Prepared for

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CCR SURFACE IMPOUNDMENT FINAL CLOSURE PLAN

BALDWIN POWER PLANT BOTTOM ASH POND (IEPA ID W1578510001-06) Baldwin, Illinois

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1. INTRODUCTION

Dynegy Midwest Generation, LLC (DMG) is the owner of the active coal-fired Baldwin Power Plant (BPP) in Baldwin, Randolph County, Illinois. This closure plan is for the Bottom Ash Pond (BAP). The BAP was present and operational prior to promulgation 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845). The BAP has an Illinois Environmental Protection Agency (IEPA) identification number of W1578510001-06.

1.1. Selected Closure Method

<u>Section 845.720(b)(3):</u> *The final closure plan must identify the proposed selected closure method and must include the information required in subsection (a)(1) and the closure alternatives analysis specified in Section 845.710.*

Closure with a final cover system has been identified as the most appropriate closure method, also known as Closure-in-Place (CIP, per Section 845.740) based on the Closure Alternatives Analysis (CAA), provided in **Attachment A**. The CAA was prepared by Gradient Corporation (Gradient) to evaluate CIP versus Closure by Removal (CBR, per Section 845.750) and a hybrid closure alternative was selected as the most appropriate closure method for the BAP. All CCR from the western 101-acre portion of the BAP will be removed and placed into the eastern portion of the BAP, which will be closed in accordance with Sections 845.740 and 845.750. Under this hybrid approach, all CCR will be removed from approximately 57% of the current footprint of the impoundment. The proposed hybrid CIP alternative will control, minimize, or eliminate, as much as feasible "post-closure infiltration of liquids" and releases of CCR, leachate, or contaminated runoff as interpreted by the IEPA in the Part 845 rulemaking.

Information developed by Geosyntec to support the Closure Alternatives Analysis is provided as an attachment to the CAA.

1.2. Organization of Final Closure Plan

This Final Closure Plan is organized in the following manner:

- **Section 1** includes an introduction to the Site and the selected closure method.
- **Section 2** includes the Final Closure Plan, as required by Section 875.720(a)(1).
- **Section 3** includes a summary of amendments of the Closure Plan.

- **Section 4** includes a discussion of how the closure using a final cover system will comply with the performance and design requirements of Sections 845.720 and 845.750, in addition to a Certification from a Qualified Professional Engineer for the final cover system design.

- **Section 5** includes additional information regarding the closure.

- **Section 6** includes a Certification from a Qualified Professional Engineer for this Final Closure Plan.

- **Section 7** includes reference documents used in the development of this Final Closure Plan.

2. FINAL CLOSURE PLAN

<u>Section 845.720(a)(1):</u> *Content of the Preliminary Closure Plan. The owner or operator of a new CCR surface impoundment or an existing CCR surface impoundment not required to close under Section 845.700 must prepare a preliminary written closure plan that describes the steps necessary to close the CCR surface impoundment at any point during the active life of the CCR surface impoundment consistent with recognized and generally accepted engineering practices.*

This section includes the final closure plan for the BAP, as required by Section 845.720(a)(1). Specific requirements of the closure plan and the relevant regulatory citations are included in the following sections.

2.1. Narrative Closure Description

<u>Section 845.720(a)(1)(A):</u> *A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.*

2.1.1. Closure Overview

The BAP will be closed in place and covered with a final cover compliant with 40 C.F.R. §257.102(d)(3) and Section 845.750. Closure of the BAP will include a consolidate-and-cap approach, where the final footprint of the BAP will be reduced from approximately 177 acres to approximately 76 acres (the closure-in-place area). This will include removing all CCR and some of the underlying subgrade materials, totaling approximately 1.5 million cubic yards (CY), from an approximately 101-acre closure-by-removal area inside the perimeter dikes to the consolidated footprint within the current BAP dikes. Figures showing the location of each area of the BAP are provided within the final closure drawings in **Attachment B**.

During the closure process, DMG will continue to assess off-site CCR beneficial use opportunities. CCR consolidation and closure-in-place with a combination of offsite beneficial use may result in a smaller footprint for the ultimate cap design along with a reduced construction schedule.

2.1.1.1. CCR and Soils to be Relocated

Specific areas and volumes that will be removed and placed into the closure-in-place area are described within this section.

- All CCR, and up to an estimated depth of one foot of the underlying subgrade soils, which are approximately 1.5 million CY in volume, will be removed from a 101-acre area inside the BAP (the closure-by-removal area) and placed into the closure-in-place area.
    - The CCR will be closed by removal from the western portions of the BAP.

- The BAP dam will be removed from the closure-by-removal area and will no longer be retaining CCR during post-closure conditions. This will include removing approximately 35,000 CY of dam soils, all CCR, and, where the CCR is present, to an estimated depth of one foot of underlying subgrade soils.

CCR removal will include excavating all CCR and up to an estimated depth of one foot of native underlying subgrade materials beneath the CCR. The removal of CCR will be verified via visual observations performed during construction, and excavation depths will be adjusted, as needed to remove all of the CCR. The removed CCR and native subgrade soils will be placed within the closure-in-place area, also referred to as "consolidated-and-capped", over existing impounded CCR that will remain in-place, as compacted fill to achieve final cover system subgrades. Dike soils that are observed as not containing CCR may be utilized as cover soil for the final cover system. Dike soils that contain CCR will be utilized as subgrade fill beneath the final cover system.

2.1.1.2. Final Cover System

A final cover system will be constructed, as part of consolidation, within the closure-in-place area, as described below.

- An approximately 76-acre final cover system will be installed completely over the extents of consolidated CCR in plan. The final cover system will consist of a geomembrane, geotextile cushion, protective cover soil, and vegetated topsoil. The final cover system will be keyed into the perimeter dikes, native foundation soils, or the existing FAPS cover with an anchor trench.

- During consolidation and capping, the BPP will be generating power and CCR materials to be placed into the BAP. An interim slope of 3 horizontal to 1 vertical (3H:1V) with temporary cover will be constructed to act as an interface during construction while the BPP is operating between the closure area and the area reserved for process flow and excavation of CCR for beneficial reuse or placement. Once the BPP is no longer generating power, the consolidation and cover system will be completed.

2.1.2. Closure Performance Features

Therefore, closing the BAP with a consolidate-and-cap approach with a final cover will result in CCR within the consolidated BAP footprint being:

- Encapsulated on the top, by the final cover system.

- Encapsulated on the bottom, by existing native clay foundation soil. The foundation soil is between 15 feet and 40 feet thick beneath the CIP area, with an average of 28 feet thick.

The foundation soil has overall horizontal and vertical hydraulic conductivities of 3.2 x 10-5 cm/s and 8.6 x 10-7 cm/s, respectively.

2.1.3. Closure Construction Narrative Sequencing

Physical construction of the consolidate-and-cap closure of the BAP with a final cover system is expected to include the following tasks:

- The construction limits of disturbance will be established, and perimeter stormwater Best Management Practices (BMPs) will be installed where needed.

- Temporary stormwater best management practices (BMPs), such as erosion control, blankets, straw wattles, and/or check dams, will be used where needed, to reduce erosion during vegetation establishment.

    - After vegetation is established, BMPs will be removed, and closure construction will be considered completed.

- A temporary water management system will be constructed within the BAP, including ditches, sumps, pumps, discharge piping, and/or temporary stormwater detention basin(s), in order to manage surface water and liquid wastes. Free liquids will be removed from the BAP via unwatering and dewatering and managed in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the facility [845.750(b)(1) and 845.750(b)(2)]. The methods by which free liquids will be removed may include drilled sumps, engineered trenches, and/or horizontal wells as discussed in **Section 4.6**. Free liquids will be routed into the stormwater management system.

    - The stormwater management system will remove liquid waste in the BAP and maintain the BAP in an unwatered state by collecting process water and contact stormwater during closure construction and prior to the installation of the cover system. Liquid waste flows will be pumped to the Cooling Pond for ultimate discharge to the Kaskaskia River at NPDES Outfall 002.

- Existing sluice pipes entering the BAP, and appurtenant structures such as pipe racks, will be demolished and disposed of beneath the final cover system of the BAP.

- The existing outflow structures and culverts connecting the BAP to the Secondary Pond and Cooling Pond will be abandoned, to reduce the risk of CCR from migrating through these conduits during post-closure conditions. Abandonment will consist of the following tasks:

    - Drop inlet spillway and 30-inch dia. culvert through the dam.
    - Pumping station and two 18-inch dia. culverts leading to the Cooling Pond.

- All CCR and an estimated depth of one foot of underlying native soils will be removed from the closure-by-removal portion of the BAP using mass mechanical excavation techniques. Excavations will be visually observed for CCR removal to verify that the CCR has been removed, and excavation depths may vary during this process. The material will be placed in the consolidated-and-capped portion of the BAP as compacted fill to provide a subgrade suitable for the construction of a final cover system. Dewatering will be performed as needed to support construction activity and excavation, using the temporary water management system.

- An alternative cover system will be installed over the CCR that remains in the BAP. The cover would minimize vertical infiltration of precipitation into the basin [Part 845.750(a)(1)].

    - The alternate final cover system will be constructed over the entire footprint of the BAP that contains CCR, and will include, from bottom to top:

        - A 40-mil linear low-density polyethylene (LLDPE) geomembrane, placed on a prepared subgrade with rocks no larger than one inch in diameter, and other sharp objects will be removed prior to geomembrane placement.

        - A nonwoven geotextile, to protect the geomembrane from rocks and/or sharp objects in the cover soil.

        - Based on a demonstration included in **Attachment C**, pursuant to Section 845.750(C)(2), the final cover system will include an alternative 1.5-foot thick protective layer (e.g., cover soil) to protect the geomembrane and 0.5 feet of topsoil capable of supporting vegetation, for a total cover soil thickness of 2 feet.

            - The cover soil will be obtained from onsite borrow sources, including portions of the perimeter dikes that are comprised of non-CCR impacted soil fill, and are within the closure-by-removal area.

    - The final cover system will be sloped to direct surface water away from the impoundment. The final cover system grades will be approximately 2% over the majority of the BAP; 25% (4H:1V) grades will be used to tie the final cover system into existing grades and reduce the overall height of the consolidated BAP. The 4H:

1V slopes will be applied for heights of up to approximately 60 ft. The final cover system will be keyed into the perimeter dikes, native foundation soils, or the existing FAPS cover, and access roads will be constructed on top of the final cover system. Beyond the final cover system, channels will direct surface water away from the BAP to the dam [Part 845.750(a)(2)].

- The final cover system will include an anchor trench for the geosynthetic materials along the entire perimeter of the BAP to secure the final cover system into constructed or existing grades.

- Existing groundwater monitoring wells and standpipe piezometers present within the consolidated footprint will be retained and modified by extending the wells through the final cover system, sealing the penetration with a pipe boot, and constructing a new surface completion on top of the final cover. Alternatively, groundwater monitoring wells may be decommissioned and replaced.

- Some of the existing geotechnical vibrating-wire piezometers (VWPs) that are within the consolidate-and-cap footprint will be retained by extending the readout cable and constructing a new protective readout box on top of the final cover. Note, the VWP readout cables are installed and sealed, by grouting, within the VWP casing. Some or all of the VWPs outside of the consolidated footprint will be abandoned by cutting the readout cable off at the ground surface.

- A post-closure non-contact stormwater management system will be constructed. The system will consist of:
  - Final Cover System
    - Stormwater diversion berms and letdown channels will be constructed to convey stormwater off the BAP final cover system.
  - Perimeter Ditch
    - A stormwater ditch around the perimeter of the final closure system will convey stormwater to the closure-by-removal areas of the BAP that will have positive drainage towards the dam.
    - Riprap energy dissipation will be placed at the outlet for each letdown to reduce erosion.

- Vegetation will be established across the BAP and other disturbed areas, by:
    - Soils to be seeded will be fertilized, as needed to support vegetation establishment, based on agronomical soil tests.
    - The final cover system in the consolidate-and-cap area and the exterior surface of the new soil containment berm will be seeded with a suitable grass species for local climate and soil conditions.
    - The closure-by-removal area will be seeded with appropriate vegetation, including upland species (e.g., grasses) in most areas. However, appropriate species and/or trees capable of growing in wet areas may be utilized along the estimated flow paths.
    - Temporary stormwater BMPs such as erosion control blankets, straw wattles, detention basins, and/or check dams, will be used, as needed to reduce erosion during vegetation establishment.
- After vegetation is established on the final cover and in closure-by-removal areas, temporary BMPs will be removed, and closure construction will be considered complete.

Engineering drawings and material specifications for the closure are provided in **Attachment B**.

2.2. Decontamination of CCR Surface Impoundment

<u>Section 845.720(a)(1)(B):</u> *If closure of the CCR surface impoundment will be accomplished through removal of CCR from the CCR surface impoundment, a description of the procedures to remove the CCR and decontaminate the CCR surface impoundment in accordance with Section 845.740.*

The portions of the BAP that will be closed-by-removal will be decontaminated as part of closure. Decontamination will occur after all CCR has been removed and will include excavating up to one foot of native underlying subgrade materials (i.e., soils) beneath the CCR, similar to decontamination procedures completed and proposed for other CCR surface impoundments that have been closed-by-removal within Illinois. These excavated subgrade materials will be disposed of beneath the final cover system of the BAP. Decontamination will also include a visual inspection of the excavated subgrade to verify that all CCR has been removed, and excavation depths will be varied, as needed, until the removal of all CCR has been verified and documented.

The equipment and materials utilized during construction will be decontaminated prior to demobilizing from the site.

2.3. Final Cover System

<u>Section 845.720(a)(1)(C):</u> *If closure of the CCR surface impoundment will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with Section 845.750, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in Section 845.750.*

A description of the final cover system design, methods and procedures used for installation, and how the final cover system will achieve the Section 845.750 performance standards is provided in **Section 4** of this Closure Plan.

2.4. Maximum CCR Inventory

<u>Section 845.720(a)(1)(D):</u> *An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR surface impoundment.*

The maximum inventory of CCR ever on-site within the BAP is approximately 3.5 million cubic yards.

2.5. Largest Surface Area Estimate

<u>Section 845.720(a)(1)(E):</u> *An estimate of the largest area of the CCR surface impoundment ever requiring a final cover (see Section 845.750), at any time during the CCR surface impoundment's active life.*

The largest surface area of the BAP, in plan, is approximately 177 acres [1]. The surface area in plan will be reduced to approximately 76 acres and the final cover system will extend completely across this consolidated area and beyond the limits of CCR in plan. This will provide a continuous encapsulation system consisting of the final cover on the top of the BAP, the clay perimeter dikes on the sides of the BAP, and the clay foundation soils beneath the BAP. Areas of the BAP that are closed-by-removal will not be capped with a final cover system, all CCR will have been removed from these areas after closure-by-removal is completed.

2.6. Closure Completion Schedule

<u>Section 845.720(a)(1)(F):</u> *A schedule for completing all activities necessary to satisfy the closure criteria in this Section, including an estimate of the year in which all closure activities for the CCR surface impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR surface impoundment, including identification of major milestones such as coordinating with and obtaining necessary approvals*

and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR surface impoundment closure.

A milestone closure completion schedule has been prepared and is provided in **Table 1**. Key sequential phases and sub-tasks that will be completed as part of the closure will include:

- Agency Coordinating, Approvals, and Permitting
  - Approval of the closure Construction Permit Application by IEPA.
  - A modification to the existing NPDES permit to allow the disposal of water generated from free liquid removal, unwatering, and dewatering operations to the Kaskaskia River *via* the existing NPDES-permitted Outfall 002 for the Site was obtained.
  - Obtaining a construction permit from the IDNR, Office of Water Resources (OWR), Dam Safety Program (DSP) to allow the dam and spillways of the BAP to be modified as part of closure.
  - A general stormwater permit for construction site activities through IEPA, including construction stormwater controls and other BMPs such as silt fences and other measures.
  - A joint water pollution control construction and operating permit (WPC Permit) as necessary.
- Final Design and Bidding
  - Completion of final design investigations, calculations, design drawings, and specifications.
  - Request for Bids and selection of a closure construction contractor.
- Unwater, Dewater and Stabilize CCR, CCR Removal, Install Final Cover System
  - Closure contractor mobilization and material procurement.
  - Installing stormwater BMPs around the construction area, per the existing NPDES permit.
  - Clearing brush and trees in the work area.

- Unwatering the BAP by pumping free surface water to the nearby Cooling Pond, which is a non-CCR surface impoundment at BPP that discharges to the Kaskaskia River via NPDES Outfall No. 002.

- Abandoning existing structures and culverts in place or by removal. Existing structurers, culverts, piping, and equipment in contact with CCR will be decontaminated by power washing.

- Stabilizing the subgrade through removal of free liquids.

- Removing all CCR from the closure-by-removal portions of the BAP.

- Grading CCR to design final cover subgrades.

- Installing the final cover system geosynthetics and anchor trench.

- Constructing the post-closure stormwater management system, including diversion berms and channels on the final cover system, and new perimeter stormwater channels.

- Potentially removing perimeter dikes for use as cover soil.

- Removing the dam to allow stormwater flow downstream.

- Placing final protective layer including topsoil over the geosynthetics.

- Site Restoration

  - Seeding and stabilizing the surface of the final cover system and other disturbed areas and allowing the vegetation to become established.

  - Restoring the closure-by-removal areas by establishing vegetation.

  - Removing temporary stormwater BMPs and other temporary stabilization measures, after vegetation is established.

  - Closure contractor demobilization from the site.

The project is expected to be completed by November of 2028. Additional project schedule may be required if delays in permitting or significant weather delays occur.

Table 1 – Closure Completion Milestone Schedule

Milestone	Timeframe (Preliminary Estimates)
Final Closure Plan Submittal	July 2023
Baldwin Power Plant Cessation of Coal Burning	December 31, 2025
Agency Coordination, Approvals, and Permitting • Obtain State permits, as needed, for dewatering and free liquid removal, water discharge, modifications, land disturbance, and dam modifications.	6 to 12 months after Final Closure Plan Approval
Final Design and Bid Process • Complete final design of the closure and select a construction contractor.	12 to 16 months after Agency Coordination, Approvals, and Permitting
Dewater and Stabilize CCR, Relocate CCR and Consolidate, Install Final Cover System • Complete contractor mobilization, installation of stormwater BMPs, and unwatering of the BAP • Abandon outfall structures, stabilize the BAP, and remove free liquids (dewater and stabilize) • Remove all CCR from the closure-by-removal area and areas outside of the BAP embankments. • Construct the new soil containment berm. • Install the final cover system and stormwater downchutes.	27 to 36 months after Final Design and Bid Process
Site Restoration • Seed and stabilize the BAP and closure-by-removal areas. • Complete contractor demobilization.	2 to 8 months after the final cover system is complete
Timeframe to Complete Closure	April 2025 – October 2028 (3 to 6 years)

<u>Section 845.720(a)(1)(F) (Continued):</u> When preparing the preliminary written closure plan, if the owner or operator of a CCR surface impoundment estimates that the time required to complete closure will exceed the timeframes specified in Section 845.760(a), the preliminary written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under Section 845.760(b).

Dynegy submitted a site-specific alternative deadline to initiate closure due to the permanent cessation of coal-fired boiler by a certain date to the USEPA in accordance with 40 CFR §257.102(f)(ii) of the CCR Rule [2]. Pursuant to the schedule in that application, construction of closure would begin by April 17, 2025 and cease receipt and placement of CCR and non-CCR wastestreams by no later than December 31, 2025 [3]. Closure will be completed by October 17, 2028 within the 5-year timeframe.

<u>Section 845.760(a):</u> Except as provided for in subsection (b), the owner or operator must complete closure of existing and new CCR surface impoundments, and any lateral expansion of a CCR surface impoundment, within the timeframe approved by the Agency in the final closure plan, or within five years of obtaining a construction permit for closure, whichever is less.

The time required to complete closure construction is not expected to exceed the timeframe specified in Section 845.760(a). Therefore, closure extensions for the BAP are not being sought at this time of the IEPA.

3. AMENDMENTS OF FINAL CLOSURE PLAN

<u>Section 845.720(b)(4):</u> *If a final written closure plan revision is necessary after closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.*

If revisions are required for this Final Closure Plan, the owner will submit a request to modify the construction permit within 60 days following the triggering event.

Table 2. CCR Final Closure Plan Revisions

Revision Number and Date	Pages or Section	Description of Revision	Professional Engineer Certifying Plan

4. CLOSURE WITH FINAL COVER SYSTEM

This section includes a description of the final closure with a final cover that will be completed for the BAP surface impoundment, including principal design and construction features, material specifications, and a discussion of how each feature is in accordance with the requirements of Sections 845.720 and 845.750. Drawings showing each design feature and material specifications are provided in **Attachment B**.

The proposed CIP design will control, minimize, or eliminate as much as feasible "post-closure infiltration of liquids" and releases of CCR, leachate, or contaminated runoff as interpreted by IEPA in the Part 845 rulemaking. Specifically, the Groundwater Modeling Report [4] shows that the CIP design will result in a reduction of total hydraulic flux into and out of the BAP by greater than 90% within 30 days of closure and approximately 96% when simulated post-construction heads in the groundwater monitoring wells are predicted to be stabilized. Due to the reduction in the hydraulic flux out of the BAP, the mass flux out of the BAP will also be controlled or minimized as much as feasible as a result of CIP.

4.1. Minimization of Post-Closure Infiltration and Releases

<u>Section 845.750(a):</u> *The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will:*

<u>Section 845.750(a)(1)</u>: *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*

This performance standard will be met through:

- A 40-mil LLDPE geomembrane low-permeability layer will be placed on the prepared subgrade to control and minimize vertical infiltration, to the maximum extend feasible, into the surface impoundment. The geomembrane will be constructed on a subgrade that is free of sharp rocks or other debris and will be protected from damage by installing a nonwoven geotextile cushion and a total of two feet of cover soil and topsoil over the top of the geomembrane.

- Surface stormwater will be routed off the top of the final cover by the construction of a free-draining post-closure stormwater management system including diversion berms, letdown channels, outlet energy dissipators, and a perimeter ditch. The stormwater management system will drain by gravity and preclude water impoundment on top of the final cover system, thereby minimizing post-closure infiltration into the CCR.

- The CCR will be encapsulated on all sides by the cover system tied into native foundation clays, the capped FAPS, or the existing perimeter berm to the north. The permeability of foundation soils beneath the CCR is estimated to be 3.2 x 10-5 cm/s (horizontal) and 8.6 x 10-7 cm/s (vertical). Free liquids will be removed from the CCR as part of closure, and the potential for future accumulation of free liquids within the CCR will be reduced by the installation of a final cover system. These features will control the lateral migration of water into the unit from stormwater and minimize any releases of CCR leachate into ground and surface waters.
    - The final cover system will be tied into native foundation clays, the capped FAPS, or the existing perimeter berm to the north, by constructing a final cover anchor trench. The final cover will therefore provide continuous encapsulation between the CCR and the surrounding environment on the top, bottom, and sides of the CCR.
    - This continuous encapsulation will result in the CCR being physically isolated from the surrounding environment on all sides, including the groundwater, surface water, and atmosphere and therefore minimize the releases of CCR, leachate, or contaminated run-off into the ground, surface waters, and atmosphere.
- Free liquid removal will significantly reduce the amount of leachate within the CCR prior to closure, and the final cover system will minimize infiltration and therefore the amount of leachate that accumulates within the CCR during post-closure.
- All existing culverts that penetrate the BAP dam and dikes will be decontaminated and removed or sealed. Sealing will include cleaning of concrete and HDPE pipe culverts and filling with cement-bentonite grout, thereby removing potential flow paths that could otherwise allow leachate to be released after closure is completed.
- CCR within the consolidated-and-capped footprint of the BAP will not be in contact with the uppermost aquifer during post-closure conditions.
    - All CCR that is currently (e.g., under pre-closure conditions) expected to be in contact with or within close proximity to the uppermost aquifer will be removed and placed under the final cover system within the consolidated-and-capped BAP footprint.

Vertical infiltration will be minimized, and this analysis is ongoing based on the completion of additional sampling events.

4.2. Preclusion of Future Impoundment

<u>Section 845.750(a)(2):</u> *Preclude the probability of future impoundment of water, sediment, or slurry;*

All areas of the final cover system will be sloped to positively drain to the exterior of the BAP and preclude future impoundment of water, sediment, or slurry. This will include installing cross-slopes at approximately 2% grades, although slopes at up to 25% grades at the tie-in between the final cover system and existing grades. Stormwater will be directed into letdown channels via diversion berms; the letdown channels will allow stormwater to flow by gravity off the BAP footprint and into the surrounding area through culverts that will be installed in the perimeter dikes. Hydrologic and hydraulic calculations used to design the stormwater channels and other control features to preclude impoundment are provided in **Attachment D**.

4.3. Provisions for Preventing Instability, Sloughing and Movement

<u>Section 845.750(a)(3):</u> *Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;*

The perimeter slopes of the final closure with be 25% and constructed of Bottom Ash with a final cover system. The stability of the final closure system has been evaluated by performing global slope stability analyses considering post-closure conditions. The resulting factors of safety exceed regulatory minimum values for static and seismic loading conditions for CCR surface impoundments [2]. Slope stability analyses are provided in **Attachment E**.

