured against by this policy.

(b) If the Company pursues its rights under Section 5 of these Conditions and is unsuccessful in establishing the Title, as insured,

(i) the Amount of Insurance shall be increased by 10%, and

(ii) the Insured Claimant shall have the right to have the loss or damage determined either as of the date the claim was made by the Insured Claimant or as of the date it is settled and paid.

(c) In addition to the extent of liability under (a) and (b), the Company will also pay those costs, attorneys' fees, and expenses incurred in accordance with Sections 5 and 7 of these Conditions.

9. LIMITATION OF LIABILITY

(a) If the Company establishes the Title, or removes the alleged defect, lien, or encumbrance, or cures the lack of a right of access to or from the Land, or cures the claim of Unmarketable Title, all as insured, in a reasonably diligent manner by any method, including litigation and the completion of any appeals, it shall have fully performed its obligations with respect to that matter and shall not be liable for any loss or damage caused to the Insured.

(b) In the event of any litigation, including litigation by the Company or with the Company's consent, the Company shall have no liability for loss or damage until there has been a final determination by a court of competent jurisdiction, and disposition of all appeals, adverse to the Title, as insured.

(c) The Company shall not be liable for loss or damage to the Insured for liability voluntarily assumed by the Insured in settling any claim or suit without the prior written consent of the Company.

10. REDUCTION OF INSURANCE; REDUCTION OR TERMINATION OF LIABILITY

All payments under this policy, except payments made for costs, attorneys' fees, and expenses, shall reduce the Amount of Insurance by the amount of the payment.

11. LIABILITY NONCUMULATIVE

The Amount of Insurance shall be reduced by any amount the Company pays under any policy insuring a Mortgage to which exception is taken in Schedule B or to which the Insured has agreed, assumed, or taken subject, or which is executed by an Insured after Date of Policy and which is a charge or lien on the Title, and the amount so paid shall be deemed a payment to the Insured under this policy.

12. PAYMENT OF LOSS

When liability and the extent of loss or damage have been definitely fixed in accordance with these Conditions, the payment shall be made within 30 days.

13. RIGHTS OF RECOVERY UPON PAYMENT OR SETTLEMENT

(a) Whenever the Company shall have settled and paid a claim under this policy, it shall be subrogated and entitled to the rights of the Insured Claimant in the Title and all other rights and remedies in respect to the claim that the Insured Claimant has against any person or property, to the extent of the amount of any loss, costs, attorneys' fees, and expenses paid by the Company. If requested by the Company, the Insured Claimant shall execute documents to evidence the transfer to the Company of these rights and remedies. The Insured Claimant shall permit the Company to sue, compromise, or settle in the name of the Insured Claimant and to use the name of the Insured Claimant in any transaction or litigation involving these rights and remedies.

If a payment on account of a claim does not fully cover the loss of the Insured Claimant, the Company shall defer the exercise of its right to recover until after the Insured Claimant shall have recovered its loss.

(b) The Company's right of subrogation includes the rights of the Insured to indemnities, guaranties, other policies of insurance, or bonds, notwithstanding any terms or conditions contained in those instruments that address subrogation rights.

14. ARBITRATION

Either the Company or the Insured may demand that the claim or controversy shall be submitted to arbitration pursuant to the Title Insurance Arbitration Rules of the American Land Title Association ("Rules"). Except as provided in the Rules, there shall be no joinder or consolidation with claims or controversies of other persons. Arbitrable matters may include, but are not limited to, any controversy or claim between the Company and the Insured arising out of or relating to this policy, any service in connection with its issuance or the breach of a policy provision, or to any other controversy or claim arising out of the transaction giving rise to this policy. All arbitrable matters when the Amount of Insurance is $2,000,000 or less shall be arbitrated at the option of either the Company or the Insured. All arbitrable matters when the Amount of Insurance is in excess of $2,000,000 shall be arbitrated only when agreed to by both the Company and the Insured. Arbitration pursuant to this policy and under the Rules shall be binding upon the parties. Judgment upon the award rendered by the Arbitrator(s) may be entered in any court of competent jurisdiction.

15. LIABILITY LIMITED TO THIS POLICY; POLICY ENTIRE CONTRACT

(a) This policy together with all endorsements, if any, attached to it by the Company is the entire policy and contract between the Insured and the Company. In interpreting any provision of this policy, this policy shall be construed as a whole.

(b) Any claim of loss or damage that arises out of the status of the Title or by any action asserting such claim shall be restricted to this policy.

(c) Any amendment of or endorsement to this policy must be in writing and authenticated by an authorized person, or expressly incorporated by Schedule A of this policy.

(d) Each endorsement to this policy issued at any time is made a part of this policy and is subject to all of its terms and provisions. Except as the endorsement expressly states, it does not (i) modify any of the terms and provisions of the policy, (ii) modify any prior endorsement, (iii) extend the Date of Policy, or (iv) increase the Amount of Insurance.

16. SEVERABILITY

In the event any provision of this policy, in whole or in part, is held invalid or unenforceable under applicable law, the policy shall be deemed not to include that provision or such part held to be invalid, but all other provisions shall remain in full force and effect.

17. CHOICE OF LAW; FORUM

(a) Choice of Law: The Insured acknowledges the Company has underwritten the risks covered by this policy and determined the premium charged therefor in reliance upon the law affecting interests in real property and applicable to the interpretation, rights, remedies, or enforcement of policies of title insurance of the jurisdiction where the Land is located.

Therefore, the court or an arbitrator shall apply the law of the jurisdiction where the Land is located to determine the validity of claims against the Title that are adverse to the Insured and to interpret and enforce the terms of this policy. In neither case shall the court or arbitrator apply its conflicts of law principles to determine the applicable law.

(b) Choice of Forum: Any litigation or other proceeding brought by the Insured against the Company must be filed only in a state or federal court within the United States of America or its territories having appropriate jurisdiction.

18. NOTICES, WHERE SENT

Any notice of claim and any other notice or statement in writing required to be given to the Company under this policy must be given to the Company at **First American Title Insurance Company, Attn: Claims National Intake Center, 1 First American Way; Santa Ana, CA 92707. Phone: 888-632-1642.**

FIRST AMERICAN

First American Title

ISSUED THROUGH THE OFFICE OF:

FIRST AMERICAN
TITLE INSURANCE
COMPANY

Corporate Office
1 First American Way
Santa Ana, CA 92707
(800) 854-3643

Form No. 1402.06
ALTA Owner's Policy (6-17-06)
1100302P050600
File No.: 20660

Policy Page 1
Policy No. 5011400-208018
SI #5011300-

SCHEDULE A

FIRST AMERICAN TITLE INSURANCE COMPANY

HUFFMAN ABSTRACT & TITLE COMPANY
48 N. Vermilion St.
Danville, IL 61832

Amount of Insurance: $5,000,000.00
Date of Policy: December 30, 2011 at 9:46 A.M.

Premium: $6250.00

1. Name of Insured: Sunrise Coal LLC, an Indiana Liability Company

2. The estate or interest in the Land that is insured by this policy is: Fee Simple

3. Title is vested in: Sunrise Coal LLC, an Indiana Liability Company

4. The Land referred to in this policy is described as follows:

   The Southwest Quarter of Section Twenty-Six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermilion County, Illinois and the Southwest Quarter of the Southeast Quarter of Section Twenty-Six (26), Township Eighteen (18) North, Range Fourteen (14) West of the Second Principal Meridian in Vermilion County, Illinois. Containing 200 acres, more or less.

By: Robert L Huff
A registered agent for First American Title

SCHEDULE B

EXCEPTIONS FROM COVERAGE

This policy does not insure against loss or damage, and the Company will not pay costs attorneys' fees, or expenses that arise by reason of:

Part One:

1. Rights or claims of parties in possession not shown by the public records.
2. Easements, or claims of easements, not shown by the public records.
3. Any encroachments, encumbrance, violation, variation or adverse circumstance affecting title that would be disclosed by an accurate and complete survey of the land pursuant to the "Minimum Standards of Practice," 68 Ill. Admin. Code, Sec. 1270.56(b)(6)(P) for residential property or the ALTA/ACSM land title survey standards for commercial/industrial property.
4. Any lien, or right to lien, for services, labor, or material heretofore or hereafter furnished, imposed by and law not shown by the public records.
5. Taxes, or special assessments, if any, not shown as existing liens by the public records.
6. Loss or damage by reason of there being recorded in the public records, any deeds, mortgages, lis pendens, liens or other title encumbrances subsequent to the Commitment date and prior to the effective date of the final Policy.

Part Two:

1. All assessments and taxes for 2011, and thereafter.

Sidell Township	Tract #342	PIN #25-26-300-001-0011
Sidell Township	Tract #344	PIN #25-26-400-002-0021

2. Rights of the public in and to any portion of the premises within the boundaries of the public road.
3. Rights of way for drainage ditches, drain tiles, feeders, laterals, and underground pipes, if any.
4. Premises fall within the Vermilion County Soil Conservation District and are subject to assessment thereunder.
5. The acreage shown is for reference only and not insured.
6. Rights of any tenants under unrecorded agreements.

7. Reservation of coal and other mineral rights as set forth in the Warranty Deed to Sunrise Coal, LLC dated and filed December 30, 2011 as Document #11-10450.

8. Memorandum of Lease Agreement between Kizer Family Farms, L.P. and Sunrise Coal, LLC dated December 30, 2011 and recorded December 30, 2011 as Document #11-10451.

Privacy Policy

We Are Committed to Safeguarding Customer Information

In order to better serve your needs now and in the future, we may ask you to provide us with certain information. We understand that you may be concerned about what we will do with such information-particularly any personal or financial information. We agree that you have a right to know how we will utilize the personal information you provide to us. Therefore, together with our parent company, The First American Corporation, we have adopted this Privacy Policy to govern the use and handling of your personal information.

Applicability

This Privacy Policy governs our use to the information which you provide to us. It does not govern the manner in which we may use information we have obtained from any other source, such as information obtained from a public record or from another person or entity. First American has also adopted broader guidelines that govern our use of personal information regardless of its source. First American calls these guidelines its *Fair Information Values*, a copy of which can be found on our website at www.firstam.com.

Types of Information

Depending upon which of our services you are utilizing, the types of nonpublic personal information that we may collect include:

- Information we received from you on applications, forms and in other communications to us, whether in writing, in person, by telephone or any other means;
- Information about your transactions with us, our affiliated companies, or others; and
- Information we receive from a consumer reporting agency.

Use of Information

We request information from you for our own legitimate business purposes and not for the benefit of any nonaffiliated party. Therefore, we will not release your information to nonaffiliated parties except: (1) as necessary for us to provide the product or service you have requested of us; or (2) as permitted by law. We may, however, store such information indefinitely, including the period after which any customer relationship has ceased. Such information may be used for any internal purpose, such as quality control efforts or customer analysis. We may also provide all of the types of nonpublic personal information listed above to one or more of our affiliated companies. Such affiliated companies include financial service providers, such as title insurers, property and casualty insurers, and trust and investment advisory companies, or companies involved in real estate services, such as appraisal companies, home warranty companies, and escrow companies. Furthermore, we may also provide all the information we collect, as described above, to companies that perform marketing services on our behalf, on behalf of our affiliated companies, or to other financial institutions with whom we or our affiliated companies have joint marketing agreements.

Former Customers

Even if you are no longer our customer, our Privacy Policy will continue to apply to you.

Confidentiality and Security

We will use our best efforts to ensure that no unauthorized parties have access to any of your information. We restrict access to nonpublic personal information about you to those individuals and entities who need to know that information to provide products or services to you. We will use our best efforts to train and oversee our employees and agents to ensure that your information will be handled responsibly and in accordance with this Privacy Policy and First American's *Fair Information Values*. We currently maintain physical, electronic, and procedural safeguards that comply with federal regulations to guard your nonpublic personal information.

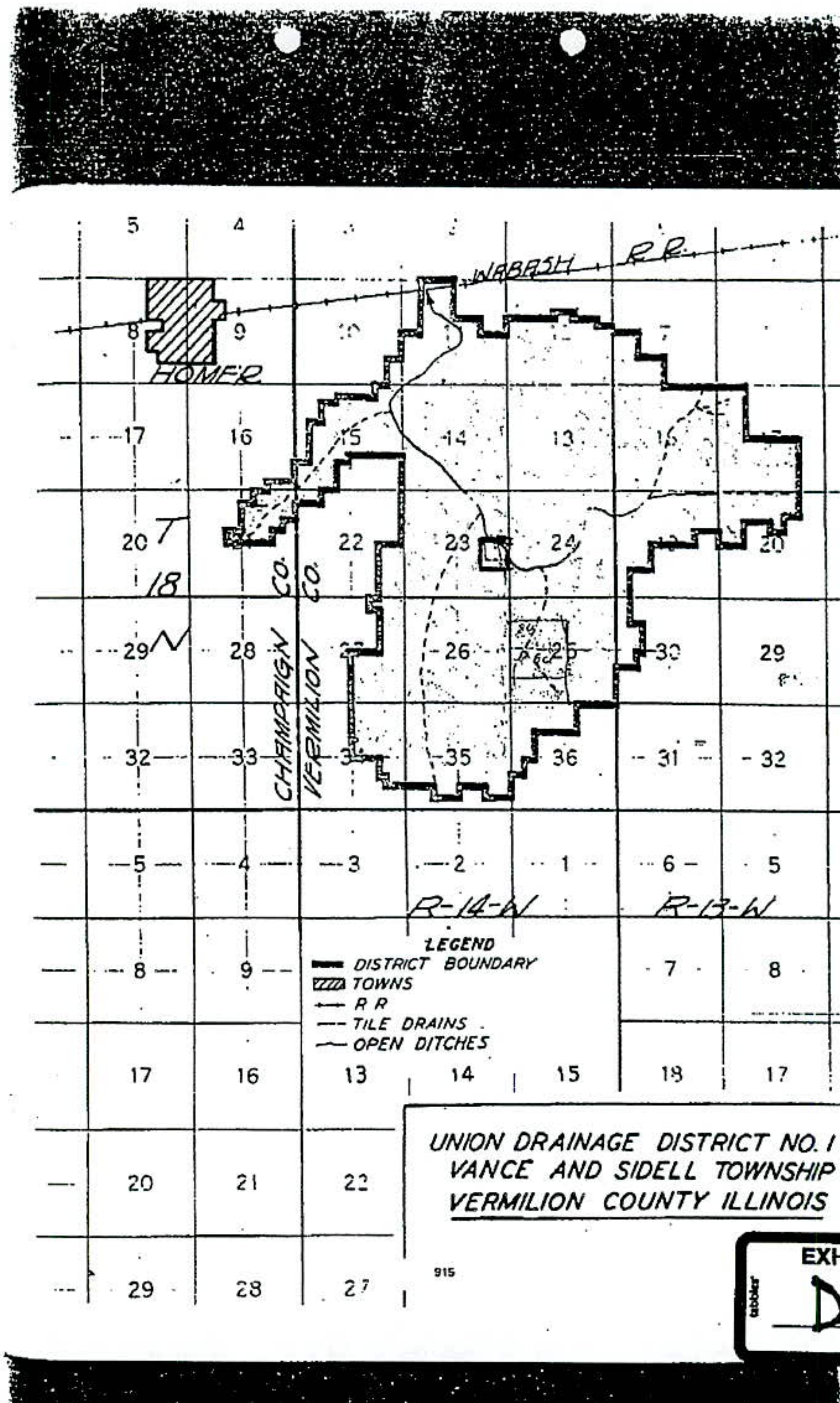


EXHIBIT
tabbies
D

Bill Number	Tract Number		P.I.N. Number	Tax Code
01915	SDLL 0345	**SUE STINE, County Treasurer / Tax Collector** 2013 VERMILION COUNTY REAL ESTATE TAXES	25-26-400-003-0021	52

Assessed Value	x	Multiplier	=	Eq. Val	-	Exemptions	=	Taxable Value	*	Total Tax Rate + Drainage - School Credit =	TOTAL TAX DUE
0 + 18,226		1.0000		18,226				18,226		8.68603 + 18.72 * - .00 **	1,601.84

Eq 77 Value 11,387

Fair Market Value

Prior Sale

Owner Occupied

Exemptions

Freeze Amount

Senior Citizen

Interest

Cost

1st Installment 800.92

2nd Installment 800.92

Assessed To

SUNRISE COAL LLC
1183 E CANVASBACK DR
TERRE HAUTE IN 47802

Acreage 40.00

Property Description

EX MINERALS, SE4 SE4 26 18 14

Property Address

tabbies

EXHIBIT

E

1st Installment Receipt	2012 Amount	Taxing District	Rate	2013 Amount	Pension	Amount Change	2nd Installment Receipt
	239.89	COUNTY	1.47315	268.50	40.28	28.61	
	20.57	CONSERVATION	.12132	22.11	2.61	1.54	
	69.22	TOWNSHIP	.41712	76.02		6.80	
	90.14	ROAD & BRIDGE	.54315	98.99		8.85	
	35.72	LIBRARY	.18549	33.81	1.18	1.91-	
	85.96	COLLEGE	.52418	95.54		9.58	
	824.79	SCHOOLS	5.02058	915.05	39.51	90.26	
	68.23	FIRE	.40104	73.09		4.86	
		SANITARY DIST					
		CITY					
		AIRPORT					
		CEMETERY					
		SPEC. SERVICE					
		SPEC. SERVICE					
		PARK					
1st Installment Due		WATER AUTHORITY					2nd Installment Due
		MULTI TWP AUTH					
	18.72	*DRAINAGE		18.72			
08/15/14	.00-*	*SCHOOL CREDIT		.00-			09/05/14

Bill Number	Tract Number	SUE STINE, County Treasurer / Tax Collector	P.I.N. Number	Tax Code
01916	SDLL 0362A	2013 VERMILION COUNTY REAL ESTATE TAXES	25-35-200-005-0021	52

Assessed Value	x	Multiplier	=	Eq. Val	-	Exemptions	=	Taxable Value	*	Total Tax Rate + Drainage - School Credit =	TOTAL TAX DUE
0 + 78,795		1.0000		78,795				78,795		8.68603 + 66.24 * - .00 **	6,910.42

Eq 77 Value	214	Exemptions		Interest	1st Installment
Fair Market Value	Prior Sale	Owner Occupied	Freeze Amount	Senior Citizen	Cost	3,455.21
						2nd Installment
						3,455.21

Assessed To

SUNRISE COAL LLC
1183 E CANVASBACK DR
TERRE HAUTE IN 47802

Acreage: 153.68

Property Description: EX N721'E381.9',NE4 35 18 14

Property Address

2012 Amount	Taxing District	Rate	2013 Amount	Pension	Amount Change
1,037.20	COUNTY	1.47315	1,160.77	174.14	123.57
88.93	CONSERVATION	.12132	95.59	11.32	6.66
299.29	TOWNSHIP	.41712	328.67		29.38
389.72	ROAD & BRIDGE	.54315	427.98		38.26
154.44	LIBRARY	.18549	146.16	5.12	8.28-
371.68	COLLEGE	.52418	413.03		41.35
3,566.11	SCHOOLS	5.02058	3,955.97	170.84	389.86
294.99	FIRE	.40104	316.00		21.01
	SANITARY DIST				
	CITY				
	AIRPORT				
	CEMETERY				
	SPEC. SERVICE				
	SPEC. SERVICE				
	PARK				
	WATER AUTHORITY				
	MULTI TWP AUTH				
66.24	*DRAINAGE		66.24		
.00-	**SCHOOL CREDIT		.00-		

1st Installment Receipt

2nd Installment Receipt

1st Installment Due 08/15/14

2nd Installment Due 09/05/14

Bill Number	Tract Number	SUE STINE, County Treasurer / Tax Collector	P.I.N. Number	Tax Code
01917	SDLL 0364A	2013 VERMILION COUNTY REAL ESTATE TAXES	25-35-100-009-0040	52

Assessed Value x	Multiplier =	Eq. Val -	Exemptions =	Taxable Value *	Total Tax Rate + Drainage - School Credit =	TOTAL TAX DUE
27,806 + 0	1.0000	27,806		27,806	8.68603 + .54 * - .00 **	2,415.76

Eq 77 Value	4,604	Exemptions		Interest	1st Installment
Fair Market Value	Prior Sale	Owner Occupied	Freeze Amount	Senior Citizen	Cost	1,207.88
83,418						2nd Installment 1,207.88

Assessed To

SUNRISE COAL LLC
1183 E CANVASBACK DR
TERRE HAUTE IN 47802

Acreage: 1.85

Property Description: N310'W260'NW4 NW4 35 18 14

Property Address: 1026 E 800 NORTH RD

2012 Amount	Taxing District	Rate	2013 Amount	Pension	Amount Change
402.80	COUNTY	1.47315	409.62	61.45	6.82
34.54	CONSERVATION	.12132	33.73	3.99	.81-
116.23	TOWNSHIP	.41712	115.98		.25-
151.35	ROAD & BRIDGE	.54315	151.03		.32-
59.98	LIBRARY	.18549	51.58	1.80	8.40-
144.34	COLLEGE	.52418	145.75		1.41
1,384.91	SCHOOLS	5.02058	1,396.02	60.28	11.11
114.56	FIRE	.40104	111.51		3.05-
	SANITARY DIST				
	CITY				
	AIRPORT				
	CEMETERY				
	SPEC. SERVICE				
	SPEC. SERVICE				
	PARK				
	WATER AUTHORITY				
	MULTI TWP AUTH				
.54	*DRAINAGE		.54		
.00-	**SCHOOL CREDIT		.00-		

1st Installment Receipt

2nd Installment Receipt

1st Installment Due 08/15/14

2nd Installment Due 09/05/14

Bill Number	Tract Number		P.I.N. Number	Tax Code
01913	SDLL 0342	**SUE STINE, County Treasurer / Tax Collector** 2013 VERMILION COUNTY REAL ESTATE TAXES	25-26-300-001-0011	52

Assessed Value	x	Multiplier	=	Eq. Val	-	Exemptions	=	Taxable Value	*	Total Tax Rate	+	Drainage	-	School Credit	=	TOTAL TAX DUE
14,591 + 84,244		1.0000		98,835				98,835		8.68603	+	71.76 *	-	.00 **		8,656.60

Eq 77 Value	4,527		Exemptions		Interest	1st Installment
Fair Market Value	Prior Sale	Owner Occupied	Freeze Amount	Senior Citizen	Cost	4,328.30
43,773						2nd Installment
						4,328.30

Assessed To

SUNRISE COAL LLC
1183 E CANVASBACK DR
TERRE HAUTE IN 47802

Acreage	Property Description
160.00	SW4 26 18 14

Property Address

1st Installment Receipt	2012 Amount	Taxing District	Rate	2013 Amount	Pension	Amount Change	2nd Installment Receipt
	1,324.24	COUNTY	1.47315	1,455.99	218.43	131.75	
	113.54	CONSERVATION	.12132	119.91	14.20	6.37	
	382.11	TOWNSHIP	.41712	412.26		30.15	
	497.57	ROAD & BRIDGE	.54315	536.82		39.25	
	197.18	LIBRARY	.18549	183.33	6.42	13.85-	
	474.54	COLLEGE	.52418	518.07		43.53	
	4,553.02	SCHOOLS	5.02058	4,962.09	214.29	409.07	
	376.63	FIRE	.40104	396.37		19.74	
		SANITARY DIST					
		CITY					
		AIRPORT					
		CEMETERY					
		SPEC. SERVICE					
		SPEC. SERVICE					
		PARK					
1st Installment Due		WATER AUTHORITY					2nd Installment Due
		MULTI TWP AUTH					
	71.76	*DRAINAGE		71.76			
08/15/14	.00-*	*SCHOOL CREDIT		.00-			09/05/14

Bill Number	Tract Number		P.I.N. Number	Tax Code
01914	SDLL 0344	**SUE STINE, County Treasurer / Tax Collector** 2013 VERMILION COUNTY REAL ESTATE TAXES	25-26-400-002-0021	52

Assessed Value	x Multiplier	= Eq. Val	- Exemptions	= Taxable Value	* Total Tax Rate	+ Drainage - School Credit =	TOTAL TAX DUE
0 + 20,317	1.0000	20,317		20,317	8.68603 +	9.36 * - .00 **	1,774.12

Eq 77 Value	11,552	Exemptions		Interest	1st Installment
					887.06
Fair Market Value	Prior Sale	Owner Occupied	Freeze Amount	Senior Citizen	Cost	2nd Installment
						887.06

Assessed To

SUNRISE COAL LLC
1183 E CANVASBACK DR
TERRE HAUTE IN 47802

Acreage	Property Description
40.00	SW4 SE4 26 18 14

Property Address

	2012 Amount	Taxing District	Rate	2013 Amount	Pension	Amount Change	
1st Installment Receipt	267.48	COUNTY	1.47315	299.30	44.90	31.82	2nd Installment Receipt
	22.93	CONSERVATION	.12132	24.65	2.91	1.72	
	77.18	TOWNSHIP	.41712	84.75		7.57	
	100.50	ROAD & BRIDGE	.54315	110.35		9.85	
	39.83	LIBRARY	.18549	37.69	1.32	2.14-	
	95.85	COLLEGE	.52418	106.50		10.65	
	919.67	SCHOOLS	5.02058	1,020.03	44.05	100.36	
	76.08	FIRE	.40104	81.48		5.40	
		SANITARY DIST					
		CITY					
		AIRPORT					
		CEMETERY					
		SPEC. SERVICE					
		SPEC. SERVICE					
		PARK					
1st Installment Due		WATER AUTHORITY					2nd Installment Due
		MULTI TWP AUTH					
	9.36	*DRAINAGE		9.36			
08/15/14	.00-*	*SCHOOL CREDIT		.00-			09/05/14

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-7)J)

PATRIOT ENGINEERING DOCUMENTS

APPENDIX A
MAPS, BORING LOGS, BORING LOCATION MAPS, MW LOCATION MAP, MW LOGS, MW READINGS, SOIL INFORMATION, SOIL PROFILES

APPENDIX B
SOIL LAB TESTS
INITIAL WATER TESTING RESULTS

SCHNABEL ENGINEERING DOCUMENTS

RESPONSES TO MSHA COMMENTS DATED OCTOBER 8, 2015 – REPORT DATED SEPT. 22, 2016

RESPONSES TO MSHA COMMENTS DATED MARCH 20, 2017 – REPORT DATED SEPT. 14, 2017

Engineering Evaluation & Construction Considerations

Coal Refuse Impoundment No. 1

Bulldog Mine

Allerton-Homer, Illinois

Patriot Project No.: 2-11-0383

Prepared For:

Sunrise Coal, LLC

Prepared By:

Patriot Engineering and Environmental, Inc.
6330 East 75th Street, Suite 216
Indianapolis, Indiana 46250

(Volume 5 of 6)

June 7, 2012

Updated September 20, 2013

APPENDIX A

VICINITY MAP
(FIGURE NO. 1)

BORING LOCATION MAP
(FIGURE NO. 2)

BORING LOCATION MAP
(FIGURE NO. 3)

SOIL PROFILES
(FIGURES NO. 4 THROUGH 8)

BORING LOGS

MONITORING WELL LOCATION MAP
(FIGURE NO. 9)

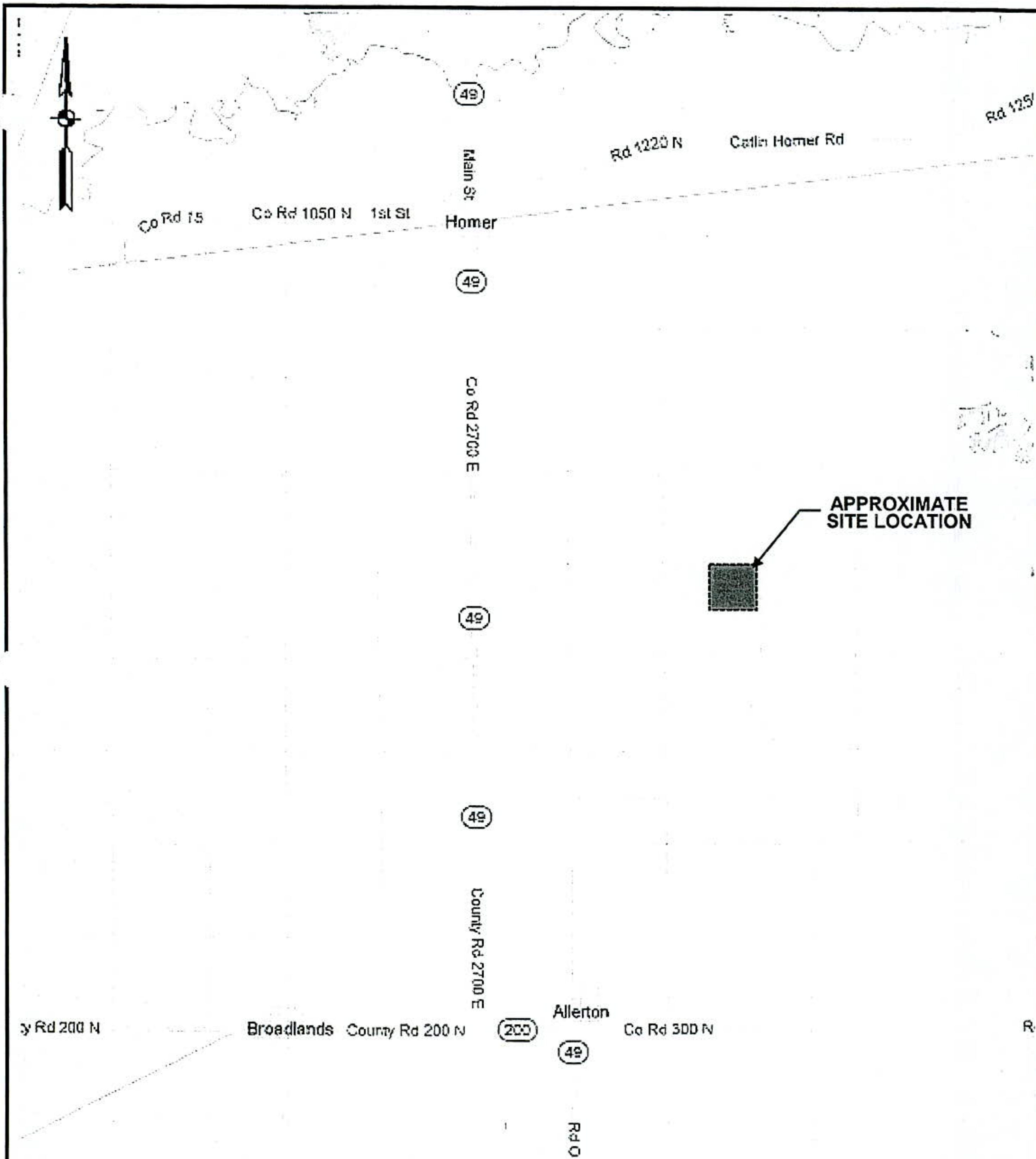
MONITORING WELL READINGS
(TABLE NO. 1)

MONITORING WELL LOGS

BORING LOG KEY

UNIFIED SOIL CLASSIFICATION SYSTEM
(USCS)

VICINITY MAP
(FIGURE NO. 1)



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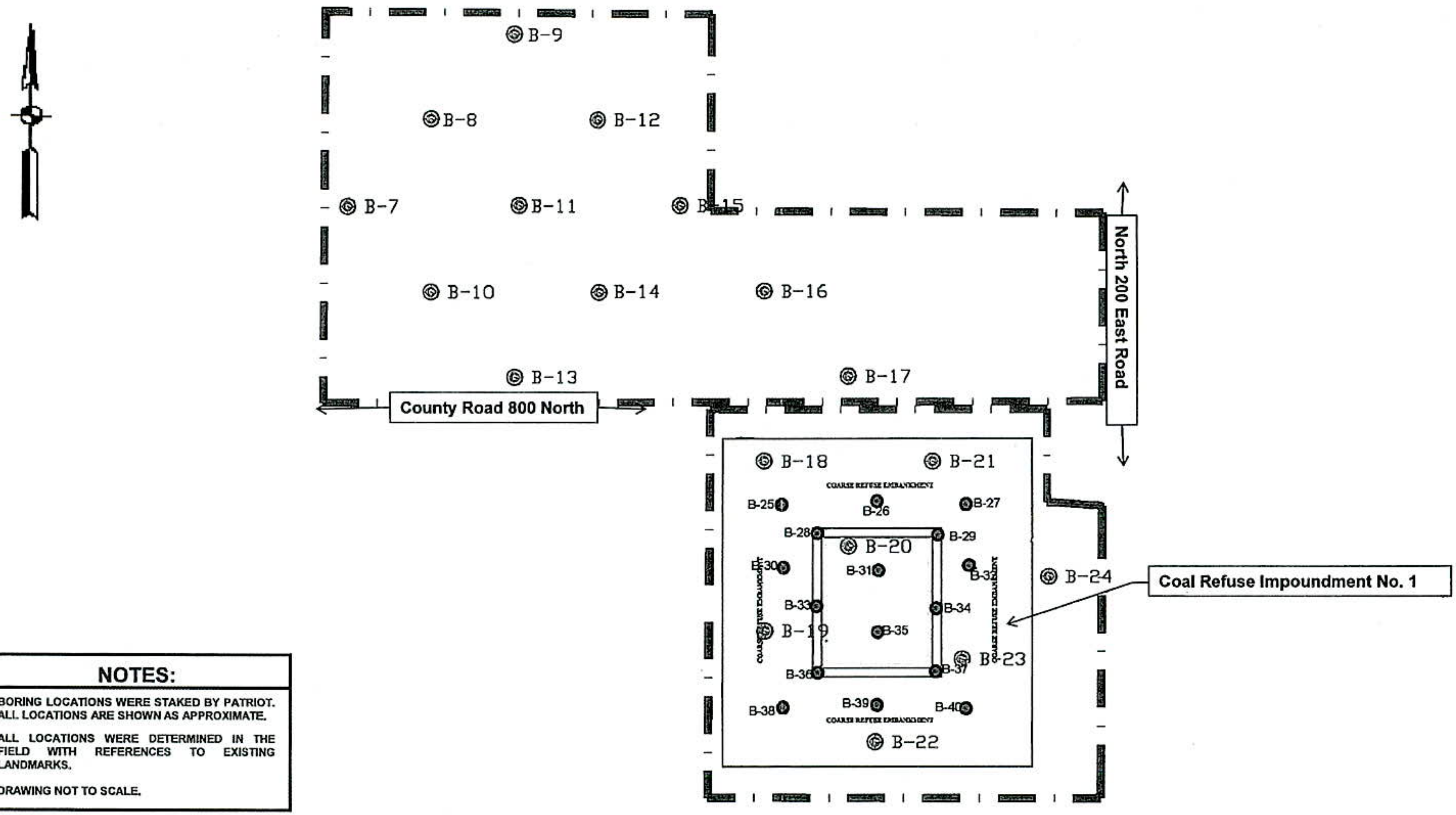
Indianapolis, Indiana 46250

Site Vicinity Map
Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton-Homer, Illinois

Job No. 2-11-0383 **Figure** 1

BORING LOCATION MAP
(FIGURE NO. 2)



NOTES:

BORING LOCATIONS WERE STAKED BY PATRIOT. ALL LOCATIONS ARE SHOWN AS APPROXIMATE.

ALL LOCATIONS WERE DETERMINED IN THE FIELD WITH REFERENCES TO EXISTING LANDMARKS.

DRAWING NOT TO SCALE.

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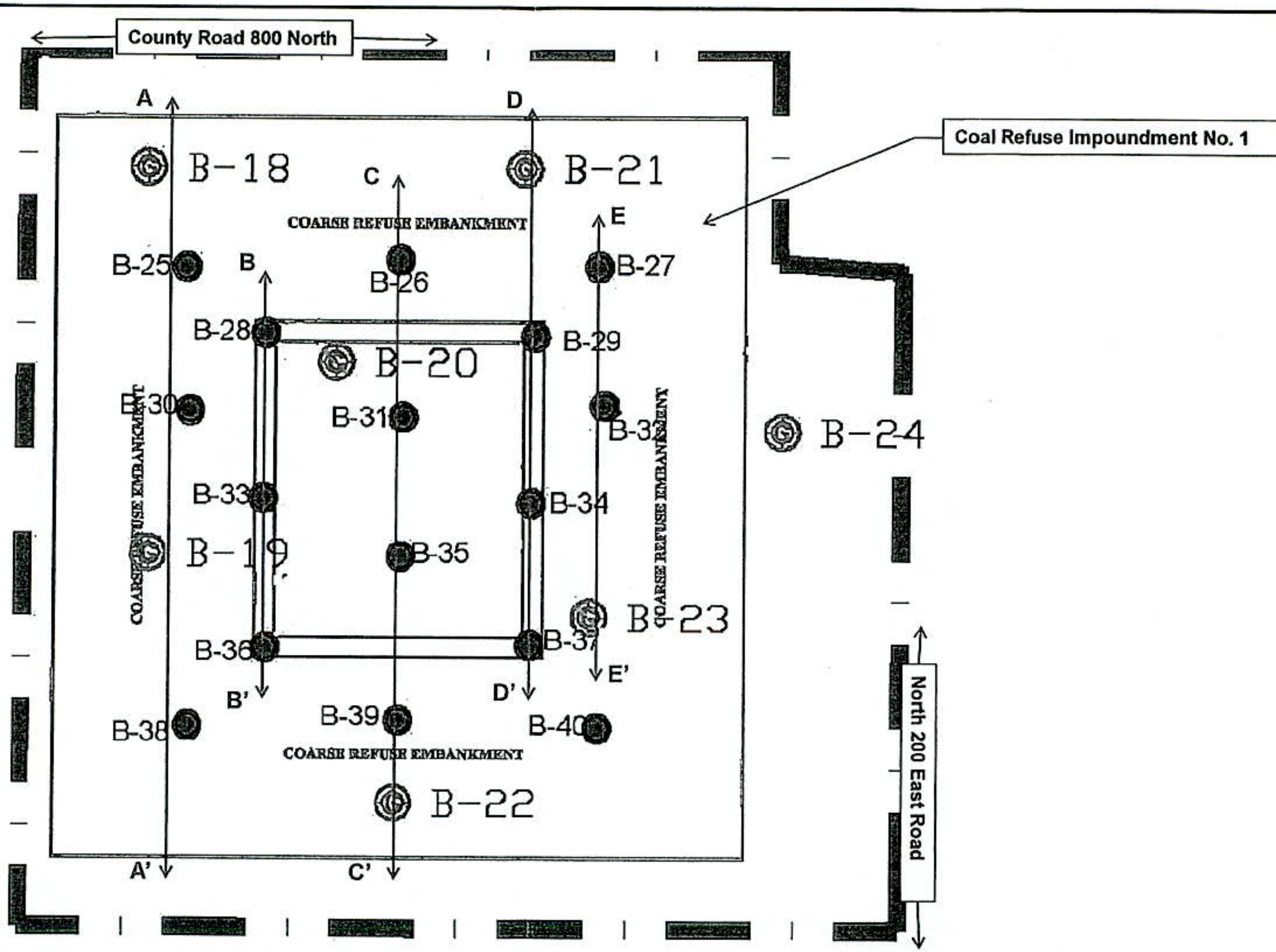
Indianapolis, Indiana 46250

Boring Location Map
Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton-Homer, Illinois

Job No.	2-11-0383	**Figure**	2

BORING LOCATION MAP
(FIGURE NO. 3)



NOTES:

BORING LOCATIONS WERE STAKED BY PATRIOT. ALL LOCATIONS ARE SHOWN AS APPROXIMATE.

ALL LOCATIONS WERE DETERMINED IN THE FIELD WITH REFERENCES TO EXISTING LANDMARKS.

DRAWING NOT TO SCALE.

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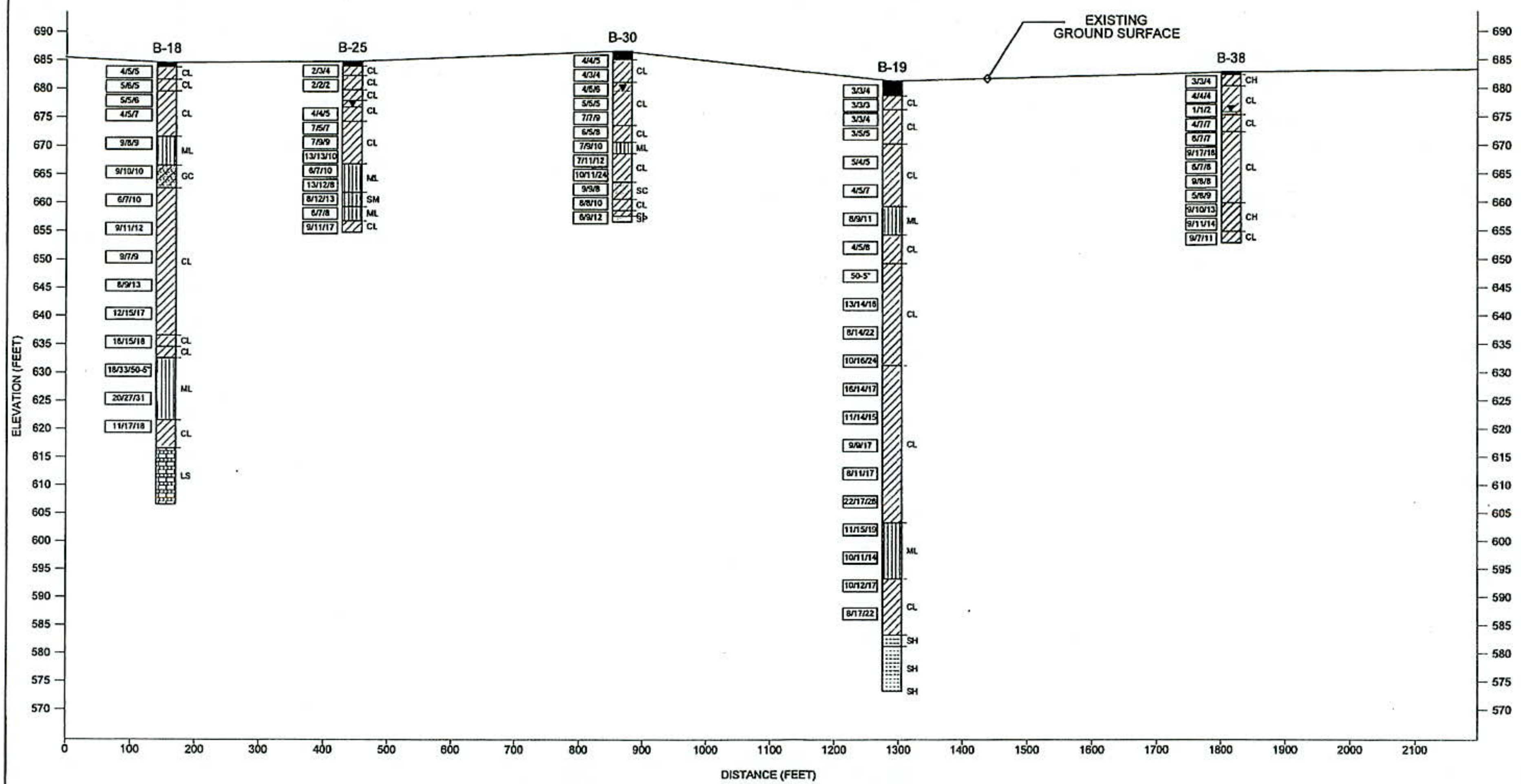
Boring and Cross Section Location Map
Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton-Homer, Illinois

Job No.	2-11-0383	**Figure**	3

SOIL PROFILES
(FIGURE NOS. 4 THROUGH 8)



SUNRISE COAL, LLC
1183 EAST CANVASBACK DRIVE
TERRE HAUTE, INDIANA 47802

PATRIOT ENGINEERING
and Environmental Inc.

SOIL PROFILE A-A'

COAL REFUSE IMPOUNDMENT NO. 1

BULLDOG MINE
ALLERTON-HOMER, ILLINOIS

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

- CLAY (CH)
- SANDY/ SILTY CLAY (CL)
- SANDY SILTY CLAY (CL)
- SILT (ML)
- SILTY SAND (SM)
- CLAYEY SAND (SC)
- POORLY GRADED SAND (SP)
- WELL GRADED SAND (SW)
- CLAYEY GRAVEL (GC)
- LIMESTONE (LS)
- SHALE (SH)
- TOPSOIL

- GROUNDWATER DURING DRILLING
- 4/5/7 BLOW COUNTS

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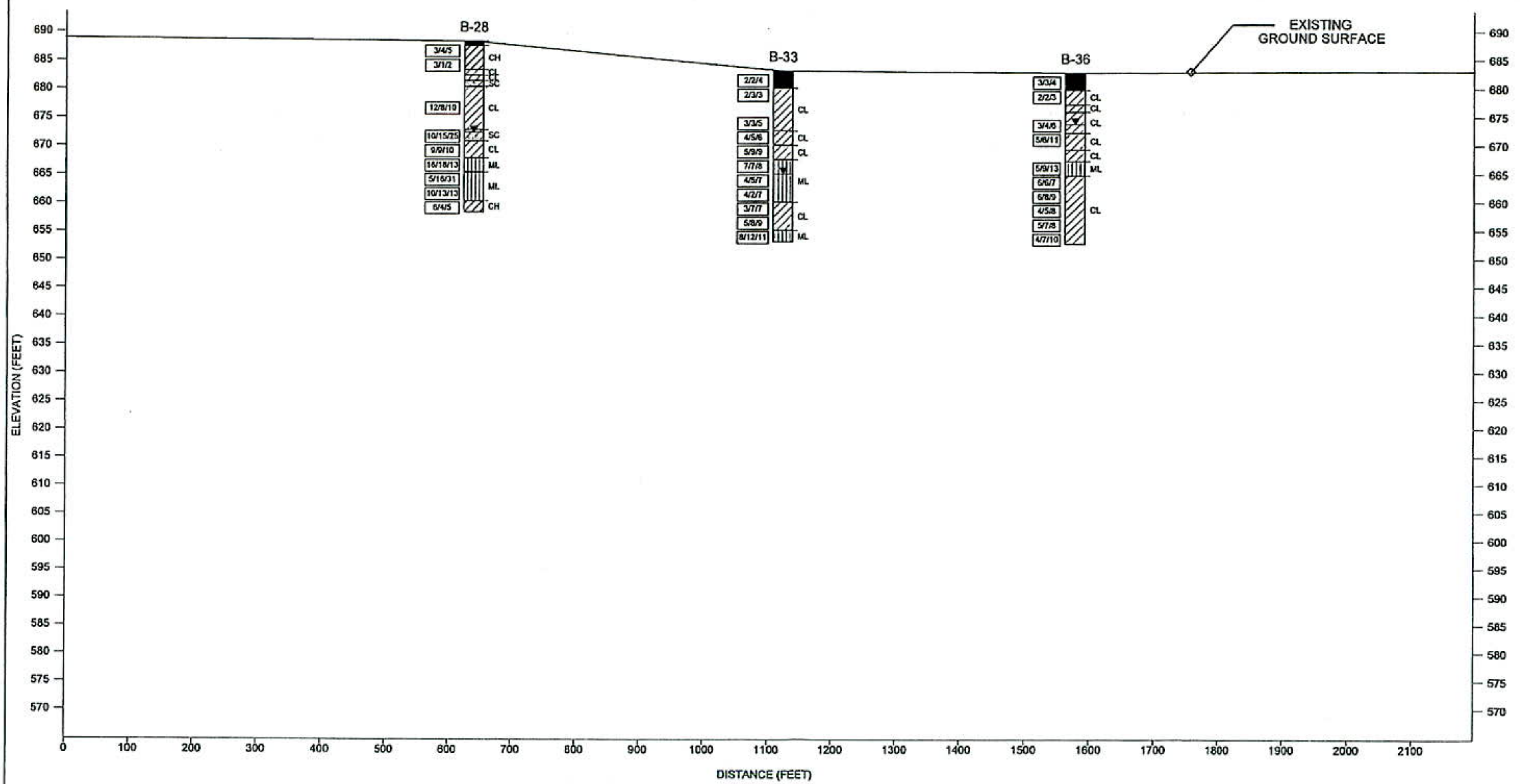

SUNRISE COAL, LLC
1183 EAST CANVASBACK DRIVE
TERRE HAUTE, INDIANA 47802

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SOIL PROFILE B-B'

COAL REFUSE IMPOUNDMENT NO. 1

BULLDOG MINE
ALLERTON-HOMER, ILLINOIS

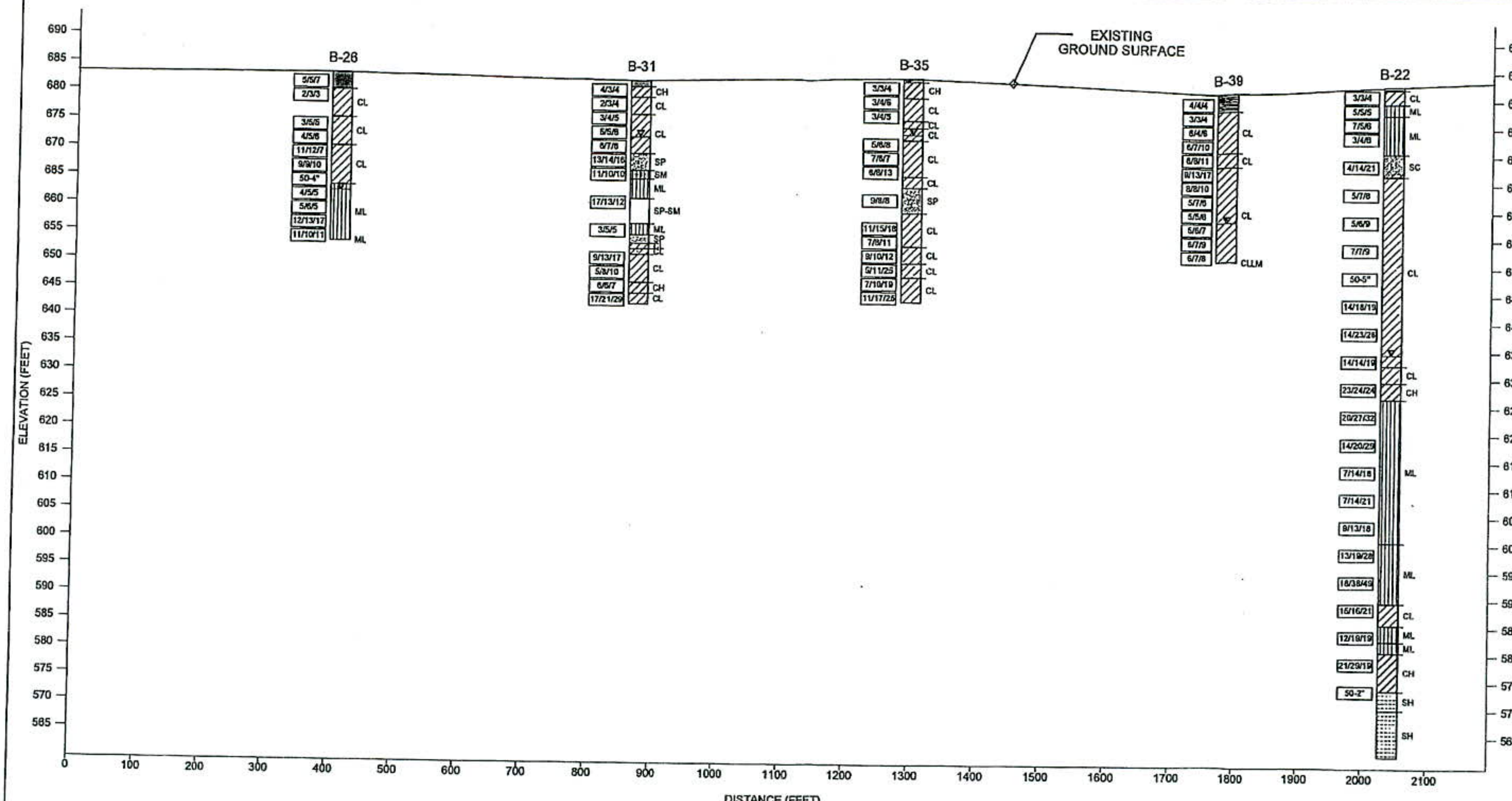
UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

- CLAY (CH)
- SANDY/ SILTY CLAY (CL)
- SANDY SILTY CLAY (CL)
- SILT (ML)
- SILTY SAND (SM)
- CLAYEY SAND (SC)
- POORLY GRADED SAND (SP)
- WELL GRADED SAND (SW)
- CLAYEY GRAVEL (GC)
- LIMESTONE (LS)
- SHALE (SH)
- TOPSOIL

- GROUNDWATER DURING DRILLING
- 4/5/7 BLOW COUNTS

FIGURE NO. 5

10-29-2012 I:\GEOTECH\PROJECTS\2011\12-0383\MTECH BORING LOGS\REVISED BORINGS\CROSS-SECTION B-B.cro



SUNRISE COAL, INC.
1183 EAST CANVASBACK DRIVE
TERRE HAUTE, INDIANA 47802

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Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmel, IL

SOIL PROFILE C-C'

COAL REFUSE IMPOUNDMENT NO. 1

BULLDOG MINE
ALLERTON-HOMER, INDIANA

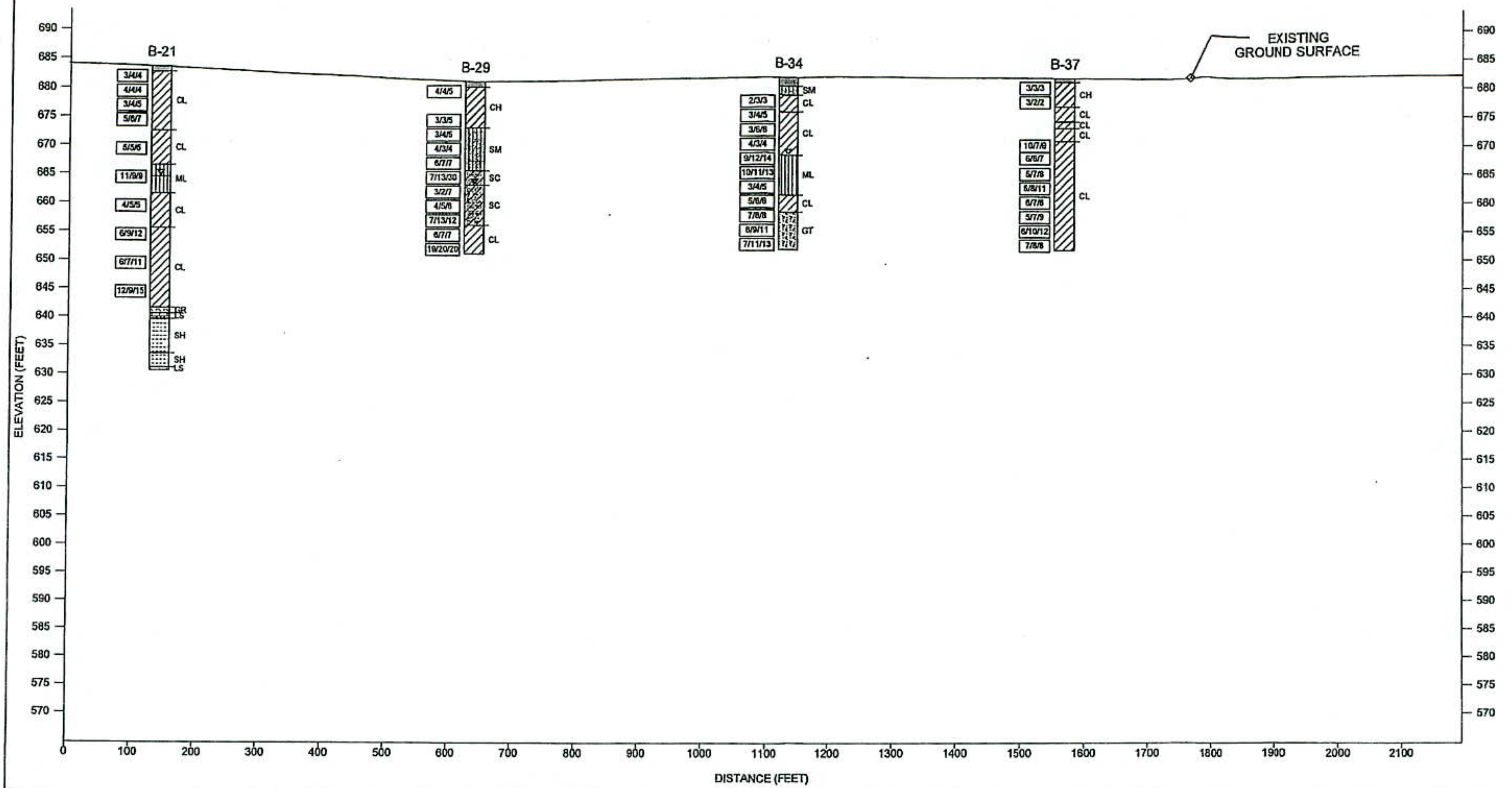
UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

- CLAY(CH)
- SANDY/ SILTY CLAY (CL)
- SANDY SILTY CLAY (CL)
- SILT (ML)
- SILTY SAND (SM)
- CLAYEY SAND (SC)
- POORLY GRADED SAND (SP)
- WELL GRADED SAND (SW)
- CLAYEY GRAVEL (GC)
- LIMESTONE (LS)
- SHALE (SH)
- TOPSOIL

- GROUNDWATER DURING DRILLING
- 4/5/7 BLOW COUNTS

FIGURE NO. 6

10-29-2012 I:\GEOTECH\PROJECTS\2011\12-0383\MTECH BORING LOGS\REVISED BORINGS\CROSS-SECTION C-C.cro



SUNRISE COAL, LLC 1183 EAST CANVASBACK DRIVE TERRE HAUTE, INDIANA 47802	SOIL PROFILE D-D'
PATRIOT ENGINEERING and Environmental Inc. Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmi, IL	COAL REFUSE IMPOUNDMENT NO. 1 BULLDOG MINE ALLERTON-HOMER, ILLINOIS

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

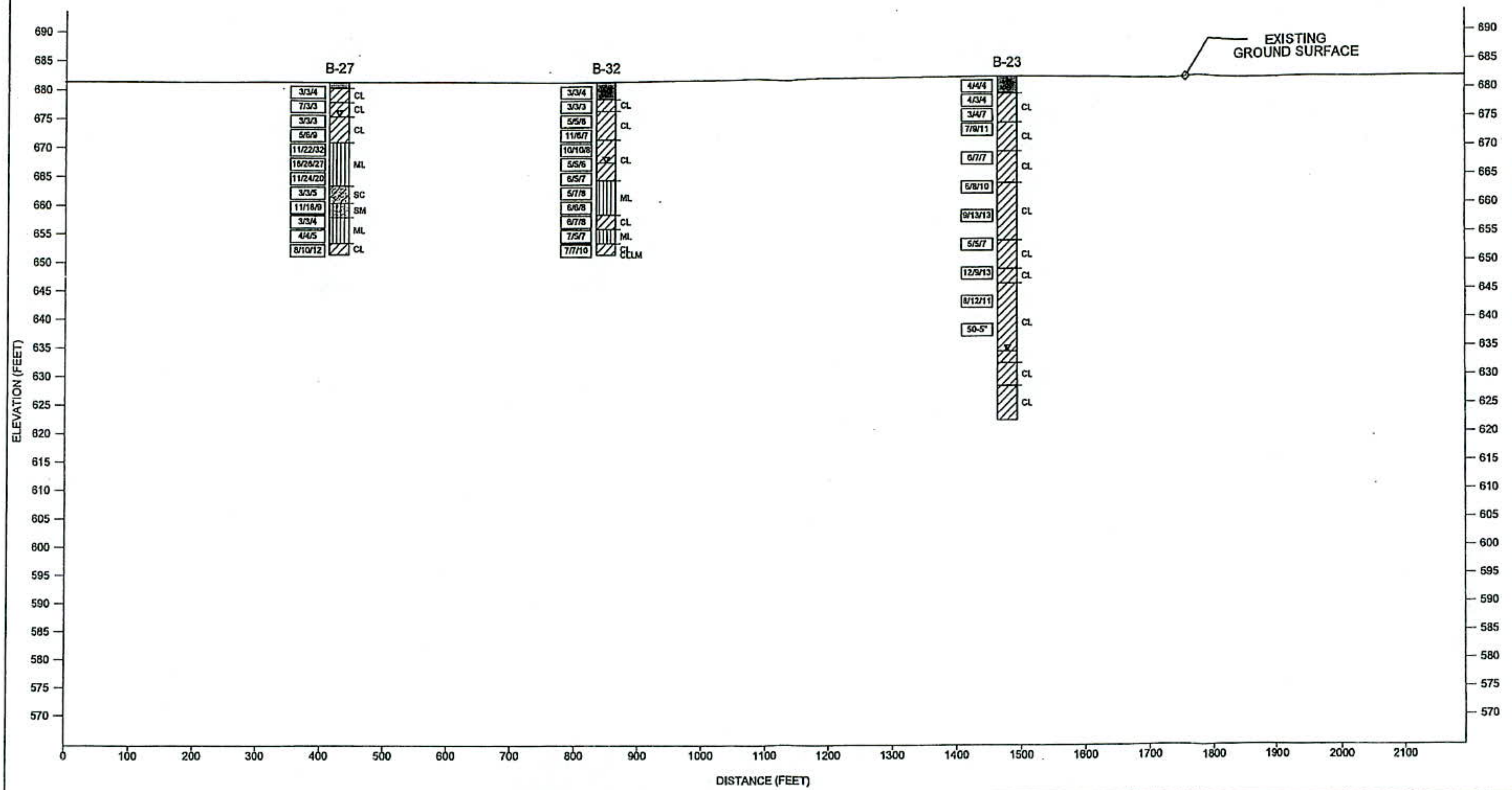
CLAY (CH)	POORLY GRADED SAND (SP)
SANDY/ SILTY CLAY (CL)	WELL GRADED SAND (SW)
SANDY SILTY CLAY (CL)	CLAYEY GRAVEL (GC)
SILT (ML)	LIMESTONE (LS)
SILTY SAND (SM)	SHALE (SH)
CLAYEY SAND (SC)	TOPSOIL

GROUNDWATER DURING DRILLING

4/5/7 BLOW COUNTS

FIGURE NO. 7

10-29-2012 I:\GEOTECH\PROJECTS\2011\12-0383\MTECH BORING LOGS\REVISED BORINGS\CROSS-SECTION D-D.cro



SUNRISE COAL, LLC
1183 EAST CANVASBACK DRIVE
TERRE HAUTE, INDIANA 47802

PATRIOT ENGINEERING and Environmental Inc.

Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmi, IL

SOIL PROFILE E-E'

COAL REFUSE IMPOUNDMENT NO. 1

BULLDOG MINE
ALLERTON-HOMER, INDIANA

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

CLAY (CH)	POORLY GRADED SAND (SP)
SANDY/ SILTY CLAY (CL)	WELL GRADED SAND (SW)
SANDY SILTY CLAY (CL)	CLAYEY GRAVEL (GC)
SILT (ML)	LIMESTONE (LS)
SILTY SAND (SM)	SHALE (SH)
CLAYEY SAND (SC)	TOPSOIL

GROUNDWATER DURING DRILLING
4/5/7 BLOW COUNTS

FIGURE NO. 8

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BORING LOGS

PATRIOT ENGINEERING and Environmental Inc.

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LOG OF BORING B-18

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Cloudy, 55F
Start Date	: 11/14/11	Latitude	: 39.9810531
Drilling Method	: HSA	Longitude	: -87.9089755

Water Levels
- During Drilling: Dry
- After Completion: 15 feet (Influenced by Coring)
- After 24-hours:

Depth in Feet	Surf. Elev. 684.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	684				TOPSOIL (10")						
			CL		Tan & Brown Mottled, moist, medium stiff to stiff, SILTY CLAY	1	100	4/5/5			
			CL		Light Brown, slightly moist, stiff, SILTY CLAY with trace fine sand	2	100	5/6/5			
5	679		CL		Light Brown, moist, stiff to very stiff, SILTY CLAY with trace to a little sand	3	67	5/5/6	1.75		
10	674					4	100	4/5/7	3.0		
15	669		ML		Gray, slightly moist, very stiff to hard, CLAYEY SILT with trace sand	5	100	9/8/9	>4.5		
20	664		GC		Gray, moist, medium dense, CLAYEY GRAVEL with trace sand	6	67	9/10/10			
25	659		CL		Gray, moist, very stiff to hard, SILTY CLAY with trace sand and trace small gravel	7	100	6/7/10	>4.5		
30	654					8	100	9/11/12	4.5		
35	649					9	100	9/7/9			
40	644					10	100	8/9/13	4.5		Sample No. 10: Atterberg Limits Tests - LL=23, PL=13, PI=10
45	639					11	100	12/15/17	>4.5		
50			CL		Bluish Gray, slightly moist, hard, SILTY CLAY	12	100	16/15/18	>4.5		

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LOG OF BORING B-18

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Cloudy, 55F
Start Date	: 11/14/11	Latitude	: 39.9810531
Drilling Method	: HSA	Longitude	: -87.9089755

Water Levels
During Drilling: Dry
After Completion: 15 feet (Influenced by Coring)
After 24-hours:

Depth in Feet	Surf. Elev. 684.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	634		CL		Bluish Gray, slightly moist, hard, SILTY CLAY						Boring caved to 51 feet upon auger removal.
55	629		ML		Gray, slightly moist, hard, CLAYEY SILT with trace sand	13	100	18/33/50-5"	>4.5		
60	624					14	100	20/27/31	>4.5		
65	619		CL		Bluish Gray, slightly moist, very stiff to hard, SILTY CLAY	15	100	11/17/18	3.5		
70	614		LS		Light Gray, heavily fractured, weathered, LIMESTONE	16	85				Auger refusal encountered at 68 feet. Sample No. 16: Rock cored from 68 to 78 feet. Rock Quality Designation: RQD = 56%
75	609										
80	604				Boring terminated at 78 feet.						
85	599										
90	594										
95	589										
100											

PATRIOT ENGINEERING and Environmental Inc.

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LOG OF BORING B-19

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Cloudy, 55F
Start Date	: 11/15/11	Latitude	: 39.9779168
Drilling Method	: HSA	Longitude	: -87.9089784

Water Levels
- During Drilling: Dry
- After Completion: 11 feet (Influenced by Coring)
- After 24-hours:

Depth in Feet	Surf. Elev. 681.3	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	681			TOPSOIL (30")	1	56	3/3/4			
			CL	Grayish Tan, moist, medium stiff to stiff, SILTY CLAY	2	22	3/3/3	1.75		
5	676		CL	Tan, very moist, medium stiff to very stiff, SILTY CLAY with trace sand	3	100	3/3/4	1.5		
10	671		CL	Gray, moist, stiff to very stiff, SANDY SILTY CLAY	4	100	3/5/5	2.0		
15	666				5	78	5/4/5	1.25		
20	661				6	100	4/5/7	3.0		
25	656		ML	Gray, moist, medium dense, SANDY SILT with trace clay	7	100	8/9/11			
30	651		CL	Gray, slightly moist, very stiff, SILTY CLAY with trace sand	8	100	4/5/8	2.5		
35	646		CL	Brown to Gray, slightly moist, hard, SANDY SILTY CLAY with trace gravel	9	0	50-5"			
40	641				10	22	13/14/16	>4.5		
45	636				11	100	8/14/22	>4.5		
50					12	100	10/16/24	>4.5		Sample No. 12: Atterberg Limits Tests - LL=35, PL=14, PI=21

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LOG OF BORING B-19

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Cloudy, 55F
Start Date	: 11/15/11	Latitude	: 39.9779168
Drilling Method	: HSA	Longitude	: -87.9089784

Water Levels
▼ During Drilling: Dry
▽ After Completion: 11 feet (Influenced by Coring)
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.3	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	631		CL		Brown to Gray, slightly moist, hard, SANDY SILTY CLAY with trace gravel						
55	626					13	0	16/14/17			
60	621					14	33	11/14/15	4.5		
65	616					15	100	9/9/17	4.25		
70	611					16	67	8/11/17	4.0		Boring caved to 72 feet upon auger removal.
75	606					17	67	22/17/28	4.5		
80	601		ML		Gray, moist, very stiff to hard, CLAYEY SILT with trace peat inclusions	18	78	11/15/19	3.75		
85	596					19	0	10/11/14			
90	591		CL		Gray, moist, very stiff, SILTY CLAY with trace fine sand	20	100	10/12/17	3.25		
95	586					21	100	8/17/22	3.0		
100			SH		Gray, heavily fractured, weathered SHALE with interbedded clay and silt seams	22	100				Auger refusal encountered at 98 feet.

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LOG OF BORING B-19

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Cloudy, 55F
Start Date	: 11/15/11	Latitude	: 39.9779168
Drilling Method	: HSA	Longitude	: -87.9089784

Water Levels
▼ During Drilling: Dry
▽ After Completion: 11 feet (Influenced by Coring)
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.3	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
100–108	581–573.3		SH		Gray, heavily fractured, weathered SHALE with interbedded clay and silt seams	22	100				Sample No. 22: Rock cored from 98 to 108 feet. Rock Quality Designation: RQD = 71%

Boring terminated at 108 feet.

Depth in Feet	Surf. Elev.
100	581
105	576
110	571
115	566
120	561
125	556
130	551
135	546
140	541
145	536
150	

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LOG OF BORING B-20

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 60F
Start Date	: 11/16/11	Latitude	: 39.9794776
Drilling Method	: HSA	Longitude	: -87.9069697

Water Levels
▼ During Drilling: 25 feet
▽ After Completion: 14 feet (Influenced by Coring)
◆ After 24-hours:

Depth in Feet	Surf. Elev. 684.0	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0				TOPSOIL (10")						
	681		CL	Brown, moist, medium stiff to stiff, SILTY CLAY	1	100	3/4/4	2.5		
5					2	78	4/5/6	2.0		
	676		CL	Reddish Gray to Tan, very moist, medium stiff to stiff, SILTY CLAY with trace fine sand	3	100	2/3/3	1.0		
10					4	67	4/5/5	1.5		
	671		CL	Gray, moist, very stiff to hard, SANDY SILTY CLAY with trace gravel						
15					5	100	8/8/9	4.5		
	666		ML	Gray, moist, medium dense, SILT with trace clay						
20					6	100	5/6/13			
	661		CL	Gray, moist, very stiff, SILTY CLAY						
25		▼			7	100	13/11/8	2.75		
	656		ML	Gray, moist, stiff to hard, CLAYEY SILT						
30					8	100	3/6/7	4.0		
	651									
35					9	100	5/11/14			
	646		CL	Reddish Brown, moist, very stiff to hard, SANDY SILTY CLAY with a little gravel						Boring caved to 36 feet upon auger removal.
40					10	100	6/8/13	4.5		
	641									
45			LS	Light Gray, highly weathered, LIMESTONE	11	28	50-5"			
	636		LS	Light Gray, weathered, LIMESTONE	12	90				Auger refusal encountered at 48 feet.
50										

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LOG OF BORING B-20

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 60F
Start Date	: 11/16/11	Latitude	: 39.9794776
Drilling Method	: HSA	Longitude	: -87.9069697

Water Levels
- During Drilling: 25 feet
- After Completion: 14 feet (Influenced by Coring)
- After 24-hours:

Depth in Feet	Surf. Elev. 684.0	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50–58	631, 626		LS		Light Gray, weathered, LIMESTONE	12	90				Sample No. 12: Rock cored from 48 to 58 feet. Rock Quality Designation: RQD = 44%

Boring terminated at 58 feet.

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100
Elevation scale: 631, 626, 621, 616, 611, 606, 601, 596, 591, 586

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LOG OF BORING B-21

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 45F
Start Date	: 11/16/11	Latitude	: 39.9810384
Drilling Method	: HSA	Longitude	: -87.9049609

Water Levels
▼ During Drilling: 19 feet
▽ After Completion: 12 feet (Influenced by Coring)
◆ Ater 24-hours:

Depth in Feet	Surf. Elev. 683.6	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683			TOPSOIL (10")						
			CL	Brown, moist, medium stiff to very stiff, SILTY CLAY with trace sand and small gravel	1	100	3/4/4	2.0		
5	678				2	100	4/4/4	2.0		
					3	100	3/4/5	2.5		
10	673				4	100	5/6/7	2.25		
			CL	Gray, moist, stiff to very stiff, SILTY CLAY with trace sand						
15	668				5	100	5/5/5	2.0		
		▼	ML	Gray, moist, medium dense, SILT with trace clay						
20	663				6	100	11/9/9			
			CL	Gray, very moist, stiff, SILTY CLAY with trace fine sand						
25	658				7	100	4/5/5	1.0		
			CL	Gray, moist, very stiff to hard, SILTY CLAY with sand and small gravel	8	100	6/9/12	4.5		
30	653									
35	648				9	100	6/7/11			Boring caved to 33 feet upon auger removal.
40	643			limestone fragments encountered at about 39 feet.	10	67	12/9/15			
			GR	GRANITE cobble						
			LS	Light Gray, highly weathered, LIMESTONE						Auger refusal encountered at 43 feet.
45	638		SH	Gray, weathered, SHALE and MUDSTONE	11	60				Sample No. 11: Rock cored from 43 to 53 feet. Rock Quality Designation: RQD = 35%
50										

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LOG OF BORING B-21

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 45F
Start Date	: 11/16/11	Latitude	: 39.9810384
Drilling Method	: HSA	Longitude	: -87.9049609

Water Levels
- During Drilling: 19 feet
- After Completion: 12 feet (Influenced by Coring)
- Ater 24-hours:

Depth in Feet	Surf. Elev. 683.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	633		SH		Gray, weathered, SHALE and MUDSTONE	11	60				
			LS		Light Gray, LIMESTONE						
55	628				Boring terminated at 53 feet.						
60	623										
65	618										
70	613										
75	608										
80	603										
85	598										
90	593										
95	588										
100											

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LOG OF BORING B-22

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/1/11&11/17/11	Latitude	: 39.9758633
Drilling Method	: HSA	Longitude	: -87.9063575

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682				TOPSOIL (6")						Boring conducted to 100-feet on November 1, 2011 then terminated. Boring was then extended to the termination depth shown on log on November 17, 2011.
			CL		Grayish Tan, moist, medium stiff to very stiff, SILTY CLAY	1	93	3/3/4	2.25		
5	677		ML		Grayish tan, slightly moist, loose, SANDY SILT with trace clay	2	100	5/5/5			
			ML		Tan, moist, medium stiff to stiff, CLAYEY SILT with trace fine sand and trace small gravel	3	100	7/5/6	2.5		
10	672					4	100	3/4/6	2.25		
15	667		SC		Gray, moist, dense, CLAYEY SAND with a little gravel	5	89	4/14/21			
			CL		Gray, slightly moist, very stiff to hard, SILTY CLAY with trace sand						
20	662					6	100	5/7/8	4.5		
25	657					7	100	5/6/9			
30	652					8	100	7/7/9	4.5		
35	647					9	0	50-5"			
40	642					10	100	14/18/19	>4.5		
45	637					11	100	14/23/28	>4.5		Sample No. 11: Atterberg Limits Test - LL=32, PL=15, PI=17
		▽ ▼									
50						12	27	14/14/19	>4.5		

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LOG OF BORING B-22

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/1/11&11/17/11	Latitude	: 39.9758633
Drilling Method	: HSA	Longitude	: -87.9063575

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	632		CL		Gray, slightly moist, very stiff to hard, SILTY CLAY with trace sand						
55	627		CH		Bluish Gray, moist, hard, CLAY with trace sand	13	67	23/24/24			
			ML		Gray, slightly moist, hard, CLAYEY SILT with trace sand and small gravel						
60	622					14	100	20/27/32	4.5		
65	617					15	100	14/20/29	>4.5		
70	612					16	100	7/14/18	>4.5		
75	607					17	100	7/14/21	>4.5		
80	602					18	100	9/13/18	>4.5		Boring caved to 81feet upon auger removal.
			ML		Dark Gray, slightly moist, hard, CLAYEY SILT						
85	597					19	100	13/19/28	4.25		
90	592					20	100	18/38/49	4.5		
95	587		CL		Gray, slightly moist, hard, SILTY CLAY with trace sand	21	100	15/16/21	>4.5		
			ML		Gray, slightly moist, hard, CLAYEY SILT with trace fine sand	22	100	12/19/19	4.5		
100											

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LOG OF BORING B-22

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/1/11&11/17/11	Latitude	: 39.9758633
Drilling Method	: HSA	Longitude	: -87.9063575

Water Levels
- During Drilling: 48 feet
- After Completion: 47 feet
- After 24-hours:

Depth in Feet	Surf. Elev. 682.6	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
100	582		ML		Gray, slightly moist, hard, CLAYEY SILT with trace fine sand						
105	577		CH		Bluish Gray, moist, hard, CLAY	23	100	21/29/19			
110	572		SH		Light Gray, highly weathered, SHALE with interbedded silt seams	24	11	50-2"			Auger refusal encountered at 111 feet.
115	567		SH		Gray, weathered, SHALE	25	99				Sample No. 25: Rock cored from 111 to 121 feet. Rock Quality Designation: RQD = 75%
120	562										
125	557				Boring terminated at 121feet.						
130	552										
135	547										
140	542										
145	537										
150											

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LOG OF BORING B-23

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/1/11	Latitude	: 39.9773797
Drilling Method	: HSA	Longitude	: -87.9042923

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.2	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682			TOPSOIL (36")	1	100	4/4/4	2.75		
			CL	Light brown, moist, medium stiff to very stiff, SILTY CLAY	2	100	4/3/4	3.0		
5	677				3	100	3/4/7	4.0		
10	672		CL	Brown, moist, very stiff to hard, SANDY CLAY	4	93	7/9/11	4.5		
15	667		CL	Gray, moist to slightly moist, very stiff to hard, SANDY SILTY CLAY	5	67	6/7/7	4.5		
20	662		CL	Gray, moist to slightly moist, very stiff to hard, SANDY SILTY CLAY	6	100	6/8/10	>4.5		
25	657				7	67	9/13/13	>4.5		
30	652		CL	Gray, moist to slightly moist, stiff to very stiff, SANDY SILTY CLAY	8	100	5/5/7	>4.5		
35	647		CL	Gray, moist to slightly moist, very stiff to hard, SANDY SILTY CLAY with a little gravel	9	100	12/9/13	>4.5		
40	642		CL	Brown, slightly moist, very stiff to hard, SANDY SILTY CLAY with some gravel	10	100	8/12/11	>4.5		Sample No. 10: Atterberg Limits Tests - LL=38, PL=13, PI=25 Boring caved to 41feet upon auger removal.
45	637			Granite Cobble encountered at 45 feet.	11	27	50-5"	>4.5		Auger refusal encountered at 45 feet.
		▽ ▼			12	100				
50										

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LOG OF BORING B-23

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/1/11	Latitude	: 39.9773797
Drilling Method	: HSA	Longitude	: -87.9042923

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.2	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	632		CL		Brown, slightly moist, very stiff to hard, SANDY SILTY CLAY with some gravel	12	100				Sample No. 12: Cored from 45 to 55 feet. Soil conditions encountered classified based on field observations.
55	627		CL		Grayish Brown, slighly moist, hard, SILTY CLAY with trace sand	13	40				Sample No. 13: Cored from 55 to 60 feet. Soil conditions encountered classified based on field observations.
60	622				Boring terminated at 60 feet.						
65	617										
70	612										
75	607										
80	602										
85	597										
90	592										
95	587										
100											

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LOG OF BORING B-23A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/17/11	Latitude	: 39.9773797
Drilling Method	: HSA	Longitude	: -87.9042923

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.2	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682				Blank drilled from 0 to 63.5 feet. Refer to Boring B-23 for descriptions of soil strata.						Boring B-23A offset 5 feet east of Boring B-23.
5	677										
10	672										
15	667										
20	662										
25	657										
30	652										
35	647										
40	642										
45	637										Boring caved to 45 feet upon auger removal.
		▽ ▼									
50											

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LOG OF BORING B-23A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Mostly Sunny, 55F
Start Date	: 11/17/11	Latitude	: 39.9773797
Drilling Method	: HSA	Longitude	: -87.9042923

Water Levels
▼ During Drilling: 48 feet
▽ After Completion: 47 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.2	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	632				Blank drilled from 0 to 63.5 feet. Refer to Boring B-23 for descriptions of soil strata.						
55	627										
60	622										
65	617		CL		Grayish brown, slighlty moist, hard, SILTY CLAY with trace sand	1	0	50-5"			
			ML		Gray, slightly moist, very stiff to hard, CLAYEY SILT with trace peat inclusions						
70	612					2	100	17/21/31	>4.5		
75	607					3	100	6/10/11	4.5		
80	602		GR		Gray, GRANITE fragments	4	27	50-5"			
			LS		Gray, fractured, LIMESTONE						Auger refusal encountered at 82 feet.
85	597		SH		Black to gray, weathered, SHALE with interbedded clay seams	5	90				Sample No. 5: Rock cored from 82 to 92 feet. Rock Quality Designation: RQD = 28%
90	592										
95	587				Boring terminated at 92 feet.						
100											

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LOG OF BORING B-23B

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 70F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
- During Drilling: 6 feet
- After Completion: Dry
- After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				Boring B-23B offset 5 feet east from boring B-23A. Refer to Boring B-23 for a description of soil strata.	1	44			23	Sample No. 1: Shelby tube pushed from 1 to 3 feet. Loss On Ignition (LOI) Organic Content = 5.4%
						2	58			24	Boring caved to 4 feet upon auger removal.
5	678	▼ (6 ft)				3	100			24	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
						4	38			19	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
10	673										Sample No. 4: Shelby tube pushed from 8 to 10 feet.
15	668				Boring terminated at 15 feet.						
20	663										
25	658										
30											

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LOG OF BORING B-24

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 10/31/11	Latitude	: 39.9788961
Drilling Method	: HSA	Longitude	: -87.9022270

Water Levels
- During Drilling: Dry
- After Completion: 7 feet (Influenced by Coring)
- After 24-hours:

Depth in Feet	Surf. Elev. 681.2	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	681				TOPSOIL (18")						
			CL		Dark Gray, moist, medium stiff to stiff, SILTY CLAY	1	33	3/4/6	2.0		
5	676		CL		Light Brown, moist, medium stiff to stiff, SILTY CLAY with trace sand	2	33	3/3/4			
						3	100	5/5/7			
10	671					4	89	4/5/7			
			ML		Gray, moist, very stiff to hard, SANDY CLAYEY SILT with trace gravel						
15	666					5	56	7/7/7	4.5		
			SM		Light Brown, slightly moist, medium dense, fine grained, SILTY SAND						
20	661					6	33	7/8/9			
			CL		Grayish Tan, moist, very stiff, SANDY SILTY CLAY						
25	656					7	33	8/9/10	3.0		
30	651					8	27	9/9/13	4.0		
			ML		Gray & Brown, slighly moist, hard, CLAYEY SILT with some sand and gravel						
35	646					9	0	40/40/35			
40	641					10	33	26/28/33	>4.5		
45	636					11	100	28/36/26			
50			CL		Tannish Gray, moist, very stiff to hard, SILTY CLAY with trace fine sand	12	100	12/15/16	4.0		

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LOG OF BORING B-24

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; NQ core
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 10/31/11	Latitude	: 39.9788961
Drilling Method	: HSA	Longitude	: -87.9022270

Water Levels
▼ During Drilling: Dry
▽ After Completion: 7 feet (Influenced by Coring)
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.2	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
50	631		CL		Tannish Gray, moist, very stiff to hard, SILTY CLAY with trace fine sand	13	33	10/8/15	4.5		Boring caved to 51feet upon auger removal.
55	626		SS		Tan and Brown, highly weathered, SANDSTONE						Auger refusal encountered at 56 feet.
60	621		LS		Light Gray, highly fractured, highly weathered, LIMESTONE with appreciable vugs Void encountered from 57 to 58 feet.	14	80				Sample No. 14: Rock cored from 56 to 66 feet. Rock Qualtiy Designation: RQD = 52%
65	616										
70	611				Boring terminated at 66 feet.						
75	606										
80	601										
85	596										
90	591										
95	586										
100											

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LOG OF BORING B-25

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/6/12	Latitude	: 39.9803569
Drilling Method	: HSA	Longitude	: -87.9085654

Water Levels
▼ During Drilling: 8 feet
▽ After Completion: 14 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 684.8	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	684			Topsoil (10")						
			CL	Dark Brown to Brown, moist, medium stiff, SILTY CLAY	1	67	2/3/4		21	
			CL	Gray & Tan Mottled, moist, soft to medium stiff, SILTY CLAY with trace sand	2	33	2/2/2	1.0	17	
5	679		CL	Light Brown, moist, medium stiff to stiff, SILTY CLAY with a little sand and trace gravel	3	92			16	Sample No. 3: Shelby tube pushed from 5 to 7 feet. Unconfined Compressive Strength Test: Qu = 1.0 tsf
		▼	CL	Light Brown, moist, medium stiff to stiff, SANDY CLAY	4	100	4/4/5	1.75	12	
10	674		CL	Gray, slightly moist, very stiff to hard, SANDY CLAY with trace to a little gravel	5	100	7/5/7	4.0	11	
		▽			6	100	7/9/9	4.5	10	Sample No. 6: Atterberg Limits Tests: LL=19, PL=12, PI=17
15	669				7	78	13/13/10	>4.5	11	
			ML	Gray, slighltly moist to moist, very stiff to hard, SANDY CLAYEY SILT	8	67	6/7/10	>4.5	12	
20	664				9	78	13/12/8		21	Sample No. 9: Atterberg Limits Tests: LL=20, PL=18, PI=2
			SM	Gray, wet, medium dense, SILTY SAND with trace clay	10	0	8/12/13			Sample No. 10: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
25	659		ML	Gray, moist, stiff, CLAYEY SILT	11	56	6/7/8		19	Boring caved to 26 feet upon auger removal.
			CL	Gray, moist, very stiff to hard, SILTY CLAY with a little sand and trace small gravel	12	100	9/11/17	>4.5	12	
30										

Boring terminated at 30 feet.