Sloughing and movement of the final cover system will be minimized by constructing the final cover system at relatively flat slopes, including 2% over most of the final cover and 25% slopes of up to 60 ft in height at the edges of the final cover, as necessary to tie into existing grades and limit the height of the consolidated BAP. The potential for sloughing and movement of the final cover system, including the 25% slopes, has been evaluated by performing veneer stability analyses for the various interfaces within the final cover system. The resulting factors of safety exceed typical minimum values for static and seismic loading conditions. Veneer stability analyses are provided in **Attachment E**.

4.4. Minimize the Need for Further Maintenance

<u>Section 845.750(a)(4):</u> *Minimize the need for further maintenance of the CCR surface impoundment; and*

Future maintenance needs will be minimized using the following design features:

- The final cover system will be installed at relatively flat 2% slopes over most of the final closure with 25% slopes in limited areas at the extents of the final cover, as needed to tie into existing grades and limit the height of the consolidated BAP.
  - Letdowns and diversion berms will minimize erosion of the final cover soils and thereby minimize maintenance needs.
  - The relatively flat slopes will also facilitate routine mowing of vegetation of the final cover system by allowing tractor-based mowing equipment to operate on the slopes with a reduced risk of equipment flip-over.
- The final cover, outside of stormwater letdown channels and diversion berms, will be stabilized by placing topsoil, fertilizing the topsoil, establishing vegetation using suitable grass species.
  - The vegetation will have a design seed mix suitable for the climate and need for robustness and longevity, and therefore will minimize erosion of the final cover system by stabilizing the topsoil.
  - Selection of a suitable grass species and the use of fertilizer to establish vegetation will minimize maintenance required to repair areas of poor vegetation establishment.
- Stormwater diversion berms will be stabilized with erosion control blankets and straw wattles. The channels will transition to riprap lined letdowns where they pass down the BAP slope to the perimeter ditch and flow into surrounding areas. Riprap or other types of energy dissipation will be placed at each letdown. The erosion control blankets, non-erodible culverts, and energy dissipation will minimize post-closure erosion and associated maintenance for the stormwater management system.
  - Calculations used to design the stormwater letdown channels and riprap armoring were based on the 100-year, 24-hour storm event. These calculations are provided in **Attachment D**.

4.5. Be Completed in Shortest Amount of Time

<u>Section 845.750(a)(5):</u> *Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.*

Closure construction is expected to be completed within an amount of time that is consistent with recognized and generally accepted timeframes required to permit, design, bid, and construct a CCR impoundment final closure system of this size (i.e., approximately 1.5 million CY of CCR excavation and placement), with a consideration of other permits form multiple State and Federal agencies that are also required for the project. An estimated closure construction schedule is provided in **Section 2.6**. It should be noted that this schedule may change based on contractor, equipment, and material availability and actual weather conditions at the time at which closure occurs.

4.6. Drainage and Stabilization

Section 845.750(b): *Drainage and Stabilization of CCR Surface Impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of this subsection (b) before installing the final cover system required by subsection (c).*

1) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.

2) Remaining wastes must be stabilized sufficiently to support the final cover system.

Prior to installing the final cover system, free liquids will be eliminated by removing the liquid waste from the BAP. Free liquids are defined as "liquids which readily separate from the solid portion of a waste under ambient temperature and pressure" by the United States Environmental Protection Agency (USEPA). Methods for free liquid removal may include, but are not limited to, the methods described below.

- Stopping of Process Flow
  - The BPP will cease producing power on December 31, 2025 and this will cease the process flow.
- Drilled Sumps
  - Drilled sumps typically consist of four to six-foot diameter borings drilled in CCR to depths of at least 10 ft. A perforated pipe is inserted into the boring and the annulus between the CCR and the pipe is backfilled with gravel. Free liquids are then allowed to flow into the pipe and are then removed via pumping.
  - A series of piezometers is typically installed near the sump to measure the corresponding drawdown in the phreatic surface in the CCR.

  - The achieved drawdown will provide data for identifying the required spacing of the sumps.

- Engineered Trenches

  - Excavated and sloped trenches may be used for CCR depths of less than 10 ft.

  - A series of piezometers is typically installed between excavated trenches to measure the corresponding drawdown in the phreatic surface in the CCR.

  - The trenches are sloped for a low point where free liquids are removed via pumping.

- Horizontal Wells

  - Horizontal wells may be directionally-drilled or installed using cut-and-cover techniques in CCR zones of low permeability that do not respond to free liquid removal using trenches drilled sumps or engineered trenches.

  - A series of piezometers is typically installed to measure the corresponding drawdown in the phreatic surface in the CCR.

  - Liquid waste is removed from the horizontal wells using a submersible pump.

Liquid waste obtained during free liquid removal will be discharged to the site's NPDES-permitted outfall. The removal of free liquids will result in the stabilization of the remaining CCR and will therefore allow the final cover to be placed on a stable subgrade.

4.7. Final Cover System

<u>Section 845.750(c):</u> *Final Cover System. If a CCR surface impoundment is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and, at a minimum, meets the requirements of this subsection (c) unless the owner or operator demonstrates that another low permeability construction technique or material provides equivalent or superior performance to the requirements of either subsection (c)(1)(A) or (c)(1)(B) and is approved by the Agency. The final cover system must consist of a low permeability layer and a final protective layer. The design of the final cover system must be included in the preliminary and final written closure plans required by Section 845.720 and the construction permit application for closure submitted to the Agency.*

An alternate final cover system has been designed consistent with the requirements of Section 845.720(c). The final cover will use a geomembrane as a low-permeability layer. The design of the final cover system is discussed within this section.

4.7.1. Low Permeability Layer - Geomembrane

<u>*Section 845.750(c)(1)(B):*</u> *A geomembrane constructed in accordance with the following standards: i) The geosynthetic membrane must have a minimum thickness of 40 mil (0.04 inches) and, in terms of hydraulic flux, must be equivalent or superior to a three-foot layer of soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec; ii) The geomembrane must have strength to withstand the normal stresses imposed by the waste stabilization process; and (iii) The geomembrane must be placed over a prepared base free from sharp objects and other materials that may cause damage.*

The geomembrane will consist of a 40-mil linear low-density polyethylene (LLDPE) layer. Ramboll completed a Hydrologic Evaluation of Landfill Performance (HELP) [5] model to compare flux through the geomembrane cover to an equivalent cover system with 3 feet of $1x10^{-7}$ cm/sec clay, in order to demonstrate that the geomembrane final cover is superior to a soil-only final cover prescribed in Part 847. The HELP modeling estimated a total infiltration of 0.00011 inches of water per year (in/yr) for the geomembrane final cover system, relative to 0.00083 in/year for the cover system using 3 feet of 1×10^{-7} cm/sec clay. Therefore, the proposed geomembrane final cover system is equivalent to the 3-foot, 1×10^{-7} cm/sec clay low-permeability layer, as infiltration is reduced by a factor of approximately 7.5.

The geomembrane will be installed on a prepared subgrade, after the underlying CCR has been stabilized. Therefore, additional normal stresses will not be imparted on the geomembrane due to the waste stabilization process.

The subgrade (e.g., base) for the geomembrane will be visually inspected and sharp objects such as rocks or debris that may damage the geomembrane will be removed, prior to deployment of the geomembrane.

4.7.2. Standards for the Final Protective Layer

An alternative final protective layer is proposed. The alternative final protective layer requirements are as follows:

<u>*Section 845.750(c)(2):*</u> *Standards for the Final Protective Layer. The final protective layer must meet the following requirements, unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2) and is approved by the Agency.*

A) Cover the entire low permeability layer;

B) Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;

C) Consist of soil material capable of supporting vegetation;

D) Be placed as soon as possible after placement of the low permeability layer; and

E) Be covered with vegetation to minimize wind and water erosion.

A final protective layer will be placed over and extend slightly beyond the entire geomembrane low-permeability layer in plan. Based on the demonstration included in **Attachment C**, pursuant to Section 845.750(c)(2), the protective layer will include, from bottom to top, a geotextile cushion, a 1.5-ft thick cover soil layer, and a 0.5-ft thick topsoil layer, for a total thickness of 2 ft.

The nonwoven geotextile cushion and 1.5-ft thick cover soil layer will protect the geomembrane from root penetration. Geomembranes are not susceptible to freeze-thaw damage, as discussed in **Attachment C**. The geotextile and cover soil will be placed as soon as practical after the geomembrane has been deployed and both quality assurance and quality control testing has been performed on the geomembrane seams.

The 0.5-ft thick topsoil layer will be fertilized, as necessary to support appropriate grass species, to vegetate the final protective layer.

<u>Section 845.750(c)(3):</u> *The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.*

Settling and subsidence has been accounted for in the design of the final cover system as discussed in **Section 4.10**.

4.8. Certification of Final Cover System

Section 845.750(c)(4): *The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the design of the final cover system meets the requirements of this Section.*

The undersigned qualified professional engineer registered in Illinois certifies that the design of the final cover system meets the requirements of Section 845.750.

Thomas W. Ward
Printed Name

Signature Date

062-069043	IL	November 31, 2023
Registration Number	State	Expiration Date

Affix Seal

4.9. Uses of CCR in Closure

<u>Section 845.750(d):</u> *This subsection specifies the allowable uses of CCR in the closure of CCR surface impoundments closing under Section 845.700. Notwithstanding the prohibition on further placement in Section 845.700, CCR may be placed in these surface impoundments, but only for purposes of grading and contouring in the design and construction of the final cover system, if:*

1) The CCR placed was generated at the facility and is located at the facility at the time closure was initiated;

2) CCR is placed entirely above the elevation of CCR in the surface impoundment, following dewatering and stabilization (see subsection (b));

3) The CCR is placed entirely within the perimeter berms of the CCR surface impoundment; and

Approximately 500,000 cubic yards of CCR is anticipated to be generated by the BPP from now until December 31, 2025, when closure construction begins. All of the CCR currently being generated by the BPP will be transported to the adjacent BAP to be beneficially used as compacted subgrade fill below the final cover system. This will support achieving design final cover system grades and maintaining final cover system slopes that promote positive stormwater drainage and preclude the impoundment of stormwater.

4.10. Final Cover System Slopes

<u>Section 845.750(d)(4):</u> *The final cover system is constructed with either:*

A) A slope not steeper than 5% grade after allowance for settlement; or

B) At a steeper grade, if the Agency determines that the steeper slope is necessary, based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential. The stability analysis, at a minimum, must evaluate the site geology; characterize soil shear strength; construct a slope stability model; establish groundwater and seepage conditions, if any; select loading conditions; locate critical failure surface; and iterate until minimum factor of safety is achieved.

Final cover slopes will typically consist of 2% cross-slopes on the top of the BAP. However, slopes of up to 25% final cover slopes will be used near the perimeter of the final cover, as needed to tie the final cover into the existing grades, as shown in the drawing package provided in **Attachment B**. Twenty-five percent slopes will be utilized to limit the total height of the consolidated-and-cap BAP. This will reduce visual impacts associated with the closure.

The stability of the 25% final cover slopes has been evaluated both for the final cover system itself (e.g., veneer stability) and the global stability of the slope. These calculations included characterizing soil shear strength based on site geology, constructing slope stability models, establishing groundwater seepage conditions, selecting loading conditions, locating the critical failure surface, and iterating until minimum factors of safety were calculated. These calculations are provided in **Attachment E**. Resulting factors of safety exceed typical minimum factors of safety for both global and veneer stability.

Settlement analyses to evaluate the effects of compression of the underlying native foundation clay soil units on the final cover system have indicated that settlements up to 14 inches are expected. These settlements are not expected to adversely impact final cover system drainage as 80 percent of the settlement will occur during construction with the final 3 inches occurring after construction.

Subsidence is not expected to be a concern for the BAP as previous Unstable Area location restrictions reports, prepared in accordance with §257.64(a) of the USEPA CCR Rule [2] , concluded that *"...karst topography or physiographic features such as sinkholes, vertical shafts, sinking streams, caves, large springs, or blind valleys do not exist at the Plant."*

5. ADDITIONAL INFORMATION

Both the lateral migration of groundwater and vertical infiltration of liquids, and releases of CCR, and leachate, and contaminated run-off into and out of the BAP will be controlled, minimized or eliminated, to the maximum extent feasible, under post-closure conditions. A description of how this will be performed is provided below.

- Free liquids will be removed from the BAP during closure, thereby reducing the amount of leachate and potential for contaminated runoff. Additionally, a final cover system will be installed to reduce the potential for future accumulation of free liquids within the CCR, as discussed in **Section 4.1**.

- The consolidated-and-capped BAP footprint will overly a native alluvial clay thickness (the upper confining unit) of 15 to 40 feet that is approximately 28 feet thick on average beneath the CCR.

    - The alluvial clay is expected to have a hydraulic conductivity on the order of 3.2 x 10^{-5} cm/sec to 8.6 x 10^{-7} cm/sec [6].

- Closure of the BAP will include constructing a final cover system that ties into native foundation clays, the capped FAPS, or the existing perimeter berm to the north, as discussed in **Section 4.1.**

- CCR within the BAP will not be in contact with the uppermost aquifer during post-closure conditions.

6. CERTIFICATION FROM A QUALIFIED PROFESSIONAL ENGINEER

Section 845.720(b)(5): *The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the final written closure plan meets the requirements of this Part.*

I, Thomas W. Ward, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this construction permit application has been prepared in accordance with the accepted practice of engineering and the requirements of Title 35, Subtitle G, Chapter I, Subchapter j, Section 845.720 of the Illinois Administrative Code.

Thomas W. Ward
Printed Name

____
Signature Date

062-06904 IL November 31, 2023
Registration Number State Expiration Date

Affix Seal

7. REFERENCES

[1] IngenAE, LLC, "CCR Facility Boundary Exhibit, Luminant Baldwin Power Plant," Earth City, MO, September 7, 2021.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Ramboll Americas Engineering Solutions, Inc. , Addendum No. 1 Baldwin Bottom Ash Pond Closure Plan, 2020.

[4] Ramboll, "Groundwater Model Report, Bottom Ash Pond, Baldwin Power Plant, Baldwin, Illinois," May 2023.

[5] United States Environmental Protection Agency, "Walkthrough to Install and Operate the Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07," 2017.

[6] Ramboll, "Hydrogeologic Site Characterization Report, Bottom Ash Pond, Baldwin Power Plant, Baldwin, Illinois," October 2021.

ATTACHMENT A

Closure Alternatives Analysis (Section 845.720(b)(3))

Closure Alternatives Analysis for the Bottom Ash Pond at the Baldwin Power Plant Baldwin, Illinois

May 24, 2023

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
BAP	Bottom Ash Pond
BMP	Best Management Practice
BPP	Baldwin Power Plant
BU	Bedrock Unit
CAA	Closure Alternatives Analysis
CBR-Offsite	Closure-by-Removal with Off-Site CCR Disposal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CY	Cubic Yard
DMG	Dynegy Midwest Generation, LLC
EJ	Environmental Justice
FEMA	Federal Emergency Management Agency
GHG	Greenhouse Gas
GWPS	Groundwater Protection Standard
IAC	Illinois Administrative Code
ID No.	Identification Number
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
LLDPE	Linear Low-Density Polyethylene
N_2O	Nitrous Oxide
NID	National Inventory of Dams
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
PM	Particulate Matter
SFWA	State Fish and Wildlife Area
TVA	Tennessee Valley Authority
UGU	Upper Groundwater Unit
US DOT	United States Department of Transportation
VOC	Volatile Organic Compound
WPC Permit	Water Pollution Control Construction and Operating Permit

Summary of Findings

Title 35, Part 845 of the Illinois Administrative Code (IAC; IEPA, 2021) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain surface impoundments containing coal combustion residuals (CCRs) in the state of Illinois. Pursuant to requirements under IAC Section 845.710, this report presents a CAA for the Bottom Ash Pond (BAP) located on Dynegy Midwest Generation, LLC's (DMG) Baldwin Power Plant (BPP) property near the village of Baldwin, Illinois. The goal of a CAA is to holistically evaluate potential closure scenarios with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IAC Part 845; IEPA, 2021). Gradient evaluated two specific closure scenarios for the BAP: Closure-in-Place with consolidation (CIP) and Closure-by-Removal with off-Site CCR disposal (CBR-Offsite). The CIP scenario entails consolidating all CCR into the eastern section of the BAP, and then capping the consolidated CCR with a new cover system consisting of, from bottom to top, a geomembrane layer, a geotextile cushion if needed, and 24 inches of vegetated soil. The CBR-Offsite scenario entails excavating all of the CCR from the BAP and transporting it to an off-Site landfill for disposal. DMG will also continue to evaluate potential opportunities for beneficial use of CCR excavated from the BAP as an alternative to disposal.

IAC Section 845.710(c)(2) requires CAAs to "[i]dentify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible" (IEPA, 2021). There is no existing on-Site landfill at the BPP Site. Additionally, no areas on the property are suitable for the construction of a new on-Site landfill that is capable of receiving all 3.8 million cubic yards (CY) of material to be excavated from the BAP (Appendix B). Geosyntec Consultants evaluated 14 different areas of the Site and found that none of them was suitable for construction of a new on-Site landfill due to various conflicts, including planned utility-scale solar and battery energy storage facility development, potential impacts to the 100-year floodplain, current or former CCR surface impoundments, existing utility corridors and roadways, and planned future uses of the property (Appendix B). For these reasons, construction of a new on-Site landfill is not a viable alternative at this Site.

Table S.1 summarizes the expected impacts of the CIP and CBR-Offsite closure scenarios with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021). Based on this evaluation and the additional details provided in Section 2 of this report, CIP has been identified as the most appropriate closure scenario for the BAP. Key benefits of the CIP scenario relative to the CBR-Offsite scenario include reduced impacts to workers, community members, and the environment during construction (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and greenhouse gas [GHG] emissions, and less traffic-related impacts). Moreover, the CIP scenario will meet the required closure schedule (*i.e.*, closure completed by October 2028) defined in IAC Section 845.700(d)(2)(C)(ii) (IEPA, 2021), whereas the CBR-Offsite scenario would be unable to meet this required schedule.

Table S.1 Comparison of Proposed Closure Scenarios

Evaluation Factor (Report Section; IAC Part 845 Section)	Closure Scenario	
	CIP	**CBR-Offsite**
Closure Alternative Descriptions (Section 2.1, IAC Section 845.710(c))	All CCR would be consolidated in the eastern section of the BAP and then capped in place with a new cover system consisting of, from bottom to top, a geomembrane layer, a geotextile cushion if needed, and 24 inches of vegetated soil. During the closure process, we will continue to assess off-Site CCR beneficial use opportunities. Ash consolidation and CIP in combination with off-Site beneficial use may result in a smaller footprint for purposes of our ultimate cap design along with a reduced construction schedule.	All CCR would be excavated from the BAP and transported *via* truck to an off-Site landfill for disposal. Expansion of the off-Site landfill may be necessary in order to accept all of the CCR from the BAP.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.3, IAC Section 845.710(b)(1)(C))	Monitoring would be performed for 30 years post-closure or until GWPSs are achieved, whichever is longer. Additionally, the final cover system for the BAP would undergo 30 years of annual inspections, mowing, and maintenance.	Monitoring would be performed for 3 years post-closure or until GWPSs are achieved, whichever is longer.
Magnitude of Reduction of Existing Risks (Section 2.2.1, IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current unacceptable risks to any human or ecological receptors associated with the BAP. Because there are no current risks, and dissolved constituent concentrations would be expected to decline post-closure, no risks to human or ecological receptors would be expected post-closure.	There are no current unacceptable risks to any human or ecological receptors associated with the BAP. Because there are no current risks, and dissolved constituent concentrations would be expected to decline post-closure, no risks to human or ecological receptors would be expected post-closure.
Likelihood of Future Releases of CCR (Section 2.2.2, IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	During closure, there would be minimal risk of dike failure occurring at the BAP (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	During closure, there would be minimal risk of dike failure occurring at the BAP (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure. Changing geochemical conditions during an extended excavation can be a mechanism that results in the mobilization and increased transport in groundwater for some constituents.
Worker Risks (Section 2.2.4.1, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.0069 worker fatalities and 0.79 worker injuries would be expected to occur due to on-Site activities under this closure scenario. An additional 0.0093 worker fatalities and 0.58 worker injuries would be expected to occur off-Site due to vehicle accidents during material deliveries and labor and equipment mobilization and demobilization. In total, 0.016 worker fatalities and 1.4 worker injuries would be expected under this closure scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site would be re-developed for use in utility-scale solar generation and battery energy storage. The simultaneous pursuit of two large construction projects may lead to traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The CIP scenario would likely result in less traffic congestion – and, hence, a smaller increase in risks to workers – than the CBR-Offsite scenario.	An estimated 0.011 worker fatalities and 1.3 worker injuries would be expected to occur due to on-Site activities under this closure scenario. An additional 0.053 worker fatalities and 3.1 worker injuries would be expected to occur off-Site due to vehicle accidents during hauling, material deliveries, and labor and equipment mobilization and demobilization. In total, 0.064 worker fatalities and 4.4 worker injuries would be expected under this closure scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site would be re-developed for use in utility-scale solar generation and battery energy storage. The simultaneous pursuit of two large construction projects may lead to traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The CIP scenario would likely result in less traffic congestion – and, hence, a smaller increase in risks to workers – than the CBR-Offsite scenario.
Community Risks (Section 2.2.4.2, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))		
▪ *Off-Site Impacts on Nearby Residents and EJ Communities*	Off-Site impacts on nearby residents (including accidents, traffic, noise, and air pollution) would be less under this closure scenario than under the CBR-Offsite scenario because it would require less off-Site vehicle and equipment travel miles than the CBR-Offsite scenario. In total, an estimated 0.0056 fatalities and 0.27 injuries would be expected to occur among community members due to off-Site activities under this scenario. With regard to traffic impacts, a haul truck would be likely to pass a location near the Site every 6.4 minutes on average during working hours for approximately 490 working days under this closure scenario. No negative EJ community impacts would be expected under either closure scenario.	Off-Site impacts on nearby residents would be greater under the CBR-Offsite closure scenario than under the CIP scenario because it would require significantly more off-Site vehicle and equipment travel miles. In total, an estimated 0.15 fatalities and 4.1 injuries would be expected to occur among community members due to off-Site activities under this scenario. With regard to traffic impacts, a haul truck would be likely to pass a location near the Site every 2.2 minutes on average during working hours for approximately 1,870 working days under this closure scenario. No negative EJ community impacts would be expected under either closure scenario.

Evaluation Factor (Report Section; IAC Part 845 Section)	Closure Scenario	
	CIP	**CBR-Offsite**
▪ *Impacts on Scenic, Historical, and Recreational Value*	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Baldwin Power Plant Cooling Lake, which lies within the Kaskaskia River State Fish and Wildlife Area. Residents living near the proposed on-Site borrow soil location and visitors to Baldwin Cemetery may also temporarily be impacted by construction at the proposed borrow soil location, since borrow is required under this scenario. Because the expected duration of construction activities is shorter under this closure scenario compared to the CBR-Offsite scenario, short-term impacts on the scenic, historical, and recreational value of natural areas near the Site would be less under this closure scenario than under the CBR-Offsite scenario.	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Baldwin Power Plant Cooling Lake, which lies within the Kaskaskia River State Fish and Wildlife Area. Because the expected duration of construction activities is longer under the CBR-Offsite scenario than under the CIP scenario, short-term impacts on the scenic, historical, and recreational value of natural areas near the Site would be greater under the CBR-Offsite scenario than under the CIP scenario.
Environmental Risks (Section 2.2.4.3, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))		
▪ *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Total energy demands and GHG emissions would be smaller under this closure scenario than under the CBR-Offsite scenario, because the total equipment and vehicle mileages required under this closure scenario would be smaller than those required under the CBR-Offsite scenario. The CIP scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the final cover system. At the grid scale, construction of a solar facility at the Site would put energy back on the grid and reduce reliance on non-renewable energy sources.	Total energy demands and GHG emissions would be greater under the CBR-Offsite closure scenario than under the CIP scenario, because the total equipment and vehicle mileages required under the CBR-Offsite scenario would be greater than those required under the CIP scenario. If expansion of the off-Site landfill became necessary in order to accept all of the CCR from the BAP, then the CBR-Offsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner. At the grid scale, construction of a solar facility at the Site would put energy back on the grid and reduce reliance on non-renewable energy sources.
▪ *Impacts on Natural Resources and Habitat*	Construction activities may have short-term negative impacts on species located near the BAP and the on-Site borrow soil location. Short-term impacts on natural resources and habitat would be smaller under the CIP scenario than under the CBR-Offsite scenario, because the overall duration of construction is shorter under the former scenario.	Construction activities may have short-term negative impacts on species located near the BAP and the off-Site landfill. Short-term impacts on natural resources and habitat would be greater under the CBR-Offsite scenario than under the CIP scenario, because the overall duration of construction is longer under the former scenario.
Time Until Groundwater Protection Standards Are Achieved (Section 2.2.5, IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the BAP under each of the proposed closure scenarios. While the groundwater modeling demonstrated that groundwater concentrations will increase at several wells post-closure under both the CIP and CBR-Offsite scenarios, the modeling also suggested that the increasing concentrations are the result of the adjacent Fly Ash Pond System, not the BAP (Ramboll, 2023). Results of groundwater modeling indicate that concentrations of boron, a common indicator parameter used in coal ash fate and transport evaluations, at the proposed BAP compliance wells that are not influenced by the Fly Ash Pond System will remain below the GWPS following implementation of either the CIP or the CBR-Offsite scenarios (Ramboll, 2023).	Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the BAP under each of the proposed closure scenarios. While the groundwater modeling demonstrated that groundwater concentrations will increase at several wells post-closure under both the CIP and CBR-Offsite scenarios, the modeling also suggested that the increasing concentrations are the result of the adjacent Fly Ash Pond System, not the BAP (Ramboll, 2023). Results of groundwater modeling indicate that concentrations of boron, a common indicator parameter used in coal ash fate and transport evaluations, at the proposed BAP compliance wells that are not influenced by the Fly Ash Pond System will remain below the GWPS following implementation of either the CIP or the CBR-Offsite scenarios (Ramboll, 2023). Additionally, changing geochemical conditions during an extended excavation can be a mechanism that results in the mobilization and increased transport in groundwater for some constituents. This may result in GWPS exceedances.
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.7; IAC Section 845.710(b)(1)(G))	CIP would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 2.2.8; IAC Section 845.710(b)(1)(H))	Corrective action is expected at the Site. An evaluation of potential corrective measures and corrective actions has not yet been completed, but will be conducted consistent with the requirements in IAC Section 845.660 and IAC Section 845.670.	Corrective action is expected at the Site. An evaluation of potential corrective measures and corrective actions has not yet been completed, but will be conducted consistent with the requirements in IAC Section 845.660 and IAC Section 845.670.
Effectiveness of the Alternative in Controlling Future Releases (Section 2.3; IAC Section 845.710(b)(2)(A and B))	There are no current or future risks to any human or ecological receptors associated with the BAP. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	There are no current or future risks to any human or ecological receptors associated with the BAP. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Ease or Difficulty of Implementing the Alternative (Section 2.4, IAC Section 845.710(b)(3))		
▪ *Degree of Difficulty Associated with Construction*	CIP is a reliable and standard method for managing and closing waste impoundments. Dewatering saturated CCR to construct a stabilized final cover system subgrade may present challenges during closure; however, these challenges are common to most CCR surface impoundment closures and are commonly addressed *via* surface water management and dewatering techniques.	Relative to CIP, CBR-Offsite poses additional implementation difficulties due to larger earthwork volumes, larger dewatering volumes, and longer construction schedules. Hauling to an off-Site landfill would be required under the CBR-Offsite scenario. Off-Site landfilling would additionally require the development of a disposal plan and could raise issues related to the co-disposal of CCR and other non-hazardous wastes. The off-Site landfill may also need to be expanded to receive all of the CCR generated during excavation.
▪ *Expected Operational Reliability*	Operational reliability would be expected under both closure scenarios.	Operational reliability would be expected under both closure scenarios.
▪ *Need for Permits and Approvals*	Permits required under both closure scenarios would include a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the BAP to be modified as part of closure; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit (WPC permit). A NPDES permit modification has already been obtained through IEPA.	Permits required under both closure scenarios would include a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the BAP to be modified as part of closure; a construction stormwater permit through IEPA; and a WPC permit. A NPDES permit modification has already been obtained through IEPA. Additional permits and approvals may be required under this scenario if the off-Site landfill must be expanded to receive all of the CCR from the BAP.
▪ *Availability of Equipment and Specialists*	CIP and CBR-Offsite rely on common construction equipment and materials and typically do not require the use of specialists. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be delays in construction under both scenarios if supply chain resilience does not improve by the time of construction. Due to smaller earthwork volumes and a lesser need for construction equipment under the CIP scenario than under the CBR-Offsite scenario, shortages may cause fewer challenges under the CIP scenario than under the CBR-Offsite scenario.	CIP and CBR-Offsite rely on common construction equipment and materials and typically do not require the use of specialists. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be delays in construction under both scenarios if supply chain resilience does not improve by the time of construction. Due to the large volume of CCR to be hauled from the site under the CBR-Offsite scenario, shortages may cause greater challenges under the CBR-Offsite scenario than under the CIP scenario.
▪ *Available Capacity and Location of Treatment, Storage, and Disposal Services*	Under the CIP scenario, all of the CCR currently within the BAP would be stored within the existing footprint of the impoundment. Treatment would consist of unwatering the BAP at the start of construction, performing limited dewatering to stabilize the CCR subgrade, and managing stormwater inflow. Water from unwatering and dewatering of the BAP would be discharged in accordance with the NPDES permit for the facility.	The capacity remaining at the chosen off-Site landfill in Marissa, Illinois (the Cottonwood Hills RDF Landfill), would be sufficient to receive all of the CCR in the BAP. However, due to the relatively short period over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that would be received and the unique CCR waste characteristics. If expansion of the chosen off-Site landfill were found to be impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A possible alternative to the Cottonwood Hills RDF Landfill is the North Milam Landfill in East Saint Louis, Illinois. Water from unwatering and dewatering of the BAP would be discharged in accordance with the NPDES permit for the facility.
Impact of Alternative on Waters of the State (Section 2.5, IAC Section 845.710(d)(4))	No current or future exceedances of any screening benchmarks for surface water would be expected under either closure scenario.	No current or future exceedances of any screening benchmarks for surface water would be expected under either closure scenario.
Potential Modes of Transportation Associated with CBR-Offsite (Section 2.1; IAC Section 845.710(c)(1)	This factor is not relevant for CIP.	IAC Section 845.710(c)(1) requires CBR-Offsite alternatives to consider multiple methods for transporting CCR off-Site, including rail, barge, and trucks. Geosyntec Consultants evaluated the feasibility of transporting CCR to the off-Site landfill *via* rail or barge and found that neither option is likely to be viable at this Site. Truck transport has been identified as the preferred option for transport of CCR to the off-Site landfill. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.
Concerns of Residents Associated with Alternatives (Section 2.6, IAC Section 845.710(b)(4))	CIP would effectively address residents' concerns regarding potential impacts to groundwater and surface water quality at the Site. Relative to CBR-Offsite, CIP also presents less risks to nearby residents in the form of accidents, traffic, noise, and air pollution.	The CBR-Offsite scenario has several disadvantages with regard to potential community concerns. Relative to CIP, CBR-Offsite presents greater risks to nearby residents in the form of accidents, traffic, noise, and air pollution.

Notes:
BAP = Bottom Ash Pond; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; EJ = Environmental Justice; GHG = Greenhouse Gas; GWPS = Groundwater Protection Standard; IAC = Illinois Administrative Code; IDNR = Illinois Department of Natural Resources; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System.

1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

Dynegy Midwest Generation, LLC's (DMG) Baldwin Power Plant (BPP) is an electric power generating facility with coal-fired units located approximately 1.5 miles north-northwest of the village of Baldwin, Illinois, along the Kaskaskia River. The facility began operating in 1970 (IEPA, 2021; Ramboll, 2021; Appendix B).

1.1.2 CCR Impoundment

The BPP produces and stores coal combustion residuals (CCRs) as a part of its operations. The Bottom Ash Pond (BAP; Vistra identification number [ID No.] CCR Unit 601, Illinois Environmental Protection Agency [IEPA] ID No. W1578510001-06, and National Inventory of Dams [NID] ID No. IL50721) is the subject of this report.

The BAP (Figure 1.1) is a 177-acre unlined surface impoundment used for the management of CCRs, primarily bottom ash, and other non-CCR process wastewaters generated by the BPP (Geosyntec Consultants, 2021; Ramboll, 2021). The construction date of the BAP is unknown (AECOM, 2016a). The footprint of the BAP primarily contains areas of stacked ash and vegetation, though ponding does occur in multiple areas (Geosyntec Consultants, 2021). A portion of the bottom ash stored in the BAP is mined for beneficial use (Ramboll, 2021).

The BAP is bounded by the BPP Cooling Lake to the north and the closed Fly Ash Pond system to the east and south. Under normal operating conditions, the BAP discharges decanted water to the non-CCR Secondary Pond shown in Figure 1.1 *via* a spillway/outfall structure on the western side of the impoundment. The Secondary Pond discharges to the non-CCR Tertiary Pond, which discharges in turn to the Kaskaskia River *via* a National Pollutant Discharge Elimination System (NPDES)-permitted outfall (Geosyntec Consultants, 2021; Ramboll, 2021). During heavy rainfall events, an emergency pumping station pumps decanted water from the BAP into the BPP Cooling Lake. The Cooling Lake discharges to the Kaskaskia River *via* a NPDES-permitted outfall (Geosyntec Consultants, 2021; Ramboll, 2021).

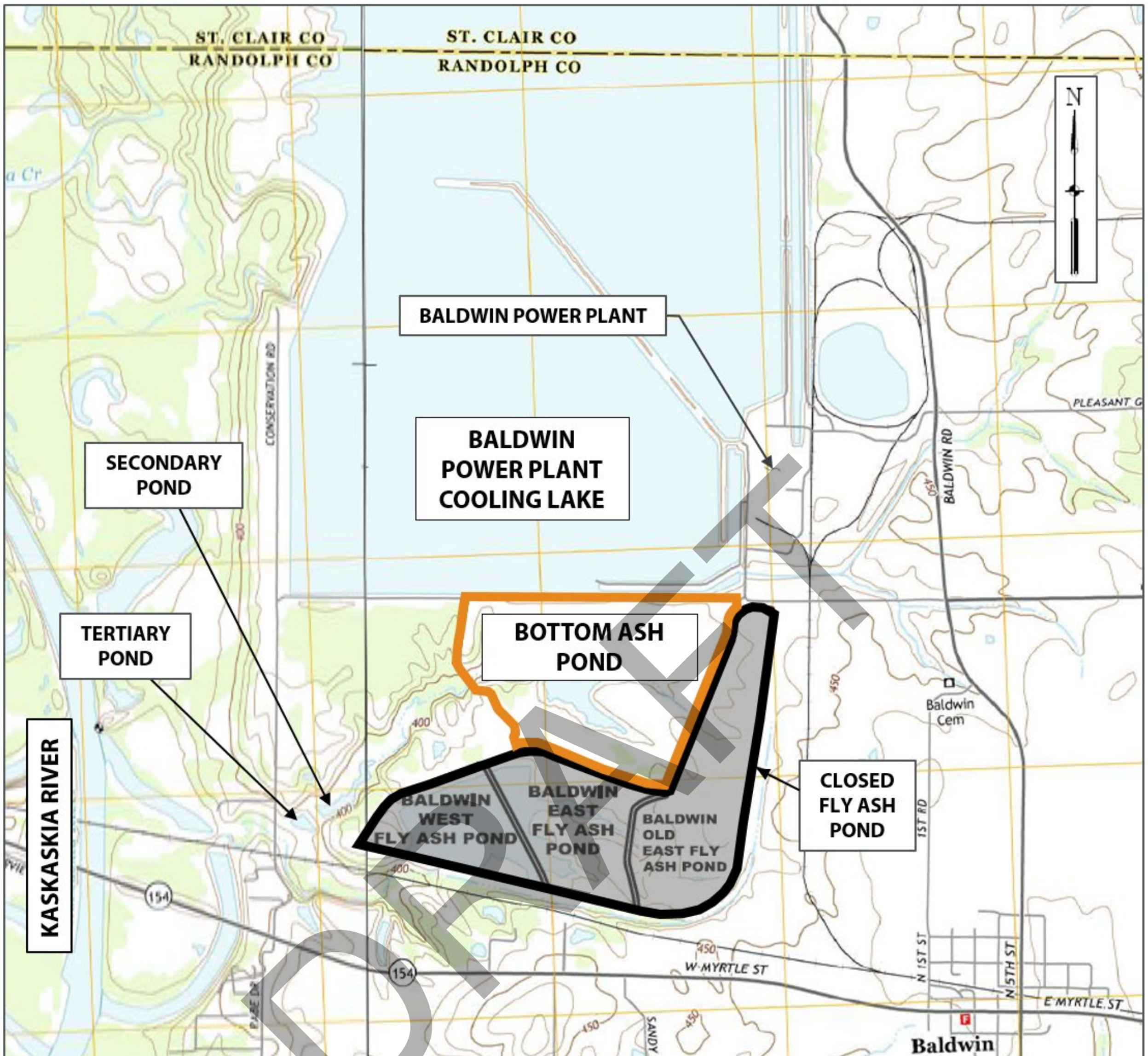

Figure 1.1 Site Location Map. Adapted from AECOM (2016a, Appendix A).

1.1.3 Surface Water Hydrology

There are 28 surface water features within 1,000 meters of the BAP (Ramboll, 2021). One freshwater emergent wetland and one freshwater forested/shrub wetland are also located within this radius (Ramboll, 2021). The most significant surface water features on or near the Site are the Kaskaskia River and the BPP Cooling Lake (Figure 1.1).

The Kaskaskia River is located approximately 1 mile west of the outer perimeter of the BAP within the Kaskaskia River Watershed (AECOM, 2016a). It is a tributary of the Mississippi River, which is located approximately 25 miles west of the Site (Ramboll, 2021). The segment of the Kaskaskia River adjacent to the Site (Section IL_O-97) is included on the 2022 Illinois Section 303(d) List as being impaired for aquatic life due to abnormal flow, degraded habitat, low oxygen, and sediment; fish consumption due to mercury and pesticides; and public and food processing water supply due to pesticides (IEPA, 2022a; US

EPA, 2022). The 2,018-acre BPP Cooling Lake, which borders the BAP to the north, was constructed between 1967 and 1970. The Cooling Lake is filled by pumping water from the Kaskaskia River. As a perched lake, it is partially hydrologically isolated from the natural surface water and groundwater features at the Site (Ramboll, 2021).

Two surface water samples were collected from the same location in the Kaskaskia River adjacent to the Site in November 2016 (Hanson Professional Services Inc., 2017). These data are summarized in Gradient's "Human Health and Ecological Risk Assessment" for the Site, which is provided as Appendix A of this report.

1.1.4 Hydrogeology

The geology underlying the Site in the vicinity of the BAP consists of unlithified materials (alluvium and glacial deposits) underlain by bedrock (Ramboll, 2021). From the surface downwards, the four principal types of unlithified materials present at the Site are the alluvial clay, sandy clay, and clayey sand of the Cahokia Formation (average thickness of 20 feet); the silt and silty clay of the Peoria Loess (average thickness of 10 feet); the clay and sandy clay of the Equality Formation, with occasional sand seams and lenses (average thickness of 13 feet); and the clay and sandy clay diamictons of the Vandalia Till, with intermittent and discontinuous sand lenses (average thickness of 21 feet; Ramboll, 2021). There are two distinct hydrostratigraphic units below the CCR at this Site: (1) the Upper Groundwater Unit (UGU), consisting of the lithologic layers identified as the Cahokia Formation, Peoria Loess, Equality Formation, and Vandalia Till; and (2) the Bedrock Unit (BU). The UGU is composed predominantly of clay with some silt and minor sand, silt layers, and occasional sand lenses. The BU is composed of interbedded shale and limestone bedrock, which is continuous across the entire Site (Ramboll, 2021). The BU has been identified as the uppermost aquifer (Ramboll, 2021). Thin sand lenses in the UGU adjacent to the BAP and the area of contact between the unlithified material and the bedrock have both been identified as potential migration pathways.

The general groundwater flow direction in the vicinity of the Site is west towards the Kaskaskia River, the principal surface drainage for the region (Ramboll, 2021). Based on groundwater hydraulic head measurements, lateral groundwater flow in the UGU and the BU is generally to the west and southwest toward the historic drainage feature at the Site and the bedrock valley underlying the Secondary and Tertiary Ponds. The receiving surface water bodies for groundwater in the UGU are assumed to be the Secondary and Tertiary Ponds (which ultimately drain to the Kaskaskia River). The receiving surface water body for groundwater in the BU (the uppermost aquifer) is the Kaskaskia River (Ramboll, 2021).

During groundwater interaction with surface water, CCR-related constituents may partition between sediments and the surface water column. It should be noted that many CCR-related constituents occur naturally in sediments and surface water (and can also arise from other industrial sources). As a result, their presence in the sediments and/or surface water of the Kaskaskia River does not necessarily signify contributions from the BAP.

The "Hydrogeologic Site Characterization Report" prepared by Ramboll as part of the operating permit for the BAP includes an evaluation of groundwater data collected from BAP monitoring wells between 2015 and 2021 (Ramboll, 2021).

1.1.5 Site Vicinity

The BPP Site is bounded by Baldwin Road to the east, Kaskaskia River to the west, and the Illinois Central Gulf railroad and State Route 154 to the south. The area around the Site is predominantly agricultural (Ramboll, 2021). The village of Baldwin, Illinois, lies approximately 1.5 miles south-southeast of the BPP.

The BAP borders the BPP Cooling Lake, which is part of the greater Kaskaskia River State Fish and Wildlife Area (SFWA). The Kaskaskia River SFWA, which spans over 20,000 acres, is popular for fishing and wildlife viewing (IDNR, 2022). A campground is located approximately 2,000 feet south of the southern perimeter of the BAP. The Wood Duck Marina is located approximately 3,500 feet west/southwest of the BAP. The Baldwin Cemetery is located approximately 3,000 feet east of the BAP (Google LLC, 2022). Gradient's "Human Health and Ecological Risk Assessment" for the Site (Appendix A of this report) describes the water wells and domestic water supply intakes in the vicinity of the Site.

Based on a review of the Illinois Department of Natural Resources (IDNR) Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of the BAP (Ramboll, 2021).

1.2 IAC Part 845 Regulatory Review and Requirements

Title 35, Part 845 of the Illinois Administrative Code (IAC; IEPA, 2021) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain CCR-containing surface impoundments in the state of Illinois. Section 2 of this report presents a CAA for the BAP pursuant to requirements under IAC Section 845.710. The goal of a CAA is to holistically evaluate each potential closure scenario with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IEPA, 2021). A CAA is a decision-making tool that is designed to aid in the selection of an optimal closure alternative for the impoundments at a site.

2 Closure Alternatives Analysis

2.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the BAP pursuant to requirements under IAC Section 845.710 (IEPA, 2021). The two closure scenarios evaluated in this CAA are Closure-in-Place with consolidation (CIP) and Closure-by-Removal with off-Site CCR disposal (CBR-Offsite). Under the CIP scenario, all CCR would be consolidated into the eastern section of the BAP, and the consolidated CCR would be capped with a new cover system. Under the CBR-Offsite scenario, all of the CCR would be excavated from the impoundment and hauled to an off-Site landfill. DMG will also continue to evaluate potential opportunities for beneficial use of CCR excavated from the BAP as an alternative to disposal.

IAC Section 845.710(c)(2) requires CAAs to, "[i]dentify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible" (IEPA, 2021). There is no existing on-Site landfill at the BPP Site. Additionally, no areas on the property are suitable for the construction of a new on-Site landfill that is capable of receiving all 3.8 million cubic yards (CY) of material to be excavated from the BAP (Appendix B). Geosyntec Consultants evaluated 14 different areas of the Site and found that none of them was suitable for construction of a new on-Site landfill due to various conflicts, including planned utility-scale solar and battery energy storage facility development, potential impacts to the 100-year floodplain, current or former CCR surface impoundments, existing utility corridors and roadways, and planned future uses of the property (Appendix B). For these reasons, construction of a new on-Site landfill is not a viable alternative at this Site.

Sections 2.1.1 and 2.1.2 provide detailed descriptions of the CIP and CBR-Offsite closure scenarios. These scenarios are based on closure documents and analyses provided to Gradient by Geosyntec Consultants, which are attached to this report as Appendix B.

2.1.1 Closure-in-Place

Under the CIP scenario, all of the CCR would be consolidated in the eastern portion of the BAP. The BAP would then be capped in place with a final cover system. This scenario includes the following work elements (Geosyntec Consultants, 2023):

- Unwatering and dewatering of the impoundment *via* pumping and passive dewatering methods. Water would be managed in accordance with the NPDES permit for the facility.
- Consolidation of CCR in the eastern portion of the impoundment, followed by contouring and grading to manage stormwater.
- Construction of an alternative cover system consisting of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, a geotextile cushion if needed, and 24 inches of protective soil cover suitable for supporting vegetative growth. The performance of this alternative cover system relative to a default cover is presented in (Geosyntec Consultants, 2023).
- Long-term (post-closure) monitoring and maintenance, including at least 30 years of groundwater monitoring at the impoundment, or until such time as groundwater protection standards (GWPSs)

are achieved. Additionally, 30 years of post-closure care would be undertaken for the final cover system, including annual cap inspections, mowing, and maintenance.

This CIP plan meets all closure requirements of IAC Part 845.750 (IEPA, 2021). Key closure elements that address the Part 845 closure requirements are summarized below. Further details are provided in the Closure Plan (Geosyntec Consultants, 2023).

- An alternative cover system would be installed over the CCR that remains in the BAP. The cover, consisting of a 40-mil LLDPE geomembrane low-permeability layer, a geotextile cushion if needed, and 24 inches of soil, would minimize vertical infiltration of precipitation into the basin [Part 845.750(a)(1)].
- The final cover system would be gently sloped to direct surface water away from the impoundment. Beyond the final cover system, channels would direct surface water away from the BAP to existing site drainages [Part 845.750(a)(2)].
- Impounded water would be removed from the BAP and managed in accordance with the NPDES permit for the facility [845.750(b)(1) and 845.750(b)(2)].
- Free liquids in the CCR would be eliminated by removing liquid wastes or solidifying the remaining wastes. Trenches would facilitate gravity drainage of liquid wastes in the CCR and direct the liquid wastes to sumps. Other engineering measures may be considered to facilitate removal of liquid wastes and stabilization of wastes. Sumps would be used to collect liquid wastes, which would be managed in accordance with the NPDES permit for the Site [845.750(b)(1) and 845.750(b)(2)].
- The proposed CIP design will control, minimize, or eliminate as much as feasible post-closure infiltration of liquids and releases of CCR, leachate, or contaminated runoff as interpreted by IEPA in the Part 845 rulemaking. Specifically, CIP will result in a reduction of infiltration into the BAP by approximately 96% compared to pre-closure conditions (Ramboll, 2023). Additionally, CIP will result in a reduction of hydraulic flux out of the BAP by 96% compared to pre-closure conditions (Ramboll, 2023). Due to the reduction in the hydraulic flux out of the BAP, the mass flux out of the BAP will also be controlled or minimized as much as feasible as a result of CIP.

Furthermore, during the closure process, we will continue to assess off-Site CCR beneficial use opportunities. Ash consolidation and closure in place in combination with off-Site beneficial use may result in a smaller footprint for purposes of our ultimate cap design, along with a reduced construction schedule.

In total, 38,600 CY of material would be required for contouring and grading of the BAP. Construction of the final cover system would also require an additional 343,000 CY of soil to be hauled to the BAP from an on-Site borrow area. Geosyntec Consultants has identified a potential on-Site borrow area located 1 mile east of the BAP. Borrow soil would be hauled from the borrow area to the impoundment using haul trucks with an assumed capacity of 16.5 CY, suitable for access to off-site county roads (Appendix B).

Under the CIP scenario, the overall expected duration of construction activities is approximately 2.4 to 3.9 years (or 29 to 47 months, Appendix B). The CIP scenario will meet the required closure schedule (*i.e.*, closure completed by October 2028) defined in IAC Section 845.700(d)(2)(C)(ii) (IEPA, 2021). Key parameters for the CIP scenario are shown in Table 2.1.

Table 2.1 Key Parameters for the Closure-in-Place Scenario

Parameter	
Surface Area of BAP	177 acres
Required Volume of Borrow Soil	381,000 CY
Distance to the Borrow Site	1 mile
Duration of Construction Activities	2.4-3.9 years
Labor Hours	
Total On-Site Labor	76,000 hours
Total Off-Site Labor	2,750 hours
30% Contingency	23,600 hours
Total Labor Hours:	102,000 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	23,200 miles
Equipment On-Site	629,000 miles
On-Site Haul Trucks (Unloaded + Loaded)	50,200 miles
Labor Mobilization	960,000 miles
Equipment Mobilization (Unloaded + Loaded)	58,800 miles
Off-Site Haul Trucks (Unloaded + Loaded)	41,500 miles
Material Deliveries (Unloaded + Loaded)	50,000 miles
Total On-Site Vehicle and Equipment Travel Miles:	703,000 miles
Total Off-Site Vehicle and Equipment Travel Miles:	1,110,000 miles
Total Vehicle and Equipment Travel Miles:	1,810,000 miles

Notes:
CY = Cubic Yards; BAP = Bottom Ash Pond.
Source: Appendix B.