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LOG OF BORING B-26

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/10/12	Latitude	: 39.9803306
Drilling Method	: HSA	Longitude	: -87.9064844

Water Levels
▼ During Drilling: 21feet
▽ After Completion: 8 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683			TOPSOIL (36")	1	33	5/5/7	2.5	25	
			CL	Gray & Brown Mottled, very moist to moist, medium stiff to very stiff, SILTY CLAY with trace to some gravel	2	56	2/3/3	1.0	27	Sample No. 2: Atterberg Limits Tests: LL=48, PL=18, PI=30
5	678				3	54		2.0	17	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
		▽	CL	Light Brown, moist, stiff, SILTY CLAY with trace sand and small gravel	4	100	3/5/5	1.5	15	
10	673				5	78	4/5/6	1.75	14	
			CL	Light Brown, moist, very stiff, SANDY SILTY CLAY	6	56	11/12/7		17	
15	668				7	0	9/9/10			Samples No. 7 & No. 8: Splitspoon sampler driven twice with no recovery. Classifications based on field observations.
					8	0	50-4"			
20	663	▼	ML	Gray, moist, stiff to very stiff, CLAYEY SILT	9	100	4/5/5	1.25	17	Boring caved to 18 feet upon auger removal.
					10	56	5/6/5	1.5	19	
25	658				11	100	12/13/17	2.0	18	
					12	67	11/10/11	2.0	20	
30										

Boring terminated at 30 feet.

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LOG OF BORING B-26A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 70F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
▼ During Drilling: 7.5 feet
▽ After Completion: 5.5 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0–15.5		▽ 5.5; ▼ 7.5			Boring B-26A offset 5 feet east from boring B-26. Refer to Boring B-26 for a description of soil strata.						
						1	40			24	Sample No. 1: Shelby tube pushed from 1 to 3 feet. Loss on Ignition (LOI) Organic Content = 3.8%
						2	71			29	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
						3	92				Sample No. 3: Shelby tube pushed from 5 to 7 feet.
						4	100			18	Sample No. 4: Shelby tube pushed from 8 to 10 feet. Boring caved to 10.5 feet upon auger removal.
						5	42			17	Sample No. 5: Shelby tube pushed from 13 to 15 feet

Boring terminated at 15.5 feet.

Depth scale: 0, 5, 10, 15, 20, 25, 30 feet; Elevation scale: 683, 678, 673, 668, 663, 658

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LOG OF BORING B-27

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 50F
Start Date	: 4/10/12	Latitude	: 39.9803325
Drilling Method	: HSA	Longitude	: -87.903908

Water Levels
▼ During Drilling: 6 feet
▽ After Completion: 6 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.37	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	681			TOPSOIL (12")						
			CL	Grayish Brown, moist, medium stiff to stiff, SILTY CLAY	1	44	3/3/4	1.25	24	
5	676	▼	CL	Gray & Brown Mottled, very moist, medium stiff, SILTY CLAY with trace sand and small gravel	2	67	7/3/3	0.75	25	Sample No. 2: Atterberg Limits Tests: LL=41, PL=18, PI=23
			CL	Light Brown, moist, medium stiff, SANDY CLAY	3	100	3/3/3	0.75	15	
10	671				4	0	5/6/9			Sample No. 4: Split-spoon sampler driven twice with no recovery. Classification based on field observation.
			ML	Gray, moist, hard, CLAYEY SILT with trace fine sand	5	89	11/22/32		17	
15	666				6	78	16/26/27			
					7	67	11/24/20		20	Boring caved to 17.5 feet upon auger removal
20	661		SC	Gray, very moist, loose, CLAYEY SAND	8	100	3/3/5			
			SM	Gray, moist, medium dense, fine to medium grained, SILTY SAND with trace clay	9	100	11/16/9			
25	656		ML	Gray, moist, medium stiff to stiff, CLAYEY SILT with trace fine sand	10	100	3/3/4		18	
					11	67	4/4/5	1.0	21	
30			CL	Gray, slightly moist, very stiff to hard, SANDY SILTY CLAY with trace small gravel	12	100	8/10/12	4.25	10	

Boring terminated at 30 feet

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LOG OF BORING B-28

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9797293
Drilling Method	: HSA	Longitude	: -87.9075741

Water Levels
▼ During Drilling: 16 feet
▽ After Completion: 13 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 688.35	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	688			TOPSOIL (10")						
			CH	Brown to Light Brown, moist, medium stiff to soft, CLAY with trace sand	1	56	3/4/5		24	Sample No. 1: Atterberg Limits Tests: LL=54, PL=23, PI=31
					2	0	3/1/2			Sample No. 2: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
5	683		CL	Brown, moist to very moist, very stiff, SILTY CLAY	3	100		2.0	20	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
			CL	Brown, very moist, medium stiff, SILTY SANDY CLAY with some gravel						
			SC	Brown, moist, CLAYEY SAND						
			CL	Brown, moist, stiff, SILTY CLAY with trace sand and gravel	4	50		1.5	16	Sample No. 4: Shelby tube pushed from 8 to 10 feet.
10	678				5	100	12/8/10	1.75	15	
		▽			6	100		1.0	16	Sample No. 6: Shelby tube pushed from 13 to 15 feet.
15	673	▼	SC	Light Brown, wet, dense, CLAYEY SAND and gravel	7	67	10/15/25			
			CL	Brown, moist, very stiff, SANDY CLAY with trace gravel	8	56	9/9/10		13	
20	668		ML	Gray, moist, dense, SANDY SILT with trace clay	9	56	16/18/13			Boring caved to 21 feet upon auger removal.
			ML	Gray, moist, hard, CLAYEY SILT with trace fine sand	10	89	5/16/31		18	
25	663				11	78	10/13/13		19	
			CH	Gray, moist, medium stiff to stiff, CLAY	12	100	6/4/5	1.25	22	
30										

Boring terminated at 30 feet.

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LOG OF BORING B-29

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 50F
Start Date	: 4/10/12	Latitude	: 39.9797358
Drilling Method	: HSA	Longitude	: -87.90458425

Water Levels
▼ During Drilling: 18 feet
▽ After Completion: 10 feet
◆ After 24-hours:

Depth in Feet / Surf. Elev. 681.21: 0 – 681; 5 – 676; 10 – 671 (▽); 15 – 666; 18 (▼); 20 – 661; 25 – 656; 30

USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
	TOPSOIL (11")						
CH	Gray & Brown Mottled, very moist to moist, medium stiff to stiff, CLAY with trace fine sand	1	67	4/4/5	2.0	25	
		2	58		2.0	27	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
		3	100	3/3/5	2.5	15	
SM	Brown, very moist, loose to medium dense, fine grained, SILTY SAND with trace clay	4	100	3/4/5			
		5	67	4/3/4			
		6	0	6/7/7			Sample No. 6: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
SC	Gray, very moist, dense, CLAYEY SAND with some gravel	7	67	7/13/30			
SC	Gray, very moist, loose to medium dense, fine grained, CLAYEY SAND	8	78	3/2/7			Boring caved to 18 feet upon auger removal.
		9	67	4/5/6			
		10	0	7/13/12			Sample No. 10: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
CL	Gray, moist, stiff to very stiff, SANDY CLAY	11	67	6/7/7	2.5		
		12	0	19/20/20			Sample No. 12: Splitspoon sampler driven twice with no recovery. Classification based on field observation.

Boring terminated at 30 feet.

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LOG OF BORING B-30

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 50F
Start Date	: 4/6/12	Latitude	: 39.9790869
Drilling Method	: HSA	Longitude	: -87.9085908

Water Levels
▼ During Drilling: 27 feet
▽ After Completion: 7 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 686.64	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	686			TOPSOIL (18")						
			CL	Gray & Tan Mottled, moist, medium stiff to stiff, SANDY SILTY CLAY	1	67	4/4/5		21	
5					2	67	4/3/4		14	
	681	▽	CL	Tan, moist, medium stiff to very stiff, SANDY SILTY CLAY	3	78	4/5/6	3.0	15	
10					4	100	5/5/5		15	
	676				5	78	7/7/9	4.0	12	
15			CL	Gray, moist, stiff to very stiff, SANDY SILTY CLAY with trace small gravel	6	67	6/5/8		12	
	671		ML	Gray, moist, medium dense, SANDY SILT with trace clay	7	78	7/9/10			
20			CL	Gray, slighlty moist, hard, SANDY SILTY CLAY with some gravel	8	100	7/11/12	>4.5	10	Boring caved to 19 feet upon auger removal
	666				9	0	10/11/24			Sample No. 9: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
25			SC	Gray, very moist, medium dense, fine to medium grained, CLAYEY SAND	10	67	9/9/8			
	661	▼	CL	Gray, slightly moist, very stiff, SILTY CLAY with a little sand	11	100	8/8/10	2.5	14	
30			CL	Gray, slightly moist, very stiff to hard, SANDY SILTY CLAY with trace small gravel	12	78	6/9/12	>4.5	11	

Boring terminated at 30 feet.

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LOG OF BORING B-31

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9790891
Drilling Method	: HSA	Longitude	: -87.9060200

Water Levels
▼ During Drilling: 10 feet
▽ After Completion: 6 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.69	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682				TOPSOIL (13")						
			CH		Grayish Tan, very moist, medium stiff to stiff, CLAY	1	56	4/3/4	1.0	26	Sample No.1: Atterberg Limits Tests: LL=59, PL=22, PI=37
5	677	▽	CL		Grayish Tan, moist, medium stiff to stiff, SILTY CLAY with some sand	2	67	2/3/4	2.5	17	Sample No. 2: Atterberg Limits Tests: LL=28, PL=16, PI=12
			CL		Brown, moist, medium stiff to very stiff, SANDY SILTY CLAY	3	89	3/4/5		17	Sample No. 3: Atterberg Limits Tests: LL=26, PL=16, PI=10
10	672	▼				4	100	5/5/6	3.25	14	Sample No. 4: Atterberg Limits Tests: LL=25, PL=14, PI=11
						5	67	6/7/6	3.0	15	Sample No. 5: Atterberg Limits Tests: LL=23, PL=15, PI=8
15	667		SP		Grayish Brown, wet, medium dense to dense, medium to coarse grained, SAND with trace silt and gravel	6	100	13/14/16			Boring caved to 14 feet upon auger removal.
			SM		Brown, wet, medium dense, fine grained, SILTY SAND	7	67	11/10/10			
20	662		ML		Gray, moist to very moist, medium stiff to stiff, CLAYEY SILT with trace gravel	8	50			23	Sample No. 8: Shelby tube pushed from 18 to 20 feet.
			SP-SM		Grayish Tan, wet, medium dense, SAND with some silt	9	78	17/13/12			
25	657					10	0				
			ML		Gray, very moist, stiff, CLAYEY SILT with trace fine sand	11	67	3/5/5	1.25		
			SP		Grayish Brown, wet, fine to medium grained, SAND						Sample No. 12: Shelby tube pushed from 28 to 30 feet.
30			CL		Gray, moist, very stiff, SILTY CLAY with trace sand and gravel	12	100		3.0	21	

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LOG OF BORING B-31

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9790891
Drilling Method	: HSA	Longitude	: -87.9060200

Water Levels
During Drilling: 10 feet
After Completion: 6 feet
After 24-hours:

Depth in Feet	Surf. Elev. 682.69	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
30	652		CL		Gray, moist, stiff to very stiff, SILTY CLAY with trace sand and gravel						
			CL		Gray, slightly moist, hard, SANDY SILTY CLAY with trace small gravel	13	78	9/13/17	>4.5	11	
						14	67	5/8/10	>4.5	13	
35	647		CH		Gray, moist, stiff, CLAY with trace sand	15	78	6/6/7	1.0	17	
			CL		Gray, slightly moist, hard, SANDY CLAY with trace small gravel	16	89	17/21/29	4.5	10	
40	642				Boring terminated at 40 feet.						
45	637										
50	632										
55	627										
60											

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LOG OF BORING B-32

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 40F
Start Date	: 4/10/12	Latitude	: 39.9791006
Drilling Method	: HSA	Longitude	: -87.9038818

Water Levels
▼ During Drilling: 14 feet
▽ After Completion: 12 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.32	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	681			TOPSOIL (36")	1	56	3/3/4	1.75	23	
			CL	Gray & Tan Mottled, moist, medium stiff to stiff, SILTY CLAY with trace sand	2	56	3/3/3	1.25	20	Sample No. 2: Atterberg Limits Tests: LL=28, PL=15, PI=13
5	676		CL	Grayish Tan, moist, stiff to very stiff, SANDY SILTY CLAY	3	67	5/5/6	2.0	16	Sample No. 3: Atterberg Limits Tests: LL=26, PL=15, PI=11
					4	0	11/6/7			Sample No. 4: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
10	671	▽	CL	Gray, slightly moist, very stiff to stiff, SANDY SILTY CLAY	5	67	10/10/8	2.75	13	Sample No. 5: Atterberg Limits Tests: LL=19, PL=13, PI=6
		▼			6	56	5/5/6	2.5	13	
15	666				7	67	6/5/7	2.5	11	
			ML	Gray, moist, stiff to very stiff, CLAYEY SILT with trace fine sand	8	78	5/7/8	2.75	20	
20	661				9	89	6/6/8	2.5	20	Boring caved to 21 feet upon auger removal.
			CL	Gray, moist, stiff, SILTY CLAY with trace sand	10	67	6/7/8		17	
25	656		ML	Gray, moist, stiff to very stiff, CLAYEY SILT	11	67	7/5/7	3.5	18	
			CL	Gray, slightly moist, stiff, SANDY SILTY CLAY	12	100	7/7/10	1.75	12	
30										

Boring terminated at 30 feet.

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LOG OF BORING B-32A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 70F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
▼ During Drilling: 6 feet
▽ After Completion: 8.5 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				Boring B-32A offset 5 feet east from boring B-32. Refer to Boring B-32 for a description of soil strata.	1	33			23	Sample No. 1: Shelby tube pushed from 1 to 3 feet.
						2	71			21	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
5	678	▼				3	100				Sample No. 3: Shelby tube pushed from 5 to 7 feet.
		▽				4	100			16	Sample No. 4: Shelby tube pushed from 8 to 10 feet. Unconfined Compressive Strength: Qu = 2.3 tsf
10	673										Boring caved to 10 feet upon auger removal.
						5	77			15	Sample No. 5: Shelby tube pushed from 13 to 15 feet
15	668				Boring terminated at 15 feet.						
20	663										
25	658										
30											

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LOG OF BORING B-33

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/6/12	Latitude	: 39.9783871
Drilling Method	: HSA	Longitude	: -87.9075433

Water Levels
▼ During Drilling: 18 feet
▽ After Completion: 10 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.16	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				TOPSOIL (36")	1	22	2/2/4		21	
			CL		Gray & Brown Mottled, moist, medium stiff to stiff, SANDY SILTY CLAY	2	0	2/3/3			
5	678					3	63		1.0	19	Sample No. 3: Shelby tube pushed from 6 to 8 feet. Unconfined Compressive Strength Test: Qu = 0.9 tsf
						4	89	3/3/5	1.0	15	
10	673	▽	CL		Grayish Brown, moist, stiff to very stiff, SILTY CLAY with trace sand	5	89	4/5/6	2.0	15	
			CL		Gray, slightly moist, very stiff to hard, SANDY SILTY CLAY with trace small gravel	6	78	5/9/9	4.25	10	
15	668		ML		Gray, very moist to moist, stiff to medium stiff, CLAYEY SILT with trace sand	7	78	7/7/8	4.0	24	
		▼				8	78	4/5/7		24	
20	663					9	67	4/2/7		13	
			CL		Gray, slightly moist, very stiff to hard, SILTY CLAY with a little sand and trace gravel	10	78	3/7/7	4.5	11	Boring caved to 23 feet upon auger removal.
25	658					11	67	5/8/9	>4.5	11	
			ML		Gray, moist, very stiff to hard, CLAYEY SILT	12	89	8/12/11	4.5	18	
30											

Boring terminated at 30 feet.

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LOG OF BORING B-33A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 70F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
During Drilling: Dry
After Completion: Dry
After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				Boring B-33A offset 5 feet east from boring B-33. Refer to Boring B-33 for a description of soil strata.	1	42			21	Sample No. 1: Shelby tube pushed from 1 to 3 feet.
						2	50			24	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
5	678					3	71			26	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
						4	100			17	Sample No. 4: Shelby tube pushed from 8 to 10 feet. Unconfined Compressive Strength: Qu = 1.5 tsf
10	673										Boring caved to 10 feet upon auger removal.
						5	100			17	Sample No. 5: Shelby tube pushed from 13 to 15 feet.
15	668				Boring terminated at 15 feet.						
20	663										
25	658										
30											

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LOG OF BORING B-34

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9784248
Drilling Method	: HSA	Longitude	: -87.9045731

Water Levels
- During Drilling: 13.5 feet
- After Completion: 9 feet
- After 24-hours:

Depth in Feet	Surf. Elev. 682.16	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682				TOPSOIL (18")						
			SM		Gray & Tan Mottled, very moist, SILTY SAND with trace clay	1	42				Sample No. 1: Shelby tube pushed from 1 to 3 feet.
			CL		Gray, Tan & Brown mottled, moist, soft to medium stiff, SILTY SANDY CLAY	2	100	2/3/3	0.50	16	
5	677										
			CL		Grayish Tan, moist, medium stiff to very stiff, SILTY SANDY CLAY with trace small gravel	3	67	3/4/5		17	
		▽				4	78	3/6/8	2.75	14	
10	672										
						5	67	4/3/4	3.0	14	Borings caved to 12 feet upon auger removal.
		▼									
			ML		Gray, wet, medium dense to loose, SANDY SILT with trace clay	6	67	9/12/14			
15	667										
						7	78	10/11/13			
						8	67	3/4/5			
20	662										
			CL		Gray, moist, stiff, SILTY CLAY with trace to a little sand	9	67	5/6/6	1.5	18	
			CL		Gray, moist, very stiff to hard, SILTY CLAY with a little sand and trace small gravel	10	89	7/8/8	4.5	12	
25	657										
						11	67	8/9/11	>4.5	11	
						12	100	7/11/13	>4.5	12	
30											

Boring terminated at 30 feet.

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LOG OF BORING B-35

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9777813
Drilling Method	: HSA	Longitude	: -87.9060221

Water Levels
▼ During Drilling: 10 feet
▽ After Completion: 10 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.4	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683			TOPSOIL (7")						
			CH	Gray & Brown Mottled, very moist, medium stiff, CLAY with trace sand	1	67	3/3/4		32	
			CL	Brown, slightly moist, medium stiff to stiff, SANDY SILTY CLAY	2	56	3/4/6		14	Sample No. 2: Atterberg Limits Tests: LL=25, PL=15, PI=10
5	678				3	78	3/4/5	2.25	12	Sample No. 3: Standard Proctor & Remolded Permeability Testing
			CL	Gray, slightly moist, stiff to very stiff, SILTY CLAY with trace sand and gravel	4	100		2.5	13	Sample No. 4: Shelby tube pushed from 8 to 10 feet.
10	673	▼	CL	Brown, slightly moist, stiff to very stiff, SILTY SANDY CLAY with trace small gravel						
			CL	Brownish Gray, moist, very stiff to hard, SILTY CLAY with a little sand and trace gravel	5	100	5/6/8	4.5	12	
15	668				6	0	7/6/7			Sample No. 6: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
					7	56	6/8/13	4.5	12	
			CL	Tan, moist to very moist, soft, SILTY CLAY with trace to some sand and trace small gravel	8	100		0.25	22	Sample No. 8: Shelby tube pushed from 18 to 20 feet.
20	663		SP	Gray, wet, medium dense, medium to coarse grained, SAND with trace silt						Boring caved to 20 feet upon auger removal.
					9	67	9/8/8			
					10	92		3.5	12	Sample No. 10: Shelby tube pushed from 23 to 25 feet.
25	658		CL	Gray, slightly moist, hard, SILTY CLAY with some sand and gravel						
					11	89	11/15/18	>4.5	12	
					12	67	7/8/11	>4.5	12	
30										

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LOG OF BORING B-35

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9777813
Drilling Method	: HSA	Longitude	: -87.9060221

Water Levels
- During Drilling: 10 feet
- After Completion: 10 feet
- After 24-hours:

Depth in Feet	Surf. Elev. 683.4	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
30	653		CL		Gray, slightly moist, hard, SILTY CLAY with some sand and gravel	13	67	9/10/12	4.5	11	
			CL		Gray, slightly moist, very stiff to hard, SANDY SILTY CLAY	14	78	5/11/25	3.5	13	
35	648		CL		Gray, slightly moist, hard, SILTY CLAY with some sand and gravel	15	67	7/10/19	>4.5	10	Sample No. 16: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
						16	0	11/17/25			
40	643				Boring terminated at 40 feet.						
45	638										
50	633										
55	628										
60											

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LOG OF BORING B-36

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/6/12	Latitude	: 39.9770876
Drilling Method	: HSA	Longitude	: -87.9075755"

Water Levels
- During Drilling: 9 feet
- After Completion: 10 feet
- After 24-hours:

Depth in Feet	Surf. Elev. 682.77	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682			TOPSOIL (36")	1	56	3/3/4	1.75	25	
5			CL	Grayish Tan, very moist, medium stiff to soft, SILTY CLAY with trace sand	2	56	2/2/3		24	
	677		CL	Light Brown, moist, medium stiff, SANDY SILTY CLAY						
			CL	Grayish Brown, moist, medium stiff to very stiff, SILTY CLAY with a little fine to medium grained sand and trace small gravel	3	100		0.5	17	Sample No. 3: Shelby tube pushed from 6 to 8 feet.
10		▼ ▽			4	67	3/4/6	2.25	15	
	672		CL	Grayish Brown, moist, stiff to very stiff, SILTY CLAY with trace fine sand	5	33	5/6/11	1.5	15	
15			CL	Gray, moist, very stiff, SILTY SANDY CLAY with a little small gravel	6	54		4.0	20	Sample No. 6: Shelby tube pushed from 13 to 15 feet.
	667		ML	Gray, moist, medium dense, SANDY SILT with trace clay	7	89	5/9/13			
20			CL	Gray, moist, very stiff to hard, SANDY SILTY CLAY with trace small gravel	8	89	6/6/7		11	Boring caved to 18 feet upon auger removal.
	662				9	78	6/8/9	4.5	13	
25					10	100	4/5/8		13	
	657				11	100	5/7/8	4.5	13	
30					12	89	4/7/10	>4.5	12	

Boring terminated at 30 feet.

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LOG OF BORING B-36A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 75F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
- During Drilling: Dry
- After Completion: Dry
- After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				Boring B-36A offset 5 feet east from boring B-36. Refer to Boring B-36 for a description of soil strata.	1	34			25	Sample No. 1: Shelby tube pushed from 1 to 3 feet. Boring caved to 3 feet upon auger removal.
						2	34			27	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
5	678					3	80			21	Sample No. 3: Shelby tube pushed from 5 to 7 feet. Atterberg Limits Tests - LL=29, PL=17, PI=12
						4	100			25	Sample No. 4: Shelby tube pushed from 8 to 10 feet. Atterberg Limits Tests - LL=39, PL=19, PI=20
10	673					5	34				Sample No. 5: Shelby tube pushed from 13 to 15 feet
15	668				Boring terminated at 15 feet.						
20	663										
25	658										
30											

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LOG OF BORING B-37

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9770914
Drilling Method	: HSA	Longitude	: -87.9045651

Water Levels
▼ During Drilling: Dry
▽ After Completion: Dry
◆

Depth in Feet	Surf. Elev. 681.86	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0					TOPSOIL (8")						
	681		CH		Grayish Brown, moist to very moist, medium stiff to soft, CLAY	1	56	3/3/3		24	Sample No.1: Atterberg Limits Tests: LL=57, PL=22, PI=35
						2	17	3/2/2		24	
5	676		CL		Tan, moist, medium stiff to stiff, SILTY CLAY with trace sand and small gravel	3	63		1.25	21	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
			CL		Brown, moist, medium stiff to stiff, SILTY CLAY with trace sand and gravel						
			CL		Brown, moist, medium stiff to stiff, SILTY CLAY with trace sand and small gravel	4	83		0.75	20	Sample No. 4: Shelby tube pushed from 8 to 10 feet.
10	671		CL		Gray, slightly moist, very stiff to hard, SANDY SILTY CLAY with trace small gravel	5	100	10/7/9	4.0	12	
						6	100	6/6/7		11	Sample No. 6: Shelby tube pushed from 13 to 15 feet.
15	666					7	67	5/7/8	4.25	11	
						8	78	5/8/11	4.25	13	Boring caved to 18 feet upon auger removal.
20	661					9	67	6/7/6		13	
25						10	100	5/7/9	4.5	11	
	656					11	67	6/10/12	>4.5	11	
30						12	89	7/8/8	4.5	11	

Boring terminated at 30 feet.

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LOG OF BORING B-38

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/6/12	Latitude	: 39.9764111
Drilling Method	: HSA	Longitude	: -87.9085816

Water Levels
▼ During Drilling: 7 feet
▽ After Completion: 12 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 682.87	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0				TOPSOIL (6")						
	682		CH	Dark Brown, very moist, medium stiff, CLAY	1	67	3/3/4		26	Sample No. 1: Atterberg Limits Tests: LL=60, PL=25, PI=35
5			CL	Gray, Tan & Brown mottled, moist to very moist, medium stiff to very soft, SANDY SILTY CLAY	2	0	4/4/4			Sample No. 2: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
	677	▼			3	56	1/1/2		23	Sample No. 3: Unconfined Compressive Strength Test: Qu=0.5 tsf
			CL	Gray & Tan Mottled, moist, stiff to very stiff, SILTY CLAY with a little sand	4	100	4/7/7	1.75	15	
10	672	▽	CL	Grayish Brown, slightly moist, very stiff to hard, SANDY SILTY CLAY with trace gravel	5	100	6/7/7		11	Boring caved to 12 feet upon auger removal.
15					6	0	9/17/18			Sample No. 6: Splitspoon sampler driven twice with no recovery. Classification based on field observation.
	667				7	100	6/7/8	4.0	12	
20					8	89	9/8/8	3.75	13	
	662				9	100	5/8/9	3.5	12	
25			CH	Gray, moist, very stiff, CLAY with a little sand and gravel	10	67	9/10/13	3.0	14	
	657				11	67	9/11/14	3.0	14	
30			CL	Gray, moist, very stiff to hard, SILTY CLAY with a little sand and trace small gravel	12	100	9/7/11	4.0	12	

Boring terminated at 30 feet.

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LOG OF BORING B-39

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 50F
Start Date	: 4/6/12	Latitude	: 39.9763982
Drilling Method	: HSA	Longitude	: -87.9060368

Water Levels
▼ During Drilling: Dry
▽ After Completion: 23 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 681.21	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	681			TOPSOIL (36")	1	33	4/4/4		25	Sample No. 1: Atterberg Limits Tests: LL=65, PL=26, PI=39
3			CL	Brown, moist, medium stiff to very stiff, SANDY CLAY with trace small gravel	2	67	3/3/4	1.5	14	
5	676				3	78	6/4/6	1.75	15	Sample No. 3: Atterberg Limits Tests: LL=23, PL=15, PI=18
					4	67	6/7/10	2.25	17	
10	671		CL	Gray, slightly moist, very stiff, SANDY SILTY CLAY with trace gravel	5	78	6/8/11	3.0	13	
13			CL	Gray, slightly moist, hard to very stiff, SANDY SILTY CLAY with trace small gravel	6	100	9/13/17	>4.5	12	
15	666				7	67	8/8/10	>4.5	12	
					8	89	5/7/6	>4.5	11	
20	661				9	89	5/5/6	2.5	11	
23		▽								
					10	67	5/6/7		13	Boring caved to 24 feet upon auger removal.
25	656				11	100	6/7/9	4.5	13	
30					12	0	6/7/8			Sample No. 12: Splitspoon sampler driven twice with no recovery. Classification based on field observation.

Boring terminated at 30 feet.

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LOG OF BORING B-39A

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Shelby Tube
Logged By	: T. Smith	Weather	: Sunny, 70F
Start Date	: 5/14/12		
Drilling Method	: HSA		

Water Levels
▼ During Drilling: 6.5 feet
▽ After Completion: 9.5 feet
◆ After 24-hours:

Depth in Feet	Surf. Elev. 683.54	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	683				Boring B-39A offset 5 feet east from boring B-39. Refer to Boring B-39 for a description of soil strata.	1	55			26	Sample No. 1: Shelby tube pushed from 1 to 3 feet. Loss on Ignition (LOI) Organic Content = 7.1%
						2	92			28	Sample No. 2: Shelby tube pushed from 3 to 5 feet.
5	678	▼				3	100			32	Sample No. 3: Shelby tube pushed from 5 to 7 feet.
		▽				4	100			18	Sample No. 4: Shelby tube pushed from 8 to 10 feet.
10	673										Boring caved to 10 feet upon auger removal.
						5					Sample No. 4: Shelby tube pushed from 13 to 14.5 feet.
15	668				Boring terminated at 14.5 feet.						
20	663										
25	658										
30											

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LOG OF BORING B-40

Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton - Homer, Illinois

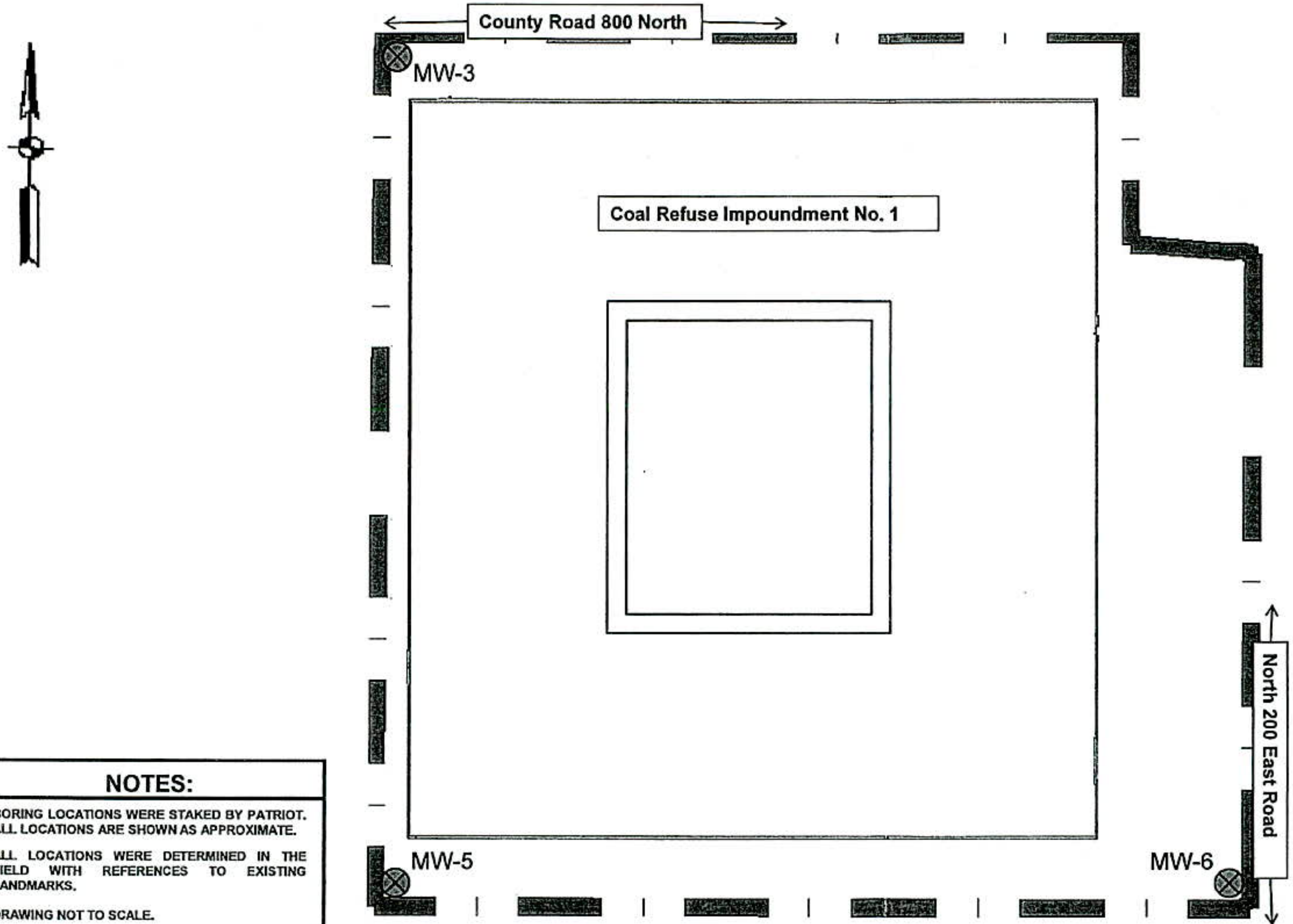
Client Name	: Sunrise Coal, LLC	Driller	: Gary Taylor
Project Number	: 2-11-0383	Sampling	: Splitspoon; Shelby Tube
Logged By	: T. Govert	Weather	: Sunny, 60F
Start Date	: 4/9/12	Latitude	: 39.9764088
Drilling Method	: HSA	Longitude	: -87.9038869

Water Levels
- During Drilling: Dry
- After Completion: Dry
- After 24-hours:

Depth in Feet	Surf. Elev. 682.77	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	Qp tsf	w %	REMARKS
0	682				TOPSOIL (10")						
			CH		Dark Gray, moist, medium stiff, CLAY	1	78	3/3/5		21	Sample No. 1: Atterberg Limits Tests: LL=54, PL=20, PI=34
						2	50				Sample No. 2: Shelby tube pushed from 3 to 5 feet.
5	677		ML		Reddish Gray, moist, medium stiff to stiff, CLAYEY SILT with trace fine sand	3	100	2/3/4	1.5	20	
			ML		Grayish Tan, moist, stiff to very stiff, CLAYEY SILT with a little fine sand	4	78	2/4/8	3.75	20	
10	672					5	67	4/5/7	3.25	21	
			CL		Gray, slightly moist, stiff to very stiff, SILTY CLAY with trace fine sand and trace gravel	6	67	6/5/6		13	
15	667					7	56	6/7/7		11	
						8	100	6/8/9	4.5	13	
20	662					9	67	7/8/10	3.5	12	Boring caved to 20 feet upon auger removal.
						10	78	5/6/6	2.0	12	
25	657					11	67	5/7/6	2.5	13	
			ML		Gray, slightly moist, stiff, CLAYEY SILT with trace fine sand	12	89	6/5/7		12	
30											

Boring terminated at 30 feet.

MONITORING WELL LOCATION MAP
(FIGURE NO. 9)



NOTES:

BORING LOCATIONS WERE STAKED BY PATRIOT. ALL LOCATIONS ARE SHOWN AS APPROXIMATE.

ALL LOCATIONS WERE DETERMINED IN THE FIELD WITH REFERENCES TO EXISTING LANDMARKS.

DRAWING NOT TO SCALE.

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Indianapolis, Indiana 46250

Monitoring Well Location Map
Coal Refuse Impoundment No. 1
Bulldog Mine
Allerton-Homer, Illinois

Job No.	2-11-0383	**Figure**	2

MONITORING WELL WATER LEVEL READINGS
(TABLE NO. 1)

TABLE NO. 4: GROUNDWATER ELEVATION TABLE

Groundwater Elevation (ft-msl)			
Sample	Well ID		
Date	MW-3	MW-5	MW-6
9/23/2011	672.8	671.2	672.2
10/20/2011	674.1	668.8	671.6
11/3/2011	674.5	668.8	671.4
12/1/2011	678.5	669.2	671.5
1/6/2012	679.1	678.5	674.1
2/14/2012	679.3	679.7	675.6
3/2/2012	679.1	679.6	675.6
4/5/2012	678.5	679.5	675.6
6/8/2012	677.1	679.1	675.4
8/10/2012	673.0	672.6	673.1
9/7/2012	673.3	668.5	671.9

MONITORING WELL LOGS

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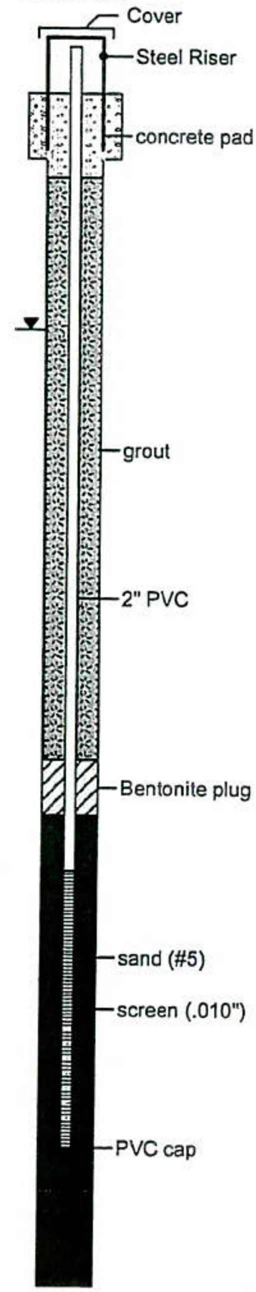
LOG OF BORING MW-3

Monitoring Well
Allerton Mine
Allerton-Homer, Illinois

Client Name	: Sunrise Coal, LLC	Latitude:	: 39.58'55"
Logged By	: T. Govert	Longitude	: 87.54'37"
Start Date	: 9/9/11		
Drilling Method	: HSA/ Washboring		
Driller	: G Taylor		

Depth in Feet	Surf. Elev. 681.8	Water Level	DESCRIPTION	REMARKS
0	682		Topsoil (6")	
			Brown & Gray Clay	
5	677			
		▼		Initial groundwater @ 673.3' on 9/13/11 prior to developing; Bailed clear to 20-ft
10	672			
15	667			
			Glacial Till	
20	662			
25	657			
30	652			
35	647			
			Limestone	Auger-drilled to 38-feet (refusal on rock); rotary drilled to 43-feet
40	642			
				Boring terminated at 43-ft.
45				

Well: MW-3
Elev.: 683.8



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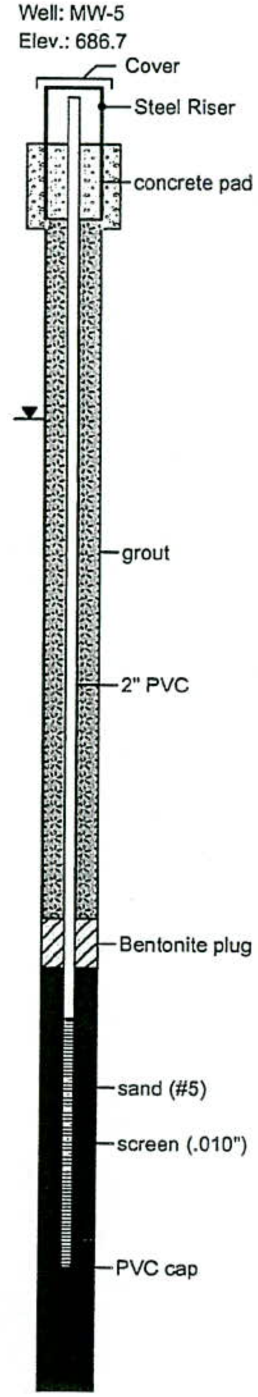
LOG OF BORING MW-5

Monitoring Well
Allerton Mine
Allerton-Homer, Illinois

Client Name	: Sunrise Coal, LLC	Latitude:	: 39.58'29"
Logged By	: T. Govert	Longitude	: 87.54'37"
Start Date	: 9/9/11		
Drilling Method	: HSA/ Washboring		
Driller	: G Taylor		

Depth in Feet	Surf. Elev. 683.7	Water Level	GRAPHIC	DESCRIPTION	REMARKS
0	683			Topsoil (9") Brown & Gray Clay	
5	678				
10	673	▼			Initial groundwater @ 672.7' on 9/13/11 prior to developing; Bailed clear to 23.4-ft
15	668				
20	663			Glacial Till	
25	658				
30	653				
35	648				
40	643				
45	638			Limestone	Auger-drilled to 45-feet (refusal on rock); rotary drilled to 50-feet
50					Boring terminated at 50-ft.



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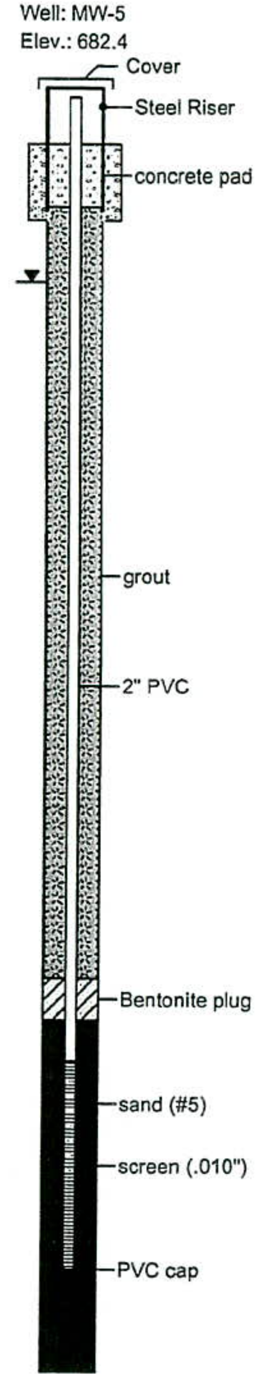
LOG OF BORING MW-6

Monitoring Well
Allerton Mine
Allerton-Homer, Illinois

Client Name	: Sunrise Coal, LLC	Latitude:	: 39.58'29"
Logged By	: T. Govert	Longitude	: 87.54'03"
Start Date	: 9/9/11		
Drilling Method	: HSA/ Washboring		
Driller	: G Taylor		

Depth in Feet	Surf. Elev. 679.2	DESCRIPTION	REMARKS
0	679	Topsoil (9") Brown & Gray Clay	
5	674		Initial groundwater @ 672.6' on 9/13/11 prior to developing; Bailed clear to 34.3-ft
10	669		
15	664		
20	659		
25	654	Glacial Till	
30	649		
35	644		
40	639		
45	634		
50	629		
55	624	Limestone	Auger-drilled to 54-feet (refusal on rock); rotary drilled to 59-feet
60			Boring terminated at 59-ft.



BORING LOG KEY

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success

BORING LOG KEY

UNIFIED SOIL CLASSIFICATION SYSTEM
FIELD CLASSIFICATION SYSTEM
FOR SOIL EXPLORATION

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	-4 blows/ft. or less
Loose	-5 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

Grain Size Terminology

Soil Fraction		Particle Size	US Standard Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to12"	3" to 12"
Gravel:	Coarse	¾" to 3"	¾" to 3"
	Small	4.76mm to ¾"	#4 to ¾"
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074 mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

RELATIVE PROPORTIONS FOR SOILS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Field Identification	Unconfined Compressive Strength (tons/sq. ft.)
Very Soft	Thumb will penetrate soil more than 1 inch	Less than 0.25
Soft	Thumb will penetrate soil about 1 inch	0.25 – < 0.5
Medium Stiff	Thumb will penetrate soil about ½ inch	0.5 - < 1.0
Stiff	Thumb will indent soil about ¼ inch	1.0 - < 2.0
Very Stiff	Readily indented by thumbnail	2.0 - < 4.0
Hard	Indented with difficulty by thumbnail	Over 4.0

Classification on logs are made by visual inspection.

Standard Penetration Test - Driving a 2.0" O.D., $1^{3/8}$" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for **Patriot** to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the drill log (Example - 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8 + 9 = 17 blows/ft.).

Strata Changes - In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (———) represents an actually observed change, a dashed line (- - - - - -) represents an estimated change.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

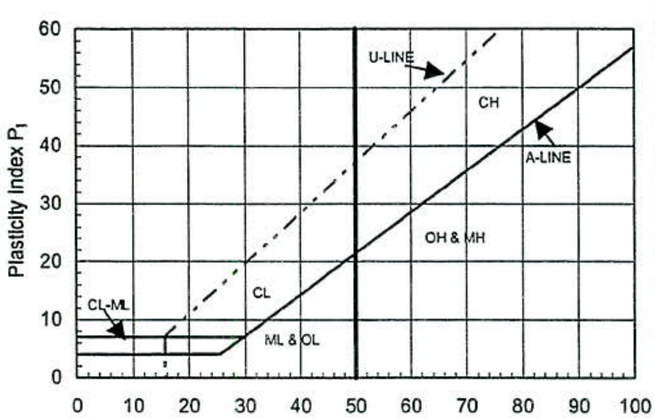
Groundwater symbols: ▼-observed groundwater elevation, encountered during drilling; ∇-observed groundwater elevation upon completion of boring.

UNIFIED SOIL CLASSIFICATION SYSTEM
(USCS)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success

Unified Soil Classification System

Major Divisions			Group Symbol	Typical Names	Classification Criteria for Coarse-Grained Soils
Coarse-grained soils (more than half of material is larger than No. 200)	Gravels (more than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_U \geq 4$; $1 \leq C_C \leq 3$; $C_U = \frac{D_{60}}{D_{10}}$; $C_C = \frac{D_{30}^2}{D_{10} D_{60}}$
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW ($C_U < 4$ or $1 > C_C > 3$)
		Gravels with fines (appreciable amount of fines)	GM d u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A line or $P_I < 4$ — Above A line with $4 < P_I < 7$ are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line or $P_I > 7$
	Sands (more than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_U \geq 6$; $1 \leq C_C \leq 3$; $C_U = \frac{D_{60}}{D_{10}}$; $C_C = \frac{(D_{30})^2}{D_{10} D_{60}}$
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW ($C_U < 6$ or $1 > C_c > 3$)
		Sands with fines (appreciable amount of fines)	SM d u	Silty sands, sand-silt mixtures	Atterberg limits below A line or $P_I < 4$ — Limits plotting in hatched zone with $4 \leq P_I \leq 7$ are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above A line with $P_I > 7$
Fine-grained soils (more than half of material is smaller than No. 200)	Silt and clays (liquid limit <50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	1. Determine percentages of sand and gravel from grain size curve. 2. Depending on percentages of fines (fraction smaller than 200 sieve size), coarse-grained soils are classified as follows: Less than 5% - GW, GP, SW, SP; More than 12% - GM, GC, SM, SC; 5-12% - Borderline cases requiring dual symbols
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and clays (liquid limit >50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
			CH	Inorganic clays or high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity, organic silts	
	Highly organic soils		PT	Peat and other highly organic soils	



U-LINE: $PI = 0.9(W_L-8)$
A-LINE: $PI = 0.73(W_L-20)$

Plasticity Chart

APPENDIX B

LABORATORY TESTING RESULTS

ATTERBERG LIMITS
TEST RESULTS

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success

Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF ATTERBERG LIMITS TEST RESULTS

Project Name: Coal Refuse Impoundment No. 1

Patriot Project No.: 2-11-0383

Project Location: Allerton-Homer, Illinois

Client: Sunrise Coal

Client Address:

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTIC INDEX (PI)
1	B-18	SS-10	38.5-40	SILTY CLAY	23	13	10
2	B-19	12	48.5-50	SILTY CLAY	35	14	21
3	B-22	11	43.5-45	SILTY CLAY	32	15	17
4	B-23	10	38.5-40	SILTY CLAY	38	13	25
5	B-25	SS-6	13.5 - 15	SANDY CLAY	19	12	17
6	B-25	SS-9	21 - 22.5	SANDY CLAYEY SILT	20	18	2
7	B-26	SS-2	3.5 - 5	SILTY CLAY	48	18	30
8	B-27	SS-2	3.5 - 5	SILTY CLAY	41	18	23
9	B-28	SS-1	1 - 2.5	CLAY	54	23	31
10	B-31	SS-1	1 - 2.5	CLAY	59	22	37
11	B-31	SS-2	3.5 - 5	SILTY CLAY	28	16	12
12	B-31	SS-3	6 - 7.5	SANDY SILTY CLAY	26	16	10
13	B-31	SS-4	8.5 - 10	SANDY SILTY CLAY	25	14	11
14	B-31	SS-5	11 - 12.5	SANDY SILTY CLAY	23	15	8
15	B-32	SS-2	3.5 - 5	SILTY CLAY	28	15	13
16	B-32	SS-3	6 - 7.5	SILTY CLAY	26	15	11
17	B-32	SS-5	11 - 12.5	SANDY SILTY CLAY	19	13	6
18	B-35	SS-2	3.5 - 5	SANDY SILTY CLAY	25	15	10
19	B-36A	ST-3	5 - 7	SILTY CLAY	29	17	12
20	B-36A	ST-4	8 - 10	SILTY CLAY	39	19	20
21	B-37	SS-1	1 - 2.5	CLAY	57	22	35

PATRIOT ENGINEERING and Environmental, Inc.

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Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF ATTERBERG LIMITS TEST RESULTS

Project Name: Coal Refuse Impoundment No. 1
Patriot Project No.: 2-11-0383
Project Location: Allerton-Homer, Illinois
Client: Sunrise Coal
Client Address:

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTIC INDEX (PI)
22	B-38	SS-1	1 - 2.5	CLAY	60	25	35
23	B-39	SS-1	1 - 2.5	ORGANIC	65	26	39
24	B-39	SS-3	6 - 7.5	SANDY CLAY	23	15	18
25	B-40	SS-1	1 - 2.5	CLAY	54	20	34

LOSS ON IGNITION (LOI) TEST RESULTS
(ORGANIC CONTENT)

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF LOSS ON IGNITION TEST RESULTS (ORGANIC CONTENT)

Project Name: Coal Refuse Impoundment No. 1
Patriot Project No.: 2-11-0383
Project Location: Allerton-Homer, Illinois

Client: Sunrise Coal
Client Address:

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	NATURAL MOISTURE CONTENT (PERCENT (%))	ORGANIC CONTENT (PERCENT (%))
1	B-23B	ST-1	1 - 3	NOT APPLICABLE (TOPSOIL)	22	5.4
2	B-26A	ST-1	1 - 3	NOT APPLICABLE (TOPSOIL)	24	3.8
3	B-39A	ST-1	1 - 3	NOT APPLICABLE (TOPSOIL)	26	7.1

NATURAL DENSITY TEST RESULTS
(UNIT WEIGHTS)

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF NATURAL DENSITY TEST RESULTS (UNIT WEIGHTS)

Project Name: Coal Refuse Impoundment No. 1
Patriot Project No.: 2-11-0383
Project Location: Allerton-Homer, Illinois

Client: Sunrise Coal
Client Address:

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	WET UNIT WEIGHT (POUNDS PER CUBIC FOOT (pcf))	DRY UNIT WEIGHT (POUNDS PER CUBIC FOOT (pcf))
1	B-23B	ST-3	5 - 7	SILTY CLAY	123	99
2	B-26A	ST-3	5 - 7	SILTY CLAY	139	117
3	B-26A	ST-5	13 - 15	SILTY CLAY	134	114
4	B-32A	ST-4	8 - 10	SANDY CLAY	143	123
5	B-32A	ST-5	13 - 15	SANDY CLAY	139	121
6	B-33A	ST-1	1 - 3	NOT APPLICABLE (TOPSOIL)	115	96
7	B-33A	ST-2	3 - 5	SILTY CLAY	128	103
8	B-33A	ST-4	8 - 10	SILTY CLAY	139	119
9	B-33A	ST-5	13 - 15	SANDY CLAY	141	120
10	B-36A	ST-1	1 - 3	NOT APPLICABLE (TOPSOIL)	117	93
11	B-36A	ST-2	3 - 5	SILTY CLAY	122	97
12	B-36A	ST-3	5 - 7	SILTY CLAY	129	106
13	B-36A	ST-4	8 - 10	SILTY CLAY	124	99
14	B-39A	ST-2	3 - 5	SILTY CLAY	127	99
15	B-39A	ST-4	8 - 10	SILTY CLAY	137	119

UNCONFINED COMPRESSIVE STRENGTH
TEST RESULTS

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS

Project Name:	Coal Refuse Impoundment No. 1	Client:	Sunrise Coal
Patriot Project No.:	2-11-0383	Client Address:	
Project Location:	Allerton-Homer, Illinois		

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT (tsf))	STRAIN AT FAILURE (PERCENT (%))
1	B-25	ST-3	5 - 7	SILTY CLAY	1.0	11
2	B-32A	ST-4	8-10	SANDY SILTY CLAY	2.3	11
3	B-33	ST-3	6 - 8	SANDY SILTY CLAY	0.9	12
4	B-33A	ST-4	8-10	SANDY SILTY CLAY	1.5	15
5	B-36A	ST-4	8 - 10	SILTY CLAY	0.4	15
6	B-37	ST-4	8 - 10	SILTY CLAY	1.7	12
7	B-37	SS-10	23.5 - 25	SANDY SILTY CLAY	5.3	15
8	B-37	SS-11	26 - 27.5	SANDY SILTY CLAY	4.0	15
9	B-38	SS-3	6 - 7.5	SANDY SILTY CLAY	0.5	15
10	B-38	SS-8	18.5 - 20	SANDY SILTY CLAY	2.8	15
11	B-38	SS-9	21 - 22.5	SANDY SILTY CLAY	2.1	15
12	B-38	SS-12	28.5 - 30	SILTY CLAY	4.7	15
13	B-39A	ST-4	8-10	SILTY CLAY	2.1	9

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Date:

Checked By:

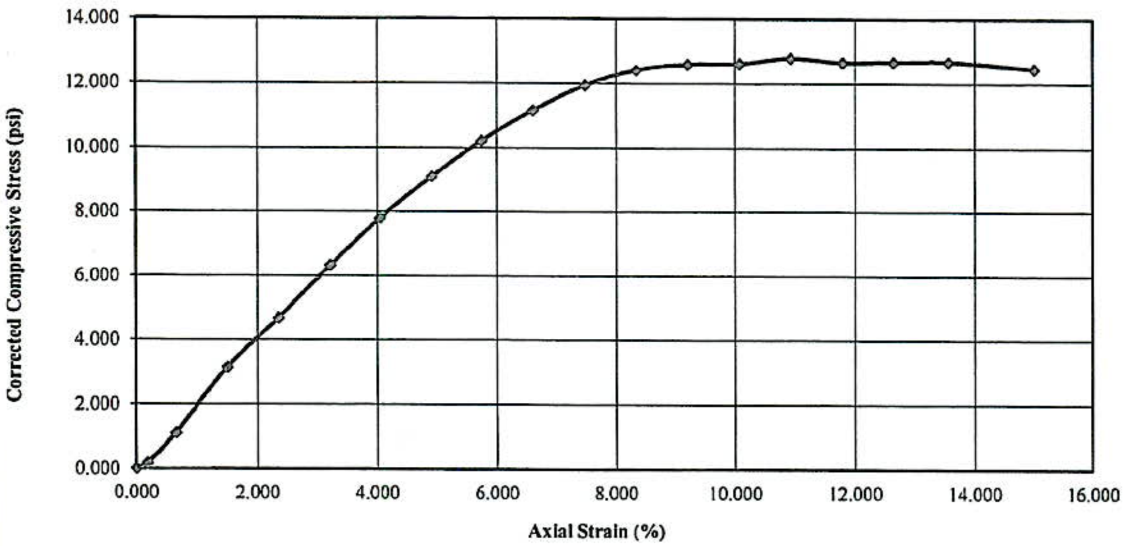
Date:

Computed By:

4/27/2012 Date:

Tested By: J. Phillips

Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	16.00
Dry Density (pcf)	137.006
Saturation (%)	105.80
Void Ratio	0.21
Diameter (in)	2.828
Height (in)	5.656
Test Data	**Test Results**
Unconfined Strength (psi)	12.763
Undrained Shear Strength (tsf)	0.459
Undrained Shear Strength (psi)	6.381
Rate of Strain (in/min)	0.050000
Strain at Failure (%)	10.93

Project Information		Specimen Description	
Project No.	2-11-0383	B-25	Light brown SILTY CLAY with a little sand and trace gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-25		
Depth	5.0-7.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

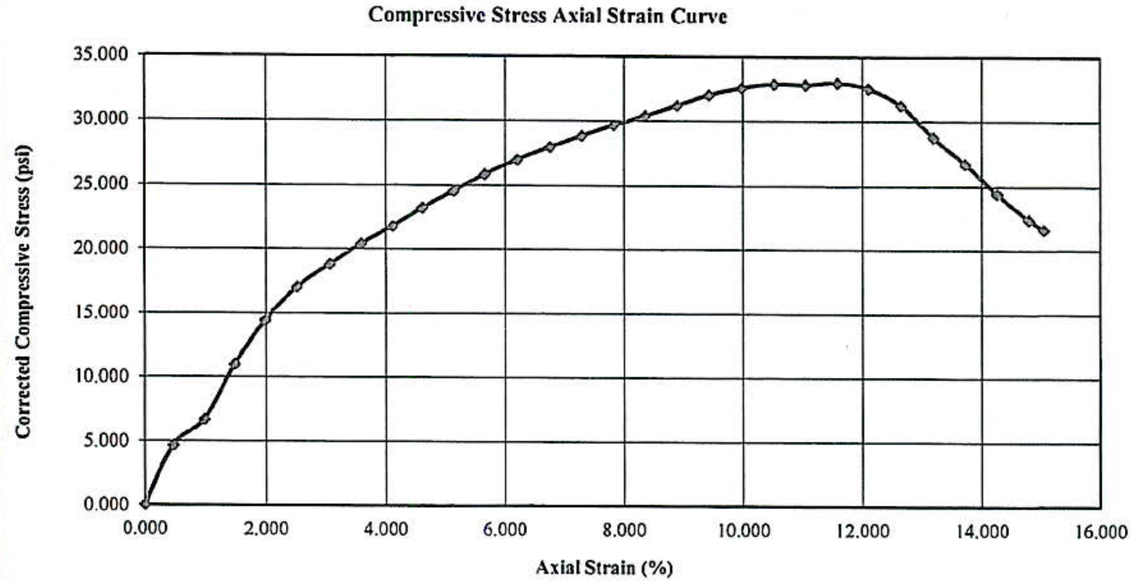
Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Date:
Checked By:
Date:
Computed By:
Date: 11/3/2012
Tested By: S. Vaught



Before Test	Sample Data
Water Content (%)	14.11
Dry Density (pcf)	121.400
Saturation (%)	103.01
Void Ratio	0.36
Diameter (in)	2.765
Height (in)	5.689
Test Data	**Test Results**
Unconfined Strength (psi)	32.937
Undrained Shear Strength (tsf)	1.186
Undrained Shear Strength (psi)	16.469
Rate of Strain (in/min)	0.060000
Strain at Failure (%)	11.59

Project Information		Specimen Description	
Project No.	2-11-0383		Brown SANDY CLAY
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-32		
Depth	8.0-10.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Test File Name

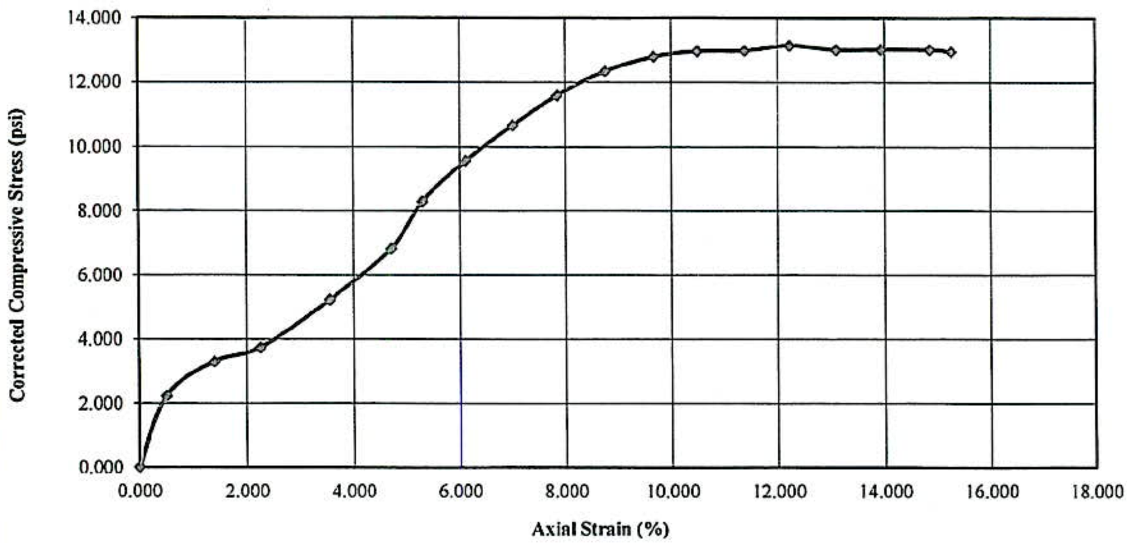
Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Date:
Checked By:
Date:
Computed By:
Date: 4/27/2012
Tested By: J. Phillips

Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	19.00
Dry Density (pcf)	133.476
Saturation (%)	106.02
Void Ratio	0.24
Diameter (in)	2.829
Height (in)	5.602
Test Data	**Test Results**
Unconfined Strength (psi)	13.126
Undrained Shear Strength (tsf)	0.473
Undrained Shear Strength (psi)	6.563
Rate of Strain (in/min)	0.050000
Strain at Failure (%)	12.23

Project Information		Specimen Description	
Project No.	2-11-0383	B-33	Gray and brown mottled SANDY SILTY CLAY
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-33		
Depth	6.0-8.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Date:

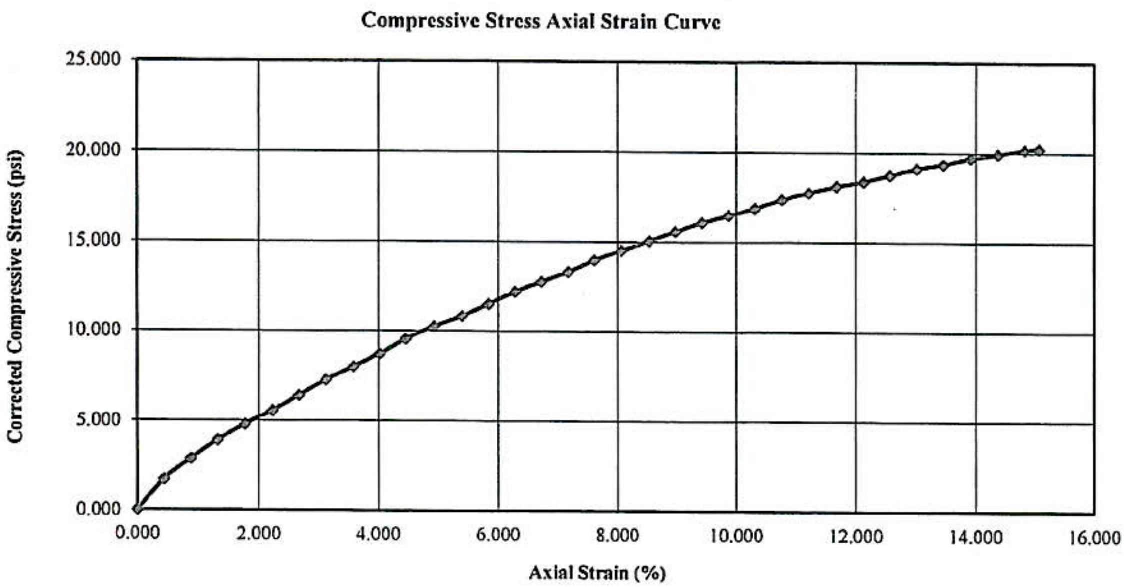
Checked By:

Date:

Computed By:

Date: 11/3/2012

Tested By: S. Vaught



Before Test	Sample Data
Water Content (%)	15.24
Dry Density (pcf)	120.800
Saturation (%)	109.28
Void Ratio	0.37
Diameter (in)	2.827
Height (in)	6.672
Test Data	**Test Results**
Unconfined Strength (psi)	20.223
Undrained Shear Strength (tsf)	0.728
Undrained Shear Strength (psi)	10.111
Rate of Strain (in/min)	0.060000
Strain at Failure (%)	15.06

Project Information		Specimen Description	
Project No.	2-11-0383		Brown SILTY CLAY
Project Name	Bulldog Mine		
Sampling Date		Test Variables	
Sample No.			
Boring No.	B-33		
Depth	8.0-10.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

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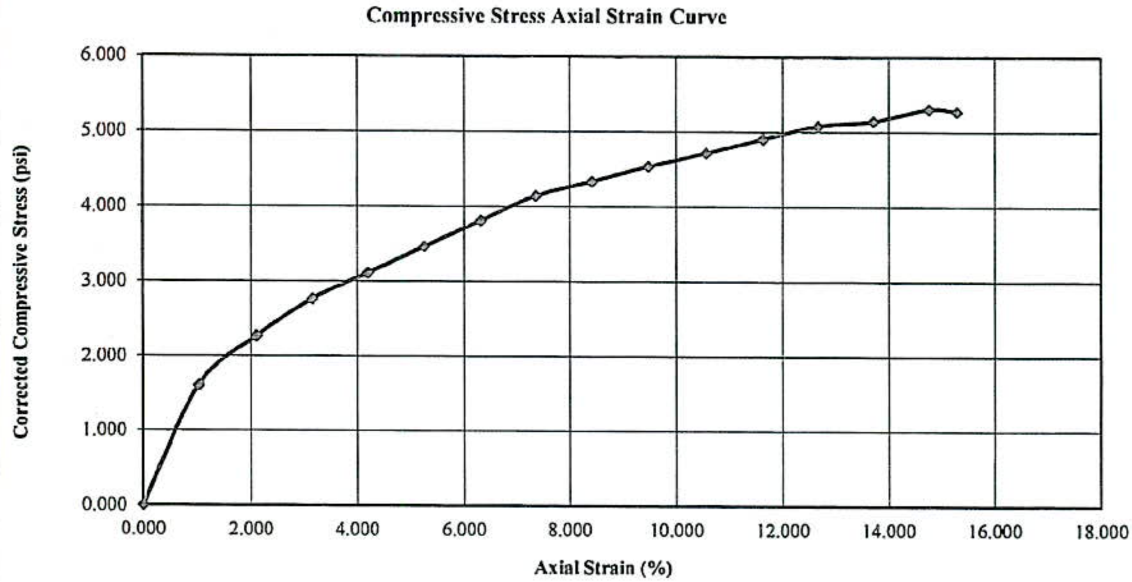

Before Test	Sample Data
Water Content (%)	23.28
Dry Density (pcf)	103.712
Saturation (%)	103.66
Void Ratio	0.60
Diameter (in)	2.789
Height (in)	5.716
Test Data	**Test Results**
Unconfined Strength (psi)	5.302
Undrained Shear Strength (tsf)	0.191
Undrained Shear Strength (psi)	2.651
Rate of Strain (in/min)	0.060000
Strain at Failure (%)	14.77

Project Information		Specimen Description	
Project No.	2-11-0383	B-36A	Brown SILTY CLAY
Project Name	Bulldog Mine		
Sampling Date	5/18/2012	**Test Variables**	
Sample No.			
Boring No.	B-36A		
Depth	8.0-10.0 feet	Specific Gravity:	2.65
Client	Sunrisre Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Tested By: T. Smith Date: 5/29/2012 Computed By: Date: Checked By: Date:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

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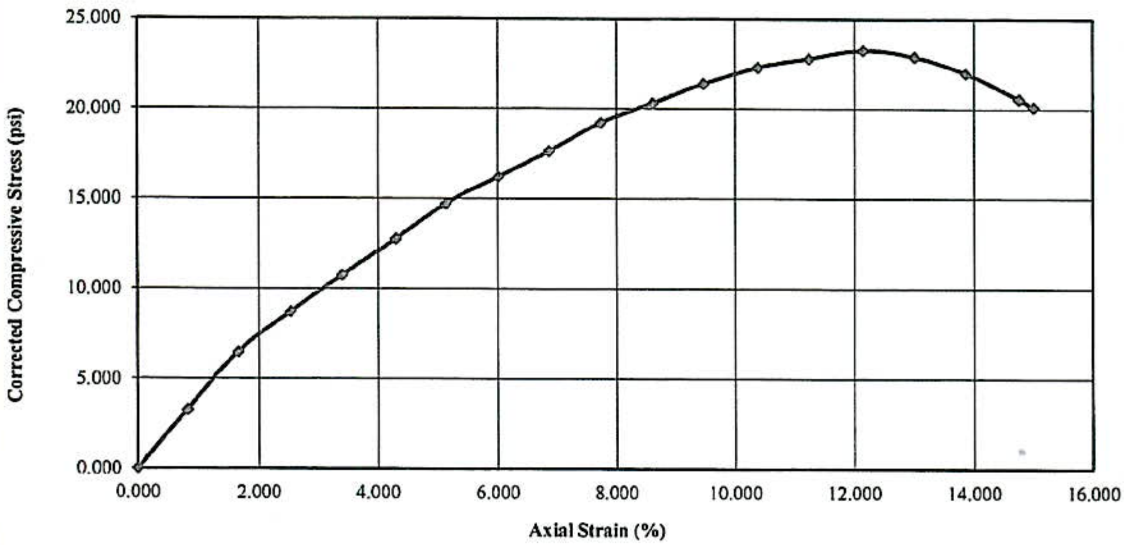
Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	20.20
Dry Density (pcf)	114.395
Saturation (%)	119.98
Void Ratio	0.45
Diameter (in)	2.852
Height (in)	5.605
Test Data	**Test Results**
Unconfined Strength (psi)	23.240
Undrained Shear Strength (tsf)	0.837
Undrained Shear Strength (psi)	11.620
Rate of Strain (in/min)	0.050000
Strain at Failure (%)	12.15

Project Information		**Specimen Description**	
Project No.	2-11-0383	B-37	Brown SILTY CLAY with trace sand and small gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-37		
Depth	8.0-10.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Tested By: J. Phillips Date: 5/18/2012 Computed By: Date: Checked By: Date:

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

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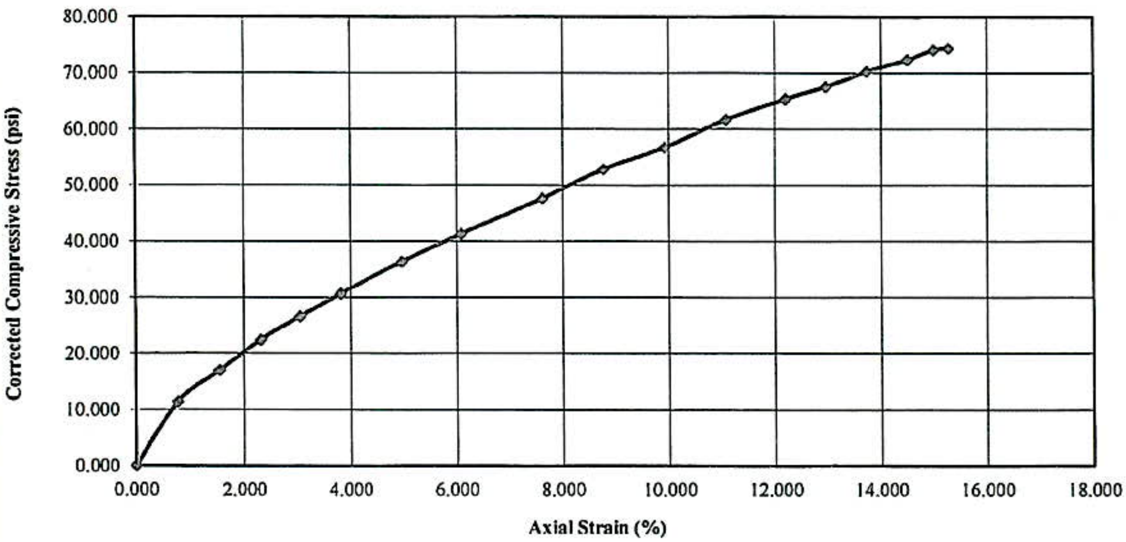
Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	11.41
Dry Density (pcf)	126.909
Saturation (%)	99.61
Void Ratio	0.30
Diameter (in)	1.415
Height (in)	2.860
Test Data	**Test Results**
Unconfined Strength (psi)	74.347
Undrained Shear Strength (tsf)	2.676
Undrained Shear Strength (psi)	37.174
Rate of Strain (in/min)	0.020000
Strain at Failure (%)	15.28

Project Information		Specimen Description	
Project No.	2-11-0383	B-37	Gray SANDY SILTY CLAY with trace small gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-37		
Depth	23.5-25.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Tested By: J. Phillips Date: 5/18/2012

Computed By: Date:

Checked By: Date:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
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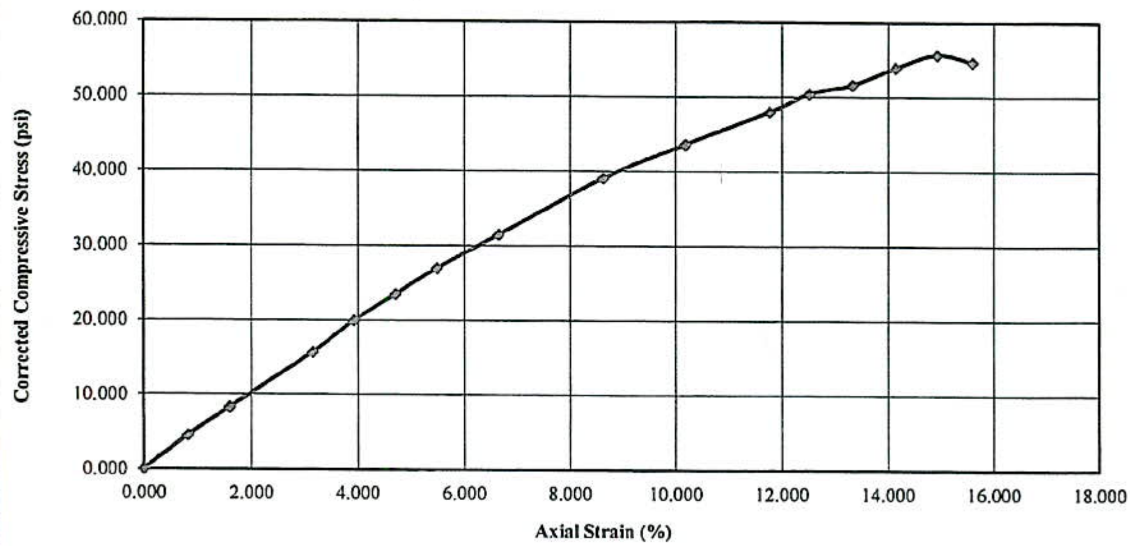
Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	13.38
Dry Density (pcf)	125.500
Saturation (%)	111.57
Void Ratio	0.32
Diameter (in)	1.403
Height (in)	2.827
Test Data	**Test Results**
Unconfined Strength (psi)	55.578
Undrained Shear Strength (tsf)	2.001
Undrained Shear Strength (psi)	27.789
Rate of Strain (in/min)	0.020000
Strain at Failure (%)	14.93

Project Information		Specimen Description	
Project No.	2-11-0383	B-37	Gray SANDY SILTY CLAY with trace small gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-37		
Depth	26.5-28.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Tested By: J. Phillips Date: 5/18/2012 Computed By: Date: Checked By: Date:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

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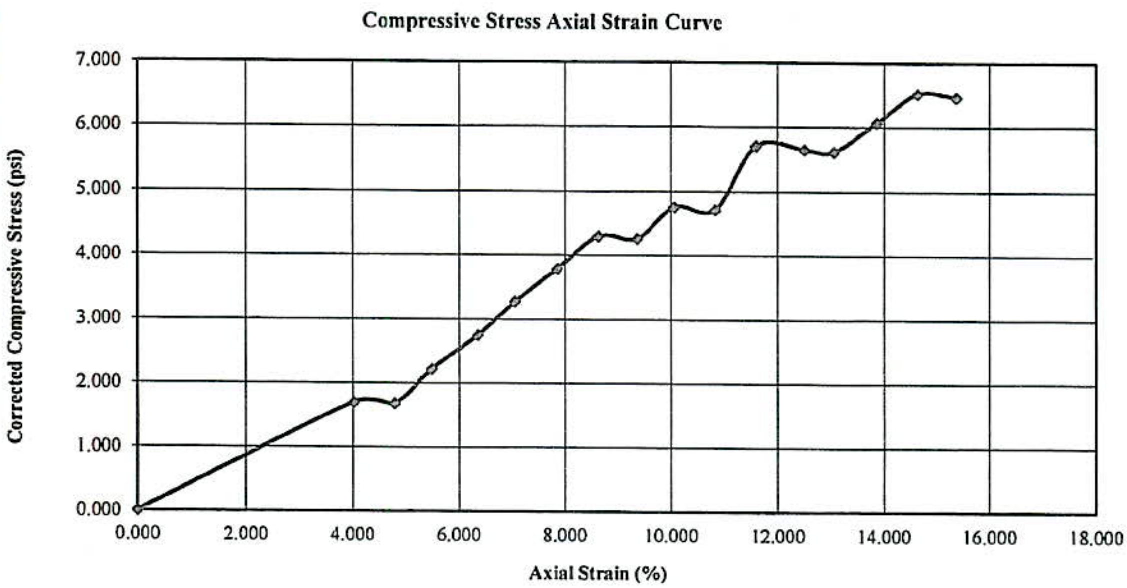


Before Test	Sample Data
Water Content (%)	23.00
Dry Density (pcf)	120.600
Saturation (%)	88.65
Void Ratio	0.37
Diameter (in)	1.473
Height (in)	2.862
Test Data	**Test Results**
Unconfined Strength (psi)	6.512
Undrained Shear Strength (tsf)	0.234
Undrained Shear Strength (psi)	3.256
Rate of Strain (in/min)	0.030000
Strain at Failure (%)	14.64

Project Information	
Project No.	2-11-0383
Project Name	Bulldog Mine
Sampling Date	
Sample No.	
Boring No.	B-38
Depth	6.0-7.5 feet
Client	Sunrise Coal, LLC

Specimen Description	
B-38	Gray, tan and brown mottled SANDY SILTY CLAY

Test Variables	
Specific Gravity:	2.65
Liquid Limit:	
Plastic Limit:	

Remarks:

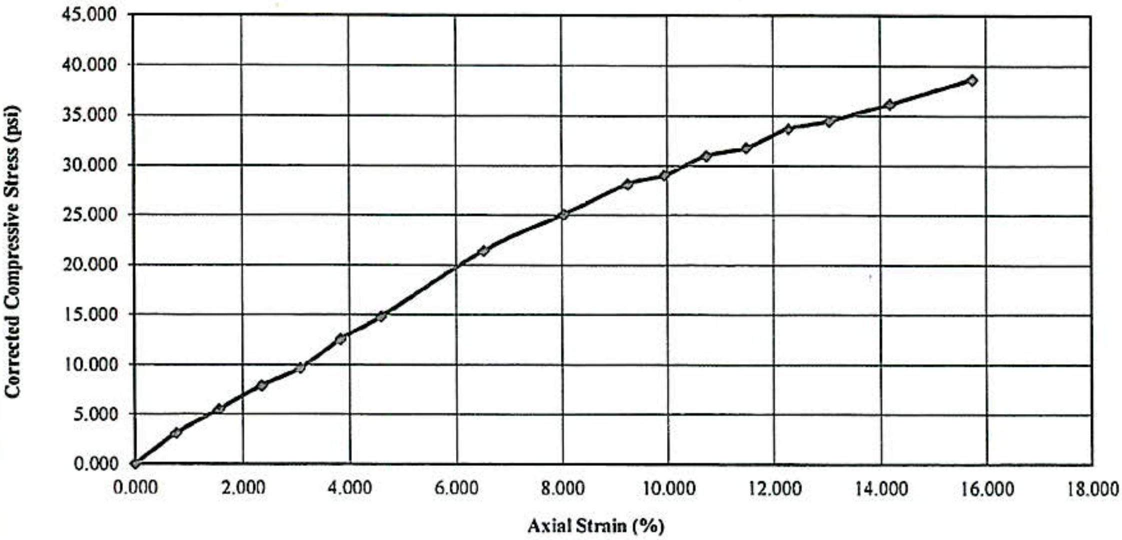
Tested By: J. Phillips Date: 4/27/2012 Computed By: Date: Checked By: Date:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers



Before Test	Sample Data
Water Content (%)	12.72
Dry Density (pcf)	125.506
Saturation (%)	105.96
Void Ratio	0.32
Diameter (in)	1.434
Height (in)	2.895
Test Data	**Test Results**
Unconfined Strength (psi)	38.602
Undrained Shear Strength (tsf)	1.390
Undrained Shear Strength (psi)	19.301
Rate of Strain (in/min)	0.020000
Strain at Failure (%)	15.75

Project Information		Specimen Description	
Project No.	2-11-0383	B-38	Grayish brown SANDY SILTY CLAY with trace gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-38		
Depth	18.5-20.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

Remarks:

Tested By: J. Phillips Date: 5/21/2012 Computed By: Date: Checked By: Date:

Test File Name

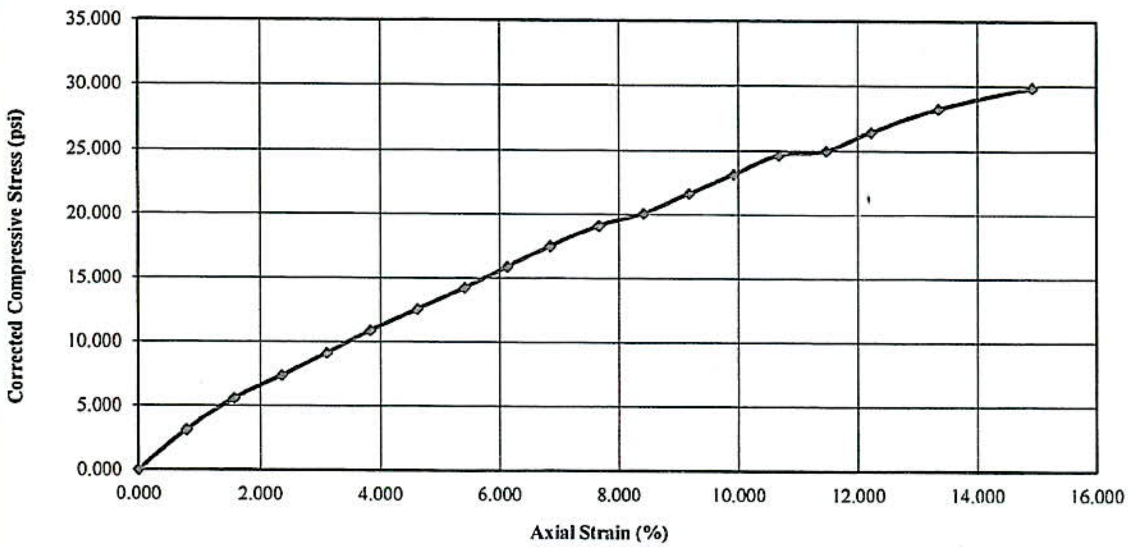
Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Tested By: J. Phillips
Date: 5/21/2012
Computed By:
Date:
Checked By:
Date:

Compressive Stress Axial Strain Curve



Before Test	Sample Data
Water Content (%)	12.28
Dry Density (pcf)	130.551
Saturation (%)	121.79
Void Ratio	0.27
Diameter (in)	1.426
Height (in)	2.921
Test Data	**Test Results**
Unconfined Strength (psi)	29.830
Undrained Shear Strength (tsf)	1.074
Undrained Shear Strength (psi)	14.915
Rate of Strain (in/min)	0.020000
Strain at Failure (%)	14.93

Project Information		Specimen Description	
Project No.	2-11-0383	B-38	Grayish brown SANDY SILTY CLAY with trace gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-38		
Depth	21.0-22.5	Specific Gravity:	2.65
Client	Sunrise Coal, LLC	Liquid Limit:	
		Plastic Limit:	

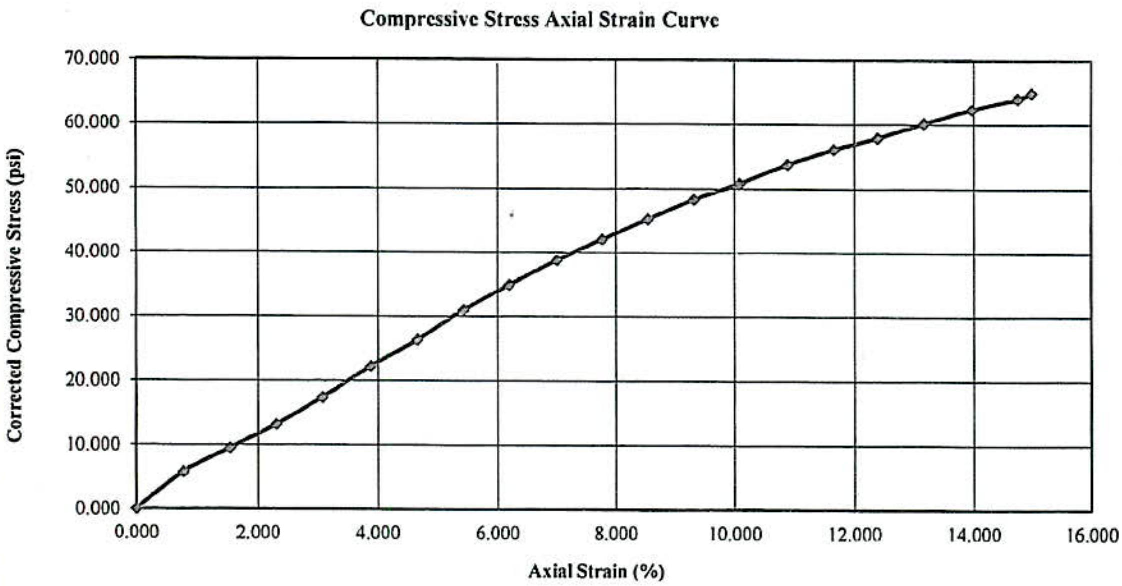
Remarks:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental Geotechnical and Materials Engineers



Before Test	Sample Data
Water Content (%)	12.25
Dry Density (pcf)	129.941
Saturation (%)	118.85
Void Ratio	0.27
Diameter (in)	1.409
Height (in)	2.856
Test Data	**Test Results**
Unconfined Strength (psi)	64.882
Undrained Shear Strength (tsf)	2.336
Undrained Shear Strength (psi)	32.441
Rate of Strain (in/min)	0.020000
Strain at Failure (%)	14.99

Project Information		**Specimen Description**	
Project No.	2-11-0383	B-38	Gray SILTY CLAY with a little sand and trace small gravel
Project Name	Bulldog Mine		
Sampling Date		**Test Variables**	
Sample No.			
Boring No.	B-38		
Depth	28.5-30.0 feet	Specific Gravity:	2.65
Client	Sunrise Coal	Liquid Limit:	
		Plastic Limit:	

Remarks:

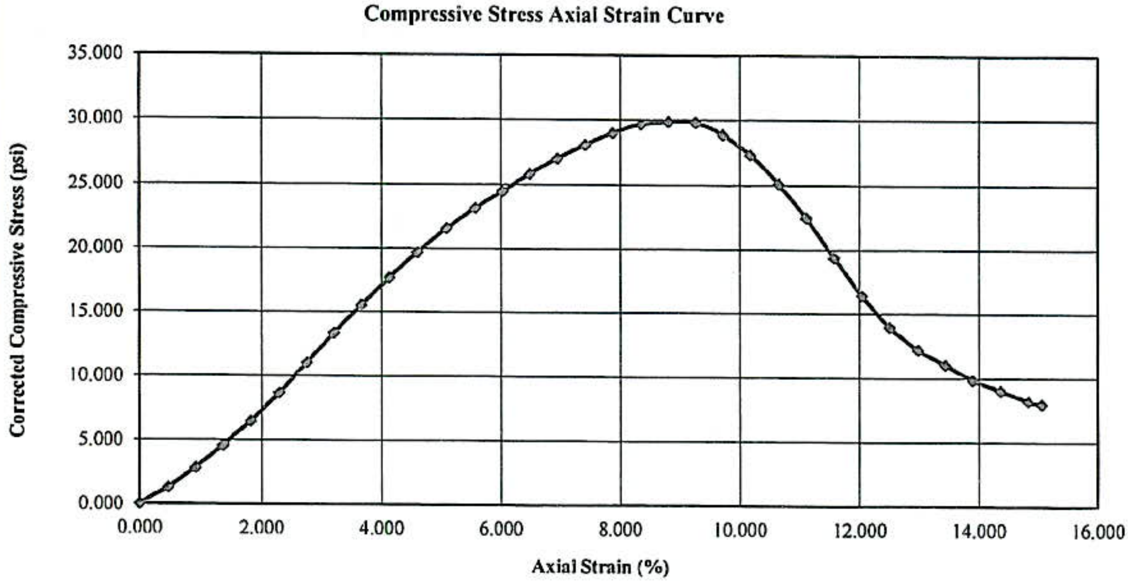
Tested By: J. Phillips Date: 5/21/2012 Computed By: Date: Checked By: Date:

Test File Name

Patriot Engineering

Unconfined Compressive Strength Test Report (ASTM D2166)

PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers



Before Test	Sample Data
Water Content (%)	15.70
Dry Density (pcf)	119.900
Saturation (%)	109.71
Void Ratio	0.38
Diameter (in)	2.857
Height (in)	6.479
Test Data	**Test Results**
Unconfined Strength (psi)	29.836
Undrained Shear Strength (tsf)	1.074
Undrained Shear Strength (psi)	14.918
Rate of Strain (in/min)	0.060000
Strain at Failure (%)	8.81

Project Information	
Project No.	2-11-0383
Project Name	Bulldog Mine
Sampling Date	
Sample No.	
Boring No.	B-39
Depth	8.0-10.0 feet
Client	Sunrise Coal, LLC

Specimen Description

	Brown SILTY CLAY

Test Variables

Specific Gravity:	2.65
Liquid Limit:	
Plastic Limit:	

Remarks:

Tested By: S. Vaught Date: 11/3/2012 Computed By: Date: Checked By: Date:

Test File Name

STANDARD PROCTOR TEST RESULTS

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF STANDARD PROCTOR TEST RESULTS

Project Name:	Coal Refuse Impoundment No. 1	Client:	Sunrise Coal
Patriot Project No.:	2-11-0383	Client Address:	
Project Location:	Allerton-Homer, Illinois		

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	MAXIMUM DRY DENSITY (POUNDS PER CUBIC FOOT (pcf))	OPTIMUM MOISTURE CONTENT (PERCENT (%))
1	B-28	BULK	5 - 15	SILTY CLAY	121.5	11.5
2	B-35	SS-4	8 - 10	SILTY SANDY CLAY	121.0	11.0
3	COMPOSITE	COMPOSITE	COMPOSITE	SILTY CLAY	107.5	10.5

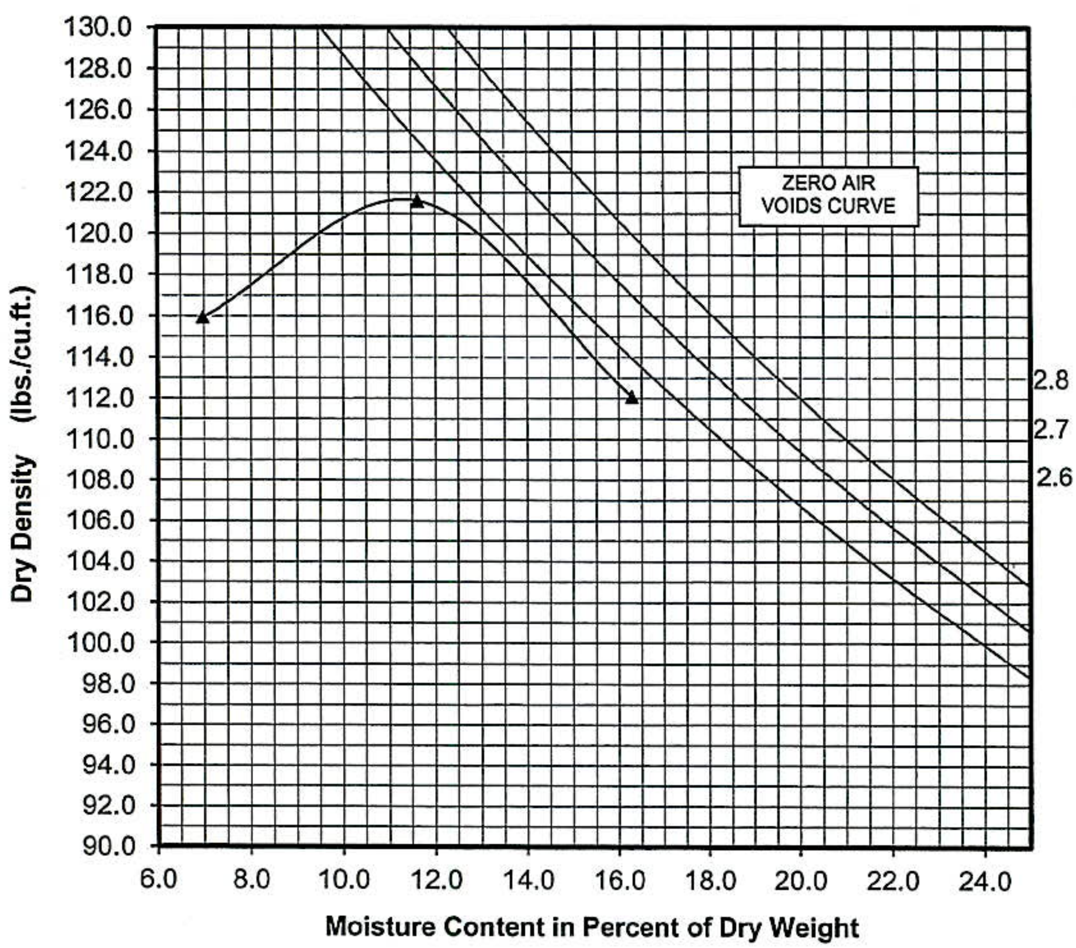
PATRIOT ENGINEERING
and Environmental, Inc.
Terre Haute, Indiana

Moisture-Density (Proctor)

ASTM D 698, AASHTO T99 (Standard)
ASTM D 1557, AASHTO T180 (Modified)

■ Original ☐ Amended

Project Name:	Allerton Mine	**Client:**	Sunrise Coal
Project Number:	02-11-0383	**Client Address:**	
Date Received:	4/20/2012		
Date Tested:	4/30/2012	**Sampled By:**	
Sample Number:	B-28 Remold perm	**Tested By:**	JP
Proctor Type:	Standard	**Sample Source:**	B-28, 5' - 15' composite



Maximum Dry Density:	121.5 pcf	**Optimum Moisture Content:**	11.5%
Sample Description:	Brown silty clay with trace sand & gravel		
Method:	B		

Revised 1-3-2002

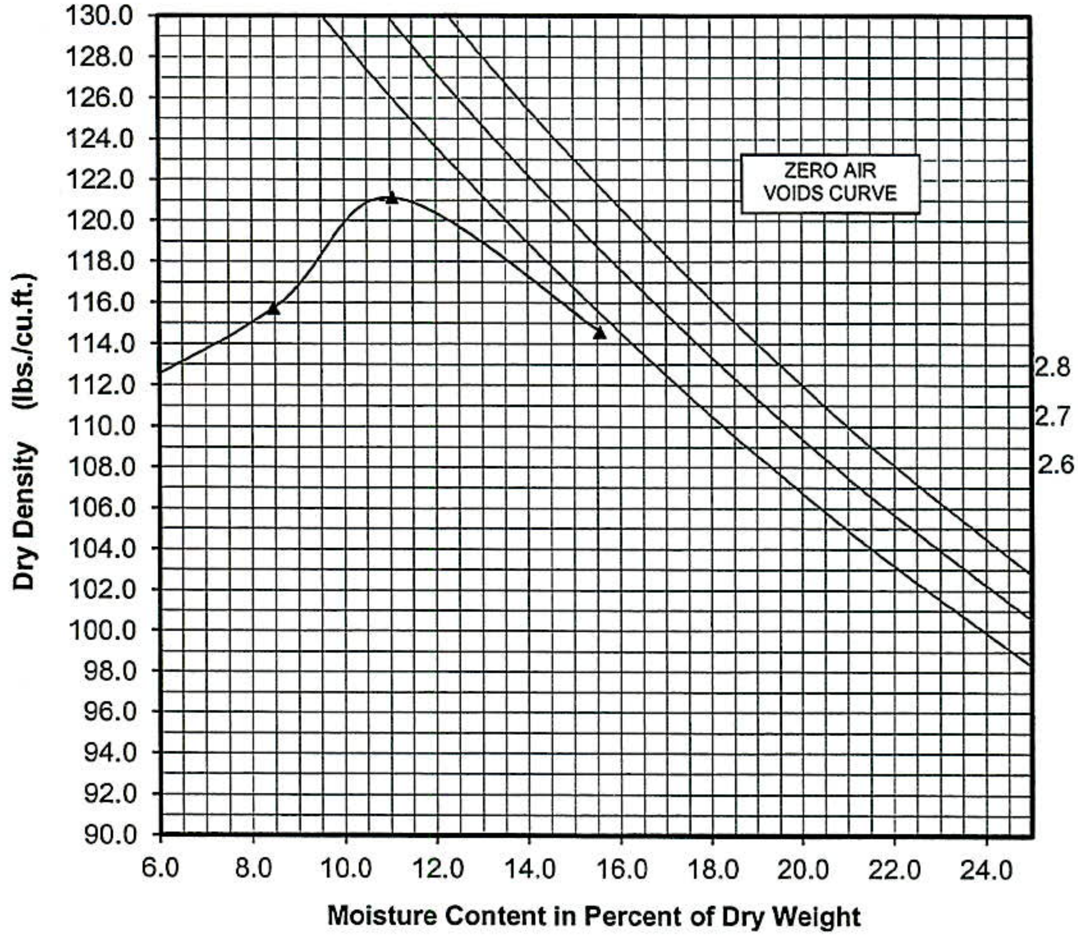
PATRIOT ENGINEERING
and Environmental, Inc.
Terre Haute, Indiana

Moisture-Density (Proctor)

ASTM D 698, AASHTO T99 (Standard)
ASTM D 1557, AASHTO T180 (Modified)

■ Original □ Amended

Project Name:	Allerton Mine	**Client:**	Sunrise Coal
Project Number:	02-11-0383	**Client Address:**	
Date Received:	4/20/2012		
Date Tested:	4/30/2012	**Sampled By:**	
Sample Number:	B-35 Remold Perm	**Tested By:**	JP
Proctor Type:	Standard	**Sample Source:**	B-35, 8'-10'



Maximum Dry Density:	121.0 pcf	**Optimum Moisture Content:**	11.0%
Sample Description:	Brown silty sandy clay with trace small gravel		
Method:	B		

PATRIOT ENGINEERING and Environmental, Inc.

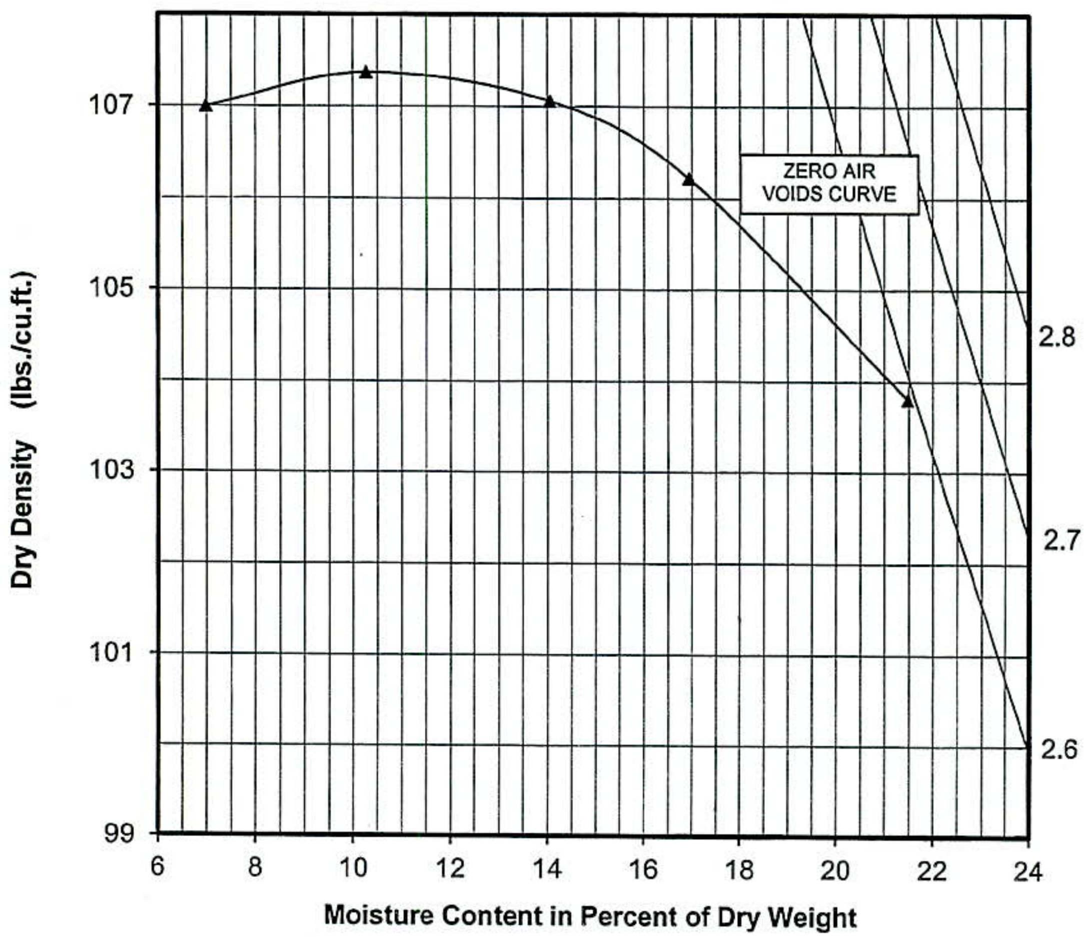
Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

Moisture-Density (Proctor)

ASTM D 698, AASHTO T99 (Standard)
ASTM D 1557, AASHTO T180 (Modified)

■ Original ☐ Amended

Project Name:	Bulldog Mine	**Client:**	Sunrise Coal, LLC
Project Number:	2-11-0383		
Date Received:			
Date Tested:	11/2/2012	**Sampled By:**	
Sample Number:	Composite	**Tested By:**	SV
Proctor Type:	Std - A	**Sample Source:**	Bulk



Maximum Dry Density: 107.5 pcf **Optimum Moisture Content:** 10.5%

Sample Description: Brown and gray, silty clay

Method: A

REMOLDED PERMEABILITY TEST RESULTS
(HYDRAULIC CONDUCTIVITY)

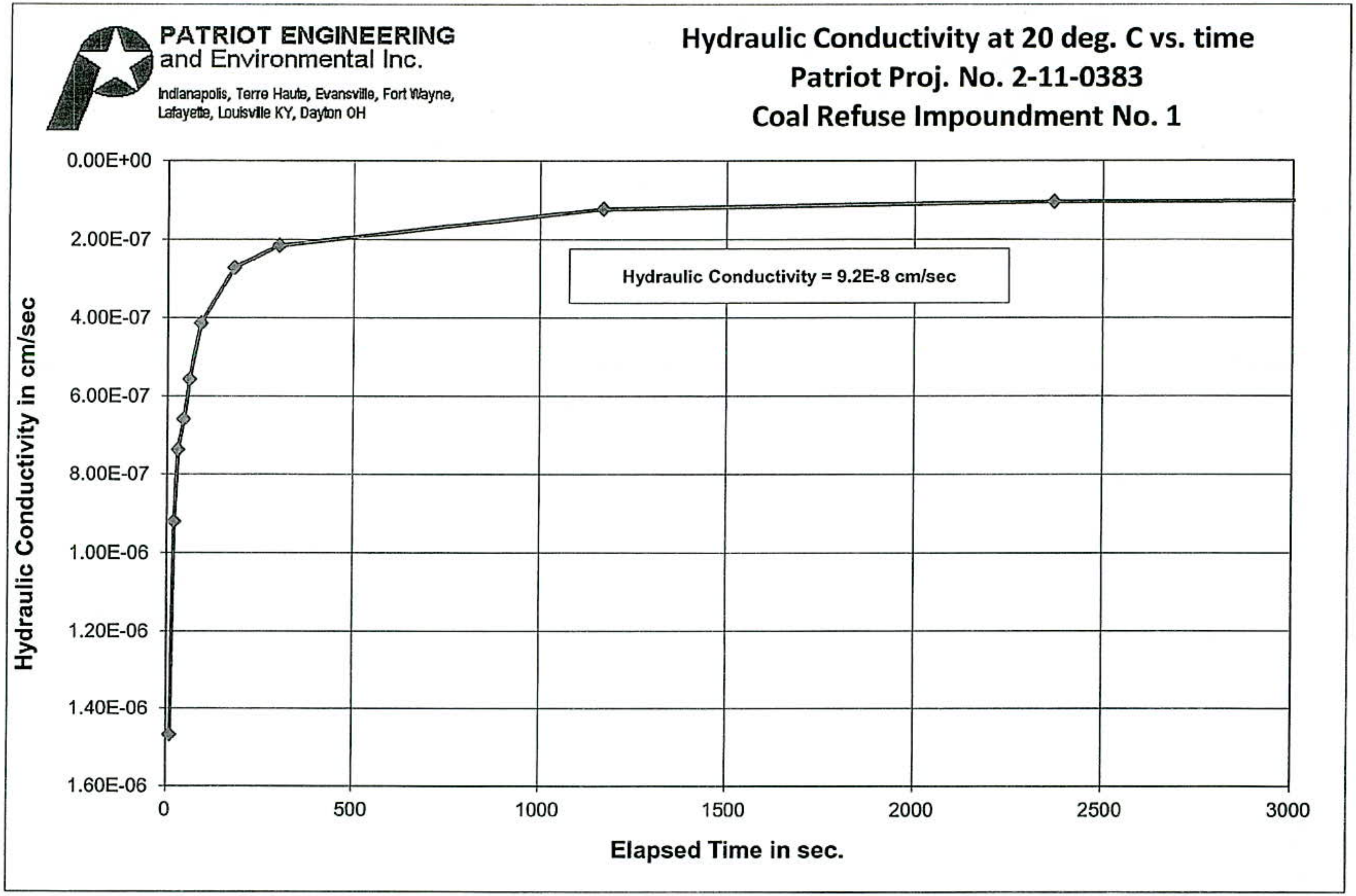
PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success
Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF REMOLDED PERMEABILITY TEST RESULTS (HYDRAULIC CONDUCTIVITY)

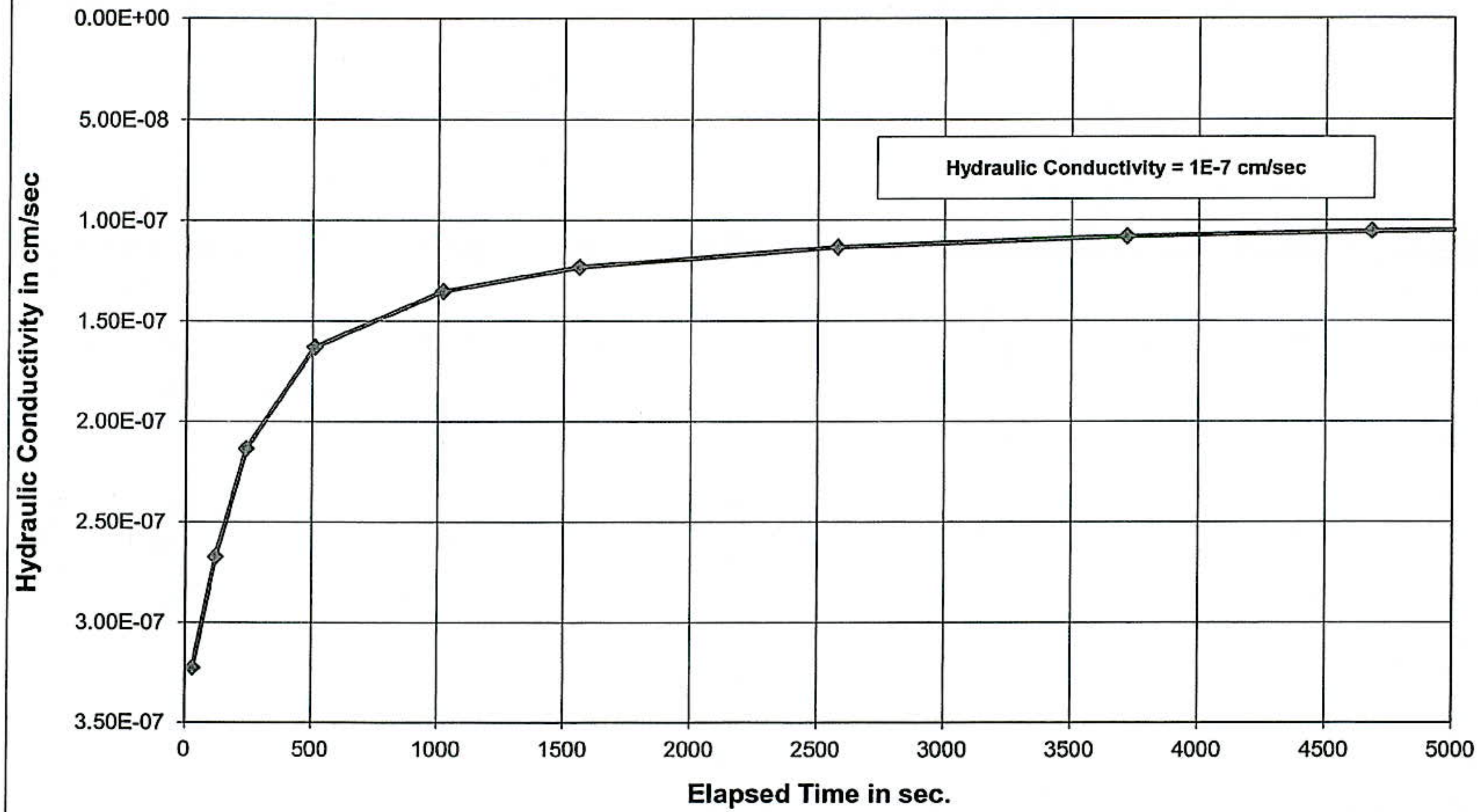
Project Name:	Coal Refuse Impoundment No. 1	Client:	Sunrise Coal
Patriot Project No.:	2-11-0383	Client Address:	
Project Location:	Allerton-Homer, Illinois		

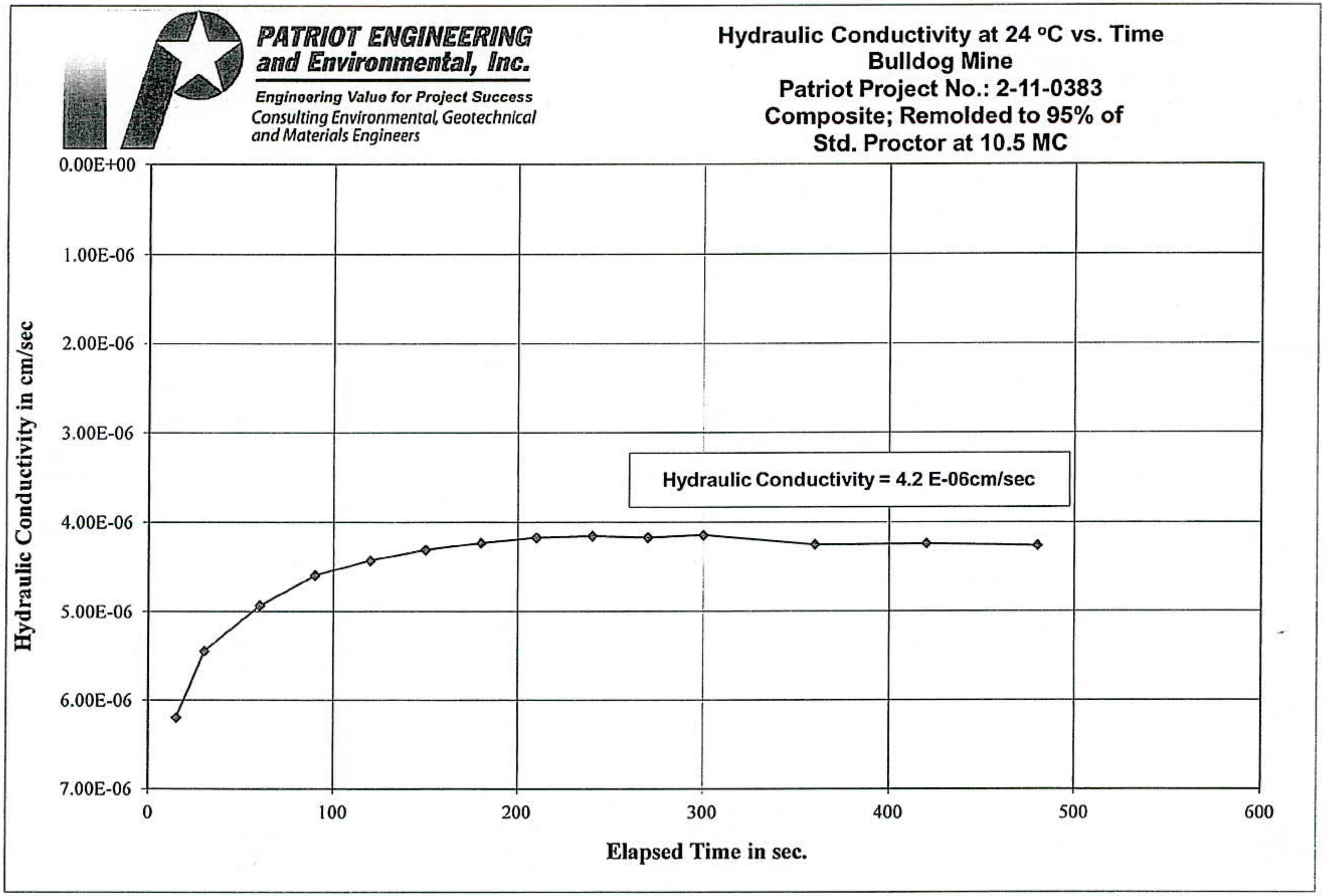
TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	REMOLDED DENSITY (STANDARD PROCTOR)	REMOLDED MOISTURE CONTENT (PERCENT (%))	HYDRAULIC CONDUCTIVITY (k) ($^{cm}/_{sec}$)
1	B-28	BULK	5 - 15	SILTY CLAY	98%	12.5	$9.2x10^{-8}$
2	B-35	SS-4	8 - 10	SILTY SANDY CLAY	95%	12	$1x10^{-7}$
3	COMPOSITE	COMPOSITE	COMPOSITE	SILTY CLAY	95%	10.5	$4x10^{-8}$


PATRIOT ENGINEERING
and Environmental Inc.
Indianapolis, Terre Haute, Evansville, Fort Wayne,
Lafayette, Louisville KY, Dayton OH
Hydraulic Conductivity at 20 deg. C vs. time
Patriot Proj. No. 2-11-0383
Coal Refuse Impoundment No. 1
Hydraulic Conductivity = 9.2E-8 cm/sec
Hydraulic Conductivity in cm/sec
0.00E+00
2.00E-07
4.00E-07
6.00E-07
8.00E-07
1.00E-06
1.20E-06
1.40E-06
1.60E-06
0
500
1000
1500
2000
2500
3000
Elapsed Time in sec.

PATRIOT ENGINEERING
and Environmental Inc.
Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH

Hydraulic Conductivity at 20 deg. C vs. time
Patriot Proj. No. 2-11-0383
Coal Refuse Impoundment No. 1




PATRIOT ENGINEERING
and Environmental, Inc.
Engineering Value for Project Success
Consulting Environmental, Geotechnical
and Materials Engineers
Hydraulic Conductivity at 24 °C vs. Time
Bulldog Mine
Patriot Project No.: 2-11-0383
Composite; Remolded to 95% of
Std. Proctor at 10.5 MC
Hydraulic Conductivity = 4.2 E-06cm/sec
Hydraulic Conductivity in cm/sec
0.00E+00
1.00E-06
2.00E-06
3.00E-06
4.00E-06
5.00E-06
6.00E-06
7.00E-06
0
100
200
300
400
500
600
Elapsed Time in sec.

CONSOLIDATED UNDRAINED TRIAXIAL
TEST RESULTS

PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success

Consulting Environmental, Geotechnical and Materials Engineers

SUMMARY OF CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Project Name: Coal Refuse Impoundment No. 1

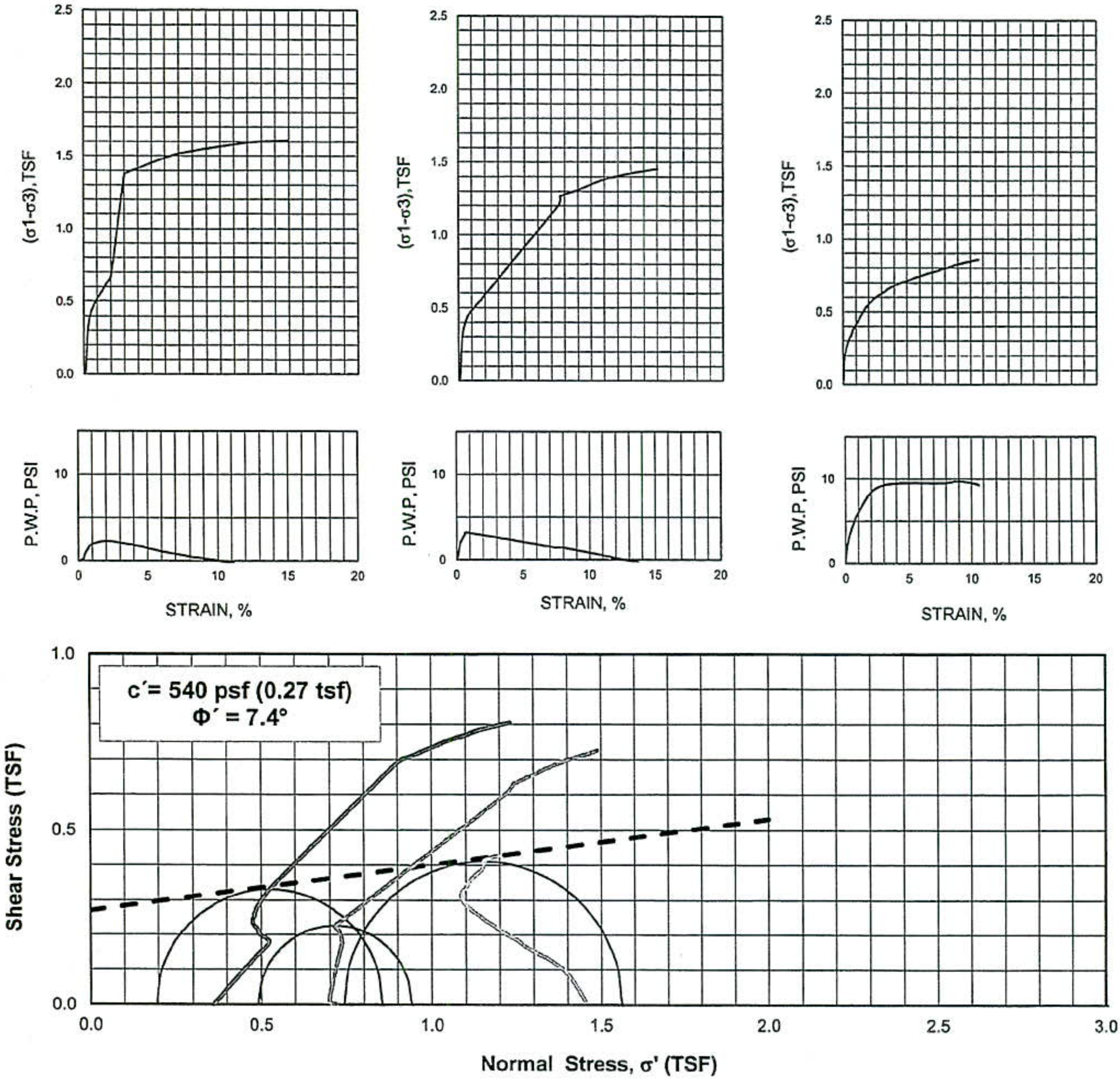
Patriot Project No.: 2-11-0383

Project Location: Allerton-Homer, Illinois

Client: Sunrise Coal

Client Address:

TEST NUMBER	BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FEET)	CLASSIFICATION (USCS)	COHESION (c') (POUNDS PER SQUARE FOOT (psf))	ANGLE OF INTERNAL FRICTION (Φ) (DEGREES)
1	B-26A	ST-3	5 - 7	SILTY CLAY	540	7.4
2	B-31, B-35 & B-36	COMPOSITE	13 - 20	SILTY CLAY	540	10.2
3	B-31 & B-35	COMPOSITE	23 - 30	SILTY CLAY	340	27
4	B-26A	ST-4	8-10	SILTY CLAY	230	30



Confing Pressure psi	Sample #	Sample Dimension		Dry Density pcf	Water Content W %
		Dia (in)	Height (in)		
5	1	2.788	5.252	117.0	19.2
10	2	2.810	5.261	116.9	19.2
20	3	2.845	5.610	105.5	20.9

PATRIOT ENGINEERING
and Environmental, Inc.
6330 East 75th Street, Suite 216
Indianapolis, IN 46250-2700
(317) 576-8058 FAX: (317) 576-1965

Consolidated Undrained Triaxial Test

Effective Stress Envelope @ Pore Water Pressure Peak

Sample Number: B-26A 5'-7'

Patriot Project Number: 2-11-0383

Figure:

Revised 1-3-2001

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6330 East 75th Street, Suite 216
Indianapolis, IN 46250-2700
(317) 576-8058 FAX: (317) 576-1965

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	Client:	Sunrise Coal
Project Number:	2-11-0383	Client Address:	Allerton, Illinois
Date Received:	5/18/2012	Sampled By:	Hoosier Drilling
Date Tested:	5/18/2012	Tested By:	T. Smith
Sample Number:	B-26A, 5'-7'	Sample Source:	Shelby Tube

Description: Brown SILTY CLAY

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	406	407	
Wet Wt+Tare:	117.25	87.74	g
Dry Wt+ Tare:	100.72	76.3	g
Tare wt:	14.41	14.26	g
Dry Wt:	86.31	62.04	g
Wt. Water:	16.53	11.44	g
% Moisture:	19.2%	18.4%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	62.5	psi
Final Skempton Value (Parameter B):	100%	
Effective Consolidation Stress (Sigma 3):	5	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.780		in.
Diameter 2:	2.812		in.
Diameter 3:	2.772		in.
Avg Diam:	2.788	0.000	in.
Length 1:	5.260		in.
Length 2:	5.230		in.
Length 3:	5.265		in.
Avg Height:	5.252	0.000	in.
Specimen Wt:	1174.60	1162.47	g
Area:	6.105	0.000	$in.^2$
Volume:	32.061	0.000	$in.^3$
Wet Unit Wt:	139.4	#DIV/0!	pcf
Dry Unit Wt:	117.0	#DIV/0!	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.88	#DIV/0!	
Void Ratio:	0.44	-1.00	
Saturation:	1.18	-0.50	

After Consolidation		
Change in Height:	-0.0161	in.
Height:	5.236	in.
Area:	6.142	in^2
Volume:	32.158	in^3
Void Ratio:	0.45	
Saturation:	1.13	

Failure Sketch:

Dial Reading (inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)		Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.010	0.00%	0.2	6.105	0.03	62.4	62.4	0.00	0.00	0.0	5.0	5.0	5.0	5.0	1.01	0.00	5.0	0.36	0.0	0.00	5.0	0.36
0.016	0.12%	1.8	6.112	0.30	62.4	62.4	0.00	0.02	0.3	5.3	5.0	5.3	5.0	1.06	0.00	5.1	0.37	0.1	0.01	5.1	0.37
0.022	0.23%	23.2	6.119	3.80	62.5	62.5	0.16	0.27	3.8	8.8	5.0	8.6	4.8	1.78	0.04	6.9	0.50	1.9	0.14	6.7	0.49
0.028	0.35%	30.4	6.126	4.96	62.6	62.6	0.20	0.36	5.0	10.0	5.0	9.8	4.8	2.03	0.04	7.5	0.54	2.5	0.18	7.3	0.52
0.035	0.47%	34.2	6.133	5.58	63.3	63.3	0.89	0.40	5.6	10.6	5.0	9.7	4.1	2.36	0.16	7.8	0.56	2.8	0.20	6.9	0.50
0.041	0.58%	37.1	6.141	6.04	63.6	63.6	1.21	0.43	6.0	11.0	5.0	9.8	3.8	2.59	0.20	8.0	0.58	3.0	0.22	6.8	0.49
0.047	0.70%	39.1	6.148	6.35	63.9	63.9	1.53	0.46	6.4	11.4	5.0	9.8	3.5	2.83	0.24	8.2	0.59	3.2	0.23	6.6	0.48
0.053	0.82%	41.6	6.155	6.76	64.2	64.2	1.77	0.49	6.8	11.8	5.0	10.0	3.2	3.09	0.26	8.4	0.60	3.4	0.24	6.6	0.48
0.059	0.93%	43.7	6.162	7.08	64.2	64.2	1.85	0.51	7.1	12.1	5.0	10.2	3.1	3.25	0.26	8.5	0.62	3.5	0.26	6.7	0.48
0.065	1.05%	45.3	6.170	7.34	64.4	64.4	1.97	0.53	7.3	12.3	5.0	10.4	3.0	3.42	0.27	8.7	0.62	3.7	0.26	6.7	0.48
0.114	1.98%	57.5	6.228	9.24	64.7	64.7	2.29	0.66	9.2	14.2	5.0	11.9	2.7	4.41	0.25	9.6	0.69	4.6	0.33	7.3	0.53
0.169	3.03%	120.6	6.296	19.16	64.5	64.5	2.09	1.38	19.2	24.2	5.0	22.1	2.9	7.59	0.11	14.6	1.05	9.6	0.69	12.5	0.90
0.218	3.97%	124.7	6.357	19.61	64.2	64.2	1.85	1.41	19.6	24.6	5.0	22.8	3.1	7.23	0.09	14.8	1.07	9.8	0.71	13.0	0.93
0.273	5.02%	129.7	6.427	20.17	63.8	63.8	1.45	1.45	20.2	25.2	5.0	23.7	3.6	6.68	0.07	15.1	1.09	10.1	0.73	13.6	0.98
0.322	5.95%	133.9	6.491	20.63	63.5	63.5	1.13	1.49	20.6	25.6	5.0	24.5	3.9	6.33	0.05	15.3	1.10	10.3	0.74	14.2	1.02
0.378	7.00%	138.2	6.564	21.05	63.2	63.2	0.80	1.52	21.1	26.1	5.0	25.2	4.2	6.02	0.04	15.5	1.12	10.5	0.76	14.7	1.06
0.433	8.05%	141.5	6.639	21.31	62.9	62.9	0.48	1.53	21.3	26.3	5.0	25.8	4.5	5.72	0.02	15.7	1.13	10.7	0.77	15.2	1.09
0.482	8.98%	144.4	6.707	21.53	62.7	62.7	0.28	1.55	21.5	26.5	5.0	26.3	4.7	5.56	0.01	15.8	1.14	10.8	0.78	15.5	1.11
0.537	10.03%	147.8	6.786	21.78	62.4	62.4	0.04	1.57	21.8	26.8	5.0	26.7	5.0	5.39	0.00	15.9	1.14	10.9	0.78	15.9	1.14
0.586	10.96%	150.5	6.857	21.95	62.1	62.1	-0.24	1.58	21.9	26.9	5.0	27.2	5.2	5.19	-0.01	16.0	1.15	11.0	0.79	16.2	1.17
0.641	12.01%	153.4	6.938	22.10	61.9	61.9	-0.48	1.59	22.1	27.1	5.0	27.6	5.5	5.03	-0.02	16.1	1.16	11.1	0.80	16.5	1.19
0.690	12.95%	155.9	7.013	22.23	61.7	61.7	-0.72	1.60	22.2	27.2	5.0	28.0	5.7	4.88	-0.03	16.1	1.16	11.1	0.80	16.8	1.21
0.745	14.00%	158.3	7.098	22.30	61.6	61.6	-0.80	1.61	22.3	27.3	5.0	28.1	5.8	4.84	-0.04	16.2	1.16	11.2	0.80	17.0	1.22
0.797	14.99%	160.6	7.181	22.36	61.5	61.5	-0.93	1.61	22.4	27.4	5.0	28.3	5.9	4.77	-0.04	16.2	1.17	11.2	0.81	17.1	1.23

Failure Cr PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure 15.0 %
Rate of Axial Strain: 0.0003 %/min.

Deviator Stress at Failure: 0.66 TSF
Effective Minor Principal Stress at Failure: 0.20 TSF
Effective Major Principal Stress at Failure: 0.86 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	Client:	Sunrise Coal
Project Number:	2-11-0383	Client Address:	Allerton, Illinois
Date Received:	5/18/2012	Sampled By:	Hoosier Drilling
Date Tested:	5/18/2012	Tested By:	T. Smith
Sample Number:	B-26A, 5'-7'	Sample Source:	Shelby Tube

Description: Brown SILTY CLAY

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	406	453	
Wet Wt+Tare:	117.25	86.72	g
Dry Wt+ Tare:	100.72	75.61	g
Tare wt:	14.41	14.45	g
Dry Wt:	86.31	61.16	g
Wt. Water:	16.53	11.11	g
% Moisture:	19.2%	18.2%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	62.5	psi
Final Skempton Value (Parameter B):	96%	
Effective Consolidation Stress (Sigma 3):	10	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.839		in.
Diameter 2:	2.800		in.
Diameter 3:	2.790		in.
Avg Diam:	2.810	0.000	in.
Length 1:	5.259		in.
Length 2:	5.254		in.
Length 3:	5.269		in.
Avg Height:	5.261	0.000	in.
Specimen Wt:	1193.70	1181.41	g
Area:	6.200	0.000	in.^{2}
Volume:	32.617	0.000	in.^{3}
Wet Unit Wt:	139.3	#DIV/0!	pcf
Dry Unit Wt:	116.9	#DIV/0!	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.87	#DIV/0!	
Void Ratio:	0.44	-1.00	
Saturation:	1.17	-0.49	

After Consolidation		
Change in Height:	-0.024	in.
Height:	5.237	in.
Area:	6.257	in^2
Volume:	32.764	in^3
Void Ratio:	0.45	
Saturation:	1.12	

Failure Sketch:

Dial Reading (Inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)		Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI
0.000	0.00%	0.2	6.200	0.03	65.4	65.4	0.00	0.00	0.0
0.006	0.12%	1.8	6.207	0.29	65.9	65.9	0.44	0.02	0.3
0.012	0.23%	23.2	6.215	3.74	67.2	67.2	1.77	0.27	3.7
0.018	0.35%	30.4	6.222	4.88	67.7	67.7	2.21	0.35	4.9
0.025	0.47%	34.2	6.229	5.49	68.0	68.0	2.58	0.40	5.5
0.031	0.58%	37.1	6.236	5.95	68.3	68.3	2.90	0.43	5.9
0.037	0.70%	39.1	6.244	6.26	68.6	68.6	3.18	0.45	6.3
0.394	7.49%	111.8	6.702	16.68	66.9	66.9	1.45	1.20	16.7
0.400	7.61%	117.9	6.711	17.57	67.0	67.0	1.53	1.27	17.6
0.406	7.73%	118.6	6.719	17.65	66.9	66.9	1.45	1.27	17.6
0.413	7.84%	119.1	6.728	17.70	66.9	66.9	1.45	1.27	17.7
0.419	7.96%	119.6	6.736	17.76	66.8	66.8	1.41	1.28	17.8
0.474	9.01%	123.9	6.814	18.19	66.6	66.6	1.13	1.31	18.2
0.529	10.06%	129.1	6.893	18.73	66.2	66.2	0.81	1.35	18.7
0.578	10.99%	133.5	6.965	19.17	66.0	66.0	0.52	1.38	19.2
0.633	12.04%	137.6	7.048	19.52	65.6	65.6	0.16	1.41	19.5
0.682	12.97%	140.7	7.124	19.74	65.4	65.4	-0.08	1.42	19.7
0.737	14.01%	144.0	7.211	19.97	65.0	65.0	-0.40	1.44	20.0
0.792	15.06%	147.5	7.300	20.20	64.8	64.8	-0.60	1.45	20.2

Dial Reading (Inches)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	10.0	10.0	10.0	10.0	1.00	0.00	10.0	0.72	0.0	0.00	10.0	0.72
0.006	10.3	10.0	9.8	9.6	1.03	1.52	10.1	0.73	0.1	0.01	9.7	0.70
0.012	13.7	10.0	12.0	8.2	1.45	0.47	11.9	0.85	1.9	0.13	10.1	0.73
0.018	14.9	10.0	12.7	7.8	1.63	0.45	12.4	0.90	2.4	0.18	10.2	0.74
0.025	15.5	10.0	12.9	7.4	1.74	0.47	12.7	0.92	2.7	0.20	10.2	0.73
0.031	15.9	10.0	13.0	7.1	1.84	0.49	13.0	0.93	3.0	0.21	10.1	0.73
0.037	16.3	10.0	13.1	6.8	1.92	0.51	13.1	0.95	3.1	0.23	9.9	0.72
0.394	26.7	10.0	25.2	8.6	2.95	0.09	18.3	1.32	8.3	0.60	16.9	1.22
0.400	27.6	10.0	26.0	8.5	3.07	0.09	18.8	1.35	8.8	0.63	17.3	1.24
0.406	27.6	10.0	26.2	8.6	3.06	0.08	18.8	1.36	8.8	0.64	17.4	1.25
0.413	27.7	10.0	26.2	8.6	3.07	0.08	18.8	1.36	8.8	0.64	17.4	1.25
0.419	27.8	10.0	26.4	8.6	3.07	0.08	18.9	1.36	8.9	0.64	17.5	1.26
0.474	28.2	10.0	27.1	8.9	3.05	0.06	19.1	1.37	9.1	0.65	18.0	1.29
0.529	28.7	10.0	27.9	9.2	3.04	0.04	19.4	1.39	9.4	0.67	18.6	1.34
0.578	29.2	10.0	28.6	9.5	3.02	0.03	19.6	1.41	9.6	0.69	19.1	1.37
0.633	29.5	10.0	29.4	9.8	2.98	0.01	19.8	1.42	9.8	0.70	19.6	1.41
0.682	29.7	10.0	29.8	10.1	2.96	0.00	19.9	1.43	9.9	0.71	20.0	1.44
0.737	30.0	10.0	30.4	10.4	2.92	-0.02	20.0	1.44	10.0	0.72	20.4	1.47
0.792	30.2	10.0	30.8	10.6	2.91	-0.03	20.1	1.45	10.1	0.73	20.7	1.49

Failure Criteria: PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure: 15.0 %
Rate of Axial Strain: 0.000 %/min.

Deviator Stress at Failure: 0.45 TSF
Effective Minor Principal Stress at Failure: 0.49 TSF
Effective Major Principal Stress at Failure: 0.94 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	=Sample1!F8	**Client:**	Sunrise Coal
Project Number:	2-11-0383	**Client Address:**	Allerton, Illinois
Date Received:	5/18/2012	**Sampled By:**	Hoosier Drilling
Date Tested:	5/18/2012	**Tested By:**	JP
Sample Number:	B-26A, 5'-7'	**Sample Source:**	Shelby Tube
Description:	Brown SILTY CLAY		

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	105	152	
Wet Wt+Tare:	57.52	76.84	g
Dry Wt+ Tare:	49.98	63.53	g
Tare wt:	13.88	13.91	g
Dry Wt:	36.1	49.62	g
Wt. Water:	7.54	13.31	g
% Moisture:	20.9%	26.8%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	67.5	psi
Final Skempton Value (Parameter B):	96%	
Effective Consolidation Stress (Sigma 3):	20	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.842		in.
Diameter 2:	2.860		in.
Diameter 3:	2.832		in.
Avg Diam:	2.845	0.000	in.
Length 1:	5.611		in.
Length 2:	5.615		in.
Length 3:	5.604		in.
Avg Height:	5.610	0.000	in.
Specimen Wt:	1194.59	1194.88	g
Area:	6.356	0.000	$in.^2$
Volume:	35.655	0.000	$in.^3$
Wet Unit Wt:	127.5	#DIV/0!	pcf
Dry Unit Wt:	105.5	#DIV/0!	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.97	#DIV/0!	
Void Ratio:	0.60	-1.00	
Saturation:	0.95	-0.72	

After Consolidation		
Change in Height:	-0.0257	in.
Height:	5.584	in.
Area:	6.414	in^2
Volume:	35.816	in^3
Void Ratio:	0.68	
Saturation:	0.93	

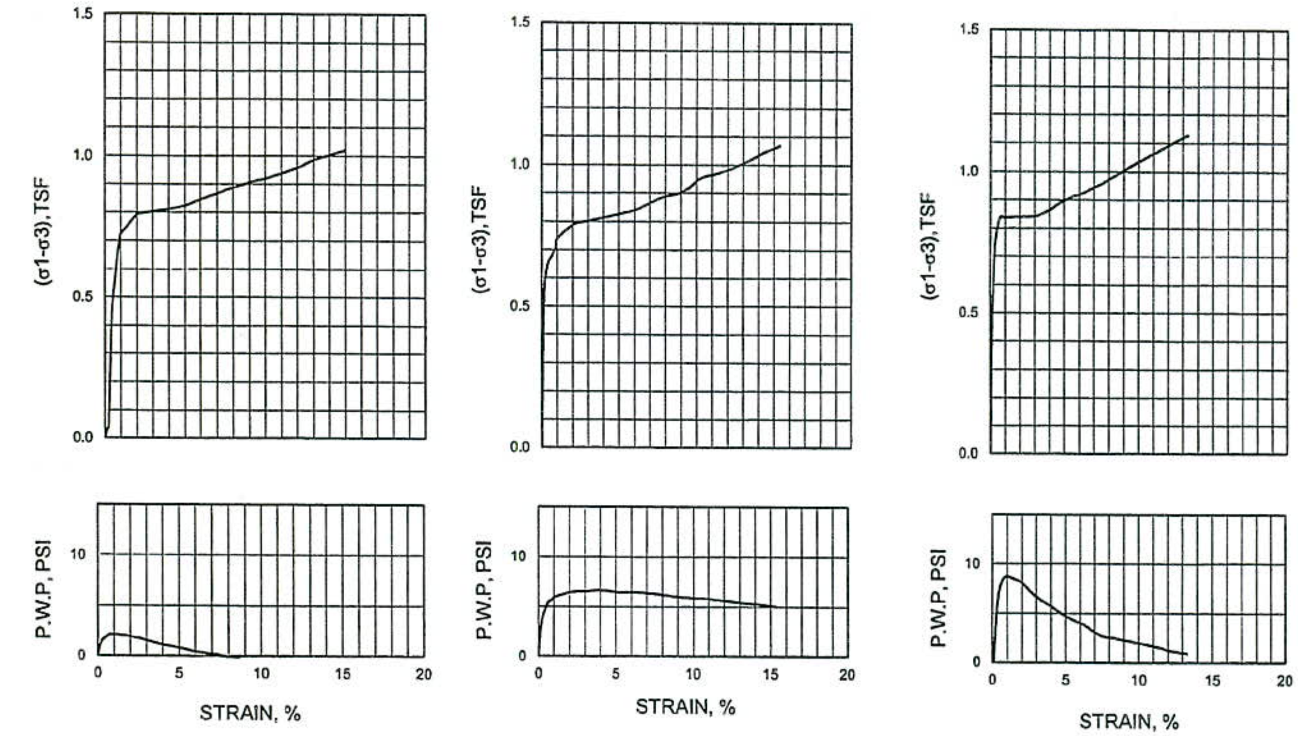
Failure Sketch:

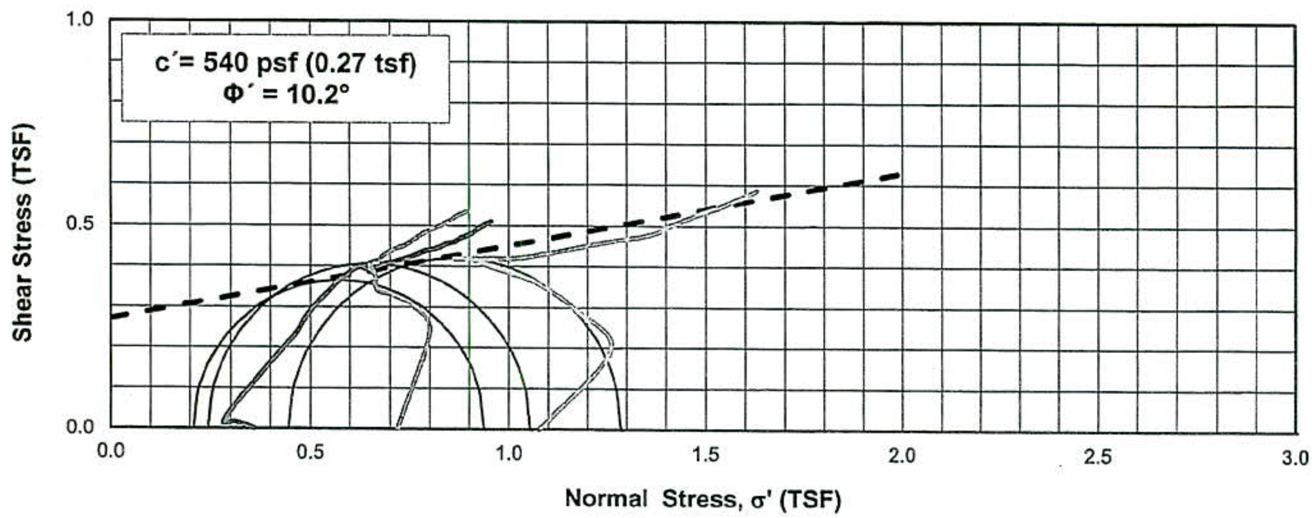
Dial Reading (inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)		Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	2.1	6.356	0.32	53.5	53.5	0.00	0.02	0.3	20.3	20.0	20.3	20.0	1.02	0.00	20.2	1.45	0.2	0.01	20.2	1.45
0.007	0.11%	14.7	6.362	2.31	55.1	55.1	1.65	0.17	2.3	22.3	20.0	20.7	18.4	1.13	0.71	21.2	1.52	1.2	0.08	19.5	1.40
0.013	0.22%	20.7	6.369	3.25	56.2	56.2	2.65	0.23	3.2	23.2	20.0	20.6	17.3	1.19	0.82	21.6	1.56	1.6	0.12	19.0	1.37
0.019	0.33%	23.9	6.376	3.75	56.8	56.8	3.30	0.27	3.7	23.7	20.0	20.4	16.7	1.22	0.88	21.9	1.57	1.9	0.13	18.6	1.34
0.025	0.44%	26.4	6.383	4.14	57.4	57.4	3.90	0.30	4.1	24.1	20.0	20.2	16.1	1.26	0.94	22.1	1.59	2.1	0.15	18.2	1.31
0.031	0.55%	28.6	6.390	4.48	57.9	57.9	4.38	0.32	4.5	24.5	20.0	20.1	15.6	1.29	0.98	22.2	1.60	2.2	0.16	17.9	1.29
0.037	0.66%	30.7	6.397	4.80	58.3	58.3	4.79	0.35	4.8	24.8	20.0	20.0	15.2	1.32	1.00	22.4	1.61	2.4	0.17	17.6	1.27
0.043	0.76%	33.2	6.404	5.19	58.7	58.7	5.23	0.37	5.2	25.2	20.0	20.0	14.8	1.35	1.01	22.6	1.63	2.6	0.19	17.4	1.25
0.049	0.87%	34.7	6.412	5.41	59.1	59.1	5.59	0.39	5.4	25.4	20.0	19.8	14.4	1.38	1.03	22.7	1.63	2.7	0.19	17.1	1.23
0.056	0.98%	36.3	6.419	5.65	59.4	59.4	5.91	0.41	5.7	25.7	20.0	19.7	14.1	1.40	1.05	22.8	1.64	2.8	0.20	16.9	1.22
0.111	1.97%	49.2	6.483	7.59	61.8	61.8	8.29	0.55	7.6	27.6	20.0	19.3	11.7	1.65	1.09	23.8	1.71	3.8	0.27	15.5	1.12
0.166	2.95%	56.5	6.549	8.63	62.7	62.7	9.21	0.62	8.6	28.6	20.0	19.4	10.8	1.80	1.07	24.3	1.75	4.3	0.31	15.1	1.09
0.227	4.04%	62.7	6.623	9.47	62.9	62.9	9.41	0.68	9.5	29.5	20.0	20.1	10.6	1.89	0.99	24.7	1.78	4.7	0.34	15.3	1.10
0.282	5.02%	66.3	6.692	9.91	63.0	63.0	9.49	0.71	9.9	29.9	20.0	20.4	10.5	1.94	0.96	25.0	1.80	5.0	0.36	15.5	1.11
0.337	6.01%	69.9	6.762	10.34	63.0	63.0	9.49	0.74	10.3	30.3	20.0	20.8	10.5	1.98	0.92	25.2	1.81	5.2	0.37	15.7	1.13
0.392	6.99%	73.1	6.833	10.70	63.0	63.0	9.45	0.77	10.7	30.7	20.0	21.2	10.5	2.01	0.88	25.4	1.83	5.4	0.39	15.9	1.14
0.448	7.97%	76.3	6.906	11.05	63.0	63.0	9.49	0.80	11.1	31.1	20.0	21.6	10.5	2.05	0.86	25.5	1.84	5.5	0.40	16.0	1.15
0.503	8.95%	79.9	6.981	11.45	63.2	63.2	9.69	0.82	11.5	31.5	20.0	21.8	10.3	2.11	0.85	25.7	1.85	5.7	0.41	16.0	1.15
0.564	10.05%	83.1	7.065	11.77	63.0	63.0	9.49	0.85	11.8	31.8	20.0	22.3	10.5	2.12	0.81	25.9	1.86	5.9	0.42	16.4	1.18
0.596	10.61%	84.6	7.110	11.90	62.8	62.8	9.25	0.86	11.9	31.9	20.0	22.6	10.7	2.11	0.78	25.9	1.87	5.9	0.43	16.7	1.20

Failure Criteri: PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure: 15.0 %

Deviator Stress at Failure: 0.82 TSF
Effective Minor Principal Stress at Failure: 0.74 TSF

Sample 1: The Max $\sigma 1$-$\sigma 3$ is :	0.66 **tsf**	**Pore water:**	2.29 psi
Sample 2: The Max $\sigma 1$-$\sigma 3$ is :	0.45 **tsf**	**Pore water:**	3.18 psi
Sample 3: The Max $\sigma 1$-$\sigma 3$ is :	0.82 **tsf**	**Pore water:**	9.69 psi





Confing Pressure psi	Sample #	Sample Dimension Dia (in)	Height (in)	Dry Density pcf	Water Content W %
5	1	2.873	5.725	120.0	11.7
10	2	2.865	5.626	120.4	11.4
15	3	2.872	5.744	117.3	11.5

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Consolidated Undrained Triaxial Test

Effective Stress Envelope @ Pore Water Pressure Peak

Sample Number: B31, B-35, B-36

Patriot Project Number: 2-11-0383

Figure:

Revised 1-3-2001

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	Client:	Sunrise Coal
Project Number:	2-11-0383	Client Address:	Allerton, Illinois
Date Received:	4/26/2012	Sampled By:	Hoosier Drilling
Date Tested:	5/2/20125/25/2012	Tested By:	JP
Sample Number:	Remold #2	Sample Source:	Composite: B36/13-15', B35/18-20', B31/18-20'

Description: Brown Sandy Silty CLAY trace Gravel

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	A		
Wet Wt+Tare:	55.65		g
Dry Wt+ Tare:	51.5		g
Tare wt:	15.88		g
Dry Wt:	35.62	0	g
Wt. Water:	4.15	0	g
% Moisture:	11.7%	#DIV/0!	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	59.5	psi
Final Skempton Value (Parameter B):	100%	
Effective Consolidation Stress (Sigma 3):	5	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.870	3.242	in.
Diameter 2:	2.875	3.301	in.
Diameter 3:	2.874	3.008	in.
Avg Diam:	2.873	3.184	in.
Length 1:	5.725	4.529	in.
Length 2:	5.726	4.540	in.
Length 3:	5.724	4.540	in.
Avg Height:	5.725	4.536	in.
Specimen Wt:	1306.50	1300.00	g
Area:	6.483	7.961	$in.^2$
Volume:	37.114	36.112	$in.^3$
Wet Unit Wt:	134.0	137.0	pcf
Dry Unit Wt:	120.0	#DIV/0!	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.99	1.42	
Void Ratio:	0.40	#DIV/0!	
Saturation:	0.78	#DIV/0!	

After Consolidation

Change in Height:	-0.016	in.
Height:	5.709	in.
Area:	6.519	in^2
Volume:	37.217	in^3
Void Ratio:	#DIV/0!	
Saturation:	0.76	

Failure Sketch:

Dial Reading (inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.483	0.00	54.5	0.00	0.00	0.0	5.0	5.0	5.0	5.0	1.00	0.00	5.0	0.36	0.0	0.00	5.0	0.36
0.006	0.10%	3	6.490	0.46	55.4	0.90	0.03	0.5	5.5	5.0	4.6	4.1	1.11	1.95	5.2	0.38	0.2	0.02	4.3	0.31
0.011	0.19%	3	6.495	0.46	55.8	1.30	0.03	0.5	5.5	5.0	4.2	3.7	1.12	2.81	5.2	0.38	0.2	0.02	3.9	0.28
0.017	0.30%	20	6.502	3.08	56.1	1.60	0.22	3.1	8.1	5.0	6.5	3.4	1.90	0.52	6.5	0.47	1.5	0.11	4.9	0.36
0.026	0.45%	42	6.512	6.45	56.3	1.80	0.46	6.4	11.4	5.0	9.6	3.2	3.02	0.28	8.2	0.59	3.2	0.23	6.4	0.46
0.030	0.52%	46	6.517	7.06	56.4	1.90	0.51	7.1	12.1	5.0	10.2	3.1	3.28	0.27	8.5	0.61	3.5	0.25	6.6	0.48
0.034	0.59%	49	6.522	7.51	56.5	2.00	0.54	7.5	12.5	5.0	10.5	3.0	3.50	0.27	8.8	0.63	3.8	0.27	6.8	0.49
0.040	0.70%	54	6.528	8.27	56.6	2.10	0.60	8.3	13.3	5.0	11.2	2.9	3.85	0.25	9.1	0.66	4.1	0.30	7.0	0.51
0.046	0.80%	59	6.535	9.03	56.6	2.10	0.65	9.0	14.0	5.0	11.9	2.9	4.11	0.23	9.5	0.69	4.5	0.33	7.4	0.53
0.052	0.91%	64	6.542	9.78	56.6	2.10	0.70	9.8	14.8	5.0	12.7	2.9	4.37	0.21	9.9	0.71	4.9	0.35	7.8	0.56
0.057	1.00%	66	6.548	10.08	56.6	2.10	0.73	10.1	15.1	5.0	13.0	2.9	4.48	0.21	10.0	0.72	5.0	0.36	7.9	0.57
0.115	2.01%	73	6.616	11.03	56.4	1.90	0.79	11.0	16.0	5.0	14.1	3.1	4.56	0.17	10.5	0.76	5.5	0.40	8.6	0.62
0.172	3.00%	73	6.684	10.92	56.0	1.50	0.79	10.9	15.9	5.0	14.4	3.5	4.12	0.14	10.5	0.75	5.5	0.39	9.0	0.65
0.229	4.00%	76	6.753	11.25	55.6	1.10	0.81	11.3	16.3	5.0	15.2	3.9	3.89	0.10	10.6	0.77	5.6	0.41	9.5	0.69
0.286	5.00%	78	6.824	11.43	55.3	0.80	0.82	11.4	16.4	5.0	15.6	4.2	3.72	0.07	10.7	0.77	5.7	0.41	9.9	0.71
0.344	6.01%	81	6.897	11.74	54.9	0.40	0.85	11.7	16.7	5.0	16.3	4.6	3.55	0.03	10.9	0.78	5.9	0.42	10.5	0.75
0.422	7.37%	85	6.999	12.15	54.6	0.10	0.87	12.1	17.1	5.0	17.0	4.9	3.48	0.01	11.1	0.80	6.1	0.44	11.0	0.79
0.462	8.07%	87	7.052	12.34	54.3	-0.20	0.89	12.3	17.3	5.0	17.5	5.2	3.37	-0.02	11.2	0.80	6.2	0.44	11.4	0.82
0.522	9.12%	90	7.133	12.62	54.1	-0.40	0.91	12.6	17.6	5.0	18.0	5.4	3.34	-0.03	11.3	0.81	6.3	0.45	11.7	0.84
0.573	10.01%	92	7.204	12.77	53.9	-0.60	0.92	12.8	17.8	5.0	18.4	5.6	3.28	-0.05	11.4	0.82	6.4	0.46	12.0	0.86
0.630	11.00%	95	7.284	13.04	53.8	-0.70	0.94	13.0	18.0	5.0	18.7	5.7	3.29	-0.05	11.5	0.83	6.5	0.47	12.2	0.88
0.687	12.00%	98	7.367	13.30	53.6	-0.90	0.96	13.3	18.3	5.0	19.2	5.9	3.25	-0.07	11.7	0.84	6.7	0.48	12.6	0.90
0.744	13.00%	102	7.451	13.69	53.5	-1.00	0.99	13.7	18.7	5.0	19.7	6.0	3.28	-0.07	11.8	0.85	6.8	0.49	12.8	0.92
0.802	14.01%	105	7.539	13.93	53.4	-1.10	1.00	13.9	18.9	5.0	20.0	6.1	3.28	-0.08	12.0	0.86	7.0	0.50	13.1	0.94
0.859	15.00%	108	7.627	14.16	53.3	-1.20	1.02	14.2	19.2	5.0	20.4	6.2	3.28	-0.08	12.1	0.87	7.1	0.51	13.3	0.96

Failure Cr PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure 1.0 %
Rate of Axial Strain: 0.040 %/min.

Deviator Stress at Failure: 0.73 TSF
Effective Minor Principal Stress at Failure: 0.21 TSF
Effective Major Principal Stress at Failure: 0.94 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	**Client:**	Sunrise Coal
Project Number:	2-11-0383	**Client Address:**	Allerton, Illinois
Date Received:	4/26/2012	**Sampled By:**	Hoosier Drilling
Date Tested:	5/2/20125/25/2012	**Tested By:**	JP
Sample Number:	Remold #2	**Sample Source:**	Composite: B36/13-15', B35/18-20', B31/18-20'
Description:	Brown Sandy Silty CLAY trace Gravel		

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	B65	1	
Wet Wt+Tare:	59.96	233.29	g
Dry Wt+ Tare:	55.42	212.89	g
Tare wt:	15.74	89.87	g
Dry Wt:	39.68	123.02	g
Wt. Water:	4.54	20.4	g
% Moisture:	11.4%	16.6%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	75	psi
Final Skempton Value (Parameter B):	100%	
Effective Consolidation Stress (Sigma 3):	10	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.854	3.300	in.
Diameter 2:	2.869	2.890	in.
Diameter 3:	2.872	2.900	in.
Avg Diam:	2.865	3.030	in.
Length 1:	5.627	4.906	in.
Length 2:	5.625	4.905	in.
Length 3:	5.626	4.905	in.
Avg Height:	5.628	4.905	in.
Specimen Wt:	1278.50	1345.50	g
Area:	6.447	7.211	$in.^2$
Volume:	36.269	35.371	$in.^3$
Wet Unit Wt:	134.2	144.8	pcf
Dry Unit Wt:	120.4	124.2	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.96	1.62	
Void Ratio:	0.40	0.36	
Saturation:	0.77	1.26	

After Consolidation		
Change in Height:	-0.0145	in.
Height:	5.612	in.
Area:	6.480	in^2
Volume:	36.362	in^3
Void Ratio:	0.39	
Saturation:	0.93	

Failure Sketch:

Dial Reading (inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.447	0.00	75.4	0.00	0.00	0.0	10.0	10.0	10.0	10.0	1.00	0.00	10.0	0.72	0.0	0.00	10.0	0.72
0.006	0.11%	43	6.454	6.66	77.6	2.20	0.48	6.7	16.7	10.0	14.5	7.8	1.85	0.33	13.3	0.96	3.3	0.24	11.1	0.80
0.012	0.21%	54	6.461	8.36	79.0	3.00	0.60	8.4	18.4	10.0	14.8	6.4	2.31	0.43	14.2	1.02	4.2	0.30	10.6	0.76
0.017	0.30%	57	6.466	8.81	79.6	4.20	0.63	8.8	18.8	10.0	14.6	5.8	2.52	0.48	14.4	1.04	4.4	0.32	10.2	0.73
0.023	0.41%	59	6.473	9.11	80.1	4.70	0.66	9.1	19.1	10.0	14.4	5.3	2.72	0.52	14.6	1.05	4.6	0.33	9.9	0.71
0.029	0.52%	60	6.480	9.26	80.5	5.10	0.67	9.3	19.3	10.0	14.2	4.9	2.89	0.55	14.6	1.05	4.6	0.33	9.5	0.69
0.035	0.62%	61	6.487	9.40	80.8	5.40	0.68	9.4	19.4	10.0	14.0	4.6	3.04	0.57	14.7	1.06	4.7	0.34	9.3	0.67
0.040	0.71%	62	6.493	9.55	80.9	5.50	0.69	9.5	19.5	10.0	14.0	4.5	3.12	0.58	14.8	1.06	4.8	0.34	9.3	0.67
0.046	0.82%	63	6.500	9.69	81.0	5.60	0.70	9.7	19.7	10.0	14.1	4.4	3.20	0.58	14.8	1.07	4.8	0.35	9.2	0.67
0.052	0.92%	65	6.507	9.99	81.2	5.80	0.72	10.0	20.0	10.0	14.2	4.2	3.38	0.58	15.0	1.08	5.0	0.36	9.2	0.66
0.058	1.03%	67	6.514	10.29	81.3	5.90	0.74	10.3	20.3	10.0	14.4	4.1	3.51	0.57	15.1	1.09	5.1	0.37	9.2	0.67
0.115	2.04%	72	6.581	10.94	81.8	6.40	0.79	10.9	20.9	10.0	14.5	3.6	4.04	0.59	15.5	1.11	5.5	0.39	9.1	0.65
0.173	3.08%	74	6.651	11.13	81.9	6.50	0.80	11.1	21.1	10.0	14.6	3.5	4.18	0.58	15.6	1.12	5.6	0.40	9.1	0.65
0.231	4.11%	76	6.723	11.30	82.0	6.60	0.81	11.3	21.3	10.0	14.7	3.4	4.32	0.58	15.7	1.13	5.7	0.41	9.1	0.65
0.290	5.15%	78	6.797	11.48	81.8	6.40	0.83	11.5	21.5	10.0	15.1	3.6	4.19	0.56	15.7	1.13	5.7	0.41	9.3	0.67
0.357	6.35%	81	6.884	11.77	81.8	6.40	0.85	11.8	21.8	10.0	15.4	3.6	4.27	0.54	15.9	1.14	5.9	0.42	9.5	0.68
0.440	7.82%	86	6.994	12.30	81.6	6.20	0.89	12.3	22.3	10.0	16.1	3.8	4.24	0.50	16.1	1.16	6.1	0.44	9.9	0.72
0.492	8.75%	88	7.065	12.46	81.4	6.00	0.90	12.5	22.5	10.0	16.5	4.0	4.11	0.48	16.2	1.17	6.2	0.45	10.2	0.74
0.535	9.51%	91	7.124	12.77	81.3	5.90	0.92	12.8	22.8	10.0	16.9	4.1	4.12	0.46	16.4	1.18	6.4	0.46	10.5	0.76
0.578	10.24%	95	7.182	13.23	81.2	5.80	0.95	13.2	23.2	10.0	17.4	4.2	4.15	0.44	16.6	1.20	6.6	0.48	10.8	0.78
0.640	11.38%	98	7.274	13.47	81.1	5.70	0.97	13.5	23.5	10.0	17.8	4.3	4.13	0.42	16.7	1.21	6.7	0.49	11.0	0.79
0.692	12.30%	101	7.351	13.74	80.9	5.50	0.99	13.7	23.7	10.0	18.2	4.5	4.05	0.40	16.9	1.21	6.9	0.49	11.4	0.82
0.754	13.40%	105	7.444	14.10	80.7	5.30	1.02	14.1	24.1	10.0	18.8	4.7	4.00	0.38	17.1	1.23	7.1	0.51	11.8	0.85
0.807	14.34%	109	7.526	14.48	80.6	5.20	1.04	14.5	24.5	10.0	19.3	4.8	4.02	0.36	17.2	1.24	7.2	0.52	12.0	0.87
0.864	15.36%	113	7.616	14.84	80.4	5.00	1.07	14.8	24.8	10.0	19.8	5.0	3.97	0.34	17.4	1.25	7.4	0.53	12.4	0.89

Failure Criteri- PWP	(Pore Water Pressure Peak or Max. Divatory Stress?)	**Deviator Stress at Failure:**	0.81 TSF
Axial Strain at Failure:	4.1 %	**Effective Minor Principal Stress at Failure:**	0.24 TSF
Rate of Axial Strain:	0.040 %/min.	**Effective Major Principal Stress at Failure:**	1.05 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	Client:	Sunrise Coal
Project Number:	2-11-0383	Client Address:	Allerton, Illinois
Date Received:	4/26/2012	Sampled By:	Hoosier Drilling
Date Tested:	5/2/20125/25/2012	Tested By:	JP
Sample Number:	Remold #2	Sample Source:	Composite: B36/13-15', B35/18-20', B31/18-20'

Description: Brown Sandy Silty CLAY trace Gravel

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	B2	HN	
Wet Wt+Tare:	55.98	55.95	g
Dry Wt+ Tare:	51.5	50.21	g
Tare wt:	12.5	12.56	g
Dry Wt:	39	37.65	g
Wt. Water:	4.48	5.74	g
% Moisture:	11.5%	15.2%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	45	psi
Final Skempton Value (Parameter B):	96%	
Effective Consolidation Stress (Sigma 3):	15	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.872	3.021	in.
Diameter 2:	2.873	3.264	in.
Diameter 3:	2.872	3.075	in.
Avg Diam:	2.872	3.120	in.
Length 1:	5.744	4.950	in.
Length 2:	5.744	4.950	in.
Length 3:	5.744	4.951	in.
Avg Height:	5.744	4.950	in.
Specimen Wt:	1278.50	1325.80	g
Area:	6.480	7.645	$in.^2$
Volume:	37.220	37.847	$in.^3$
Wet Unit Wt:	130.7	133.3	pcf
Dry Unit Wt:	117.3	115.7	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	2.00	1.59	
Void Ratio:	0.44	0.46	
Saturation:	0.71	0.90	

After Consolidation		
Change in Height:	-0.016	in.
Height:	5.728	in.
Area:	6.516	in^2
Volume:	37.323	in^3
Void Ratio:	0.44	
Saturation:	0.80	

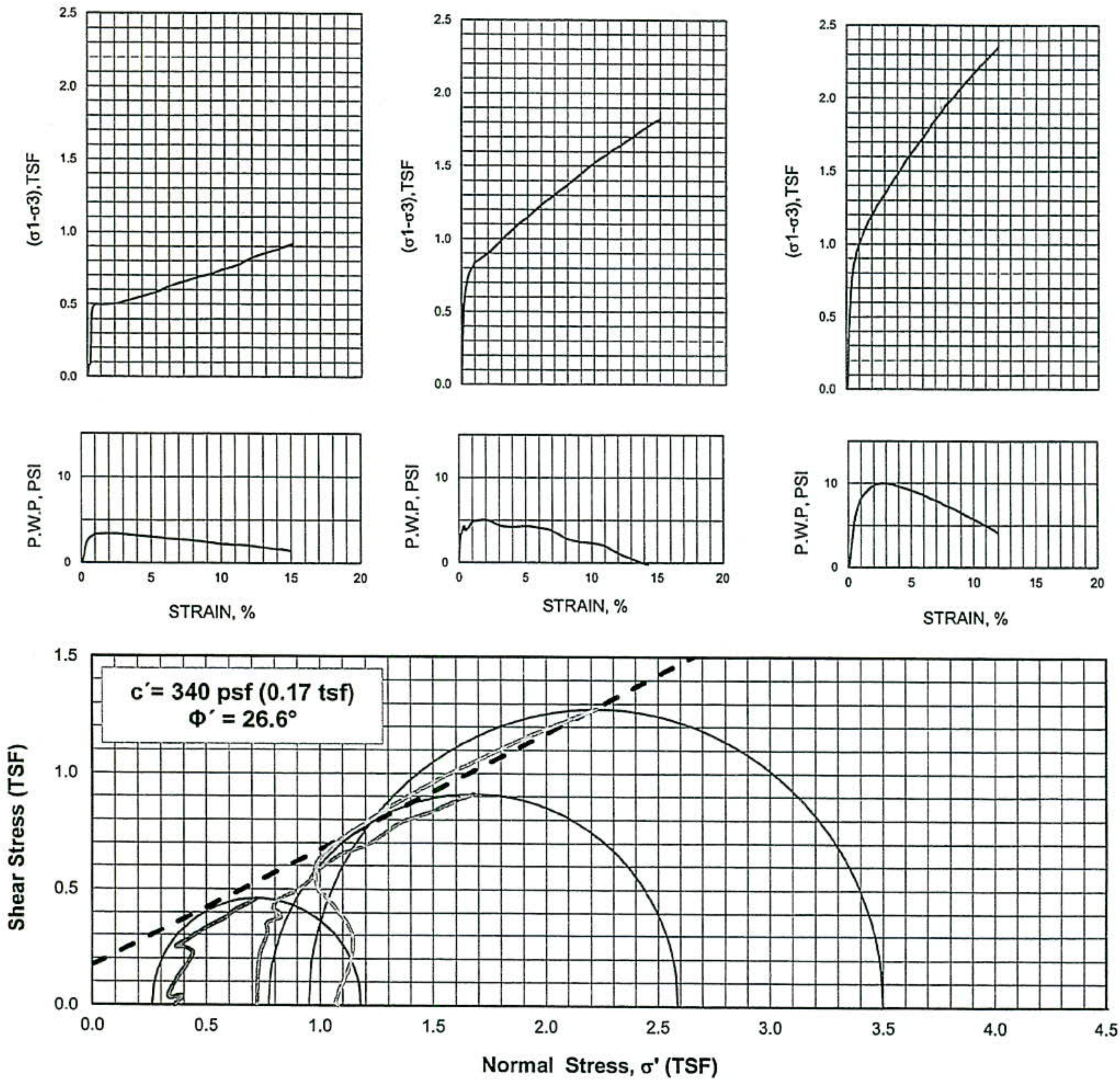
Failure Sketch:

Dial Reading (Inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.480	0.00	44.2	0.00	0.00	0.0	15.0	15.0	15.0	15.0	1.00	0.00	15.0	1.08	0.0	0.00	15.0	1.08
0.006	0.10%	35	6.487	5.40	44.4	0.20	0.39	5.4	20.4	15.0	20.2	14.8	1.36	0.04	17.7	1.27	2.7	0.19	17.5	1.26
0.011	0.19%	53	6.492	8.16	47.0	2.80	0.59	8.2	23.2	15.0	20.4	12.2	1.67	0.34	19.1	1.37	4.1	0.29	16.3	1.17
0.017	0.30%	65	6.499	10.00	49.3	5.10	0.72	10.0	25.0	15.0	19.9	9.9	2.01	0.51	20.0	1.44	5.0	0.36	14.9	1.07
0.023	0.40%	70	6.506	10.76	50.8	6.60	0.77	10.8	25.8	15.0	19.2	8.4	2.28	0.61	20.4	1.47	5.4	0.39	13.8	0.99
0.029	0.50%	73	6.513	11.21	51.7	7.50	0.81	11.2	26.2	15.0	18.7	7.5	2.49	0.67	20.6	1.48	5.6	0.40	13.1	0.94
0.034	0.59%	75	6.518	11.51	52.2	8.00	0.83	11.5	26.5	15.0	18.5	7.0	2.64	0.70	20.8	1.49	5.8	0.41	12.8	0.92
0.040	0.70%	76	6.525	11.65	52.6	8.40	0.84	11.6	26.6	15.0	18.2	6.6	2.76	0.72	20.8	1.50	5.8	0.42	12.4	0.89
0.046	0.80%	76	6.532	11.63	52.8	8.60	0.84	11.6	26.6	15.0	18.0	6.4	2.82	0.74	20.8	1.50	5.8	0.42	12.2	0.88
0.052	0.91%	76	6.539	11.62	52.9	8.70	0.84	11.6	26.6	15.0	17.9	6.3	2.84	0.75	20.8	1.50	5.8	0.42	12.1	0.87
0.057	0.99%	76	6.545	11.61	53.0	8.80	0.84	11.6	26.6	15.0	17.8	6.2	2.87	0.76	20.8	1.50	5.8	0.42	12.0	0.86
0.115	2.00%	77	6.612	11.65	52.3	8.10	0.84	11.6	26.6	15.0	18.5	6.9	2.69	0.70	20.8	1.50	5.8	0.42	12.7	0.92
0.172	2.99%	78	6.680	11.68	50.9	6.70	0.84	11.7	26.7	15.0	20.0	8.3	2.41	0.57	20.8	1.50	5.8	0.42	14.1	1.02
0.230	4.00%	81	6.750	12.00	49.9	5.70	0.86	12.0	27.0	15.0	21.3	9.3	2.29	0.48	21.0	1.51	6.0	0.43	15.3	1.10
0.289	5.03%	85	6.823	12.46	48.9	4.70	0.90	12.5	27.5	15.0	22.8	10.3	2.21	0.38	21.2	1.53	6.2	0.45	16.5	1.19
0.363	6.32%	89	6.017	12.87	48.0	3.80	0.93	12.9	27.9	15.0	24.1	11.2	2.15	0.30	21.4	1.54	6.4	0.46	17.6	1.27
0.432	7.52%	93	7.007	13.27	46.9	2.70	0.96	13.3	28.3	15.0	25.6	12.3	2.08	0.20	21.6	1.56	6.6	0.48	18.9	1.36
0.500	8.70%	98	7.098	13.81	46.6	2.40	0.99	13.8	28.8	15.0	26.4	12.6	2.10	0.17	21.9	1.58	6.9	0.50	19.5	1.40
0.571	9.94%	103	7.195	14.32	46.2	2.00	1.03	14.3	29.3	15.0	27.3	13.0	2.10	0.14	22.2	1.60	7.2	0.52	20.2	1.45
0.639	11.12%	108	7.291	14.81	45.8	1.60	1.07	14.8	29.8	15.0	28.2	13.4	2.11	0.11	22.4	1.61	7.4	0.53	20.8	1.50
0.694	12.08%	112	7.370	15.20	45.4	1.20	1.09	15.2	30.2	15.0	29.0	13.8	2.10	0.08	22.6	1.63	7.6	0.55	21.4	1.54
0.764	13.30%	117	7.474	15.65	45.1	0.90	1.13	15.7	30.7	15.0	29.8	14.1	2.11	0.06	22.8	1.64	7.8	0.56	21.9	1.58
0.815	14.19%	120	7.551	15.89	44.9	0.70	1.14	15.9	30.9	15.0	30.2	14.3	2.11	0.04	22.9	1.65	7.9	0.57	22.2	1.60
0.862	15.01%	124	7.624	16.26	44.7	0.50	1.17	16.3	31.3	15.0	30.8	14.5	2.12	0.03	23.1	1.67	8.1	0.59	22.6	1.63

Failure Criteri PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure: 1.0 %

Deviator Stress at Failure: 0.84 TSF
Effective Minor Principal Stress at Failure: 0.45 TSF

Sample 1: The Max $\sigma1-\sigma3$ is :	0.73 **tsf**	**Pore water:**	2.1 psi
Sample 2: The Max $\sigma1-\sigma3$ is :	0.81 **tsf**	**Pore water:**	6.6 psi
Sample 3: The Max $\sigma1-\sigma3$ is :	0.84 **tsf**	**Pore water:**	8.8 psi



Confing Pressure psi	Sample #	Sample Dimension		Dry Density pcf	Water Content W %
		Dia (in)	Height (in)		
5	1	2.870	5.753	123.1	10.1
10	2	2.871	5.750	124.0	10.4
15	3	2.870	5.583	126.4	10.4

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Consolidated Undrained Triaxial Test

Effective Stress Envelope @ Pore Water Pressure Peak

Sample Number: B-31, B-35

Patriot Project Number: 2-11-0383

Figure:

Revised 1-3-2001

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	**Client:**	Sunrise Coal
Project Number:	2-11-0383	**Client Address:**	Allerton, Illinois
Date Received:	4/26/2012	**Sampled By:**	Hoosier Drilling
Date Tested:	6/1/2102	**Tested By:**	JP
Sample Number:	Composite Remold #3	**Sample Source:**	Composite Sample B-21, 28-30'/B-35, 23-25'

Description: Brown SANDY SILT CLAY with trace grvel

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	A	5	
Wet Wt+Tare:	276.58	407.69	g
Dry Wt+ Tare:	270.89	384.22	g
Tare wt:	214.5	214.5	g
Dry Wt:	56.39	169.72	g
Wt. Water:	5.69	23.47	g
% Moisture:	10.1%	13.8%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	68.5	psi
Final Skempton Value (Parameter B):	100%	
Effective Consolidation Stress (Sigma 3):	5	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.869	3.206	in.
Diameter 2:	2.870	3.206	in.
Diameter 3:	2.870	3.299	in.
Avg Diam:	2.870	3.237	in.
Length 1:	5.756	4.950	in.
Length 2:	5.749	4.960	in.
Length 3:	5.755	4.970	in.
Avg Height:	5.753	4.960	in.
Specimen Wt:	1325.10	1359.50	g
Area:	6.468	8.230	$in.^2$
Volume:	37.211	40.818	$in.^3$
Wet Unit Wt:	135.5	126.8	pcf
Dry Unit Wt:	123.1	111.4	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	2.00	1.53	
Void Ratio:	0.37	0.51	
Saturation:	0.74	0.73	

After Consolidation		
Change in Height:	-0.009	in.
Height:	5.744	in.
Area:	6.488	in^2
Volume:	37.269	in^3
Void Ratio:	0.38	
Saturation:	0.81	

Failure Sketch:

Dial Reading (Inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.468	0.00	63.6	0.00	0.00	0.0	5.0	5.0	5.0	5.0	1.00	0.00	5.0	0.36	0.0	0.00	5.0	0.36
0.006	0.10%	7	6.474	1.08	63.7	0.10	0.08	1.1	6.1	5.0	6.0	4.9	1.22	0.09	5.5	0.40	0.5	0.04	5.4	0.39
0.012	0.21%	8	6.481	1.23	64.6	1.00	0.09	1.2	6.2	5.0	5.2	4.0	1.31	0.81	5.6	0.40	0.6	0.04	4.6	0.33
0.017	0.30%	39	6.487	6.01	65.5	1.90	0.43	6.0	11.0	5.0	9.1	3.1	2.94	0.32	8.0	0.58	3.0	0.22	6.1	0.44
0.023	0.40%	43	6.494	6.62	66.0	2.40	0.48	6.6	11.6	5.0	9.2	2.6	3.55	0.36	8.3	0.60	3.3	0.24	5.9	0.43
0.029	0.50%	44	6.501	6.77	66.3	2.70	0.49	6.8	11.8	5.0	9.1	2.3	3.94	0.40	8.4	0.60	3.4	0.24	5.7	0.41
0.035	0.61%	45	6.507	6.92	66.5	2.90	0.50	6.9	11.9	5.0	9.0	2.1	4.29	0.42	8.5	0.61	3.5	0.25	5.6	0.40
0.040	0.70%	45	6.513	6.91	66.6	3.00	0.50	6.9	11.9	5.0	8.9	2.0	4.45	0.43	8.5	0.61	3.5	0.25	5.5	0.39
0.046	0.80%	45	6.520	6.90	66.7	3.10	0.50	6.9	11.9	5.0	8.8	1.9	4.63	0.45	8.5	0.61	3.5	0.25	5.4	0.39
0.052	0.90%	45	6.527	6.89	66.8	3.20	0.50	6.9	11.9	5.0	8.7	1.8	4.83	0.46	8.4	0.61	3.4	0.25	5.2	0.38
0.058	1.01%	45	6.534	6.89	66.9	3.30	0.50	6.9	11.9	5.0	8.6	1.7	5.05	0.48	8.4	0.61	3.4	0.25	5.1	0.37
0.115	2.00%	46	6.600	6.97	67.0	3.40	0.50	7.0	12.0	5.0	8.6	1.6	5.36	0.49	8.5	0.61	3.5	0.25	5.1	0.37
0.173	3.01%	49	6.668	7.35	66.9	3.30	0.53	7.3	12.3	5.0	9.0	1.7	5.32	0.45	8.7	0.62	3.7	0.26	5.4	0.39
0.250	4.35%	53	6.762	7.84	66.7	3.10	0.56	7.8	12.8	5.0	9.7	1.9	5.13	0.40	8.9	0.64	3.9	0.28	5.8	0.42
0.300	5.21%	56	6.824	8.21	66.6	3.00	0.59	8.2	13.2	5.0	10.2	2.0	5.10	0.37	9.1	0.66	4.1	0.30	6.1	0.44
0.360	6.26%	61	6.899	8.84	66.4	2.80	0.64	8.8	13.8	5.0	11.0	2.2	5.02	0.32	9.4	0.68	4.4	0.32	6.6	0.48
0.411	7.14%	64	6.965	9.19	66.3	2.70	0.66	9.2	14.2	5.0	11.5	2.3	4.99	0.29	9.6	0.69	4.6	0.33	6.9	0.50
0.460	8.00%	67	7.030	9.53	66.2	2.60	0.69	9.5	14.5	5.0	11.9	2.4	4.97	0.27	9.8	0.70	4.8	0.34	7.2	0.52
0.518	9.00%	70	7.108	9.85	66.0	2.40	0.71	9.8	14.8	5.0	12.4	2.6	4.79	0.24	9.9	0.71	4.9	0.35	7.5	0.54
0.575	9.99%	74	7.186	10.30	65.8	2.20	0.74	10.3	15.3	5.0	13.1	2.8	4.68	0.21	10.1	0.73	5.1	0.37	7.9	0.57
0.633	11.00%	78	7.267	10.73	65.7	2.10	0.77	10.7	15.7	5.0	13.6	2.9	4.70	0.20	10.4	0.75	5.4	0.39	8.3	0.60
0.690	11.99%	84	7.349	11.43	65.6	2.00	0.82	11.4	16.4	5.0	14.4	3.0	4.81	0.17	10.7	0.77	5.7	0.41	8.7	0.63
0.800	13.90%	92	7.512	12.25	65.2	1.60	0.88	12.2	17.2	5.0	15.6	3.4	4.60	0.13	11.1	0.80	6.1	0.44	9.5	0.69
0.863	15.00%	97	7.609	12.75	65.0	1.40	0.92	12.7	17.7	5.0	16.3	3.6	4.54	0.11	11.4	0.82	6.4	0.46	10.0	0.72

Failure Cr PWP (Pore Water Pressure Peak or Max. Divatory Stress?) **Deviator Stress at Failure:** 0.92 TSF
Axial Strain at Failur 15.0 % **Effective Minor Principal Stress at Failure:** 0.26 TSF
Rate of Axial Strain: 0.040 %/min. **Effective Major Principal Stress at Failure:** 1.18 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	Bulldog Mine	**Client:**	Sunrise Coal
Project Number:	2-11-0383	**Client Address:**	Allerton, Illinois
Date Received:	4/26/2012	**Sampled By:**	Hoosier Drilling
Date Tested:	6/1/2102	**Tested By:**	JP
Sample Number:	Composite Remold #3	**Sample Source:**	Composite Sample B-21, 28-30'/B-35, 23-25'
Description:	Brown SANDY SILT CLAY with trace grvel		

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	B65	1	
Wet Wt+Tare:	288.26	233.29	g
Dry Wt+ Tare:	280.87	216.98	g
Tare wt:	209.59	89.87	g
Dry Wt:	71.28	127.11	g
Wt. Water:	7.39	16.31	g
% Moisture:	10.4%	12.8%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	75	psi
Final Skempton Value (Parameter B):	100%	
Effective Consolidation Stress (Sigma 3):	10	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.869	2.884	in.
Diameter 2:	2.871	3.204	in.
Diameter 3:	2.872	3.299	in.
Avg Diam:	2.871	3.129	in.
Length 1:	5.751	4.950	in.
Length 2:	5.749	4.959	in.
Length 3:	5.751	4.968	in.
Avg Height:	5.750	4.959	in.
Specimen Wt:	1338.10	1307.00	g
Area:	6.472	7.690	$in.^2$
Volume:	37.218	38.132	$in.^3$
Wet Unit Wt:	136.8	136.4	pcf
Dry Unit Wt:	124.0	120.9	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	2.00	1.58	
Void Ratio:	0.36	0.39	
Saturation:	0.78	0.88	

After Consolidation		
Change in Height:	-0.009	in.
Height:	5.741	in.
Area:	6.493	in^2
Volume:	37.276	in^3
Void Ratio:	0.36	
Saturation:	0.84	

Failure Sketch:

Dial Reading (Inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.472	0.00	60.5	0.00	0.00	0.0	10.0	10.0	10.0	10.0	1.00	0.00	10.0	0.72	0.0	0.00	10.0	0.72
0.000	0.10%	37	6.479	5.71	63.2	2.70	0.41	5.7	15.7	10.0	13.0	7.3	1.78	0.47	12.9	0.93	2.9	0.21	10.2	0.73
0.012	0.21%	53	6.486	8.17	64.0	3.50	0.59	8.2	18.2	10.0	14.7	6.5	2.26	0.43	14.1	1.01	4.1	0.29	10.6	0.76
0.017	0.30%	59	6.491	9.09	64.4	3.90	0.65	9.1	19.1	10.0	15.2	6.1	2.49	0.43	14.5	1.05	4.5	0.33	10.6	0.77
0.023	0.40%	64	6.498	9.85	64.8	4.30	0.71	9.8	19.8	10.0	15.5	5.7	2.73	0.44	14.9	1.07	4.9	0.35	10.6	0.76
0.029	0.50%	68	6.505	10.45	64.3	3.80	0.75	10.5	20.5	10.0	16.7	6.2	2.69	0.36	15.2	1.10	5.2	0.38	11.4	0.82
0.038	0.66%	71	6.515	10.90	64.6	4.10	0.78	10.9	20.9	10.0	16.8	5.9	2.85	0.38	15.4	1.11	5.4	0.39	11.3	0.82
0.040	0.70%	72	6.518	11.05	64.6	4.10	0.80	11.0	21.0	10.0	16.9	5.9	2.87	0.37	15.5	1.12	5.5	0.40	11.4	0.82
0.046	0.80%	73	6.524	11.19	64.8	4.30	0.81	11.2	21.2	10.0	16.9	5.7	2.96	0.38	15.6	1.12	5.6	0.40	11.3	0.81
0.054	0.94%	75	6.534	11.48	65.2	4.70	0.83	11.5	21.5	10.0	16.8	5.3	3.17	0.41	15.7	1.13	5.7	0.41	11.0	0.79
0.058	1.01%	76	6.538	11.62	65.3	4.80	0.84	11.6	21.6	10.0	16.8	5.2	3.24	0.41	15.8	1.14	5.8	0.42	11.0	0.79
0.118	2.05%	83	6.608	12.56	65.5	5.00	0.90	12.6	22.6	10.0	17.6	5.0	3.51	0.40	16.3	1.17	6.3	0.45	11.3	0.81
0.173	3.01%	92	6.673	13.79	64.9	4.40	0.99	13.8	23.8	10.0	19.4	5.6	3.46	0.32	16.9	1.22	6.9	0.50	12.5	0.90
0.230	4.00%	101	6.742	14.98	64.7	4.20	1.08	15.0	25.0	10.0	20.8	5.8	3.58	0.28	17.5	1.26	7.5	0.54	13.3	0.96
0.288	5.01%	109	6.813	16.00	64.8	4.30	1.15	16.0	26.0	10.0	21.7	5.7	3.81	0.27	18.0	1.30	8.0	0.58	13.7	0.99
0.345	6.00%	118	6.885	17.14	64.6	4.10	1.23	17.1	27.1	10.0	23.0	5.9	3.90	0.24	18.6	1.34	8.6	0.62	14.5	1.04
0.403	7.01%	126	6.960	18.10	64.3	3.80	1.30	18.1	28.1	10.0	24.3	6.2	3.92	0.21	19.1	1.37	9.1	0.65	15.3	1.10
0.460	8.00%	134	7.035	19.05	63.4	2.90	1.37	19.0	29.0	10.0	26.1	7.1	3.68	0.15	19.5	1.41	9.5	0.69	16.6	1.20
0.518	9.01%	143	7.113	20.10	63.0	2.50	1.45	20.1	30.1	10.0	27.6	7.5	3.68	0.12	20.1	1.44	10.1	0.72	17.6	1.26
0.575	10.00%	152	7.191	21.14	62.8	2.30	1.52	21.1	31.1	10.0	28.8	7.7	3.75	0.11	20.6	1.48	10.6	0.76	18.3	1.32
0.633	11.01%	160	7.273	22.00	62.5	2.00	1.58	22.0	32.0	10.0	30.0	8.0	3.75	0.09	21.0	1.51	11.0	0.79	19.0	1.37
0.690	12.00%	168	7.355	22.84	61.6	1.10	1.64	22.8	32.8	10.0	31.7	8.9	3.57	0.05	21.4	1.54	11.4	0.82	20.3	1.46
0.748	13.01%	176	7.440	23.66	61.0	0.50	1.70	23.7	33.7	10.0	33.2	9.5	3.49	0.02	21.8	1.57	11.8	0.85	21.3	1.54
0.805	14.00%	185	7.526	24.58	60.4	-0.10	1.77	24.6	34.6	10.0	34.7	10.1	3.43	0.00	22.3	1.60	12.3	0.88	22.4	1.61
0.863	15.01%	193	7.615	25.34	59.8	-0.70	1.82	25.3	35.3	10.0	36.0	10.7	3.37	-0.03	22.7	1.63	12.7	0.91	23.4	1.68

Failure Criteri: PWP (Pore Water Pressure Peak or Max. Divatory Stress?)
Axial Strain at Failure: 15.0 %
Rate of Axial Strain: 0.040 %/min.

Deviator Stress at Failure: 1.82 TSF
Effective Minor Principal Stress at Failure: 0.77 TSF
Effective Major Principal Stress at Failure: 2.59 TSF

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CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION OF COHESIVE SOIL

ASTM D 4767, AASHTO T 297

☐ Original ☐ Amended

Project Name:	=Sample1!F8	Client:	Sunrise Coal
Project Number:	2-11-0383	Client Address:	Allerton, Illinois
Date Received:	4/26/2012	Sampled By:	Hoosier Drilling
Date Tested:	6/1/2102	Tested By:	JP
Sample Number:	Composite Remold #3	Sample Source:	Composite Sample B-21, 28-30'/B-35, 23-25'

Description: Brown SANDY SILT CLAY with trace grvel

WATER CONTENTS:

	Before Testing	After Shear	
Tare #:	12	HN	
Wet Wt+Tare:	284.65	410.25	g
Dry Wt+ Tare:	277.64	387.54	g
Tare wt:	210.01	211.11	g
Dry Wt:	67.63	176.43	g
Wt. Water:	7.01	22.71	g
% Moisture:	10.4%	12.9%	
Cuttings/total?:			

Method Used For Specimen Saturation:	Wet	
Total Back Pressure:	57.5	psi
Final Skempton Value (Parameter B):	96%	
Effective Consolidation Stress (Sigma 3):	15	psi
Time to 50% Primary Consolidation:		min.
Area after consolidation (Method):	B	

SPECIMEN DIMENSIONS AND WEIGHTS:

	Before Testing	After Shear	
Diameter 1:	2.870	3.007	in.
Diameter 2:	2.870	3.131	in.
Diameter 3:	2.870	3.110	in.
Avg Diam:	2.870	3.083	in.
Length 1:	5.590	4.794	in.
Length 2:	5.580	4.797	in.
Length 3:	5.580	4.798	in.
Avg Height:	5.583	4.796	in.
Specimen Wt:	1323.47	1339.50	g
Area:	6.469	7.464	$in.^2$
Volume:	36.120	35.797	$in.^3$
Wet Unit Wt:	139.5	142.4	pcf
Dry Unit Wt:	126.4	126.2	pcf
Specific Gravity:	2.70	(assumed)	
L/D:	1.95	1.56	
Void Ratio:	0.33	0.33	
Saturation:	0.84	1.04	

After Consolidation		
Change in Height:	-0.017	in.
Height:	5.566	in.
Area:	6.509	in^2
Volume:	36.229	in^3
Void Ratio:	0.35	
Saturation:	0.87	

Failure Sketch:

Dial Reading (inches)	Axial Strain	Axial Load (lbs.)	Corrected Area (in^2)	Divatory Stress (psi)	Pore Water Pressure (psi)	Differential PWP (psi)	Deviator Stress TSF	Deviator Stress PSI	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	P (TSF)	Q (psi)	Q (TSF)	P' (psi)	P' (TSF)
0.000	0.00%	0	6.469	0.00	49.5	0.00	0.00	0.0	15.0	15.0	15.0	15.0	1.00	0.00	15.0	1.08	0.0	0.00	15.0	1.08
0.006	0.11%	3	6.476	0.46	49.9	0.40	0.03	0.5	15.5	15.0	15.1	14.6	1.03	0.86	15.2	1.10	0.2	0.02	14.8	1.07
0.011	0.20%	33	6.482	5.09	51.3	1.80	0.37	5.1	20.1	15.0	18.3	13.2	1.39	0.35	17.5	1.26	2.5	0.18	15.7	1.13
0.017	0.30%	53	6.489	8.17	52.7	3.20	0.59	8.2	23.2	15.0	20.0	11.8	1.69	0.39	19.1	1.37	4.1	0.29	15.9	1.14
0.022	0.39%	64	6.495	9.85	53.9	4.40	0.71	9.9	24.9	15.0	20.5	10.6	1.93	0.45	19.9	1.43	4.9	0.35	15.5	1.12
0.028	0.50%	73	6.502	11.23	55.1	5.60	0.81	11.2	26.2	15.0	20.6	9.4	2.19	0.50	20.6	1.48	5.6	0.40	15.0	1.08
0.033	0.59%	78	6.508	11.99	55.8	6.30	0.86	12.0	27.0	15.0	20.7	8.7	2.38	0.53	21.0	1.51	6.0	0.43	14.7	1.06
0.039	0.70%	82	6.515	12.59	56.4	6.90	0.91	12.6	27.6	15.0	20.7	8.1	2.55	0.55	21.3	1.53	6.3	0.45	14.4	1.04
0.045	0.81%	86	6.522	13.19	56.9	7.40	0.95	13.2	28.2	15.0	20.8	7.6	2.74	0.56	21.6	1.55	6.6	0.47	14.2	1.02
0.050	0.90%	88	6.528	13.48	57.3	7.80	0.97	13.5	28.5	15.0	20.7	7.2	2.87	0.58	21.7	1.57	6.7	0.49	13.9	1.00
0.056	1.00%	91	6.535	13.93	57.7	8.20	1.00	13.9	28.9	15.0	20.7	6.8	3.05	0.59	22.0	1.58	7.0	0.50	13.8	0.99
0.112	2.01%	110	6.602	16.66	59.2	9.70	1.20	16.7	31.7	15.0	22.0	5.3	4.14	0.58	23.3	1.68	8.3	0.60	13.6	0.98
0.171	3.06%	125	6.674	18.73	59.4	9.90	1.35	18.7	33.7	15.0	23.8	5.1	4.67	0.53	24.4	1.75	9.4	0.67	14.5	1.04
0.223	3.99%	138	6.738	20.48	59.1	9.60	1.47	20.5	35.5	15.0	25.9	5.4	4.79	0.47	25.2	1.82	10.2	0.74	15.6	1.13
0.283	5.07%	153	6.815	22.45	58.6	9.10	1.62	22.5	37.5	15.0	28.4	5.9	4.81	0.41	26.2	1.89	11.2	0.81	17.1	1.23
0.335	6.00%	165	6.882	23.97	58.1	8.60	1.73	24.0	39.0	15.0	30.4	6.4	4.75	0.36	27.0	1.94	12.0	0.86	18.4	1.32
0.424	7.59%	187	7.001	26.71	57.0	7.50	1.92	26.7	41.7	15.0	34.2	7.5	4.56	0.28	28.4	2.04	13.4	0.96	20.9	1.50
0.466	8.35%	196	7.058	27.77	56.5	7.00	2.00	27.8	42.8	15.0	35.8	8.0	4.47	0.25	28.9	2.08	13.9	1.00	21.9	1.58
0.580	10.39%	221	7.219	30.61	54.9	5.40	2.20	30.6	45.6	15.0	40.2	9.6	4.19	0.18	30.3	2.18	15.3	1.10	24.9	1.79
0.632	11.32%	232	7.295	31.80	54.2	4.70	2.29	31.8	46.8	15.0	42.1	10.3	4.09	0.15	30.9	2.22	15.9	1.14	26.2	1.89
0.670	12.00%	240	7.351	32.65	53.6	4.10	2.35	32.6	47.6	15.0	43.5	10.9	4.00	0.13	31.3	2.26	16.3	1.18	27.2	1.96
0.742	13.29%	253	7.461	33.91	52.6	3.10	2.44	33.9	48.9	15.0	45.8	11.9	3.85	0.09	32.0	2.30	17.0	1.22	28.9	2.08
0.783	14.02%	260	7.524	34.55	52.1	2.60	2.49	34.6	49.6	15.0	47.0	12.4	3.79	0.08	32.3	2.32	17.3	1.24	29.7	2.14
0.837	14.99%	270	7.610	35.48	51.3	1.80	2.55	35.5	50.5	15.0	48.7	13.2	3.69	0.05	32.7	2.36	17.7	1.28	30.9	2.23

Failure Criteri PWP (Pore Water Pressure Peak or Max. Divatory Stress?) Deviator Stress at Failure: 2.55 TSF
Axial Strain at Failure: 1.0 % Effective Minor Principal Stress at Failure: 0.95 TSF

Sample 1: The Max σ1-σ3 is :	0.92 **tsf**	**Pore water:**	1.4 psi
Sample 2: The Max σ1-σ3 is :	1.82 **tsf**	**Pore water:**	-0.7 psi
Sample 3: The Max σ1-σ3 is :	2.55 **tsf**	**Pore water:**	1.8 psi

Patriot Engineering

Consolidated Undrained Triaxial Test (ASTM D4767)

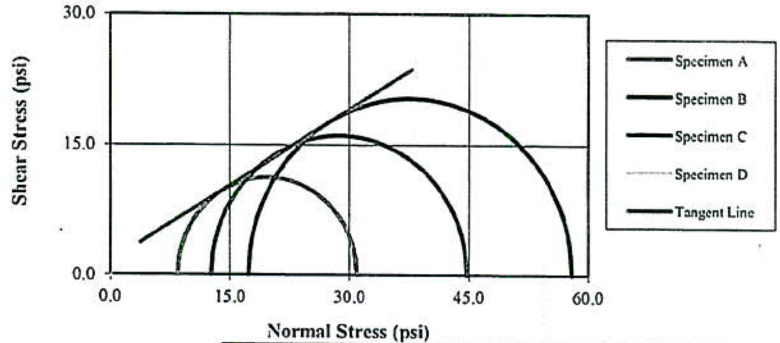
Date:

Checked By:

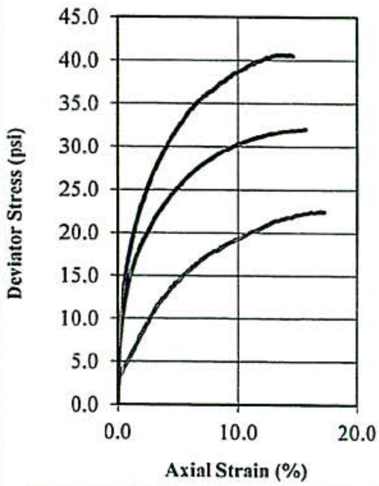
Date: 6/16/2012

Tested By: T. Smith

Effective Stress at Maximum Deviator Stress Criterion



Deviator Stress Vs. Axial Strain



Initial	A	B	C	D
Water Content (%)	19.5	14.9	14.0	
Dry Density (pcf)	114.4	120.3	121.7	
Saturation (%)	115.77	105.26	103.32	
Void Ratio	0.446	0.373	0.357	
Diameter (in)	2.853	2.851	2.856	
Height (in)	5.218	5.727	6.154	
Specific Gravity	2.65	2.65	2.65	
Liquid Limit	0	23	0	
Plastic Limit	0	15	0	
After Consolidation	**A**	**B**	**C**	**D**
B-Value	100.00	96.00	100.00	
Water Content (%)	19.0	14.5	13.5	
Dry Density (pcf)	117.36	120.68	122.10	
Saturation (%)	100.00	100.00	100.00	
Void Ratio	0.410	0.371	0.355	
Effective Stress (psi)	3.9	9.8	15.7	
Back Press. (psi)	58.5	53.1	54.3	
Rate of Strain	0.0003	0.0003	0.0003	
After Shear	**A**	**B**	**C**	**D**
σ'1 at Failure (psi)	30.93	44.73	57.93	
σ'3 at Failure (psi)	8.47	12.69	17.31	

Maximium Deviator Stress Criterion	
C (psi)	5.3
C' (psi)	1.6
Ø (deg)	25.7
Ø' (deg)	30.3

Project:	Bulldog Mine
Location:	
Project Number:	2-11-0383
Boring Number:	B-26A
Sample Number:	
Depth:	8.0-10.0 feet
Sample Type:	Undisturbed
Description:	Brown SILTY CLAY with trace gravel
Test Type	Consolidated Undrained
Remarks	Top of sample A was soft and slightly deformed

N/A

Failure Photographs

Patriot Engineering

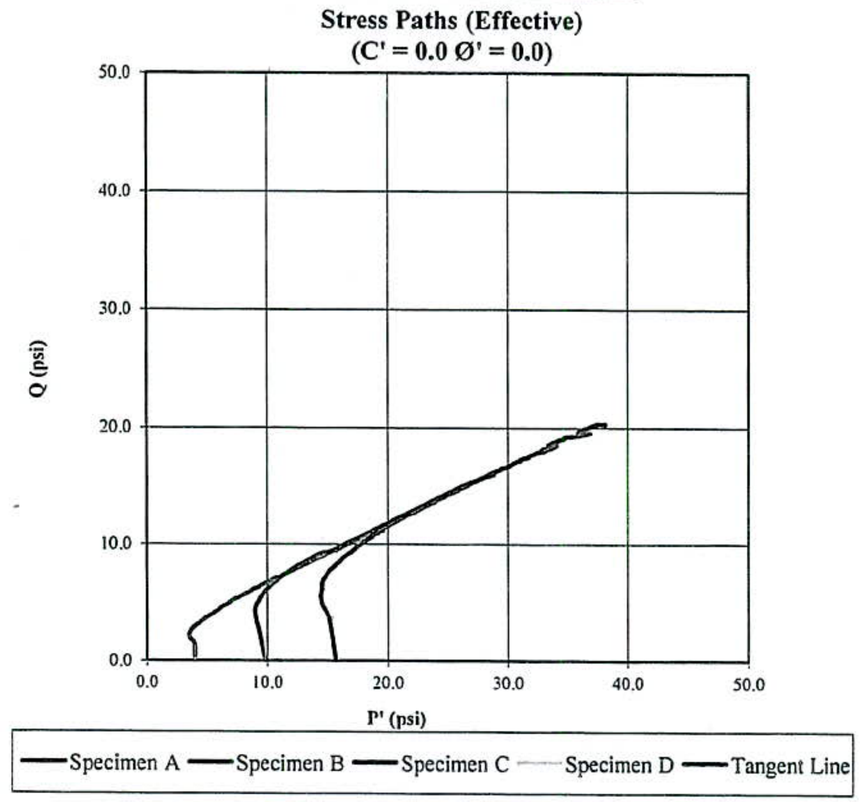
Consolidated Undrained Triaxial Test (ASTM D4767)

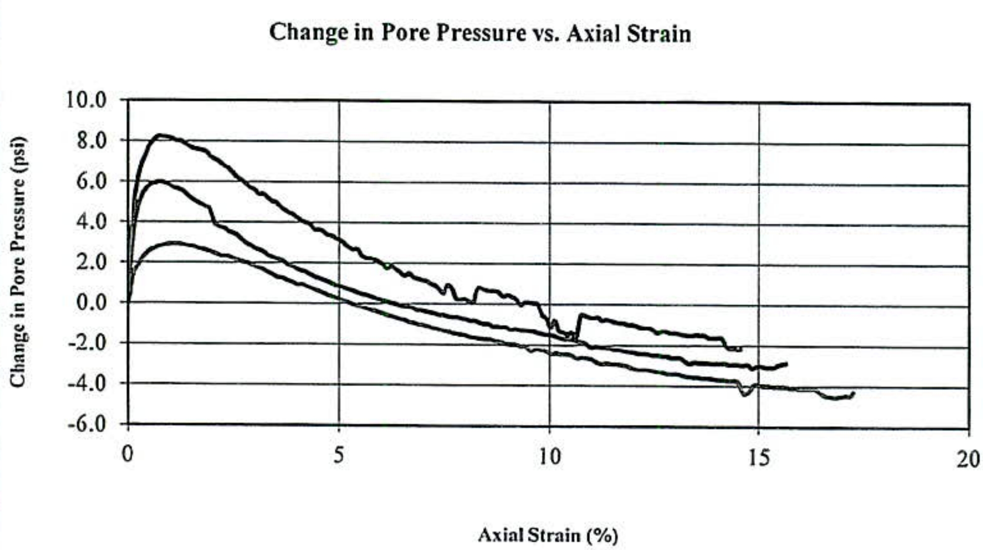
Date:

Checked By:

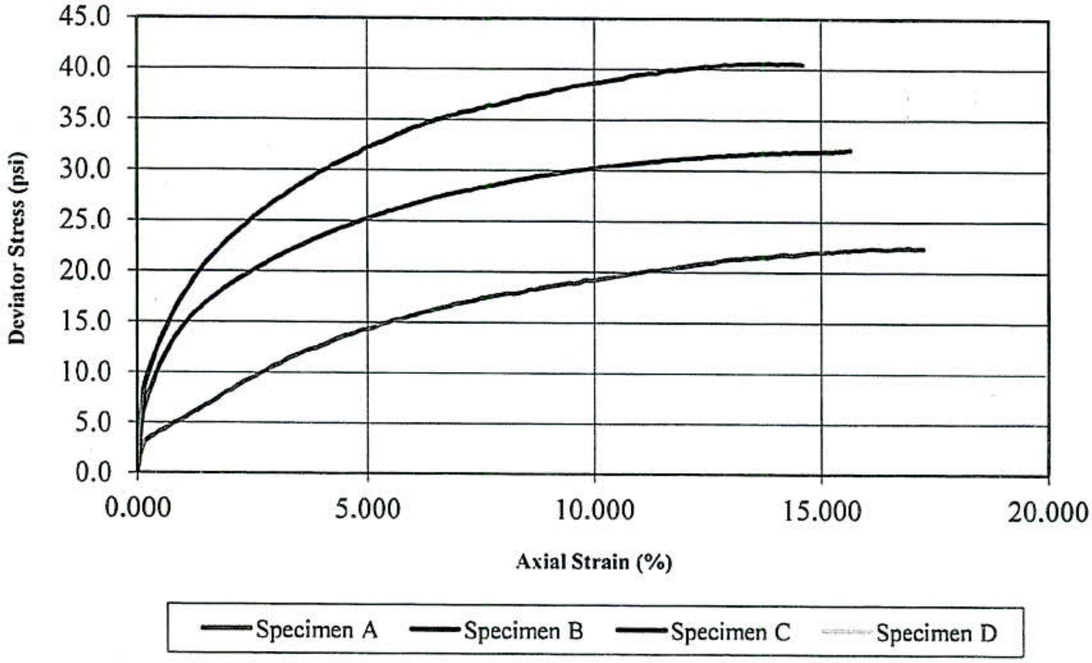
Date: 6/16/2012

Tested By: T. Smi

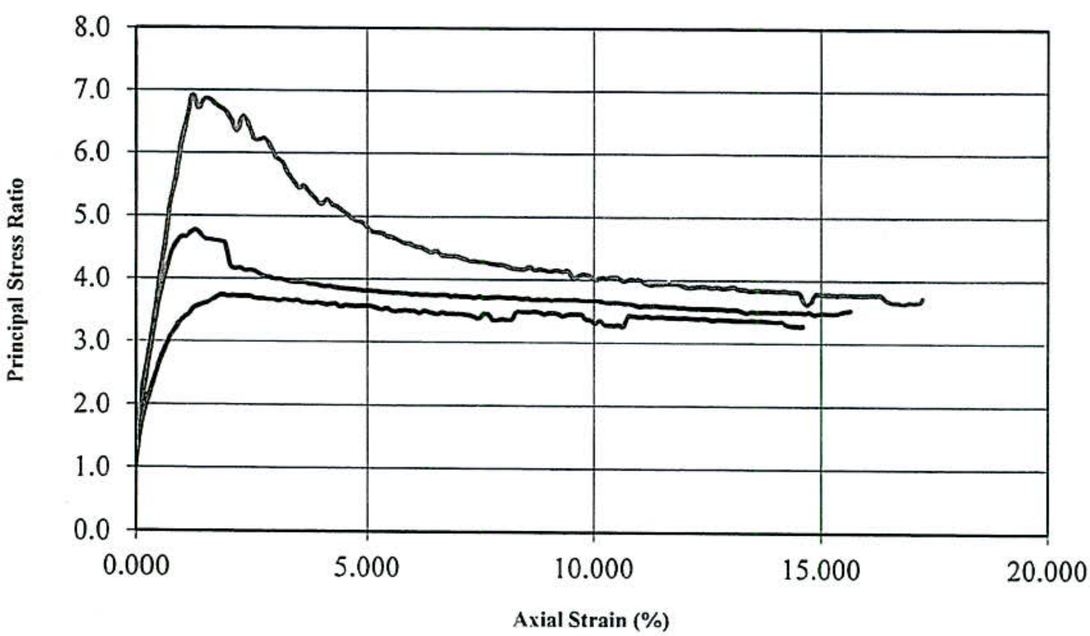


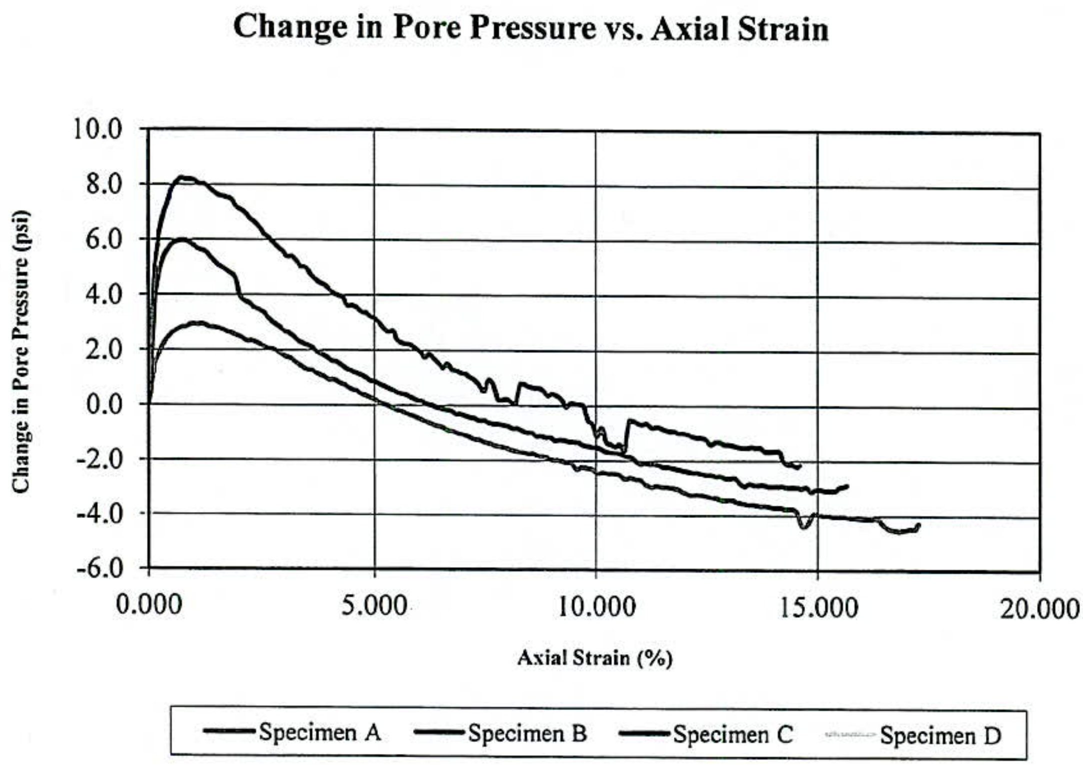


Deviator Stress vs. Axial Strain



Principal Stress Ratio vs. Axial Strain

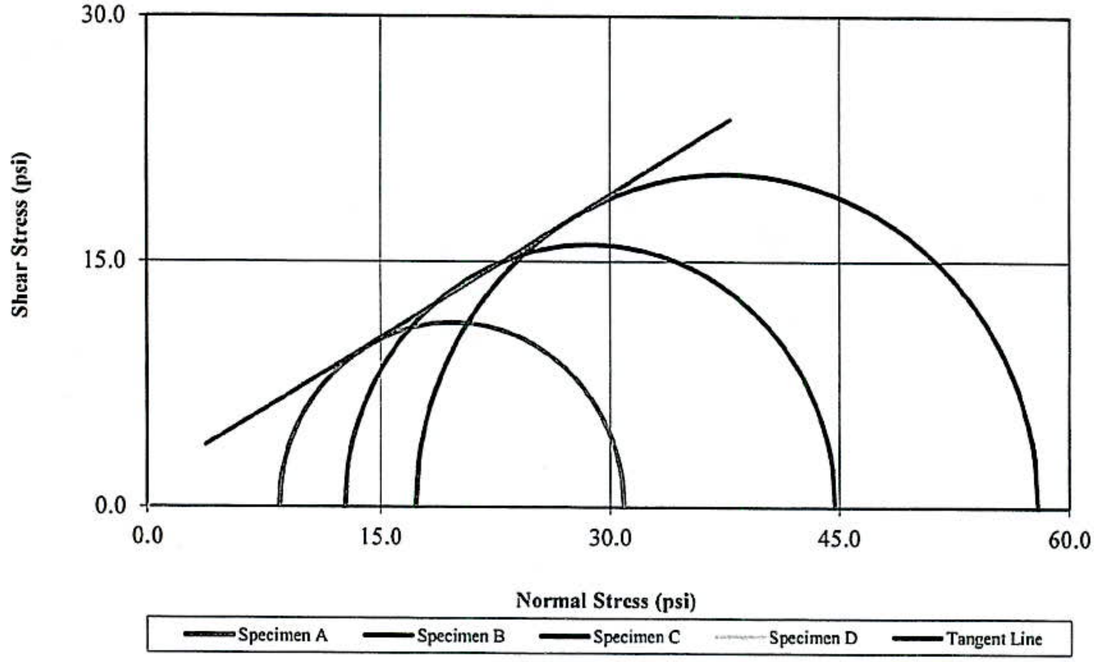



Change in Pore Pressure vs. Axial Strain
Change in Pore Pressure (psi)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
0.000
5.000
10.000
15.000
20.000
Axial Strain (%)
Specimen A
Specimen B
Specimen C
Specimen D

Mohr Stress Circles at Maximum Deviator Stress Criterion

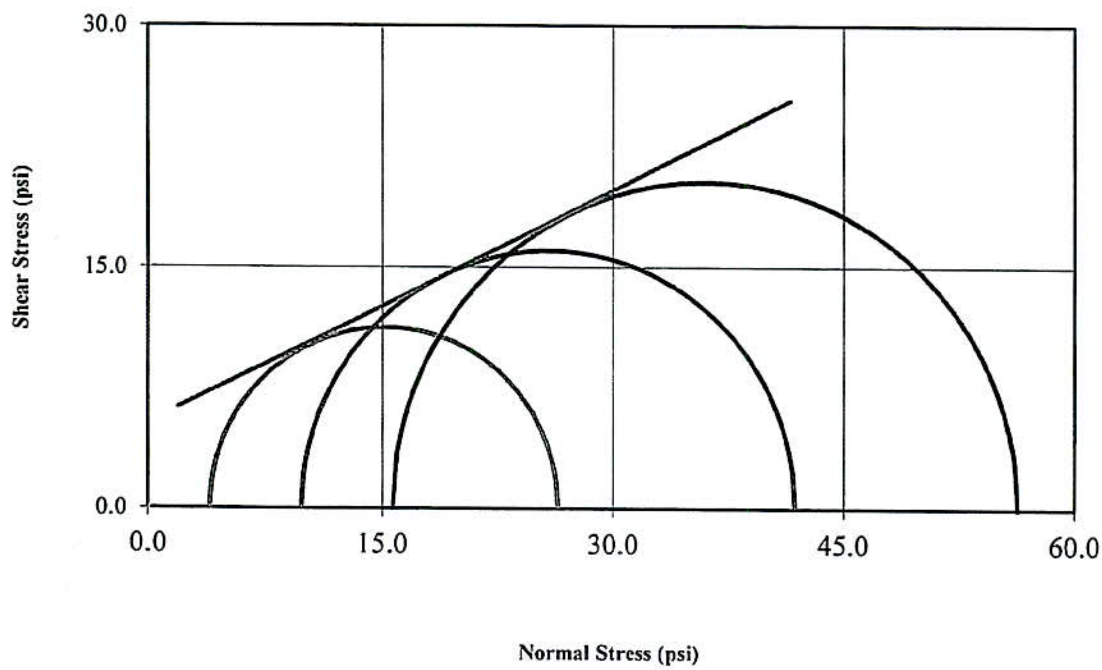
Effective Stress

(C' = 1.6 Ø' = 30.3)



Total Stress

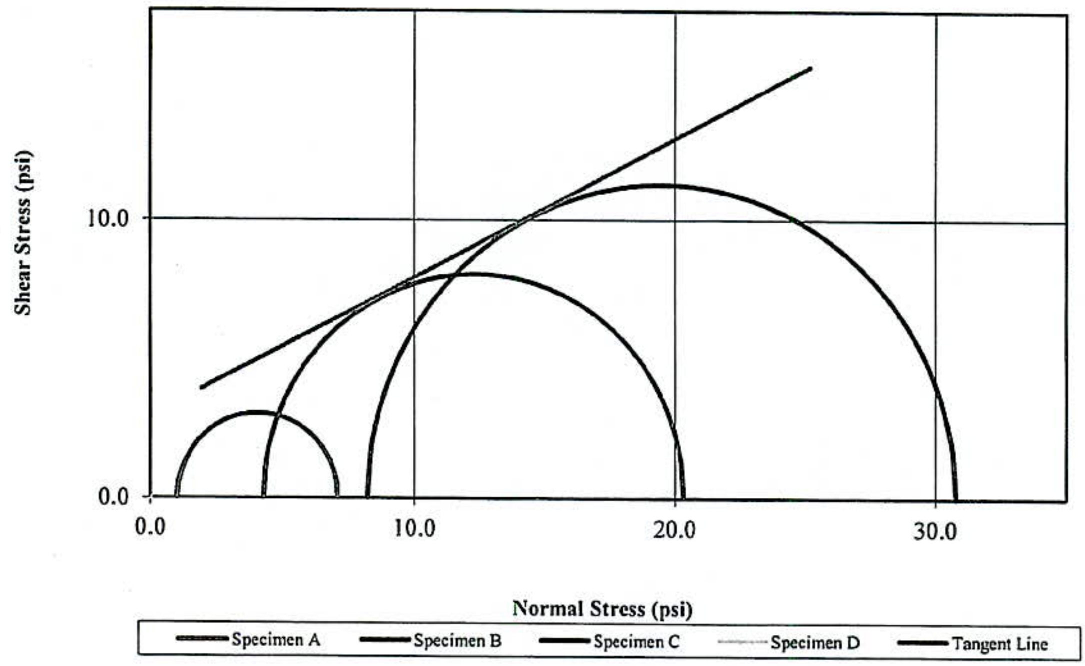
(C = 5.3 Ø = 25.7)



Mohr Stress Circles at Maximum Principal Stress Ratio Criterion

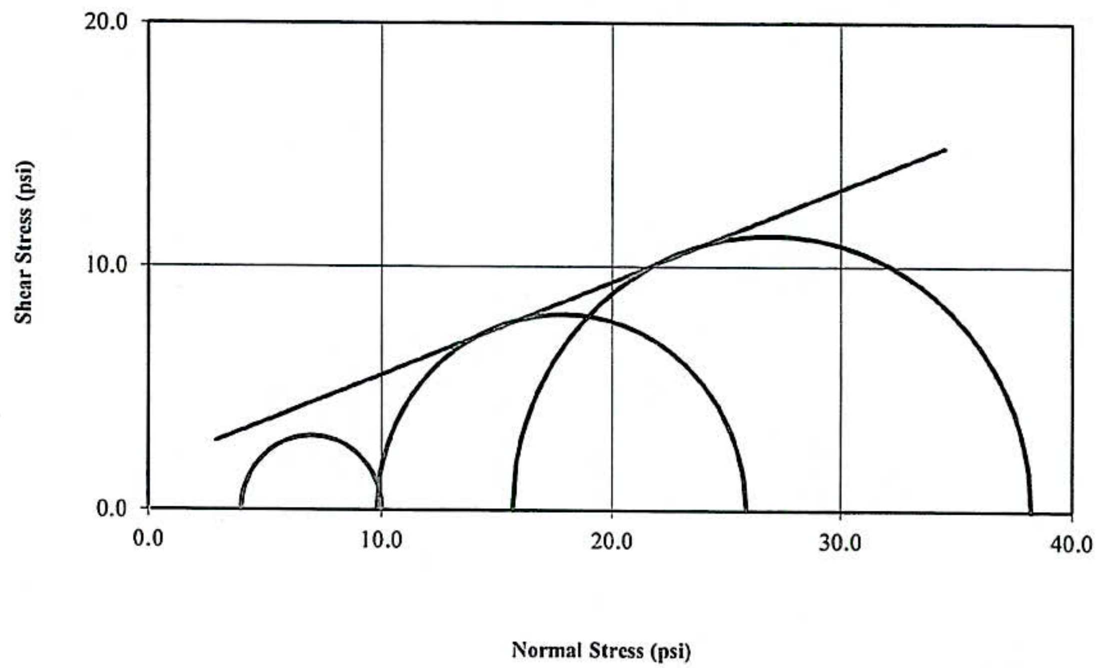
Effective Stress

(C' = 2.9 Ø' = 26.5)

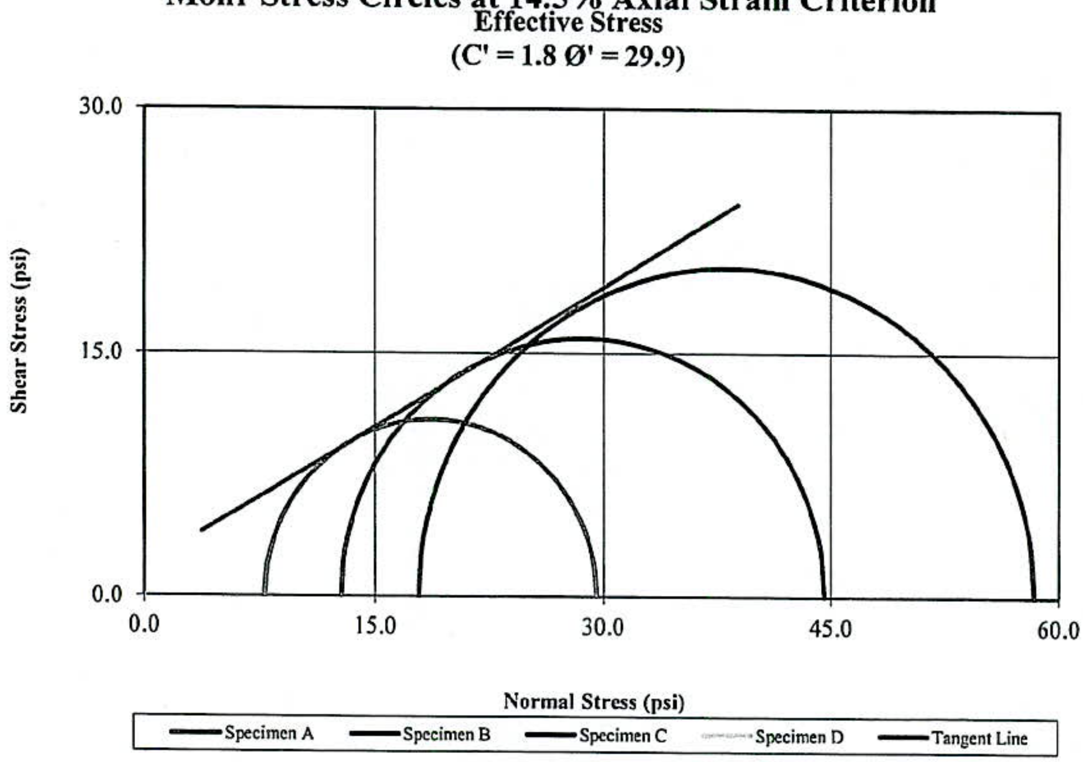


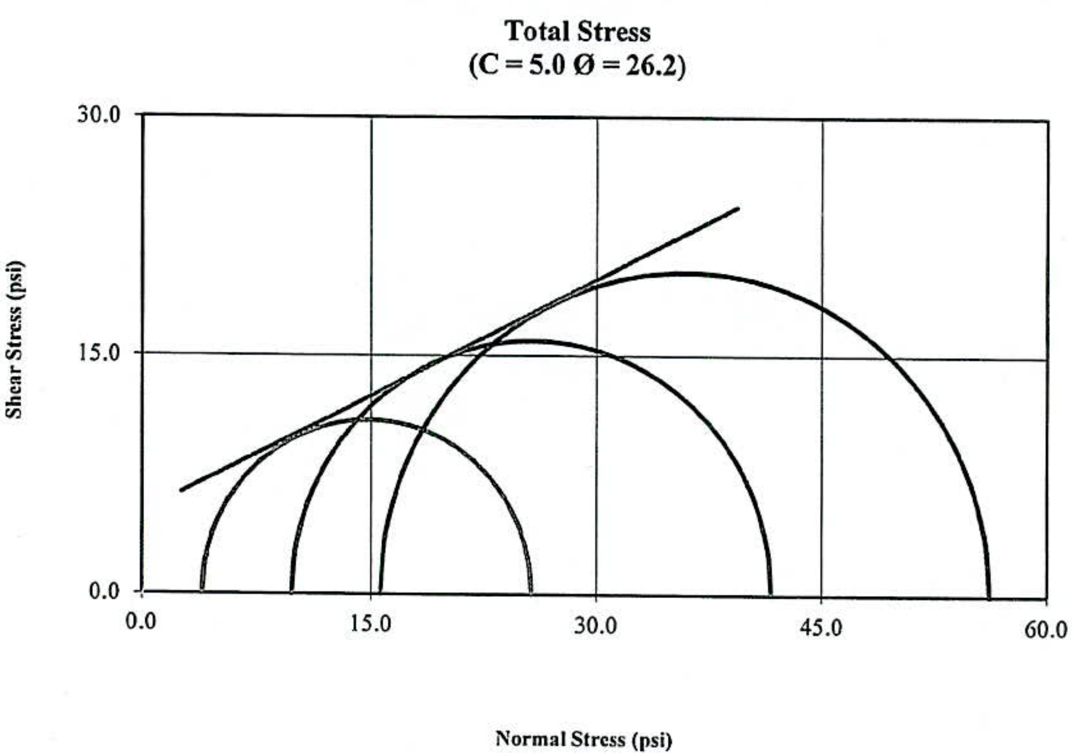
Total Stress

(C = 1.7 Ø = 20.9)

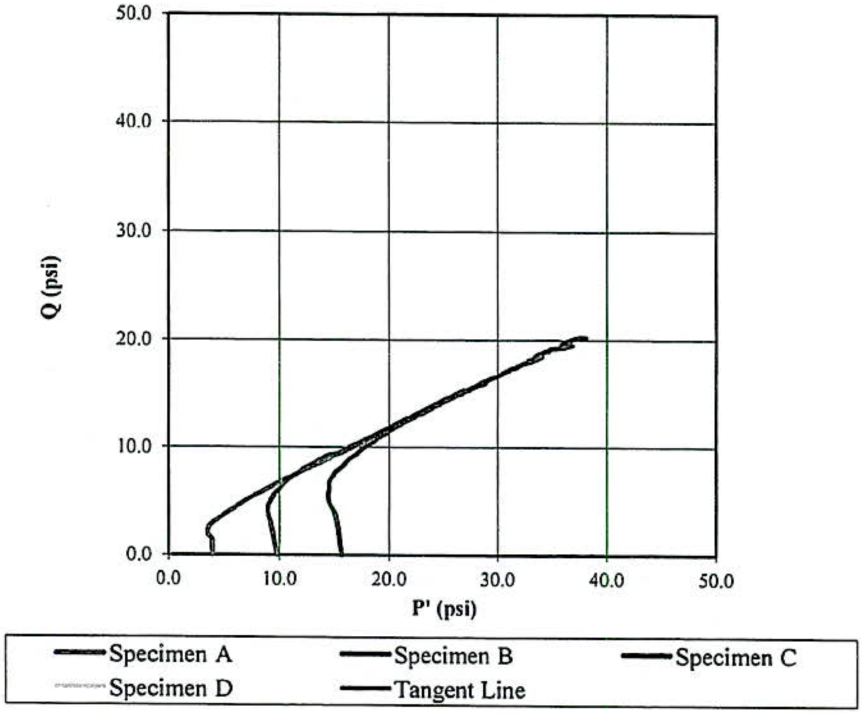


Mohr Stress Circles at 14.5% Axial Strain Criterion

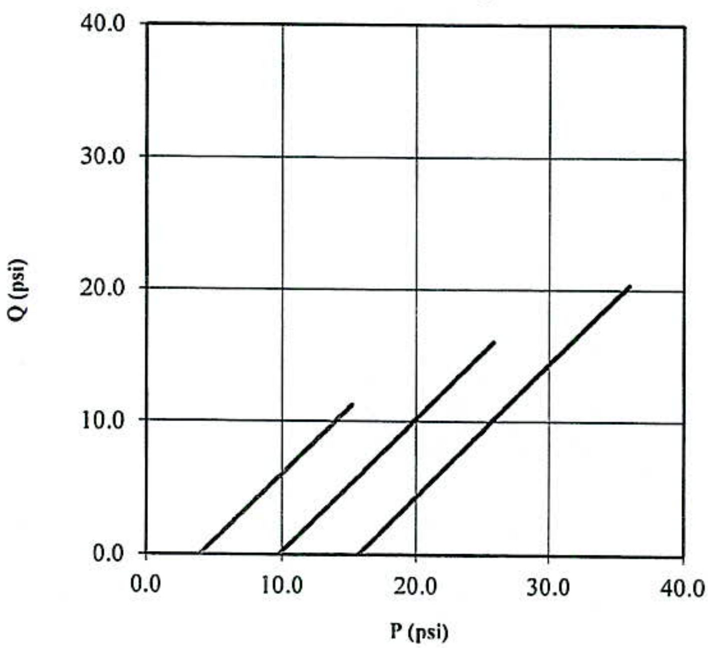




Stress Paths (Effective)
(C' = 0.0 Ø' = 0.0)



Stress Paths (Total)
(C' = 0.0 Ø' = 0.0)



Specimen A Shear Data

CU Triaxial Test | **Patriot Engineering**

File Location
Triaxial 2-0383 B-26A 8-10.HSD

Project Information

Project No. 2-11-0383
Project Name: Bulldog Mine
Client: Sunrise Coal, LLC
Sample Location:
Sample Description: Brown SILTY CLAY with trace gravel
Remarks: A

Sample Data

Sample Type: Undisturbed
Specific Gravity: 2.6500001
LL: 0.000
PL: 0.000

Sample Parameters	Initial	After Consolidation	Final
Diameter (in)	2.853	2.837	
Height (in)	5.218	5.226	
Weight (grams)	1197.14		1183.79
Moisture (%)	19.50		16.32
Dry Density (pcf)	114.38	117.36	
Saturation (%)	115.77	100.00	
Void Ratio	0.446	0.410	

Test Data

Rate of Strain: 0.0003
Cell Pressure (psi): 62.490
Effective Confining Stress (psi): 3.9
Corrected Peak Deviator Stress (psi): 22.459 at reading number: 140

Specimen A

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
0	3.3	0.000	58.5	0.0	6.32	0.000	0.000	0.000	3.9	3.9	3.9	3.9	1.00	0.00	3.9	0.0	3.9
1	20.6	0.006	59.9	1.4	6.33	0.121	2.743	2.740	6.7	3.9	5.3	2.5	2.08	0.51	5.3	1.4	3.9
2	24.8	0.013	60.4	1.9	6.34	0.242	3.396	3.388	7.3	3.9	5.5	2.1	2.64	0.56	5.6	1.7	3.8
3	27.2	0.019	60.8	2.3	6.34	0.363	3.788	3.774	7.7	3.9	5.4	1.7	3.27	0.60	5.8	1.9	3.6
4	29.7	0.025	61.1	2.5	6.35	0.484	4.180	4.160	8.1	3.9	5.6	1.4	3.92	0.61	6.0	2.1	3.5
5	31.4	0.032	61.2	2.7	6.36	0.605	4.441	4.414	8.4	3.9	5.7	1.3	4.49	0.61	6.2	2.2	3.5
6	33.9	0.038	61.3	2.8	6.37	0.726	4.833	4.798	8.7	3.9	5.9	1.1	5.19	0.58	6.3	2.4	3.5
7	35.5	0.044	61.4	2.8	6.37	0.847	5.094	5.051	9.0	3.9	6.2	1.1	5.57	0.56	6.5	2.5	3.6
8	37.2	0.051	61.5	2.9	6.38	0.968	5.355	5.303	9.3	3.9	6.3	1.0	6.17	0.55	6.6	2.7	3.7
9	39.6	0.057	61.5	2.9	6.39	1.089	5.747	5.685	9.6	3.9	6.7	1.0	6.54	0.51	6.8	2.8	3.9
10	42.1	0.063	61.5	2.9	6.40	1.210	6.139	6.065	10.0	3.9	7.1	1.0	6.91	0.48	7.0	3.0	4.1
11	43.8	0.070	61.4	2.8	6.41	1.331	6.400	6.315	10.3	3.9	7.4	1.1	6.71	0.45	7.1	3.2	4.3
12	46.2	0.076	61.3	2.8	6.41	1.452	6.792	6.693	10.6	3.9	7.8	1.1	6.84	0.42	7.3	3.3	4.5
13	47.9	0.082	61.3	2.8	6.42	1.573	7.053	6.942	10.9	3.9	8.1	1.2	6.86	0.40	7.4	3.5	4.7
14	50.4	0.089	61.2	2.7	6.43	1.694	7.445	7.319	11.3	3.9	8.6	1.3	6.78	0.37	7.6	3.7	4.9
15	52.8	0.095	61.1	2.6	6.44	1.814	7.837	7.695	11.6	3.9	9.0	1.3	6.72	0.34	7.8	3.8	5.2
16	55.3	0.101	61.1	2.5	6.45	1.935	8.229	8.070	12.0	3.9	9.5	1.4	6.66	0.31	8.0	4.0	5.5
17	57.0	0.107	61.0	2.4	6.45	2.056	8.490	8.315	12.3	3.9	9.8	1.5	6.52	0.29	8.1	4.2	5.7
18	59.4	0.114	60.9	2.3	6.46	2.177	8.882	8.689	12.6	3.9	10.3	1.6	6.34	0.27	8.3	4.3	6.0

Specimen A

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
19	61.9	0.120	60.9	2.3	6.47	2.298	9.274	9.061	13.0	3.9	10.7	1.6	6.57	0.26	8.5	4.5	6.2
20	63.6	0.126	60.8	2.2	6.48	2.419	9.535	9.304	13.3	3.9	11.0	1.7	6.45	0.24	8.6	4.7	6.4
21	65.2	0.133	60.7	2.1	6.49	2.540	9.796	9.547	13.5	3.9	11.4	1.8	6.23	0.22	8.7	4.8	6.6
22	67.7	0.139	60.6	2.0	6.49	2.661	10.188	9.917	13.9	3.9	11.8	1.9	6.20	0.21	8.9	5.0	6.9
23	69.4	0.145	60.5	2.0	6.50	2.782	10.449	10.159	14.1	3.9	12.1	1.9	6.22	0.20	9.0	5.1	7.0
24	71.8	0.152	60.4	1.9	6.51	2.903	10.841	10.526	14.5	3.9	12.6	2.1	6.10	0.18	9.2	5.3	7.3
25	73.5	0.158	60.3	1.8	6.52	3.024	11.102	10.767	14.7	3.9	13.0	2.2	5.93	0.16	9.3	5.4	7.6
26	75.1	0.164	60.2	1.7	6.53	3.145	11.364	11.006	15.0	3.9	13.3	2.3	5.86	0.15	9.4	5.5	7.8
27	77.6	0.171	60.1	1.5	6.53	3.266	11.755	11.372	15.3	3.9	13.8	2.4	5.69	0.13	9.6	5.7	8.1
28	79.3	0.177	59.9	1.4	6.54	3.387	12.017	11.610	15.6	3.9	14.2	2.5	5.56	0.12	9.8	5.8	8.4
29	80.9	0.183	59.8	1.3	6.55	3.508	12.278	11.847	15.8	3.9	14.5	2.7	5.44	0.11	9.9	5.9	8.6
30	82.6	0.190	59.8	1.2	6.56	3.629	12.539	12.084	16.0	3.9	14.8	2.7	5.47	0.10	10.0	6.0	8.7
31	84.2	0.196	59.7	1.1	6.57	3.750	12.800	12.320	16.3	3.9	15.1	2.8	5.36	0.09	10.1	6.2	9.0
32	85.0	0.202	59.6	1.0	6.58	3.871	12.931	12.431	16.4	3.9	15.3	2.9	5.28	0.08	10.2	6.2	9.1
33	86.7	0.209	59.5	0.9	6.58	3.992	13.192	12.666	16.6	3.9	15.7	3.0	5.19	0.07	10.3	6.3	9.4
34	88.3	0.215	59.5	0.9	6.59	4.113	13.454	12.900	16.8	3.9	15.9	3.0	5.26	0.07	10.4	6.5	9.5
35	90.0	0.221	59.3	0.8	6.60	4.234	13.715	13.134	17.1	3.9	16.3	3.1	5.17	0.06	10.5	6.6	9.7
36	91.6	0.228	59.3	0.7	6.61	4.355	13.976	13.367	17.3	3.9	16.6	3.2	5.14	0.05	10.6	6.7	9.9
37	93.3	0.234	59.1	0.6	6.62	4.476	14.237	13.600	17.5	3.9	16.9	3.3	5.06	0.04	10.7	6.8	10.1
38	94.1	0.240	59.1	0.5	6.63	4.597	14.368	13.707	17.7	3.9	17.1	3.4	5.00	0.04	10.8	6.9	10.3
39	95.8	0.247	58.9	0.4	6.63	4.718	14.629	13.939	17.9	3.9	17.5	3.5	4.93	0.03	10.9	7.0	10.5
40	97.4	0.253	58.9	0.3	6.64	4.839	14.890	14.170	18.1	3.9	17.8	3.6	4.91	0.02	11.0	7.1	10.7
41	98.2	0.259	58.8	0.2	6.65	4.960	15.021	14.276	18.2	3.9	18.0	3.7	4.85	0.02	11.1	7.1	10.8
42	99.1	0.266	58.7	0.1	6.66	5.081	15.152	14.382	18.3	3.9	18.2	3.8	4.76	0.01	11.1	7.2	11.0
43	100.7	0.272	58.6	0.0	6.67	5.201	15.413	14.611	18.6	3.9	18.5	3.9	4.74	0.00	11.3	7.3	11.2
44	102.4	0.278	58.5	0.0	6.68	5.322	15.674	14.840	18.8	3.9	18.8	4.0	4.72	0.00	11.4	7.4	11.4
45	103.2	0.284	58.4	-0.1	6.68	5.443	15.805	14.944	18.9	3.9	19.0	4.1	4.67	-0.01	11.4	7.5	11.5
46	104.9	0.291	58.3	-0.2	6.69	5.564	16.066	15.172	19.1	3.9	19.3	4.1	4.66	-0.01	11.5	7.6	11.7
47	105.7	0.297	58.3	-0.3	6.70	5.685	16.196	15.276	19.2	3.9	19.5	4.2	4.61	-0.02	11.6	7.6	11.9
48	106.5	0.303	58.2	-0.4	6.71	5.806	16.327	15.379	19.3	3.9	19.7	4.3	4.57	-0.02	11.6	7.7	12.0
49	108.2	0.310	58.1	-0.4	6.72	5.927	16.588	15.605	19.6	3.9	20.0	4.4	4.56	-0.03	11.7	7.8	12.2
50	109.0	0.316	58.0	-0.5	6.73	6.048	16.719	15.708	19.7	3.9	20.2	4.5	4.52	-0.03	11.8	7.9	12.3
51	110.6	0.322	57.9	-0.6	6.74	6.169	16.980	15.933	19.9	3.9	20.5	4.5	4.50	-0.04	11.9	8.0	12.5
52	111.5	0.329	57.9	-0.7	6.75	6.290	17.111	16.034	20.0	3.9	20.7	4.6	4.47	-0.04	12.0	8.0	12.6
53	112.3	0.335	57.8	-0.8	6.75	6.411	17.241	16.136	20.1	3.9	20.8	4.7	4.43	-0.05	12.0	8.1	12.8
54	113.9	0.341	57.7	-0.8	6.76	6.532	17.503	16.359	20.3	3.9	21.1	4.7	4.45	-0.05	12.1	8.2	12.9
55	114.8	0.348	57.6	-0.9	6.77	6.653	17.633	16.460	20.4	3.9	21.3	4.9	4.38	-0.06	12.2	8.2	13.1
56	115.6	0.354	57.6	-1.0	6.78	6.774	17.764	16.561	20.5	3.9	21.5	4.9	4.37	-0.06	12.2	8.3	13.2
57	117.2	0.360	57.5	-1.0	6.79	6.895	18.025	16.782	20.7	3.9	21.8	5.0	4.37	-0.06	12.3	8.4	13.4
58	118.1	0.367	57.5	-1.1	6.80	7.016	18.156	16.882	20.8	3.9	21.9	5.0	4.36	-0.06	12.4	8.4	13.5
59	118.9	0.373	57.4	-1.2	6.81	7.137	18.286	16.981	20.9	3.9	22.1	5.1	4.33	-0.07	12.4	8.5	13.6