2.1.2 Closure-by-Removal

Under the CBR-Offsite scenario, all CCR would be excavated from the BAP and transported to an off-Site landfill for disposal. Evaluation of landfill capacity and permitted use must be taken into consideration for each landfill considered for off-Site disposal. For example, a municipal landfill is often designed and permitted to accept waste from the local community at a specific rate. The landfill owner relies on this information to determine the remaining life of a landfill and determine when it will be necessary to expand or close the landfill. Due to the lengthy permitting and construction process, a landfill would need to continue accepting current waste streams and ash for a significant period of time to be a viable option, assuming the landfill owner and state approve. Furthermore, given the volume of ash that would need to be transported, it is important to evaluate impacts to communities that will be affected by the increase in truck traffic to and from the landfill. The nearest operating landfill to meet these criteria is the Cottonwood Hills RDF Landfill in Marissa, Illinois (10400 Hillstown Road, Marissa, IL 62257), which is located approximately 10 road miles from the Site (Appendix B). CCR would be hauled to the off-Site landfill using haul trucks with a capacity of 16.5 CY. As is described below in Section 2.4.5, it is possible that the Cottonwood Hills RDF Landfill would have to be expanded in order to accept all of the material excavated from the BAP.

IAC Section 845.710(c)(1) requires CBR-Offsite alternatives to consider multiple methods for transporting CCR off-Site, including rail, barge, and trucks. Geosyntec Consultants evaluated the feasibility of transporting CCR to the off-Site landfill *via* rail or barge and found that neither option is likely to be viable at this Site (Appendix B). Transporting CCR by rail would require the construction of a new spur/terminal and loading facility on-Site and the construction of a new rail spur and unloading terminal near the off-Site landfill. The construction of new spurs and rail terminals would require coordination with the railroad and additional permitting, which could negatively impact the project schedule. Trucks would still be needed to haul CCR to and from the terminals, and additional CCR exposures could occur during the loading and unloading of CCR into trucks and rail cars (Appendix B).

Barge transport would similarly require the construction of a new loading terminal along the Kaskaskia River or modification of the existing Kaskaskia Regional Port District Dock No. 2 (KRPD #2) to allow for multiple barges to be loaded simultaneously and to allow for stockpiling of CCR, which would necessitate additional permitting and could negatively impact the project schedule. Additionally, the closest off-Site landfill with sufficient capacity to receive all of the CCR excavated from the BAP is the Cottonwood Hills RDF Landfill, which is not located near a river and therefore is not accessible by barge. The next closest landfill with sufficient capacity, the North Milam Landfill, is located approximately 6 miles from the Cahokia Marine Terminal in East St. Louis, Illinois. Use of this terminal would require negotiating an agreement with the terminal owner. Additionally, upgrades might be required at this terminal to make it suitable for the unloading of CCR. As with rail terminals, trucks would still be needed to haul CCR to and from the loading and unloading terminals, and additional CCR exposures could occur during the loading and unloading of CCR into trucks and onto barges (Appendix B). Finally, both the North Milam Landfill and the Cahokia Marine Terminal are located within an environmental justice (EJ) community or within the 1-mile buffer zone of an EJ community (IEPA, 2019).

For the reasons listed above, truck transport has been identified as the preferred option for transport of CCR to the off-Site landfill. Transport *via* truck would not require the construction of additional loading or unloading infrastructure and would not result in project delays due to permitting and coordination with other parties. The existing travel routes from the Site to the off-Site landfill are suitable for CCR transport *via* truck, although some upgrades to local roadways would potentially be required to accommodate the expected increase in traffic volumes under the CBR-Offsite scenario (Appendix B). The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

This scenario includes the following work elements (Appendix B):

- Unwatering and dewatering of the impoundment *via* pumping and passive dewatering methods. Stormwater control structures would be constructed to convey runoff away from the impoundment during construction. The ponding area behind the dam would be used as a temporary settling pond for contact stormwater and dewatering flows collected during construction. Unwatering flows would be pumped to the Secondary Pond. Water would be managed in accordance with the NPDES permit for the facility.
- Excavation of CCR from the impoundment, as well as excavation of any CCR observed outside the BAP boundary. Approximately 1 foot of native soils would also be excavated from beneath the excavated CCR.
- Transport of CCR and CCR-impacted native soils to the off-Site landfill using haul trucks.
- Notching of the BAP embankment dam to facilitate the flow of post-closure stormwater from the BAP area into the Secondary Pond. Grading and (if required) backfilling would also be performed to promote surface water drainage towards the notched BAP embankment dam.
- Site restoration, including revegetation of the disturbed area.
- Monitoring for 3 years post-closure or until such time as GWPSs are achieved, whichever is longer.

In total, approximately 4,130,000 CY of CCR would be excavated from the impoundment under this scenario. An on-Site borrow soil location would not need to be established. A capacity of 16.5 CY is assumed for the haul trucks transporting CCRs to the off-Site landfill. Non-CCR material used for backfilling, if required, would be sourced from the existing BAP embankments (Appendix B).

The overall duration of construction activities under this closure scenario is approximately 7.4 to 11 years (or 89 to 132 months Appendix B, Table 2). The CBR-Offsite scenario will not meet the required closure schedule (*i.e.*, closure completed by October 2028) defined in IAC Section 845.700(d)(2)(C)(ii) (IEPA, 2021). Key parameters for the CBR-Offsite scenario are shown in Table 2.2.

Table 2.2 Key Parameters for the Closure-by-Removal Scenario

Parameter	Value
Surface Area of BAP	177 acres
Distance to the Off-Site Landfill	10 miles
Hauled Volume of CCR	4,130,000 CY
Duration of Construction Activities	7.4-11 years
Labor Hours	
Total On-Site Labor	126,000 hours
Total Off-Site Labor	200,000 hours
30% Contingency	98,000 hours
Total Labor Hours:	425,000 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	72,000 miles
Equipment On-Site	2,060,000 miles
On-Site Haul Trucks (Unloaded + Loaded)	122,000 miles
Labor Mobilization	2,620,000 miles
Equipment Mobilization (Unloaded + Loaded)	224,000 miles
Off-Site Haul Trucks (Unloaded + Loaded)	10,000,000 miles
Material Deliveries (Unloaded + Loaded)	50,000 miles
Total On-Site Vehicle and Equipment Travel:	2,260,000 miles
Total Off-Site Vehicle and Equipment Travel:	12,900,000 miles
Total Vehicle and Equipment Travel:	15,200,000 miles

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yard; BAP = Bottom Ash Pond.
Source: Appendix B.

2.2 Long- and Short-Term Effectiveness of the Closure Alternative (IAC Section 845.710(b)(1))

2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient has performed a Human Health and Ecological Risk Assessment for the Site (Appendix A of this report), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the BAP. This report concluded that there are no current unacceptable risks to any human or ecological receptors associated with the BAP. Because there are no current risks to any human or ecological receptors, and dissolved constituent concentrations would be expected to decline post-closure, no post-closure risks would be expected under either closure scenario. Thus, there would be no current risk or future risk under either closure scenario, and the magnitude of reduction of existing risks would be the same under both closure scenarios.

2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future releases of CCR that may occur during dike failure and storm-related events.

Storm-Related Releases and Dike Failure During Flood Conditions

Based on the effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for the Site, one area in the western portion of the BAP is located within Zone A, meaning this area is potentially located within the 100-year flood zone for the Kaskaskia River; however, no base flood elevation has been established in this area (Figure 2.1; FEMA, 2008). Engineering analyses show that the risk of overtopping occurring during flood conditions is minimal under current conditions. Specifically, AECOM and Geosyntec Consultants have evaluated the risk of flood overtopping occurring at the BAP and found that the impoundment can adequately manage flow during peak discharge from a 1,000-year storm event without overtopping of the embankments (AECOM, 2016b; Geosyntec Consultants, 2021). Additionally, engineering analyses show that the BAP dikes are expected to remain stable under static, seismic, and flood conditions (AECOM, 2016c). Prior to closure (*i.e.*, under current conditions), the risk of dike failure occurring during floods or other storm-related events is therefore minimal. Post-closure, the risks of overtopping and dike failure occurring due to floods or other storm-related events would be even smaller than they are currently. Under the CIP scenario, all CCR would be consolidated in the eastern portion of the impoundment, which does not lie within the area designated Zone A on the FEMA Flood Insurance Rate Map (FEMA, 2008). Additionally, under the CIP scenario, a new cover system would be installed, which would include 24 inches of soil and a geomembrane liner, as well as new stormwater control structures. Relative to current conditions, this cover system would provide increased protection against berm and surface erosion, groundwater infiltration, and other adverse effects that could potentially trigger a dike slope failure event. Under the CBR-Offsite scenario, all of the CCR in the BAP would be excavated and relocated, eliminating the risk of a CCR release occurring post-closure. In summary, there is minimal current or future risk of sudden CCR releases occurring under either closure scenario either during or following closure.

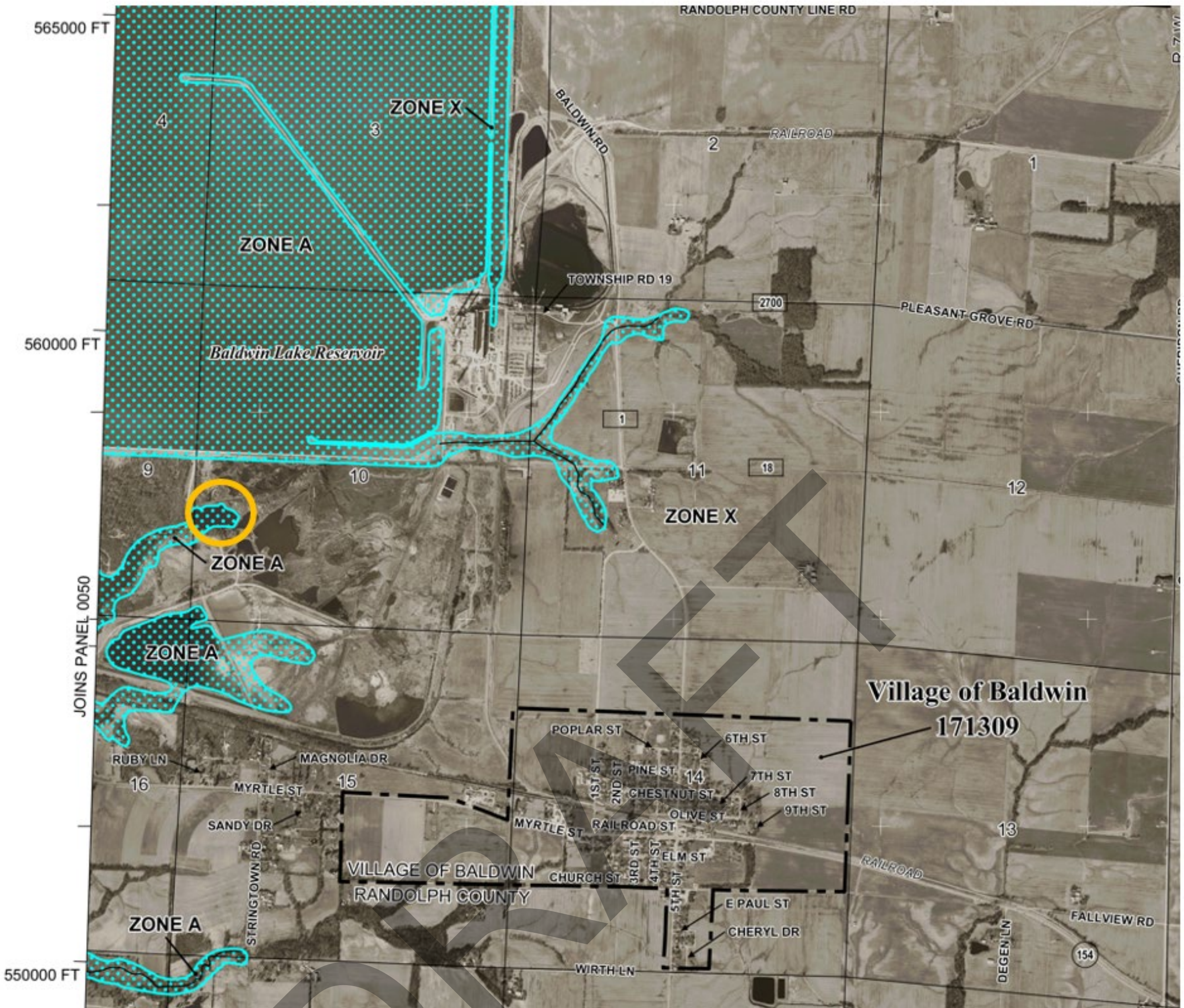

Figure 2.1 Flood Map of Site and Vicinity. The gold circle indicates the portion of the Bottom Ash Basin that lies within Zone A ("Special Flood Hazard Areas Subject to Inundation by the 1% Annual Chance Flood"/"No Base Flood Elevations Determined"). Source: FEMA (2008).

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks arising from the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2020). The BPP property is located within a seismic impact zone. However, the BAP meets the seismic safety requirements of 40 CFR Section 257.63(a) and IAC Section 845.330(a). Thus the overall risk of dike failure due to seismicity is expected to be low (Burns & McDonnell, 2021a). Additionally, the BAP does not lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Burns & McDonnell, 2021b). The nearest known mapped fault is the Cottage Grove Fault System, which is located about 24 miles southeast of the BAP. The time frame of the most recent activity on this fault is unknown (Burns & McDonnell, 2021b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is low at the BAP.

2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the BAP under each closure scenario are described in Section 2.1 (Closure Alternatives Descriptions). In summary, under the CIP scenario, the BAP would undergo monitoring for 30 years post-closure, or until such time as GWPSs are achieved. Under the CBR-Offsite scenario, the BAP would undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved. The post-closure care plan for the CIP scenario would additionally include annual inspections, mowing, and maintenance of the final cover system.

2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

2.2.4.1 Worker Risks

Best practices would be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate the risk of accidents occurring during construction activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization/demobilization, material deliveries, and the hauling of CCR.

As shown in Tables 2.1 and 2.2, Geosyntec Consultants estimates that the CIP scenario would require 76,000 on-Site labor hours and the CBR-Offsite scenario would require 126,000 on-Site labor hours (Appendix B). The US Bureau of Labor Statistics (US DOL, 2020a,b) provides an estimate of the hourly fatality and injury rates for construction workers. Based on the accident rates reported by US Bureau of Labor Statistics and the on-Site labor hours reported in Appendix B, we estimate that approximately 0.79 worker injuries and 0.0069 worker fatalities would occur on-Site under the CIP scenario, and approximately 1.3 worker injuries and 0.011 worker fatalities would occur on-Site under the CBR-Offsite scenario (Table 2.3). The rate of on-Site worker accidents is therefore expected to be highest under the CBR-Offsite scenario and lowest under the CIP scenario.

Table 2.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario

Closure Scenario	Injuries	Fatalities
CIP	0.79	0.0069
CBR-Offsite	1.3	0.011

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place.

Greater numbers of haul truck miles, labor and equipment mobilization/demobilization miles, and material delivery miles would be required off-Site under the CBR-Offsite scenario than would be required under the CIP scenario (Tables 2.1 and 2.2). Under the CBR-Offsite scenario, 12,900,000 haul truck miles would be required to haul CCR from the Site to an off-Site landfill, and under the CIP scenario, only 1,110,000 haul truck miles would be required (Appendix B). The United States Department of Transportation (US DOT, 2022) provides estimates of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks and passenger vehicles. Table 2.4 shows the expected number of off-Site accidents under each closure scenario due to all categories of off-Site vehicle usage. For these calculations, it was assumed that labor mobilization/demobilization would rely on passenger vehicles (cars or light trucks, including pickups, vans, and sport utility vehicles) and that hauling, equipment mobilization/demobilization, and material deliveries would rely on large trucks. Based on US DOT's accident statistics and the mileage estimates in Appendix B, an estimated 0.58 worker injuries and 0.0093 worker fatalities would be expected to occur due to off-Site activities under the CIP scenario; an estimated 3.1 worker injuries and 0.053 worker fatalities would be expected to occur due to off-Site activities under the CBR-Offsite scenario.

Table 2.4 Expected Number of Off-Site Worker Accidents Under Each Closure Scenario

Off-Site Vehicle-Use Category	CIP		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0.006	1.1×10^{-4}	1.5	0.028
Labor Mobilization/Demobilization	0.56	0.0089	1.5	0.024
Equipment Mobilization/Demobilization	0.0088	1.6×10^{-4}	0.033	6.2×10^{-4}
Material Deliveries	0.0074	1.4×10^{-4}	0.074	1.4×10^{-4}
Total:	0.58	0.0093	3.1	0.053

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place.

Overall, taking into account accidents occurring both on- and off-Site, 1.4 worker injuries and 0.016 worker fatalities would be expected under the CIP scenario, and 4.4 worker injuries and 0.064 worker fatalities would be expected under the CBR-Offsite scenario. Thus, overall risks to workers would be highest under the CBR-Offsite scenario and lowest under the CIP scenario.

Concurrently with closure activities, a utility-scale solar and battery energy storage facility would be constructed on the BPP Site. The simultaneous pursuit of closure-related construction and solar facility construction may lead to traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from closure or solar re-development alone. Because the CIP scenario would require less hauling activity (and other forms of ingress and egress to and from the Site) than the CBR-Offsite scenario and would also be completed over a shorter time period, the CIP scenario would be expected to result in less congestion on Site access roads during Site re-development – and, hence, a smaller increase in the risks to workers – than would occur under the CBR-Offsite scenario.

In summary, risks to workers due to accidents would be expected to be greatest under the CBR-Offsite scenario and least under the CIP scenario. Differences in worker risks between the two scenarios would largely be driven by off-Site activities.

2.2.4.2 Community Risks

Accidents

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members, as well as workers. Based on the accident statistics reported by US DOT (2022) and the off-Site travel mileages reported in Appendix B, off-Site vehicle accidents could result in an estimated 0.27 injuries and 0.0056 fatalities among community members (*i.e.*, people involved in construction-related vehicle accidents, who are neither drivers nor passengers, including pedestrians, drivers of other vehicles, *etc.*) under the CIP scenario (Table 2.5). Under the CBR-Offsite scenario, off-Site vehicle accidents could result in an estimated 4.1 community injuries and 0.15 community fatalities.

Table 2.5 Expected Number of Community Accidents Under Each Closure Scenario

Off-Site Vehicle-Use Category	CIP		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0.01	6.0×10^{-4}	3.4	0.14
Labor Mobilization/Demobilization	0.22	0.0035	0.6	0.0096
Equipment Mobilization/Demobilization	0.02	8.0×10^{-4}	0.076	0.0031
Material Deliveries	0.017	6.8×10^{-4}	0.017	6.8×10^{-4}
Total:	0.27	0.0056	4.1	0.15

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place.

Traffic

Haul routes would be expected to use major arterial roads and highways wherever possible, which would reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in increased traffic near the Site and the off-Site landfill. Traffic could potentially cause travel delays on local roads and also cause damage to local roadways.

Traffic may increase temporarily around the Site under both closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts would be expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). These impacts would therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site due to CCR hauling. Under the CBR-Offsite scenario, hauling-related construction activities would be expected to take approximately 1,870 working days and require approximately 250,000 truckloads of CCR (Appendix B). Assuming 10-hour working days, a haul truck would need to pass a given location near the Site once every 2.2 minutes on average under this closure scenario. Off-Site traffic demands due to hauling are expected to be lesser under the CIP scenarios than under the CBR-Offsite scenario because no off-Site hauling of CCR would be required. The CIP scenario requires approximately 23,000 truckloads to transport borrow soil to the Site, which corresponds with a haul truck passing a given location near the Site once every 6.4 minutes on average for the approximately 490 working days duration of hauling-related construction activities (Appendix B).

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the Tennessee Valley Authority (TVA, 2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance…at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." There are no residences or businesses within 1,500 feet of the BAP. However, there are a small number of residences within 1,500 feet of the proposed on-Site borrow soil location, which may be required under the CIP scenario. The proposed borrow soil location also lies within 1,500 feet of the Baldwin Cemetery. Recreators and wildlife within the Kaskaskia River SFWA could also be temporarily impacted by construction noise at the BAP under both scenarios, since the Kaskaskia River SFWA includes the BPP Cooling Lake, which lies immediately north of the BAP. The duration of noise impacts in the vicinity of the BAP (both scenarios) and the proposed on-Site borrow soil location (CIP scenario only) would be greater under the CBR-Offsite scenario than under the CIP scenario, because the expected duration of construction is longer (2.4 to 3.9 years under the CIP scenario *vs.* 7.4 to 11 years under the CBR-Offsite scenario).

In addition to impacts in the immediate vicinity of planned construction areas at the Site, local roads near the Site and the off-Site landfill may also experience noise pollution due to high volumes of haul truck traffic under the CBR-Offsite scenario. As described above (Traffic), the construction schedule for the CBR-Offsite scenario requires haul trucks to pass by a given location every 2.2 minutes on average for 10 hours each day for approximately 1,870 working days, and the construction schedule for the CIP scenario requires haul trucks to pass a given location every 6.4 minutes on average for 10 hours each day for approximately 490 working days. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019).

In addition to haul truck impacts, noise pollution may also arise under both closure scenarios from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These impacts would be expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). These impacts would therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario. In summary, noise impacts are likely to be greatest under the CBR-Offsite scenario and least under the CIP scenario.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regard to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks that would be used to haul material to and from the Site. Diesel exhaust contains air pollutants, including nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs; Hesterberg *et al*., 2009; Mauderly and Garshick, 2009). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and Best Management Practices (BMPs) such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

On-Site, emissions would be higher under the CBR-Offsite scenario than under the CIP scenario, due to the greater amount of on-Site vehicle and equipment travel miles required under the CBR-Offsite scenario (703,000 total on-Site travel miles under the CIP scenario *versus* 2,260,000 total on-Site travel miles under the CBR-Offsite scenario; Tables 2.1 and 2.2). Off-Site, emissions would similarly be higher under the CBR-Offsite scenario than under the CIP scenario due to the greater amount of off-Site vehicle and equipment travel miles required under the CBR-Offsite scenario (1,110,000 total off-Site travel miles under the CIP scenario *versus* 12,900,000 total off-Site travel miles under the CBR-Offsite scenario).

Environmental Justice

The state of Illinois defines EJ communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (IEPA, 2019), the outer perimeter of the 1-mile buffer zone for the nearest EJ community lies approximately 7.5 miles east/southeast of the property boundary for the Site near Sparta, IL (Figure 2.2). As described above (Noise), significant noise impacts due to construction are expected to be limited to potential receptors located within 1,500 feet (0.28 miles) of the Site. Similarly, the air quality impacts of construction are expected to be limited to potential receptors located within 1,000 feet (0.19 miles) of the Site (CARB, 2005; BAAQMD, 2017). Along heavily trafficked roadways, air quality impacts are expected to be limited to potential receptors located within 600 feet of the roadway (0.11 miles; US EPA, 2014). The EJ community near Sparta is therefore unlikely to be directly impacted by on-Site air emissions, noise pollution, or other negative impacts arising at the Site.

EJ communities can potentially be impacted by construction-related activities occurring off-Site, including CCR hauling (CBR-Offsite scenario only), labor and equipment mobilization/demobilization, and material deliveries. Off-Site impacts due to labor and equipment mobilization/demobilization and material deliveries would be expected to be diffuse (*i.e.,* to span a wide range of transport routes originating over a wide area). Additionally, these impacts would be expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). Hauling, in contrast, would rely on a single transport route used continuously throughout the entire excavation period. Off-Site hauling is therefore more likely to have a significant impact on EJ communities than other types of off-Site vehicle use.

In general, EJ communities located along haul routes or near the preferred off-Site landfill can be negatively impacted throughout excavation by air pollution, noise, traffic, and accidents generated by CCR-hauling activities. In the case of BAP closure at the BPP Site, however, a review of the Illinois map of EJ communities reveals that the preferred off-Site landfill (the Cottonwood Hills RDF Landfill in Marissa, Illinois) is not located within or near any EJ communities. Moreover, haul routes from the Site to the off-Site landfill do not pass through any EJ communities. Thus, no EJ impacts would be expected under either closure scenario.