Specimen A

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
60	119.7	0.379	57.3	-1.2	6.82	7.258	18.417	17.080	21.0	3.9	22.3	5.2	4.29	-0.07	12.5	8.5	13.7
61	120.5	0.386	57.3	-1.3	6.82	7.379	18.548	17.179	21.1	3.9	22.4	5.2	4.29	-0.07	12.5	8.6	13.8
62	122.2	0.392	57.2	-1.4	6.83	7.500	18.809	17.398	21.3	3.9	22.7	5.3	4.28	-0.08	12.6	8.7	14.0
63	123.0	0.398	57.1	-1.4	6.84	7.621	18.939	17.496	21.4	3.9	22.8	5.3	4.27	-0.08	12.7	8.7	14.1
64	123.8	0.405	57.1	-1.5	6.85	7.742	19.070	17.594	21.5	3.9	23.0	5.4	4.24	-0.08	12.7	8.8	14.2
65	124.7	0.411	57.0	-1.5	6.86	7.863	19.201	17.691	21.6	3.9	23.2	5.5	4.24	-0.09	12.8	8.8	14.3
66	125.5	0.417	57.0	-1.6	6.87	7.984	19.331	17.788	21.7	3.9	23.3	5.5	4.23	-0.09	12.8	8.9	14.4
67	126.3	0.424	56.9	-1.6	6.88	8.105	19.462	17.885	21.8	3.9	23.5	5.6	4.20	-0.09	12.9	8.9	14.5
68	126.3	0.430	56.9	-1.7	6.89	8.226	19.462	17.861	21.8	3.9	23.5	5.6	4.17	-0.09	12.9	8.9	14.6
69	127.1	0.436	56.8	-1.7	6.90	8.347	19.592	17.957	21.9	3.9	23.6	5.7	4.17	-0.10	12.9	9.0	14.6
70	128.0	0.443	56.8	-1.8	6.91	8.468	19.723	18.053	22.0	3.9	23.8	5.7	4.16	-0.10	13.0	9.0	14.7
71	129.6	0.449	56.8	-1.8	6.91	8.588	19.984	18.268	22.2	3.9	24.0	5.7	4.20	-0.10	13.1	9.1	14.8
72	129.6	0.455	56.7	-1.8	6.92	8.709	19.984	18.244	22.2	3.9	24.0	5.8	4.15	-0.10	13.1	9.1	14.9
73	131.3	0.462	56.7	-1.9	6.93	8.830	20.246	18.458	22.4	3.9	24.3	5.8	4.17	-0.10	13.2	9.2	15.1
74	132.1	0.468	56.6	-2.0	6.94	8.951	20.376	18.552	22.5	3.9	24.5	5.9	4.14	-0.11	13.2	9.3	15.2
75	132.9	0.474	56.5	-2.0	6.95	9.072	20.507	18.646	22.6	3.9	24.6	5.9	4.14	-0.11	13.3	9.3	15.3
76	133.8	0.480	56.5	-2.0	6.96	9.193	20.637	18.740	22.7	3.9	24.7	5.9	4.15	-0.11	13.3	9.4	15.3
77	134.6	0.487	56.5	-2.1	6.97	9.314	20.768	18.834	22.8	3.9	24.9	6.0	4.12	-0.11	13.4	9.4	15.4
78	135.4	0.493	56.5	-2.1	6.98	9.435	20.899	18.927	22.9	3.9	25.0	6.0	4.14	-0.11	13.4	9.5	15.5
79	135.4	0.499	56.2	-2.3	6.99	9.556	20.899	18.902	22.8	3.9	25.2	6.3	4.02	-0.12	13.4	9.5	15.7
80	136.2	0.506	56.3	-2.2	7.00	9.677	21.029	18.994	22.9	3.9	25.2	6.2	4.07	-0.12	13.4	9.5	15.7
81	137.9	0.512	56.3	-2.3	7.01	9.798	21.291	19.204	23.2	3.9	25.4	6.2	4.08	-0.12	13.5	9.6	15.8
82	137.9	0.518	56.2	-2.3	7.02	9.919	21.291	19.179	23.1	3.9	25.4	6.3	4.06	-0.12	13.5	9.6	15.9
83	138.7	0.525	56.1	-2.5	7.03	10.040	21.421	19.270	23.2	3.9	25.7	6.4	4.00	-0.13	13.6	9.6	16.1
84	139.5	0.531	56.1	-2.4	7.04	10.161	21.552	19.362	23.3	3.9	25.7	6.4	4.03	-0.13	13.6	9.7	16.1
85	140.4	0.537	56.1	-2.5	7.05	10.282	21.682	19.453	23.4	3.9	25.9	6.4	4.03	-0.13	13.7	9.7	16.2
86	141.2	0.544	56.1	-2.5	7.05	10.403	21.813	19.544	23.5	3.9	26.0	6.4	4.04	-0.13	13.7	9.8	16.2
87	142.0	0.550	56.0	-2.5	7.06	10.524	21.944	19.634	23.6	3.9	26.1	6.5	4.04	-0.13	13.8	9.8	16.3
88	142.8	0.556	55.9	-2.7	7.07	10.645	22.074	19.724	23.7	3.9	26.4	6.6	3.98	-0.14	13.8	9.9	16.5
89	143.7	0.563	55.9	-2.6	7.08	10.766	22.205	19.814	23.8	3.9	26.4	6.6	4.01	-0.13	13.9	9.9	16.5
90	144.5	0.569	55.9	-2.7	7.09	10.887	22.335	19.904	23.9	3.9	26.5	6.6	4.00	-0.13	13.9	10.0	16.6
91	145.3	0.575	55.8	-2.7	7.10	11.008	22.466	19.993	23.9	3.9	26.7	6.7	4.00	-0.14	13.9	10.0	16.7
92	146.1	0.582	55.7	-2.9	7.11	11.129	22.597	20.082	24.0	3.9	26.9	6.8	3.94	-0.14	14.0	10.0	16.9
93	147.0	0.588	55.6	-3.0	7.12	11.250	22.727	20.171	24.1	3.9	27.1	6.9	3.92	-0.15	14.0	10.1	17.0
94	147.0	0.594	55.6	-2.9	7.13	11.371	22.727	20.143	24.1	3.9	27.0	6.9	3.93	-0.15	14.0	10.1	16.9
95	147.8	0.601	55.6	-3.0	7.14	11.492	22.858	20.231	24.2	3.9	27.1	6.9	3.93	-0.15	14.1	10.1	17.0
96	148.6	0.607	55.6	-3.0	7.15	11.613	22.989	20.319	24.3	3.9	27.2	6.9	3.94	-0.15	14.1	10.2	17.1
97	149.4	0.613	55.5	-3.0	7.16	11.734	23.119	20.406	24.4	3.9	27.4	6.9	3.94	-0.15	14.1	10.2	17.2
98	150.3	0.620	55.5	-3.0	7.17	11.855	23.250	20.494	24.4	3.9	27.5	7.0	3.93	-0.15	14.2	10.2	17.2
99	151.1	0.626	55.4	-3.2	7.18	11.975	23.380	20.580	24.5	3.9	27.7	7.1	3.90	-0.15	14.2	10.3	17.4
100	151.9	0.632	55.3	-3.2	7.19	12.096	23.511	20.667	24.6	3.9	27.9	7.2	3.88	-0.16	14.3	10.3	17.5

Specimen A

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
101	152.7	0.639	55.3	-3.2	7.20	12.217	23.642	20.753	24.7	3.9	27.9	7.2	3.89	-0.16	14.3	10.4	17.6
102	153.6	0.645	55.3	-3.2	7.21	12.338	23.772	20.839	24.8	3.9	28.0	7.2	3.90	-0.16	14.4	10.4	17.6
103	154.4	0.651	55.3	-3.3	7.22	12.459	23.903	20.925	24.9	3.9	28.2	7.2	3.89	-0.16	14.4	10.5	17.7
104	154.4	0.657	55.2	-3.3	7.23	12.580	23.903	20.896	24.8	3.9	28.2	7.3	3.88	-0.16	14.4	10.4	17.7
105	156.0	0.664	55.2	-3.4	7.24	12.701	24.164	21.095	25.0	3.9	28.4	7.3	3.89	-0.16	14.5	10.5	17.9
106	156.9	0.670	55.1	-3.4	7.25	12.822	24.295	21.180	25.1	3.9	28.6	7.4	3.87	-0.16	14.5	10.6	18.0
107	157.7	0.676	55.1	-3.4	7.26	12.943	24.425	21.264	25.2	3.9	28.7	7.4	3.88	-0.16	14.6	10.6	18.0
108	158.5	0.683	55.1	-3.4	7.27	13.064	24.556	21.348	25.3	3.9	28.7	7.4	3.89	-0.16	14.6	10.7	18.1
109	158.5	0.689	55.0	-3.5	7.28	13.185	24.556	21.318	25.3	3.9	28.8	7.5	3.85	-0.17	14.6	10.7	18.1
110	159.3	0.695	55.0	-3.6	7.29	13.306	24.687	21.402	25.3	3.9	28.9	7.5	3.85	-0.17	14.6	10.7	18.2
111	159.3	0.702	54.9	-3.6	7.30	13.427	24.687	21.372	25.3	3.9	28.9	7.5	3.83	-0.17	14.6	10.7	18.2
112	160.2	0.708	54.9	-3.6	7.31	13.548	24.817	21.455	25.4	3.9	29.0	7.5	3.84	-0.17	14.7	10.7	18.3
113	161.0	0.714	54.9	-3.6	7.32	13.669	24.948	21.538	25.5	3.9	29.1	7.6	3.84	-0.17	14.7	10.8	18.4
114	161.0	0.721	54.9	-3.6	7.33	13.790	24.948	21.507	25.5	3.9	29.1	7.6	3.83	-0.17	14.7	10.8	18.3
115	161.8	0.727	54.9	-3.7	7.34	13.911	25.078	21.590	25.5	3.9	29.2	7.6	3.83	-0.17	14.7	10.8	18.4
116	162.6	0.733	54.8	-3.7	7.35	14.032	25.209	21.672	25.6	3.9	29.3	7.7	3.83	-0.17	14.8	10.8	18.5
117	163.5	0.740	54.8	-3.7	7.36	14.153	25.340	21.753	25.7	3.9	29.4	7.7	3.84	-0.17	14.8	10.9	18.5
118	163.5	0.746	54.8	-3.8	7.37	14.274	25.340	21.723	25.7	3.9	29.4	7.7	3.82	-0.17	14.8	10.9	18.6
119	163.5	0.752	54.8	-3.8	7.38	14.395	25.340	21.692	25.6	3.9	29.4	7.7	3.81	-0.17	14.8	10.8	18.6
120	164.3	0.759	54.7	-3.8	7.39	14.516	25.470	21.773	25.7	3.9	29.6	7.8	3.80	-0.18	14.8	10.9	18.7
121	165.1	0.765	54.2	-4.4	7.40	14.637	25.601	21.854	25.8	3.9	30.2	8.3	3.63	-0.20	14.9	10.9	19.2
122	166.0	0.771	54.2	-4.3	7.42	14.758	25.731	21.934	25.9	3.9	30.2	8.3	3.65	-0.20	14.9	11.0	19.2
123	166.8	0.778	54.6	-4.0	7.43	14.879	25.862	22.014	26.0	3.9	29.9	7.9	3.78	-0.18	15.0	11.0	18.9
124	166.8	0.784	54.6	-4.0	7.44	15.000	25.862	21.983	25.9	3.9	29.9	7.9	3.78	-0.18	14.9	11.0	18.9
125	167.6	0.790	54.5	-4.0	7.45	15.121	25.993	22.062	26.0	3.9	30.0	7.9	3.78	-0.18	15.0	11.0	19.0
126	167.6	0.797	54.5	-4.0	7.46	15.242	25.993	22.031	26.0	3.9	30.0	7.9	3.77	-0.18	15.0	11.0	19.0
127	168.4	0.803	54.5	-4.0	7.47	15.362	26.123	22.110	26.1	3.9	30.1	8.0	3.77	-0.18	15.0	11.1	19.0
128	169.3	0.809	54.5	-4.0	7.48	15.483	26.254	22.189	26.1	3.9	30.2	8.0	3.78	-0.18	15.0	11.1	19.1
129	169.3	0.816	54.5	-4.0	7.49	15.604	26.254	22.157	26.1	3.9	30.1	8.0	3.77	-0.18	15.0	11.1	19.1
130	170.1	0.822	54.5	-4.1	7.50	15.725	26.385	22.235	26.2	3.9	30.3	8.0	3.77	-0.18	15.1	11.1	19.1
131	170.1	0.828	54.5	-4.1	7.51	15.846	26.385	22.204	26.2	3.9	30.2	8.0	3.77	-0.18	15.0	11.1	19.1
132	170.9	0.834	54.4	-4.1	7.52	15.967	26.515	22.281	26.2	3.9	30.3	8.1	3.76	-0.18	15.1	11.1	19.2
133	171.7	0.841	54.4	-4.1	7.53	16.088	26.646	22.359	26.3	3.9	30.4	8.1	3.77	-0.18	15.1	11.2	19.2
134	171.7	0.847	54.4	-4.1	7.54	16.209	26.646	22.327	26.3	3.9	30.4	8.1	3.77	-0.18	15.1	11.2	19.2
135	171.7	0.853	54.4	-4.1	7.55	16.330	26.646	22.294	26.2	3.9	30.4	8.1	3.76	-0.18	15.1	11.1	19.2
136	171.7	0.860	54.2	-4.3	7.57	16.451	26.646	22.262	26.2	3.9	30.5	8.3	3.69	-0.19	15.1	11.1	19.4
137	172.6	0.866	54.1	-4.5	7.58	16.572	26.776	22.339	26.3	3.9	30.8	8.4	3.65	-0.20	15.1	11.2	19.6
138	173.4	0.872	54.0	-4.5	7.59	16.693	26.907	22.415	26.4	3.9	30.9	8.5	3.65	-0.20	15.2	11.2	19.7
139	173.4	0.879	54.0	-4.6	7.60	16.814	26.907	22.383	26.3	3.9	30.9	8.5	3.63	-0.20	15.1	11.2	19.7
140	174.2	0.885	54.0	-4.5	7.61	16.935	27.038	22.459	26.4	3.9	30.9	8.5	3.65	-0.20	15.2	11.2	19.7
141	173.4	0.891	54.1	-4.5	7.62	17.056	26.907	22.318	26.3	3.9	30.7	8.4	3.65	-0.20	15.1	11.2	19.6

Specimen A

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
142	174.2	0.898	54.1	-4.5	7.63	17.177	27.038	22.393	26.3	3.9	30.8	8.4	3.66	-0.20	15.1	11.2	19.6
143	174.2	0.901	54.3	-4.3	7.64	17.246	27.038	22.375	26.3	3.9	30.6	8.2	3.72	-0.19	15.1	11.2	19.4

Specimen B Shear Data

CU Triaxial Test | **Patriot Engineering**

File Location
Triaxial 2-0383 B-26A 8-10.HSD

Project Information

Project No. 2-11-0383
Project Name: Bulldog Mine
Client: Sunrise Coal, LLC
Sample Location:
Sample Description: Brown SILTY CLAY with trace gravel
Remarks: B

Sample Data

Sample Type: Undisturbed
Specific Gravity: 2.6500001
LL: 23.000
PL: 15.000

Sample Parameters	Initial	After Consolidation	Final
Diameter (in)	2.851	2.839	
Height (in)	5.727	5.736	
Weight (grams)	1326.79		1328.75
Moisture (%)	14.90		15.53
Dry Density (pcf)	120.30	120.68	
Saturation (%)	105.26	100.00	
Void Ratio	0.373	0.371	

Test Data

Rate of Strain: 0.0003
Cell Pressure (psi): 62.870
Effective Confining Stress (psi): 9.8
Corrected Peak Deviator Stress (psi): 32.042 at reading number: 147

Specimen B

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
0	0.5	0.000	53.1	0.0	6.33	0.000	0.000	0.000	9.8	9.8	9.8	9.8	1.00	0.00	9.8	0.0	9.8
1	34.1	0.007	56.2	3.2	6.34	0.107	5.315	5.310	15.1	9.8	11.9	6.6	1.80	0.60	12.5	2.7	9.3
2	48.5	0.013	57.6	4.6	6.34	0.214	7.584	7.568	17.4	9.8	12.8	5.2	2.45	0.60	13.6	3.8	9.0
3	57.4	0.019	58.4	5.3	6.35	0.320	8.997	8.968	18.8	9.8	13.5	4.5	2.99	0.59	14.3	4.5	9.0
4	64.9	0.025	58.7	5.6	6.36	0.427	10.177	10.133	19.9	9.8	14.3	4.2	3.42	0.55	14.9	5.1	9.3
5	71.6	0.031	58.9	5.9	6.36	0.534	11.240	11.180	21.0	9.8	15.1	3.9	3.83	0.52	15.4	5.6	9.5
6	77.6	0.037	59.0	5.9	6.37	0.641	12.186	12.108	21.9	9.8	16.0	3.9	4.13	0.49	15.9	6.1	9.9
7	83.5	0.043	59.0	6.0	6.38	0.748	13.107	13.009	22.8	9.8	16.8	3.8	4.40	0.46	16.3	6.5	10.3
8	88.1	0.049	59.0	5.9	6.38	0.854	13.846	13.727	23.5	9.8	17.6	3.9	4.55	0.43	16.7	6.9	10.7
9	92.7	0.056	58.9	5.9	6.39	0.961	14.572	14.432	24.2	9.8	18.4	3.9	4.66	0.41	17.0	7.2	11.2
10	96.8	0.062	58.8	5.7	6.40	1.068	15.207	15.045	24.8	9.8	19.1	4.1	4.66	0.38	17.3	7.5	11.6
11	100.5	0.068	58.7	5.6	6.41	1.175	15.803	15.618	25.4	9.8	19.8	4.2	4.73	0.36	17.6	7.8	12.0
12	103.6	0.074	58.6	5.5	6.41	1.282	16.296	16.087	25.9	9.8	20.4	4.3	4.77	0.34	17.8	8.0	12.3
13	106.5	0.080	58.4	5.3	6.42	1.388	16.750	16.517	26.3	9.8	21.0	4.5	4.70	0.32	18.1	8.3	12.7
14	109.2	0.086	58.2	5.1	6.43	1.495	17.177	16.921	26.7	9.8	21.6	4.7	4.63	0.30	18.3	8.5	13.1
15	111.8	0.092	58.1	5.0	6.43	1.602	17.592	17.311	27.1	9.8	22.1	4.8	4.62	0.29	18.5	8.7	13.4
16	114.3	0.098	58.0	4.9	6.44	1.709	17.981	17.674	27.5	9.8	22.6	4.9	4.60	0.28	18.6	8.8	13.7
17	116.9	0.105	57.8	4.8	6.45	1.815	18.396	18.062	27.9	9.8	23.1	5.0	4.59	0.26	18.8	9.0	14.1
18	119.5	0.111	57.7	4.6	6.45	1.922	18.798	18.437	28.2	9.8	23.6	5.2	4.55	0.25	19.0	9.2	14.4

Specimen B

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
19	121.5	0.117	57.0	4.0	6.46	2.029	19.122	18.734	28.5	9.8	24.6	5.8	4.21	0.21	19.2	9.4	15.2
20	123.7	0.123	56.8	3.8	6.47	2.136	19.459	19.044	28.8	9.8	25.1	6.0	4.16	0.20	19.3	9.5	15.6
21	125.8	0.129	56.8	3.7	6.48	2.243	19.796	19.352	29.2	9.8	25.5	6.1	4.17	0.19	19.5	9.7	15.8
22	127.7	0.135	56.6	3.5	6.48	2.349	20.094	19.622	29.4	9.8	25.9	6.3	4.13	0.18	19.6	9.8	16.1
23	129.7	0.141	56.5	3.4	6.49	2.456	20.406	19.904	29.7	9.8	26.3	6.4	4.13	0.17	19.8	10.0	16.3
24	131.7	0.147	56.4	3.3	6.50	2.563	20.730	20.198	30.0	9.8	26.7	6.5	4.12	0.16	19.9	10.1	16.6
25	133.7	0.154	56.2	3.1	6.50	2.670	21.041	20.479	30.3	9.8	27.2	6.7	4.07	0.15	20.0	10.2	16.9
26	135.5	0.160	56.0	3.0	6.51	2.777	21.326	20.734	30.5	9.8	27.6	6.8	4.03	0.14	20.2	10.4	17.2
27	137.6	0.166	55.9	2.8	6.52	2.883	21.663	21.038	30.8	9.8	28.0	7.0	4.03	0.14	20.3	10.5	17.5
28	139.5	0.172	55.8	2.7	6.52	2.990	21.961	21.305	31.1	9.8	28.4	7.1	3.99	0.13	20.5	10.7	17.8
29	141.4	0.178	55.7	2.6	6.53	3.097	22.259	21.570	31.4	9.8	28.8	7.2	4.00	0.12	20.6	10.8	18.0
30	143.0	0.184	55.6	2.5	6.54	3.204	22.519	21.797	31.6	9.8	29.1	7.3	3.98	0.11	20.7	10.9	18.2
31	144.8	0.190	55.4	2.3	6.55	3.311	22.804	22.049	31.9	9.8	29.5	7.5	3.95	0.11	20.8	11.0	18.5
32	146.6	0.196	55.3	2.2	6.55	3.417	23.076	22.288	32.1	9.8	29.8	7.6	3.95	0.10	20.9	11.1	18.7
33	148.3	0.203	55.2	2.2	6.56	3.524	23.348	22.526	32.3	9.8	30.2	7.6	3.95	0.10	21.1	11.3	18.9
34	149.7	0.209	55.2	2.1	6.57	3.631	23.569	22.713	32.5	9.8	30.4	7.7	3.94	0.09	21.2	11.4	19.1
35	151.6	0.215	55.0	1.9	6.58	3.738	23.867	22.975	32.8	9.8	30.9	7.9	3.92	0.08	21.3	11.5	19.4
36	153.1	0.221	54.9	1.8	6.58	3.845	24.113	23.186	33.0	9.8	31.1	8.0	3.91	0.08	21.4	11.6	19.5
37	154.5	0.227	54.8	1.7	6.59	3.951	24.334	23.372	33.2	9.8	31.4	8.1	3.89	0.07	21.5	11.7	19.8
38	156.1	0.233	54.7	1.6	6.60	4.058	24.580	23.583	33.4	9.8	31.8	8.2	3.88	0.07	21.6	11.8	20.0
39	157.5	0.239	54.6	1.6	6.60	4.165	24.800	23.767	33.6	9.8	32.0	8.2	3.89	0.07	21.7	11.9	20.1
40	158.9	0.245	54.5	1.4	6.61	4.272	25.021	23.952	33.8	9.8	32.3	8.4	3.87	0.06	21.8	12.0	20.3
41	160.6	0.252	54.4	1.3	6.62	4.378	25.293	24.186	34.0	9.8	32.7	8.5	3.85	0.05	21.9	12.1	20.6
42	161.9	0.258	54.3	1.2	6.63	4.485	25.500	24.357	34.2	9.8	32.9	8.6	3.85	0.05	22.0	12.2	20.7
43	163.2	0.264	54.2	1.2	6.63	4.592	25.708	24.527	34.3	9.8	33.2	8.6	3.84	0.05	22.1	12.3	20.9
44	164.8	0.270	54.2	1.1	6.64	4.699	25.954	24.735	34.5	9.8	33.5	8.7	3.84	0.04	22.2	12.4	21.1
45	166.0	0.276	54.1	1.0	6.65	4.806	26.149	24.892	34.7	9.8	33.7	8.8	3.83	0.04	22.2	12.4	21.2
46	167.6	0.282	54.0	0.9	6.66	4.912	26.395	25.098	34.9	9.8	34.0	8.9	3.81	0.04	22.4	12.5	21.5
47	168.8	0.288	53.9	0.8	6.66	5.019	26.589	25.255	35.1	9.8	34.2	9.0	3.82	0.03	22.4	12.6	21.6
48	169.9	0.294	53.8	0.8	6.67	5.126	26.771	25.399	35.2	9.8	34.4	9.0	3.81	0.03	22.5	12.7	21.7
49	171.4	0.301	53.8	0.7	6.68	5.233	27.004	25.591	35.4	9.8	34.7	9.1	3.81	0.03	22.6	12.8	21.9
50	172.3	0.307	53.7	0.6	6.69	5.340	27.147	25.697	35.5	9.8	34.9	9.2	3.79	0.02	22.7	12.8	22.0
51	174.0	0.313	53.6	0.5	6.69	5.446	27.406	25.914	35.7	9.8	35.2	9.3	3.79	0.02	22.8	13.0	22.2
52	174.9	0.319	53.5	0.4	6.70	5.553	27.549	26.019	35.8	9.8	35.4	9.4	3.78	0.02	22.8	13.0	22.4
53	176.2	0.325	53.5	0.4	6.71	5.660	27.756	26.185	36.0	9.8	35.6	9.4	3.79	0.02	22.9	13.1	22.5
54	177.3	0.331	53.4	0.3	6.72	5.767	27.938	26.327	36.1	9.8	35.8	9.5	3.78	0.01	23.0	13.2	22.6
55	178.6	0.337	53.3	0.2	6.72	5.874	28.145	26.492	36.3	9.8	36.1	9.6	3.77	0.01	23.0	13.2	22.8
56	179.7	0.343	53.2	0.2	6.73	5.980	28.314	26.620	36.4	9.8	36.3	9.6	3.76	0.01	23.1	13.3	23.0
57	180.9	0.350	53.2	0.1	6.74	6.087	28.508	26.773	36.6	9.8	36.5	9.7	3.77	0.00	23.2	13.4	23.1
58	181.9	0.356	53.1	0.0	6.75	6.194	28.664	26.888	36.7	9.8	36.6	9.8	3.75	0.00	23.2	13.4	23.2
59	183.2	0.362	53.1	0.0	6.76	6.301	28.858	27.040	36.8	9.8	36.8	9.8	3.76	0.00	23.3	13.5	23.3

Specimen B

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
60	184.2	0.368	53.0	-0.1	6.76	6.408	29.027	27.167	37.0	9.8	37.0	9.9	3.75	0.00	23.4	13.6	23.5
61	185.5	0.374	52.9	-0.1	6.77	6.514	29.221	27.318	37.1	9.8	37.2	9.9	3.75	0.00	23.5	13.7	23.6
62	186.4	0.380	52.9	-0.2	6.78	6.621	29.377	27.432	37.2	9.8	37.4	10.0	3.75	-0.01	23.5	13.7	23.7
63	187.7	0.386	52.9	-0.2	6.79	6.728	29.571	27.582	37.4	9.8	37.6	10.0	3.76	-0.01	23.6	13.8	23.8
64	188.5	0.392	52.7	-0.3	6.79	6.835	29.701	27.671	37.5	9.8	37.8	10.1	3.73	-0.01	23.6	13.8	24.0
65	189.5	0.399	52.7	-0.3	6.80	6.941	29.856	27.784	37.6	9.8	37.9	10.1	3.74	-0.01	23.7	13.9	24.0
66	190.1	0.405	52.7	-0.4	6.81	7.048	29.960	27.848	37.6	9.8	38.1	10.2	3.73	-0.01	23.7	13.9	24.1
67	191.3	0.411	52.6	-0.4	6.82	7.155	30.142	27.985	37.8	9.8	38.2	10.2	3.73	-0.02	23.8	14.0	24.2
68	191.9	0.417	52.6	-0.5	6.83	7.262	30.232	28.037	37.8	9.8	38.3	10.3	3.73	-0.02	23.8	14.0	24.3
69	192.8	0.423	52.5	-0.6	6.83	7.369	30.388	28.149	38.0	9.8	38.5	10.4	3.72	-0.02	23.9	14.1	24.4
70	194.1	0.429	52.5	-0.6	6.84	7.475	30.582	28.296	38.1	9.8	38.7	10.4	3.73	-0.02	23.9	14.1	24.5
71	194.6	0.435	52.4	-0.6	6.85	7.582	30.673	28.347	38.1	9.8	38.8	10.4	3.71	-0.02	24.0	14.2	24.6
72	195.8	0.441	52.4	-0.7	6.86	7.689	30.855	28.482	38.3	9.8	39.0	10.5	3.72	-0.02	24.0	14.2	24.7
73	196.5	0.448	52.4	-0.7	6.87	7.796	30.971	28.557	38.4	9.8	39.0	10.5	3.72	-0.02	24.1	14.3	24.8
74	197.7	0.454	52.3	-0.7	6.87	7.903	31.153	28.691	38.5	9.8	39.2	10.5	3.73	-0.03	24.1	14.3	24.9
75	198.3	0.460	52.3	-0.8	6.88	8.009	31.244	28.741	38.5	9.8	39.3	10.6	3.72	-0.03	24.2	14.4	24.9
76	199.2	0.466	52.2	-0.8	6.89	8.116	31.399	28.851	38.7	9.8	39.5	10.6	3.71	-0.03	24.2	14.4	25.1
77	200.4	0.472	52.2	-0.8	6.90	8.223	31.581	28.984	38.8	9.8	39.6	10.6	3.72	-0.03	24.3	14.5	25.1
78	201.1	0.478	52.1	-0.9	6.91	8.330	31.697	29.057	38.9	9.8	39.8	10.7	3.71	-0.03	24.3	14.5	25.3
79	202.0	0.484	52.1	-1.0	6.91	8.437	31.827	29.142	38.9	9.8	39.9	10.8	3.70	-0.03	24.4	14.6	25.4
80	202.9	0.490	52.1	-1.0	6.92	8.543	31.970	29.238	39.0	9.8	40.0	10.8	3.71	-0.03	24.4	14.6	25.4
81	203.7	0.497	51.9	-1.1	6.93	8.650	32.099	29.323	39.1	9.8	40.2	10.9	3.68	-0.04	24.5	14.7	25.6
82	204.4	0.503	51.9	-1.1	6.94	8.757	32.216	29.395	39.2	9.8	40.3	10.9	3.69	-0.04	24.5	14.7	25.6
83	205.3	0.509	51.9	-1.2	6.95	8.864	32.358	29.490	39.3	9.8	40.5	11.0	3.69	-0.04	24.5	14.7	25.7
84	205.9	0.515	51.9	-1.2	6.95	8.971	32.449	29.538	39.3	9.8	40.5	11.0	3.69	-0.04	24.6	14.8	25.7
85	206.7	0.521	51.8	-1.3	6.96	9.077	32.579	29.622	39.4	9.8	40.7	11.1	3.67	-0.04	24.6	14.8	25.9
86	207.5	0.527	51.8	-1.2	6.97	9.184	32.709	29.705	39.5	9.8	40.7	11.0	3.69	-0.04	24.7	14.9	25.9
87	208.3	0.533	51.8	-1.3	6.98	9.291	32.825	29.775	39.6	9.8	40.9	11.1	3.69	-0.04	24.7	14.9	26.0
88	209.1	0.539	51.7	-1.3	6.99	9.398	32.955	29.858	39.7	9.8	41.0	11.1	3.68	-0.04	24.7	14.9	26.1
89	209.8	0.546	51.7	-1.3	6.99	9.504	33.072	29.928	39.7	9.8	41.1	11.1	3.69	-0.04	24.8	15.0	26.1
90	210.5	0.552	51.7	-1.4	7.00	9.611	33.175	29.987	39.8	9.8	41.2	11.2	3.69	-0.05	24.8	15.0	26.2
91	211.1	0.558	51.6	-1.4	7.01	9.718	33.279	30.045	39.8	9.8	41.3	11.2	3.67	-0.05	24.8	15.0	26.3
92	212.0	0.564	51.6	-1.5	7.02	9.825	33.409	30.126	39.9	9.8	41.4	11.3	3.67	-0.05	24.9	15.1	26.3
93	213.0	0.570	51.5	-1.5	7.03	9.932	33.577	30.242	40.0	9.8	41.6	11.3	3.67	-0.05	24.9	15.1	26.4
94	213.4	0.576	51.5	-1.5	7.04	10.038	33.642	30.265	40.1	9.8	41.6	11.3	3.67	-0.05	24.9	15.1	26.5
95	214.3	0.582	51.5	-1.6	7.04	10.145	33.785	30.357	40.2	9.8	41.8	11.4	3.66	-0.05	25.0	15.2	26.6
96	214.8	0.588	51.4	-1.7	7.05	10.252	33.862	30.391	40.2	9.8	41.9	11.5	3.65	-0.06	25.0	15.2	26.7
97	215.4	0.595	51.3	-1.7	7.06	10.359	33.953	30.436	40.2	9.8	42.0	11.5	3.64	-0.06	25.0	15.2	26.7
98	216.0	0.601	51.3	-1.7	7.07	10.466	34.044	30.481	40.3	9.8	42.0	11.5	3.64	-0.06	25.0	15.2	26.8
99	216.6	0.607	51.3	-1.8	7.08	10.572	34.148	30.537	40.3	9.8	42.1	11.6	3.64	-0.06	25.1	15.3	26.8
100	217.3	0.613	51.2	-1.8	7.09	10.679	34.251	30.594	40.4	9.8	42.2	11.6	3.63	-0.06	25.1	15.3	26.9

Specimen B

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
101	218.0	0.619	51.2	-1.9	7.10	10.786	34.355	30.649	40.5	9.8	42.3	11.7	3.62	-0.06	25.1	15.3	27.0
102	218.4	0.625	51.1	-2.0	7.10	10.893	34.433	30.682	40.5	9.8	42.5	11.8	3.60	-0.07	25.1	15.3	27.1
103	219.2	0.631	50.9	-2.1	7.11	11.000	34.549	30.749	40.6	9.8	42.7	11.9	3.58	-0.07	25.2	15.4	27.3
104	219.7	0.637	51.0	-2.1	7.12	11.106	34.627	30.781	40.6	9.8	42.7	11.9	3.59	-0.07	25.2	15.4	27.3
105	220.4	0.644	50.9	-2.1	7.13	11.213	34.744	30.848	40.6	9.8	42.8	11.9	3.59	-0.07	25.2	15.4	27.4
106	221.2	0.650	50.9	-2.1	7.14	11.320	34.861	30.914	40.7	9.8	42.8	11.9	3.59	-0.07	25.3	15.5	27.4
107	221.4	0.656	50.9	-2.2	7.15	11.427	34.899	30.912	40.7	9.8	42.9	12.0	3.58	-0.07	25.3	15.5	27.4
108	222.4	0.662	50.8	-2.2	7.16	11.534	35.055	31.012	40.8	9.8	43.1	12.0	3.57	-0.07	25.3	15.5	27.6
109	223.0	0.668	50.8	-2.2	7.16	11.640	35.146	31.055	40.9	9.8	43.1	12.0	3.58	-0.07	25.3	15.5	27.6
110	223.5	0.674	50.8	-2.3	7.17	11.747	35.224	31.086	40.9	9.8	43.2	12.1	3.57	-0.07	25.3	15.5	27.6
111	223.8	0.680	50.7	-2.3	7.18	11.854	35.275	31.094	40.9	9.8	43.2	12.1	3.56	-0.07	25.3	15.5	27.7
112	224.7	0.687	50.7	-2.4	7.19	11.961	35.418	31.182	41.0	9.8	43.3	12.2	3.56	-0.08	25.4	15.6	27.8
113	225.0	0.693	50.7	-2.4	7.20	12.067	35.470	31.190	41.0	9.8	43.4	12.2	3.55	-0.08	25.4	15.6	27.8
114	225.6	0.699	50.6	-2.4	7.21	12.174	35.561	31.231	41.0	9.8	43.5	12.2	3.55	-0.08	25.4	15.6	27.9
115	226.2	0.705	50.6	-2.4	7.22	12.281	35.651	31.273	41.1	9.8	43.5	12.2	3.55	-0.08	25.4	15.6	27.9
116	226.6	0.711	50.6	-2.5	7.22	12.388	35.716	31.292	41.1	9.8	43.6	12.3	3.55	-0.08	25.4	15.6	27.9
117	227.5	0.717	50.5	-2.5	7.23	12.495	35.859	31.378	41.2	9.8	43.7	12.3	3.55	-0.08	25.5	15.7	28.0
118	227.9	0.723	50.5	-2.5	7.24	12.601	35.924	31.397	41.2	9.8	43.7	12.3	3.55	-0.08	25.5	15.7	28.0
119	228.6	0.729	50.5	-2.6	7.25	12.708	36.040	31.460	41.3	9.8	43.8	12.4	3.54	-0.08	25.5	15.7	28.1
120	228.8	0.736	50.5	-2.6	7.26	12.815	36.066	31.444	41.2	9.8	43.8	12.4	3.54	-0.08	25.5	15.7	28.1
121	229.4	0.742	50.4	-2.6	7.27	12.922	36.157	31.485	41.3	9.8	43.9	12.4	3.53	-0.08	25.5	15.7	28.2
122	229.9	0.748	50.4	-2.6	7.28	13.029	36.248	31.525	41.3	9.8	44.0	12.4	3.53	-0.08	25.6	15.8	28.2
123	230.3	0.754	50.4	-2.6	7.29	13.135	36.300	31.531	41.3	9.8	44.0	12.4	3.53	-0.08	25.6	15.8	28.2
124	230.9	0.760	50.3	-2.8	7.30	13.242	36.403	31.583	41.4	9.8	44.2	12.6	3.50	-0.09	25.6	15.8	28.4
125	231.3	0.766	50.1	-2.9	7.31	13.349	36.468	31.600	41.4	9.8	44.3	12.7	3.48	-0.09	25.6	15.8	28.5
126	232.2	0.772	50.2	-2.8	7.31	13.456	36.598	31.673	41.5	9.8	44.3	12.6	3.50	-0.09	25.6	15.8	28.5
127	232.2	0.778	50.2	-2.9	7.32	13.563	36.598	31.634	41.4	9.8	44.3	12.7	3.49	-0.09	25.6	15.8	28.5
128	233.1	0.785	50.2	-2.9	7.33	13.669	36.740	31.718	41.5	9.8	44.4	12.7	3.50	-0.09	25.7	15.9	28.5
129	233.3	0.791	50.2	-2.9	7.34	13.776	36.779	31.712	41.5	9.8	44.4	12.7	3.50	-0.09	25.7	15.9	28.5
130	233.9	0.797	50.1	-2.9	7.35	13.883	36.870	31.751	41.6	9.8	44.5	12.7	3.49	-0.09	25.7	15.9	28.6
131	234.1	0.803	50.1	-2.9	7.36	13.990	36.909	31.745	41.5	9.8	44.5	12.7	3.49	-0.09	25.7	15.9	28.6
132	234.4	0.809	50.1	-2.9	7.37	14.097	36.961	31.751	41.6	9.8	44.5	12.7	3.49	-0.09	25.7	15.9	28.6
133	235.1	0.815	50.1	-2.9	7.38	14.203	37.064	31.800	41.6	9.8	44.5	12.7	3.50	-0.09	25.7	15.9	28.6
134	235.3	0.821	50.1	-3.0	7.39	14.310	37.090	31.783	41.6	9.8	44.6	12.8	3.49	-0.09	25.7	15.9	28.7
135	236.1	0.827	50.1	-3.0	7.40	14.417	37.220	31.854	41.7	9.8	44.6	12.8	3.49	-0.09	25.7	15.9	28.7
136	236.1	0.834	50.1	-3.0	7.41	14.524	37.220	31.814	41.6	9.8	44.6	12.8	3.49	-0.09	25.7	15.9	28.7
137	236.6	0.840	50.1	-3.0	7.41	14.630	37.298	31.841	41.6	9.8	44.7	12.8	3.49	-0.09	25.7	15.9	28.7
138	236.9	0.846	50.1	-3.0	7.42	14.737	37.350	31.845	41.6	9.8	44.6	12.8	3.49	-0.09	25.7	15.9	28.7
139	237.1	0.852	49.9	-3.1	7.43	14.844	37.376	31.828	41.6	9.8	44.8	12.9	3.46	-0.10	25.7	15.9	28.8
140	237.6	0.858	50.0	-3.0	7.44	14.951	37.466	31.865	41.7	9.8	44.7	12.8	3.48	-0.10	25.7	15.9	28.8
141	238.1	0.864	50.0	-3.0	7.45	15.058	37.544	31.891	41.7	9.8	44.7	12.8	3.48	-0.10	25.7	15.9	28.8

Specimen B

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
142	238.5	0.870	50.0	-3.1	7.46	15.164	37.596	31.895	41.7	9.8	44.8	12.9	3.47	-0.10	25.7	15.9	28.8
143	238.6	0.876	50.0	-3.1	7.47	15.271	37.622	31.877	41.7	9.8	44.8	12.9	3.47	-0.10	25.7	15.9	28.8
144	239.3	0.883	50.0	-3.1	7.48	15.378	37.726	31.924	41.7	9.8	44.8	12.9	3.48	-0.10	25.8	16.0	28.9
145	239.8	0.889	50.1	-3.0	7.49	15.485	37.803	31.950	41.8	9.8	44.7	12.8	3.50	-0.09	25.8	16.0	28.7
146	240.5	0.895	50.1	-2.9	7.50	15.592	37.920	32.008	41.8	9.8	44.7	12.7	3.51	-0.09	25.8	16.0	28.7
147	240.9	0.898	50.2	-2.9	7.50	15.645	37.985	32.042	41.8	9.8	44.7	12.7	3.53	-0.09	25.8	16.0	28.7

Specimen C Shear Data **CU Triaxial Test**	**Patriot Engineering**

File Location
Triaxial 2-0383 B-26A 8-10.HSD

Project Information

Project No. 2-11-0383
Project Name: Bulldog Mine
Client: Sunrise Coal, LLC
Sample Location:
Sample Description: Brown SILTY CLAY with trace gravel
Remarks: C

Sample Data

Sample Type: Undisturbed
Specific Gravity: 2.6500001
LL: 0.000
PL: 0.000

Sample Parameters	Initial	After Consolidation	Final
Diameter (in)	2.856	2.837	
Height (in)	6.154	6.177	
Weight (grams)	1435.83		1439.13
Moisture (%)	14.03		14.95
Dry Density (pcf)	121.65	122.10	
Saturation (%)	103.32	100.00	
Void Ratio	0.357	0.355	

Test Data

Rate of Strain: 0.0003
Cell Pressure (psi): 69.980
Effective Confining Stress (psi): 15.7
Corrected Peak Deviator Stress (psi): 40.625 at reading number: 135

Specimen C

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
0	-0.8	0.000	54.3	0.0	6.32	0.000	0.000	0.000	15.7	15.7	15.7	15.7	1.00	0.00	15.7	0.0	15.7
1	43.8	0.006	58.3	4.0	6.33	0.102	7.051	7.044	22.7	15.7	18.7	11.6	1.61	0.57	19.2	3.5	15.2
2	59.4	0.013	60.2	5.8	6.34	0.205	9.532	9.512	25.2	15.7	19.3	9.8	1.97	0.61	20.4	4.8	14.6
3	69.4	0.019	61.1	6.8	6.34	0.307	11.099	11.065	26.7	15.7	20.0	8.9	2.24	0.61	21.2	5.5	14.4
4	77.6	0.025	61.6	7.3	6.35	0.409	12.404	12.354	28.0	15.7	20.7	8.4	2.48	0.59	21.8	6.2	14.5
5	84.2	0.032	62.1	7.8	6.36	0.512	13.449	13.380	29.0	15.7	21.2	7.8	2.71	0.58	22.3	6.7	14.5
6	90.8	0.038	62.4	8.1	6.36	0.614	14.494	14.405	30.1	15.7	22.0	7.6	2.89	0.56	22.9	7.2	14.8
7	97.4	0.044	62.5	8.2	6.37	0.716	15.538	15.427	31.1	15.7	22.9	7.4	3.07	0.53	23.4	7.7	15.2
8	103.2	0.051	62.5	8.2	6.38	0.819	16.452	16.318	32.0	15.7	23.8	7.5	3.18	0.50	23.8	8.2	15.6
9	109.0	0.057	62.5	8.2	6.38	0.921	17.366	17.206	32.9	15.7	24.7	7.5	3.30	0.48	24.3	8.6	16.1
10	113.9	0.063	62.5	8.1	6.39	1.023	18.150	17.964	33.6	15.7	25.5	7.5	3.39	0.45	24.6	9.0	16.5
11	118.1	0.070	62.3	8.0	6.40	1.126	18.803	18.591	34.2	15.7	26.2	7.6	3.43	0.43	25.0	9.3	16.9
12	123.0	0.076	62.3	8.0	6.40	1.228	19.586	19.345	35.0	15.7	27.0	7.6	3.53	0.41	25.3	9.7	17.3
13	127.1	0.082	62.2	7.9	6.41	1.330	20.239	19.970	35.6	15.7	27.7	7.8	3.57	0.40	25.6	10.0	17.8
14	131.3	0.089	62.1	7.7	6.42	1.433	20.892	20.592	36.3	15.7	28.5	7.9	3.60	0.38	26.0	10.3	18.2
15	134.6	0.095	61.9	7.6	6.42	1.535	21.414	21.085	36.7	15.7	29.1	8.0	3.62	0.36	26.2	10.5	18.6
16	137.9	0.101	61.9	7.6	6.43	1.637	21.936	21.577	37.2	15.7	29.7	8.1	3.67	0.35	26.4	10.8	18.9
17	141.2	0.107	61.9	7.5	6.44	1.740	22.459	22.068	37.7	15.7	30.2	8.1	3.72	0.34	26.7	11.0	19.2
18	144.5	0.114	61.8	7.4	6.44	1.842	22.981	22.558	38.2	15.7	30.8	8.2	3.75	0.33	26.9	11.3	19.5

Specimen C

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
19	147.8	0.120	61.5	7.2	6.45	1.944	23.503	23.046	38.7	15.7	31.5	8.4	3.73	0.31	27.2	11.5	20.0
20	150.3	0.126	61.4	7.1	6.46	2.047	23.895	23.406	39.1	15.7	32.0	8.6	3.73	0.30	27.4	11.7	20.3
21	152.7	0.133	61.3	7.0	6.46	2.149	24.287	23.765	39.4	15.7	32.5	8.7	3.73	0.29	27.5	11.9	20.6
22	156.0	0.139	61.1	6.8	6.47	2.251	24.809	24.250	39.9	15.7	33.1	8.9	3.73	0.28	27.8	12.1	21.0
23	158.5	0.145	61.0	6.6	6.48	2.354	25.201	24.607	40.3	15.7	33.6	9.0	3.73	0.27	28.0	12.3	21.3
24	161.8	0.152	60.8	6.4	6.48	2.456	25.723	25.091	40.7	15.7	34.3	9.2	3.72	0.26	28.2	12.5	21.8
25	164.3	0.158	60.5	6.2	6.49	2.559	26.115	25.447	41.1	15.7	34.9	9.5	3.69	0.24	28.4	12.7	22.2
26	166.8	0.164	60.4	6.1	6.50	2.661	26.506	25.801	41.5	15.7	35.4	9.6	3.69	0.24	28.6	12.9	22.5
27	169.3	0.171	60.2	5.9	6.50	2.763	26.898	26.155	41.8	15.7	35.9	9.7	3.69	0.23	28.7	13.1	22.8
28	171.7	0.177	60.0	5.7	6.51	2.866	27.290	26.508	42.2	15.7	36.4	9.9	3.67	0.22	28.9	13.3	23.2
29	174.2	0.183	59.9	5.6	6.52	2.968	27.682	26.860	42.5	15.7	36.9	10.1	3.67	0.21	29.1	13.4	23.5
30	176.7	0.190	59.7	5.4	6.52	3.070	28.073	27.211	42.9	15.7	37.5	10.3	3.65	0.20	29.3	13.6	23.9
31	178.3	0.196	59.7	5.4	6.53	3.173	28.334	27.435	43.1	15.7	37.7	10.3	3.67	0.20	29.4	13.7	24.0
32	180.8	0.202	59.6	5.2	6.54	3.275	28.726	27.785	43.4	15.7	38.2	10.4	3.67	0.19	29.6	13.9	24.3
33	183.3	0.209	59.4	5.0	6.54	3.377	29.118	28.134	43.8	15.7	38.8	10.6	3.65	0.18	29.7	14.1	24.7
34	185.8	0.215	59.3	5.0	6.55	3.480	29.510	28.483	44.1	15.7	39.1	10.7	3.67	0.18	29.9	14.2	24.9
35	187.4	0.221	59.1	4.8	6.56	3.582	29.771	28.704	44.4	15.7	39.6	10.9	3.63	0.17	30.0	14.4	25.3
36	189.9	0.228	58.9	4.6	6.56	3.684	30.162	29.051	44.7	15.7	40.1	11.1	3.62	0.16	30.2	14.5	25.6
37	191.5	0.234	58.8	4.5	6.57	3.787	30.424	29.272	44.9	15.7	40.5	11.2	3.62	0.15	30.3	14.6	25.8
38	194.0	0.240	58.7	4.4	6.58	3.889	30.815	29.617	45.3	15.7	40.9	11.3	3.63	0.15	30.5	14.8	26.1
39	195.7	0.247	58.6	4.2	6.59	3.991	31.076	29.836	45.5	15.7	41.3	11.4	3.61	0.14	30.6	14.9	26.3
40	197.3	0.253	58.4	4.1	6.59	4.094	31.338	30.055	45.7	15.7	41.6	11.6	3.59	0.14	30.7	15.0	26.6
41	199.8	0.259	58.3	4.0	6.60	4.196	31.729	30.398	46.1	15.7	42.1	11.7	3.60	0.13	30.9	15.2	26.9
42	201.5	0.266	58.2	3.9	6.61	4.298	31.990	30.615	46.3	15.7	42.4	11.8	3.61	0.13	31.0	15.3	27.1
43	203.1	0.272	57.9	3.6	6.61	4.401	32.252	30.832	46.5	15.7	42.9	12.0	3.56	0.12	31.1	15.4	27.4
44	204.8	0.278	57.9	3.6	6.62	4.503	32.513	31.049	46.7	15.7	43.1	12.0	3.58	0.12	31.2	15.5	27.6
45	206.4	0.284	57.9	3.5	6.63	4.605	32.774	31.265	46.9	15.7	43.4	12.1	3.58	0.11	31.3	15.6	27.7
46	208.1	0.291	57.7	3.4	6.64	4.708	33.035	31.480	47.1	15.7	43.8	12.3	3.56	0.11	31.4	15.7	28.0
47	209.7	0.297	57.7	3.3	6.64	4.810	33.296	31.695	47.4	15.7	44.0	12.3	3.57	0.11	31.5	15.8	28.2
48	212.2	0.303	57.5	3.2	6.65	4.912	33.688	32.033	47.7	15.7	44.5	12.4	3.58	0.10	31.7	16.0	28.5
49	213.8	0.310	57.5	3.1	6.66	5.015	33.949	32.247	47.9	15.7	44.8	12.5	3.58	0.10	31.8	16.1	28.6
50	215.5	0.316	57.3	3.0	6.66	5.117	34.210	32.460	48.1	15.7	45.1	12.7	3.56	0.09	31.9	16.2	28.9
51	217.1	0.322	57.1	2.8	6.67	5.219	34.471	32.672	48.3	15.7	45.6	12.9	3.54	0.09	32.0	16.3	29.2
52	218.0	0.329	57.0	2.7	6.68	5.322	34.602	32.761	48.4	15.7	45.8	13.0	3.52	0.08	32.0	16.4	29.4
53	219.6	0.335	57.0	2.7	6.69	5.424	34.863	32.972	48.6	15.7	45.9	13.0	3.54	0.08	32.1	16.5	29.4
54	221.3	0.341	56.7	2.4	6.69	5.526	35.124	33.183	48.8	15.7	46.5	13.3	3.50	0.07	32.2	16.6	29.9
55	222.9	0.348	56.6	2.3	6.70	5.629	35.385	33.394	49.1	15.7	46.8	13.4	3.49	0.07	32.4	16.7	30.1
56	224.6	0.354	56.5	2.2	6.71	5.731	35.647	33.604	49.3	15.7	47.0	13.4	3.50	0.07	32.5	16.8	30.2
57	226.2	0.360	56.5	2.2	6.71	5.833	35.908	33.813	49.5	15.7	47.3	13.5	3.51	0.06	32.6	16.9	30.4
58	227.9	0.367	56.4	2.1	6.72	5.936	36.169	34.022	49.7	15.7	47.6	13.6	3.50	0.06	32.7	17.0	30.6
59	229.5	0.373	56.3	1.9	6.73	6.038	36.430	34.230	49.9	15.7	48.0	13.7	3.49	0.06	32.8	17.1	30.8

Specimen C

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
60	230.4	0.379	56.1	1.7	6.74	6.140	36.561	34.316	50.0	15.7	48.2	13.9	3.46	0.05	32.8	17.2	31.1
61	232.0	0.386	56.2	1.9	6.74	6.243	36.822	34.523	50.2	15.7	48.3	13.8	3.50	0.05	32.9	17.3	31.1
62	233.7	0.392	56.0	1.7	6.75	6.345	37.083	34.730	50.4	15.7	48.7	14.0	3.49	0.05	33.0	17.4	31.3
63	234.5	0.398	55.9	1.5	6.76	6.447	37.213	34.814	50.5	15.7	48.9	14.1	3.46	0.04	33.1	17.4	31.5
64	236.1	0.405	55.7	1.4	6.77	6.550	37.475	35.020	50.7	15.7	49.3	14.3	3.45	0.04	33.2	17.5	31.8
65	237.0	0.411	55.8	1.5	6.77	6.652	37.605	35.104	50.8	15.7	49.3	14.2	3.48	0.04	33.2	17.6	31.7
66	238.6	0.417	55.6	1.3	6.78	6.754	37.866	35.309	51.0	15.7	49.7	14.4	3.46	0.04	33.3	17.7	32.0
67	239.4	0.424	55.6	1.2	6.79	6.857	37.997	35.391	51.0	15.7	49.8	14.4	3.46	0.04	33.4	17.7	32.1
68	240.3	0.430	55.5	1.2	6.80	6.959	38.127	35.474	51.1	15.7	50.0	14.5	3.45	0.03	33.4	17.7	32.2
69	241.9	0.436	55.4	1.1	6.80	7.061	38.389	35.678	51.3	15.7	50.2	14.5	3.46	0.03	33.5	17.8	32.4
70	242.7	0.443	55.3	1.0	6.81	7.164	38.519	35.760	51.4	15.7	50.4	14.7	3.44	0.03	33.5	17.9	32.5
71	243.6	0.449	55.2	0.9	6.82	7.266	38.650	35.841	51.5	15.7	50.6	14.7	3.43	0.03	33.6	17.9	32.7
72	244.4	0.455	55.0	0.7	6.83	7.369	38.780	35.923	51.6	15.7	50.9	14.9	3.41	0.02	33.6	18.0	32.9
73	246.0	0.462	54.8	0.5	6.83	7.471	39.041	36.125	51.8	15.7	51.3	15.1	3.39	0.01	33.7	18.1	33.2
74	246.9	0.468	55.2	0.9	6.84	7.573	39.172	36.205	51.9	15.7	50.9	14.7	3.46	0.03	33.8	18.1	32.8
75	248.5	0.474	55.1	0.8	6.85	7.676	39.433	36.406	52.1	15.7	51.3	14.9	3.44	0.02	33.9	18.2	33.1
76	248.5	0.480	54.6	0.2	6.86	7.778	39.433	36.366	52.0	15.7	51.8	15.4	3.36	0.01	33.8	18.2	33.6
77	249.3	0.487	54.5	0.2	6.86	7.880	39.564	36.446	52.1	15.7	51.9	15.5	3.36	0.01	33.9	18.2	33.7
78	251.0	0.493	54.6	0.2	6.87	7.983	39.825	36.646	52.3	15.7	52.1	15.4	3.38	0.01	34.0	18.3	33.7
79	251.8	0.499	54.4	0.1	6.88	8.085	39.955	36.725	52.4	15.7	52.3	15.5	3.36	0.00	34.0	18.4	33.9
80	253.5	0.506	54.4	0.1	6.89	8.187	40.217	36.924	52.6	15.7	52.5	15.6	3.37	0.00	34.1	18.5	34.0
81	254.3	0.512	55.1	0.8	6.89	8.290	40.347	37.003	52.7	15.7	51.9	14.9	3.48	0.02	34.2	18.5	33.4
82	255.1	0.518	55.1	0.8	6.90	8.392	40.478	37.081	52.7	15.7	52.0	14.9	3.49	0.02	34.2	18.5	33.4
83	256.8	0.525	55.0	0.7	6.91	8.494	40.739	37.278	52.9	15.7	52.3	15.0	3.49	0.02	34.3	18.6	33.6
84	257.6	0.531	55.0	0.6	6.92	8.597	40.869	37.356	53.0	15.7	52.4	15.0	3.49	0.02	34.3	18.7	33.7
85	258.4	0.537	55.0	0.6	6.93	8.699	41.000	37.433	53.1	15.7	52.4	15.0	3.49	0.02	34.4	18.7	33.7
86	259.2	0.544	54.9	0.6	6.93	8.801	41.131	37.511	53.2	15.7	52.6	15.1	3.49	0.02	34.4	18.8	33.8
87	260.1	0.550	54.7	0.4	6.94	8.904	41.261	37.587	53.2	15.7	52.9	15.3	3.46	0.01	34.5	18.8	34.1
88	260.9	0.556	54.8	0.4	6.95	9.006	41.392	37.664	53.3	15.7	52.9	15.2	3.48	0.01	34.5	18.8	34.0
89	262.5	0.563	54.7	0.4	6.96	9.108	41.653	37.859	53.5	15.7	53.2	15.3	3.48	0.01	34.6	18.9	34.2
90	263.4	0.569	54.6	0.2	6.96	9.211	41.783	37.935	53.6	15.7	53.4	15.4	3.46	0.01	34.6	19.0	34.4
91	264.2	0.575	54.3	0.0	6.97	9.313	41.914	38.011	53.7	15.7	53.7	15.7	3.42	0.00	34.7	19.0	34.7
92	265.0	0.582	54.4	0.1	6.98	9.415	42.045	38.086	53.7	15.7	53.7	15.6	3.44	0.00	34.7	19.0	34.6
93	266.7	0.588	54.4	0.1	6.99	9.518	42.306	38.279	53.9	15.7	53.9	15.6	3.46	0.00	34.8	19.1	34.7
94	267.5	0.594	54.4	0.0	7.00	9.620	42.436	38.354	54.0	15.7	54.0	15.6	3.46	0.00	34.8	19.2	34.8
95	268.3	0.601	54.3	0.0	7.00	9.722	42.567	38.428	54.1	15.7	54.1	15.7	3.45	0.00	34.9	19.2	34.9
96	269.2	0.607	53.8	-0.5	7.01	9.825	42.697	38.503	54.2	15.7	54.7	16.2	3.38	-0.01	34.9	19.3	35.4
97	270.0	0.613	53.6	-0.7	7.02	9.927	42.828	38.577	54.2	15.7	54.9	16.3	3.36	-0.02	34.9	19.3	35.6
98	270.8	0.620	53.2	-1.1	7.03	10.029	42.959	38.650	54.3	15.7	55.4	16.8	3.30	-0.03	35.0	19.3	36.1
99	271.6	0.626	53.5	-0.8	7.04	10.132	43.089	38.724	54.4	15.7	55.2	16.5	3.35	-0.02	35.0	19.4	35.8
100	272.5	0.632	53.0	-1.3	7.04	10.234	43.220	38.797	54.5	15.7	55.8	17.0	3.28	-0.03	35.1	19.4	36.4

Specimen C

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
101	273.3	0.639	52.9	-1.4	7.05	10.336	43.350	38.869	54.5	15.7	55.9	17.1	3.28	-0.04	35.1	19.4	36.5
102	274.1	0.645	52.8	-1.5	7.06	10.439	43.481	38.942	54.6	15.7	56.1	17.1	3.27	-0.04	35.1	19.5	36.6
103	274.9	0.651	52.9	-1.4	7.07	10.541	43.611	39.014	54.7	15.7	56.1	17.1	3.29	-0.04	35.2	19.5	36.6
104	275.8	0.657	52.7	-1.6	7.08	10.643	43.742	39.086	54.7	15.7	56.4	17.3	3.26	-0.04	35.2	19.5	36.8
105	277.4	0.664	53.8	-0.6	7.08	10.746	44.003	39.275	54.9	15.7	55.5	16.2	3.42	-0.01	35.3	19.6	35.9
106	278.2	0.670	53.8	-0.6	7.09	10.848	44.134	39.346	55.0	15.7	55.6	16.2	3.43	-0.01	35.3	19.7	35.9
107	279.1	0.676	53.7	-0.6	7.10	10.950	44.264	39.417	55.1	15.7	55.7	16.3	3.42	-0.02	35.4	19.7	36.0
108	279.9	0.683	53.6	-0.7	7.11	11.053	44.395	39.488	55.1	15.7	55.8	16.3	3.42	-0.02	35.4	19.7	36.1
109	280.7	0.689	53.7	-0.6	7.12	11.155	44.526	39.559	55.2	15.7	55.9	16.3	3.43	-0.02	35.4	19.8	36.1
110	281.5	0.695	53.5	-0.8	7.13	11.257	44.656	39.629	55.3	15.7	56.1	16.5	3.41	-0.02	35.5	19.8	36.3
111	281.5	0.702	53.6	-0.8	7.13	11.360	44.656	39.583	55.2	15.7	56.0	16.4	3.41	-0.02	35.4	19.8	36.2
112	283.2	0.708	53.5	-0.8	7.14	11.462	44.917	39.769	55.4	15.7	56.2	16.5	3.42	-0.02	35.5	19.9	36.3
113	284.0	0.714	53.4	-0.9	7.15	11.564	45.048	39.838	55.5	15.7	56.4	16.5	3.41	-0.02	35.6	19.9	36.5
114	284.8	0.721	53.4	-0.9	7.16	11.667	45.178	39.908	55.6	15.7	56.5	16.6	3.41	-0.02	35.6	20.0	36.5
115	284.8	0.727	53.4	-0.9	7.17	11.769	45.178	39.861	55.5	15.7	56.4	16.6	3.40	-0.02	35.6	19.9	36.5
116	285.7	0.733	53.3	-1.0	7.17	11.871	45.309	39.930	55.6	15.7	56.6	16.7	3.40	-0.03	35.6	20.0	36.6
117	286.5	0.740	53.3	-1.0	7.18	11.974	45.440	39.999	55.7	15.7	56.7	16.7	3.40	-0.03	35.7	20.0	36.7
118	287.3	0.746	53.3	-1.0	7.19	12.076	45.570	40.067	55.7	15.7	56.8	16.7	3.40	-0.03	35.7	20.0	36.7
119	288.1	0.752	53.2	-1.1	7.20	12.178	45.701	40.135	55.8	15.7	56.9	16.8	3.39	-0.03	35.7	20.1	36.9
120	289.0	0.759	53.2	-1.2	7.21	12.281	45.831	40.203	55.9	15.7	57.0	16.8	3.39	-0.03	35.8	20.1	36.9
121	289.8	0.765	53.2	-1.2	7.22	12.383	45.962	40.270	55.9	15.7	57.1	16.8	3.39	-0.03	35.8	20.1	37.0
122	290.6	0.771	53.1	-1.2	7.23	12.486	46.092	40.338	56.0	15.7	57.2	16.9	3.39	-0.03	35.8	20.2	37.1
123	290.6	0.778	52.9	-1.4	7.23	12.588	46.092	40.290	55.9	15.7	57.4	17.1	3.36	-0.03	35.8	20.1	37.2
124	291.4	0.784	53.0	-1.3	7.24	12.690	46.223	40.357	56.0	15.7	57.3	17.0	3.38	-0.03	35.8	20.2	37.2
125	292.3	0.790	53.0	-1.3	7.25	12.793	46.354	40.424	56.1	15.7	57.4	17.0	3.38	-0.03	35.9	20.2	37.2
126	293.1	0.797	52.9	-1.4	7.26	12.895	46.484	40.490	56.1	15.7	57.6	17.1	3.37	-0.03	35.9	20.2	37.3
127	293.1	0.803	52.9	-1.4	7.27	12.997	46.484	40.442	56.1	15.7	57.5	17.1	3.37	-0.03	35.9	20.2	37.3
128	293.9	0.809	52.9	-1.4	7.28	13.100	46.615	40.508	56.2	15.7	57.6	17.1	3.37	-0.04	35.9	20.3	37.4
129	294.7	0.816	52.8	-1.5	7.28	13.202	46.745	40.574	56.2	15.7	57.7	17.1	3.37	-0.04	35.9	20.3	37.4
130	294.7	0.822	52.8	-1.5	7.29	13.304	46.745	40.526	56.2	15.7	57.7	17.2	3.36	-0.04	35.9	20.3	37.5
131	295.6	0.828	52.8	-1.5	7.30	13.407	46.876	40.591	56.2	15.7	57.8	17.2	3.36	-0.04	36.0	20.3	37.5
132	295.6	0.834	52.8	-1.5	7.31	13.509	46.876	40.543	56.2	15.7	57.7	17.1	3.36	-0.04	35.9	20.3	37.4
133	296.4	0.841	52.8	-1.5	7.32	13.611	47.006	40.608	56.3	15.7	57.8	17.2	3.36	-0.04	36.0	20.3	37.5
134	296.4	0.847	52.8	-1.5	7.33	13.714	47.006	40.560	56.2	15.7	57.7	17.2	3.36	-0.04	35.9	20.3	37.5
135	297.2	0.853	52.7	-1.7	7.34	13.816	47.137	40.625	56.3	15.7	57.9	17.3	3.35	-0.04	36.0	20.3	37.6
136	297.2	0.860	52.7	-1.7	7.35	13.918	47.137	40.576	56.2	15.7	57.9	17.3	3.34	-0.04	35.9	20.3	37.6
137	297.2	0.866	52.7	-1.7	7.35	14.021	47.137	40.528	56.2	15.7	57.8	17.3	3.34	-0.04	35.9	20.3	37.6
138	298.1	0.872	52.7	-1.7	7.36	14.123	47.268	40.592	56.2	15.7	57.9	17.3	3.35	-0.04	36.0	20.3	37.6
139	298.1	0.879	52.3	-2.0	7.37	14.225	47.268	40.544	56.2	15.7	58.2	17.7	3.29	-0.05	35.9	20.3	37.9
140	298.9	0.885	52.2	-2.1	7.38	14.328	47.398	40.607	56.3	15.7	58.4	17.8	3.28	-0.05	36.0	20.3	38.1
141	298.9	0.891	52.2	-2.1	7.39	14.430	47.398	40.559	56.2	15.7	58.4	17.8	3.28	-0.05	35.9	20.3	38.1

Specimen C

Reading No.	Deviator Load (lbs)	Axial Deformation (in)	Pore Pressure (psi)	Change in Pore Pressure (psi)	Corrected Area (in2)	Axial Strain (%)	Deviator Stress (psi)	Corrected Deviator Stress (psi)	σ_1 (psi)	σ_3 (psi)	σ'_1 (psi)	σ'_3 (psi)	σ'_1/σ'_3	Abar	P (psi)	Q (psi)	P' (psi)
142	298.9	0.898	52.1	-2.2	7.40	14.532	47.398	40.510	56.2	15.7	58.4	17.9	3.27	-0.05	35.9	20.3	38.1
143	298.9	0.901	52.2	-2.1	7.40	14.591	47.398	40.482	56.1	15.7	58.3	17.8	3.28	-0.05	35.9	20.2	38.0

WATER TESTING RESULTS

RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1696-03
Date Received: 6/12/2012
Date Reported: 7/13/2012

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	6.65	feet	Field Measure	HMS	6/8/2012
Depth to Water	677.15	feet	Field Measure	HMS	6/8/2012
pH	7.34	SU	SM 4500-H+ B	HMS	6/8/2012
Temperature	16.6	deg C	SM 2550 B	HMS	6/8/2012
Acidity, Total	<10	mg/L as CaCO3	SM 2310 B	MJL	6/14/2012
Alkalinity, Total	220	mg/L as CaCO3	SM 2320 B	MJL	6/14/2012
Chloride	17	mg/L	SM 4500-CL B	MJL	6/14/2012
Iron, Total	0.21	mg/L	EPA 200.7	MJL	6/30/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	6/30/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	6/14/2012
Hardness	210	mg/L as CaCO3	SM 2340 C	MJL	6/30/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Sulfate	10	mg/L	D51690,02	CCV	6/12/2012
Solids, Total Dissolved	340	mg/L	SM 2540 C	CCV	6/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	6/30/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012

Phone: 812-897-2530 • Fax: 812-897-2531

RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1696-03

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result	Method	Analyst	Analysis Date
Boron, Total	0.21 mg/L	EPA 200.7	MJL	6/30/2012
Barium, Total	0.024 mg/L	EPA 200.7	MJL	6/30/2012
Beryllium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Cadmium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Cyanide, Total	<0.010 mg/L	SM 4500CNCE	MLI	6/21/2012
Cobalt, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Chromium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Copper, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Mercury, Total	<0.0002 mg/L	EPA 245.1	MLI	6/25/2012
Molybdenum, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Nickel, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Lead, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Phenolics, Tot. Recoverable	0.058 mg/L	EPA 420.4	MLI	6/27/2012
Antimony, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Selenium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Thallium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Vanadium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Zinc, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012

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Lab Number: 2012-1696-03

Reviewed by Rodger Wilson

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RoseDale Services, Inc.

1125 E. Walnut Street
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Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1696-05
Date Received: 6/12/2012
Date Reported: 7/13/2012

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	7.65	feet	Field Measure	HMS	6/8/2012
Depth to Water	679.05	feet	Field Measure	HMS	6/8/2012
pH	7.45	SU	SM 4500-H+ B	HMS	6/8/2012
Temperature	17.4	deg C	SM 2550 B	HMS	6/8/2012
Acidity, Total	<10	mg/L as CaCO3	SM 2310 B	MJL	6/14/2012
Alkalinity, Total	240	mg/L as CaCO3	SM 2320 B	MJL	6/14/2012
Chloride	19	mg/L	SM 4500-CL B	MJL	6/14/2012
Iron, Total	<0.1	mg/L	EPA 200.7	MJL	6/30/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	6/30/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	6/14/2012
Hardness	180	mg/L as CaCO3	SM 2340 C	MJL	6/30/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Sulfate	40	mg/L	D51690,02	CCV	6/12/2012
Solids, Total Dissolved	520	mg/L	SM 2540 C	CCV	6/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	6/30/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012

RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1696-05

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result	Method	Analyst	Analysis Date
Boron, Total	0.17 mg/L	EPA 200.7	MJL	6/30/2012
Barium, Total	0.039 mg/L	EPA 200.7	MJL	6/30/2012
Beryllium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Cadmium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Cyanide, Total	<0.010 mg/L	SM 4500CNCE	MLI	6/21/2012
Cobalt, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Chromium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Copper, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Mercury, Total	<0.0002 mg/L	EPA 245.1	MLI	6/25/2012
Molybdenum, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Nickel, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Lead, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Phenolics, Tot. Recoverable	0.085 mg/L	EPA 420.4	MLI	6/27/2012
Antimony, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Selenium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Thallium, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012
Vanadium, Total	<0.002 mg/L	EPA 200.7	MJL	6/30/2012
Zinc, Total	<0.005 mg/L	EPA 200.7	MJL	6/30/2012

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Terre Haute, IN 47802

Lab Number: 2012-1696-06
Date Received: 6/12/2012
Date Reported: 7/13/2012

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	7.02	feet	Field Measure	HMS	6/8/2012
Depth to Water	675.38	feet	Field Measure	HMS	6/8/2012
pH	7.47	SU	SM 4500-H+ B	HMS	6/8/2012
Temperature	16.7	deg C	SM 2550 B	HMS	6/8/2012
Acidity, Total	<10	mg/L as CaCO3	SM 2310 B	MJL	6/14/2012
Alkalinity, Total	260	mg/L as CaCO3	SM 2320 B	MJL	6/14/2012
Chloride	22	mg/L	SM 4500-CL B	MJL	6/14/2012
Iron, Total	<0.1	mg/L	EPA 200.7	MJL	6/30/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	6/30/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	6/14/2012
Hardness	180	mg/L as CaCO3	SM 2340 C	MJL	6/30/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	6/30/2012
Sulfate	70	mg/L	D51690,02	CCV	6/12/2012
Solids, Total Dissolved	600	mg/L	SM 2540 C	CCV	6/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	6/30/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012

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Lab Number: 2012-1696-06

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 6/8/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.18	mg/L	EPA 200.7	MJL	6/30/2012
Barium, Total	0.040	mg/L	EPA 200.7	MJL	6/30/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Cyanide, Total	<0.010	mg/L	SM 4500CNCE	MLI	6/21/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	6/25/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Phenolics, Tot. Recoverable	0.072	mg/L	EPA 420.4	MLI	6/27/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	6/30/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	6/30/2012

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Lab Number: 2012-1871-03
Date Received: 7/24/2012
Date Reported: 8/17/2012

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	9.08	feet	Field Measure	HMS	7/20/2012
pH	7.26	SU	SM 4500-H+ B	HMS	7/20/2012
Temperature	17.4	deg C	SM 2550 B	HMS	7/20/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	7/26/2012
Alkalinity as CaCO3	240	mg/L	SM 2320 B	MJL	7/26/2012
Chloride	15	mg/L	SM 4500-CL B	MJL	7/26/2012
Iron, Total	0.16	mg/L	EPA 200.7	MJL	7/31/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	7/31/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	7/26/2012
Hardness	190	mg/L as CaCO3	SM 2340 C	MJL	7/31/2012
Manganese, Total	0.012	mg/L	EPA 200.7	MJL	7/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	7/31/2012
Sulfate	40	mg/L	D51690,02	CCV	7/25/2012
Solids, Total Dissolved	340	mg/L	SM 2540 C	CCV	7/25/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	7/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Boron, Total	0.22	mg/L	EPA 200.7	MJL	7/31/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1871-03

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Barium, Total	0.020	mg/L	EPA 200.7	MJL	7/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Cyanide, Total	<0.010	mg/L	EPA 335.4	MLI	7/31/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/6/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Phenolics, Tot. Recoverable	0.24	mg/L	EPA 420.4	MLI	8/4/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012

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Terre Haute, IN 47802

Lab Number: 2012-1871-05
Date Received: 7/24/2012
Date Reported: 8/17/2012

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	10.67	feet	Field Measure	HMS	7/20/2012
pH	7.39	SU	SM 4500-H+ B	HMS	7/20/2012
Temperature	17.8	deg C	SM 2550 B	HMS	7/20/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	7/26/2012
Alkalinity as CaCO3	250	mg/L	SM 2320 B	MJL	7/26/2012
Chloride	22	mg/L	SM 4500-CL B	MJL	7/26/2012
Iron, Total	<0.1	mg/L	EPA 200.7	MJL	7/31/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	7/31/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	7/26/2012
Hardness	160	mg/L as CaCO3	SM 2340 C	MJL	7/31/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	7/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	7/31/2012
Sulfate	37	mg/L	D51690,02	CCV	7/25/2012
Solids, Total Dissolved	690	mg/L	SM 2540 C	CCV	7/25/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	8/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Boron, Total	0.20	mg/L	EPA 200.7	MJL	8/31/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
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Lab Number: 2012-1871-05

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Barium, Total	0.036	mg/L	EPA 200.7	MJL	8/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cyanide, Total	<0.010	mg/L	EPA 335.4	MLI	7/31/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/6/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Phenolics, Tot. Recoverable	0.057	mg/L	EPA 420.4	MLI	8/4/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012

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Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1871-06
Date Received: 7/24/2012
Date Reported: 8/17/2012

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	8.46	feet	Field Measure	HMS	7/20/2012
pH	7.35	SU	SM 4500-H+ B	HMS	7/20/2012
Temperature	20.1	deg C	SM 2550 B	HMS	7/20/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	7/26/2012
Alkalinity as CaCO3	240	mg/L	SM 2320 B	MJL	7/26/2012
Chloride	18	mg/L	SM 4500-CL B	MJL	7/26/2012
Iron, Total	0.13	mg/L	EPA 200.7	MJL	7/26/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	7/26/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	7/26/2012
Hardness	170	mg/L as CaCO3	SM 2340 C	MJL	7/31/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	7/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	7/31/2012
Sulfate	50	mg/L	D51690,02	CCV	7/30/2012
Solids, Total Dissolved	690	mg/L	SM 2540 C	CCV	7/30/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	7/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Boron, Total	0.14	mg/L	EPA 200.7	MJL	7/31/2012

RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1871-06

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 7/20/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Barium, Total	0.035	mg/L	EPA 200.7	MJL	7/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Cyanide, Total	<0.010	mg/L	EPA 335.4	MLI	7/31/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/6/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Phenolics, Tot. Recoverable	<0.05	mg/L	EPA 420.4	MLI	8/4/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	7/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	7/31/2012

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1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1963-03
Date Received: 8/13/2012
Date Reported: 9/18/2012

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	10.85	feet	Field Measure	HMS	8/10/2012
Depth to Water	672.95	feet	Field Measure	HMS	8/10/2012
pH	7.16	SU	SM 4500-H+ B	HMS	8/10/2012
Temperature	17.1	deg C	SM 2550 B	HMS	8/10/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	8/15/2012
Alkalinity as CaCO3	300	mg/L	SM 2320 B	MJL	8/15/2012
Chloride	18	mg/L	SM 4500-CL B	MJL	8/15/2012
Iron, Total	0.13	mg/L	EPA 200.7	MJL	8/31/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	8/31/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	8/15/2012
Hardness	200	mg/L as CaCO3	SM 2340 C	MJL	8/31/2012
Manganese, Total	0.010	mg/L	EPA 200.7	MJL	8/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	8/31/2012
Sulfate	49	mg/L	D51690,02	CCV	8/14/2012
Solids, Total Dissolved	330	mg/L	SM 2540 C	CCV	8/16/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	8/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1963-03

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.19	mg/L	EPA 200.7	MJL	8/31/2012
Barium, Total	0.025	mg/L	EPA 200.7	MJL	8/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cyanide, Total	<0.010	mg/L	EPA 335.4	MLI	8/22/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/21/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Phenolics, Tot. Recoverable	0.10	mg/L	EPA 420.4	MLI	8/25/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012

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Lab Number: 2012-1963-03

Reviewed by Rodger Wilson

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RoseDale Services, Inc.

1125 E. Walnut Street
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Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1963-05
Date Received: 8/13/2012
Date Reported: 9/18/2012

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	14.08	feet	Field Measure	HMS	8/10/2012
Depth to Water	672.62	feet	Field Measure	HMS	8/10/2012
pH	7.35	SU	SM 4500-H+ B	HMS	8/10/2012
Temperature	18.4	deg C	SM 2550 B	HMS	8/10/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	8/23/2012
Alkalinity as CaCO3	290	mg/L	SM 2320 B	MJL	8/23/2012
Chloride	17	mg/L	SM 4500-CL B	MJL	8/23/2012
Iron, Total	0.11	mg/L	EPA 200.7	MJL	8/31/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	8/31/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	8/23/2012
Hardness	180	mg/L as CaCO3	SM 2340 C	MJL	8/31/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MJL	8/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	8/31/2012
Sulfate	41	mg/L	D51690,02	CCV	8/20/2012
Solids, Total Dissolved	320	mg/L	SM 2540 C	CCV	8/16/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	8/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012

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RoseDale Services, Inc.

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Lab Number: 2012-1963-05

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.19	mg/L	EPA 200.7	MJL	8/31/2012
Barium, Total	0.036	mg/L	EPA 200.7	MJL	8/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cyanide, Total	<0.010	mg/L	SM 4500 CN E	MLI	8/22/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/21/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Phenolics, Tot. Recoverable	0.086	mg/L	EPA 420.4	MLI	8/25/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012

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Lab Number: 2012-1963-05

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-1963-06
Date Received: 8/13/2012
Date Reported: 9/18/2012

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	9.32	feet	Field Measure	HMS	8/10/2012
Depth to Water	673.08	feet	Field Measure	HMS	8/10/2012
pH	7.25	SU	SM 4500-H+ B	HMS	8/10/2012
Temperature	19.8	deg C	SM 2550 B	HMS	8/10/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	8/23/2012
Alkalinity as CaCO3	290	mg/L	SM 2320 B	MJL	8/23/2012
Chloride	14	mg/L	SM 4500-CL B	MJL	8/23/2012
Iron, Total	<0.1	mg/L	EPA 200.7	MJL	8/31/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MJL	8/31/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	8/23/2012
Hardness	180	mg/L as CaCO3	SM 2340 C	MJL	8/31/2012
Manganese, Total	0.015	mg/L	EPA 200.7	MJL	8/31/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MJL	8/31/2012
Sulfate	56	mg/L	D51690,02	CCV	8/20/2012
Solids, Total Dissolved	520	mg/L	SM 2540 C	CCV	8/16/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MJL	8/31/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012

RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-1963-06

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 8/10/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.22	mg/L	EPA 200.7	MJL	8/31/2012
Barium, Total	0.032	mg/L	EPA 200.7	MJL	8/31/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Cyanide, Total	<0.010	mg/L	SM 4500 CN E	MLI	8/22/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	8/21/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Phenolics, Tot. Recoverable	0.15	mg/L	EPA 420.4	MLI	8/25/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MJL	8/31/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MJL	8/31/2012

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1125 E. Walnut Street
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Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-2053-03
Date Received: 9/10/2012
Date Reported: 10/18/2012

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	10.53	feet	Field Measure	HMS	9/7/2012
Depth to Water	673.27	feet	Field Measure	HMS	9/7/2012
pH	7.21	SU	SM 4500-H+ B	HMS	9/7/2012
Temperature	17.3	deg C	SM 2550 B	HMS	9/7/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	9/18/2012
Alkalinity as CaCO3	270	mg/L	SM 2320 B	MJL	9/18/2012
Chloride	22	mg/L	SM 4500-CL B	MJL	9/18/2012
Iron, Total	0.16	mg/L	EPA 200.7	MLI	9/21/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MLI	9/21/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	9/18/2012
Hardness	190	mg/L as CaCO3	SM 2340 C	MLI	9/21/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MLI	9/21/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MLI	9/21/2012
Sulfate	44	mg/L	D51690,02	CCV	9/17/2012
Solids, Total Dissolved	430	mg/L	SM 2540 C	CCV	9/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MLI	9/21/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-2053-03

Sample Identification

Bulldog Mine
MW-3

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.24	mg/L	EPA 200.7	MLI	9/21/2012
Barium, Total	0.031	mg/L	EPA 200.7	MLI	9/21/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Cyanide, Total	<0.010	mg/L	EPA 335.4	MLI	9/14/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	9/24/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Phenolics, Tot. Recoverable	0.084	mg/L	EPA 420.4	MLI	9/19/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012

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Lab Number: 2012-2053-03

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RoseDale Services, Inc.

1125 E. Walnut Street
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Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Lab Number: 2012-2053-05
Date Received: 9/10/2012
Date Reported: 10/18/2012

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	18.25	feet	Field Measure	HMS	9/7/2012
Depth to Water	668.45	feet	Field Measure	HMS	9/7/2012
pH	7.34	SU	SM 4500-H+ B	HMS	9/7/2012
Temperature	15.9	deg C	SM 2550 B	HMS	9/7/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	9/18/2012
Alkalinity as CaCO3	250	mg/L	SM 2320 B	MJL	9/18/2012
Chloride	20	mg/L	SM 4500-CL B	MJL	9/18/2012
Iron, Total	0.28	mg/L	EPA 200.7	MLI	9/21/2012
Iron, Dissolved	0.12	mg/L	EPA 200.7	MLI	9/21/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	9/18/2012
Hardness	200	mg/L as CaCO3	SM 2340 C	MLI	9/21/2012
Manganese, Total	<0.01	mg/L	EPA 200.7	MLI	9/21/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MLI	9/21/2012
Sulfate	36	mg/L	D51690,02	CCV	9/17/2012
Solids, Total Dissolved	350	mg/L	SM 2540 C	CCV	9/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Aluminum, Total	<0.05	mg/L	EPA 200.7	MLI	9/21/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-2053-05

Sample Identification

Bulldog Mine
MW-5

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Boron, Total	0.25	mg/L	EPA 200.7	MLI	9/21/2012
Barium, Total	0.041	mg/L	EPA 200.7	MLI	9/21/2012
Beryllium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Cadmium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Cyanide, Total	<0.010	mg/L	SM 4500 CN E	MLI	9/14/2012
Cobalt, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Chromium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Copper, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Mercury, Total	<0.0002	mg/L	EPA 245.1	MLI	9/24/2012
Molybdenum, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Nickel, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Lead, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Phenolics, Tot. Recoverable	0.077	mg/L	EPA 420.4	MLI	9/19/2012
Antimony, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Selenium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Thallium, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012
Vanadium, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Zinc, Total	<0.005	mg/L	EPA 200.7	MLI	9/21/2012

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Terre Haute, IN 47802

Lab Number: 2012-2053-06
Date Received: 9/10/2012
Date Reported: 10/18/2012

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result		Method	Analyst	Analysis Date
Depth	10.51	feet	Field Measure	HMS	9/7/2012
Depth to Water	671.89	feet	Field Measure	HMS	9/7/2012
pH	7.39	SU	SM 4500-H+ B	HMS	9/7/2012
Temperature	18.8	deg C	SM 2550 B	HMS	9/7/2012
Acidity as CaCO3	<10	mg/L	SM 2310 B	MJL	9/18/2012
Alkalinity as CaCO3	230	mg/L	SM 2320 B	MJL	9/18/2012
Chloride	8	mg/L	SM 45[illegible]0-CL B	MJL	9/18/2012
Iron, Total	<0.1	mg/L	EPA 200.7	MLI	9/21/2012
Iron, Dissolved	<0.1	mg/L	EPA 200.7	MLI	9/21/2012
Fluoride	<0.1	mg/L	SM 4500-F D	MJL	9/18/2012
Hardness	140	mg/L as CaCO3	SM 2340 C	MLI	9/21/2012
Manganese, Total	0.012	mg/L	EPA 200.7	MLI	9/21/2012
Manganese, Dissolved	<0.01	mg/L	EPA 200.7	MLI	9/21/2012
Sulfate	30	mg/L	D51690,02	CCV	9/17/2012
Solids, Total Dissolved	420	mg/L	SM 2540 C	CCV	9/13/2012
Silver, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012
Aluminum, Total	0.052	mg/L	EPA 200.7	MLI	9/21/2012
Arsenic, Total	<0.002	mg/L	EPA 200.7	MLI	9/21/2012

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RoseDale Services, Inc.

1125 E. Walnut Street
Boonville, IN 47601

Lab Number: 2012-2053-06

Sample Identification

Bulldog Mine
MW-6

Date Sampled: 9/7/2012
Sampled by: HMS

Sample Analysis

Parameter	Result	Method	Analyst	Analysis Date
Boron, Total	0.28 mg/L	EPA 200.7	MLI	9/21/2012
Barium, Total	0.045 mg/L	EPA 200.7	MLI	9/21/2012
Beryllium, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Cadmium, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Cyanide, Total	<0.010 mg/L	SM 4500 CN E	MLI	9/14/2012
Cobalt, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Chromium, Total	<0.002 mg/L	EPA 200.7	MLI	9/21/2012
Copper, Total	<0.002 mg/L	EPA 200.7	MLI	9/21/2012
Mercury, Total	<0.0002 mg/L	EPA 245.1	MLI	9/24/2012
Molybdenum, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Nickel, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Lead, Total	<0.002 mg/L	EPA 200.7	MLI	9/21/2012
Phenolics, Tot. Recoverable	0.099 mg/L	EPA 420.4	MLI	9/19/2012
Antimony, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Selenium, Total	<0.002 mg/L	EPA 200.7	MLI	9/21/2012
Thallium, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012
Vanadium, Total	<0.002 mg/L	EPA 200.7	MLI	9/21/2012
Zinc, Total	<0.005 mg/L	EPA 200.7	MLI	9/21/2012

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Lab Number: 2012-2053-06

Reviewed by Rodger Wilson

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ENGINEERING CERTIFICATION

I hereby certify the engineering design used in preparation of this application, attachments, and supplements were done by me or under my direct supervision.

I further certify to the best of my knowledge all such design is in accordance with all applicable local, state and federal laws, rules and regulations. I have placed an "X" in the box below if that item is relevant.

[ ] Whereas the Reclamation Plan calls for an alternative land use, I also certify the plans to conform to applicable accepted standards for adequate land stability, drainage, vegetative cover, and aesthetic design appropriate for the post-mining use of the site.

[X] Whereas the operation proposes disposal of spoil or waste materials in areas other than mining workings or excavations, I also certify such fills are designed in accordance with recognized professional standards and all applicable laws. (Note: Schnabel certification below applies only to the design information prepared by Schnabel).

[ ] Certification of the Illinois Environmental Protection Agency-35 Ill. Adm. Code 405-104(a) Permit. In my professional judgment, the plans and specifications submitted as part of this application describe an operation which will meet all applicable effluent and water quality standards. I certify that I am familiar with all of the plans, specifications, reports, and maps submitted as part of this application and that said plans, etc. are accurate insofar as they represent existing conditions.

INDIVIDUAL P.E. CERTIFICATION

Mitchell S. Halsey Name	**062.068185** Illinois Registration Number (Seal)
Schnabel Engineering, LLC Firm	**(865) 584-0344** Telephone Number
3502 Overlook Circle Address	**Knoxville TN 37909**
MSH Signature	9-29-17 Date

LICENSED PROFESSIONAL ENGINEER
MITCHELL SCOTT HALSEY
062-068185
9-29-17
STATE OF ILLINOIS

PROFESSIONAL DESIGN FIRM CERTIFICATION

Complete if applicable. If not, respond NA.

X As an employee of a "professional design firm" as defined by the Illinois Department of Financial and Professional Regulation, I certify that the professional design firm is registered and in good standing with the Illinois Department of Financial and Professional Regulation.

Schnabel Engineering, LLC Professional Design Firm Name	**05392063** Professional Design Firm Number

Sunrise Coal LLC
Bulldog Mine
Permit 429

PART V

RECLAMATION PLAN

1) Provide a reclamation plan outlining proposed reclamation of the lands within the proposed permit area. The reclamation plan shall include the following:

1) A) Provide for each major step in the proposed reclamation plan a detailed timetable for completion.

When mining is completed, final reclamation of the mine site will begin. The area will be reclaimed in accordance with the timeframes and limits established in the permanent program rules and regulations that exist at that time. If variances or grading time extensions become necessary, the permittee will submit timely grading time requests to the Department for their approval.

Following recovery of the useable underground mining equipment, the mine entry slope and shafts will be backfilled and sealed in accordance with all applicable rules and regulations. Surface facilities and structures not required to support the approved post-mining land use will be removed. Salvageable structures and materials will be sold if economically possible. Obsolete structures and materials will be removed from the mine site and deposited in an approved landfill. Affected areas will be graded to conform to the approved reclamation plan.

Soil replacement and establishing vegetation are dependent on seasonal weather conditions. To obtain optimum efficiency and avoid undesirable compaction, soil replacement will be accomplished during the dryer summer. Soil materials required for final reclamation will be obtained from stockpiled soil that was removed from the site prior to disturbing the area by mining activity. Sufficient soil material will be stockpiled on site so that additional borrow areas will not be necessary to complete final reclamation. Reclaimed areas will be seeded during the first normal planting period following soil replacement. Soil will be replaced, and vegetation established in accordance with the approved post-mining land uses.

The following table provides a timetable for completion of each step of the reclamation:

Reclamation Activity	**Approximate Start**	**Completion**
Mine Slope and Shaft backfill	Within 12 months after active use	6 months
Road and Railroad removal	Within 12 months after active use	2 months
Dewater and backfill Treatment Ponds	Within 12 months after active use as ground conditions allow	4 months
Grading and covering of Refuse Pile/Slurry Impoundment	Within 12 months after active use	12 months
Structure removal (Buildings, Concrete)	Within 12 months after active use	6 months
Reclamation of Parking Areas/Supply Yard	Within 12 months after active use	2 months
Grading and shaping of Disturbed Areas	Within 12 months after active use	10 months

Soil replacement and establishment of temporary ground cover	Within 12 months after active use	12 months
Seeding of herbaceous wildlife and the planting of trees.	In the spring after soil replacement	1 month
Dewater and backfill Sediment Pond, Treatment Pond, and Holding Pond	Upon determination by IDNR that the sediment ponds are no longer required	1 month

Surface water and groundwater monitoring will continue at the site as required until approval is obtained from the proper regulatory agencies to discontinue monitoring.

1) B) Provide a detailed estimate of the cost of reclamation for the proposed surface mining operation required to be covered by a performance bond. Provide calculations and/or drawings, cross sections, maps, etc. to support the reclamation cost estimate.

See *Attachment V-1B* for a detailed reclamation cost estimate.

Provide extra calculations for multiple portals or refuse areas.

The estimate of the cost of reclamation should be based on the following:

1) B) 1) REFUSE

1) B) 1) a) Gob Pile(s)	**1**
Pile ID	**Refuse Impoundment**
Initial Height	**30'**
Final Height	**50'**
Average Bottom Diameter	**1300' X 1880'**
Lime Application (Tons/Ac)	**Lime quantities will be determined by toxicity testing that will be performed after the Refuse Impoundment is constructed.**
Cover Thickness	**5'**
Method of Replacement	**Tractors w/wheeled pans**
Average Haul Distance	**1,500'**

1) B) 1) b) Gob and Slurry Disposal	
*Below grade or in levees	**N/A**
Disposal Area ID	
Cover Thickness	
Method of Replacement	
Average Haul Distance	
Lime Application (Tons/Ac)	

1) B) 2) SUPPORT AREAS (Use separate sheets for each portals) Support Structure Dimensions

The response to questions 1)B)2)a) through c) is indicated in the following table. The table lists all the proposed building structures proposed to be constructed on-site. The building/structure locations are illustrated on the *Surface Drainage Map, Map D.*

Structure	Construction Material	Structure Dimensions (W' x L' x H')	Concrete Floor Dimensions (W x L x T)
Washplant	Pre-Eng. Metal	60' X 80'X 90'	60' X 80 'X 12"
Office/Showerhouse	Pre-Eng. Metal	80' X 180' X 30'	60 'X 130 'X 4"
Shop	Pre-Eng. Metal	60' X 130' X 30	60' X 180' X 8"
Warehouse	Pre-Eng. Metal	60' X 130' X 30	60' X 180' X 8"
VFD Building	Pre-Eng. Metal	20' X 30' X 12'	20' X 30' X 4"
Transfer Building	Pre-Eng. Metal	20' X 20' X 12'	20' X 20' X 4"
North Stacker	Metal Truss	180' Radius X 80' H	
South Stacker	Metal Truss	180' Radius X 80' H	
Thickner	Concrete	10'H X 90'Dia X 12"Wall	
Truck Scale	Concrete	(2) 12' X 20' X 1.5'	

In addition to the buildings and structures listed in the previous table, the following structures and boreholes will be constructed on site:

Air Shafts: Intake – 16' Diameter X 365' Deep
Return – 16' Diameter X 365' Deep

Man & Material Slopes: 2380'L X 15'W X 10.5'H

Boreholes:
Monitoring Well 1 – 2" Dia. X 29' Deep
Monitoring Well 2 – 2' Dia. X 32' Deep
Monitoring Well 3 – 2" Dia. X 38' Deep
Monitoring Well 4 – 2" Dia. X 35' Deep
Monitoring Well 5 – 2" Dia. X 45' Deep
Monitoring Well 6 – 2" Dia. X 54' Deep

1) B) 2) a) Structure — Structure ID — Height Ft. — Width Ft. — Length Ft.

See table above

1) B) 2) b) Concrete Structures — Structure ID — Height Ft. — Width Ft. — Length Ft.

See table above

1) B) 2) c) Silos — Structure ID — Height Ft. — Width Ft. — Length Ft.

N/A

1) B) 2) e) Conveyors — Length

Conveyors (Total) **3000'**

1) B) 3) Railroads to be Removed — Length

Potential Future Rail	**6,407'**	

1) B) 4) Haulroads to be Removed	Width	Length
Haul Road #1	**20'**	**3,104'**
Haul Road #2	**20'**	**5,443'**
Haul Road #3	**20'**	**4,779'**
Haul Road #4	**20'**	**1,930'**

1) B) 5) Support Area Liming (Acres) — Non-Refuse (for areas required to have more than topsoil replaced)

	Non-Refuse
Lime Appl. (Tons/Ac)	______
Subsoil Cover Thickness	______
Method of Replacement	______
Average Haul Distance	______

It is not anticipated that lime application will be necessary to achieve post-mining vegetation/productivity.

1) B) 6) Indicate location and size of buried volatile material storage facilities.

This permit does not propose any buried volatile material storage sites.

1) C) Backfilling and Grading

Provide a plan for backfilling, soil stabilization, compacting and grading, with contour map or cross-sections showing the anticipated final surface configuration of the proposed permit area (in accordance with 62 Ill. Adm. Code 1817.102 through 1817.107). The plan shall include the following:

1) C) 1) Describe how approximate original contour will be achieved. Discuss method(s) to be employed for overburden removal, spoil placement, and grading, including the removal and redistribution of soil. Mention type of equipment to be used for each phase of work.

Backfilling, grading and soil replacement will be accomplished with dump trucks, dozers, tractors with wheeled pans and road graders. Disturbed areas, except for the Refuse Impoundment, will be restored to approximate original contour. This will be accomplished by blending the disturbed areas with the natural ground surface of the undisturbed areas during the grading process then replacing topsoil on the disturbed areas.

The out slopes of the Refuse Impoundment will not exceed 5H:1V. After all coarse refuse waste material generated by coal processing has been disposed of, toxicity testing will be performed to determine the net neutralization potential of the waste material. Lime, if determined to be necessary, will be incorporated into the surface of the refuse before covering it with 5 feet of non-toxic, non-combustible soil materials. The post-

mining final reclamation soil cover will consist of 48" of sub-soil, and 12" of topsoil. Before the 12" of topsoil is placed, a relatively impermeable 48" sub-soil cap will be constructed using the clayey soils encountered on site. The bottom 36" of the cap will be constructed in accordance with the Quality Assurance/Quality Control Plan for Clay Liner Installation included in Attachment IV-6D of this permit application. The soils will be placed in 6-8 inch loose lifts and compacted until three (3) feet of clayey fill has been placed and compacted. The three (3) feet of clay fill should provide a liner with a permeability of approximately 1 x 10^{-7} cm/sec. If the in situ soils do not produce a liner having a permeability of 1 x 10^{-7} cm/sec. or less, bentonite will be added to the soil to achieve the required permeability. The embankment will be constructed, and reclamation will be completed in a manner that will promote unimpeded surface water runoff.

1) C) 2) Provide sufficient contour maps and cross-sections to show the anticipated final surface configuration of the proposed permit area when reclamation work is completed.

Except for the reclaimed Refuse Impoundment, the post-mining topography will closely resemble the pre-mining topography of the area as indicated on available USGS topographic mapping.

The Refuse Impoundment will be approximately 50 feet high with 5H:1V out slopes.

1) C) 3) The areas other than those reclaimed to the standards of high capability lands and prime farmlands, describe all water and erosion control structures to be constructed such as terraces, diversions, etc.

Refer to the report prepared by Schnabel Engineering titled, Reponses to MSHA Comments dated October 8, 2015; Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundment No. 1; Allerton-Homer, Illinois dated September 12, 2016. The report is included under separate cover and also has drawings, cross-sections and design details regarding the refuse impoundment design.

1) C) 4) Describe the timing in which all grading and the construction and removal or renovation of water and erosion control structures will be complete and the sequence for accomplishing the work in relation to seasonal weather conditions.

Removal of water and erosion control structures will be done under favorable weather conditions and in accordance with Section 1817.41 of the regulations.

1) C) 5) Are any roads constructed to facilitate surface coal mining operations proposed to be permanent?
Yes ______ No __X__

If yes, locate on the reclamation map. Provide the information required for Part IV 5)C)2) to describe each post-mining road if it is to be modified. Include appropriate discussion how modifications will be accomplished including the removal and disposition of any excess road material.

1) D) Provide a plan for revegetation of the proposed permit area including but not limited to the following:

1) D) 1) Provide a schedule of revegetation for each reclamation area or sub area within the permit area.

See the responses to 1)D)2)b) and 1)D)3) below for a schedule of revegetation activities.

1) D) 2) a) For areas other than forest and/or wildlife habitat planting, list the species and seeding rates on a per acre basis for each species proposed to be utilized.

There are no post-post mining land uses proposed other than herbaceous wildlife, woody wildlife and wildlife water. There are 2.6 acres of cropland proposed that will not be affected due to being within the 300 foot radius buffer zone of an occupied dwelling. Since these acres will not and cannot be affected no discussion is provided for species and seeding rates.

1) D) 2) b) For forestry and/or wildlife habitat areas, list the planned species and density on a per acre basis of trees, shrubs and herbaceous cover to be seeded and planted.

Please refer to the following Standard Tree Mix Table.

STANDARD TREE MIX

Wildlife Woody

Hickory	**10.0%**
Red/Silver/Sugar Maple	**10.0%**
Sweet/Red Gum	**10.0%**
Sycamore	**10.0%**
Oaks	**50.0%**

Bur oak, chestnut oak, chinkapin oak, overcup oak, post oak, swamp chestnut oak, swamp white oak, white oak, black oak, blackjack oak, cherrybark oak, northern pin oak, northern red oak, nuttall oak, pin oak, scarlet oak, shingle oak, shumard oak, southern red oak, and willow oak)

Other*	**10.0%**

Other*

Button Bush	**Hackberry**	**Cypress**
Black Walnut	**Red Bud**	**Red Mulberry**
Flowering Dogwood	**Sumac**	**Chestnut**
Crabapple	**Red Cedar**	**Pecan**
Hawthorn	**Persimmon**	**American Elm**
River Birch	**Bitternut Hickory**	**Pignut Hickory**
Shellbark Hickory	**Shagbark Hickory**	**Mockernut Hickory**
Sourwood	**Shortleaf Pine**	**Slippery Elm**

Density per acre: Wildlife trees will be planted on an 9' X 9' spacing grid for a planting rate of 500 trees per acre.

Note:
This species list is variable and dependent upon nursery availability and site conditions.

Acceptable and countable volunteer species will include, but will not be limited to the following:

Sassafras	**Wild Grape**	**Wild Blackberry**
Cottonwood	**Black Locust**	**Willow**
Poison Ivy		

The operator does not intend to plant black locust, *Robinia pseudoacacia*. However, it is included as an acceptable species for the Indiana bat in the Revised February 2013 "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines" prepared jointly by the Office of Surface Mining, the U.S. Fish and Wildlife Service, and a representative group of regulatory authorities on behalf of the Interstate Mining Compact Commission. Therefore, black locust will be considered an acceptable and countable volunteer species. In accordance with guidance provided by the Department in Operator Memorandum 2017-02, black locust will not be used in any supplemental planting efforts that take place within the first two years of applicable responsibility. A sampling plot being a 1/60th acre plot used for measuring tree and/or shrub populations as prescribed at 62 Ill. Adm. Code 1816/1817.117(c)(2).

The following is the species list and density and of ground cover seed mix for woody wildlife plantings.

Woody Wildlife Ground Cover	**Lb./Ac.**
Side oats grama	**5**
Schizachyrium scoparium	**5**
Cover Crop (Temporary)	*****

*** 3 Bu./Ac. Wheat (fall)**
3 Bu./Ac. Spring Oats (spring)
30 lbs./Ac. Sudex/Sudangrass or equivalent summer annual

These species were selected based on their low growing and bunching habit that will be less competitive with the planted trees then other tall growing or sod forming species. Both species are warm-season grasses native to Illinois.

All areas will be seeded during the first favorable planting season following final grading except where it is determined appropriate to use a dormant seeding. If it is later determined that the dormant seeding was not successful, the area will be reseeded during the following established optimum planting period.

Wheat, Spring Oats, German Millet and Japanese Millet are all highly desirable cover crops used extensively to benefit agriculture and wildlife in Illinois. They help to reduce wind and water erosion, conserve soil moisture, and increase organic matter, all of which result in better soil structure. These cover crops also provide abundant shelter and nutrients to foraging wildlife, including deer, rabbit, pheasant, insects and birds.

All of the listed species also provide excellent ground cover necessary to control erosion.

The following is the species list and density of the herbaceous wildlife plantings:

Wildlife Herbaceous	**Lb./Ac.**
Illinois Bundleflower	2
Black-eyed Susan	2
Purple Coneflower	2
Partridge Pea	2
Two (2) or more of the following:	
Big Blue Stem	4
Indian Grass	4
Side Oats Gramma	4
Little Blue Stem	4
Switch Grass	2
Cover Crop(Temporary)	*

*** 3 Bu./Ac. Wheat (fall)**
3 Bu./Ac. Spring Oats (spring)
30 lbs./Ac. Sudex/Sudangrass or equivalent summer annual

Surface drainage control structure and surface disturbed areas not actively used for the mine's operation including soil stockpiles will be vegetated after construction using the following seed mixture:

Smooth Brome Grass	15 lbs./ac.
Timothy	5 lbs./ac.
Red Top	5 lbs./ac.
Cover(Temporary)	*

*** 3 Bu./Ac. Wheat (fall)**
3 Bu./Ac. Spring Oats (spring)
30 lbs./Ac. Sudex/Sudangrass or equivalent summer annual

The herbaceous wildlife species were chosen based on their suitability for successful reclamation of tall grass prairie habitat and to provide high quality habitat for wildlife species. All of the species included in the herbaceous wildlife plant mix are native to Illinois and are commonly found in remnant tall grass prairies in Illinois. These species are known for robust growth, ground cover, and high quality wildlife habitat. Historically, prior to farming the permit area would have been dominated by tall grass prairie. Following reclamation, the permit area will provide much needed grassland prairie habitat for grassland birds and mammals in Vermilion County, IL.

The cover crop (temporary) seed mix was chosen to provide the best rapid growing commonly used species in the geographic area based on season to provide ground cover until a more permanent ground cover can be established.

The seed mix for surface drainage control structure, and surface disturbed areas including soil stockpiles was chosen based on NRCS recommendations for erosion control and waterway vegetation.

1) D) 3) Describe the methods to be used in planting and seeding. Include the type of equipment to be used for seeding and seedbed preparation.

After final grading of the affected areas, the herbaceous wildlife areas will be seeded using the following methods:

Weed Control: A combination herbicide treatment will be applied 7 to 10 days prior to seeding to suppress the germination of competitor plants and to kill any cool season grasses that may have emerged or where planted as temporary ground cover during mine operations.

Seeding: The warm season grasses/legumes will be seeded using a warm season grass no-till drill (upon availability) or a conventional drill. Seed will be planted to a depth of no greater than 1/4 inch.

Seeding Dates: Seeding will occur in the spring between early May and mid-June after final soil replacement.

Maintenance: Mowing and/or burning will be used to control competition in the herbaceous wildlife areas.

Mowing would be conducted in the spring or early summer at a height above emerging warm season grasses and legumes.

Prescribed burns would be conducted in March or April after consultation with the NRCS and/or the Illinois Department of Natural Resources.

Woody wildlife areas will receive the same weed control treatment as herbaceous wildlife areas. Herbaceous ground cover of the short warm season grass will also be established using the same method as the herbaceous wildlife areas. Prior to tree planting, herbicide will be applied in 4' strips on centers to eliminate competition for moisture from ground cover. Soon after the herbicide application trees will be planted with a mechanical tree planter, or other type of equipment suitably designed for tree planting, and/or will be hand planted using a dibble bar. Trees will be planted with a spacing of 9'x 9' for a total planting of 500 trees per acre. Trees planted will include species approved by IDNR. Herbicide will be applied to control competing vegetation.

1) D) 4) Is irrigation proposed? If so discuss. Are pest and disease control measures proposed? If so discuss.

Irrigation is not proposed. No pest and disease control is proposed. If pest and disease control measures become necessary, appropriate technical assistance will be obtained.

1) D) 5) Are areas to be temporarily seeded and/or mulched to control erosion?
Yes __X__ No ______

Temporary seed mix and mulching on surface drainage control structure, and surface disturbed areas including soil stockpiles will consist of the following. Spring – 3 bu./Ac. Oats, Summer – 30 lbs./Ac. Sudex/Sudangrass or equivalent summer annual, Fall – 3 bu./Ac. Wheat. Straw mulch or straw bales and/or a combination of both will be used

for small critical areas and erosion control structure repairs.

See the response at Part IV (2)(B)(2) for a discussion regarding soil stockpile erosion control.
See the Cover Crop (Temporary) seed mixture provided at Part V (1)(D)(2)(b).
See the response to Part V (1)(D)(3) for the plan to transition from a temporary seed mix to the permanent seed mix.

If no, explain. If yes discuss in detail, including species, seeding rate by species per acre, mulching methods, mulching rates and type of mulch.

1) D) 6) Provide Measures proposed to be used to determine success of revegetation required under 62 Ill. Adm. Code 1817.117.

Measures to be used to determine success of re-vegetation on the reclaimed areas will be 70% ground cover composed of approved permanent native species as required by the Illinois Department of Natural Resources, Office of Mines and Minerals, Permanent Program Rules and Regulations.

For woody wildlife reclamation, the standard for success will be 250 trees or shrubs per acre of approved native tree species within the tree planting area. To determine the success of the tree planting, the procedures identified in Section 1817.117(C) will be used including surveys to estimate the number of trees per acre.

1) D) 7) If any of the post-mining land uses are to include industrial or residential uses, describe revegetation measures to control erosion.

N/A

1) D) 8) Are there any plans to use nurse crops or crop rotations to improve future rowcrop productivity?
Yes ______ No __**X**__

If yes describe type, duration and management of these areas.

1) D) 9) Describe soil testing plan for evaluation of soil nutrients and amendments necessary for revegetation.

An agronomist or soil scientist will be consulted concerning soil nutrients and amendments necessary for achieving the re-vegetation and productivity requirements for final bond release.

1) E) Describe measures to be employed to maximize the use and conservation of the coal resources per regulation Section 1817.59.

The operator intends to recover all coal reserves that are economically feasible to mine at this time by room and pillar mining methods. After mining by this operation, there should be no significant amount of reserves left in the mining area that would warrant interests in future mining by today's standards.

1) F) Describe measures to be employed to ensure that all debris, acid-forming and toxic-forming materials, and materials constituting a fire hazard are disposed of in accordance with Section

1817.89 and 1817.102(f). Provide a description of contingency plans which have been developed to preclude sustained combustion of such materials.

Non-coal waste material will be stored and disposed in accordance with the provisions set forth in Section 1817.89. Grease, lubricants, paints and flammable liquids will be removed from the site by a licensed waste hauler.

Openings to the underground mine workings will be sealed as discussed in the response to the following question.

1) G) Describe the measures including cross-sections and maps to be used to seal or manage mine openings, and to plug, case, or manage exploration holes, other bore holes, wells and other openings within the proposed permit area.

The permittee will comply with 30 CFR 75.1711 of the federal regulations in regard to sealing all openings to the mine. The slope entry and air shafts to the mine will be backfilled and sealed with non-combustible, non-toxic, non-acid forming earthen materials. A poured concrete seal, backed by steel stopping and securely anchored to the roof, floor and walls will be installed approximately 200 feet into the slope entry. The concrete seals will provide an additional barrier to seepage of surface water into the abandoned works. Earthen backfill will be placed behind the seal. The intake and return air shafts will be sealed with a concrete cap in accordance with Sections 1817.13 and consistent with 30 CFR 75.1711.

Any well or drill hole established for any reason on this permit area will be properly cased and protected to prevent contamination of the groundwater. Upon abandonment, any such well or drill hole will be sealed with grout or other acceptable material in accordance with Sections 1817.13 and consistent with 30 CFR 75.1711.

No bore holes are currently proposed for this operation. However, all future bore holes (if any) within the permit area which extend beneath a coal seam and into water- bearing strata shall be permanently plugged unless the bore holes have been approved for use as a groundwater well.

Refer to *Attachment V-1G* for detail drawings showing the reclamation and sealing of the mine openings.

1) H) Provide a description of the steps to be taken to comply with the requirements of the Clean Air Act (42 U.S.C. 7401 et seq.), and other health and safety standards.

All applicable air and water quality laws and regulations will be met by use of one or more of the following:

1) Applying a wearing course of durable non-toxic material to all access roads or other heavily traveled areas.

2) Watering or sealing of all heavily traveled areas during dry or dusty periods.

3) The dust control system at the coal processing facility will include a high pressure water mist spray system. A chemical surfactant system can be added later if necessary. The system includes a surge water tank, high pressure water pumps, chemical injection metering pumps with relief valves and controls, and spray manifolds at each dust

suppression station. Dust suppression will be applied at all conveyor transfer points, the crusher discharge, and the reclaim points in both reclaim tunnels. Additional dust suppression will use "rainbird" type sprinklers mounted on the stacking tubes.

4) **All disturbed areas will have, at all times, drainage control structures that are in proper working order, that provides adequate treatment to comply with the applicable water quality standards.**

5) **Immediately after final re-grading, preparations for the seed bed will begin and re-vegetation will be accomplished.**

2) Post Mining Land Use

2) A) Provide a detailed description of proposed post-mining land uses employing the land use categories listed below. Provide acreage figures for each post-mining land use proposed and designate the post-mining land uses on the Post Mining Land Use Map.

Bulldog Mine
Post-Mining Land Use/Capability
Acreage Table

Permit Area				
Land Use	**Capability**	**Pre-Mining**	**Post-Mining**	**Change**
Cropland	Prime Farmland	389.0	2.6*	-386.4
Industrial/Commercial	Prime Farmland	1.3		-1.3
Herbaceous Wildlife	High Capability	0.0	302.4	+302.4
Herbaceous Wildlife	Limited Capability	0.0	61.8	+61.8
Woody Wildlife	High Capability	0.0	0.9	+ 0.9
Wildlife - Water	Limited Capability	0.0	22.6	+22.6
Support Area Total		390.3	390.3	

***This acreage will not be affected since they are located within the 300 foot buffer radius from an occupied dwelling.**

2) B) 1) Provide a description of how the proposed post-mining land uses are to be achieved, and describe any necessary support activities which will be needed to achieve the proposed land uses.

Wildlife habitat will be re-established through approved herbaceous species plantings and native woody wildlife tree planting. Seedbed preparation and fertilization will be employed as necessary to insure adequate stand establishment.

2) B) 2) Discuss the utility and capacity of the reclaimed lands to support a variety of alternative uses and the relationship of the proposed uses to existing land use policies and plans.

The reclaimed land will have the potential to support a variety of future uses, which could include cropland, pasture and/or forestry, but will generally be reclaimed to support their intended uses. Reclaimed herbaceous wildlife habitat and woody wildlife habitat will be well suited to support wildlife, recreational and sporting activities, and wildlife water acres.

2) B) 3) Where grazing is the proposed post-mining land use, explain the detailed management plans to be implemented, if any.

Grazing or pasture areas are not proposed.

2) B) 4) Where a post-mining land use different from a pre-mining land use is proposed alternate post-mining land uses may be approved by the Department after considering the relationship of the intended uses to the existing land use policies and plans and the comments of any owner of the surface, and land use agency having jurisdiction over the land.

Provide a discussion explaining the consideration which has been given to making all of the proposed surface mining activities consistent with surface owner plans and applicable State and local land use plans and programs.

The Post-Mining Land Use/Capability Acreage Table above shows the planned changes from pre-mining to post-mining land uses and capabilities.

The proposed reclamation plan results in a loss of 386.4 acres of prime farmland. In accordance with 62 Ill. Adm. Code 1823.11(a) and (b) this loss is justifiable because, a) 305.9 acres are located within areas occupied by the coal preparation plant and associated coal stockpiles, support facilities, and mine roads that will be actively used over an extended period of more than twenty (20) years based on current coal reserves and estimated annual production. Areas with no current designation of a land disturbance will be utilized for future expansion such as parking area, storage yards, rail, equipment staging, soil stockpiles, and coal waste disposal. These areas will also be actively used over an extended period of more than twenty (20) years based on the coal reserves and estimated annual production. These uses affect a minimal amount of land when compared to the total area that will be affected by the underground mining operations. Such uses meet the requirements of 62 Ill. Adm. Code 1817 for underground mining activities, and b) the remaining 61.8 acres of the 386.4 acre loss are located within areas occupied by disposal sites containing coal mine waste resulting from underground mining.

Coal mine waste storage is not economically feasible in the underground mine works or on areas within the local vicinity that is non-prime farmland.

According to the National Research Council, Coal Waste Impoundments; Risks, Responses, and Alternatives; Chapter 7 - Alternatives to Future Coal Waste Disposal, states that although there are alternatives to disposing of coal waste impoundments, no specific alternative can be recommended in all cases. *"Acceptable alternatives are highly dependent upon regional and site-specific conditions...One of the factors limiting implementation to this point has been the cost associated with the various alternatives."* In other words, some technologies exist to dispose of wastes other than in impoundments, but a major factor is that they are not economically feasible. Other limiting factors are also outlined in this publication.

The primary concern is for the underground workers and their safety. For that reason the introduction of coal mine waste is not feasible in active workings in active mines. Ventilation, roof control and ground control issues ensue due to filling voids with material that must be transported underground. Placement of coarse refuse underground creates

safety issues in terms of inadequate ventilation and the potential for spontaneous combustion. Currently, there is no economic design to transport coarse refuse underground via conveyor belt or other mechanical means. The Mine Safety and Health Administration (MSHA) and state mining regulators would have to approve this procedure and historically have not approved the disposal of fine refuse slurry or coarse mine waste that has the potential to endanger underground workers. Also, MSHA typically requires the timely closure and sealing of old workings in order to reduce the potential for the production of methane and the consumption air quantities needed for proper ventilation of old workings. The introduction of coarse refuse into worked out areas would prolong the time frame to seal old workings.

Coal mine waste disposal underground has only been approved in abandoned workings after extensive design, permitting and regulatory approval by state agencies, MSHA and the Environmental Protection Agency. Before any disposal can take place, it would take years of operation to create the abandoned or old workings that would be necessary for consideration of void space. Therefore, above ground storage is necessary before any consideration could be given to underground storage. This defeats the purpose of this evaluation in this context, to save farm ground, because refuse disposal is necessary for a considerable number of years.

The introduction of coarse refuse underground is not practical from a material handling standpoint. Sunrise Coal is not aware of any operator that is allowed by MSHA to take coarse refuse underground for disposal. The refuse would have to be disposed of in non-active workings away from the active workings. Plus, it is not a flow-able material which means it would require additional material handling. Therefore, it would require transportation on the surface to dump points that would have limited dispersion. Access on land would have to be extensive and impractical due to the large number of drill holes into the mine for dump points and access roads. Large plots of land to create dump points and roadways would consume acreage. Also, it is not safe or feasible to dump coarse refuse in old mine workings where methane gas is most likely present and put personnel at risk on the surface. Surface dump points could create airways into the mine that would allow air into or air to escape which would present issues for the underground ventilation system. It would require regulatory approval that would not be permitted for safety concerns.

In order for slurry disposal to be undertaken many factors are to be considered, some of which create barriers. As mentioned above, it must first be permitted and approved by regulatory agencies. One of their concerns is the potential for groundwater contamination at the injection borehole site as slurry is injected underground and possible slurry leaks due to pipelines to and from boreholes that could affect surface water. This does not take into account the potential influence on active underground workings or additional operational issues imposed on the mine personnel which adds to the cost of operation. Such factors include but are not limited to; bulkheads have to be constructed and monitored to insure no leaks of gas or liquid enter the active part of the mine, additional monitoring/repair of slurry pipelines outside of the mine property, monitoring injection points for proper operation, monitoring return water wells for proper operation, etc.

A number of other factors are taken in to consideration as part of the approval process or to design the system. An adequate supply of water, beyond what is necessary for coal processing, is necessary to pump the slurry via pipelines and generate water to be returned from the workings back to the mine operation on the surface. Surface ownership

and acquisition is necessary in order to access injection points above mine workings and provide for multiple pipeline corridors or right-of-ways. Injection locations and access roads would consume land and create obstacles to farming. Surface layout, surface drainage, terrain and other factors must be part of the design, including injection and return wells to be scattered for slurry injection and water retrieval. Also, leap frogging between sites when one injection site is filled with fines and can no longer "push" slurry due to underground voids being filled. Wells then have to be abandoned at some point and additional wells installed.

Underground bulkheads must be designed and installed which may be problematic due to the coal seam elevations, slope and other factors. MSHA approval is not guaranteed due to the proximity of injection sites and abandoned workings to active workings and underground workers. The storage of water and slurry behind bulkhead seals must be "downstream" or at an elevation below active workings. The coal seam is relatively flat and would create uncertainty in how practical the design would be. MSHA typically does not allow for water to accumulate behind seals or bulkheads that creates pressure that could compromise the structure.

For effective injection, underground water must be retrieved and circulated back to the preparation plant which creates water treatment and storage issues. The water returned from the underground workings will contain sediment and other potential contaminants. A water storage pond large enough to contain the water to allow for sediments to settle out and create a decant water supply is necessary before utilizing the water in the plant. Plus, the water may require some treatment prior to utilization. This would consume land for water storage and treatment beyond the proposed sediment ponds, similar to the slurry impoundment already proposed. Therefore, there is no gain or trade off in terms of water created from the plant processing operation that can be eliminated.

Introduction of slurry and water into dry workings would possibly create potential subsidence issues. The coal seam has an underlying member that is a soft underclay referred to as "fireclay". When this material becomes saturated, it becomes weak. It is not uncommon for the remaining coal pillars to "punch" into the clay layer causing it to extrude into the voids. As a result, potential ground control becomes an issue. This also could compromise the seals and allow leaking gas into active workings.

The refuse area acreage will be reclaimed to limited capability herbaceous wildlife habitat. Acid or toxic producing material in the refuse pile will be treated with lime and covered with 48" of sub-soil and 12" of topsoil. The other non-toxic/non-acid producing areas affected by the surface facilities will be covered with an average of 12" of topsoil.

Areas proposed to be reclaimed to high capability standards may have a clay or synthetic liner installed during operations. Prior to replacing the soil material during reclamation, clay liners will be ripped using a dozer or grader to alleviate the compaction and to provide for cohesion in the soils. If a synthetic liner is present, the liner will be removed and disposed of as non-coal waste prior to soil replacement.

The current owner of the property, Sunrise Coal, LLC, has been consulted regarding the proposed post-mining land uses. The current owner of the property approves of the post-mining reclamation plan. State and local agencies will have the opportunity to comment on the plan during the permit review process.

The proposed land use/capability changes do not present any actual or probable hazard to the public health and safety, nor do they pose any threat to water diminution or pollution. The changes will allow maximum recovery of the coal resources, and will facilitate both practical and reasonable future land management.

2) C) Provide a copy of the comments concerning the proposed land use by the owner of the surface of the proposed permit area and by the State or local government agencies which would have to initiate, implement, approve or authorize the proposed uses of the land following reclamation.

The current owner of the property, Sunrise Coal, LLC, has been consulted regarding the proposed post-mining land uses. The current owner of the property approves of the post-mining reclamation plan.

State and local agencies will have the opportunity to comment on the plan during the permit review stage.

3) A) Provide a fish and wildlife protection and enhancement plan meeting the requirements of 62 Ill. Adm. Code 1817.97 and which shall include the following:

Several documents are included herein regarding fish and wildlife, streams, and wetlands site specific resource information within the permit area. These documents were prepared by a qualified Wildlife Biologist on staff with Midwest Reclamation Resources, Inc. Shawn Duncan is the staff Wildlife Biologist for Midwest Reclamation Resources, Inc. He received a Bachelor's of Science from Purdue University in Wildlife Science in 2005. Additionally, he received a Master's of Science from Southern Illinois University Carbondale in Zoology in 2011. He has ten years of experience conducting vegetation and animal surveys and is qualified to conduct surveys and make habitat determinations for Endangered and Threatened Species within Illinois. Additionally, he has been trained and certified in conducting wetland delineations and other aspects of the Clean Water Act through the Richard Chinn Environmental Training program. Descriptions of methodologies used to collect and analyze the data are outlined in the various site specific resource information documents included herein.

3) A) 1) A statement of the protective measures that will be used to minimize disturbances and adverse impacts on fish and wildlife and related environmental values during surface coal mining operations.

The mining operation will comply with all applicable rules and regulations. The rules and regulations provide a comprehensive set of environmental protection measures for controlling adverse ecological impacts resulting from coal mining.

The control measures include considerations for air, water, acid/toxic producing materials, soils, vegetation and erosion control, etc., in both special and temporal capacities. In general, the protective measures that will be employed at this mine site are inherent within the permanent program regulations.

Fish and wildlife resources downstream of the permit area will be protected by regulating discharges to approved IEPA NPDES outfalls. All discharges from these outfalls must meet a water quality standard that will not have negative impacts on downstream resources. By

implementing the NPDES program fish and wildlife and related environmental values will be protected during mining operations. A more detailed discussion of the NPDES program and how it will protect downstream water quality can be found in Attachment V-3B1.

This mining facility will limit mining related disturbance to only the acreage that is necessary to perform mining operations compliant with all applicable mining regulations. Surface disturbances not required for mining related activities will be minimal.

Based on the attached resource information documents there are no wildlife habitats or areas of unusually high value for fish and wildlife within or surrounding the permit area. There is no predicted impact to State or Federally Listed endangered or threatened species.

In accordance with 62 Ill. Adm. Code 1817.97(e)(1), electric powerline and other transmission facilities used for, or incidental to, underground mining activities on the permit area will be designed and constructed to minimize electrocution and collision hazards to raptors and other birds. *Attachment V-3A1* provides a protective measures plan that will minimize electrocution and collision hazards to raptors and other birds caused by improperly designed, located, or constructed electric powerlines.

3) A) 2) Discuss the enhancement measures that will be used during the reclamation and post mining phase of the operation to develop aquatic and terrestrial habitat.

Following surface operations, 364.2 acres of the permit area will be reclaimed to herbaceous wildlife. The standard seed mix of native warm-season grasses and forbs will be used to establish a warm-season prairie. The warm-season prairie in the permit area will provide extensive habitat for grassland birds such as Henslow's Sparrow, Grasshopper Sparrow, Field Sparrow, Dickcissel, Bobolink, Eastern Meadowlark, Northern Harrier, Eastern Kingbird, Sedge Wren, Upland Sandpiper, and other open land species. A more detailed description of the measures to be used to establish the prairie habitat can be found in section (1)(D)(2)(b).

There are no pre-mining aquatic resources located within the permit area. However, 22.6 acres of aquatic wildlife habitat will be constructed within the permit area during reclamation. These ponds will provide aquatic habitat for native fish and wildlife and provide foraging and resting areas for birds, such as: Bald Eagle, migratory waterfowl, herons, and other waterbirds.

Following surface operations a minimum of 0.9 acres of woody wildlife will be planted within the permit area to replace the small amount of pre-mining trees within the permit area. A minimum of 450 trees will be planted within the permit area to create potential roosting areas for Northern Long-eared Bats and Indiana Bats. Additionally, these trees will provide roosting and resting area for other wildlife using the grassland habitat established within the permit area.

3) A) 3) If the applicant's fish and wildlife plan finds it impracticable to provide for enhancement of fish and wildlife and related environmental values, the applicant shall provide a statement which establishes why it is not practical to achieve enhancement.

The reclamation of the permit area will include enhancement measures for fish and wildlife as described in sections (3)(A)(2) and (1)(D)(2)(b).

3) B) The applicant shall provide a statement explaining how impact control measures, management techniques, and monitoring methods will be utilized to protect or enhance the following, if they are to be affected by the proposed surface coal mining and reclamation operations:

3) B) 1) Threatened or endangered species of plants or animals listed by the Secretary of the United States Department of the Interior (Secretary) under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) and their critical habitats.

The staff wildlife biologist of Midwest Reclamation Resources, Inc. conducted field work and prepared a site specific resource report to determine the existence of threatened or endangered species of plants or animals within and adjacent to the permit area. The report is included in *Attachment V-3B1*. Based on the findings of the site specific resource reports the only endangered or threatened species that may occur within the permit area is the federally threatened Northern Long-eared Bat. Further discussion of this species may be found in section (3)(B)(4) and in *Attachment V-3B4. There* are no other federally endangered or threatened species within or adjacent to the permit area; therefore, no other protection and enhancement plans were required.

3) B) 2) Species such as eagles, migratory birds or other animals protected by State or Federal law, and their habitats; or other species identified through the consultation process pursuant to 62 Ill. Adm. Code 1784.21; or

The staff wildlife biologist of Midwest Reclamation Resources, Inc. conducted field work and prepared a report entitled "Bald Eagle (*Haliaeetus leucocephalus*) and Golden Eagle (*Aquila chrysaetos*) Resource Report" to determine the potential impact of the proposed project upon eagles, migratory birds or other animals protected by State or Federal law and their habitats. The report is included in *Attachment V-3B2*. Based on the findings of the resource reports there are no potential impacts to eagles, migratory birds or other animals protected by State or Federal law and their habitats within or adjacent to the permit area; therefore, no protection and enhancement plans were required.

3) B) 3) Habitats of unusually high value for fish and wildlife, such as wetlands, riparian areas, cliffs supporting raptors, areas offering special shelter or protection, reproduction and nursery areas, and wintering areas.

The staff wildlife biologist of Midwest Reclamation Resources, Inc. conducted field work and prepared site specific resource information to determine the existence of habitats of unusually high value for fish and wildlife within and adjacent to the permit area. The reports are included in *Attachment V-3B1* and *Attachment V-3B3*. Based on the findings of the site specific resource reports there are no habitats of unusually high value for fish and wildlife, such as wetlands, riparian areas, cliffs supporting raptors, areas offering special shelter or protection, reproduction and nursery areas, or wintering areas within the permit area; therefore, no protection and enhancement plans are required.

The Louisville District, U.S. Army Corps of Engineers (USACE) has been contacted to confirm the wetlands and streams report's findings and the necessity to obtain a Section 404 permit. No wetlands were identified within the permit area; therefore, compensatory mitigation will not be conducted.

3) B) 4) For the Indiana Bat, Myotis sodalis, include an assessment of potential or known breeding and/or wintering habitat in the proposed permit area. Identify any mitigation measures

necessary to prevent loss of critical habitat, and to prevent potential "taking" (killing) of the animal, i.e., restricting timber removal to those seasons when the bat is not present in Illinois.

The staff wildlife biologist of Midwest Reclamation Resources, Inc. conducted field work and prepared site specific resource information to determine the existence of Indiana bat and Northern Long-eared bat habitat within and adjacent to the permit area. The report is included in *Attachment V-3B4*. Based on the findings of the site specific resource reports there is no Indiana bat habitat within the permit area. However there is potential summer habitat for Northern Long-eared bats within the permit area; therefore, a protection and enhancement plan is required. The Protection and Enhancement Plan can be found in *Attachment V-3B4.*

Pond, impoundments, banks, dams and embankments.

4) A) Permanent impoundments, including sedimentation ponds, must be authorized by the Regulatory Authority based upon the requirements of Section 1817.49(a) and (b).

4) A) 1) Include sufficient design data and calculations to substantiate that the design is in accordance with SCS engineering standard 378 "Ponds" or SCS technical release #60 "Earth Dams and Reservoirs".

As indicated on *Reclamation Plan Map, Map E,* Treatment Pond #1, Treatment Pond #2, Sediment Pond #2, and Sediment Pond #3 will be the only permanent impoundments. The design for these impoundments are in accordance with SCS engineering standard 378 "Ponds" and/or SCS technical release #60. Calculations are enclosed within Part IV of the application for the spillway design using the appropriate criteria for storm events. The plan view and details are shown on *Sediment Pond #2 & Treatment Pond #1, Plan Profile & Cross Sections, Map P-2 and Sediment Pond #3 & Treatment Pond #2 Plan Profile & Cross Sections, Map P-3.*

4) A) 2) Provide evidence that water quality is to be suitable for the intended use.

Water quality in the permanent impoundments are expected to be similar to water quality presently discharging from other permanent post-mining impoundments in Illinois. The intended uses of the permanent impoundments is wildlife habitat. Water quality should be suitable for wildlife, stock watering, fish culture, and supplemental irrigation. Water quality will be monitored for compliance with NPDES standards.

4) A) 3) Indicate the relationship of the impoundment to the post-mining land use.

The proposed impoundments are expected to provide wildlife habitat, as well as aesthetic value. In addition, the storage capacity of such impoundments can serve as sources of agricultural water for uses such as irrigation, stock watering, and fish culture.

4) A) 4) Describe methods of dropping surface runoff over excavated impoundment sideslopes. Discuss design criteria to be employed for downdrain structures and perimeter diversions.

It is not anticipated it will be necessary to construct any downdrain structures and

perimeter diversions to drop surface runoff over excavated impoundment side slopes. In the future, should it be determined these structures are required, a design will be submitted seeking Department review and approval.

4) A) 5) Provide plans of access roads and other use related facilities.

Not applicable. No permanent water impounding structures are proposed.

4) B) Describe proposed reclamation for all refuse disposal areas including timing of final coverage, depth of final cover, restoration planned for disposal area and restoration planned for borrow areas. **After all refuse generated by coal processing has been disposed of in the approved manner, toxicity testing will be performed to determine the net neutralization potential of the waste material. Lime, if determined to be necessary, will be incorporated into the surface of the refuse before covering it with 5 feet of non-toxic, non-combustible soil materials. Cover material will be obtained from soil stockpiles constructed at the time of initial disturbance.**

SOIL BALANCE VOLUMES

Ponds (Cut does not include Topsoil)	**Cut**	**Fill**	**Fill + 15%**
Sediment Pond #1	46,141	46,141	53,062
Sediment Pond #2	200,699		0
Sediment Pond #3	54,047		0
Treatment Pond #1	251,035		0
Treatment Pond #2	189,728		0
Holding Pond	29,524	29,524	33,953
Total	**771,174**	---	**87,015**
Shafts/Slopes			
2 Shafts	5,433	5,433	6,248
Slope	14,000		67
Total	**19,433**	---	**6,315**
Reclamation Material Removal			
Road	11,300		
RR Ballast	3,987		
Concrete	182		
Parking	15,817		
Surface	21,775		
Total	**53,061**	---	**0**
Slurry/Coarse Refuse			
Soil Excavation (Does Not Include Topsoil)	1,630,647		
Bottom Liner Placement		407,382	468,490
Phase I Construction		1,087,193	1,250,272
5' Cover (Includes Topsoil)		513,242	590,228

Total	**1,630,647**	**---**	**2,308,990**
Topsoil			
Removal (Entire Site = 387.7 acres)	625,489		
Placement (Minus Ponds & Gob = 303.3 acres)		489,324	562,723
Total	**625,489**	**---**	**562,723**
Grand Total	**3,099,804**	**---**	**2,965,042**
Surplus	**134,762**		

The information contained in the table above demonstrates that additional soil borrow areas will not be needed to complete the approved site reclamation post mining. The surplus yardage will be stockpiled and will be available for any future expansion at the mine.

4) C) If any structure is 20 feet or higher or impounds more than 20 acre-feet, provide a stability analysis of each structure which shall include strength parameters, pore pressures, and long-term seepage conditions. Also, to be included is a description of each engineering design assumption and calculation with a discussion of each alternative considered in selection design parameters and construction methods.

Refer to the report prepared by Schnabel Engineering titled, Reponses to MSHA Comments dated October 8, 2015; Proposed Stages 1 and 2; Bulldog Mine Refuse Impoundment No. 1; Allerton-Homer, Illinois dated September 12, 2016. The report is included under separate cover and also has drawings, cross-sections and design details regarding the refuse impoundment design.

4) D) Submission of MSHA certification documents for a detailed design plan shall satisfy the requirements, in so far as, the MSHA informational and design standard requirements are duplicative of the requirements.

5) Area closure or abandonment.

5) A) Describe all reclamation efforts to be expended to satisfy the requirements of abandonment. If an exemption request is to be made, it should be included.

5) A) 1) Include the timing to meet the final grading and revegetation requirements.

When permanent cessation of the mining operation occurs, final reclamation of the mine site will begin. The area will be reclaimed in accordance with the approved reclamation plan, and the permanent program rules and regulations that exist at that time.

Following recovery of the useable underground mining equipment, the underground shafts and slope entries will be backfilled and sealed. Surface facilities and structures not required to support the approved post-mining land use will be removed. Salvageable structures and materials will be sold if economically possible. Obsolete structures and materials will be removed from the mine site and deposited in an approved landfill. Affected areas will be graded to conform to the approved reclamation plan.

Soil replacement and establishing vegetation are dependent on seasonal weather conditions. To obtain optimum efficiency and avoid undesirable compaction, soil replacement will be accomplished during the dryer summer. Soil materials required for final reclamation will be obtained from stockpiled soil that was removed from the site prior to disturbing the area by mining activity. Sufficient soil material will be stockpiled on site so that additional borrow areas will not be necessary to complete final reclamation.

SOIL BALANCE VOLUMES

Ponds (Cut does not include Topsoil)	**Cut**	**Fill**	**Fill + 15%**
Sediment Pond #1	46,141	46,141	53,062
Sediment Pond #2	200,699		0
Sediment Pond #3	54,047		0
Treatment Pond #1	251,035		0
Treatment Pond #2	189,728		0
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Total	**19,433**	---	**6,315**
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Road	11,300		
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Concrete	182		
Parking	15,817		
Surface	21,775		
Total	**53,061**	---	**0**
Slurry/Coarse Refuse			
Soil Excavation (Does Not Include Topsoil)	1,630,647		
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Removal (Entire Site = 387.7 acres)	625,489		
Placement (Minus Ponds & Gob = 303.3 acres)		489,324	562,723
Total	**625,489**	---	**562,723**
Grand Total	**3,099,804**	---	**2,965,042**

Surplus	**134,762**

The information contained in the table above demonstrates that additional soil borrow areas will not be needed to complete the approved site reclamation post mining. The surplus yardage will be stockpiled and will be available for any future expansion at the mine.

Surface water and groundwater monitoring will continue at the site as required until approval is obtained from the proper regulatory agencies to discontinue monitoring.

5) A) 2) Include a description of the final graded slopes, and the type of seed and seeding.

Backfilling, grading and soil replacement will be accomplished with dump trucks, dozers, tractor/scrapers and road graders. Disturbed areas, except for the Refuse Impoundment, will be restored to approximate original contour. This will be accomplished by blending the disturbed areas with the natural ground surface of the undisturbed areas during the grading process then replacing topsoil on the disturbed areas.

The out slopes of the Refuse Impoundment will not exceed 3H:1V. After all coarse refuse waste material generated by coal processing has been disposed of in the Refuse Impoudment, toxicity testing will be performed to determine the net neutralization potential of the waste material. Lime, if determined to be necessary will be incorporated into the surface of the Refuse Impoundment before covering the waste material with 5 feet of non-toxic, non-combustible soil materials. The post-mining final reclamation soil cover will consist of 48" of sub-soil, and 12" of topsoil. Before the 12" of topsoil is placed, a relatively impermeable 48" sub-soil cap will be constructed using the clayey soils encountered on site. The bottom 36" of the cap will be constructed in accordance with the Quality Assurance/Quality Control Plan for Clay Liner Installation included in Attachment IV-6D of this permit application. The soils will be placed in 6-8 inch loose lifts and compacted until three (3) feet of clayey fill has been placed and compacted. The three (3) feet of clay fill should provide a liner with a permeability of approximately 1 x 10^{-7} cm/sec. If the in situ soils do not produce a liner having a permeability of 1 x 10^{-7} cm/sec. or less, bentonite will be added to the soil to achieve the required permeability. The embankment will be constructed, and reclamation will be completed in a manner that will promote unimpeded surface water runoff.

Seed species and application rates are listed in the Standard Seed Mixture table found earlier in Part V.

5) A) 3) Explain final coverage of treatment of toxic areas and locate all borrow pits.

Please refer to the previous response for a discussion of treatment for potentially toxic materials in the Refuse Impoundment. No borrow pits are currently anticipated.

5) B) Describe in detail a rehabilitation design plan for each siltation structure, diversion, impoundment and treatment facility to be implemented and completed prior to abandonment. Any departures from detailed design plan requirements must be designated as such and be accompanied by supporting documentation.

After completion of mining and final reclamation, the permittee will solicit approval from IDNR-OMM and IEPA to reclassify Sediment Ponds #1, #2 and #3, and Treatment Ponds #1 and #2 to reclamation drainage standards. After compiling sufficient monitoring data to demonstrate continued surface water quality compliant with applicable water quality standards, the Ponds will be reclaimed.

Reclamation will begin by dewatering Sediment Pond #1, and the Holding Pond. A sufficient amount of soil material will be hauled in from soil stockpiles and deposited in the ponds to approximate original contours. This will be accomplished by blending the disturbed areas with the natural ground surface of the undisturbed areas during the grading process then replacing topsoil on the disturbed areas. Sediment Pond #2, Sediment Pond #3, Treatment Pond #1, and Treatment Pond #2 will be left as wildlife water areas.

6) Perennial and Intermittent Stream Diversion Note: If stream diversion is not planned, indicate N/A.

Not applicable. There are no perennial or intermittent stream diversions proposed. According to 62 Ill. Adm. Code 1701.APP.A, a perennial stream is a stream that flows continuously all of the calendar year or part of the stream that flows continuously as a result of groundwater discharge or surface runoff. According to 62 Ill. Adm. Code 1701.APP.A, an intermittent stream is a stream or reach of stream that drains a watershed of at least one square mile; of a stream or reach of stream that is below the local water table for at least some or part of the year, and obtains its flow from both surface runoff and groundwater discharge. On-site inspections were conducted on March 26, 2012 to characterize the existing stream resources within the permit area. No ephemeral, intermittent, or perennial streams were identified within the permit area. For a more detailed description of the on-site inspections please see Attachment V-3B3.

6) A) Overview, Alternative, Justification:

6) A) 1) Discuss in detail the reasons for diverting the stream. Include justification and possible alternatives to relocating it.

6) A) 2) Discuss the general overview of the proposed diversion project. General information should include: temporary, permanent; time length of diversion; single phase, multiphase; restore on placeland, restore in approximately original location after mining; etc.

6) B) Pre-disturbance information

6) B) 1) The following general information shall be provided for the stream to be diverted:

6) B) 1) a) Name of the stream to be diverted,

6) B) 1) b) Classification (intermittent, perennial),
6) B) 1) c) Total length of segment affected,

6) B) 1) d) Total drainage area of existing stream at the point where relocation begins (miles) and ends (miles),

6) B) 1) e) Depth of the water table adjacent to the stream and yearly fluctuation.

6) B) 2) An aerial photograph or map (scale at 1 in = 400 ft or other approved scale) shall be provided illustrating the following for the existing stream:

6) B) 2) a) Existing stream channel and adjacent land use,

6) B) 2) b) Watershed limits upstream of the proposed relocation,

6) B) 2) c) Proposed permit area; property boundaries,
6) B) 2) d) An outline of the 100-year and 2-year frequency flood plains along the existing channel; include the acreage inundated by each storm event,

6) B) 2) e) Locations where representative cross-sections have been taken

6) B) 2) f) Riparian habitat (vegetation),

6) B) 2) g) Riffles, list total number and locate on the map or photo,

6) B) 2) h) Pools; list total number and locate on the map or photo,

6) B) 2) i) Meanders; list total number and locate on the map or photo.

6) B) 3) Plan-profile and cross-sectional drawings of the existing stream shall be provided showing the following information:

6) B) 3) a) Stream bed and significant drops,

6) B) 3) b) Water surface at low flow,

6) B) 3) c) Water surface at the 100 year and 2 year flood event.

Include the calculated flow rate (cfs) and velocity (ft/sec) at the representative locations for low flow and the 100-year flood conditions.

6) B) 4) Describe the habitat of the existing stream including the following information at a minimum:

6) B) 4) a) Channelization or other disturbances,

6) B) 4) b) Shade provided by stream bank vegetation,

6) B) 4) c) Stream substrate composition,

6) B) 4) d) Steepness and elevation of the banks,

6) B) 4) e) Riparian vegetation (species, relative abundance),

6) B) 4) f) Aquatic vegetation (species, relative abundance),

6) B) 4) g) Potential Indiana bat habitat shall be addressed with a plan to prevent "taking" of the animal during breeding seasons.

6) C) The following design and construction plan information shall be provided for TEMPORARY STREAM CHANNEL DIVERSIONS. If none are proposed, indicate N/A.

6) C) 1) The following estimated construction planting dates shall be provided:

a) Begin construction ______________________________

b) End construction ______________________________

c) Begin planting ______________________________

Give a detailed description of the construction practices to be followed, and the equipment to be employed.

6) C) 2) After stabilization of the temporary diversion and prior to diversion of the existing stream into the temporary stream channel, the applicant will be required to contact the Department and gain approval. The applicant shall provide an estimation of the date when erosion control structures and vegetation will be sufficiently established to allow diversion of the water into the temporary channel.

6) C) 3) Discuss the erosion control practices to be followed during construction of the temporary diversion and the features of the proposed channel which will help minimize erosion of the stream banks in the future. Discuss the necessity, if any, of using a stilling basine to aid in reducing siltation.

6) C) 4) Discuss the impacts the temporary diversion ditch will have on downstream water quality, biological communities and water users and describe a monitoring program to measure these impacts.

6) C) 5) Describe reclamation of temporary stream diversions when no longer needed.

6) C) 6) A detailed revegetation plan shall be proposed, including soil preparation procedures, plant species and rates, fertilizer rates and mulching rates.

6) C) 7) Describe how the temporary diversion ditch spoil will be handled to minimize the impact on the surrounding area.

6) C) 8) Provide an aerial photo or map (scale of 1 in = 400 ft) illustrating the following:

6) C) 8) a) Proposed temporary stream channel diversion.

6) C) 8) b) Proposed spoil locations.

6) C) 8) c) An outline of the 10-year frequency flood plain along the proposed temporary diversion.

6) C) 8) d) Locations where representative cross-sections have been taken.

6) C) 9) Design information shall be provided as follows:

6) C) 9) a) Plan-profile drawings clearly depicting locations and flow line slopes.

6) C) 9) b) Sufficient cross-sections to depict side slopes and inflection points such as cuts and fills.

6) C) 9) c) A clearly outlined drainage area which the temporary diversion ditch will serve including hydrologic characteristics such as slopes, soil types, vegetative cover, etc.

6) C) 9) d) Detailed calculations of runoff volumes from the drainage area upon which to base ditch sizing calculations.

6) C) 9) e) Detailed ditch sizing calculations to demonstrate the projected temporary stream channel diversion ditch is adequate to convey the 10-year 24 hour storm event pursuant to Sections 1817.43(c) and (f).

6) D) The following design, construction and restoration plan information shall be provided for the PERMANENT RESTORED STREAM (________) or the PERMANENT RELOCATED STREAM CHANNEL (________), which ever is applicable. Check the appropriate category.

6) D) 1) The following estimated construction dates shall be provided:

6) D) 1) a) Begin construction ______________________________

6) D) 1) b) End construction ______________________________

6) D) 1) c) Give a detailed description of the construction practices to be followed, and the equipment to be employed.

6) D) 1) d) A program shall be established to regularly report on the progress of the permanent stream channel reconstruction including as-built designs of the channel and flood plain and a description of habitat restoration. Discuss the timing and content of the proposed restoration progress report program.

6) D) 2) Describe how the new channel spoil will be graded and handled to minimize the impact on the surrounding area, including the flood plain capacity, flooding and the riparian zone.

6) D) 3) After the restored channel is adequately stabilized and prior to diversion of the temporary diversion ditch into the permanently restored stream channel, the applicant will be required to contact the Department and gain approval. The applicant shall provide an estimation of the date diversion of the water into the permanent channel.

6) D) 4) Discuss the erosion control practices to be followed during construction of the permanent stream restoration and the features of the proposed channel when will help minimize erosion and enhance stability of the stream banks in the future.

6) D) 5) Discuss the impacts the permanently restored stream channel will have on downstream water quality, biological communities and water users and describe a monitoring program to measure these impacts.

6) D) 6) Provide an aerial photo or map (scale of 1 in = 400 ft) illustrating the following:

6) D) 6) a) Proposed permanently restored stream channel,

6) D) 6) b) Proposed spoil locations,

6) D) 6) c) An outline of the 100-year and 2-year frequency flood plains along the proposed permanent restored channel,

6) D) 6) d) Locations where representative cross-sections have been taken,

6) D) 6) e) Riparian habitat (vegetation),

6) D) 6) f) Riffles; list total number and locate on the map or photo,

6) D) 6) g) Pools; list total number and locate on the map or photo,

6) D) 6) h) Meanders; list total number and locate on the map or photo,

6) D) 7) Design information shall be provided as follows:

6) D) 7) a) Stream bed and significant drops,

6) D) 7) b) Water surface elevations at low flow,

6) D) 7) c) Water surface elevations at the 100-year and 2-year floods,

6) D) 7) d) Gradeline for the proposed restored stream channel,

6) D) 7) e) Plan-profile drawings clearly depicting locations and flow line slopes,

6) D) 7) f) Sufficient cross-sections to depict side slopes and inflection points such as cuts, fills, curves and straight sections,

6) D) 7) g) A clearly outlined drainage area which the permanent channel will serve including hydrologic characteristics such as slopes, soil types, vegetative cover, etc.,

6) D) 7) h) Detailed calculations of runoff volumes from the drainage area upon which to base channel sizing calculations,flood plain are adequate to convey the 100-year 24 hour storm event.

6) D) 7) i) Detailed channel sizing calculations to demonstrate the projected permanent channel and

6) D) 7) j) Include the calculated flow rate (cfs) and velocity (ft/sec) at the representative locations for low flow and the 100-year flood condition.

6) D) 8) Describe other habitat restoration methods to be employed as follows:

6) D) 8) a) Provide typical plans, maps and drawings for boulder deflectors, check dams, current deflectors or other in-stream habitat structures, if any,

6) D) 8) b) Provide typical plans, profiles and cross-sections for proposed floodplain potholes and/or wetlands, if any,

6) D) 8) c) A detailed revegetation plan shall be proposed, including soil preparation procedures, plant species and rates, fertilizer rates and mulching rates. Provide details on riparian habitat revegetation including a discussion of the herbaceous ground cover, woody species to be planted and the number and distribution of the stems to be planted. The riparian zone must

be reclaimed to forest with a minimum of 450 trees/acre necessary for bond release,

6) D) 8) d) If the restored stream will traverse inclines or final cuts, provide measures to be employed to enhance the diversity of the impoundments.

7) Are coal processing wastes proposed to be returned to abandoned underground workings?
Yes ______ No __X__

If the response above is yes, provide information required under 62 Ill. Adm. Code 1784.25(a) through (f).

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT V-1B

RECLAMATION COST ESTIMATE

Total Reclamation Cost = $1,312,315.00

Mine Slope - $3,600.00

Backfill Slope - $1,800.00

Scope of Work – Backfill slopes 15' W x 10.5' H x 200' L = 1167 cu. yds.
Equipment – Equipment – D5 LGP Dozer @ $70.00/hour
Productivity – Assume 50 cu yds per dozer hour
Cost Estimate – (1167 cy)+(15% compaction)/(50 cy/per hr.) = 25.7 hrs X $70.00/hr = $1,800.00

Seal Slope- $1,800.00

Scope of Work – Seal slope 15' W x 10.5' H x 2' T
Equipment – Contract equipment and labor for concrete stopping @ $150.00/cu. yd.
Cost Estimate – 12 cu. yds. Concrete ($150.00/cu. yd.) = $1,800.00

2 Air Shafts - $7,380.00

Backfill Shafts - $2,880.00

Scope of Work – Backfill 2 shafts (16' Dia. x 365') 5,433 cu. yds.
Equipment – Equipment – D10 LGP Dozer @ $90.00/hour
Productivity – Assume 200 cu yds per dozer hour
Cost Estimate – (5,433 cy)+(15%compaction)/(200 cy/per hr.) = 32 hrs X $90.00/hr = $2,880.00

Seal Shafts- $4,500.00

Equipment – Contract equipment and labor for concrete cap @ $150.00/cu. yd.
Cost Estimate – 30 cu. yds. Concrete ($150.00/cu. yd.) = $4,500.00

Road Removal - $7,275.00

Road Removal - $7,275.00

Scope of Work – Remove 15,256 LF x 20'W x 1'D road rock. Dispose of road material in mine slopes/air shafts.
Average 3500' one way haul distance
Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour
Productivity – 7 loads/hour @ 20 cy/load = 140 cy/hour
Cost Estimate – (11,300 cu yds)(~~1.~~20 % swell)/140 cy/hr = 97 hrs X $75.00/hr = $7,275.00

Potential Future Rail Removal - $60,030.00

Rail and Tie Removal - $57,855.00

Scope of work – Remove 6,407 LF of rail
Cost Estimate – Crane/Shovel plus labor @ $9.03/LF X 6,407 LF = $57,855.00

Ballast Removal- $2,175.00

Scope of Work – Remove 6,407 LF x 20'W x .84'D rock. Dispose of ballast material in mine slopes/air shafts. Average 3500' one way haul distance

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 7 loads/hour @ 20 cy/load = 140 cy/hour

Cost Estimate – (3,987 cu yds)/140 cy/hr = 29 hrs X $75.00/hr = $2,175.00

Pond Elimination - $36,300.00

Backfill Sediment Pond #1-$22,125.00

Scope of Work – Backfill 46,141 cubic yards (includes topsoil) and blend with surrounding topography. Average 1,000' one way haul distance.

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 9 loads/hour @ 20 cy/load = 180 cy/hour

Cost Estimate – (46,141 cy)+(15% compaction)/180 cy/hr = 295 hrs X $75.00/hr = $22,125.00

Backfill Sediment Pond #2-$0

This pond will remain as a permanent impoundment.

Backfill Sediment Pond #3-$0

This pond will remain as a permanent impoundment.

Backfill Treatment Pond #1-$0

This pond will remain as a permanent impoundment.

Backfill Treatment Pond #2-$0

This pond will remain as a permanent impoundment.

Backfill Holding Pond -$14,175.00

Scope of Work – Backfill 29,524 cubic yards (includes topsoil) and blend with surrounding topography. Average 1,000' one way haul distance.

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 9 loads/hour @ 20 cy/load = 180 cy/hour

Cost Estimate – (29,524 cy)+(15% compaction)/180 cy/hr = 189 hrs X $75.00/hr = $14,175.00

Coarse Refuse Pile/Slurry Impoundment – $451,005.00

Minor Grading and Shaping - $21,630.00

Scope of Work – Clean up site and bury debris prior to applying lime and covering refuse.

Equipment – D5 LGP Dozer @ $70.00/hour

Productivity – Assume 5 dozer hours/acre

Cost Estimate – 61.8 ac. (5 hrs/ac.)($70.00/hr) = $21,630.00

Replace Topsoil - $429,375.00

Scope of Work – Cover 61.8 acres with 60" of soil from stockpiles.
Average 1,500' one way haul distance

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 5 loads/hour @ 20 cy/load = 100 cy/hour

Cost Estimate – 61.8 ac. (8,055 cy/ac.)+(15% compaction)/100 cy/hr = 5,725 hrs X $75.00/hr =$429,375.00

Coal Preparation Plant/Stockpiles – $10,200.00

Remove Structures - $0

No reclamation liability costs are anticipated for structure removal. Previous experience while reclaiming idled coal mines in the area indicates the coal handling structures, including conveyor belts, can be sold to private individuals for scrap value.

Remove Waste Material - $10,200.00

Scope of Work – Remove 4.5 acres x 3' thick of fine coal waste and crushed rock from the area @ and dispose in shafts.
Average 1,800' one way haul distance

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 8 loads/hour @ 20 cy/load = 160 cy/hour

Cost Estimate – 4.5 ac. (4,839 cy/ac.)/160 cy/hr=136 hrs X $75.00/hr = $10,200.00

Structure Removal – $191,146.00

Remove Buildings - $179,000.00

Scope of Work – Demolish buildings/concrete and dispose in approved land fill.

Shop ....7,800 sq. ft.
Washplant ....4,800 sq. ft.
Office/Bath House ....14,400 sq. ft.
Warehouse ....7,800 sq. ft.
VFD Building ....600 sq. ft.
Transfer Building....................400 sq. ft.

Assume all buildings and structures associated with the coal preparation plant will be removed incidental to prep plant demolition.

Equipment – Contract equipment and labor @ $5.00/sq. ft.

Cost Estimate – 35,800 sq. ft.($5.00/sq. ft.) = $179,000.00

Remove Concrete Structures - $4,732.00

Scope of Work – Demolish concrete and dispose in shafts/slope.

Thickner...........................155 cu. yd.
Truck Scale.........................27 cu. yd.

Equipment – Contract equipment and labor @ $26.00/cu. yd.

Cost Estimate – 182 cu. yd.($26.00/cu. yd.) = $4,732.00

Parking Areas/Supply Yard - $7,414.00

Scope of Work – Remove 19.6 acres of crushed rock from parking lot @ 6" thick and bury on-site. Average 1,000' one way haul distance

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 8 loads/hour @ 20 cy/load = 160 cy/hour

Cost Estimate – 19.6 ac. (807 cy/ac.)/160 cy/hr($75.00/hr) = $7,414.00

Surface Disturbed Areas*- $457,755.00

Rough Grading and Replace Sub-soil - $0

Rough grading and sub-soil replacement will not be necessary. All structures, toxic and acid forming materials, and contaminated soil will be removed from the area while removing and salvaging the coal processing facilities. The remaining material will be used to backfill the shafts and slope entries. No other reclamation efforts are anticipated in preparation for topsoil replacement.

Minor Grading and Shaping - $106,155

Scope of Work – Final site clean up and bury debris prior to spreading 12" of topsoil.

Equipment – D5 LGP Dozer @ $70.00/hour

Productivity – Assume 5 dozer hours/acre

Cost Estimate – 303.3 ac. (5 hrs/ac.)($70.00/hr) = $106,155.00

Replace Topsoil - $351,600.00

Scope of Work – Cover 264.8 acres with 12" of topsoil from stockpiles. Average 5,000' one way haul distance

Equipment – 4X4 tractor, w/2-10 cy scrapers @ $75.00/hour

Productivity – 6 loads/hour @ 20 cy/load = 120 cy/hour

Cost Estimate – 303.3 ac. (1613 cy/ac.)+(15% compaction)/120 cy/hr = 4,688 hrs X $75.00/hr =$351,600.00

* ***Surface disturbed areas not including Impoundments and the Coarse Refuse Pile/Slurry Impoundment.***

Re-Vegetation- $87,624.00

Apply Seed and Mulch - $87,624.00

Scope of Work – Plant herbaceous/woody wildlife seed mix. Assume over seeding 20% for additional disturbance beyond item boundaries.

Material and Equipment – Assume historical cost for similar work @ $200.00/acre

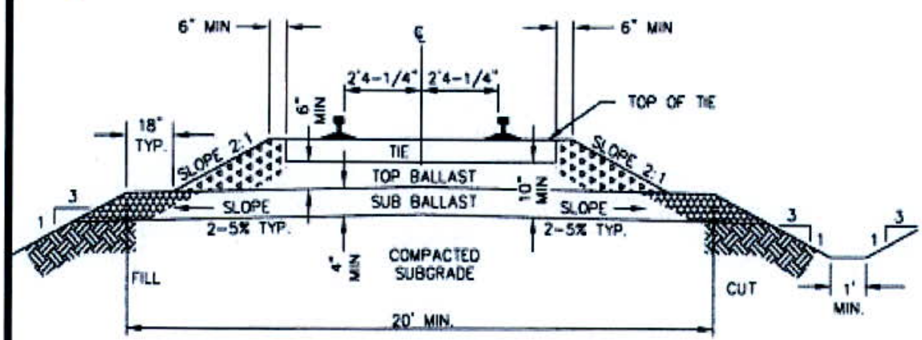
Cost Estimate – 365.1 ac. (20% overseed)($200.00/ac.) = $87,624.00

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT V-1B3

TYPICAL CROSS-SECTION

"POTENTIAL FUTURE RAIL"

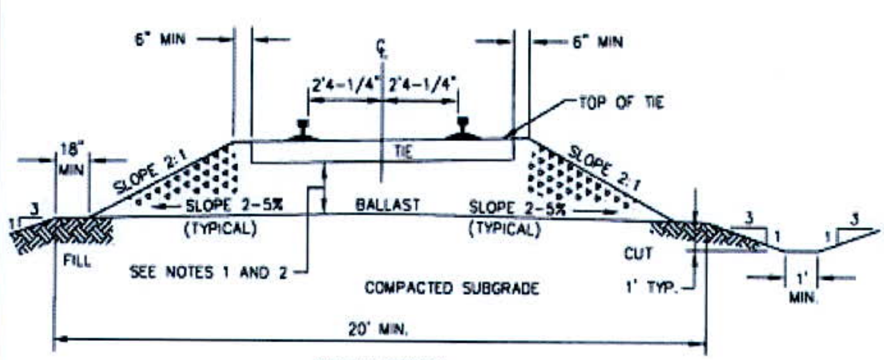


TYPICAL SECTION

NOT TO SCALE

NOTES:

1. DEPTH OF BALLAST SECTION WILL DEPEND ON SUBGRADE STRENGTH, TRAFFIC DENSITY, AND WHEEL LOADS. USE RECOMMENDED STRUCTURAL ANALYSIS TO DETERMINE APPROPRIATE DEPTH FOR EACH SITE.
2. MINIMUM THICKNESS OF BALLAST/SUBBALLAST IS 10 INCHES BELOW BOTTOM OF TIE
3. THICKNESS OF BALLAST AND SUBBALLAST MAY BE VARIED TO OBTAIN BEST STRUCTURAL AND ECONOMIC DESIGN WHILE MEETING MINIMUM THICKNESS REQUIREMENTS.
4. CUT OR FILL ACCORDING TO LOCAL CONDITIONS.



TYPICAL SECTION

NOT TO SCALE

NOTES:

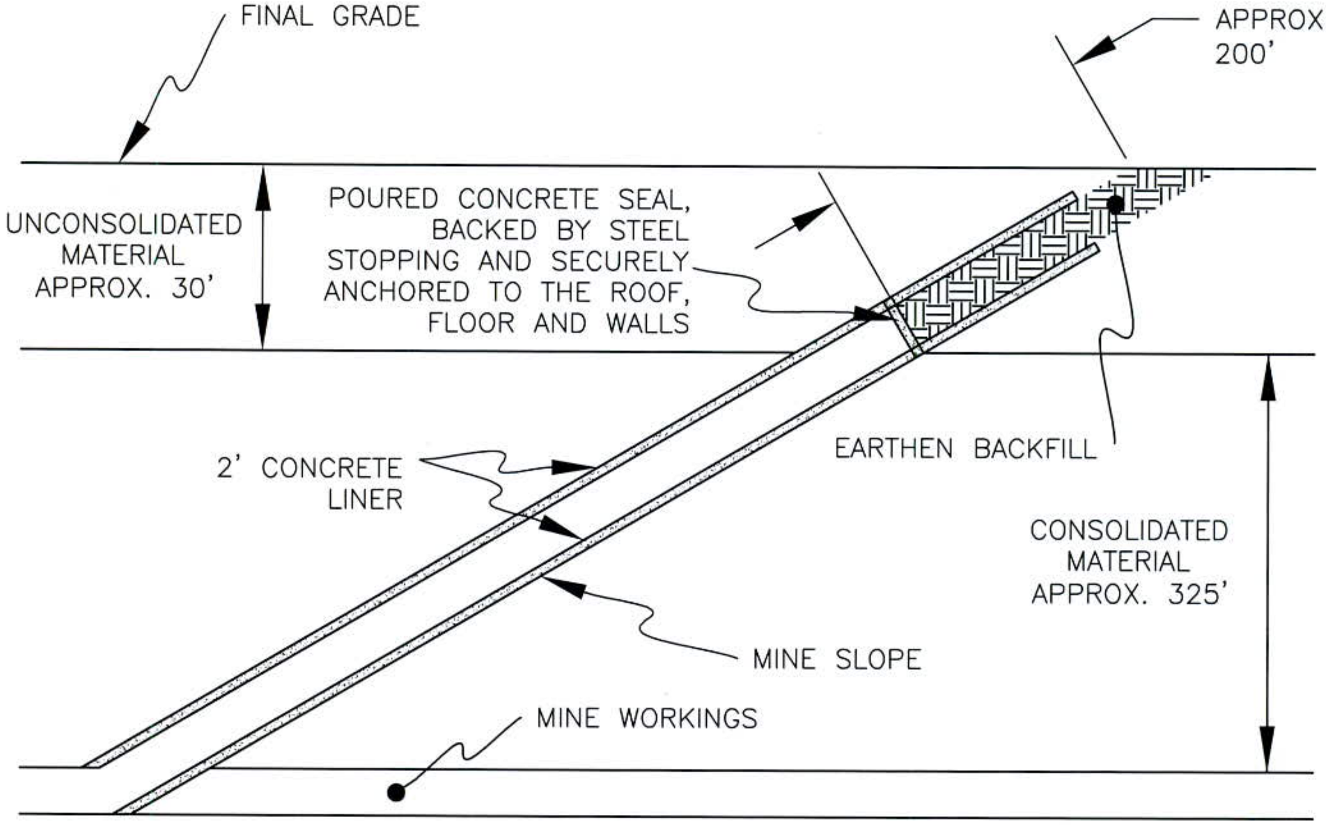
1. DEPTH OF BALLAST SECTION WILL DEPEND ON SUBGRADE STRENGTH, TRAFFIC DENSITY, AND WHEEL LOADS. USE RECOMMENDED STRUCTURAL ANALYSIS TO DETERMINE APPROPRIATE DEPTH FOR EACH SITE.
2. MINIMUM THICKNESS OF BALLAST IS 8 INCHES BELOW THE BOTTOM OF THE TIE AT THE INSIDE RAIL OF THE CURVE.
3. ON CURVES OF 6 DEGREES OR GREATER A BALLAST SHOULDER WIDTH OF 8 INCHES SHOULD BE USED.
4. CUT AND FILL ACCORDING TO LOCAL CONDITIONS.