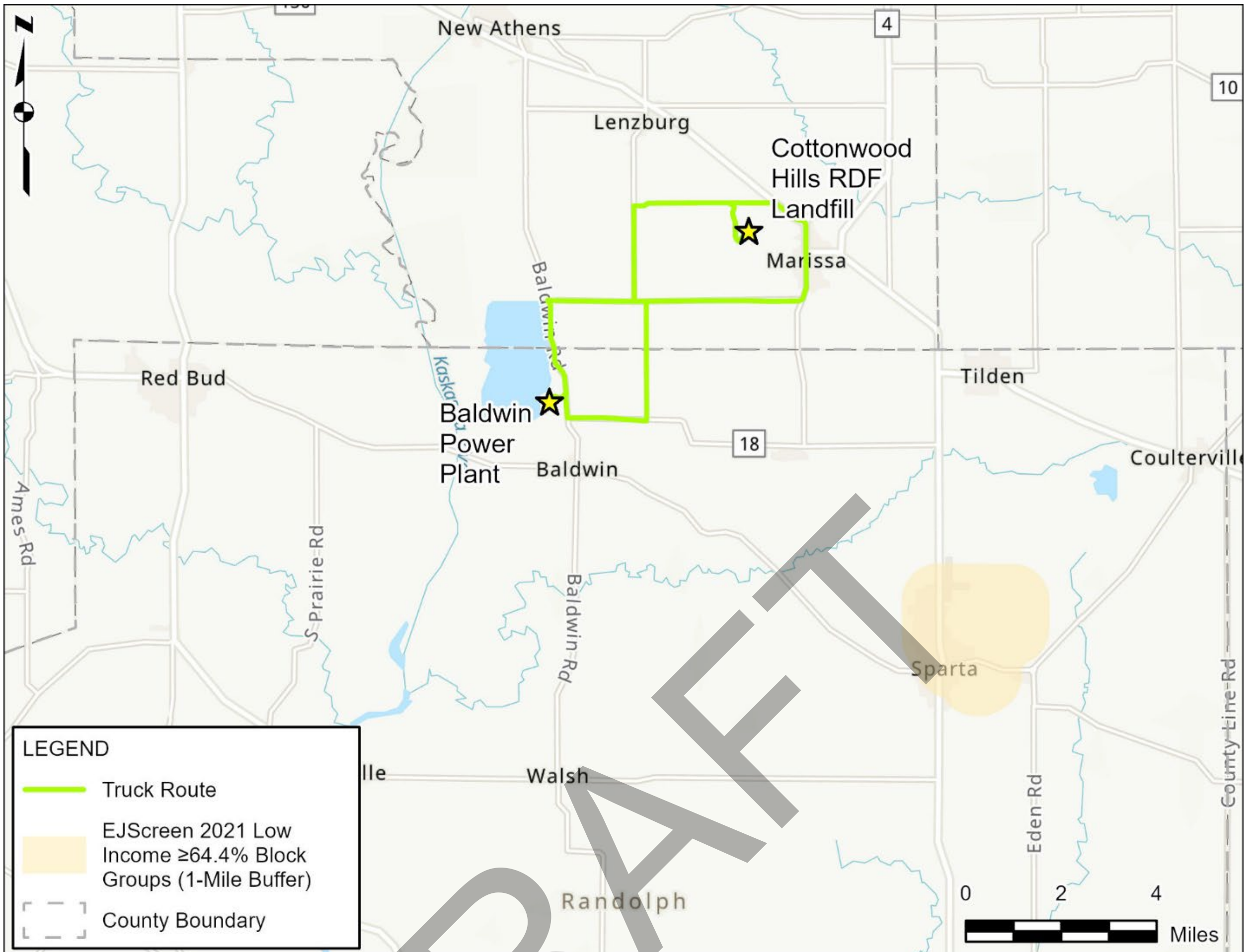

Figure 2.2 Environmental Justice (EJ) Communities in the Vicinity of the Site and the Off-Site Landfill.
Source: IEPA (2019); US EPA (2020); Google LLC (2022).

Scenic, Historical, and Recreational Value

During construction activities, negative impacts on scenic and recreational value may occur within the Kaskaskia River SFWA, which includes the BPP Cooling Lake. The Cooling Lake lies immediately north of the BAP and is a popular spot for fishing year-round (IDNR, 2022). The proposed on-Site borrow soil location, which is required under the CIP scenario, also lies with 1,500 feet of the Baldwin Cemetery and a small number of residences. Noise impacts were described above. In addition, construction activities at the BAP may be visible to recreators using these scenic and recreational areas, potentially interfering with enjoyment of the view. Negative impacts would not be expected to occur within any scenic or recreational areas located further away from the Site, including the campground south of the BAP and the Wood Duck Marina (see Section 1.1.5). The expected duration of construction activities is longer under the CBR-Offsite scenario than under the CIP scenario (2.4 to 3.9 years under the CIP scenario *vs.* 7.4 to 11 years under the CBR-Offsite scenario). It is therefore anticipated that short-term impacts on the scenic and recreational value of natural areas near the Site would be greater under the CBR-Offsite scenario than under the CIP scenario.

Based on a review of the IDNR Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of the BAP or the on-Site borrow soil location (Ramboll, 2021).

2.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 2.2.4.2, construction equipment emits greenhouse gases (GHGs), including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each closure scenario on GHG emissions is proportional to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 2.2.4.2. In summary, GHG emissions from construction equipment and vehicles would be greater under the CBR-Offsite scenario than under the CIP scenario, because the total on-Site and off-Site vehicle and equipment travel miles required under the CBR-Offsite scenario (15,200,000 total vehicle and equipment travel miles) is greater than those required under the CIP scenario (1,810,000 total vehicle and equipment travel miles; Tables 2.1 and 2.2).

We did not quantify the carbon footprint of the approximately 177 acres of 40-mil LLDPE geomembrane liner required for the final BAP cover system under the CIP scenario. The carbon footprint of this geomembrane (*i.e.*, the fossil fuel emissions required to manufacture it) is an additional source of GHG emissions at the Site under the CIP scenario. The potential expansion of the off-Site landfill under the CBR-Offsite scenario would have an additional, unquantified carbon footprint due to the manufacture of geomembranes used in the expanded landfill liner.

Energy Consumption

Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. Specifically, the energy demands of construction equipment and vehicles would be greater under the CBR-Offsite scenario than under the CIP scenario. We did not quantify the energy demands of the geomembranes required for the construction of the final cover system under the CIP scenario or, potentially, the geomembranes required for expansion of the off-Site landfill under the CBR-Offsite scenario.

The BPP Site is slated for re-development as a utility-scale solar power generating facility and battery energy storage facility. The installation of the utility-scale solar power generating facility and a battery energy storage facility will provide additional tax revenue to the local community, jobs, benefit the reliability of the electrical grid, and support Illinois' path toward 100 percent clean energy by 2050.

Natural Resources and Habitat

During closure, major construction activities such as the excavation of the impoundment, the excavation of the borrow area (CIP scenario only), and, potentially, the expansion of the off-Site landfill (CBR-Offsite scenario only) may require the destruction of some existing habitat atop portions of these construction areas, resulting in negative impacts to natural resources and habitat within the footprint of these areas. Construction may also have indirect negative impacts on the natural resources and habitat in the immediate vicinity of these locations by causing alarm and escape behavior in nearby wildlife (*e.g.*, due to noise disturbances). Finally, although erosion prevention and sediment control measures will be undertaken under both closure scenarios, it is possible that limited negative short-term impacts could occur to sensitive aquatic and wetland species in wetlands or surface water bodies located near the BAP (see Section 1.1.3) due to sediment runoff during construction. The duration of time over which various short-term negative habitat impacts might occur due to construction would be longer under the CBR-Offsite scenario than under the CIP scenario, due to the longer expected duration of construction activities under the former scenario 2.4 to 3.9 years for CIP *vs.* 7.4 to 11 years for CBR-Offsite). Thus, negative short-term impacts to natural resources and habitat due to closure activities would likely be greater under the CBR-Offsite scenario than under the CIP scenario.

In addition to the short-term negative habitat impacts caused by construction activities, closure may also result in long-term shifts in the habitat types overlying the major construction locations associated with closure. This assessment does not make any value judgments regarding the relative value of the habitat types currently overlying these locations and the habitat types that could potentially overlie these locations post-closure under the two closure scenarios. For example, we did not attempt to determine whether the conversion of open water to grassland within the footprint of the BAP would constitute a positive or negative long-term change with regard to factors such as biodiversity, ecosystem services, or the preferences of recreators/sightseers.

According to the IDNR Natural Heritage Database, there are 7 state threatened species and 25 state endangered species within Randolph County (Ramboll, 2021). To our knowledge, however, no threatened or endangered species have been identified at the Site. Based on the information that is currently available, we do not expect construction activities to have negative impacts on any threatened or endangered species.

2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

The time horizon over which GWPSs would be exceeded at the Site is immaterial from a risk perspective, because there is no unacceptable risk associated with exceedances of a GWPS at the Site (see Section 2.2.1).

As described above in Section 1.1.4 (Hydrogeology), groundwater (and CCR-related constituents) originating from the BAP may migrate vertically downward through the UGU into the uppermost aquifer, or BU. Groundwater flows laterally to the west and southwest through the UGU and the BU and ultimately discharges to the Kaskaskia River. Identified potential migration pathways at the Site include the thin sand lenses in the UGU adjacent to the BAP and the area of contact between the UGU and the BU. Dissolved constituents in groundwater may partition between river sediments and Kaskaskia River surface water.

While the groundwater modeling demonstrated that groundwater concentrations will increase at several wells post-closure under both the CIP and CBR-Offsite scenarios, the modeling also suggested that the increasing concentrations are the result of the adjacent Fly Ash Pond System, not the BAP (Ramboll, 2023). Results of groundwater modeling indicate that concentrations of boron, a common indicator parameter used in coal ash fate and transport evaluations, at the proposed BAP compliance wells that are not influenced by the Fly Ash Pond System will remain below the GWPS following implementation of either the CIP or the CBR-Offsite scenarios (Ramboll, 2023).

Additionally, changing geochemical conditions during an extended excavation associated with the CBR-Offsite scenario can be a mechanism that results in the mobilization and increased transport in groundwater for some constituents. This may result in GWPS exceedances.

2.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F))

Section 2.2.1 evaluates potential risks to human and ecological receptors arising from the leaching of CCR-associated constituents into groundwater during closure activities and following closure of the BAP. Section 2.2.2 evaluates the potential for CCR releases to occur due to dike failure or overtopping during floods or other storm-related events. In summary, there is no current or future risk to any human or ecological receptors associated with the BAP. Additionally, there is minimal current or future risk of overtopping occurring at the embankments due to flood conditions at the Site. Dike failure due to, *e.g.*, seismic activity and storm-related events is also exceedingly unlikely.

Section 2.2.4 evaluates several potential risks to human health and the environment during closure activities, including risks of accidents occurring among workers; risks to nearby residents related to accidents, traffic, noise, and air pollution; and risks to natural resources and wildlife. The findings from this section of the text are summarized in Table S.1 (Summary of Findings).

2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

Post-closure, there is minimal risk of engineering or institutional failures leading to sudden releases of CCR from the impoundment under the CIP scenario. There is no post-closure risk of engineering or institutional failures under the CBR-Offsite scenario (see Section 2.2.2 above). Additionally, there are no current or future unacceptable risks to any human or ecological receptors under either closure scenario (see Section 2.2.1 above). Moreover, reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) would be implemented at the off-Site landfill under the CBR-Offsite scenario. Both of the evaluated closure scenarios are therefore reliable with respect to long-term engineering and institutional controls.

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

Corrective action is expected at the Site. An evaluation of potential corrective measures and corrective actions has not yet been completed, but will be conducted consistent with the requirements in IAC Section 845.660 and IAC Section 845.670.

2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

The CCR in the BAP currently poses no unacceptable risks to human health or the environment (Section 2.2.1). Because current conditions do not present a risk to human health or the environment, and dissolved constituent concentrations would be expected to decline post-closure, there would also be no unacceptable risks to human health or the environment following closure, regardless of the closure scenario.

Section 2.2.2 discussed the potential for dike failure or overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is minimal risk of sudden CCR releases occurring during or following closure under either closure scenario.

2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

Under both closure scenarios, water generated during the dewatering and unwatering of the impoundment would be treated if necessary prior to disposal. Following treatment, water from unwatering and dewatering would be discharged to the Kaskaskia River in accordance with the NPDES permit for the facility.

2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

CIP using a final cover system is a reliable and standard method for managing and closing impoundments that relies on common construction activities. Dewatering saturated CCR to construct a stabilized final cover system subgrade can present challenges during closure; however, these challenges are common to most CCR surface impoundment closures and are commonly addressed *via* surface water management and dewatering techniques.

Excavation and landfilling of CCR is also a reliable and standard method for closing impoundments. However, relative to CIP, CBR-Offsite poses additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, longer construction schedules, and the need to haul CCR over public roads. As described in Section 2.2.4.2 (Community Risks), off-Site hauling may also have detrimental community impacts due to an increased incidence of vehicle accidents, traffic-related impacts, noise, and air pollution.

In addition to off-Site hauling, off-Site landfilling under the CBR-Offsite scenario may pose particular challenges. A disposal plan would need to be developed between DMG and the owner/operator of the third-party landfill in order to outline acceptable waste conditions upon delivery, daily waste production rates, and the expected duration of the project. Off-Site landfilling may additionally raise issues related to the co-disposal of CCR and other non-hazardous wastes. Finally, the construction schedule for excavation may be negatively impacted if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the materials excavated from the BAP.

2.4.2 Expected Operational Reliability of the Closure Alternative

There is no post-closure risk of operational failures leading to sudden releases of CCR from the impoundment under the CBR-Offsite scenario. There is minimal post-closure risk of sudden CCR releases occurring under the CIP scenario, because: (i) the final cover system will be constructed and maintained in accordance with all relevant state and federal safety regulations, and (ii) the dikes, final cover, and stormwater control features have all been designed to withstand earthquakes and storm events (see Section 2.2.2 above). Moreover, appropriate operational controls are expected to be implemented at the off-Site landfill under the CBR-Offsite scenario. As such, operational reliability would be expected under both closure scenarios.

2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

Permits and approvals would be needed under both closure scenarios. Components of both closure scenarios that would be expected to require a permit include:

- A NPDES permit modification has been obtained through IEPA to allow the disposal of water generated from unwatering and dewatering operations to the Kaskaskia River *via* the existing NPDES-permitted outfall for the Site;
- A construction permit from the IDNR, Office of Water Resources, Dam Safety Program to allow the embankment and spillways of the BAP to be modified as part of closure;
- A construction stormwater permit through IEPA, including construction stormwater controls and other BMPs, such as silt fences and other measures; and
- A joint water pollution control construction and operating permit (WPC permit).

As discussed below in Section 2.4.5, it may be necessary to expand the off-Site landfill under the CBR-Offsite scenario in order to accommodate all of the material excavated from the BAP. Additional permitting may be required under this scenario for transport of the CCR and to expand the off-Site landfill. It may also be necessary to modify the operating plan for the off-Site landfill in order to accommodate the increased rate of filling of the landfill and the likely need for additional equipment and personnel to manage the receipt and disposal of the CCR.

2.4.4 Availability of Necessary Equipment and Specialists

CIP and CBR-Offsite are reliable and standard methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment under both closure scenarios, if supply chain resilience does not improve by the time of construction. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to the large volume of CCR to be hauled from the Site under the CBR-Offsite scenario, shortages in construction equipment may cause greater challenges under the CBR-Offsite scenario than under the CIP scenario. If sufficient trucks and truck drivers are not available, the construction schedule at the impoundment may lengthen based on hauling-related delays.

The availability of critical materials such as metal, wood, and electronic chips has also been impacted by the COVID-19 pandemic. However, soil materials and geomembrane liner materials have generally been available during 2021 and early 2022 for landfill development and closure projects.

2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

Under the CIP scenario, all of the CCR currently within the BAP would be stored within the existing footprint of the BAP. Treatment would consist of unwatering the BAP at the start of construction, performing limited dewatering to stabilize the CCR subgrade, and managing stormwater inflow. Water from unwatering and dewatering of the BAP would be discharged in accordance with the NPDES permit for the facility. Under the CBR-Offsite scenario, water treatment would similarly consist of unwatering and dewatering the BAP at the start of construction and discharging water from unwatering/dewatering in accordance with the NPDES permit for the facility. Due to the need for dewatering prior to CCR hauling, a higher volume of water would be expected to be generated during dewatering under the CBR-Offsite scenario than under the CIP scenario.

For the CBR-Offsite scenario, 4,130,000 CY of CCR would be excavated from the BAP and require disposal. According to the IEPA "Landfill Disposal Capacity Report" for 2022 (IEPA, 2022b), the closest nearby third-party landfill with the ability to receive and dispose of CCR from the Site is the Cottonwood Hills RDF Landfill in Marissa, Illinois. This facility has 27,900,000 CY of remaining capacity in its current permitted footprint. It receives 338,000 CY of waste annually, and is located 10 miles from the Site by road. The Cottonwood Hills RDF Landfill therefore has sufficient capacity to receive CCR from the BAP. However, closure of the BAP would increase the annual waste receipt rate at the off-Site landfill. Due to the short time frame over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that would be received and the unique CCR waste characteristics. Elements of this disposal plan might include increasing daily operational capacity and procedures, expediting planned airspace construction, and potentially expediting landfill expansion.

If expansion of the Cottonwood Hills RDF Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A possible alternative to the Cottonwood Hills RDF Landfill is the North Milam Landfill in East Saint Louis, Illinois. The North Milam Landfill has 10,200,000 CY of remaining capacity in its current permitted footprint, receives 2,380,000 CY of waste annually, and is located 44 road miles from the Site (Appendix B; IEPA, 2022b).

2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in Gradient's "Human Health and Ecological Risk Assessment" (Appendix A), both modeled and measured surface water concentrations in the Kaskaskia River are all below relevant human health and ecological screening benchmarks. Surface water concentrations of CCR-associated constituents would be expected to decline over time under both closure scenarios. Thus, no current or future exceedances of any human health or ecological screening benchmarks would be anticipated under either closure scenario.

The lined landfill that would receive the CCR excavated from the impoundment under the CBR-Offsite scenario would be managed to ensure that no surface water impacts would occur in the vicinity of the landfill. In summary, no impacts on any waters of the state would be expected under either closure scenario.

2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Nonprofits representing community interests near the Site have raised concerns regarding the potential impacts of the coal ash impoundment at this Site on groundwater and surface water quality, including Earthjustice and the Sierra Club (Earthjustice *et al.*, 2018; Sierra Club and CIHCA, 2014). These parties generally prefer CBR-Offsite to CIP, citing fears that allowing CCR to remain in place "allows the widespread groundwater contamination to continue indefinitely" (Earthjustice *et al*., 2018, p. 24). However, it is not the case that closing the BAP *via* CIP rather than CBR-Offsite would result in undue risks to groundwater and surface water post-closure. As described in Sections 2.2.1 and 2.2.2, no current or future unacceptable risks to human or ecological receptors are associated with the BAP under any scenario. There is also minimal risk of future CCR releases occurring under any scenario. Furthermore, the groundwater model conservatively estimated that concentrations of boron, a common indicator parameter used in coal ash fate and transport evaluations, at the proposed BAP compliance wells that are not influenced by the Fly Ash Pond System will remain below the GWPS following implementation of either the CIP or the CBR-Offsite scenarios (Ramboll, 2023). Both closure scenarios are therefore responsive to residents' concerns regarding impacts to groundwater and surface water quality.

The CIP scenario has several advantages over the CBR-Offsite scenario with regard to likely community concerns. Notably, the CIP scenario presents fewer risks to workers and nearby residents during construction in the form of accidents, traffic-related impacts, noise, and air pollution (Section 2.2.4 above). Closure would also be achieved more rapidly under the CIP scenario than under the CBR-Offsite scenario, due to the shorter duration of construction activities.

2.7 Class 4 Estimate (IAC Section 845.710(d)(1))

Analyses in the Final Closure Plan will be prepared consistent with Class 4 estimates based on the Association for the Advancement of Cost Engineering (AACE) Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021).

2.8 Summary

Table S.1 (Summary of Findings) summarizes the expected impacts of the CIP and CBR-Offsite closure scenarios with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021). Based on this evaluation and the details provided in Section 2 above, CIP has been identified as the most appropriate closure scenario for the BAP. Key benefits of the CIP scenario relative to the CBR-Offsite scenario include reduced impacts to workers, community members, and the environment due to construction activities (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and GHG emissions, and less traffic-related impacts). Moreover, the CIP scenario will meet the required closure schedule (*i.e.*, closure completed by October 2028) defined in IAC Section 845.700(d)(2)(C)(ii) (IEPA, 2021), whereas the CBR-Offsite scenario would be unable to meet this required schedule.

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Appendix A

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
Bottom Ash Pond
Baldwin Power Plant
Baldwin, Illinois

January 26, 2023

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Abbreviations

ADI	Acceptable Daily Intake
BAP	Bottom Ash Pond
BCF	Bioconcentration Factor
BCG	Biota Concentration Guide
BPP	Baldwin Power Plant
BU	Bedrock Unit
CAA	Closure Alternatives Assessment
CCR	Coal Combustion Residuals
CEM	Conceptual Exposure Model
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
ESV	Ecological Screening Value
FAPS	Fly Ash Pond System
GWPS	Groundwater Protection Standard
GWQS	Groundwater Quality Standard
HTC	Human Threshold Criteria
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
K_d	Equilibrium Partitioning Coefficient
MCL	Maximum Contaminant Level
NRWQC	National Recommended Water Quality Criteria
ORNL RAIS	Oak Ridge National Laboratory's Risk Assessment Information System
pCi/L	PicoCuries per Liter
PRG	Preliminary Remediation Goal
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SFWA	State Fish and Wildlife Area
SWQS	Surface Water Quality Standard
UA	Uppermost Aquifer
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
UGU	Upper Groundwater Unit

1 Introduction

Dynegy Midwest Generation, LLC operates the Baldwin Power Plant (BPP or "the Site") in Baldwin, Illinois. BPP is an electric power generating facility with coal-fired units that began operation in 1970 (Ramboll, 2021). The BPP has several surface impoundments for storage of coal combustion residuals (CCR): the Bottom Ash Pond (BAP) (Vistra identification [ID] number [No.] 601, Illinois Environmental Protection Agency [IEPA] ID No. W1578510001-06), the Fly Ash Pond System (FAPS, an IEPA closed CCR Unit) (Vistra ID No. 605; IEPA ID Nos. W1578510001-01, W1578510001-02, and W1578510001-03), the Secondary Pond, Tertiary Pond, and Cooling Pond (Ramboll, 2021). The BAP, which is "a 177-acre unlined CCR surface impoundment" (Ramboll, 2021), is the subject of this report.

This report presents the results of an evaluation that characterizes potential risk to human and ecological receptors that may be exposed to CCR constituents in environmental media originating from the BAP. This risk evaluation was performed to support the Closure Alternatives Assessment (CAA) for the BAP in accordance with requirements in Title 35 Part 845 of the Illinois Administrative Code (IAC) (IEPA, 2021). Human and ecological risks were evaluated for Site-specific constituents of interest (COIs). The conceptual site model (CSM) assumed that Site-related COIs in groundwater may migrate to the Kaskaskia River and affect surface water and sediment in the vicinity of the Site.

Consistent with United States Environmental Protection Agency (US EPA) guidance (US EPA, 1989), this report used a tiered approach to evaluate potential risks, which included the following steps:

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: Constituents detected in groundwater were considered COIs if their maximum detected concentration over the period from 2015 to 2021 exceeded a groundwater protection standard (GWPS) identified in Part 845.600 (IEPA, 2021), or a relevant surface water quality standard (SWQS) (IEPA, 2019; US EPA Region IV, 2018).
3. Perform screening-level risk analysis: Compare maximum measured or modeled COI concentrations in surface water and sediment to conservative, health-protective benchmarks in order to determine constituents of potential concern (COPCs).
4. Perform refined risk analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks associated with the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

This assessment relies on a conservative (*i.e.*, health-protective) approach and is consistent with the risk approaches outlined in US EPA guidance. Specifically, we considered evaluation criteria detailed in IEPA guidance documents (*e.g.*, IEPA, 2013, 2019), incorporating principles and assumptions consistent with the Federal CCR Rule (US EPA, 2015a) and US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014).

US EPA has established acceptable risk metrics. Risks above these US EPA-defined metrics are termed potentially "unacceptable risks." Based on the evaluation presented in this report, no unacceptable risks to human or ecological receptors resulting from CCR exposures associated with the BAP were identified. This means that the risks from the Site are likely indistinguishable from normal background risks. Specific risk assessment results include the following:

- No completed exposure pathways were identified for any groundwater receptors; consequently, no risks were identified relating to the use of groundwater.
- No unacceptable risks were identified for recreators boating in the Kaskaskia River to the west of the Site.
- No unacceptable risks were identified for recreators exposed to sediment in the Kaskaskia River to the west of the Site.
- No unacceptable risks were identified for anglers consuming locally caught fish.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. Moreover, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when the BAP is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and consequently potential exposures to CCR-related constituents in the environment will also decline.

2 Site Overview

2.1 Site Description

The BPP is located in southwest Illinois in Randolph and St. Clair Counties. The BAP is located "approximately one-half mile west-northwest of the Village of Baldwin" (Figure 2.1) (Ramboll, 2021). The BAP (Vistra ID No. 601, IEPA ID No. W1578510001-06, and National Inventory of Dams [NID] No. IL50721), is a Part 845 regulated CCR Unit (Ramboll, 2021). The BAP is north of and adjacent to the FAPS, which was approved for closure by IEPA in August 2016, with the final cover system completed in November 2020 (Ramboll, 2021).

"The BPP property is bordered to the west by the Kaskaskia River; to the east by Baldwin Road, farmland, and strip mining areas; to the southeast by the village of Baldwin; to the south by the Illinois Central Gulf railroad tracks, scattered residences, and State Route 154; and to the north by farmland. The St. Clair/Randolph County Line crosses east-west at approximately the midpoint of Baldwin Lake (Cooling Pond)" (Figure 2.1) (Ramboll, 2021).

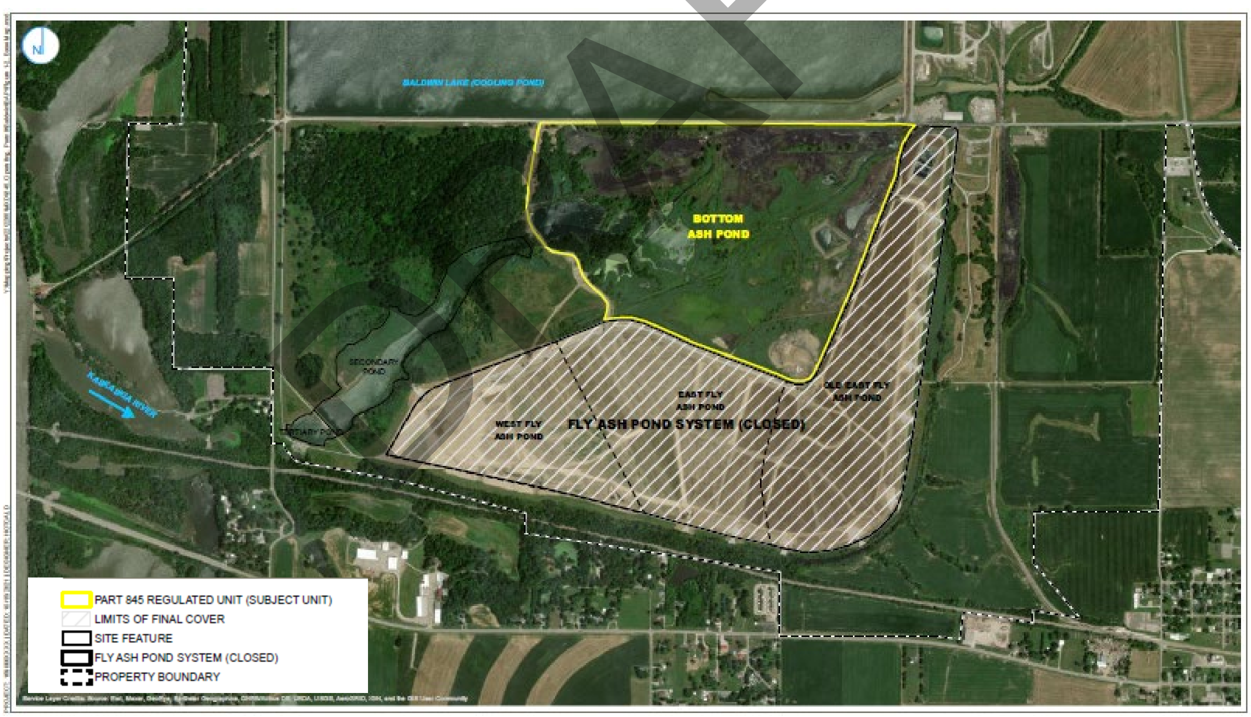

Figure 2.1 Site Location Map. Source: Ramboll (2021).

2.2 Geology/Hydrogeology

The geology underlying the Site in the vicinity of the BAP consists of unlithified materials (alluvium and glacial deposits) underlain by bedrock (Ramboll, 2021). From the surface downwards, the four principal types of unlithified materials present at the Site are the alluvial clay, sandy clay, and clayey sand of the Cahokia Formation (average thickness of 20 ft); the silt and silty clay of the Peoria Loess (average thickness of 10 ft); the clay and sandy clay of the Equality Formation, with occasional sand seams and lenses (average thickness of 13 ft); and the clay and sandy clay diamictons of the Vandalia Till, with intermittent and discontinuous sand lenses (average thickness of 21 ft; Ramboll, 2021). There are two distinct hydrostratigraphic units below the CCR at this Site: (1) the Upper Groundwater Unit (UGU), consisting of the lithologic layers identified as the Cahokia Formation, Peoria Loess, Equality Formation, and Vandalia Till; and (2) the Bedrock Unit (BU). The UGU is composed predominantly of clay with some silt and minor sand, silt layers, and occasional sand lenses. The BU is composed of interbedded shale and limestone bedrock, which is continuous across the entire Site (Ramboll, 2021). The BU has been identified as the uppermost aquifer (UA) (Ramboll, 2021). Thin sand lenses in the UGU adjacent to the BAP and the area of contact between the unlithified material and the bedrock have both been identified as potential migration pathways. The geometric mean horizontal hydraulic conductivities for the UGU and the BU are 3.2×10^{-5} and 5.0×10^{-6} cm/sec, respectively (Ramboll, 2021).

The general groundwater flow direction in the vicinity of the Site is west towards the Kaskaskia River, the principal surface drainage for the region (Ramboll, 2021). Based on groundwater hydraulic head measurements, lateral groundwater flow in the UGU and the BU is generally to the west and southwest toward the historic drainage feature at the Site and the bedrock valley underlying the Secondary and Tertiary Ponds. The receiving surface water bodies for groundwater in the UGU are assumed to be the Secondary and Tertiary Ponds (which ultimately drain to the Kaskaskia River) and the Kaskaskia River. The receiving surface water body for groundwater in the BU (the UA) is the Kaskaskia River (Ramboll, 2021).

2.3 Conceptual Site Model

A CSM describes sources of contamination, the hydrogeological units, and the physical processes that control the transport of water and solutes. In this case, the CSM describes how groundwater underlying the BAP migrates and potentially interacts with surface water and sediment in the adjacent Kaskaskia River. The CSM was developed using available hydrogeologic data specific to the BAP (Ramboll, 2021), including information on groundwater flow and surface water characteristics. Groundwater (and CCR-related constituents) originating from the BAP may migrate vertically downward through the UGU into the UA, or BU. Groundwater flows laterally to the west and southwest through the UGU and the BU and ultimately flows into the Kaskaskia River. Identified potential migration pathways at the Site include the thin sand lenses in the UGU adjacent to the BAP, and the area of contact between the UGU and the BU. Dissolved constituents in groundwater may partition between river sediments and Kaskaskia River surface water.

2.4 Groundwater Monitoring

A total of four wells have been used to monitor the groundwater quality downgradient of the BAP; these include MW-356, MW-369, MW-370, and MW-382 (Figure 2.2). These wells are screened in the upper aquifer (bedrock) (Table 2.1). The analyses presented in this report relied on all available data from the four wells collected between December 2015 and September 2022, which is the period subsequent to the promulgation of the Federal CCR Rule. Groundwater samples were analyzed for a suite of total metals, specified in Illinois CCR Rule Part 845.600 (IEPA, 2021),[1] as well as general water quality parameters (chloride, fluoride, sulfate, and total dissolved solids). A summary of the groundwater data used in this risk evaluation is presented in Table 2.2. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with the BAP or that they have been identified as potential groundwater exceedances.

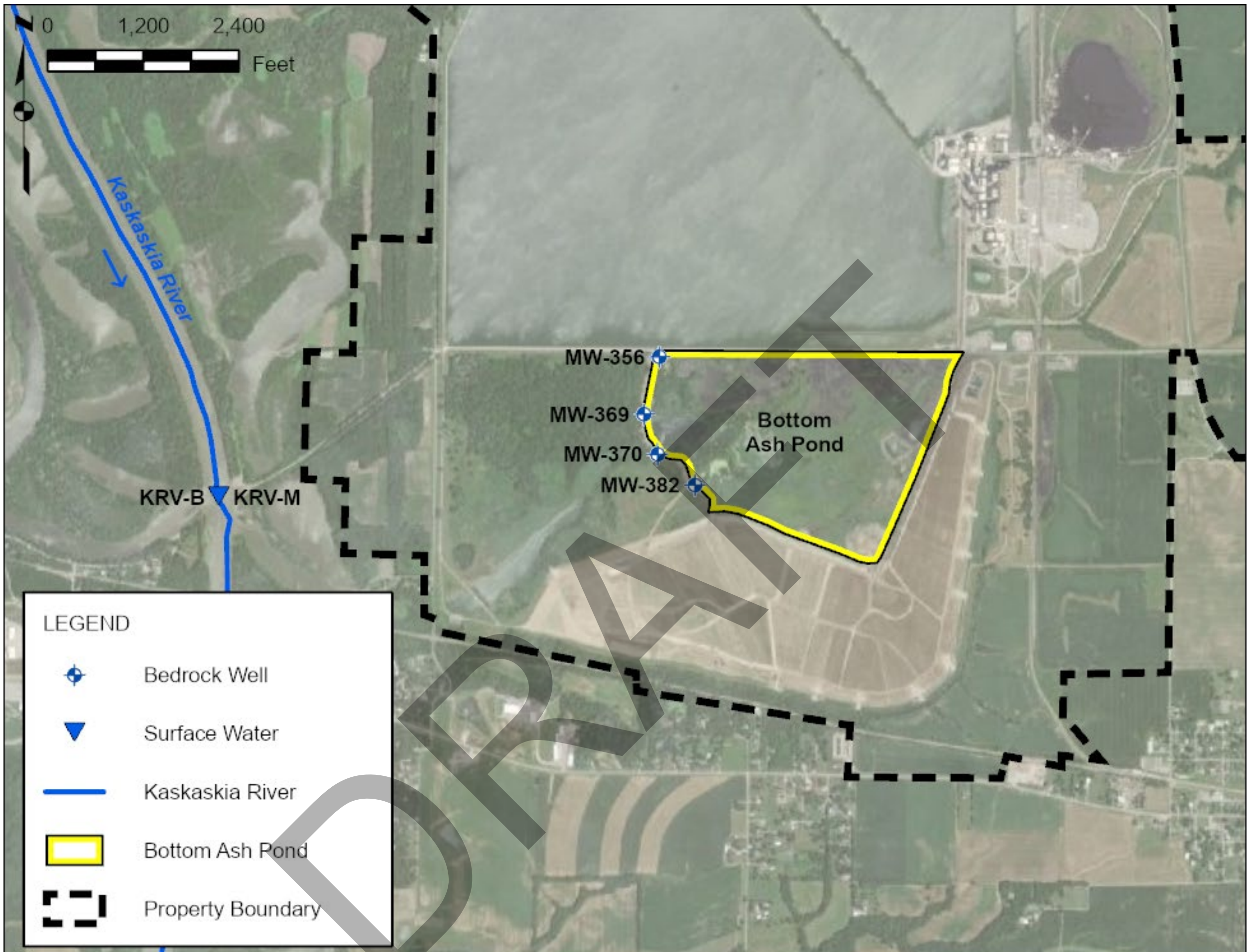

Figure 2.2 Monitoring Well Locations. Source: Ramboll (2021).

[1] Samples were analyzed for a longer list of inorganic constituents and general water quality parameters (chloride, fluoride, sulfate, and total dissolved solids), but these constituents were not evaluated in the risk evaluation.

Table 2.1 Groundwater Monitoring Wells Related to Bottom Ash Pond

Well	Hydrogeologic Unit	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth (ft bgs)
MW-356	UA	10/1/2015	56.0	66.0	66.0
MW-369	UA	11/19/2015	56.0	66.0	66.0
MW-370	UA	11/25/2015	53.0	63.0	63.0
MW-382	UA	11/23/2015	56.0	66.0	66.0

Notes:
bgs = Below Ground Surface; ft = Feet; UA = Uppermost Aquifer (Bedrock).
Source: Ramboll (2021).

Table 2.2 Groundwater Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Total Metals (mg/L)					
Antimony	10	60	0.0011	0.0038	0.0038
Arsenic	50	72	0.0006	0.014	0.0139
Barium	72	72	0.008	0.12	0.123
Beryllium	0	52			0.0005
Boron	76	76	0.592	2.9	2.92
Cadmium	0	52			0.0005
Calcium	76	76	4.12	110	110
Chromium	18	68	0.001	0.013	0.0131
Cobalt	9	64	0.0003	0.0039	0.0039
Lead	8	64	0.001	0.0049	0.0049
Lithium	72	72	0.0177	0.22	0.223
Mercury	0	52			0.0001
Molybdenum	61	72	0.001	0.076	0.0761
Selenium	8	60	0.001	0.028	0.0275
Thallium	0	52			0.001
Radionuclides (pCi/L)					
Radium 226+228	72	72	0.01	4.8	4.84
Other (mg/L)					
Chloride	76	76	29	1,560	1,560
Fluoride	76	76	0.68	3.8	3.83
Sulfate	76	76	38	509	509
Total Dissolved Solids	76	76	636	3,320	3,320

Notes:
pCi/L = PicoCuries per Liter.
Blank cells indicate constituent was not detected.

2.5 Surface Water Monitoring

Two surface water samples were collected from the same location in the Kaskaskia River in November, 2016 (Hanson Professional Services Inc., 2017). The sample location is shown in Figure 2.2, and the sampling results are summarized in Table 2.3.

Table 2.3 Surface Water Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Total Metals (mg/L)					
Arsenic	0	2			0.013
Barium	2	2	0.073	0.074	0.074
Boron	2	2	0.040	0.042	0.042
Cadmium	0	2			0.0010
Chromium	0	2			0.0025
Chromium (hexavalent)	0	2			0.0050
Copper	0	2			0.0025
Cyanide	0	2			0.0025
Iron	2	2	1.2	1.2	1.2
Lead	0	2			0.0075
Manganese	2	2	0.22	0.23	0.23
Mercury	2	2	2.00E-06	4.00E-06	0.000004
Nickel	0	2			0.0025
Selenium	0	2			0.020
Silver	0	2			0.0025
Zinc	0	2			0.0050
Other (mg/L)					
Chloride	2	2	19	21	21
Fluoride	2	2	0.21	0.22	0.22
Oil and Grease	0	2			3.0
Phenols	0	2			0.0025
Phosphorus	2	2	0.26	0.26	0.26
Sulfate	2	2	23	23	23
Total Suspended Solids (TSS)	2	2	35	49	49
pH	2	2	8.1	8.2	8.2

Note:
Blank cells indicate constituent was not detected.

3 Risk Evaluation

3.1 Risk Evaluation Process

A risk evaluation was conducted to determine whether constituents present in groundwater underlying and downgradient of the BAP have the potential to pose adverse health effects to human and ecological receptors. The risk evaluation is consistent with the principles of risk assessment established by US EPA and has considered evaluation criteria detailed in Illinois guidance documents (*e.g.*, IEPA, 2013, 2019).

The general risk evaluation approach is summarized in Figure 3.1 and discussed below.

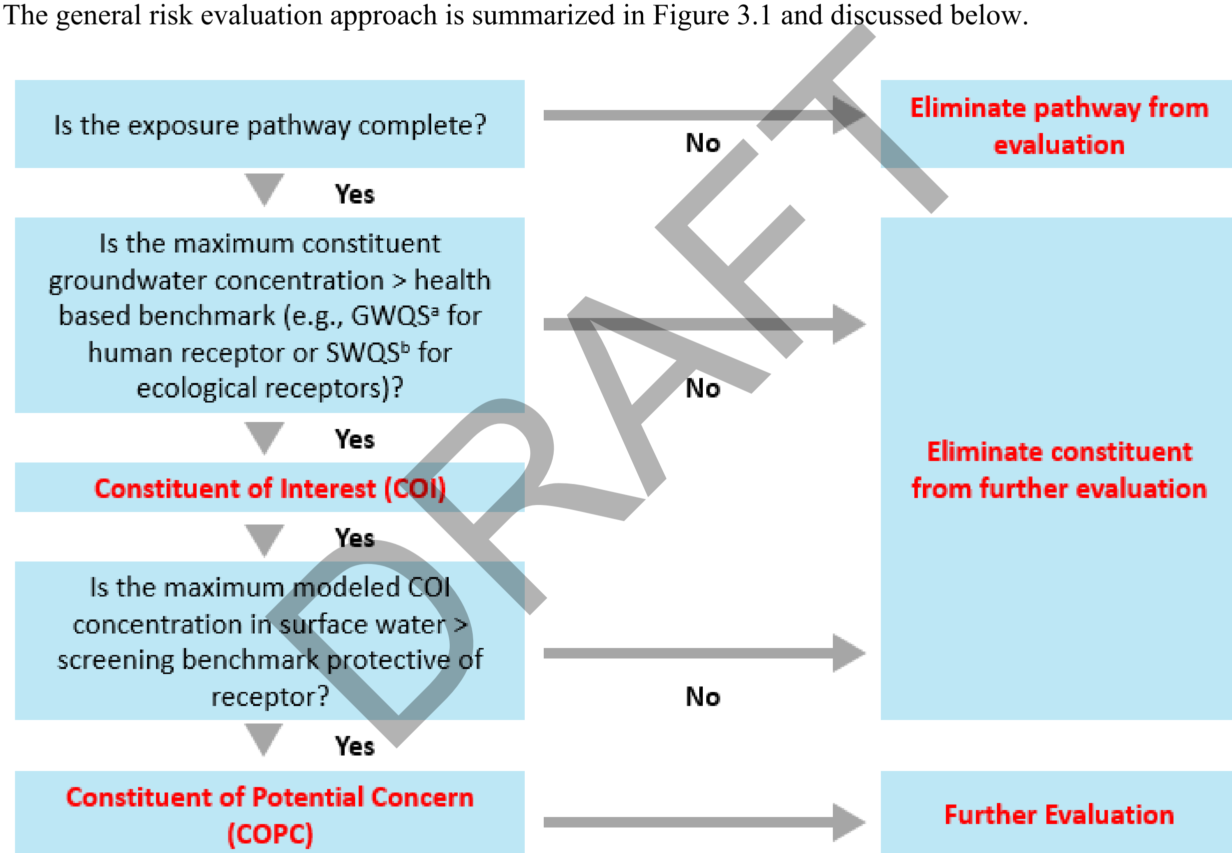

Figure 3.1 Overview of Risk Evaluation Methodology. IEPA = Illinois Environmental Protection Agency; GWQS = IEPA Groundwater Quality Standards; SWQS = IEPA Surface Water Quality Standards. (a) The IEPA Part 845 Groundwater Protection Standards (GWPS) were used to identify COIs. (b) IEPA SWQS protective of chronic exposures to aquatic organisms were used to identify ecological COIs. In the absence of an SWQS, US EPA Region IV Ecological Screening Values (ESVs) were used.

The first step in the risk evaluation was to develop the CEMs and identify complete exposure pathways. All potential receptors and exposure pathways based on groundwater use and surface water use in the vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation.

Groundwater data were used to identify COIs. COIs were identified as constituents with maximum concentrations in groundwater in excess of groundwater quality standards (GWQS)[2] for human receptors and SWQS for ecological receptors. Based on the CSM (Section 2.2), some groundwater underlying the BAP has the potential to interact with surface water in the Kaskaskia River. Therefore, potential BAP-related constituents in groundwater may potentially flow toward and into surface water in the Kaskaskia River.

Surface water samples have been collected from Kaskaskia River adjacent to the Site; however, sediment samples have not been collected from the river. Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to receptors (see Section 3.3.3).

Gradient modeled the COI concentrations in surface water and sediment based on the groundwater data from the BAP-related wells. The measured and modeled COI concentrations in surface water and sediment were compared to conservative, generic risk-based screening benchmarks for human health and ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of site-specific characteristics. Human health benchmarks are receptor-specific values calculated for each pathway and environmental medium that are designed to be protective of human health. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological and human health screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a measured or modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but only that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

As described in more detail below, this evaluation relied on the screening assessment to demonstrate that constituents present in groundwater underlying the BAP do not pose an unacceptable human health or ecological risk. That is, after the screening step, no COPCs were identified and further assessment was not warranted.

3.2 Human and Ecological Conceptual Exposure Models

A CEM provides an overview of the receptors and exposure pathways requiring risk evaluation. The CEM describes the source of the contamination, the mechanism that may lead to a release of contamination, the environmental media to which a receptor may be exposed, the route of exposure (exposure pathway), and the types of receptors that may be exposed to these environmental media.

3.2.1 Human Conceptual Exposure Model

The human CEM for the Site depicts the relationships between the off-Site environmental media potentially impacted by constituents in groundwater and human receptors that could be exposed to these media. Figure 3.2 presents a human CEM for the Site. It considers a human receptor who could be exposed to COIs hypothetically released from the BAP into groundwater, surface water, sediment, and fish. The following human receptors and exposure pathways were evaluated for inclusion in the Site-specific CEM.

[2] As discussed further in Section 3.3.2, GWQS are protective of human health and not necessarily of ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially enter into the adjacent surface water and impact ecological receptors. Therefore, two sets of COIs were identified: one for humans and another for ecological receptors.

- Residents – exposure to groundwater/surface water as drinking water;
- Residents – exposure to groundwater/surface water used for irrigation;
- Recreators in the river adjacent to the Site:
  - Boaters – exposure to surface water and sediment while boating;
  - Swimmers – exposure to surface water and sediment while swimming;
  - Anglers – exposure to surface water and sediment and consumption of locally caught fish.

All of these exposure pathways were considered to be complete, except for residential exposure to groundwater or surface water used for drinking water or irrigation. Section 3.2.1.1 explains why the residential drinking water and irrigation pathways are incomplete. Section 3.2.1.2 provides additional description of the recreational exposures.

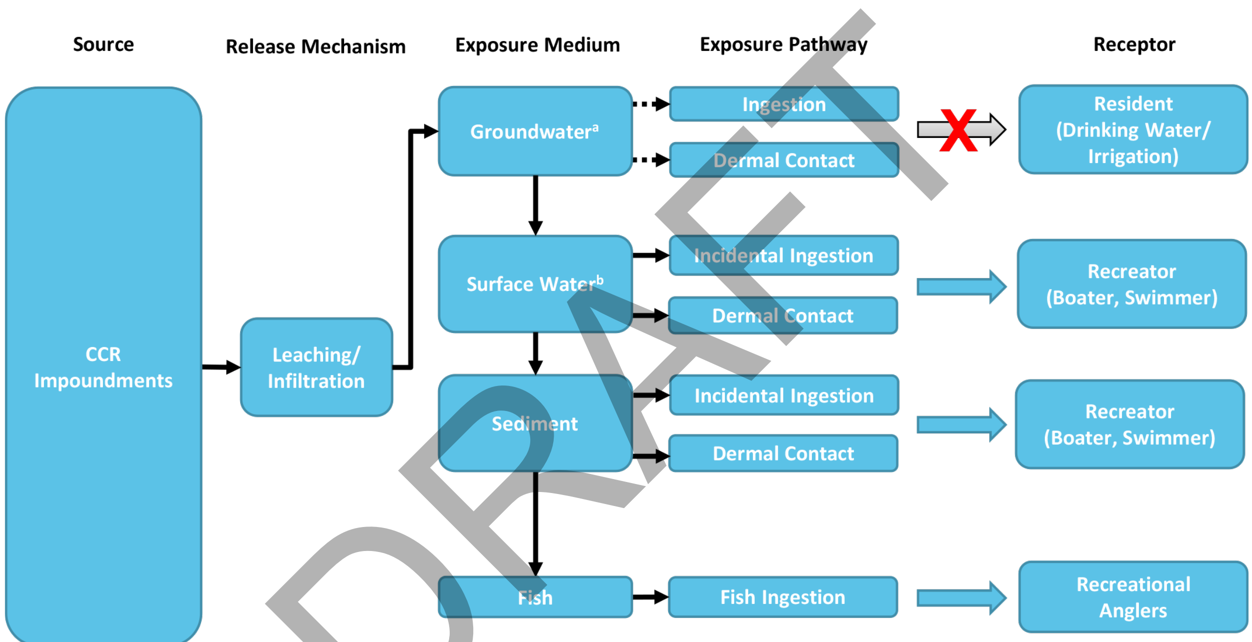

Figure 3.2 Human Conceptual Exposure Model. CCR = Coal Combustion Residuals. Dashed line/Red X = Incomplete or insignificant exposure pathway. (a) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source. (b) Surface water is not used as a drinking water source.

3.2.1.1 Groundwater or Surface Water as a Drinking Water/Irrigation Source

A receptor survey was conducted in 2021 to identify potential users of groundwater in the vicinity of the BAP (Ramboll, 2021). Specific sources that were used in this survey include the Illinois State Geological Survey (ISGS), Illinois State Water Survey (ISWS), and the IEPA (Ramboll, 2021). A total of 10 wells were identified within 1,000 meters of the BAP, which included six private water wells, four monitoring wells, and one temporary piezometer for Illinois Power (Figure 3.3). The wells are summarized in Table 3.1. The four monitoring wells, owned by Illinois Power, were installed in 1992 and are located north of the BAP but within the BPP. Well 121572596900, owned by Illinois Power, is 27 feet deep and screened in the UGU. Well 121572592700 is a private well 160 feet deep into the BU, but is listed as a dry hole. Both of these wells are shown as being on the BPP property (Figure 3.3), but their coordinates are likely incorrect. Furthermore, because Well 121572592700 is a dry hole, there is no exposure to impacted groundwater that can occur. Four private wells are located south of the BPP (Wells 121570240900, 121572280600, 121572284200, and 121572681800[3]) (Figure 3.3). These wells range in depth from 24 to 37 ft and are screened in the UGU. Groundwater beneath the BAP generally flows to the southwest towards the Kaskaskia River. These four private wells are side-gradient of the BAP and are not expected to be impacted by any CCR constituents in groundwater that originate from the BAP.