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

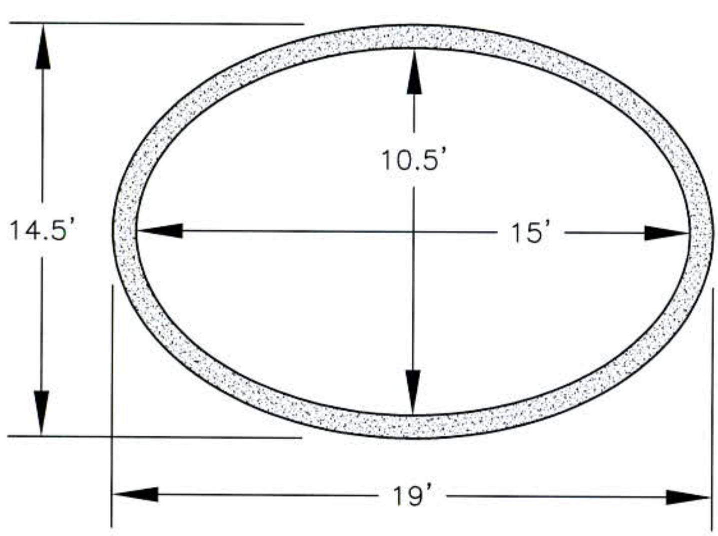
ATTACHMENT V-1G

MINE SLOPE, AIR SHAFTS, AND WELL/DRILL HOLE
SEALING DETAIL

Attachment V-1G



MINE SLOPE
TYPICAL PROFILE
NOT TO SCALE



MINE SLOPE
TYPICAL CROSS SECTION
NOT TO SCALE

SUNRISE COAL, LLC
1183 EAST CANVASBACK DR. • TERRE HAUTE, IN 47802

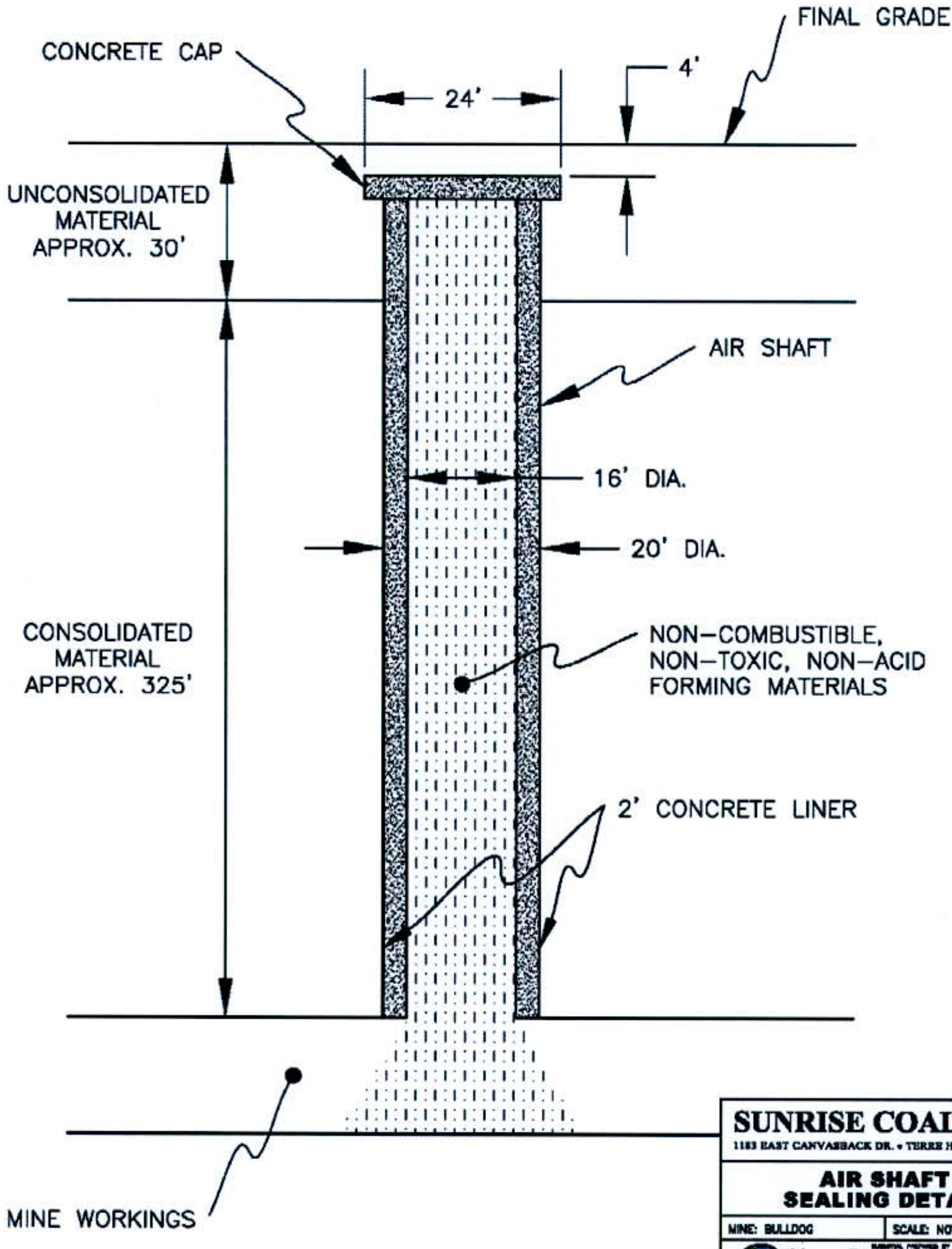
MINE SLOPE SEALING DETAIL

MINE: BULLDOG	SCALE: NOT TO SCALE

SUBMITTAL PREPARED BY
MIDWEST RECLAMATION RESOURCES INC.
P.O. BOX 1642
MURPHYSBORO, IL. 62966
618-687-5590

FILE: BULLDOG SEALING DETAIL.DWG

Attachment V-1G



SUNRISE COAL, LLC
1183 EAST CANVASBACK DR. • TERRE HAUTE, IN 47802

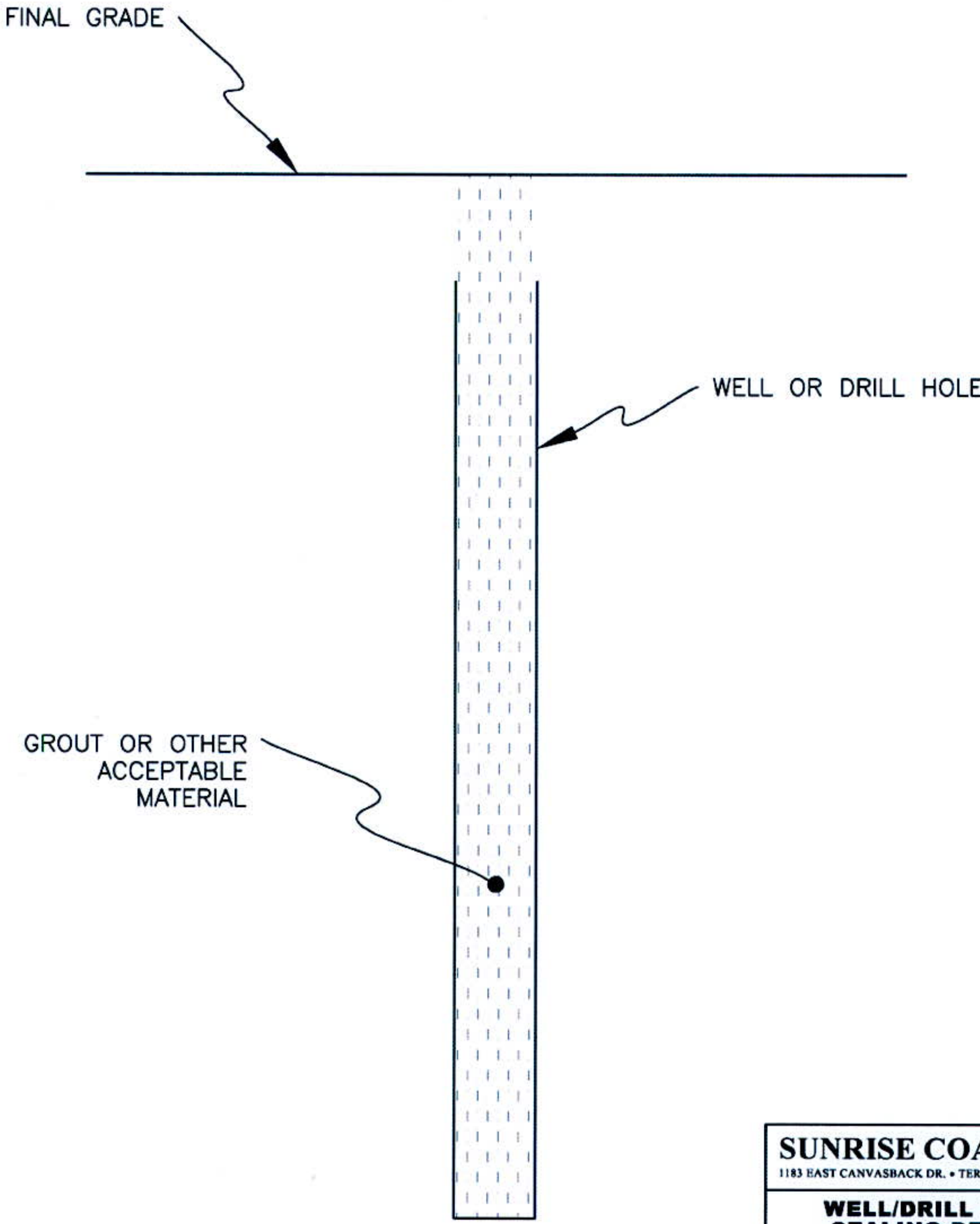
AIR SHAFT SEALING DETAIL

MINE: BULLDOG	SCALE: NOT TO SCALE

MIDWEST RECLAMATION RESOURCES INC.
P.O. BOX 1643
MURPHYSBORO, IL 62966
618-687-3390

FILE: BULLDOG SEALING DETAIL.DWG

Attachment V-1G



SUNRISE COAL, LLC
1183 EAST CANVASBACK DR. • TERRE HAUTE, IN 47802

WELL/DRILL HOLE SEALING DETAIL

MINE: BULLDOG	SCALE: NOT TO SCALE

SUBMITTAL PREPARED BY
MIDWEST RECLAMATION RESOURCES INC.
P.O. BOX 1642
MURPHYSBORO, IL 62966
618-687-5590

FILE: BULLDOG SEALING DETAIL.DWG

Response: Attachment I-6 (Ownership and Control Information) and Attachment I-9 (Violation History) have been revised.

31. The Department is requiring the applicant to revise Attachment I-9 to include violations received for any provision of the Federal Act or of any **Federal State law, rule, or regulation pertaining to air or water environmental protection** (emphasis added) incurred in connection with any surface coal mining operations in the last three years from the date of the application, for all entities associated with the applicant's owners/ controllers.

    Response: Attachment I-9 (Violation History) has been updated to include violations received for any provision of the Federal Act or of any Federal State law, rule, or regulation pertaining to air or water environmental protection incurred in connection with any surface coal mining operations in the last three years.

32. Pursuant to 62 Ill. Adm. Code 1784.13(1)(5) and as required by Part V(l)(A) of the application, the applicant is required to provide an overview of each major step in the reclamation process. The applicant's description is vague and quite general. Pursuant to 62 Ill. Adm. Code 1784.13(1)(5) the applicant shall provide a detailed timetable for the approximate completion of each major step in the reclamation plan. Table form is sufficient.

    √KP

    Response: Part V(1)(A) of the application has been modified by providing a table outlining the completion of each major step of the reclamation process.

33. Pursuant to 62 Ill. Adm. Code 1817.111 and as required by Part V(1)(D)(2)(a) of the application, the applicant is required to provide revegetation information for areas other than forest and/or wildlife habitat. The narrative provided discusses wildlife herbaceous habitat and waterway seeding species. This narrative should be moved to other sections of Part V- see below.

    Response: Part V(1)(D)(2)(a) has been revised to indicate that no post-mining land-uses other than herbaceous wildlife and wildlife water are proposed for the reclamation of the permit area. The seed mix for grass waterways utilizing fescue has been removed. The existing narrative discussing herbaceous wildlife has been moved to Part V(1)(D)(2)(b). √KD

34. Pursuant to 62 Ill. Adm. Code 1817.111(a)(2) and section 1817.111(b)(l) and as required by Parts V(1)(D)(2)(b), V(I)(D)(3), and V(I)(D)(5) of the application, permanent vegetative cover should be comprised of species native to the area (warm season grasses) and compatible with the Post Mining Land Use (PMLU) designation. Throughout the application PMLU is listed as "herbaceous wildlife", however many of the listed species *(Festuca* spp. for example) are suitable for pasture rather than herbaceous wildlife. √KP -Brome-
    - Suitable substitutes are available for *Festuca* spp. and other cool season pasture grasses. The applicant should eliminate cool season pasture grasses from any lands bounded or bordered by wildlife herbaceous land use including waterways and propose a seeding mix compatible with approved PMLU.

Pursuant to section 1784.13(b)(5) and as required by the above listed application Parts, the applicant must provide a more detailed plan for revegetation to meet regulations as required in 1817.111 through 1817.117 so that a finding under section 1773.15(c) can be made. With the understanding that establishment of warm season grasses as the PMLU final cover requires more intensive establishment practices and more time, details required of the applicant include:

a) A ground cover vegetative species list that is predominantly composed of native species. This will fulfill the stated goal of SMCRA that plant species used are to provide "...a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected..." Species proposed for use can be both cool and warm season types. A good mix should contain several species of both grasses and forbs.
b) If a revegetation strategy is to use non-native types as a nurse crop and/or for site stabilization, then in addition to a species list, the management strategy and time table sequence that is to be followed for conversion of the stand to predominantly native species must be specified.

Pursuant to sections 1817.116(a)(3)(D) and 1817.117(a)(2) the applicant should note that final bond release requirements for herbaceous wildlife is 70% ground cover; this 70% ground cover shall be composed of native species.

Pursuant to section 1777.ll(a) and (b) all information provided shall be clear, concise, and appropriately referenced.

Response: The proposed seed mix has been revised to remove non-native species from the mixture. The narrative discussing the seed mix for herbaceous wildlife has been moved from Part V(1)(D)(2)(a) to Part V(1)(D)(2)(b). A discussion of the management strategy for the establishment of the herbaceous wildlife vegetation has been added to Part V(1)(D)(3). In addition, the response to Part V(1)(D)(6) now includes a statement that 70% ground cover of native species will be the measure to be used to determine success of re-vegetation.

KP

35. Pursuant to 62 Ill. Adm. Code 1780.16(a)(2)(a) and as required by Part V(3)(B)(4) and Part II(8) of the application, the applicant must address "listed or proposed endangered or threatened species". A narrative is provided regarding the Indiana Bat *(Myotis soda/is)* Attachment V-3B1 describing why conditions in the proposed permit area are unsuitable habitat for the species. This information is insufficient to address the species and should be amended to include:

a) The flowchart found in section 2.0 of the "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines" (USFWS 2009, updated 2013) and a more detailed narrative explaining each step in ruling out a PEP for the species.
b) Any reference to a "cut period" for trees must indicate October 15th to March 31st. If not tree cutting is required, this should be stated in the narrative. Maps indicate an area of trees within the permit area associated with structures.
c) Pursuant to section 1773.13 the applicant shall provide names of persons or

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT V-3A1

PROTECTIVE MEASURES TO HELP MINIMIZE POWERLINE ELECTROCUTION AND COLLISION HAZARDS TO RAPTORS AND OTHER BIRDS

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

Introduction

Bird deaths from powerline electrocution were first documented in the 1920's. Since that time, the research directed at preventing those electrocutions has grown and developed along with the United States electric grid. The result has been that many avian/powerline electrocution issues have been resolved by properly designing and constructing electric powerlines. Collisions with powerlines are also a source of mortality and injury to birds. Research in preventing and minimizing fatal collisions with powerlines has progressed and provided many options that can be utilized in utility and industrial settings.

Biological and behavioral factors unique to raptors put them at greater risk for electrocution from electric utility structures and lines than most birds. To address raptors special needs and provide guidelines for electric utilities, *Suggested Practices for Raptor Protection on Power Lines* was first published by researchers in 1975, later updated in 1981, 1996, and 2006 by Edison Electric Institute and the Avian Power Line Interaction Committee in collaboration with the Raptor Research Foundation. The 2006 version (which is recognized internationally by researchers, industry, policymakers, and the public) presents the history and successes of more than two decades of research and implementation of solutions to avian electrocutions. It examines the history of raptor/powerline interactions from biological and electrical perspectives and proposes specific solutions for reducing avian fatalities.

Collisions with powerlines can affect a wide array of bird species and in 2012, the Avian Power Line Interaction Committee and Edison Electric Institute published an updated manual titled: "Reducing Avian Collisions with Power Lines: The State of the Art in 2012". The 2012 manual provides the current understanding of avian collisions with powerlines and suggests various methods to mitigate the danger of powerlines. Sunrise Coal intends to rely heavily on the recommendations presented in the 2006 and 2012 manuals when designing and constructing the electric powerlines that will be used to supply electricity to the Bulldog Mine.

Understanding the Electrical Systems

Powerlines are rated and categorized, in part, by the voltage levels to which they are energized. Because the magnitudes of voltage used by the power industry are large, voltage is often specified with the unit of kilovolt (kV) where 1kV is equal to 1,000 volts (v). Generally, from the point of origin to the end of an electric system, line voltage is used to designate four classes or types of powerlines; generation plant, 12 V to 22 kV; transmission, 60 kV to 700+ kV; distribution, 2.4 kV to 60 kV, and utilization 120 V to 600 V.

In addition to the voltage level, powerline classification is dependent on the purpose of the line. Since this mining operation will not operate a generation plant, and low voltage (≤600 v) utilization lines

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

are not often involved in avian electrocutions (APLIC 2006), the Bulldog Mine is concerned with electrocution hazards posed to birds by transmission lines ≥60 kV, and distribution lines <60 kV.

Generally, the mining industry is powered by three-phase overhead powerline systems that utilize support structures from which insulators and electrical conductors are attached. Support structures usually consist of preservative-treated wood poles. Insulators are made of porcelain or polymer materials that do not normally conduct electricity. Electrical conductors are usually manufactured from copper or aluminum. Three-phase circuits consist of structures, as described, that support at least three electrical phase conductors with or without a neutral (or grounded) conductor. Three-phase systems can be used for both transmission and distribution lines.

Transmission line structures always support at least one three-phase circuit, but can also consist of more than one three-phase circuit supported on the same structure. They have three energized conductors (more if bundled), and may have one or two grounded conductors (usually referred to as static wires) installed above the phase conductors for lightening protection.

Distribution line structures may support a variety of conductor configurations. A distribution line could consist of three phase conductors only, or three separate phase conductors and a single neutral (grounded) conductor. The neutral conductor could be the top-most conductor on the supporting structure or it could be placed below or even with the phase conductors. Distribution lines could also consist of two phase conductors alone or two phase conductors and a neutral conductor, again with the neutral conductor being above, below, or even with the phase conductors. A distribution line may also have just a single phase conductor and a neutral conductor with the neutral being above, below, or even with the phase conductor. However, most distribution lines have the neutral conductor placed below the phase conductors. The neutral conductor is used to complete the electrical circuit and serves as part of the conducting path for phase current flowing from the mine back to the substation where the circuit originates. The earth itself serves as the other part of the return current path.

Avian Electrocutions and Powerline Design

Birds can be electrocuted by simultaneously contacting energized and/or grounded structures, conductors, hardware, or equipment. Electrocutions may occur because of a combination of biological and electrical design factors. Biological factors are those that influence avian use of poles, such as habitat, prey, and avian species. The electrical design factor most crucial to avian electrocutions is the physical separation between energized and/or grounded structures, conductors, hardware, or equipment that can be bridged by birds to complete a circuit. As a general rule, electrocution can occur on structures with the following;

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

- Phase conductors separated by less than the wrist-to-wrist or head-to-foot (flesh-to-flesh) distance of a bird. The wrist is the joint toward the middle of the leading edge of a bird's wing. The skin covering the wrist is the outermost fleshy part on the wing.
- Distance between grounded hardware (e.g., grounded wires, metal braces) and any energized phase conductor that is less than the wrist-to-wrist or head-to-foot (flesh-to-flesh) distance of a bird.

In the 1970s, Morley Nelson evaluated electrocution risks of eagles to identify configurations and voltages that could electrocute birds (Nelson 1979b, 1980b; Nelson and Nelson 1976, 1977). Because bird feathers provide insulation, contact must typically be made with fleshy parts, such as the skin, feet, or bill. Nelson determined that 60-inch spacing is necessary to accommodate the wrist-to-wrist distance of an eagle. As a result, a 60-inch separation has been widely accepted as the standard foe eagle protection since the 1975 edition of *Suggested Practices*. Although wingspans can measure up to 7.5 feet for golden eagles (*Aquila chrysaetos*) and 8 feet for bald eagles (*Haliaeetus leucocephalus*), the distance between fleshy parts (wrist-to-wrist) is less than 60-inches for both species. Therefore, a 60-inch separation should provide adequate spacing for an eagle to safely perch. Larger birds such as condors or storks may warrant special consideration; however, these species are not typically found in this region. The Bulldog Mine will concentrate on protecting species as large as eagles when designing and constructing powerlines.

Although avian-safe construction minimizes electrocution risk, electrocutions can never be completely eliminated. Because wet feathers and wet wood are conductive, birds can be electrocuted during wet weather on normally benign poles.

With an understanding of how birds can be electrocuted on powerlines, designs can be selected that are avian-safe and help to avoid and/or mitigate electrical hazards to birds. Voltage, conductor separation, and grounding practices are a particular concern when designing avian-safe structures; however, public safety, governed throughout the United States by the current National Electric Safety Code (NESC), and Mine Safety and Health Administration (MSHA) are the primary design considerations.

Avian Collisions and Powerline Design

Collisions with man-made structures are a major source of mortality for avian species. The risk of a fatal collision with a powerline is different among bird species with various characteristics impacting the risk, including: body size, weight, wing shape, flight behavior, and nesting habits. Additionally, the location of powerlines upon a landscape with relation to bird habitat is a major consideration in predicting and minimizing collisions. For example, placing powerlines adjacent to water bodies may increase the

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

likelihood of a powerline collision by waterfowl and other waterbirds. Additionally, risk of collision may be increased when a powerline is installed between resting areas, feeding areas, or along known migratory routes. Installing powerlines in a manner that considers landscape and topographical features can reduce the risk of collisions.

The construction and design of powerlines also has an impact on the risk of bird collisions. Line orientation can impact collision risk with powerlines running parallel to known flight paths posing less risk than powerlines oriented perpendicular. Line configuration also impacts the risk of collisions with vertically aligned phase conductors posing a greater collision risk than horizontally aligned phase conductors. Vertically aligned phase conductors present a larger collision area than horizontally aligned phase conductors. Additionally, multiple powerline poles can be clustered into a single right-of-way corridor to minimize collision risks by increasing the visibility and confining the network of lines to a smaller area.

Collision risk with powerlines can also be reduced by increasing the visibility of the phase conductors and static/shield lines. Several options for increasing powerline visibility include: increasing the diameter of the wire, bundling wire, and line marking. Line marking devices are an effective method of reducing avian collisions with powerlines. Line Markers attach directly to phase conductors or shield wires and visually alert birds of powerlines using several methods such as changing the profile of the wires; increasing their visibility by color, reflectivity, or glowing surfaces; or increasing their visibility through movable suspended markers. A list of line marking devices can be found in Chapter 6 of the 2012 Avian Collisions Manual.

Site Specific Plans

The NESC and MSHA dictate powerline phase-to-phase separations and the clearances of line components above ground. As such, both the distance between phase conductors and the distance that conductors are hung above ground is based on the line voltage and the activity that does and could take place in the area of the power line. These requirements are considered the minimum distances and separations needed to be certain that the facilities will not be harmful to the general public or the line crews that have to operate and maintain them.

Distribution lines are built with smaller separations between energized conductors and between energized conductors/hardware and grounded line components than are transmission lines. Consequently, avian electrocution risk is greater on distribution lines.

Transmission conductors are generally spaced 3 to 30 feet apart, and are supported on poles or towers that range from 50 to 120 feet in height. Distribution line conductors are generally spaced 2 to 6

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feet apart, and are supported on wood, steel, composite or concrete poles that range from 30 to 65 feet in height. As with transmission poles and towers, distribution poles can accommodate more than one circuit. The addition of jumper wires, transformers, switches, and electrical protective devices (fuses, reclosers, and other circuit sectionalizing equipment), as well as grounded hardware included on pole-top assemblies, increase the potential for avian electrocutions due to close separation of energized and grounded parts.

Although it is not realistic to expect to eliminate all hazards to birds, it is feasible to reduce known and potential hazards. At the Bulldog Mine, two basic principles (isolation and insulation) will be utilized to insure avian-safe powerlines to minimize electrocution hazards. The term isolation refers to providing a minimum separation of 60-inches between phase conductors or a phase conductor and grounded hardware/conductor. The isolation principle is the most effective method to minimize electrocution hazards. The term insulation refers to covering phases or grounds where adequate separation is not feasible. Examples of such coverings include, but may not be limited to, phase covers, bushing covers, arrester covers, cutout covers, jumper wire hoses, and covered conductors. In addition, perch discouragers may be used to deter birds from landing on pole locations that are hazardous to birds where isolation, covers, or other insulating techniques cannot be used. Perch discouragers are used to deter perching between closely separated phase conductors. Perch discouragers can be constructed from various materials and designs but most commonly used perch discouragers are triangular shaped objects that are mounted on power pole crossarms between phase conductors. Some equipment poles may necessitate using a combination of techniques to achieve avian safety.

Sunrise Coal will implement several techniques to prevent and reduce bird collisions with powerlines within the permit area. Rural distribution powerlines not owned or operated by Sunrise Coal run along the roads surrounding the permit area. In situations where rural distribution powerlines and utility lines run adjacent to open water within the permit area, Sunrise Coal will work with the powerline owner to install line markers to reduce the risk of collision for birds flying to and from the ponds. The model of line marker used will be based on availability and the approval of the powerline owner. If other areas of potential bird habitat are identified to occur adjacent to powerlines within the permit area then additional line markers will be installed to increase powerline visibility. Most ponds within the permit area will not have adjacent elevated powerlines but will use diesel powered pumps or have ground laid cables.

Distribution of electricity throughout the mine will originate from the primary substation located in the western corner of the permit area near the underground shaft entrances. Powerlines will be installed

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

between the substation, preparation plant, and other surface support buildings. There are no ponds adjacent to any of these structures. Most of the surface support buildings within the permit area will have exterior lighting at night which will increase the visibility of powerlines near these structures. Large soil stockpiles will be constructed adjacent to the preparation plant, coal yard, and powerline paths. The elevation of these stockpiles above the prevailing landscape will encourage any birds flying through the permit area to fly over hazards such as powerlines and conveyors. Additionally, phase conductors will be aligned horizontally to reduce the collision area of powerlines.

Sunrise Coal is committed to operating safe, environmentally conscious mining operations. This goal can only be achieved by properly designing and constructing our mining operations using the best technology currently available. The measures outlined in this plan intend to protect and minimize electrocution and collision hazards to raptors and other birds using the best technology currently available. As such, Sunrise Coal will utilize this plan to insure the best possible protections from electrocution and collision hazards are provided to raptors and other birds at the Bulldog Mine.

Protective Measures to Help Minimize Powerline Electrocution and Collision Hazards to Raptors and Other Birds

Literature Cited and Bibliography

The majority of information used to prepare this document was obtained from the following publication, *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (CEC-500-2006-022).

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Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT V-3B1

SITE SPECIFIC
PRE-MINING ASSESSMENT
ENDANGERED AND THREATENED SPECIES

Site Specific
Pre-Mining Assessment
Endangered and Threatened Species

Sunrise Coal - Bulldog Mine

Permit #429

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INTRODUCTION

Sunrise Coal, LLC has proposed an underground Room-and-Pillar mine (IDNR OMM #429) mined by 2 continuous miners to extract ~1.2-1.4 million tons of coal per year. The underground mine will be supported by 390.3 acres of surface support area in Vermilion County (T18N, R 14W, Sec 26 and 35), Illinois (Figure 1; pg. 12). The proposed permit area will be impacted by the construction and operation of surface support structures including: a preparation plant, coal stackers, coal stockpiles, soil stockpiles, refuse stockpiles, slurry impoundments, treatment ponds, sediment ponds, and underground mine portals.

This report provides a review of the endangered and threatened species known to occur within Vermilion Counties and the surrounding Illinois Counties and the likelihood that a species occurs within the permit area, pursuant to 62 Ill. Adm. Code 1780.16. This document identifies all habitats, resources, and land uses within the permit area.

METHODS

Aerial photos, soil maps, and geographic information were used to evaluate the habitat within and adjacent to the permit area. Additionally, an on-site investigation was conducted 26 March 2012 to identify and characterize the habitats within the permit area. A list of 77 endangered and threatened species known to occur within Vermilion County and adjacent counties (Iroquois, Ford, Champaign, Douglas, and Edgar) has been compiled to assist in the assessment of the potential biological resources within the proposed permit areas (Table 4, pg. 36-38). The proposed permit area is located in south western Vermilion County.

The habitat requirements of the 77 species listed in Vermilion, Iroquois, Ford, Champaign, Douglas, and Edgar Counties were investigated and described. Each species habitat requirements were compared to the habitats available at the permit areas and a determination was made concerning the likelihood of occurrence of each species on, and adjacent to, the permit area (Table 5, pg. 39-41; Table 6, pg. 42-43). Distributions and habitat requirements for evaluated species were obtained by referencing the Illinois Endangered Species Protection Boards' "Endangered and Threatened Species of Illinois: Status and Distribution; Vol. 1 – Plants (Herkert and Ebinger, ed. 2002), Vol. 2 – Animals, Vol. 3 – 2004 Plant Changes, and Vol. 4 – 2009 and 2010 Changes". Additional information on distributions and habitat requirements obtained from Illinois Natural History Survey collections database (www.inhs.uiuc.edu/animals_plants/ index.html, Accessed 3/28/2012).

Credentials

The determinations of the potential occurrence or impact upon protected resources by the proposed activities were made by Shawn Duncan, the staff Wildlife Biologist for Midwest Reclamation Resources, Inc. He received a Bachelor's of Science from Purdue University in Wildlife Science in 2005 and received a Master's of Science from Southern Illinois University Carbondale in Zoology in 2011. He has ten years of experience conducting vegetation and animal surveys and is qualified to conduct surveys and make habitat determinations for Endangered and Threatened Species within Illinois. Additionally, he has been trained and certified in conducting wetland delineations and other aspects of the Clean Water Act through a Certified Environmental Training program.

"ADJACENT AREA" DEFINED

As defined in 62 Ill. Adm. Code Section 1701.APPENDIX A, "'adjacent area' means the area located outside the permit area, or shadow area, where a resource or resources, determined according to the context in which adjacent area is used, are or reasonably could be expected to be adversely impacted by proposed mining operations."

Description of Mining Operations

The proposed mining plan for the 390.3 acre permit areas is to construct and operate support structures for a 13,025.5 acre underground mine. Structures constructed within the permit area include a preparation plant, coal stackers, coal stockpiles, soil stockpiles, refuse stockpiles, slurry impoundments, treatment ponds, sediment ponds, and underground mine portals. A potential future railroad loop may be constructed within the permit area to be used in transporting coal off-site. Two continuous miners will operate in a room-and-pillar mine with no planned subsidence.

Impacts of Mining Operations to Water Quality and Quantity

Development of surface facilities will result in soil disturbance and increased sediment yields in surface runoff. Increased sediment and turbidity will only occur within the permitted area since all effluent must pass through an approved sediment basin. Outflow from the sediment basin is required to meet all IEPA NPDES requirements. A detailed description of the water quality standards regulated by the IEPA NPDES can be found in Part III of the IDNR permit application. These standards include specific maximum allowable daily and 30-day average limits for water quality parameters (Table 1). Discharges that follow these standards will not impact the water quality of downstream aquatic resources.

There are approximately 18,943 acres within the Olive Branch Watershed. Drainage from the permit area will contribute ~ 2% of the total runoff within the Olive Branch Watershed. At the confluence of Olive Branch with Salt Fork there are approximately 242,691 acres within the Salt Fork Watershed. Drainage from the permit area will contribute ~0.16% of the total runoff within the Salt Fork Watershed. The reach of Olive Branch downstream of the last discharge point is approximately 7.7 miles to the confluence with Salt Fork which will provide a significant separation between the permit area and known mussel communities. Based on the size of the total contributing watersheds to the Salt Fork, there will be an approximately 622-fold reduction in concentrations of discharges from the permit area. Because the permit area accounts for such a small percentage (2%) of the total surface runoff within Olive Branch Watershed it is unlikely for the normal flow regime within Olive Branch to be significantly impacted by the small changes in flow from the permit area.

The total expected maximum volume of water that may discharge from the permit area is estimated at 28,000 gallons per day of underground pumpage as indicated in Part III(2)(D)(1)(a) of the permit application. Additional discharge volume will be associated with precipitation events. Sunrise Coal does not have detailed water quality data on the expected underground mine pumpage, however; water quality data is available for the nearby Riola Mine Complex, Vermilion Grove Portal and is representative of the expected discharges from the Bulldog Mine. The Vermilion Grove Portal is currently closed but operated from 2002-2009 before closing with water quality data available for 2008 and 2009 (Table 2). Additionally, Sunrise Coal has collected water quality samples for Olive Branch from 2011 – 2014 at locations upstream and downstream of the proposed discharge locations (Table 3).

A major threat to freshwater mussels is the siltation of streams and riverbeds. Surface water runoff from row crop agriculture in the Salt Fork watershed is likely to have more impact on water quality then the proposed NPDES discharges. Sediment and treatment ponds will be used to ensure that all effluent from the mine site meets IEPA water quality standards and protects downstream resources from harmful contaminants. The concentration of suspended solids expected to discharge from the permit area is equivalent to or lower then the suspended solids observed by the stream monitoring of Olive Branch.

Chlorides can have negative impacts on freshwater mussel glochidia viability in streams and rivers with elevated concentrations. Gillis (2011) examined the concentrations of sodium chloride (NaCl) that have impacts on the viability of freshwater mussel glochidia. Median effective concentrations (EC50) were estimated for 5 species of freshwater mussels, including: *Lampsilis siliquoidea* (fatmucket); *Lampsilis cardium* (plain pocketbook); *Lampsilis fasciola* (wavy-rayed lampmussel); *Epioblasma rangiana* (northern riffleshell); and *Pychobranchus fasciolaris* (kidneyshell). All of these species either occur or historically occurred within the Vermilion River watershed (Stodola et al. 2013). EC50 is the concentration of chloride at which an acute exposure (i.e., 24 hours) caused 50% of the sampled glochidia to become non-viable (i.e., lose the ability to close valves). Estimated EC50 values for acute chloride exposure in reconstituted water were highly variable with *Epioblasma rangiana* (244 mg/l) and *Lampsilis fasciola (*113-285 mg/l*)* being the most sensitive to the acute chloride exposures. However, *Lampsilis fasciola* exhibited much higher EC50 values (1265-1559 mg/l) for chloride exposures conducted in natural waters taken from the sample rivers form which mussels were collected. Additionally, water hardness exhibited a positive relationship with EC50 values indicating a potential mitigating factor for elevated chloride concentrations. Furthermore; the EC50 value for *Pychobranchus fasciolaris* glochidia encased in the species conglutinate lure was relatively high (3416 mg/l). These values provide a baseline concentration of chlorides that may predict potential impacts to freshwater mussel communities.

An analysis of the expected pollutant loading was completed for the IEPA NPDES application and included in the report entitled “Assessment of Alternatives for Minimal Environmental Degradation and Economic Benefit Analysis.” Based on a Mass Balance analysis of chloride concentrations there is an expected increase of 2.7 mg/L in chloride concentration in

Olive Branch above the average upstream sampled concentration. This increase in chloride concentration is small and well below the EC50 values that would have significant impacts to the freshwater mussel community. Similar small increases in concentrations can be expected from other water quality parameters and are unlikely to have any impact on downstream water quality and wildlife. Other sources of chloride within the Vermilion River watershed include deicing salt for roads, potassium chloride fertilizers for agricultural fields, and natural salt springs (Kelly et al. 2012). Many of these sources may have a greater impact upon the water quality of the Salt Fork and Olive Branch then the small regulated discharges from the permit area.

Within the permit area there are no ephemeral, intermittent, or perennial streams. Small roadside ditches are present along the roads bounding each section. The roadside ditches only drain upland agricultural fields and are vegetated by mowed cool season grasses. No affected area runoff from within the surface permit area will report to the roadside ditches prior to discharge from an IDNR/IEPA approved sedimentation basin. A drainage pipe running through the western portion of the permit area drains the agricultural fields within the permit area.

The onsite preparation plant will require a continuous source of water, and to provide this 2 treatment ponds will be constructed upstream of the sedimentation ponds. Water for the preparation plant will be circularly pumped to and from the treatment ponds. Sediment basins will be constructed to control any effluent discharged from the permit area. Excess water in the treatment ponds will drain into the sediment ponds. The sediment basins will result in smaller peak flows during storm events, due to the increased storage and delayed release of storm flow. Due to the water requirements of the preparation plant and the relatively small watershed of the permit area very little water is anticipated to discharge from the permit area.

Table 1. Proposed discharge limits for Bulldog Mine Draft IEPA NPDES Permit.

Discharge Condition	Parameters														
	Total Suspended Solids (3) (mg/l)		Iron (total) (3) (4) (mg/l)		pH (3) (S.U.)	Alkalinity/ Acidity (3)	Sulfate (1) (mg/l)	Chloride (mg/l)	Mn (total) (mg/l)		Hardness (5)	Mercury	Flow (MGD)	Settleable Solids (2) (ml/l)
	30 day average	daily maximum	30 day average	daily maximum					30 day average	daily maximum				
I	35	70	3.0	6.0	6.5-9.0	Alk.>Acid	1515	500	2.0	4.0	Monitor only	Monitor only	Measure When Sampling	-
II	-	-	-	-	6.0-9.0	-	1515	500	-	-	Monitor only	-	Measure When Sampling	0.5
III	-	-	-	-	6.0-9.0	-	1515	500	-	-	Monitor only	-	Measure When Sampling	-
IV	35	70	3.0	6.0	6.5-9.0	Alk.>Acid	1515	500	2.0	4.0	Monitor only	Monitor only	Measure When Sampling	-

(1) Sulfate water quality standards and effluent limiations determine in accordance with 35 Ill. Adm. Code 302.208(h).

(2) Settleable solids are monitored only as a result of a discharge due to precipitation events which exceed a predetermined 24-hour duration or snowmelt total. Settleable solids effluent limitations for alkaline mine discharges are contained in 35 Ill. Adm. Code 406.110.

(3) Effluent standards for mine discharges are contained in 35 Ill. Adm. Code 406.106.

(4) Discharges from Outfalls 001, 002 and 003, being approved after July 27, 1987, are subhect to a 30-day average effluent limitation for Iron of 3.0 mg/l. Daily maximum effluent concertrations area calculated as twice the 30-day average.

(5) Hardness monitoring is required to determine the appropriateness of the sulfate permit limit.

Table 1. Summarized water quality for Riola Mine Complex - Vermilion Grove Portal. NPDES Permit No. IL0074802 - DMRs (2008-2009).

Parameter	Minimum	Mean	Maximum
pH (SU)	7.5	*	8.82
Total Suspended Solids (mg/L)	1	10	33
Total Acidity (mg/L)	-74	< 5.9	130
Total Alkalinity (mg/L)	< 1	126	153
Total Iron (mg/L)	< 0.02	0.22	0.66
Total Manganese (mg/L)	0.01	0.198	0.44
Total Sulfate (mg/L)	66.7	439	714
Chloride (mg/L)	27	232	512

Table 2. Summarized water quality samples for Olive Branch (2011-2014).

Parameter	**Outfall 001 (Downstream)**			**Outfall 003 (Upstream)**		
	Min	Mean	Max	Min	Mean	Max
Flow (CFS)	0.000	7.979	75.000	0.000	1.428	16.667
pH (SU)	7.04	7.61	8.03	7.05	7.53	8.04
Temperature C	5.0	13.3	25.4	4.4	12.1	20.3
Acidity (mg/L)	<10	<10	<10	<10	<10	<10
Alkalinity (mg/L)	100.0	230.4	363.0	150.0	220.4	283.0
Chloride (mg/L)	6.0	17.7	64.0	6.0	16.6	34.5
Specific Conductivity (uS/cm)	580.0	694.0	762.0	710.0	763.5	807.0
Iron (mg/L)	0.05	0.33	0.84	0.05	0.33	1.90
Hardness (mg/L)	180.0	252.2	330.0	190.0	267.5	350.0
Manganese (mg/L)	0.0	0.1	0.7	0.005	0.057	0.530
Sulfate (mg/L)	1.00	10.86	42.00	6.0	26.7	50.0
Total Dissolved Solids (mg/L)	200.0	374.3	580.0	240.0	408.3	660.0
Total Suspended Solids (mg/L)	1.0	11.6	37.0	1.0	8.5	56.0

Impacts of Mining Operations to Noise

Mining operations such as construction, dozer and tractor operation, vehicular traffic, prep plant operation will increase the noise and vibration within the permit area and adjacent areas.

Impacts of Mining to Forested Habitat

The permit area consists entirely of agricultural fields with no forested habitats. A few isolated trees are located adjacent to the agricultural structures within the permit area. No significant impacts are anticipated by the removal of the few isolated trees.

Adjacent Area Defined for Different Groups of Species

Plants

No impacts to plants outside of the permit boundary line are anticipated. Operations within the permit area will not impact adjacent areas. The surrounding area is dominated by agricultural cropland and will not be disturbed by operations within the permit area. A distance of 0 ft is determined to be the adjacent area at which plants may be impacted.

Birds

Birds located adjacent to the permit area may be impacted by increased noise on the mine permit area. Noise can distract and alarm foraging and nesting birds, and even cause nesting birds to abandon their nests. It is difficult to determine the distance at which birds may be impacted by noise.

The National Bald Eagle Management Guidelines have established buffer distances at which Bald Eagles should not be disturbed by mining, off road vehicles, and blasting (USFWS 2007). The buffer distance suggested for mining, off-road vehicles is 660ft. The buffer distances recommended for blasting activities are ½ mile for areas with no direct line-of-sight to communal roosting sites or nests and 1 mile for areas with a direct line-of-sight to communal roosting sites or nests. Direct line-of-site is determined by whether or not there is an obstruction in view between the eagle and the blasting activity. Preferred obstructions include forested habitats and topographical buffers. Blasting is not proposed within the Bulldog Mine permit area; therefore 660 ft was determined to be the adjacent area at which Bald Eagles may be impacted.

These guidelines were determined to be the best available information and appropriate for other nesting and foraging birds. A distance of 660 ft was used in determining the adjacent area for birds other then bald eagles.

Terrestrial reptiles

Terrestrial reptiles located immediately adjacent to the permit boundary line may be impacted by noise and vibration. However, the habitats adjacent to the permit area are extremely poor for terrestrial reptiles. As a result, adjacent area for terrestrial reptiles is defined as 660 ft from the permit line. Terrestrial reptiles located outside of 660 ft from the permit area boundary would not be expected to be impacted by mining operations.

Aquatic reptiles

Aquatic reptiles located downstream of the permit area could be impacted by mining operations if water quality and/or quantity was expected to be impacted by the proposed mining operations. As discussed above, there are no expected negative impacts to water quality or quantity downstream of the proposed permit area. As a result, it is determined that the mining operations will not impact aquatic reptiles in adjacent areas therefore the adjacent area is considered 0 ft.

Fish

Fish located downstream of the permit area could be impacted by mining operations if water quality and/or quantity was expected to be impacted by the proposed mining operations. As discussed above, there are no expected negative impacts to water quality or quantity downstream of the proposed permit area. As a result, it is determined that the mining operations will not impact fish in adjacent areas therefore the adjacent area is considered 0 ft.

Freshwater Mussels

It is unlikely that freshwater mussels located downstream of the permit area will be impacted by the proposed mining operations. As discussed above, there are no expected negative impacts to water quality or quantity downstream of the proposed permit area. As a result, it is determined that the mining operations will not impact freshwater mussels in adjacent areas therefore the adjacent area is considered 0 ft.

Mammals

Mammals located immediately adjacent to the permit boundary line may be impacted by noise and vibration. However, the habitats adjacent to the permit area are extremely poor for mammals. As a result, adjacent area for mammals is defined as 660 ft from the permit line. Mammals located outside of 660 ft from the permit area boundary would not be expected to be impacted by mining operations.

Project Location

The surface permit area is located within Sections 26 and 35 of Township 18N and Range 14W in Vermilion County (Figure 1; pg. 10). The permit area is located in the southwestern ¼ and the southern ½ of the southeastern ¼ within section 26 and the northeastern ¼ of section 36 excluding a small 6-acre residential tract in the northeast corner of section 36.

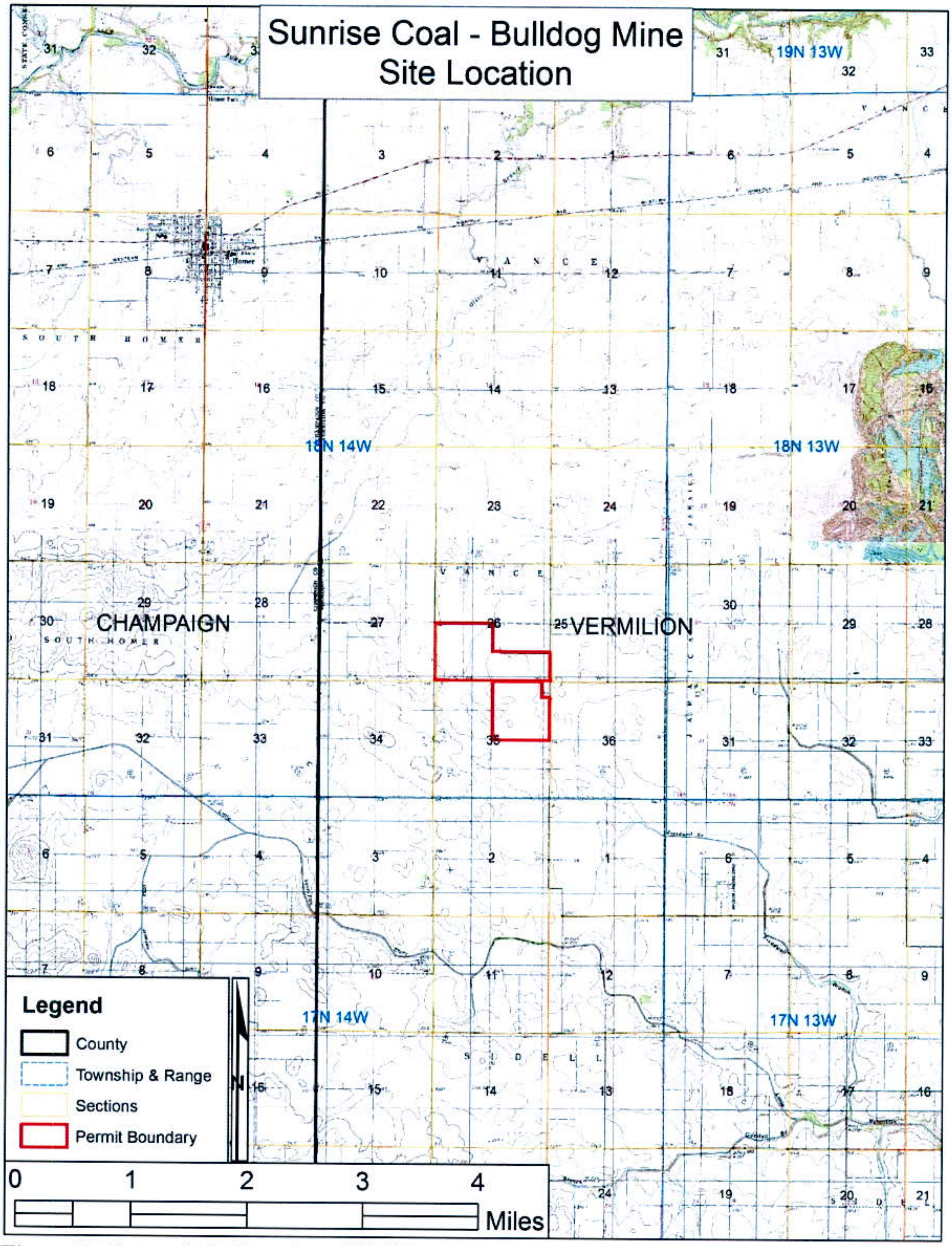

Figure 1. General site location of Bulldog Mine permit area in Section 26 & 36 of Township 18N and Range 14W in Vermilion County, IL.

SITE SPECIFIC RESOURCE INFORMATION

Site Description

The habitat within the permit area is entirely composed of intensive rowcrop agriculture (Figure 2; Pg. 14). The soils of the permit area are predominantly Mollisol "black prairie soils" Drummer and Flanagan silty clay loams.

Forest Habitat

There are no forest habitats within the permit area. A few isolated trees are located near a group of agricultural buildings.

Grassland Habitat

There are no grassland habitats within the permit area. A limited amount of grassy road-side ditches are located along the roads adjacent to the permit area.

Stream and Wetland Habitat

There are no stream or wetland habitats within the permit area. Wetland delineations were conducted throughout the permit area but did not identify any wetland habitats. Additionally, no ephemeral, intermittent, or perennial streams were identified within the permit area. Very small road-side ditches are located along the roads adjacent to the permit area. Additional information can be found in the attached report: "Site Specific Wetland and Stream Resources Pre-mining Assessment." There are no open water habitats within the permit area.

Miscellaneous Habitat

Of the 390.3 acres in the permit area all but 1.3 acres are intensive row-crop agriculture. The remaining 1.3 acres are associated with agricultural buildings and a few isolated trees.

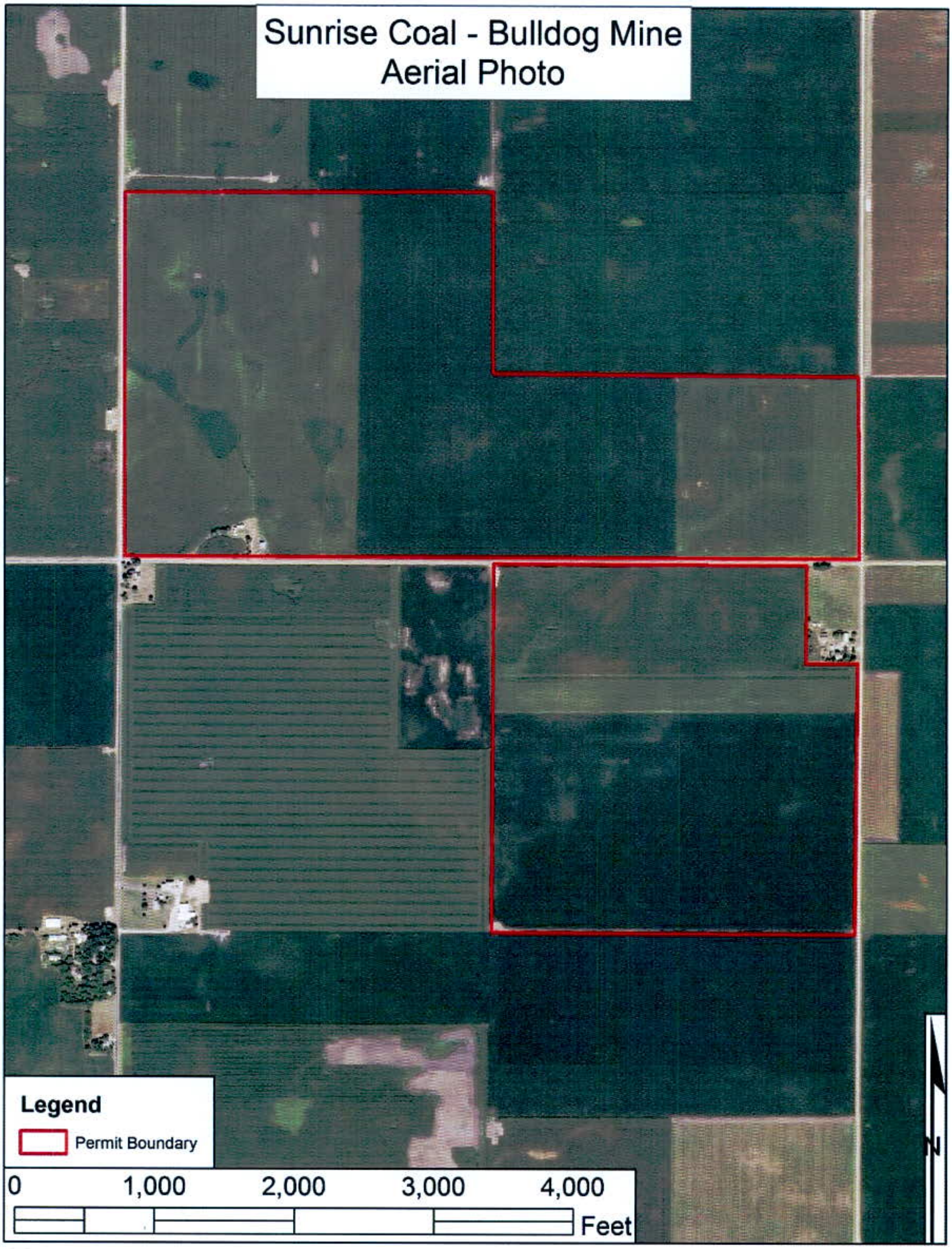

Figure 2. Aerial photo of Bulldog Mine permit area.

SPECIES INVESTIGATIONS

Arthropods

Swamp Metalmark (Calephelis muticum)

The state endangered Swamp Metalmark is found in wet meadows, marshes, and bogs and requires its host plant, *Cirsium muticum*, to successfully reproduce. In Illinois, the Swamp Metalmark is extremely rare and only known from a few locations. There are no wet meadows or other habitats within the permit area; therefore, it is unlikely for the Swamp Metalmark to occur within the permit area.

Regal Fritillary (Speyeria idalia)

The state threatened Regal Fritillary is found in tallgrass prairies, wet meadows, and other open habitats. There are no tallgrass prairies or other open habitats within the permit area; therefore, it is unlikely for Regal Fritillary to occur on or adjacent to the permit area.

Freshwater Mussels

Slippershell (Alasmidonta viridis)

The state threatened Slippershell is found in small to medium sized streams typically in sandy substrates in shallow water. In a major freshwater mussel survey, Stodola et al. (2013) did not document any Slippershell mussels occupying the Salt Fork River. There are no streams within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for Slippershells to be impacted by mining activities within the permit area.

Purple Wartyback (Cyclonaias tuberculata)

The state threatened Purple Wartyback is found in medium to large rivers with a bottom of mixed sand, gravel, or mud typically in areas of flowing current. Purple Wartyback mussels were documented in the Salt Fork River by Stodala et al. (2013). There are no rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for Purple Wartybacks to be impacted by mining activities within the permit area.

Spike (Elliptio dilatata)

The state threatened Spike is found in small to large stream and lakes in mud or gravel substrates. Only relict shells of Spike mussels were documented within the Salt Fork River by Stodola et al. (2013). There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for the Spike to be impacted by mining activities within the permit area.

Northern Riffleshell (Epioblasma rangiana)

The Northern Riffleshell is a federally endangered mussel that was previously extirpated from Illinois. In 2010, as part of a recovery plan for the Northern Riffleshell and Clubshell, live mussels were translocated into the Middle Fork and North Fork of the Vermilion River. The required habitat for Northern Riffleshells are gravel riffles in medium to large rivers. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely that the Northern Riffleshell will be impacted by mining activities within the permit area.

Snuffbox (Epioblasma triquetra)

The state endangered Snuffbox is typically found in medium to large rivers in clear, sand and gravel riffles. Stodola et al. (2013) did not document any Snuffbox mussels occupying the Salt Fork River. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely that the Snuffbox will be impacted by mining activities within the permit area.

Wavy-rayed Lampmussel (Lampsilis fasciola)

The state endangered Wavy-rayed Lampmussel is typically found in coarse sand and gravel bottomed rivers with flowing current. Wavy-rayed Lampmussels were documented in the Salt Fork River by Stodala et al. (2013). There are no rivers or streams within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for Wavy-rayed Lampmussels to be impacted by mining activities within the permit area.

Black Sandshell (Ligumia recta)

The state threatened Back Sandshell is found in medium to large rivers in riffles and raceways in gravel or firm sand substrates. Black Sandshell mussels were documented in the Vermilion River but not the Salt Fork River by Stodola et al. (2013). There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely that the Black Sandshell will be impacted by mining activities within the permit area.

Clubshell (Pleurobema clava)

The federally endangered Clubshell is found in small to medium sized rivers deeply buried in sand and fine gravel bottoms. In 2010, as part of a recovery plan for the Northern Riffleshell and Clubshell, live mussels were translocated into the Middle Fork and North Fork of the Vermilion River. Stodola et al. (2013) did not document any Clubshell mussels occupying the Salt Fork River. There are no rivers or streams within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for the Clubshell to be impacted by mining activities within the permit area.

Kidneyshell (Ptychobranchus fasciolaris)

The state endangered Kidneyshell is found in course sand and gravel substrates in flowing currents of small to medium sized rivers and in shallow riffles of larger rivers. Stodola et al. (2013) only documented relict and dead Kidneyshell mussels in the Vermilion and Little Vermilion watersheds. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely that the Kidneyshell will be impacted by mining activities within the permit area.

Rabbitsfoot (Quadrula cylindrica)

The state endangered Rabbitsfoot is found in sand and gravel substrates in flowing current of rivers. In Illinois, the Rabbitsfoot is limited to the North Fork of the Vermilion River. Stodola et al. (2013) documented live rabbitsfoot mussels in the North Fork of the Vermilion River and 1 relict shell in the middle fork of the Vermilion River. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely that the Rabbitsfoot mussel will be impacted by mining activities within the permit area.

Salamander Mussel (Simpsonaias ambigua)

The state endangered Salamander Mussel is most commonly on mud or gravel bars under flat stones in areas of swift current. The larval stage of the Salamander Mussel (glochidia) is dependent upon mudpuppies (Necturus maculosus). Stodola et al. (2013) did not document any Salamander mussels in the Vermilion River watershed.There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for the Salamander Mussel to occur within or be impacted by mining activities within the permit area.

Purple Lilliput (Toxolasma lividus)

The state endangered Purple Lilliput is found in sand or fine gravel beds (occasionally in mud) in small streams with shallow running water. In Illinois the Purple Lilliput is rare or uncommon in tributaries of the Wabash and Ohio rivers. Stodola et al. (2013) documented relict shells in the Salt Fork River and 1 live mussel in the North Fork of the Vermilion River. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for Purple Lilliputs to occur within or be impacted by mining activities within the permit area.

Rainbow (Villosa iris)

The state endangered Rainbow inhabits creeks and small to medium rivers in sandy or sand/mud bottom substrates associated with riffles. Stodola et al. (2013) documented 2 live Rainbow mussels in the Salt Fork River. There are no rivers or stream within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork River. It is unlikely for the Rainbow to occur within or be impacted by mining activities within the permit area.

Little Spectaclecase (Villosa lienosa)

The state threatened Little Spectaclecase is found in streams and small rivers with a mixed bottom of sand and mud in shallow water. Stodola et al. (2013) documented relict and dead shells of Little Spectaclecase mussels in the Salt Fork River. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or mussel populations in Olive Branch or the Salt Fork

River. It is unlikely for Little Spectaclecases to occur within or be impacted by mining activities within the permit area.

Fish

Eastern Sand Darter (Ammocrypta pellucidum)

The state threatened Eastern Sand Darter is found in sandy runs of small to medium rivers with good water quality and in water deeper than 60 cm. In Illinois the Eastern Sand Darter is known from the Vermilion, Embarras, and Little Wabash River systems. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Eastern Sand Darter to occur within or be impacted by mining activities within the permit area.

Gravel Chub (Erimystax x-punctatus)

The state threatened Gravel Chub is found in small rivers in deep riffles and channels of moderate to very fast current over substrate of gravel or firm sand-gravel. In Illinois, the Gravel Chub is known from the Rock River system and the Wabash River. There are no stream or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Gravel Chub to occur within or be impacted by mining activities within the permit area.

Bluebreast Darter (Etheostoma camurum)

The state endangered Bluebreast Darter inhabits large, clear streams near large boulders in fast riffles in 10-30 cm deep water. In Illinois, the Bluebreast Darter is known from the Vermilion River system. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Bluebreast Darter to occur within or be impacted by mining activities within the permit area.

Iowa Darter (Etheostoma exile)

The state threatened Iowa darters are found in vegetated lakes, pools of headwaters, and small to medium creeks. In Illinois, the Iowa Darter is known from glacial lakes and a few streams in Northeastern Illinois and Jordan Creek in Vermilion County. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Iowa darter to occur within or be impacted by mining activities within the permit area.

Starhead Topminnow (Fundulus dispar)

The state threatened Starhead Topminnow is found in glacial lakes and clear, well-vegetated floodplain lakes, swamps, and marshes over sand or mud. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Starhead Topminnow to occur within or be impacted by mining activities within the permit area.

Bigeye Chub (Hybopsis amblops)

The Bigeye Chub is found in flowing rocky pools near riffles and vegetation. Bigeye Chub are highly sensitive to degradation of the stream bottom due to siltation. In Illinois, the Bigeye Chub is known limited records from the Vermilion River, Little Vermilion River, Embarras River, and Little Wabash River. There are no streams or rivers within the permit area area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Bigeye Chub to occur within or be impacted by mining activities within the permit area.

Pallid Shiner (Hybopsis amnis)

The Pallid Shiner is found in medium to large rivers having clear water and a sand-silt substrate. In Illinois the Pallid Shiner is known from the upper reach of the Sangamon River and the lower reach of the Kankakee River. There are not streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Pallid Shiner to occur within or be impacted by mining activities within the permit area.

River Redhorse (Moxostoma carinatum)

The state threatened river redhorse is found in deep, swift, gravelly riffles of small to medium rivers. The species is intolerant of silty river bottoms, turbid water, intermittent flow, and pollution. Current records of the river redhorse in Illinois are limited to the upper Illinois river basin and the Vermillion river basin of the Wabash river. There are no rivers on or adjacent to the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. The river redhorse is unlikely to occur within or be impacted by mining activities within the permit.

River Chub (Nocomis micropogon)

The state endangered River Chub is found in rocky runs and flowing pools of small to medium rivers. In Illinois, the River Chub is known from the Little Vermilion River. There are no rivers on or adjacent to the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. The River Chub is unlikely to occur within or be impacted by mining activities within the permit.

Bigeye Shiner (Notropis boops)

The state endangered Bigeye Shiner is found in flowing, clear and rocky, pools of creeks and small to medium rivers. Typically, Bigeye Shiner are most often found in upland streams and creeks. There are no rivers on or adjacent to the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. The Bigeye Shiner is unlikely to occur within or be impacted by mining activities within the permit area.

Ironcolor Shiner (Notropis chalybaeus)

The state threatened Ironcolor Shiner is found in small, clear, low-gradient streams with a sand/organic matter substrate and an abundance of aquatic macrophytes. In Illinois, the Ironcolor Shiner is known from the Kankakee River and a tributary of the Sangamon River. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. The Ironcolor Shiner is unlikely to occur within or be impacted by mining activities within the permit area.

Blacknose Shiner (Notropis heterolepis)

The state endangered Blacknose Shiner occurs in clear vegetated lakes, and pools and runs of clear streams with sand and mud substrates. In Illinois, the Blacknose Shiner is primarily known from glacial lakes in northern Illinois. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Blacknose Shiner to occur within or be impacted by mining activities within the permit area.

Weed Shiner (Notropis texanus)

The state endangered Weed Shiner inhabits clear sand-bottom creeks with submerged vegetation. In Illinois, the Weed Shiner is known form the Kankakee and Green Rivers. There are no streams of rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Weed Shiner to occur within or be impacted by mining activities within the permit area.

Northern Madtom (Noturus stigmosus)

The state endangered Northern Madtom occurs in mixed sand and rock riffles and runs with debris in fast flowing small to large rivers. In Illinois, the Northern Madtom is only known from a few records including a recent record (within 20 years) from the Ohio river and an historical record from the Vermilion river. There are no streams or rivers within the permit area and discharges from the approved NPDES outfalls are unlikely to have any impact on downstream water quality or fish populations in Olive Branch or the Salt Fork River. It is unlikely for the Northern Madtom to occur within or be impacted by mining activities within the permit area.

Amphibians

Jefferson Salamander (Ambystoma jeffersonianum)

The state threatened Jefferson Salamander occurs in beech-maple upland deciduous forests where it resides in rodent burrows or under leaf litter, logs, and other surface debris. The known distribution of Jefferson Salamanders is restricted to Edgar and Marshal Counties. There are no deciduous forests within the permit area; therefore, it is unlikely for the Jefferson Salamander to occur within the permit area.

Silvery Salamander (Ambystoma platineum)

The state endangered Silvery Salamander is a unisexual polyploid that requires the presence of small-mouthed salamanders to successfully breed. The Silvery Salamander is only found at a nature preserve in Vermilion County in a wooded upland and adjacent mesic ravine with a vernal pool. There are no woodland or vernal pools within the permit area; therefore, it is unlikely for the Silvery Salamander to occur within the permit area.

Four-toed Salamander (Hemidactylium scutatum)

The state threatened Four-toed Salamander occur in boggy woodland ponds, sphagnum areas adjacent to woodlands, and springfed headwaters of small woodland streams. In Illinois, the Four-toed Salamander is sporadically located in isolated populations. There are moist woodlands within the permit area; therefore, it is unlikely for the Four-toed Salamander to occur within the permit area.

Mudpuppy (Necturus maculosus)

The state threatened Mudpuppy is found in lakes, ponds, rivers, and large creeks preferably with clear water. In Illinois, the Mudpuppy is known from a scattering of counties throughout the state with the most abundant sites near Lake Michigan. There are streams or rivers within the permit area; therefore it unlikely for the Mudpuppy to occur within the permit area.

Reptiles

Kirtland's Snake (Clonophis kirtlandi)

The state threatened Kirtland's Snake is found in wet meadows, open swamp-forests, reservoirs, and occasionally wet, vacant urban areas. In Illinois, the Kirtland's Snake is known from a few locations in East Central Illinois and North Eastern Illinois. There are no wet meadows or other habitats within the permit area; therefore, it is unlikely for the Kirtland's Snake to occur within the permit area.

Blanding's Turtle (Emydoidea blandingii)

The state threatened Blanding's Turtle is found in quiet waters in marshes, prairie wetlands, wet sedge meadows, and shallow, vegetated portions of lakes. In Illinois, the Blanding's Turtle is mostly known from Counties in Northeastern Illinois and previously from prairie marshes throughout northern Illinois prior to their draining. There are no marshes or other wetlands within the permit area; therefore, it is unlikely for the Blanding's Turtle to occur within the permit area.

Western Hog-nosed Snake (Heterodon nasicus)

The state threatened Western Hog-nosed Snake is associated with dry prairies with sandy soils. In Illinois, the Western Hog-nosed Snake is known from remnant prairies in Northwestern and west-central Counties. There are no sandy prairies within the permit area; therefore, it is unlikely for the Western Hog-nosed Snake to occur within the permit area.

Ornate Box Turtle (Terrapene ornate)

The ornate box turtle is found in prairies and grasslands across Illinois (Nyboer et al. 2006). The ornate box turtle prefers grasslands with sandy soils in which it can burrow (Redder et al. 2006). Illinois incorporates the eastern edge of the range for the ornate box turtle. The ornate box turtle is uncommon within Illinois. There are no areas of grassland habitat suitable for ornate box turtles within the permit area. It is unlikely that the ornate box turtle occurs on or adjacent to the permit area.

Birds

Short-eared Owl (Asio flammeus)

The state endangered Short-eared Owl is nests and forages in prairies, meadows, marshes, savanna, and dunes. Specifically, the Short-eared Owl is associated with 30-60 cm tall vegetation. The short-eared owl is one of the world's most widely distributed owls (Wiggins et al. 2006). The owl's range extends across all of North America with breeding populations present in Canada and the northern U.S., and wintering populations present in the southern U.S. and Mexico (Wiggins et al. 2006). There are no grassland or marshy habitats within the permit area; therefore, it is unlikely for the Short-eared Owl to occur within the permit area.

Upland Sandpiper (Bartramia longicauda)

The state endangered Upland Sandpiper is unique among shorebirds in that it is associated with upland pastures, prairies, and hay fields (Houston, Jackson, and Bowen 2011). The Upland Sandpiper is listed as an uncommon migrant and summer resident in Illinois (Nyboer et al. 2006). In Illinois, Upland Sandpipers generally breed in the northern half of the state. Upland Sandpipers require a diverse matrix of grassland habitats to successfully breed; including: short, medium, and tall grasslands created through disturbances such as grazing and prescribed burning. Additionally, Upland Sandpipers typically use large (> 250 acres) grassland habitats located within a landscape dominated by grasslands (Herkert et al. 1993). There are no grassland habitat within or adjacent to the permit area; therefore, it is unlikely for the Upland Sandpiper to occur within the permit area.

Northern Harrier (Circus cyaneus)

The state endangered Northern Harrier's range extends across all of North America with breeding populations present in Canada and the northern U.S., and wintering populations present in the southern U.S., Mexico, and Central America (Macwhirter et al. 1996). Northern harriers utilize open habitats such as grasslands, emergent wetlands, and agricultural areas (Robinson 1997, Macwhirter et al. 1996). There are no grasslands or emergent wetland within the proposed permit area; therefore, it is unlikely for the Northern Harrier to occur within the permit area.

Cerulean Warbler (Dendroica cerulea)

The state threatened Cerulean Warbler is a small, canopy-foraging songbird that breeds in mature and older deciduous forests with heterogeneous canopy structures (Hamel 2000). In Illinois this bird nests in the canopies of large dominant trees in the driest portions of bottomland forests. The Cerulean Warbler is typically considered an area-sensitive species but the strength of the relationship is unclear. Research from different regions have indicated significantly different results ranging from requirements for forest-tracts >1,600 ha to 20-30 ha large (Hamel 2000). There are no forested habitats within the permit area; therefore, it is unlikely for the Cerulean Warbler to occur within the permit area.

Common Moorhen (Gallinula chloropus)

The state endangered Common Moorhen breeds throughout much of the eastern United States and locally in the west (Bannor et al. 2002). It migrates to winter in southeastern and southwestern states with the largest concentration in Florida. The habitat of the Common Moorhen includes wetlands, such as: marshes, ponds, and ditches, where pools with deep water are interspersed with emergent or shoreline vegetation (Bannor et al. 2002). There are no wetlands within or adjacent to the permit area; therefore, it is unlikely for the Common Moorhen to occur within the permit area.

Least Bittern (Ixobrychus exilis)

The state threatened Least Bittern's breeding populations are distributed across the eastern U.S. and California (Poole et al. 2009). Year round populations are found in Florida and Central America, and wintering populations are found in the Baja Peninsula (Poole et al. 2009). The Least Bittern uses wetland habitat characterized by tall, dense emergent vegetation and clumps of woody plants over deep water (Poole 2009). There are no wetland habitats within or adjacent to the permit area; therefore, it is unlikely for the Least Bittern to occur within the permit area.

Loggerhead Shrike (Lanius ludovicianus)

The state endangered Loggerhead Shrike occupy many types of grassland habitats, but those containing shorter grasses interspersed with small trees and shrubs are generally preferred (Yosef 1996). Cattle pasture has become some of the most important habitat for loggerhead shrike. There are no grasslands within or adjacent to the permit area; therefore, it is unlikely for the Loggerhead Shrike to occur within the permit area.

Barn Owl (Tyto alba)

The state endangered Barn Owl is one of the most widespread vertebrate species on Earth, occurring on every continent except Antarctica (Marti et al. 2005). Barn owls inhabit open areas, including agricultural fields, grasslands and marshes. Their diet is dominated by voles and other small mammals (Marti et al. 2005). Barn owls nest and roost in a variety of places including hollows or natural cavities in trees, man-made structures, caves, and cliffs. There are no grasslands or forests within or adjacent to the permit; therefore, it is unlikely for the Barn Owl to occur within the permit area.

Mammals

Northern Long-eared Bat (Myotis Septentrionalis)

The northern long-eared bat has been listed by the U.S. Fish and Wildlife Service as threatened, effective May 4, 2015. To determine if northern long-eared bats will be impacted by the proposed activities, a habitat determination was conducted following the guidelines provided in the 2014 "Northern Long-Eared Bat Interim Conference and Planning Guidance". Based on the small area of available habitat within the permit area there is "Suitable" northern long-eared bat habitat within the permit area. A more detailed habitat determination can be found in the attached Report, "Indiana Bat (*Myotis* sodalis) and Northern Long-eared Bat (*Myotis septentrionalis*) Habitat Determination and Protection and Enhancement Plan".

Indiana Bat (Myotis sodalis)

The state and federally endangered Indiana Bat utilizes caves and mines to hibernate during the winter. The Indiana Bat utilizes trees with exfoliating bark or other cavities for roosting during the summer. Typically, Indiana Bats are associated with forested streams and other flyways where they feed 2-30 m above the ground. There are no forested habitats, trees with exfoliating bark, caves, or mines within the permit area characteristic of Indiana Bat habitat. Based on the available habitat within the permit area there are no "Suitable" or "Known" Indiana Bat habitat within the permit area as determined by the Revised 2013 "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines" (USFWS 2009). A more detailed habitat determination can be found in the attached Report, "Indiana Bat (*Myotis* sodalis) and Northern Long-eared Bat (*Myotis septentrionalis*) Habitat Determination and Protection and Enhancement Plan".

Franklin's Ground Squirrel (Spermophilus franklinii)

The state threatened Franklin's Ground Squirrel is associated with remnant prairies and other grassland habitats. In Illinois, the Franklin's Ground Squirrel is found along habitat edges with suitable cover and dry loose soils suitable for burrowing and hibernation during the winter. There are no suitable grassland or shrubland habitats within the permit area; therefore, it is unlikely for the Franklin's Ground Squirrel to occur within the permit area.

Plants

A total of 28 endangered or threatened plant species were identified as occurring within Vermilion, Iroquois, Ford, Champaign, Douglas, and Edgar Counties. This list of plant species was further sorted into the 3 ecological groups: Woodlands and Savannas, Grasslands and Prairies, Wetlands. Each ecological group's general habitat requirements were then compared against the available habitat within the permit area. The ecological groups and the species associated with each are identified in Table 5 – Plant Groups.

Woodlands and Savannas

The 8 species in the "Woodlands and Savannas" ecological group are found in a variety of forest habitats ranging from moist bottomlands to dry upland bluffs. There are no forest habitats within the permit area; therefore, it is unlikely for any of the endangered or threatened "Woodland and Savanna" plants to occur within the permit area.

Grasslands and Prairies

The 14 species in the "Grassland and Prairie" ecological group are found in a variety of remnant prairies, sand prairies, wet prairies, mesic barrens, and other open habitats. There are no grassland habitats within the permit area; therefore, it is unlikely for any of the endangered or threatened "Grassland and Prairies" plants to occur within the permit area.

Wetlands

The 6 species in the "Wetlands" ecological group are found in a variety of wet prairies, bogs, seeps, marshes, and other wetland habitats. There are no wetlands within the permit area; therefore, it is unlikely for any of the endangered or threatened "Wetland" plants to occur within the permit area.

Summary

Out of the 77 endangered or threatened species evaluated to occur within the Bulldog Mine permit area none were determined to be likely to occur within the permit area. The permit area is composed entirely of intensive row-crop agriculture and does not provide any quality wildlife habitat. Additionally, there are no expected impacts to adjacent habitats or downstream water quality or biological stream communities.

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Table 4. Endandgered and Threatened Species in Vermilion, Champaign, Douglas, Edgar, Ford, and Iroquois Counties, IL.

#	Scientific Name	Common Name	Group	Status	Vermilion	Champaign	Douglas	Edgar	Ford	Iroquois
1	*Calephelis muticum*	Swamp Metalmark	Invertebrate	Endandgered	X					
2	*Speyeria idalia*	Regal Fritillary	Invertebrate	Threatened						X
3	*Alasmidonta viridis*	Slippershell	Mussel	Threatened	X	X	X		X	
4	*Cyclonaias tuberculata*	Purple Wartyback	Mussel	Threatened	X	X				X
5	*Elliptio dilatata*	Spike	Mussel	Threatened		X	X			X
6	*Epioblasma rangiana*	Northern Riffleshell	Mussel	Endandgered **	X	X				
7	*Epioblasma triquetra*	Snuffbox	Mussel	Endandgered			X			
8	*Lampsilis fasciola*	Wavy-rayed Lampmussel	Mussel	Endandgered	X	X			X	
9	*Ligumia recta*	Black Sandshell	Mussel	Threatened						X
10	*Pleurobema clava*	Clubshell	Mussel	Endandgered **	X					
11	*Ptychobranchus fasciolaris*	Kidneyshell	Mussel	Endandgered	X		X			
12	*Quadrula cylindrica*	Rabbitsfoot	Mussel	Endandgered*	X					
13	*Simpsonaias ambigua*	Salamander Mussel	Mussel	Endandgered	X	X				
14	*Toxolasma lividus*	Purple Lilliput	Mussel	Endandgered	X		X			
15	*Villosa iris*	Rainbow	Mussel	Endandgered	X					
16	*Villosa lienosa*	Little Spectaclecase	Mussel	Threatened	X	X	X	X	X	X
17	*Ammocrypta pellucidum*	Eastern Sand Darter	Fish	Threatened	X	X			X	
18	*Erimystax x-punctatus*	Gravel Chub	Fish	Threatened	X					
19	*Etheostoma camurum*	Bluebreast Darter	Fish	Endandgered	X					
20	*Etheostoma exile*	Iowa Darter	Fish	Threatened	X					
21	*Fundulus dispar*	Starhead topminnow	Fish	Threatened						X
22	*Hybopsis amblops*	Bigeye Chub	Fish	Endandgered	X			X		
23	*Hybopsis amnis*	Pallid Shiner	Fish	Endandgered		X				
24	*Moxostoma carinatum*	River Redhorse	Fish	Threatened	X					
25	*Nocomis micropogon*	River Chub	Fish	Endandgered	X					
26	*Notropis boops*	Bigeye Shiner	Fish	Endandgered	X			X		
27	*Notropis chalybaeus*	Ironcolor Shiner	Fish	Threatened						X
28	*Notropis heterolepis*	Blacknose Shiner	Fish	Endandgered						X
29	*Notropis texanus*	Weed Shiner	Fish	Endandgered						X

Table 4. Continued

#	Scientific Name	Common Name	Group	Status	Vermilion	Champaign	Douglas	Edgar	Ford	Iroquois
30	*Noturus stigmosus*	Northern Madtom	Fish	Endandgered	X					
31	*Ambystoma jeffersonianum*	Jefferson Salamander	Amphibian	Threatened				X		
32	*Ambystoma platineum*	Silvery Salamander	Amphibian	Endandgered	X					
33	*Hemidactylium scutatum*	Four-toed Salamander	Amphibian	Threatened	X					
34	*Necturus maculosus*	Mudpuppy	Amphibian	Threatened	X	X		X		
35	*Clonophis kirtlandi*	Kirtland's Snake	Reptile	Threatened			X			
36	*Emydoidea blandingii*	Blanding's Turtle	Reptile	Endandgered	X	X				X
37	*Heterodon nasicus*	Western Hog-nosed Snake	Reptile	Threatened						X
38	*Terrapene ornata*	Ornate Box Turtle	Reptile	Threatened						X
39	*Asio flammeus*	Short-eared Owl	Bird	Endandgered	X					
40	*Bartramia longicauda*	Upland Sandpiper	Bird	Endandgered	X	X			X	
41	*Circus cyaneus*	Northern Harrier	Bird	Endandgered	X	X				
42	*Dendroica cerulea*	Cerulean Warbler	Bird	Threatened				X		
43	*Gallinula chloropus*	Common Moorhen	Bird	Endandgered			X			
44	*Ixobrychus exilis*	Least Bittern	Bird	Threatened	X	X				
45	*Lanius ludovicianus*	Loggerhead Shrike	Bird	Endandgered		X				
46	*Tyto alba*	Barn Owl	Bird	Endandgered		X			X	X
47	*Myotis septentrionalis*	Northern Long-eared Bat	Mammal	Threatened*						
48	*Myotis sodalis*	Indiana Bat	Mammal	Endandgered**	X	X			X	
49	*Spermophilus franklinii*	Franklin's Ground Squirrel	Mammal	Threatened	X	X			X	
50	*Asclepias meadii*	Mead's Milkweed	Plant	Endandgered*	X				X	
51	*Baptisia tinctoria*	Yellow Wild Indigo	Plant	Endandgered						X
52	*Calopogon tuberosus*	Grass Pink Orchid	Plant	Endandgered						X
53	*Carex arkansana*	Arkansas Sedge	Plant	Endandgered			X			
54	*Carex bromoides*	Sedge	Plant	Threatened	X					
55	*Carex communis*	Fibrous-rooted Sedge	Plant	Threatened	X					
56	*Carex cumulata*	Sedge	Plant	Endandgered						X
57	*Carex prasina*	Drooping Sedge	Plant	Threatened	X					
58	*Carex willdenowii*	Willdenow's Sedge	Plant	Threatened	X					
59	*Drosera intermedia*	Narrow-leaved Sundew	Plant	Threatened						X

Table 4. Continued

#	Scientific Name	Common Name	Group	Status	Vermilion	Champaign	Douglas	Edgar	Ford	Iroquois
60	*Filipendula rubra*	Queen-of-the-prairie	Plant	Endandgered	X				X	
61	*Hymenopappus scabiosaeus*	Old Plainsman	Plant	Threatened						X
62	*Hypericum adpressum*	Shore St. John's Wort	Plant	Endandgered						X
63	*Lycopodium dendroideum*	Ground Pine	Plant	Endandgered						X
64	*Phlox pilosa ssp. sangamonensis*	Sangamon Phlox	Plant	Endandgered		X				
65	*Platanthera clavellata*	Wood Orchid	Plant	Endandgered						X
66	*Platanthera flava var. herbiola*	Tubercled Orchid	Plant	Threatened						X
67	*Platanthera leucophaea*	Eastern Prairie Fringed Orchid	Plant	Endandgered*						X
68	*Poa wolfii*	Wolf's Bluegrass	Plant	Endandgered	X					
69	*Polygala incarnata*	Pink Milkwort	Plant	Endandgered						X
70	*Polygonum careyi*	Carey's Heartsease	Plant	Endandgered						X
71	*Rubus schneideri*	Bristly Blackberry	Plant	Threatened						X
72	*Silene regia*	Royal Catchfly	Plant	Endandgered	X					
73	*Sisyrinchium atlanticum*	Eastern Blue-eyed Grass	Plant	Threatened						X
74	*Tomanthera auriculata*	Ear-leafed Foxglove	Plant	Threatened		X				X
75	*Valerianella umbilicata*	Corn Salad	Plant	Endandgered						X
76	*Veronica scutellata*	Marsh Speedwell	Plant	Threatened						X
77	*Viola primulifolia*	Primrose Violet	Plant	Endandgered						X

* Federally Threatened

** Federally Endangered

Table 5. Habitat requirements and Probability of Occurrence of Illinois threatened and endangered animals at the Bulldog Mine permit area.