Table 3.1 Summary of Water Wells Within 1,000 Meters of the Bottom Ash Pond

API Number	Status	Date Drilled	Latitude	Longitude	Owner	Depth (ft)	Formation
121570240900	Water	4/16/1970	38.18528	-89.8698	Private	32	Sand & gravel
121572280600	Water	6/30/1974	38.18364	-89.8646	Private	24	Red sand & gravel
121572284200	Water	10/1/1974	38.18364	-89.8646	Private	33	Sand & gravel
121572592700	Water	1992	38.19013	-89.8724	Private	160	Lime
121572681800	Water	7/10/2021	38.18639	-89.8736	Private	37	Brown silty clay
121572596900	Water	3/19/1995	38.19013	-89.8724	Illinois Power	27	Silty - clay
121572594000	Monitoring	8/23/1992	38.20553	-89.8573	Illinois Power	23	Silty clay
121572594100	Monitoring	8/25/1992	38.20553	-89.8573	Illinois Power	18	Silty clay, med sand
121572594200	Monitoring	8/25/1992	38.20553	-89.8573	Illinois Power	18	NA
121572594300	Monitoring	8/25/1992	38.20553	-89.8573	Illinois Power	18	NA

Note:
NA = Not Available.

[3] Well 121572681800 was installed on 7/10/21 and is not included in the 2021 Ramboll HCR (Ramboll, 2021).

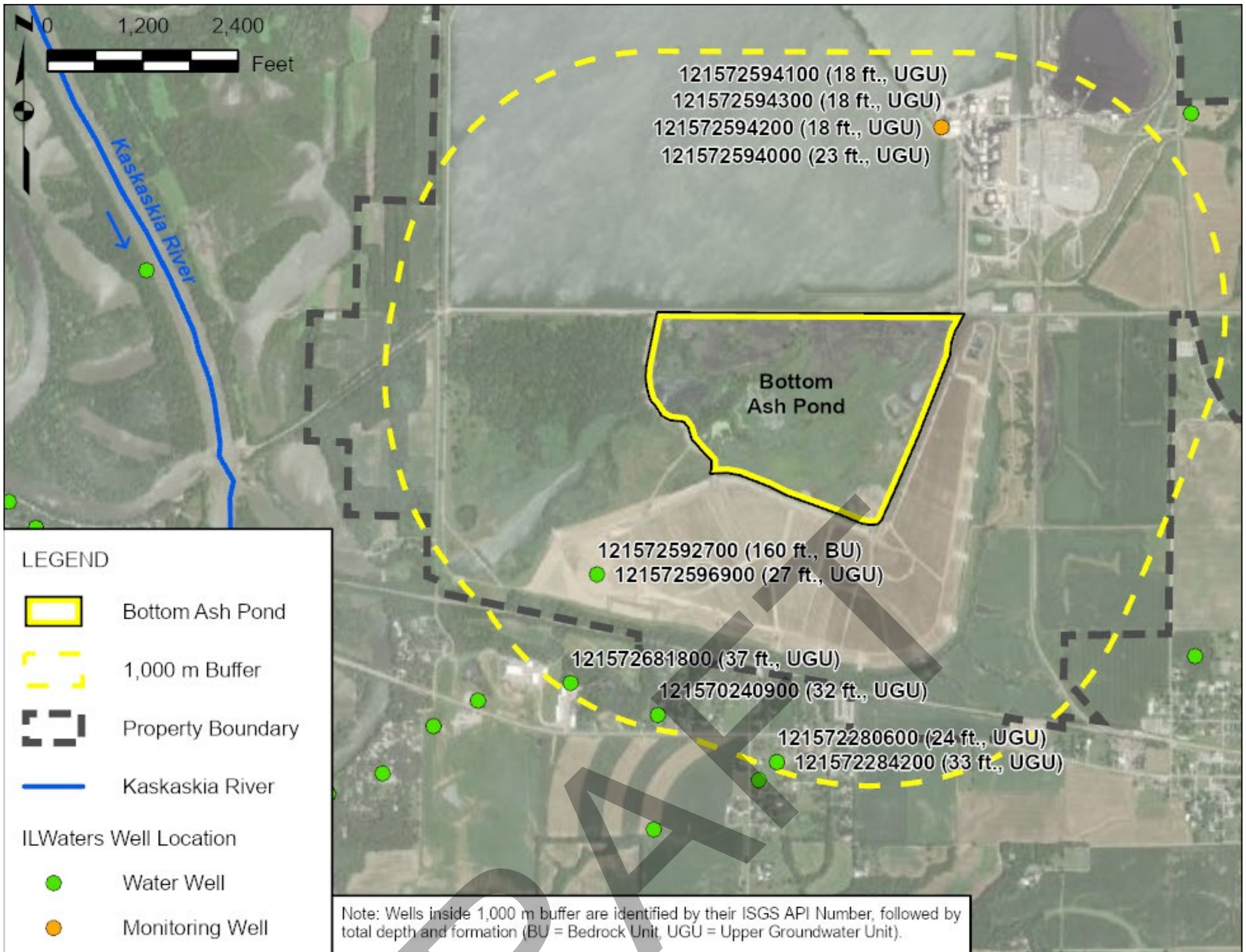

Figure 3.3 Water Wells Within 1,000 Meters of the Bottom Ash Pond. Source: Ramboll (2021).

3.2.1.2 Recreational Exposures

The Kaskaskia River is located to the west of the BPP. The river and its adjacent area to the west of the BPP are part of the Kaskaskia River State Fish and Wildlife Area (SFWA) (Figure 3.4) (Ramboll, 2021). "The Illinois Department of Transportation owns the land along the river and leases most of the land to the Illinois Department of Natural Resources to manage for fish, wildlife and other recreational activities" (IDNR, 2022). The recreational uses of the SFWA include fishing, boating, hunting (IDNR, 2022). Recreational exposure to surface water and sediment may occur during activities such as boating or fishing in the river. Recreational anglers may also consume locally caught fish from the Kaskaskia River.

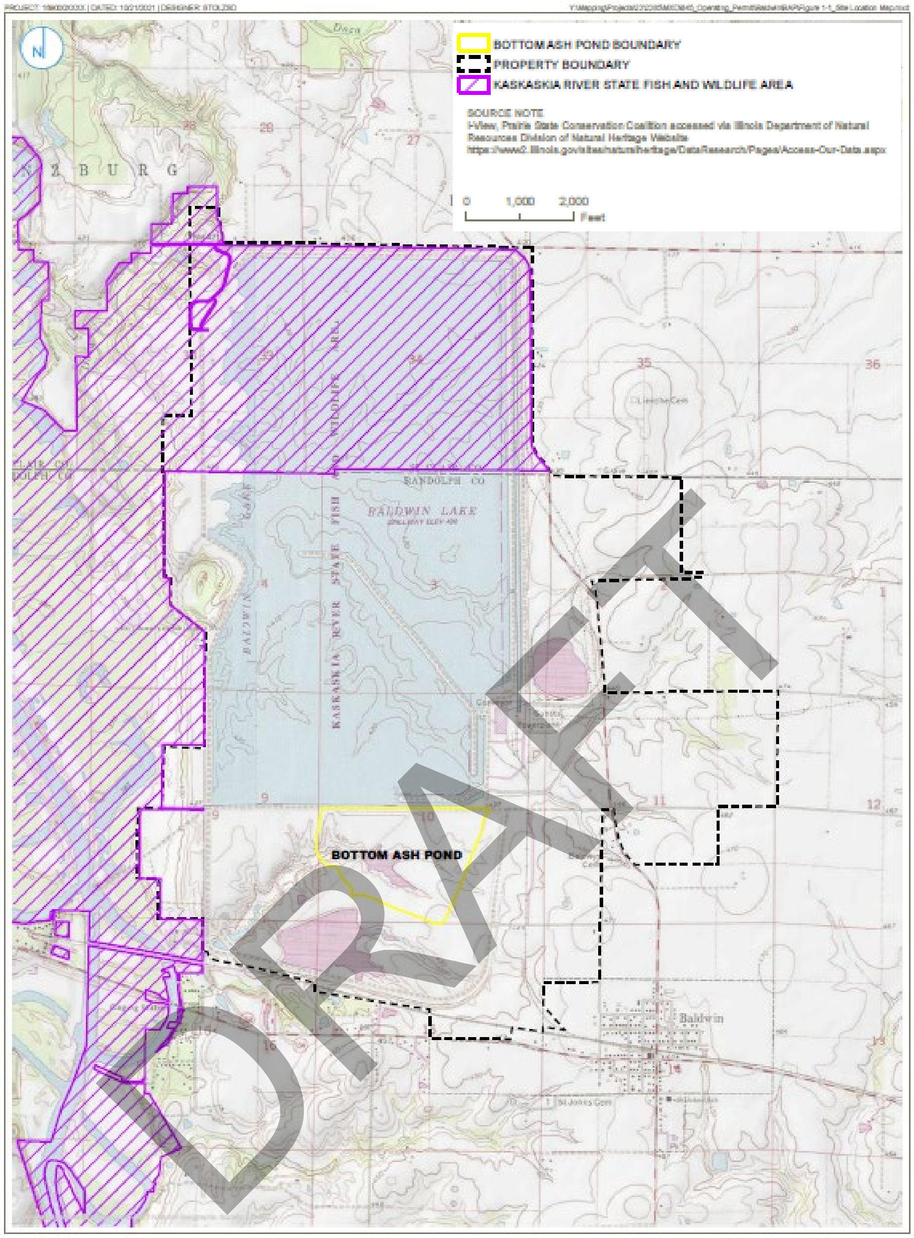

Figure 3.4 Kaskaskia River State Fish and Wildlife Area. Source: Ramboll (2021).

3.2.2 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be exposed to these media. The ecological risk evaluation considered both direct toxicity as well as secondary toxicity *via* bioaccumulation. Figure 3.5 presents the ecological CEM for the Site. The following ecological receptor groups and exposure pathways were considered:

- **Ecological Receptors Exposed to Surface Water:**
  - Aquatic plants, amphibians, reptiles, and fish.

- **Ecological Receptors Exposed to Sediment:**
    - Benthic invertebrates (*e.g.*, insects, crayfish, mussels).
- **Ecological Receptors Exposed to Bioaccumulative COIs:**
    - Higher trophic-level wildlife (avian and mammalian) *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of prey (*e.g.*, plants, invertebrates, small mammals, fish).

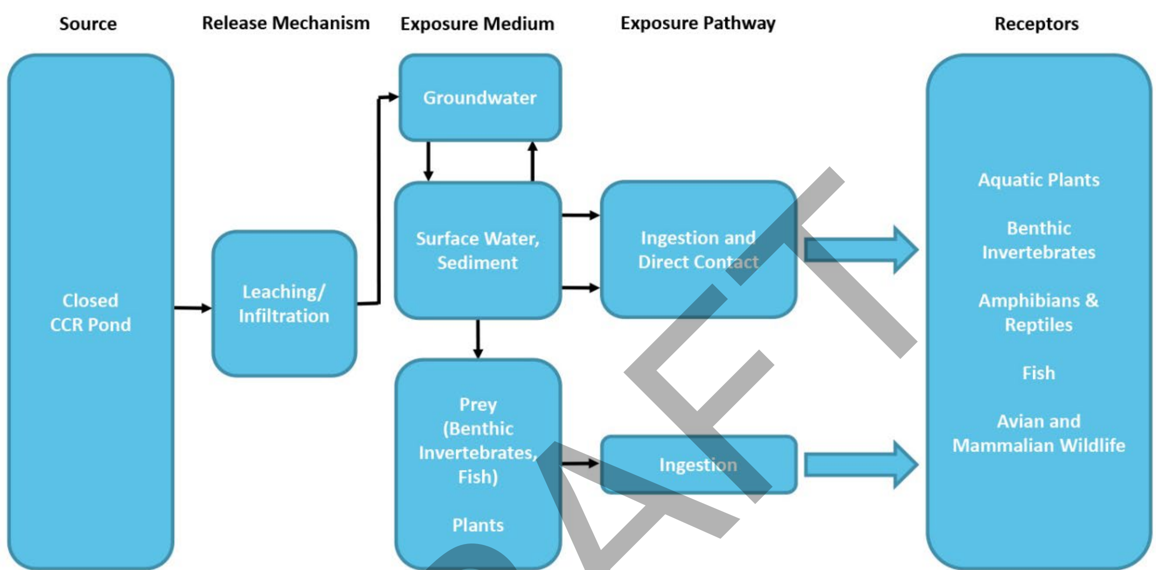

Figure 3.5 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residuals.

3.3 Identification of Constituents of Interest

Risks were evaluated for COIs. A constituent was considered a COI if the maximum detected constituent concentration in groundwater exceeded a health-based benchmark. According to US EPA risk assessment guidance (US EPA, 1989), this screening step is designed to reduce the number of constituents carried through the risk evaluation that are anticipated to have a minimal contribution to the overall risk. Identified COIs are the constituents that are most likely to pose a risk concern in the surface water adjacent to the Site.

3.3.1 Human Health Constituents of Interest

For the human health risk evaluation, COIs were conservatively identified as constituents with maximum concentrations in groundwater above the GWPS listed in the Illinois CCR Rule Part 845.600 (IEPA, 2021). Gradient used the maximum detected concentrations from groundwater samples collected from all of the BAP-associated wells, regardless of hydrostratigraphic unit. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with the BAP or that they have been identified as potential groundwater exceedances. Using this approach, 3 COIs (arsenic, boron, and lithium) were identified for the human health risk evaluation *via* the surface water pathway (Table 3.2).

The water quality parameters that exceeded the GWPS included chloride, sulfate, and total dissolved solids; however, these constituents were not included in the risk evaluation because the GWPS is based on aesthetic quality and there is an absence of studies regarding toxicity to human health. The US EPA secondary maximum contaminant levels (MCLs) for chloride, sulfate, and total dissolved solids are based on aesthetic quality. The secondary MCLs for chloride and sulfate (250 mg/L) are based on salty taste (US EPA, 2021). The secondary MCL for total dissolved solids (500 mg/L) is based on hardness, deposits, colored water, staining, and salty taste (US EPA, 2021). Given that these parameters are not likely to pose a human health risk concern in the event of exposure, they were not considered to be human health COIs.

Table 3.2 Human Health Constituents of Interest

Constituents[a]	Maximum Concentration	GWPS[b]	Human Health COI[c]
Total Metals (mg/L)			
Antimony	0.0038	0.006	No
Arsenic	0.014	0.01	Yes
Barium	0.12	2	No
Beryllium	ND	0.004	No
Boron	2.9	2	Yes
Cadmium	ND	0.005	No
Calcium	110		No
Chromium	0.013	0.1	No
Cobalt	0.0039	0.006	No
Lead	0.0049	0.0075	No
Lithium	0.22	0.04	Yes
Mercury	ND	0.002	No
Molybdenum	0.076	0.1	No
Selenium	0.028	0.05	No
Thallium	ND	0.002	No
Radionuclides (pCi/L)			
Radium 226+228	4.8	5	No
Other (mg/L)			No
Chloride	1,560	200	No[d]
Fluoride	3.8	4	No
Sulfate	509	400	No[d]
Total Dissolved Solids	3,320	1,200	No[e]

Notes:
COI = Constituent of Interest; GWPS = Groundwater Protection Standard; MCL = Maximum Contaminant Level; ND = Not Detected; pCi/L = PicoCuries per Liter.
Shaded = Compound identified as a COI.
(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021).
(b) The IL Part 845.600 GWPS (IEPA, 2021) were used to identify COIs.
(c) COIs are constituents for which the maximum concentration exceeds the groundwater standard.
(d) This constituent is not likely to pose a human health risk concern due to the absence of studies regarding toxicity to human health. Therefore, this constituent is not considered a COI.
(e) Total dissolved solids are not considered a COI because the MCL is based on aesthetic quality.

3.3.2 Ecological Constituents of Interest

The Illinois GWPS, as defined in IEPA's guidance, were developed to protect human health but not necessarily ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially migrate into the adjacent surface water and impact ecological receptors. Therefore, to identify ecological COIs, the maximum concentrations of constituents detected in groundwater were compared to ecological surface water benchmarks protective of aquatic life.

The surface water screening benchmarks for freshwater organisms were obtained from the following hierarchy of sources:

- IEPA (2019) SWQS. IEPA SWQS are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQS for several metals are hardness dependent (cadmium, chromium, copper, lead, manganese, nickel, and zinc). Screening benchmarks for these constituents were calculated assuming US EPA's default hardness of 100 mg/L (US EPA, 2022a).[4]
- US EPA Region IV (2018) surface water Ecological Screening Values (ESVs) for hazardous waste sites.

Benchmarks from the United States Department of Energy's (US DOE) guidance document ("A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota") were used for radium (US DOE, 2019). US DOE presents benchmarks for radium-226 and radium-228 (4 and 3 picoCuries per liter [pCi/L], respectively). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations.

Consistent with the human health risk evaluation, Gradient used the maximum detected concentrations from groundwater samples collected from all of the BAP-associated wells (regardless of hydrostratigraphic unit) without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation. The COIs identified for ecological receptors include radium-226+228 and chloride (Table 3.3).

[4] Hardness data are available from the Kaskaskia River at Roots, Illinois (USGS Site No. 595400), 16 miles downstream of the BPP. Based on 130 samples collected from April 1980 to March 1997, the average hardness at this location was 173 mg/L (USGS, 2022a). Due to the age of the samples and the distance from the site, the US EPA (2022a) default hardness of 100 mg/L was used. Use of a higher hardness value would result in less stringent screening values, thus, use of the US EPA default hardness is conservative.

Table 3.3 Ecological Constituents of Interest

Constituent[a]	Maximum Groundwater Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Total Metals (mg/L)				
Antimony	0.0038	0.19	US EPA R4 ESV	No
Arsenic	0.014	0.19	IEPA SWQC	No
Barium	0.12	5	IEPA SWQC	No
Beryllium		0.064	US EPA R4 ESV	No
Boron	2.9	7.6	IEPA SWQC	No
Cadmium		0.0011	IEPA SWQC	No
Chromium	0.013	0.21	IEPA SWQC	No
Cobalt	0.0039	0.019	US EPA R4 ESV	No
Lead	0.0049	0.02	IEPA SWQC	No
Lithium	0.22	0.44	US EPA R4 ESV	No
Mercury		0.0011	IEPA SWQC	No
Molybdenum	0.076	7.2	US EPA R4 ESV	No
Selenium	0.028	1	IEPA SWQC	No
Thallium		0.006	US EPA R4 ESV	No
Radionuclides (pCi/L)				
Radium-226+228	4.8	3	US DOE	Yes
Other (mg/L)				
Chloride	1,560	500	IEPA SWQC	Yes
Fluoride	3.8	4	IEPA SWQC	No
Sulfate	509	NA	NA	No
Total Dissolved Solids	3,320	NA	NA	No

Notes:
BAP = Bottom Ash Pond; COI = Constituent of Interest; GWPS = Groundwater Protection Standard; IEPA SWQC = Illinois Environmental Protection Agency Surface Water Quality Criteria; NA = Not Available; pCi/L = PicoCuries per Liter; US DOE = United States Department of Energy; US EPA R4 ESV = United States Environmental Protection Agency Region IV Ecological Screening Value.
Shaded = Compound identified as a COI.
(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021) that were detected in at least one groundwater sample from the wells related to the BAP.
(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQC (IEPA, 2019); US EPA R4 "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018); and US DOE's guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).
(c) Constituents with maximum detected concentrations exceeding a benchmark protective of surface water exposure are considered ecological COIs.

3.3.3 Surface Water and Sediment Modeling

To estimate the potential contribution to surface water (and sediment) from groundwater specifically associated with the BAP, Gradient modeled concentrations in the Kaskaskia River surface water and sediment from groundwater flowing into the river for the detected human and ecological COIs. This is because the constituents detected in groundwater above an ecological or health-based benchmark are most likely to pose a risk concern in the adjacent surface water. Gradient modeled human health and ecological COI concentrations in the surface water and sediment using a mass balance calculation based on the surface water and groundwater mixing. The model assumes a well-mixed groundwater-surface water location. The maximum detected concentrations in groundwater (regardless of well location) from December 2015 to

September 2022 were conservatively used to model COI concentrations in surface water and sediment. The groundwater data were measured as total metals. Use of the total metal concentration for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.

The modeling approach does not account for geochemical transformations that may occur during groundwater mixing with surface water. Gradient assumed that predicted surface water concentrations were influenced only by the physical mixing of groundwater as it enters the surface water and were not further influenced by the geochemical reactions in the water and sediment, such as precipitation. In addition, the model only predicts surface water and sediment concentrations as a result of the potential migration of COI concentrations in BAP-related groundwater and does not account for background concentrations in surface water or sediment.

For this evaluation, Gradient adapted a simplified and conservative form of US EPA's indirect exposure assessment methodology (US EPA, 1998) that was used in US EPA's coal combustion waste risk assessment (US EPA, 2014). The model is a mass balance calculation based on surface water and groundwater mixing and the concept that the dissolved and sorbed concentrations can be related through an equilibrium partitioning coefficient (K_d). The model assumes a well-mixed groundwater-surface water location, with partitioning among total suspended solids, dissolved water column, sediment pore water, and solid sediments.

Sorption to soil and sediment is highly dependent on the surrounding geochemical conditions. To be conservative, we ignored the natural attenuation capacity of soil and sediment and estimated the surface water concentration based only on the physical mixing of groundwater and surface water (*i.e.*, dilution) at the point where groundwater flows into surface water.

The aquifer properties used to estimate the volume of groundwater flowing into Kaskaskia River and surface water concentrations are presented in Table 3.4 (for the UGU) and Table 3.5 (for the UA or BU). The surface water properties used in the modeling are presented in Table 3.6. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partitioning coefficients and the sediment properties presented in Table 3.6. In the absence of Site-specific information for the Kaskaskia River, Gradient used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. The modeled surface water and sediment concentrations are presented in Table 3.7. These modeled concentrations reflect conservative contributions from groundwater. A description of the modeling and the detailed results are presented in Appendix A.

Table 3.4 Groundwater Properties Used in Modeling of the Upper Groundwater Unit (UGU)

Parameter	Value	Unit	Notes/Source
COI Concentration	Constituent specific	mg/L	Maximum detected concentration in groundwater.
Cross-Sectional Area for the UGU[a]	5,940	m^2	Length of the groundwater discharge zone (1,500 m) multiplied by the estimated thickness of the UGU/PMP intersecting Kaskaskia River (3.96 m) (Ramboll, 2021).
Hydraulic Gradient	0.013	m/m	Average horizontal hydraulic gradient determined for the UGU (Ramboll, 2021).
Hydraulic Conductivity of the UGU	0.000032	cm/s	Average horizontal hydraulic conductivity determined for the upper groundwater unit (Ramboll, 2021).

Notes:
COI = Constituent of Interest; PMP = Potential Migration Pathway; UGU = Upper Groundwater Unit.
(a) The cross-sectional area represents the area through which groundwater flows from the UGU to the Kaskaskia River.

Table 3.5 Groundwater Properties Used in Modeling of the Uppermost Aquifer (UA, or Bedrock Unit)

Parameter	Value	Unit	Notes/Source
COI Concentration	Constituent specific	mg/L	Maximum detected concentration in groundwater.
Cross-Sectional Area for the UA[a]	12,600	m^2	The length of the groundwater discharge zone (1,500 m) multiplied by the estimated thickness of the bedrock aquifer intersecting the Kaskaskia River (8.4 m) (Ramboll, 2021).
Hydraulic Gradient	0.015	m/m	Average horizontal hydraulic gradient determined for the bedrock aquifer (Ramboll, 2021).
Hydraulic Conductivity of the UA	0.000005	cm/s	Average horizontal hydraulic conductivity determined for the bedrock aquifer (Ramboll, 2021).

Notes:
COI = Constituent of Interest; UA = Uppermost Aquifer.
(a) The cross-sectional area represents the area through which groundwater flows from the UA to the Kaskaskia River.