Species Name	Common Name	Habitat Type	Probability of Occurrence
		Invertebrate	
Calephelis muticum	Swamp Metalmark	Wet Meadows, Marshes, and Bogs	Not Likely
Speyeria idalia	Regal Fritillary	Tallgrass Prairie, Wet Meadows, Open Habitats	Not Likely
		Mussel	
Alasmidonta viridis	Slippershell	Small to Medium Streams	Not Likely
Cyclonaias tuberculata	Purple Wartyback	Medium to Large Rivers	Not Likely
Elliptio dilatata	Spike	Large Streams and Lakes	Not Likely
Epioblasma rangiana	Northern Riffleshell	Medium to Large Rivers	Not Likely
Epioblasma triquetra	Snuffbox	Medium to Large Rivers	Not Likely
Lampsilis fasciola	Wavy-rayed Lampmussel	Sandy and Gravel Bottomed Rivers	Not Likely
Ligumia recta	Black Sandshell	Medium to Large Rivers	Not Likely
Pleurobema clava	Clubshell	Small to Medium Rivers	Not Likely
Ptychobranchus fasciolaris	Kidneyshell	Small to Medium Rivers	Not Likely
Quadrula cylindrica	Rabbitsfoot	Sandy and Gravel Bottomed Rivers	Not Likely
Simpsonaias ambigua	Salamander Mussel	Mud or Gravel Bars under Flat Stones in Swift Current	Not Likely
Toxolasma lividus	Purple Lilliput	Sand or Fine Gravel in Small Streams	Not Likely
Villosa iris	Rainbow	Small to Medium Rivers	Not Likely
Villosa lienosa	Little Spectaclecase	Streams and Small Rivers	Not Likely
		Fish	
Ammocrypta pellucidum	Eastern Sand Darter	Sandy Runs of Small to Medium Rivers	Not Likely
Erimystax x-punctatus	Gravel Chub	Deep Riffles and Channels of Small Rivers	Not Likely
Etheostoma camurum	Bluebreast Darter	Near Large Boulders in Large Clear Streams	Not Likely

Table 5. Continued

Species Name	Common Name	Habitat Type	Probability of Occurrence
Etheostoma exile	Iowa Darter	Vegetated Lakes, Small and Medium Creeks	Not Likely
Fundulus dispar	Starhead topminnow	Glacial Lakes, Swamps, Marshes	Not Likely
Hybopsis amblops	Bigeye Chub	Rocky Pools near Riffles and Vegetation	Not Likely
Hybopsis amnis	Pallid Shiner	Medium to Large Rivers	Not Likely
Moxostoma carinatum	River Redhorse	Small to Medium Rivers	Not Likely
Nocomis micropogon	River Chub	Small to Medium Rivers	Not Likely
Notropis boops	Bigeye Shiner	Creeks, Small to Medium Rivers	Not Likely
Notropis chalybaeus	Ironcolor Shiner	Small, Clear, Low-Gradient Streams	Not Likely
Notropis heterolepis	Blacknose Shiner	Clear, Vegetated Lakes, Pools and Runs of Streams	Not Likely
Notropis texanus	Weed Shiner	Clear Sand-Bottom Creeks	Not Likely
Noturus stigmosus	Northern Madtom	Sand and Rock Riffles and Runs	Not Likely
		Amphibian	
Ambystoma jeffersonianum	Jefferson Salamander	Beech-Maple Upland Deciduous Forests	Not Likely
Ambystoma platineum	Silvery Salamander	Wooded Upland and Mesic Ravine in Vermilion County	Not Likely
Hemidactylium scutatum	Four-toed Salamander	Boggy Woodland Ponds	Not Likely
Necturus maculosus	Mudpuppy	Lakes, Ponds, Rivers, and Large Creeks	Not Likely
		Reptile	
Clonophis kirtlandi	Kirtland's Snake	Wet Meadows, Open Swamp-Forests, Reservoirs	Not Likely
Emydoidea blandingii	Blanding's Turtle	Marshes, Prairie Wetlands, Sedge Meadows, Lakes	Not Likely
Heterodon nasicus	Western Hog-nosed Snake	Dry-Prairies with Sandy Soils	Not Likely
Terrapene ornata	Ornate Box Turtle	Grasslands with Sandy Soils	Not Likely

Table 5. Continued

Species Name	Common Name	Habitat Type	Probability of Occurrence
		Bird	
Asio flammeus	Short-eared Owl	Prairies, Meadows, Marshes, Savanna, and Dunes	Not Likely
Bartramia longicauda	Upland Sandpiper	Upland Pastures, Prairies, and Hay Fields	Not Likely
Circus cyaneus	Northern Harrier	Grasslands, Emergent Wetlands, Agricultural Areas	Not Likely
Dendroica cerulea	Cerulean Warbler	Mature and Older Deciduous Forests	Not Likely
Gallinula chloropus	Common Moorhen	Marshes, Ponds, and Ditches with Interspersed Vegetation	Not Likely
Ixobrychus exilis	Least Bittern	Tall, Dense Emergent Vegetation over Deep Water	Not Likely
Lanius ludovicianus	Loggerhead Shrike	Grasslands with Shorter Grasses with Small Trees	Not Likely
Tyto alba	Barn Owl	Open Habitats: Agricultural Fields, Grasslands, and Marshes	Not Likely
		Mammal	
Myotis septentrionalis	Northern Long-eared Bat	Caves and Mines, Trees with cracks, crevices, and hollows	Presence Assumed
Myotis sodalis	Indiana Bat	Caves and Mines, Trees with Exfoliating Bark	Not Likely
Spermophilus franklinii	Franklin's Ground Squirrel	Remnant Prairies and other Grassland Habitats	Not Likely

Table 6. Habitat requirements and Probability of Occurrence of Illinois threatened and endangered plants at the Bulldog Mine permit area.

Species Name	Common Name	Habitat Type	Probability of Occurrence
		Woodlands and Savannas	
Baptisia tinctoria	Yellow Wild Indigo	Open Woodlands and Savannas with dry, sterile soils	Not Likely
Carex arkansana	Arkansas Sedge	Moist Flatwoods	Not Likely
Carex bromoides	Sedge	Wet Woods, Swamps, and Bogs	Not Likely
Carex communis	Fibrous-rooted Sedge	Open Rocky Woods	Not Likely
Carex prasina	Drooping Sedge	Forested Seeps and Sandstone Undercuts	Not Likely
Carex willdenowii	Willdenow's Sedge	Dry to mesic upland Forest	Not Likely
Lycopodium dendroideum	Ground Pine	Mesic Sand Forest, Sand Prairie, and Forested Ravines	Not Likely
Poa wolfii	Wolf's Bluegrass	Woodland	
		Prairie	
Asclepias meadii	Mead's Milkweed	Remnant Prairies, Barrens, Railroad Prairies	Not Likely
Carex cumulata	Sedge	Disturbed Fields, Open Savannas, Sand Prairies	Not Likely
Hymenopappus scabiosaeus	Old Plainsman	Sand Prairies and Open Sand Forests	Not Likely
Phlox pilosa ssp. sangamonensis	Sangamon Phlox	Forest Openings, Blufftops, and Prairies along the Sangomon River	Not Likely
Platanthera clavellata	Wood Orchid	Mesic Sand Prairies and Thickets	Not Likely
Platanthera leucophaea	Eastern Prairie Fringed Orchid	Mesic to Wet Prairies	Not Likely
Polygala incarnata	Pink Milkwort	Sand Prairies, Hill Prairies, and Barrens	Not Likely
Polygonum careyi	Carey's Heartsease	Sand Prairies	Not Likely
Rubus schneideri	Bristly Blackberry	Wet, Mestic Sand Prairies	Not Likely
Silene regia	Royal Catchfly	Dry-Messic Barrens and Prairies	Not Likely
Sisyrinchium atlanticum	Eastern Blue-eyed Grass	Mesic Prairie Habitat	Not Likely

Table 6. Continued

Species Name	Common Name	Habitat Type	Probability of Occurrence
Tomanthera auriculata	Ear-leafed Foxglove	Prairies and Savannas	Not Likely
Valerianella umbilicata	Corn Salad	Mesic to Dry Dolomite and Sandstone Bluffs, Low Ground, Sandy Slopes	Not Likely
Viola primulifolia	Primrose Violet	Wet-Mesic Sand Prairies	Not Likely
		Wetlands	
Calopogon tuberosus	Grass Pink Orchid	Wet Prairies , Bogs, and Fens	Not Likely
Drosera intermedia	Narrow-leaved Sundew	Peat Bogs and Wet Sand Prairies	Not Likely
Filipendula rubra	Queen-of-the-prairie	Fens, Mesic Sand Prairies, and Seeps	Not Likely
Hypericum adpressum	Shore St. John's Wort	Sandy Damp Peaty Areas	Not Likely
Platanthera flava var. herbiola	Tubercled Orchid	Wet-mesic sand prairies	Not Likely
Veronica scutellata	Marsh Speedwell	Marshes, Graminoid Fens, Wetlands	Not Likely

Sunrise Coal, LLC
Bulldog Mine
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ATTACHMENT V-3B2

BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*)
AND
GOLDEN EAGLE (*AQUILA CHRYSAETOS*)
RESOURCE REPORT

Attachment V-3B2

Bald Eagle (*Haliaeetus leucocephalus*)

and

Golden Eagle (*Aquila chrysaetos*)

Resource Report

Bulldog Mine

Permit #429

Vermilion County, IL

Prepared by

Shawn Duncan, M.S. Zoology

Midwest Reclamation Resources

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INTRODUCTION

Sunrise Coal, LLC has proposed an underground Room-and-Pillar mine (IDNR OMM #429) mined by 2 continuous miners to extract ~1.2-1.4 million tons of coal per year. The underground mine will be supported by 390.3 acres of surface support area in Vermilion County (T18N, R 14W, Sec 26 and 35), Illinois (Figure 1). To fulfill requirements for the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act a site-specific pre-mining assessment was conducted regarding the likelihood that bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*) occur on or adjacent to the proposed permit area. The "National Bald Eagle Management Guidelines" (USFWS 2007) were consulted to determine the potential impact of the proposed activities within the permit area to local bald eagles. This report identifies the likelihood of occurrence of eagles within the proposed permit area and identifies any potential conflict with eagles.

IMPACTS

The proposed permit area will be impacted by the construction and operation of surface support structures including: a preparation plant, coal stackers, coal stockpiles, soil stockpiles, refuse stockpiles, slurry impoundments, treatment ponds, sediment ponds, and underground mine portals. The surface areas of the permit will be cleared of all vegetation including trees while top soil will be removed and stored in stockpiles. Blasting is not proposed for this mining operation.

METHODS

Aerial photos, soil maps, and geographic information were used to evaluate the habitat within and adjacent to the permit area. Additionally, on-site inspections were conducted on 26 March 2012, 17 October 2014, and 20 October 2014 to identify and characterize the habitats within the permit area and to search for eagle nests within and adjacent to the permit area. Additionally, ebird.org, an online bird sighting database, was referenced for records of bald eagles and golden eagles throughout Vermilion County, Illinois.

RESULTS

Site Description

The permit area consists of 389 acres of cropland and 1.3 acres of industrial/commercial. The industrial/commercial area is associated with several agricultural grain bins and buildings.

Adjacent to these buildings are several trees including a wind row of 10-12 coniferous trees and several scattered deciduous trees. There are no lakes or large streams within 1 mile of the permit area that would provide suitable fishing habitat for eagles. The surrounding area is predominantly intensive row-crop agriculture and does not provide significant habitat for migratory birds or other animals protected by State or Federal Law.

Occurrence of Bald Eagles

On-site inspections and records of bald eagle nests and sightings near the permit area were used to evaluate the occurrence of bald eagles on or near the permit area (Figure 2). No bald eagles were detected during on-site inspections. The ebird.org database, accessed 4 May 2015, indicated bald eagle sightings at the nearby Fairmount Quarry (Site 1), Homer Lake Conservation Area (Site 2), and Salt Fork River (Site 3). The Fairmount Quarry, located approximately 2.5-3 miles northeast of the permit area, has a record of a single bald eagle on 30 April 2013. The Homer Lake State Conservation Area, located approximately 6.0 miles northwest of the permit area, has numerous bald eagle sightings in 2013, 2014, and 2015. Additionally, there is record dated 30 April 2013 of a bald eagle nest along the Salt Fork River located approximately 6.0 miles northeast of the permit area. All of these records are greater than 1 mile away from the permit area. There ebird.org database contains no records of golden eagles within Vermilion County.

Given the lack of bald eagle habitat within and directly adjacent to the permit area it is unlikely that the proposed activities will have a detrimental effect on bald eagles. The planned activities meet all the guidelines regarding distance to active nests, secondary nests, and communal roosts identified within the "National Bald Eagle Management Guidelines". Mining activities will not take place within 660 feet of an eagle nest and landscape buffers that screen the nest from mining activity will not be removed. There are no anticipated impacts to eagles as a result of the proposed mine operations.

LITERATURE CITED

U.S. Fish and Wildlife Service. 2007. National Bald Eagle Management Guidelines.

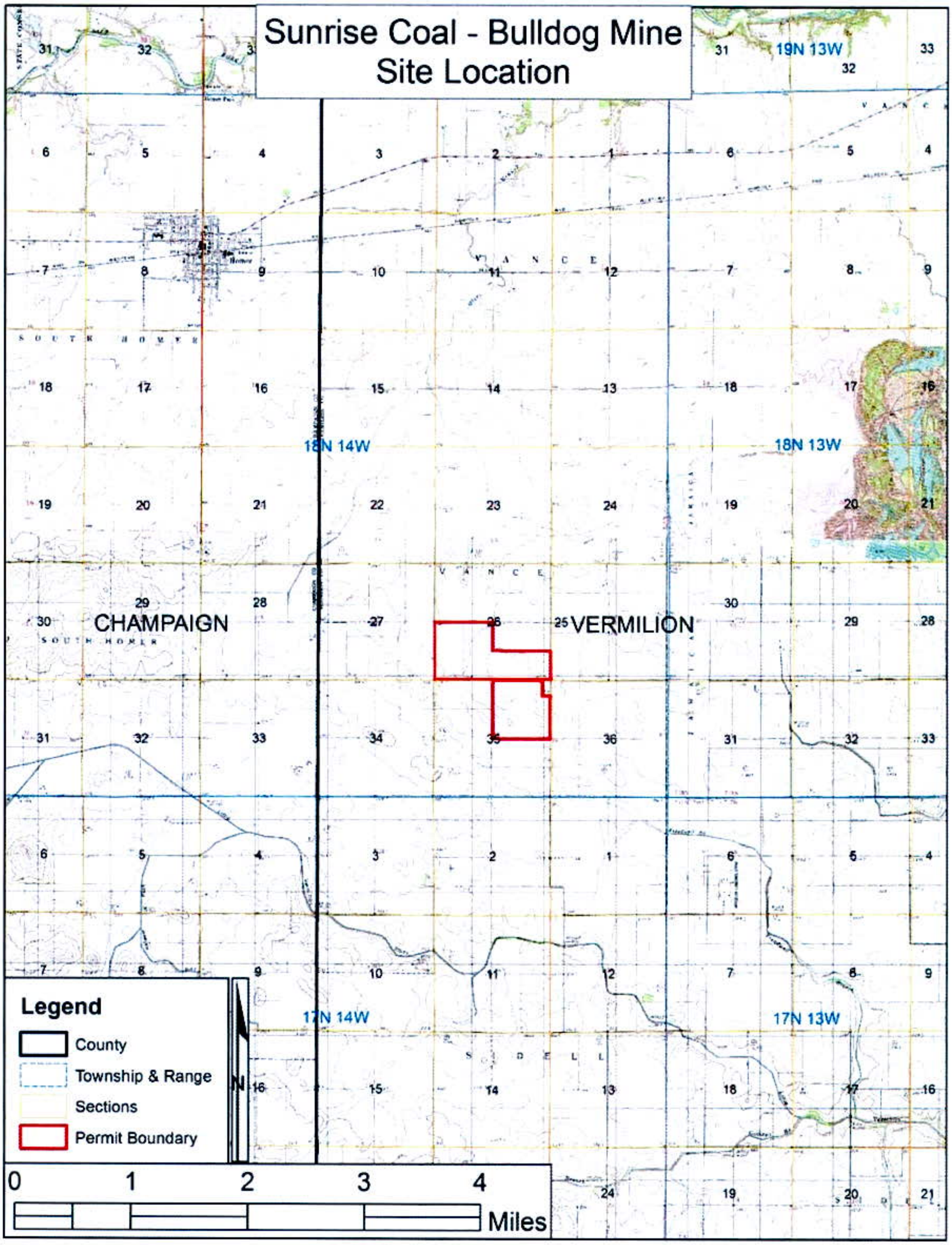

Figure 1. Location of the proposed surface operations for the underground Bulldog Mine.

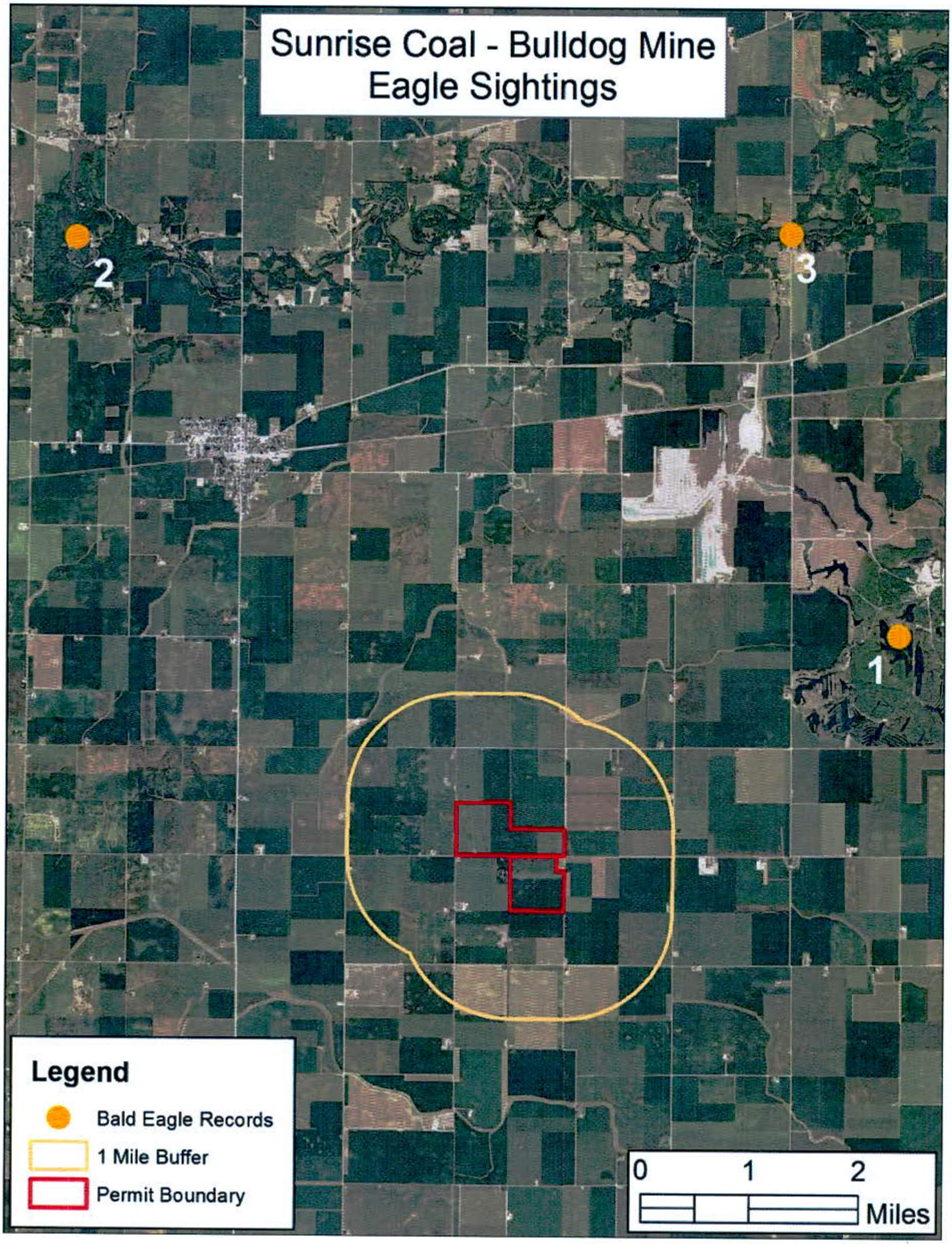

Figure 2. Eagle sightings near Bulldog Mine permit area.

Sunrise Coal, LLC
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ATTACHMENT V-3B3

SITE SPECIFIC
WETLAND AND STREAM RESOURCES
PRE-MINING ASSESSMENT

Attachment V-3B3

Site Specific
Wetland and Stream Resources
Pre-Mining Assessment

Sunrise Coal - Bulldog Mine

Permit # 429

Vermilion County, IL

Prepared by

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INTRODUCTION

Sunrise Coal, LLC has proposed an underground Room-and-Pillar mine (IDNR OMM #429) mined by 2 continuous miners to extract ~1.2-1.4 million tons of coal per year. The underground mine will be supported by 390.3 acres of surface support area in Vermilion County (T18N, R 14W, Sec 26 and 35), Illinois (Figure 1; pg. 4). The proposed permit area will be impacted by the construction and operation of surface support structures including: a preparation plant, coal stackers, coal stockpiles, soil stockpiles, refuse stockpiles, slurry impoundments, treatment ponds, sediment ponds, and underground mine portals. This report provides a review of the wetland and stream resources known to occur within the permit area.

METHODS

Wetlands were identified according to the criteria listed in "Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region". Wetland determinations were made based on the presence of hydrophytic vegetation, hydric soil, and wetland hydrology identified during site investigations. National Wetlands Inventory (NWI) data (Figure 2, pg. 5), USGS National Hydrography Dataset (NHD) (Figure 3, pg. 6), and National Resources Conservation Service (NRCS) soil maps (Figure 4, pg. 7) were used to help identify wetlands in addition to observations taken in the field. Wetland area delineations were determined through on-site inspections, GPS, and 2011 NRCS national USDA imagery. Wetland determination data forms can be found in Appendix A.

Site inspections were conducted on March 26, 2012. Baselines and transects were utilized to locate sample locations for wetland delineations (Figure 4, pg. 7). In the previous month there were 1.39 inches of precipitation including 0.23 inches of precipitation 3-days prior to the on-site inspection. This report identifies potential wetlands based on my expert opinion; however, final jurisdictional determination is contingent upon the U. S. Army Corps of Engineers (ACOE).

RESULTS

A NRCS soils report was reviewed to assist in wetland determinations (Figure 4, Page 7; Table 1). Two hydric soil-types occur within the proposed permit area: a Drummer silty clay loam, 0-2% slopes (152A); and a Harpster silty clay loam, 0-2% slopes (67A). The Drummer silty clay loam soil type consists of very deep poorly drained soils formed in loess or other silty material on nearly level or depressional areas. The Harpster silty clay loam soil type consists of very deep poorly drained soils formed in calcareous loess or glacial drift on nearly level or depressional areas. The most prominent soil types within the permit area are the Drummer silty clay loam and the Flanagan silt loam. The permit area is drained by road-side ditches and buried drainage tiles. The overall topography of the land is flat draining to the north into the Salt Fork of the Vermilion River.

Table 1. Soil types within the Bulldog Mine permit area.

Soil Mapping Unit	Soil Name	Hydric Rating	Acres
56B2	Dana silt loam, 2-5% slopes, eroded	Not Hydric	11.1
67A	Harpster silty clay loam, 0-2% slopes	Hydric	5.2
152A	Drummer silty clay loam, 0-2% slopes	Hydric	214.9
154A	Flanagan silt loam, 0-2% slopes	Not Hydric	157.3
171B	Catlin slit loam, 2-5% slopes	Not Hydric	1.8
			390.3

The NWI on-line wetlands mapper database was accessed to identify existing wetlands within the permit area (Figure 3, Page 6). Using infrared satellite imagery from the 1980's the NWI did not identify any wetlands. Based upon on-site inspections and wetland delineations there are no wetlands of any type within the permit area. The permit area is completely cultivated and farmed and possesses no wetland plants. Even though a large portion of the permit area is made up of Drummer silty clay loam (a hydric soil), the soils have improved drainage as a result of roadside ditches and underground drainage systems and do not exhibit any hydric soil indicators. The hydrology of the site has been altered resulting in the water table being lowered to a level that the upper 12 inches of soil are not saturated.

There are no streams within the permit area. Along the rural roads that bound the sections in area are shallow grassy ditches that collect drainage from the flat topography. An underground pipe collects drainage from the area and transports it north eventually into the Olive Branch, a tributary of the Salt Fork.

SUMMARY

There are no wetlands, streams, or other water bodies within the Bulldog Mine permit area. There are no jurisdictional waters of the U.S. within the Bulldog Mine permit area.

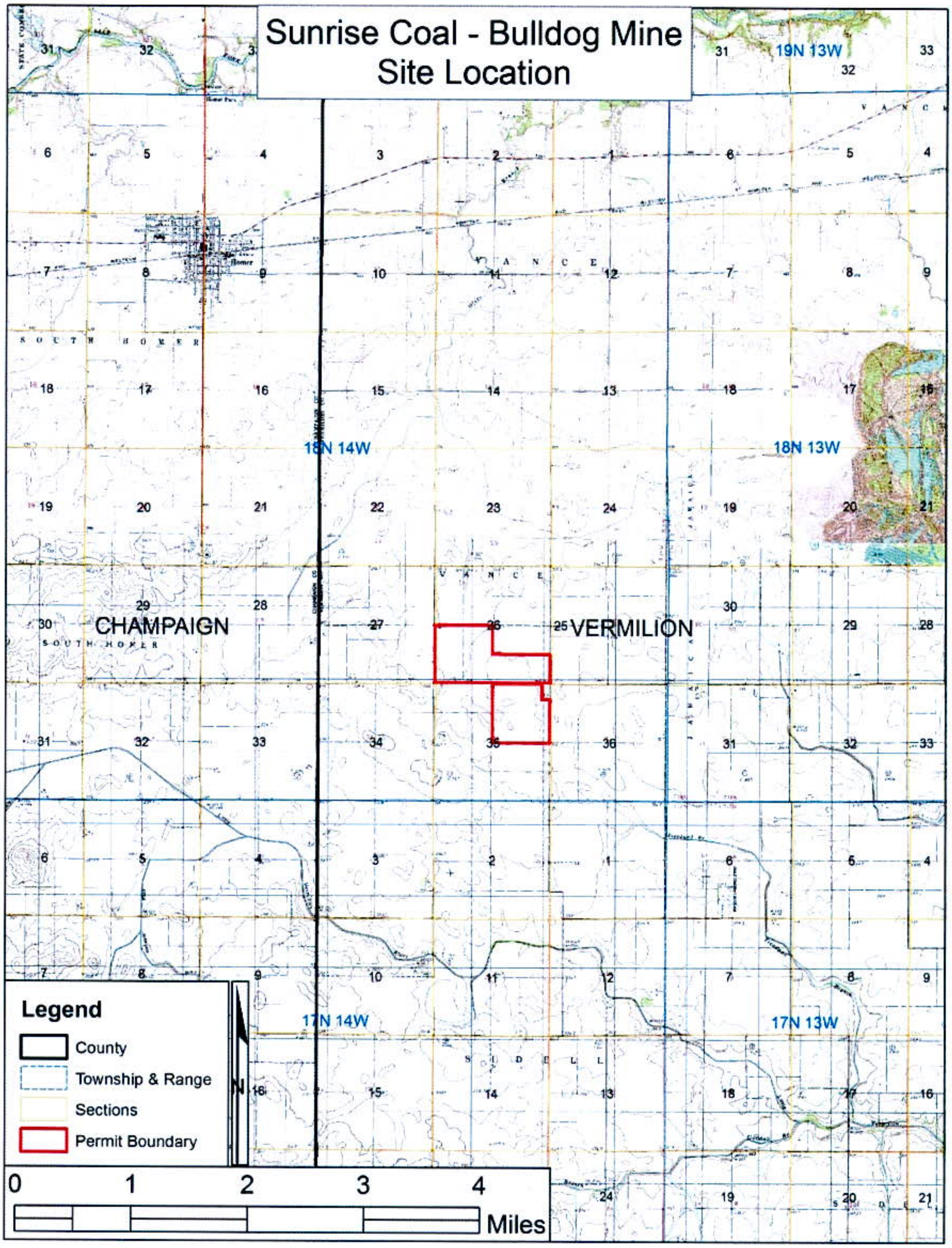

Figure 1. General site location of Bulldog Mine permit area in Section 26 & 36 of Township 18N and Range 14W in Vermilion County, IL.

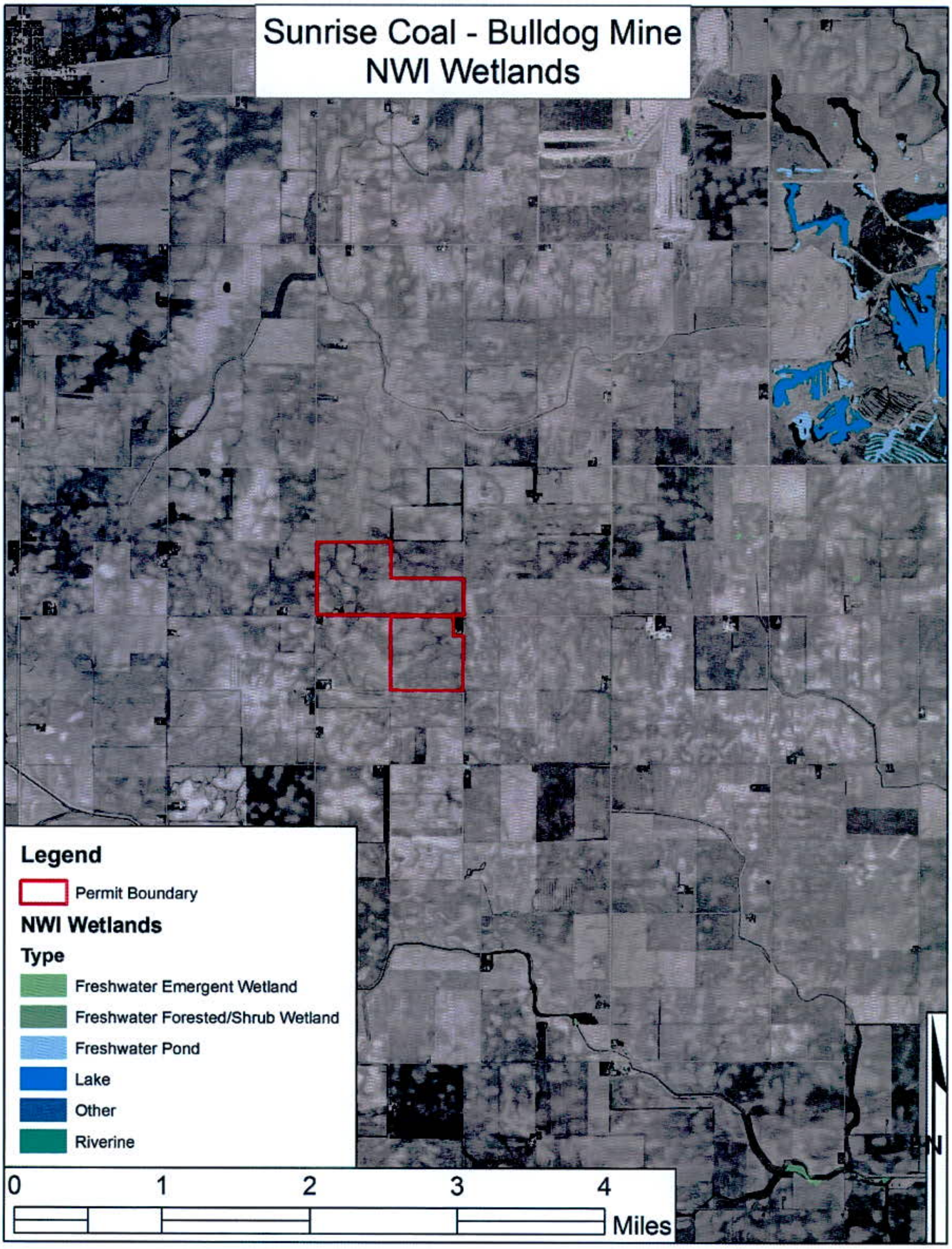

Figure 2. NWI wetlands identified near the Bulldog Mine permit area.

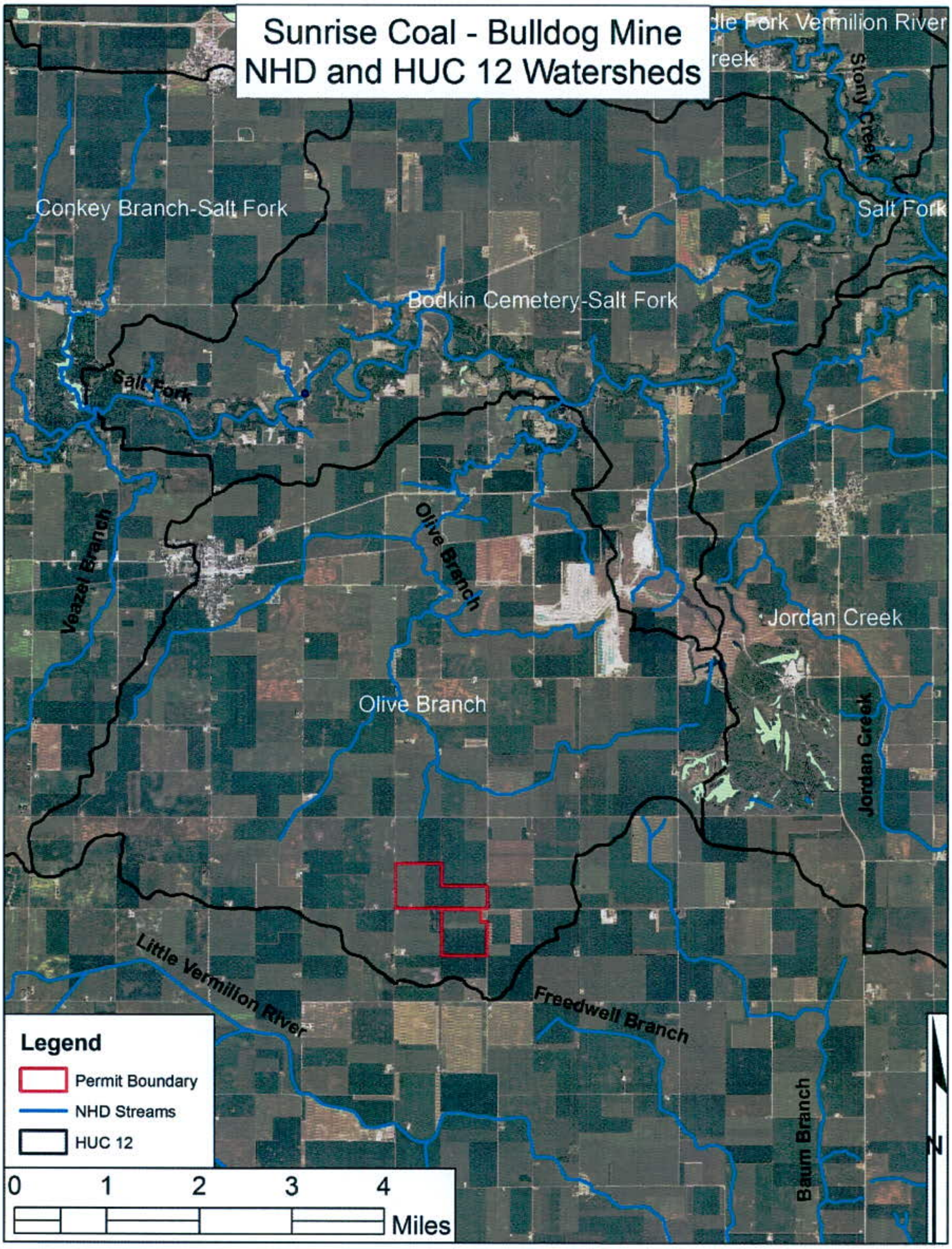

Figure 3. NHD streams and 12-digit HUC Watersheds near the Bulldog Mine permit area.

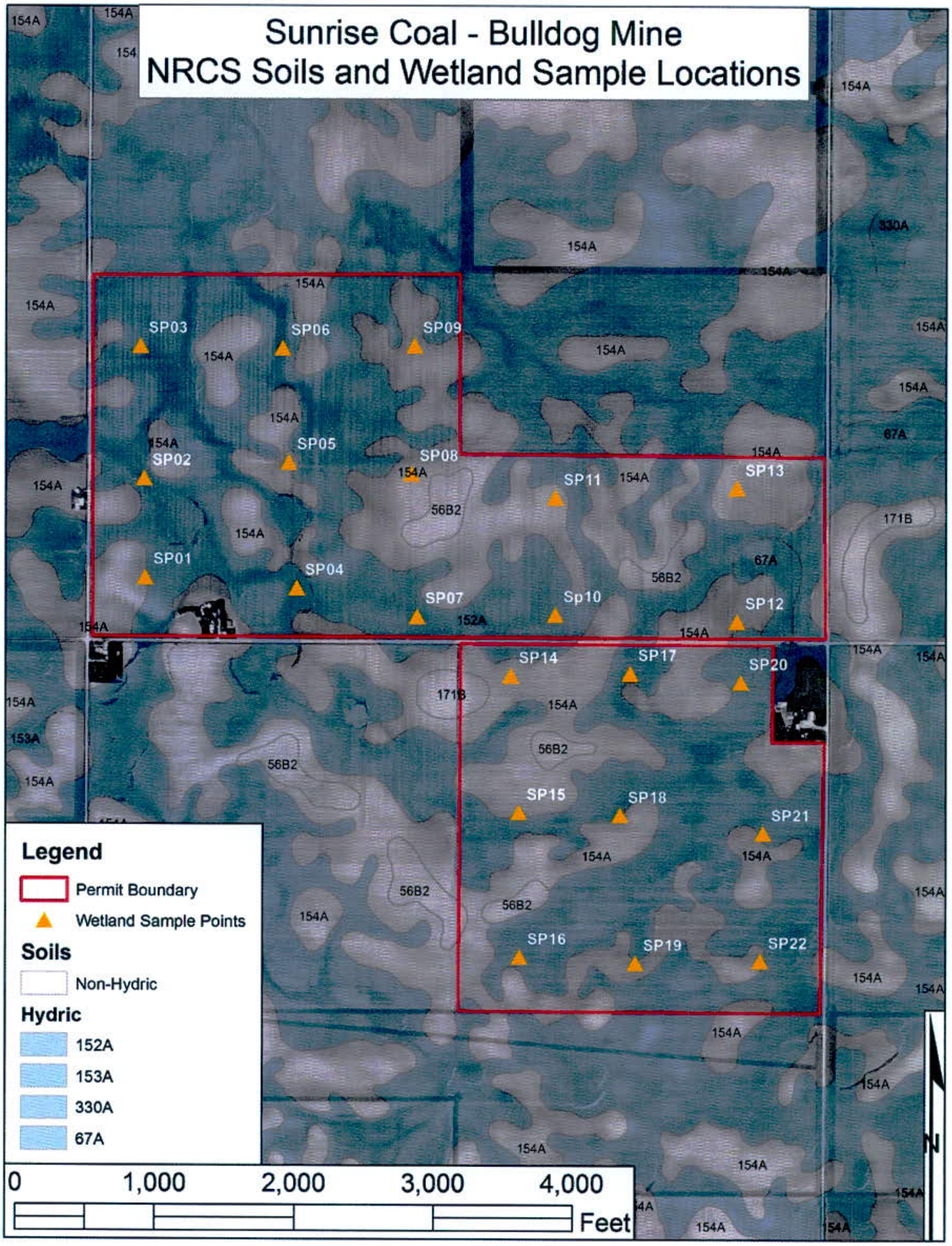

Figure 4. NRCS soils and locations of Wetland Sample points in the Bulldog Mine permit area.

PHOTOS

Photo 1. Photo of Bulldog Mine permit area.

Photo 2. Road-side ditches adjacent to the Bulldog Mine permit area.

APPENDIX A

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 01

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 59.316"N Long: 87° 55' 6.048"W Datum: NAD 83

Soil Map Unit Name: Flanagan Silt Loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓	
Wetland Hydrology Present?	Yes ___ No ✓	

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: NA)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot size: 10')			
1. Soybean stubble	70		NA
2. Bare Ground	30		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybean Stubble

SOIL — Bulldog Mine — Sampling Point: SP 01

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay loam	Black Prairie Soil
12-14	10YR 2/2	95					silty clay loam	
12-14	10YR 3/2	5					silty clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ 2 cm Muck (A10)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 5 cm Mucky Peat or Peat (S3)
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

__ Coast Prairie Redox (A16)
__ Iron-Manganese Masses (F12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ____ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Sparsely Vegetated Concave Surface (B8)
__ Water-Stained Leaves (B9)
__ Aquatic Fauna (B13)
__ True Aquatic Plants (B14)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres on Living Roots (C3)
__ Presence of Reduced Iron (C4)
__ Recent Iron Reduction in Tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Gauge or Well Data (D9)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Drainage Patterns (B10)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Stunted or Stressed Plants (D1)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ______
Water Table Present? Yes ____ No X Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): ______

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 02

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 6.416"N Long: 87° 55' 6.311"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ___	No ✓
Wetland Hydrology Present?	Yes ___	No ✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	65		NA
2. Bare Ground	35		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: NA)			
1.			
2.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag field - Soybean Stubble

SOIL

Bulldog Mine

Sampling Point: SP 02

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					Silty Clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 5 cm Mucky Peat or Peat (S3)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ Coast Prairie Redox (A16)
___ Iron-Manganese Masses (F12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ True Aquatic Plants (B14)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Gauge or Well Data (D9)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water Table Present? Yes ___ No x Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 15.729"N Long: 87° 55' 6.796"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland?	Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓		
Wetland Hydrology Present?	Yes ___ No ✓		

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	75		NA
2. Bare Ground	25		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: NA)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag field - Soybean Stubble

SOIL

Bulldog Mine

Sampling Point: SP 03

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty Clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ______

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 04

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 58.659" N Long: 87° 54' 52.103" W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓
Is the Sampled Area within a Wetland?		✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1. Bare Ground	100		
2.			
3.			
4.			
5.			
= Total Cover	100		
Herb Stratum (Plot size: NA)			
1. Bare Ground	100		
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size:)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field

SOIL Bulldog Mine Sampling Point: SP 04

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100						
12-15	10YR 3/2	70						
12-15	10YR 5/2	30						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): _____
Water Table Present?	Yes _____	No X	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 05

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 7.567" N Long: 87° 54' 52.903"W Datum: NAD 83

Soil Map Unit Name: Flanagan silt loam: 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean stubble	50		NA
2. Bare Ground	50		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag field - Soybean

SOIL

Bulldog Mine

Sampling Point: SP 05

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay loam	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** ______ **No** X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ____	Depth (inches): ________
Water Table Present?	Yes ____	No ____	Depth (inches): ________
Saturation Present? (includes capillary fringe)	Yes ____	No ____	Depth (inches): ________

Wetland Hydrology Present? **Yes** ______ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 06

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 15.775" N Long: 87° 54' 53.619"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland?	Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓		
Wetland Hydrology Present?	Yes ___ No ✓		

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	50		
2. Bare Ground	50		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field- soybeans

SOIL

Bulldog Mine

Sampling Point: SP 06

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ______ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ____________

Water Table Present? Yes ______ No X Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ____________

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 07

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 56.794" N Long: 87° 54' 41.135"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ___	No ✓
Wetland Hydrology Present?	Yes ___	No ✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean stubble	80		NA
2. Bare Ground	20		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - soybeans

SOIL Bulldog Mine Sampling Point: SP 07

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					Silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ______ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No x Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 08

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 6.943" N Long: 87° 54' 41.521" W Datum: NAD 83

Soil Map Unit Name: Flanagan silt loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓

Is the Sampled Area within a Wetland? Yes ☐ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	80		
2. Bare Ground	20		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field- Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 08

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100						Black Prairie Soil
12-14	10YR 2/2	90						
12-14	10YR 3/2	10						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ______

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 09

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 15.953" N Long: 87° 54' 41.585" W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam: 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ___	No ✓
Wetland Hydrology Present?	Yes ___	No ✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	75		
2. Bare Ground	25		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 09

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-14	10YR 2/2	100					Silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No x	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No x	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 10

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 57.093"N Long: 89° 54' 28.115" W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ✓
Hydric Soil Present?	Yes ☐	No ✓
Wetland Hydrology Present?	Yes ☐	No ✓

Is the Sampled Area within a Wetland? Yes ☐ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: NA)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean stubble	70		NA
2. Bare Ground	25		NA
3. Barbarea vulgaris arcuata	5	N	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: NA)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

__ Dominance Test is >50%

__ Prevalence Index is ≤3.0[1]

__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ______ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ____________

Water Table Present? Yes ______ No x Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes ______ No x Depth (inches): ____________

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 11

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 5.244"N Long: 87° 54' 28.279"W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam: 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓	
Wetland Hydrology Present?	Yes ___ No ✓	

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: NA)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 10')			
1. Soybean Stubble			
2. Bare Ground			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ___	x 1 = ___
FACW species ___	x 2 = ___
FAC species ___	x 3 = ___
FACU species ___	x 4 = ___
UPL species ___	x 5 = ___
Column Totals: ___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine — Sampling Point: SP 11

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay	Black Prairie Soil
12-14	10YR 2/2	80						
12-14	10YR 3/2	20						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	
Water Table Present?		x	
Saturation Present? (includes capillary fringe)		x	

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 12

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 56.709"N Long: 87° 54' 11.376"W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ✓	Is the Sampled Area within a Wetland?	Yes ☐	No ✓
Hydric Soil Present?	Yes ☐	No ✓			
Wetland Hydrology Present?	Yes ☐	No ✓			

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	70		
2. Bare Ground	30		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 12

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay	Black Prairie Soil
12-14	10YR3/2	100						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ______

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 13

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 59' 6.105" N Long: 87° 54' 11.5" W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ___	No ✓
Wetland Hydrology Present?	Yes ___	No ✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean stubble	70		NA
2. Bare Ground	30		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 13

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ 2 cm Muck (A10)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 5 cm Mucky Peat or Peat (S3)
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

__ Coast Prairie Redox (A16)
__ Iron-Manganese Masses (F12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ____ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Sparsely Vegetated Concave Surface (B8)
__ Water-Stained Leaves (B9)
__ Aquatic Fauna (B13)
__ True Aquatic Plants (B14)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres on Living Roots (C3)
__ Presence of Reduced Iron (C4)
__ Recent Iron Reduction in Tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Gauge or Well Data (D9)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Drainage Patterns (B10)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Stunted or Stressed Plants (D1)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ____

Water Table Present? Yes ____ No x Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ____ No x Depth (inches): ____

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 14

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 52.727"N Long: 87° 54' 32.24" W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ✓
Hydric Soil Present?	Yes ☐	No ✓
Wetland Hydrology Present?	Yes ☐	No ✓

Is the Sampled Area within a Wetland? Yes ☐ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: NA)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Bare soil	80		
2. Corn Stubble	20		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn Stubble

SOIL

Bulldog Mine

Sampling Point: SP 14

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					Silty Clay	Black Prairie Soil
12-14	10YR 2/2	95						
12-14	10YR 3/2	5						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ 2 cm Muck (A10)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 5 cm Mucky Peat or Peat (S3)
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Loamy Mucky Mineral (F1)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

__ Coast Prairie Redox (A16)
__ Iron-Manganese Masses (F12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________

Depth (inches): ________

Hydric Soil Present? Yes ____ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Sparsely Vegetated Concave Surface (B8)
__ Water-Stained Leaves (B9)
__ Aquatic Fauna (B13)
__ True Aquatic Plants (B14)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres on Living Roots (C3)
__ Presence of Reduced Iron (C4)
__ Recent Iron Reduction in Tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Gauge or Well Data (D9)
__ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Drainage Patterns (B10)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Stunted or Stressed Plants (D1)
__ Geomorphic Position (D2)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No x	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No x	Depth (inches): ____

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 15

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 43.08" N Long: 87° 54' 31.332"W Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland?	Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓		
Wetland Hydrology Present?	Yes ___ No ✓		

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean stubble	70		
2. Bare Ground	30		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybean stubble

SOIL

Bulldog Mine

Sampling Point: SP 15

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10Yr 2/2	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** ____ **No** X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ____

Water Table Present? Yes ____ No x Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ____ No x Depth (inches): ____

Wetland Hydrology Present? **Yes** ____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 16

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 32.611" N Long: 87° 54' 31.193" W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ✓	Is the Sampled Area within a Wetland? Yes ☐ No ✓
Hydric Soil Present?	Yes ☐ No ✓	
Wetland Hydrology Present?	Yes ☐ No ✓	

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Soybean Stubble	85		NA
2. Bare Ground	15		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 16

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100						Black Prairie Soil
12-15	10YR 3/2	5						
12-15	10YR 2/1	95						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 5 cm Mucky Peat or Peat (S3)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ Coast Prairie Redox (A16)
___ Iron-Manganese Masses (F12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ____ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ True Aquatic Plants (B14)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Gauge or Well Data (D9)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ______

Water Table Present? Yes ____ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ____ No x Depth (inches): ______

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 17

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 52.9" N Long: 87° 54' 52.143"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓	
Wetland Hydrology Present?	Yes ___ No ✓	

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: NA)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 10')			
1. Corn Stubble	40		NA
2. Bare Ground	60		NA
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn field

SOIL

Bulldog Mine

Sampling Point: SP 17

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water Table Present? Yes ___ No x Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 18

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 42.814"N Long: 87° 54' 22.074"W Datum: NAD 83

Soil Map Unit Name: Drummer/Flanagan silty clay loam; 154A/152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ✓
Hydric Soil Present?	Yes ☐	No ✓
Wetland Hydrology Present?	Yes ☐	No ✓

Is the Sampled Area within a Wetland? Yes ☐ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Corn stubble	80		
2. Bare Ground	20		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn

SOIL

Bulldog Mine

Sampling Point: SP 18

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	90					silty clay	black Prairie Soil
0-12	10YR 3/1	10						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ______

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 19

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 32.377" N Long: 87° 54' 20.464" W Datum: NAD 83

Soil Map Unit Name: Finagan silty clay loam;154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ___	No ✓
Wetland Hydrology Present?	Yes ___	No ✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Bare Ground	95		
2. Soybean Stubble	5		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag field - Soybeans

SOIL

Bulldog Mine

Sampling Point: SP 19

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	80					silty clay	Black Prairie Soil
0-12	10YR 3/2	20						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water Table Present? Yes ___ No x Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 20

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 52.48"N Long: 87° 54' 11.024"W Datum: NAD 83

Soil Map Unit Name: Drummer silty clay loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland?	Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓		
Wetland Hydrology Present?	Yes ___ No ✓		

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Corn Stubble	60		
2. Bare soil	40		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn

SOIL Bulldog Mine Sampling Point: SP 20

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/1	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

Mollisol - drained, no hydric indicators

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No x Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No x Depth (inches): ______

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 21

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 58' 41.684"N Long: 87° 54' 8.807"W Datum: NAD 83

Soil Map Unit Name: Drummer silty loam; 152A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 10')			
1. Corn Stubble	90		
2. Bare Soil	10		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	100		
Woody Vine Stratum (Plot size:)			
1.			
2.			
= Total Cover			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn

SOIL

Bulldog Mine

Sampling Point: SP 21

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ___ No X

Remarks:

Mollisol - Drained, no hydric indicators

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ______

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: Bulldog Mine City/County: Vermilion County Sampling Date: 3/26/2012

Applicant/Owner: Sunrise Coal LLC. State: IL Sampling Point: SP 22

Investigator(s): Shawn Duncan Section, Township, Range: Sections 26 & 35, T 18N, R 14W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none

Slope (%): 0 Lat: 39° 54' 8.813" W Long: 39° 58' 32.478"N Datum: NAD 83

Soil Map Unit Name: Flanagan silty clay loam; 154A NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes ___ No ✓	
Wetland Hydrology Present?	Yes ___ No ✓	

Remarks:

Farmed black prairie soils (Mollic epipedon). Historically drained ca. 1920's. Hydrophytic vegetation not present, hydric soil indicators not present, and wetland hydrology not present.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: NA)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 10')			
1. Corn Stubble	90		
2. Bare Ground	10		
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: NA)			
1.			
2.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ___ (A)

Total Number of Dominant Species Across All Strata: ___ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: NA (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = NA

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Ag Field - Corn

SOIL

Bulldog Mine

Sampling Point: SP 22

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 2/2	100					silty clay	Black Prairie Soil

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ____ No X

Remarks:

Mollisol - Drained

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Gauge or Well Data (D9)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland hydrology not observed. Historic tiling and draining has lowered the average water table below 12". Observed water table was ca. 4 ft. below surface (as observed through existing bore hole pit).

SUNRISE COAL, LLC
Bulldog Mine
Permit No. 429

ATTACHEMENT V-3B4

INDIANA BAT (*MYOTIS SODALIS*)
AND
NORTHERN LONG-EARED BAT (*MYOTIS SEPTENTRIONALIS*)
HABITAT DETERMINATION
AND
PROTECTION AND ENHANCEMENT PLAN

Attachment V-3B3

Indiana Bat (*Myotis sodalis*)
and
Northern Long-eared Bat (*Myotis septentrionalis*)
Habitat Determination
And
Protection and Enhancement Plan

Sunrise Coal, LLC
Bulldog Mine
Permit #429
Vermilion County, IL

Prepared by Shawn Duncan, M.S. Zoology

Midwest Reclamation Resources
1023 North 14th Street
P.O. Box 1642
Murphysboro, IL 62966

TABLE OF CONTENTS

INTRODUCTION

Sunrise Coal, LLC has proposed an underground Room-and-Pillar mine (IDNR OMM #429) mined by 2 continuous miners to extract ~1.2-1.4 million tons of coal per year. The underground mine will be supported by 390.3 acres of surface support area in Vermilion County (T18N, R 14W, Sec 26 and 35), Illinois (Figure 1; pg. 7). Coal mining operations may affect the Indiana bat (Myotis sodalis; INBA) and Northern Long-eared Bat (Myotis septentrionalis; NLEB) in situations where proposed surface disturbance areas are located near a documented Indiana bat or Northern Long-eared Bat hibernaculum, maternity roost, and or collection record, or when forested habitat which could serve as foraging, roosting, or travel corridor habitat is cleared to facilitate the mining activity (USFWS 2009).

In February 2013, a revised edition of the "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines for Surface Coal-Mining Operations" (here-after referred to as "the guidelines") were established in order to set minimum standards for determining the presence of Indiana bat habitat and developing Indiana bat Protection and Enhancement Plans. Additionally, the U.S. Fish and Wildlife Service (FWS) has approved the listing of the Northern Long-eared Bat for listing as threatened under the Endangered Species Act, effective May 4, 2015. Range-wide guidelines have not been developed for the Northern Long-eared Bat but in the meantime the Indiana Bat guidelines and the "Northern Long-Eared Bat Interim Conference and Planning Guidance" (USFWS 2014) will be used to determine the presence of Northern Long-eared Bat habitat and developing Northern Long-eared Bat Protection and Enhancement Plans. The following report was prepared in accordance with these guidelines.

IMPACT

The proposed permit area will be impacted by the construction and operation of surface support structures including: a preparation plant, coal stackers, coal stockpiles, soil stockpiles, refuse stockpiles, slurry impoundments, treatment ponds, sediment ponds, and underground mine portals. The surface areas of the permit will be cleared of all vegetation including trees while top soil will be removed and stored in stockpiles.

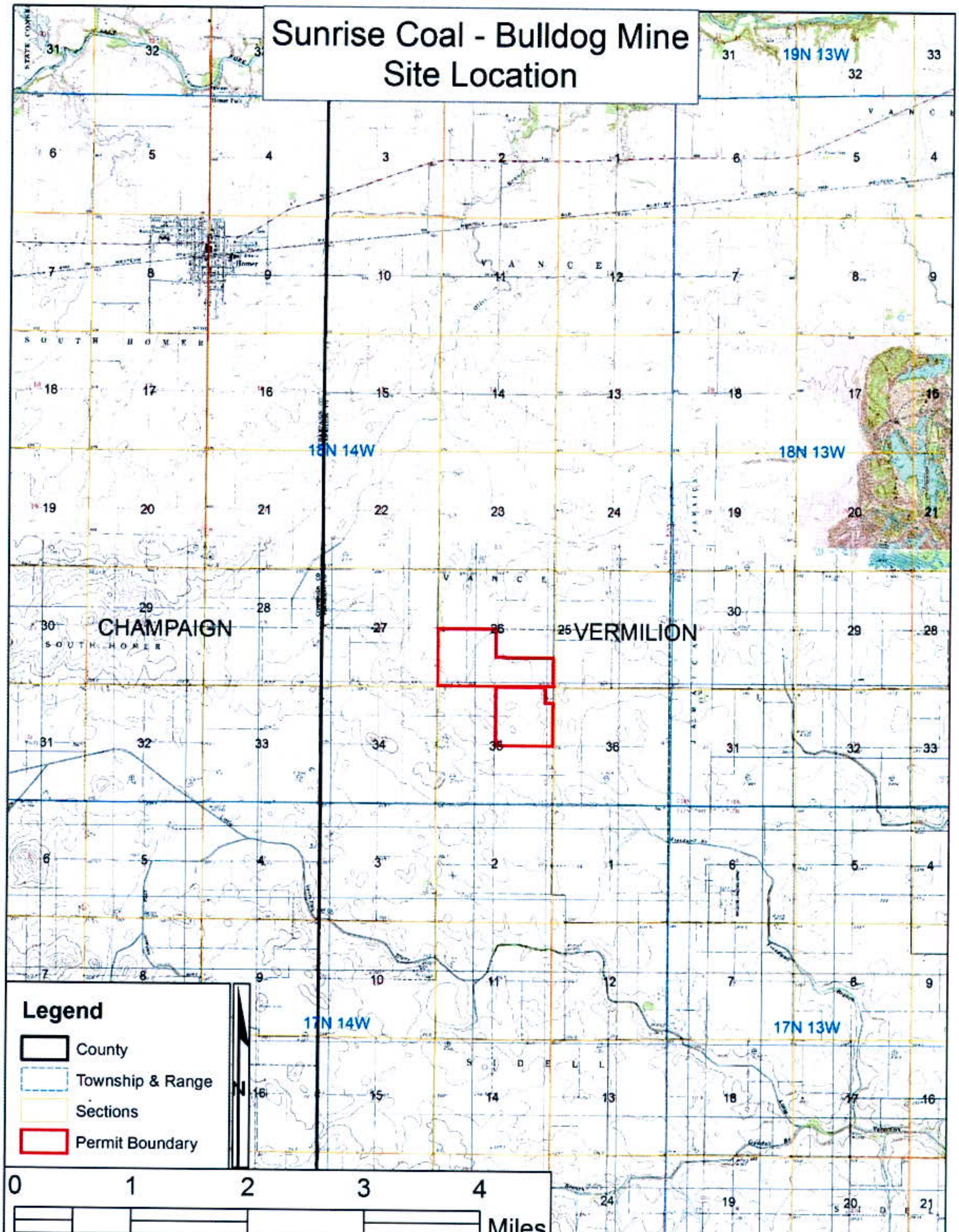

Figure 1. General site location of Bulldog Mine permit area in Section 26 & 36 of Township 18N and Range 14W in Vermilion County, IL.

STEP 1: INITIAL HABITAT INFORMATION

The permit area was inspected for bat habitat on March 26, 2012 and August 3, 2015 by Midwest Reclamation Resources Biologist, Shawn Duncan. The permit area consists of 389 acres of cropland and 1.3 acres of industrial/commercial (Figure 2). The industrial/commercial area is associated with several agricultural grain bins and buildings. Adjacent to these buildings are several trees including a windrow of 12 white pines (*Pinus strobes*), 1 sugar maple (Acer saccharum), and 1 spruce tree (*Picea sp.*; Photo 1). Also scattered throughout the farm yard is 1 black walnut (*Juglans nigra*), 2 sugar maple (Photo 2), 1 Hawthorn (*Crataegus sp.)*, and 1 red pine (Pinus resinosa; Photo 3). Most of the trees have a diameter at breast height (DBH) ≥ 3". The only apparent potential habitat within the permit area is a large dead hollow stump adjacent to the hawthorn tree (Photo 4). No other trees with obvious exfoliating bark, cracks, crevices, or cavities were identified; however, it is likely that there are broken limbs or other crevices out of sight in the canopy of the trees.

STEP 2: HABITAT DETERMINATION

Indiana Bat

Known Habitat

Known habitat is defined as habitat occupied by INBA based on capture records, survey information, or other sources. Information was received from the Illinois Natural Heritage Database (INHD), Illinois Department of Natural Resources in order to identify known habitat that may occur in and adjacent to the proposed mine permit area.

There are no documented caves or other underground openings where INBA have been recorded within the mine permit area. Based on this information, the permit areas do not meet the criteria to be considered "known winter or summer habitat" (USFWS 2013).

The nearest Priority 1 hibernaculum is located 210 miles southwest of the permit area. The nearest Priority 2 hibernaculum is located 100 miles northwest of the permit area. The nearest Priority 3 hibernaculum is located 165 miles southwest of the permit area. The nearest Priority 4 hibernaculum is located 180 miles west of the permit area. Based on this information, the permit area does not meet the criteria to be considered "known swarming habitat".

The nearest capture site for a female or juvenile Indiana Bat is located 15 miles east of the permit area. The nearest known Indiana Bat maternity roost tree is located 15 miles east of the permit area. The nearest capture site for a male Indiana Bat is 15 miles east of the permit area. Based on this information, the permit area does not meet the criteria to be considered "known summer habitat" for Indiana Bat.

Suitable/Potential Habitat

Suitable/potential habitat is defined as habitat that is "within the range of the species and is (a) currently suitable for habitation by INBA but for which no survey or other data is available showing that INBA are present or (b) may be suitable pending a definitive analysis of its suitability for bat use which is especially relevant for potential winter habitat" (USFWS 2013). There are three types of suitable/potential habitat described for INBA, including: potential winter; 2) potential swarming habitat; and 3) potential summer habitat.

Caves, underground mine workings, rock shelters, bridges, tunnels, dams, and other underground opening where no INBA have been recorded and where no previous surveys and habitat analysis of such habitat have been conducted are identified as "potential winter and summer habitat" (USFWS 2013). There are no known caves or other underground openings within the permit area. Therefore the area is not "potential winter habitat".

Forests containing trees $\geq$5 inches in diameter with exfoliating bark that lie within a 10 mile radius of any potential hibernaculum where no previous surveys and no habitat analysis of the potential hibernaculum have been conducted are identified as "potential swarming habitat" for INBA (USFWS 2013). There are no trees with characteristic exfoliating bark present within the permit area. Therefore the area is not "potential swarming habitat".

Forests containing trees $\geq$5 inches in diameter with exfoliating bark are identified as "potential summer habitat" for INBA (USFWS 2013). There are no trees with characteristic exfoliating bark present within the permit area. Therefore the area is not "potential summer habitat".

Assuming Presence of Indiana Bats

Based on the lack of habitat within the permit area, the presence of INBA is not assumed and a Protection and Enhancement Plan for INBA is not required

Northern Long-eared Bat

Suitable Habitat

Based on Appendix H of the *Northern Long-Eared Bat Interim Conference and Planning Guidance*, suitable forested habitat is described as:

> "... a wide variety of forested/wooded habitats where they [NLEB] roost, forage, and travel and may also include some adjacent and interspersed non-forested

> habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥ 3 inches dbh that have exfoliating bark, cracks, crevices, and/or cavities), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree and are less than 1000 feet from the next nearest suitable roost tree, woodlot, or wooded fencerow." (USFWS 2014)

There are trees within the permit area that potentially meet the criteria for suitable forested habitat; including; cracks, crevices, or cavities on trees with DBH ≥ 3inches. Therefore; the IBR area is identified as potential summer maternity/non-maternity habitat and potential spring staging/fall swarming habitat.

Suitable winter habitat is identified as:

> "… known or potential hibernacula that include underground caves and cave-like structures (e.g., abandoned mines, railroad tunnels). These hibernacula typically have large passages with significant cracks and crevices for roosting; relatively constant, cooler temperatures (0-9°C) and with high humidity and minimal air currents." (USFWS 2014)

There are no known caves or other underground openings within the permit area, therefore; the area is not "suitable winter habitat"

Known Habitat

Known habitat is identified based on the distance of Suitable habitat to documented NLEB occurrences such as roost trees, capture sites, acoustic detections, and hiberculum (USFWS 2014). Information was received from the Illinois Natural Heritage Database (INHD), Illinois Department of Natural Resources in order to identify known habitat that may occur in or adjacent to the proposed mine permit area.

The INHD has limited data available for the northern long-eared bat. The nearest documented hibernacula for northern long-eared bats is 100 miles north of the permit area. Known spring staging/fall swarming habitat is identified as suitable forested habitat within 5.0

miles of a NLEB hibernaculum; therefore, based on the distance of the closest documented hibernacula the permit area does not qualify as known spring staging or fall swarming habitat.

The nearest maternity colony for northern long-eared bats is 18 miles east of the permit area. Known summer habitat is identified as 1) suitable forested habitat within 1.5miles of a NLEB summer roost tree/trees or 2) suitable forested habitat within 3.0 miles of a NLEB summer capture or acoustic detection. Based on the distance of the closest documented roost tree the permit area does not qualify as known summer habitat.

Known winter habitat is identified as underground caves and cave-like structures where NLEBs have been documented. Based on the lack of suitable winter habitat within the permit area there is no known winter habitat within the permit area.

Assuming Presence of Northern Long-eared Bats

Based on the presence of suitable forested habitat within the permit area, the presence of NLEB within the permit area is assumed. As a result, a Protection and Enhancement Plan is required and an incidental take permit for Northern Long-eared Bats is requested.

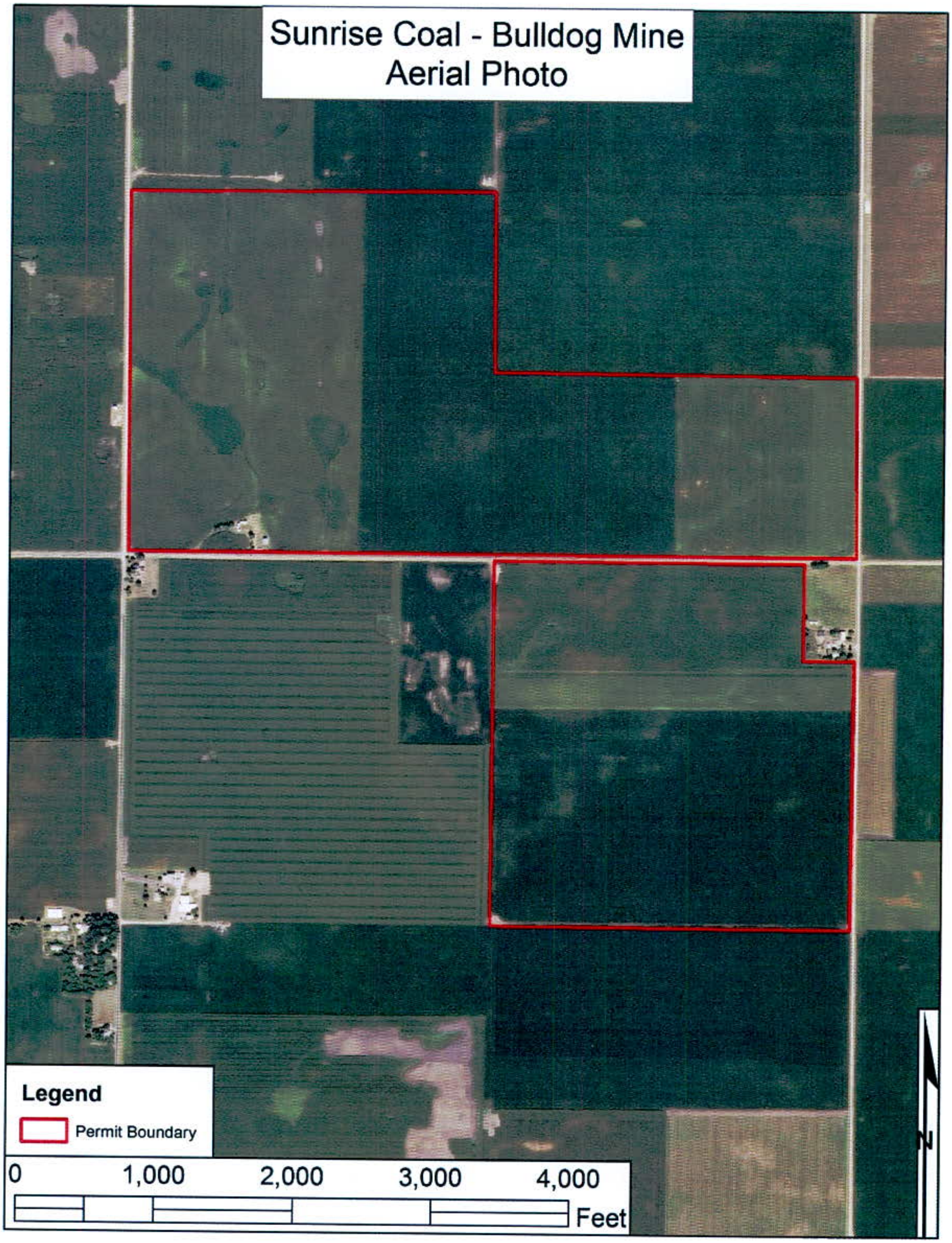

Figure 2. Aerial photo of Bulldog Mine permit area.

Flow Chart Summary

A flow chart is provided in the "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines" to describe the steps used in determining the necessity for a Protection and Enhancement Plan (Figure 3). The steps in the flow chart are answered below.

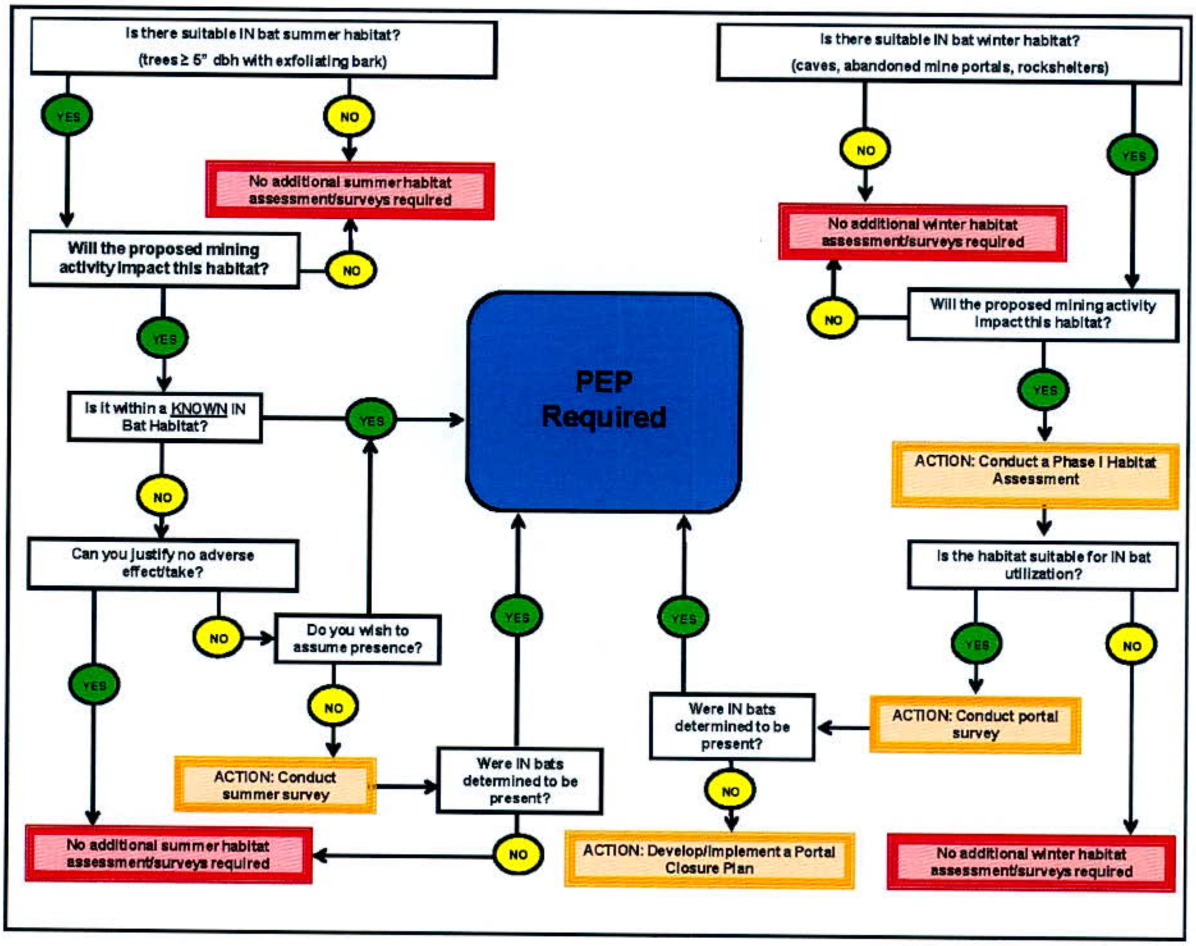

Figure 3. Flow chart of the steps outlined in the "Range-wide Indiana Bat Protection and Enhancement Plan Guidelines".

<u>Is there suitable Indiana Bat winter habitat?</u> **No.**

<u>Is there suitable Indiana Bat summer habitat?</u> **No.**

Based on the answers above, a "Protection and Enhancement Plan" is NOT required for Indiana Bats.

PROTECTION AND ENHANCEMENT PLAN

The following Protection and Enhancement Plan (PEP) was created to avoid and minimize the potential take of Indiana bats and Northern Long-eared bats and to provide post-mining long-term habitat for these species.

Objective 1 – Avoidance and Minimization

The first objective of the protection and enhancement plan is to avoid the potential take of Indiana bats and Northern Long-eared bats by avoiding or minimizing disturbance to known or potential habitat areas.

Tree clearing restrictions

Potential adverse effects to Indiana bats and Northern Long-eared bats caused by timber removal can be minimized by restricting the season in which trees can be removed. The forested habitats of the permit area are classified as "Suitable summer habitat". Tree clearing during summer months could cause adverse effects to Indiana bats and Northern Long-eared bats and will be avoided. Tree clearing operations will only occur from 15 October – 31 March, unless otherwise authorized by the Illinois Department of Natural Resources. These clearing restriction dates are identified in the Illinois DNR, Land Reclamation Division Memorandum No.2014-03 and are based on recommendations by the U.S Fish and Wildlife Service.

Buffering caves and abandoned underground mines

There are no known caves or other underground openings within the proposed permit area.

Riparian buffer zone protection

There are no streams or wetlands within the permit. Riparian habitats will not be disturbed by the proposed mining activities.

Minimization of disturbed areas

The proposed permit area includes 390.3 acres with 1.3 acres of industrial/commercial land use that has 19 scattered trees. These are the only trees within the permit area. The remainder of the permit area is intensive row-crop agriculture without any trees. The proposed activities will affect the areas necessary to construct the surface operations and does not include any unnecessary areas.

Objective 2 – Short Term Habitat Measures

The second objective of the PEP is to minimize the potential take of Indiana bats and northern long-eared bats by providing short-term habitat measures.

Staged Tree Removal

The few trees within the permit area are located within one small area and will be cleared completely within one season.

Objective 3 – Long Term Habitat Measures

The third objective of the PEP is to provide long-term habitat measures for the Indiana bats and northern long-eared bats in the post-mine reclamation plan.

Reforestation

A total of 1.3 acres of farm yard with scattered trees will be impacted by the proposed mine operation. A total of 0.9 acres of trees will be planted during reclamation to provide future roosting habitat for Indiana bats and northern long-eared bats (Map E, IDNR Permit No. 429). This reclamation of woody wildlife meets the 70% reforestation standard provided in the guidelines.

Herbaceous Ground Cover

In the area that will be reforested, an herbaceous ground cover will be established prior to tree plantings. A standard mix of native will be established to control erosion and increase soil productivity for tree development (Table 1). This mix of plants has been proven to establish sufficient ground cover on mine soils, be non-competitive with planted trees, and provide cover and habitat for wildlife.

Table 1. Herbaceous groundcover seeding for mined land reclamation.

Species Name	Common Name	Rate (lbs./ac.)
Bouteloua curtipendula	Side oats grama	5
Schizachyrium scoparium-	Little bluestem	5

Tree Species Selection

The guidelines provide a list of tree species that should be used for Indiana bat habitat (Table 2). A minimum of 6 different species from the list will be chosen to be established in the reforestation plot. Four of these species will have exfoliating bark. Tree species will be chosen based on site characteristics and seedling availability. At the time of bond release, a stocking success rate of not less than 250 stems per acre will be met. The exfoliating bark species will represent at least 40% of the minimum stems per acre.

Table 2. Tree species list of Indiana bat protection and enhancement plans.

Scientific name	Common name
Exfoliating Bark Species	
Acer saccharum	Sugar Maple
Carya cordiformis	Bitternut hickory
Carya glabra	Pignut hickory
Carya laciniosa	Shellbark hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Fraxinus americana	White ash
Fraxinus pennsylvanica	Green ash
Oxydendron arboreum	Sourwood
Pinus echinata	Shortleaf pine
Populus detloides	Cottonwood
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus falcata	Southern red oak
Quercus imbricaria	Shingle oak
Quercus prinus	Chestnut oak
Quercus rubra	Northern red oak
Quercus stellata	Post oak
Quercus velutina	Black oak
Sassafras albidum	Sassafras
Ulmus americana	American elm
Ulmus rubra	Slippery elm
Nitrogen-fixing Trees	
Cercis canadensis	Redbud
Robinia pseudoacacia	Black Locust
Other Trees	
Cornus florida	Flowering dogwood
Disopyrus virginiana	Persimmon
Morus rubra	Red mulberry
Prunus serotina	Wild blackcherry

LITERATURE CITED

U.S Fish and Wildlife Service (USFWS). 2007. Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 258pp.

U.S. Fish and Wildlife Service (USFWS). 2009. Range-wide Indiana Bat Protection and Enhancement Plan Guidelines for Surface Coal-Mining Operations. Revised: February 2013.

U.S. Fish and Wildlife Service (USFWS). 2013. Range-wide Indiana Bat Protection and Enhancement Plan Guidelines.

U.S. Fish and Wildlife Service (USFWS). 2014. Northern Long-Eared Bat Interim Conference and Planning Guidance

Attachment V-3B4

SITE PHOTOS

Photo 1. Trees in windrow within the farm yard.

Photo 2. Sugar maple and black walnut trees within farm yard.

Photo 3. Red pine within farm yard.

Photo 4. Hollow stump next to hawthorn tree.

INCIDENTAL TAKE PERMIT FOR BULLDOG MINE PERMIT AREA

Type and amount of incidental take resulting from SMCRA permits issued by the [IDNR[a]] for [2015[b]].

Permit No.[c]	Forest Habitat [d] (# acres)			Roost Trees [e] (# trees)		Hibernacula [f] (# hibernacula)	Individual Bats [g] (# bats)	Maternity Colonies [h] (# colonies)
	Known	Potential	Proposed PMLU[i]	Known	Potential			
429	NA	1.3	0.9	NA	NA	Unknown	NA	NA
Annual total:		1.3	0.9					

[a] Enter the name of the RA that compiled the data for the table in place of "[RA]".

[b] Enter the year or other period of time for which the table was prepared in place of "[Year or reporting period]".

[c] Enter the permit number for all permits (including amendments and revisions) where Indiana bat incidental take was expected and used based on known occurrence or when Indiana bat presence is assumed. Additional rows should be added to the table as necessary to include all permits where incidental take occurred in a given year.

[d] Enter the number of acres of known and/or potential habitat that will be cleared, removed, or destroyed by the permitted action. Potential habitat (e.g., assumed habitat) and known habitat must be accounted for separately in the table. Most permits will have at least one acreage entry for Forest Habitat and some permits may have entries for both. Indeterminable entries should be marked as "NA" in the table.

[e] Enter the number of acres of known and/or potential habitat that will be cleared, removed, or destroyed by the permitted action. Potential habitat (e.g., assumed habitat) and known habitat must be accounted for separately in the table. Most permits will have at least one acreage entry for Forest Habitat and some permits may have entries for both. Indeterminable entries should be marked as "NA" in the table.

[f] Enter the number of known hibernacula that will be impacted (e.g., changes in air flow, etc.) or destroyed (e.g., mined-through or entrances closed). Indeterminable entries should be marked as "Unknown" in the table.

[g] Enter the number of individual Indiana bats that were adversely affected by the permitted mining activity. For most permits, and especially those permits where Indiana bat presence was assumed, this number will not be known, because sufficient demographic data is unavailable. If no specific information or data is available regarding the number of Indiana bats that were adversely affected, this entry should be marked as "NA", which will mean that the number of individuals was indeterminable.

[h] Enter the number of maternity colonies that were adversely affected by the permitted mining activity. For most permits, and especially those permits where Indiana bat presence was assumed, this number will not be known because sufficient demographic data was unavailable. If no specific information or data is available regarding the number of Indiana bat maternity colonies that were adversely affected, this entry should be marked as "NA", which will mean that the number of maternity colonies was indeterminable.

[i] Enter the acreage of the proposed Post Mining Forest land use.