Table 3.6 Surface Water Properties Used in Modeling

Parameter	Value	Unit	Notes/Source
Surface Water Flow Rate	5.4×10^{11}	L/year	Representative low-flow (10^{th} percentile) discharge rate estimated at Kaskaskia River monitoring location USGS05595000 at New Athens, IL (2009-2022) (USGS, 2022b).
Total Suspended Solids (TSS)	84.5	mg/L	Median of suspended solid concentration measured in the Kaskaskia River monitoring location USGS05595000 at New Athens, IL (2015-2022) (USGS, 2022c).
Depth of the Water Column	2.74	m	Average water depth of the Kaskaskia River near BPP (Bist LLC, 2022).
Suspended Sediment to Water Partition Coefficient	Constituent specific	mg/L	Values based on US EPA (2014).

Notes:
BPP = Baldwin Power Plant; UA = Uppermost Aquifer; US EPA = United States Environmental Protection Agency; USGS = United States Geological Survey.

Table 3.7 Sediment Properties Used in Modeling

Parameter	Value	Unit	Notes/Source
Depth of Upper Benthic Layer	0.03	m	Default (US EPA, 2014).
Depth of Water Body	2.77	m	Depth of water column (2.74 m) in the Kaskaskia River (Bist LLC, 2022) plus depth of upper benthic layer (0.03 m) (US EPA, 2014).
Bed Sediment Particle Concentration	1	g/cm^3	Default (US EPA, 2014).
Bed Sediment Porosity	0.6	–	Default (US EPA, 2014).
Total Suspended Solids (TSS) Mass per Unit Area	0.23	kg/m^2	Depth of water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3).
Sediment Mass per Unit Area	30	kg/m^2	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g and 10^6 cm^3/m^3).
Sediment to Water Partitioning Coefficients	Constituent specific	mg/L	Values based on US EPA (2014).

Note:
US EPA = United States Environmental Protection Agency.

Table 3.8 Surface Water and Sediment Modeling Results

COI	Groundwater Concentration (mg/L or pCi/L)	Total Water Column Concentration (mg/L or pCi/L)	Concentration Sorbed to Bottom Sediments (mg/kg or pCi/kg)
Arsenic	0.014	2.8E-08	4.3E-06
Boron	2.9	6.0E-06	2.3E-05
Lithium	0.22	4.6E-07	(a)
Radium-226+228	4.84	9.9E-06	4.5E-02
Chloride	1,560	3.2E-03	(a)

Notes:
COI = Constituent of Interest; K_d = Equilibrium Partition Coefficient; pCi/kg = Picocuries per Kilogram; pCi/L = Picocuries per Liter.
(a) Lithium and chloride do not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling, therefore, the modeled sediment concentration is 0.

3.4 Human Health Risk Evaluation

The section below presents the results of the human health risk evaluation for recreators (boaters and anglers) in the Kaskaskia River adjacent to the Site. Risks were assessed using the maximum measured or modeled COIs in surface water.

3.4.1 Recreators Exposed to Surface Water

Screening Exposures: Recreators could be exposed to surface water *via* incidental ingestion and dermal contact while boating. In addition, anglers could consume fish caught in the Kaskaskia River. The maximum measured or modeled COI concentrations in surface water were used as conservative upper-end estimates of the COI concentrations to which a recreator might be exposed directly (incidental ingestion of COIs in surface water while boating) and indirectly (consumption of locally caught fish exposed to COIs in surface water).

Screening Benchmarks: Illinois surface water criteria (IEPA, 2019), known as human threshold criteria (HTC), are based on incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities, as well as the consumption of fish. The HTC values were calculated from the following equation (IEPA, 2019):

$$\text{HTC} = \frac{\text{ADI}}{\text{W} + (\text{F} \times \text{BCF})}$$

where:

HTC = Human health protection criterion in milligrams per liter (mg/L)
ADI = Acceptable daily intake (mg/day)
W = Water consumption rate (L/day)
F = Fish consumption rate (kg/day)
BCF = Bioconcentration factor (L/kg-tissue)

Illinois defines the acceptable daily intake (ADI) as the "maximum amount of a substance which, if ingested daily for a lifetime, results in no adverse effects to humans" (IEPA, 2019). US EPA defines its chronic reference dose (RfD) as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for a chronic duration (up to a lifetime) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (US EPA, 2011a). Illinois lists methods to derive an ADI from the primary literature (IEPA, 2019). In accordance with Illinois guidance, Gradient derived an ADI by multiplying the MCL by the default water ingestion rate of 2 L/day (IEPA, 2019). In the absence of an MCL, Gradient applied the RfD used by US EPA to derive its Regional Screening Levels (RSLs) (US EPA, 2022b) as a conservative estimate of the ADI. The RfDs are given in mg/kg-day, while the ADIs are given in mg/day; thus, Gradient multiplied the RfD by a standard body weight of 70 kg to obtain the ADI in mg/day. The calculation of the HTC values is shown in Appendix B, Table B.1.

Gradient used bioconcentration factors (BCFs) from a hierarchy of sources. The primary BCFs were those that US EPA used to calculate the National Recommended Water Quality Criteria (NRWQC) for human health (US EPA, 2002). Other sources included BCFs used in the US EPA coal combustion ash risk assessment (US EPA, 2014) and BCFs reported by Oak Ridge National Laboratory's Risk Assessment

Information System (ORNL RAIS) (ORNL, 2020).[5] Lithium did not have a BCF value available from any authoritative source; therefore, the water quality criterion for lithium was calculated assuming a BCF of 1. This is a conservative assumption, as lithium does not readily bioaccumulate in the aquatic environment (ECHA, 2020a,b; ATSDR, 2010).

Illinois recommends a fish consumption rate of 0.020 kg/day (20 g/day) for an adult weighing 70 kg (IEPA, 2019). Illinois recommends a water consumption rate of 0.01 L/day for "incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities" (IEPA, 2019). Appendix B, Table B.1 presents the calculated HTC for fish and water and for fish consumption only.

The HTC for fish consumption for radium-226+228 was calculated as follows:

$$\mathrm{HTC} = \frac{\mathrm{TCR}}{(\mathrm{SF} \times \mathrm{BAF} \times \mathrm{F})}$$

where:

HTC	=	Human health protection criterion in picoCuries per liter (pCi/L)
TCR	=	Target cancer risk (1×10^{-5})
SF	=	Food ingestion slope factor (risk/pCi)
BAF	=	Bioaccumulation factor (L/kg-tissue)
F	=	Fish consumption rate (kg/day)

The food ingestion slope factor (lifetime excess total cancer risk per unit exposure, in risk/pCi) used to calculate the HTC was the highest value of those for radium-226 (Ra-226), radium-228 (Ra-228), and "Ra-228+D" (US EPA, 2001). According to US EPA (2001), "+D" indicates that "the risks from associated short-lived radioactive decay products (*i.e.,* those decay products with radioactive half-lives less than or equal to 6 months) are also included."

Screening Risk Evaluation: The maximum modeled and measured COI concentrations in surface water were compared to the calculated Illinois HTC values (Table 3.9). All surface water concentrations were below their respective benchmarks. The HTC values are protective of recreational exposure *via* water and/or fish ingestion and do not account for dermal exposures to COIs in surface water while boating. However, given that the measured and modeled COI surface water concentrations are orders of magnitude below HTC protective of water and/or fish ingestion, dermal exposures to COIs are not expected to be a risk concern. Moreover, the dermal uptake of metals is considered to be minimal and only a small proportion of ingestion exposures. Thus, none of the COIs evaluated would be expected to pose an unacceptable risk to recreators exposed to surface water while boating and anglers consuming fish caught in the Kaskaskia River.

[5] Although recommended by US EPA (2015b), US EPA EpiSuite 4.1 (US EPA, 2019) was not used as a source of BCFs because inorganic compounds are outside the estimation domain of the program.

Table 3.9 Risk Evaluation of Recreators Exposed to Surface Water

COI	Maximum Surface Water Concentration		HTC for Water and Fish	HTC for Water Only	HTC for Fish Only	COPC	
	Modeled	Measured[a]				Based on Modeled Concentrations	Based on Measured Concentrations
Metals (mg/L)							
Arsenic	2.8E-08		0.022	2.0	0.023	No	NA
Boron	6.0E-06	4.2E-02	467	1,400	700	No	No
Lithium	4.6E-07		4.7	14	7.0	No	NA

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; HTC = Human Threshold Criteria; NA = Not Applicable.
(a) Measured concentrations are listed only for the constituents identified as COIs. Measured surface water concentrations may be different from modeled concentrations because measured data include the effects of background and other industrial sources. Modeled concentrations only represent the potential effect on surface water quality resulting from the measured groundwater concentrations.

3.4.2 Recreators Exposed to Sediment

Recreational exposure to sediment may occur during boating activity in the Kaskaskia River; exposure to sediment may occur through incidental ingestion and dermal contact.

Screening Exposures: COIs in impacted groundwater flowing into the river can sorb to sediments. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations.

Screening Benchmarks: There are no established recreator RSLs that are protective of recreational exposures to sediment (US EPA, 2022c). Therefore, benchmarks that are protective of recreational exposures to sediment *via* incidental ingestion and dermal contact were calculated using US EPA's RSL guidance (US EPA, 2022c). These benchmarks were calculated using the recommended assumptions (*i.e.*, oral bioavailability, body weights, averaging time) and toxicity reference values (*i.e.*, RfD and cancer slope factor [CSF]). Recreators were assumed to be exposed to sediment while recreating 60 days a year (or two weekend days per week for 30 weeks a year, from April to October). The exposure duration was assumed for a child 6 years of age and an adult 20 years of age, per US EPA guidance (Stalcup, 2014). The daily recommended residential soil ingestion rates of 200 mg/day for a child and 100 mg/day for an adult are based on an all-day exposure to residential soils (Stalcup, 2014; US EPA, 2011b). Since recreational exposures to sediment are assumed to occur for less than four hours per day, one-third of the daily residential soil ingestion (67 mg/day for a child and 33 mg/day for an adult) was used as a conservative assumption. For dermal exposures, recreators were assumed to be exposed to sediment on their lower legs and feet (1,026 cm^2 for the child and 3,026 cm^2 for the adult, based on the age-weighted surface areas reported in US EPA, 2011b). While other body parts may be exposed to sediment, the contact time will likely be very short, as the sediment would wash off in the surface water. Gradient used US EPA's recommended adherence factor of 0.2 mg/cm^2 based on child exposure to wet soil (US EPA, 2004; Stalcup, 2014), which was used in the US EPA RSL User's Guide for a child recreator exposed to soil or sediment (US EPA, 2022c). The sediment screening benchmarks were calculated based on a target hazard quotient of 1, or a target cancer risk of 1×10^{-5}. Appendix B, Table B.2 presents the calculation of screening benchmarks protective of recreational exposures to sediment. A recreator sediment screening benchmark for radium-226+228 was based on soil Preliminary Remediation Goals (PRGs) calculated for radium-226 and radium-228 using US EPA's PRG calculator (US EPA, 2020). The lower of the two values was used as the recreator sediment screening benchmark for radium-226+228 (Appendix B, Table B.3).

Screening Risk Evaluation: The modeled sediment concentrations were well below the recreational sediment screening benchmarks (Table 3.10). Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while boating.

Table 3.10 Risk Evaluation of Recreators Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	Recreator Sediment Screening Benchmark (mg/kg)	COPC
Total Metals (mg/kg)			
Arsenic	4.3E-06	6.8E+01	No
Boron	2.3E-05	2.7E+05	No
Lithium	(a)	2.7E+03	NA

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; K_d = Equilibrium Partition Coefficient; NA = Not Applicable.
(a) Lithium does not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling.

3.5 Ecological Risk Evaluation

Based on the ecological CEM (Figure 3.5), ecological receptors could be exposed to surface water and dietary items (*i.e.*, prey and plants) potentially impacted by identified COIs (radium-226+228 and chloride).

3.5.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in the Kaskaskia River potentially impacted by identified ecological COIs. Measured and modeled surface water concentrations were compared to risk-based ecological screening benchmarks.

Screening Benchmarks: Surface water screening benchmarks protective of aquatic life were obtained from the following hierarchy of sources:

- IEPA SWQS (IEPA, 2019), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For cadmium, the surface water benchmark is hardness dependent and calculated using a default hardness of 100 mg/L (US EPA, 2022a);[6]
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites; and
- US DOE benchmarks from the guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).

Risk Evaluation: The maximum measured and modeled COI concentrations in surface water were compared to the benchmarks protective of aquatic life (Table 3.11). The measured and modeled surface water concentrations for the COIs were below their respective benchmarks. Thus, none of the COIs evaluated are expected to pose an unacceptable risk to aquatic life in the Kaskaskia River.

[6] Conservatisms associated with using a default hardness value are discussed in Section 3.6.

Table 3.11 Risk Evaluation of Ecological Receptors Exposed to Surface Water

COI	Maximum Surface Water Concentration		Ecological Freshwater Benchmark	Basis	COPC	
	Modeled	Measured			Based on Modeled Concentration	Based on Measured Concentration
Radionuclides (pCi/L)						
Radium-226 + 228	9.9E-06	NA	3.0	US DOE (2019)	No	NA
Other (mg/L)						
Chloride	3.2E-03	19	500	IEPA SWQC (IEPA, 2019)	No	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; IEPA SWQC = Illinois Environmental Protection Agency Surface Water Quality Criteria; NA = Not Applicable; pCi/L = PicoCuries per Liter; US DOE = United States Department of Energy.

3.5.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater flowing into Kaskaskia River can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration originating from groundwater.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations (TECs) from MacDonald *et al.* (2000), which provide consensus values that identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. In the absence of an ESV for radium-226+228, a sediment screening value of 90,000 pCi/kg was used, based on the biota concentration guide (BCG) for radium-228 (US DOE, 2019).[7] Chloride and fluoride are not expected to sorb to sediment; therefore, risk to ecological receptors exposed to sediment was not evaluated for these constituents. The benchmarks used in this evaluation are listed in Table 3.12.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks (Table 3.12). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than 1% of the sediment screening benchmark. Therefore, the modeled sediment concentrations attributed to potential contributions from Site groundwater are not expected to significantly contribute to ecological exposures in the Kaskaskia River adjacent to the Site.

[7] The BCG for sediment is 90 pCi/g for Ra-228 and 100 pCi/g for Ra-226; the lower of the two values was used for Ra-226+228, and converted to pCi/kg (US DOE, 2019).

Table 3.12 Risk Evaluation of Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration	ESV	COPC	% of Benchmark
Radionuclides (pCi/kg)				
Radium 226 + 228	4.5E-02	90,000[a]	No	0.00005%
Other (mg/kg)				
Chloride	(b)	NA	No	-

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; K_d = Equilibrium Partition Coefficient; NA = Not Available; pCi/kg = PicoCuries per Kilogram; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) ESV from US DOE (2019); value converted from 90 pCi/g to 90,000 pCi/kg.
(b) Chloride does not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling, thus the modeled concentration in sediment is zero.

3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest

Screening Exposures: COIs with bioaccumulative properties can impact higher-trophic-level wildlife exposed to these COIs *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, and fish).

Screening Benchmark: US EPA Region IV (2018) guidance and IEPA SWQS (IEPA, 2019) guidance were used to identify constituents with potential bioaccumulative effects.

Risk Evaluation: The ecological COIs (radium-226+228, chloride) were not identified as having potential bioaccumulative effects. Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation. IEPA (2019) identifies mercury as the only metal with bioaccumulative properties, however, mercury was not detected in groundwater.[8]

3.6 Uncertainties and Conservatisms

A number of uncertainties and their potential impact on the risk evaluation are discussed below. Wherever possible, conservative assumptions were used in an effort to minimize uncertainties and overestimate rather than underestimate risks.

Exposure Estimates:

- The risk evaluation included the IL Part 845.600 constituents detected in groundwater samples (above GWPS) collected from wells associated with the BAP. However, it is possible that not all of the detected constituents are related specifically to the BAP.
- The human health and ecological risk characterizations were based on the maximum measured or modeled COI concentrations, rather than on averages. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates human and ecological exposures, given that receptors are mobile and concentrations change over time. For example, US EPA guidance states that risks should be estimated using

[8] US EPA Region IV (2018) identifies selenium as having potential bioaccumulative effects. Although selenium was detected in groundwater, it was not considered an ecological COI.

average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, Gradient has greater confidence that there is no risk concern.

- Only constituents detected in groundwater were used to identify COIs and model COI concentrations in surface water and sediment. For the constituents that were not detected in BAP groundwater, the detection limits were below the IL Part 845.600 GWPS and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total COI concentrations in groundwater. Modeling surface water concentrations using total metal concentrations may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-AP-related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to Site groundwater mixing with surface water were evaluated. While not quantified, exposures from potential BAP-related groundwater contributions are likely to represent only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-AP-related sources.
- Screening benchmarks for human health were developed using exposure inputs based on US EPA's recommended values for reasonable maximum exposure (RME) assessments (Stalcup, 2014). RME is defined as "the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures" (US EPA, 2004). US EPA states the "intent of the RME is to estimate a conservative exposure case (*i.e.*, well above the average case) that is still within the range of possible exposures" (US EPA, 1989). US EPA also notes that this high-end exposure "is the highest dose estimated to be experienced by some individuals, commonly stated as approximately equal to the 90th percentile exposure category for individuals" (US EPA, 2015c). Thus, most individuals will have lower exposures than those presented in this risk assessment.

Toxicity Benchmarks:

- Screening-level ecological benchmarks were compiled from IEPA and US EPA guidance and designed to be protective of the majority of Site conditions, leaving the option for Site-specific refinement. In some cases, these benchmarks may not be representative of the Site-specific conditions or receptors found at the Site, or may not accurately reflect concentration-response relationships encountered at the Site. For example, the ecological benchmark for cadmium is hardness dependent, and Gradient relied on US EPA's default hardness of 100 mg/L. Use of a higher hardness value would increase the cadmium SWQS because benchmarks become less stringent with higher levels of hardness. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the SWQS.
- In addition, for the ecological evaluation, Gradient conservatively assumed all constituents to be 100% bioavailable. Modeled COI concentrations in surface water are considered total COI concentrations. In addition, the measured surface water data used in this report represent total concentrations. US EPA recommends using dissolved metals as a measure of exposure to ecological receptors because it represents the bioavailable fraction of metal in water (US EPA, 1993). Therefore, the modeled surface water COI concentrations may be an overestimation of exposure concentrations to ecological receptors.

- In general, it is important to appreciate that the human health toxicity factors used in this risk evaluation are developed to account for uncertainties, such that safe exposure levels used as benchmarks are often many times lower (even orders of magnitude lower) than the levels that cause effects that have been observed in human or animal studies. For example, toxicity factors incorporate a 10-fold safety factor to protect sensitive subpopulations. This means that a risk exceedance does not necessarily equate to actual harm.

4 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the BPP in Baldwin, Illinois. The CSM developed for the Site indicates that groundwater beneath the BAP flows into the Kaskaskia River adjacent to the Site and may potentially impact surface water and sediment.

CEMs were developed for human and ecological receptors. The complete exposure pathways for humans include recreators (boaters) in the Kaskaskia River who are exposed to surface water and sediment, and anglers who consume locally caught fish. Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated. The complete exposure pathways for ecological receptors include aquatic life (including aquatic and marsh plants, amphibians, reptiles, and fish) exposed to surface water; benthic invertebrates exposed to sediment; and avian and mammalian wildlife exposed to bioaccumulative COIs in surface water, sediment, and dietary items.

Groundwater data collected from 2015 to 2022 were used to estimate exposures. The available surface water data collected from the Kaskaskia River were also evaluated. For groundwater constituents retained as COIs, surface water and sediment concentrations were modeled using the maximum detected groundwater concentration. Surface water and sediment exposure estimates were screened against benchmarks protective of human health and ecological receptors for this risk evaluation.

US EPA has established acceptable risk metrics. Risks above these US EPA-defined metrics are termed potentially "unacceptable risks." Based on the evaluation presented in this report, no unacceptable risks to human or ecological receptors resulting from CCR exposures associated with the BAP were identified. This means that the risks from the Site are likely indistinguishable from normal background risks. Specific risk assessment results include the following:

- For recreators exposed to surface water, all COIs were below the conservative risk-based screening benchmarks. Therefore, none of the COIs evaluated in surface water are expected to pose an unacceptable risk to recreators in the Kaskaskia River adjacent to the Site.
- For recreators exposed to sediment *via* incidental ingestion and dermal contact, the modeled sediment concentrations were below health-protective sediment benchmarks. Therefore, the modeled sediment concentrations are not expected to pose an unacceptable risk to recreators exposed to sediment in the Kaskaskia River adjacent to the Site.
- For anglers consuming locally caught fish, the modeled concentrations of all COIs in surface water (as well as the measured data) were below conservative benchmarks protective of fish consumption. Therefore, none of the COIs evaluated are expected to pose an unacceptable risk to recreators consuming fish caught in the Kaskaskia River.
- Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the modeled or measured COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks; therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors.

- Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish). Mercury was the only ecological COI identified as having potential bioaccumulative effects. However, the modeled concentrations did not exceed benchmarks protective of bioaccumulative effects. Therefore, mercury is not considered to pose an ecological risk *via* bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. The risk evaluation was based on the maximum detected COI concentration; however, US EPA guidance states that risks should be based on a representative average concentration such as the 95% upper confidence limit on the mean; thus, using the maximum concentration tends to overestimate exposure. Although the COIs identified in this evaluation also occur naturally in the environment, the contributions to exposure from natural background sources and nearby industry were not considered; thus, CCR-related exposures were likely overestimated. Exposure estimates assumed 100% metal bioavailability, which likely results in overestimates of exposure and risks. Exposure estimates were based on inputs to evaluate the "reasonable maximum exposure"; thus, most individuals will have lower exposures than those estimated in this risk assessment.

Finally, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when the BAP is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline.

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Appendix A

Surface Water and Sediment Modeling

Gradient modeled concentrations of constituents of interest (COIs) in the Kaskaskia River surface water and sediment based on available groundwater data. First, we estimated the flow rate of COIs discharged to the Kaskaskia River *via* groundwater. Then, we adapted United States Environmental Protection Agency (US EPA) indirect exposure assessment methodology (US EPA, 1998) in order to model surface water and sediment water concentrations in the Kaskaskia River.

Model Overview

The groundwater flow to the river is represented by a one-dimensional, steady-state model. In this model, the groundwater plume migrates horizontally in the Upper Groundwater Unit (UGU)/Potential Migration Pathway (PMP) and the Bedrock Unit (BU)/Uppermost Aquifer (UA) prior to flowing to the Kaskaskia River. For both layers, the groundwater flow entering the river is the flow going through a cross-sectional area that has a length equal to the length of the river adjacent to the Bottom Ash Pond (BAP) with potential coal combustion residuals (CCR)-related impacts and a height equal to each layer's estimated thickness. It was assumed that all the groundwater flowing through these two layers would ultimately discharge to the Kaskaskia River, thus the total flow into the river is the sum of the flows in the two layers. The length of the groundwater discharge zone was estimated using Google Earth Pro (Google, LLC, 2022).

The groundwater flow to the Kaskaskia River mixes with the surface water in the river. The COIs entering the river *via* groundwater can dissolve into the water column, sorb to suspended sediments, or sorb to benthic sediments. Using US EPA's indirect exposure assessment methodology (US EPA, 1998), the model evaluates the surface water and sediment COI concentrations at a location downstream of the groundwater discharge point, assuming a well-mixed water column.

Groundwater Discharge Rate

The groundwater discharge rate was evaluated using conservative assumptions. Gradient conservatively assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration of each individual COI, in both the UGU and the UA. Further, Gradient ignored adsorption by subsurface soil and assumed that all the groundwater flowing through UGU and UA and intersecting the river bank was discharged into the river.

For each groundwater unit, the groundwater flow rate into the river was derived using Darcy's Law:

$$\mathrm{Q} = \mathrm{K} \times \mathrm{i} \times \mathrm{A}$$

where:

Q	=	Groundwater flow rate (m^3/s)
K	=	Hydraulic conductivity (m/s)
i	=	Hydraulic gradient (m/m)
A	=	Cross-sectional area (m^2)

For each COI, the mass discharge rate into the river was then calculated by:

$$\mathrm{m_c} = \mathrm{C_c} \times \mathrm{Q} \times \mathrm{CF}$$

where:

m_c	=	Mass discharge rate of the COI (mg/year)
C_c	=	Maximum groundwater concentration of the COI (mg/L)
Q	=	Groundwater flow rate (m^3/s)
CF	=	Conversion factors: 1,000 L/m^3 and 31,557,600 s/year

The values of the aquifer parameters used for these calculations are provided in Table A.1. The calculated mass discharge rates were then used as inputs for the surface water and sediment partitioning model.

The cross-sectional area for the UGU and UA were 5,943 and 12,600 m^2, respectively. The length of the discharge zone was estimated to be approximately 1,500 m. The height of the discharge zone was estimated to be 3.96 m for the UGU and 8.40 m for the UA (Ramboll, 2021). The average horizontal hydraulic gradient was 0.013 m/m for the UGU and 0.015 m/m for the UA (calculated from data in Ramboll, 2021). The average horizontal hydraulic conductivity of the UGU was 0.000032 cm/sec and the UA was 0.000005 cm/sec (calculated from data in Ramboll, 2021).

Surface Water and Sediment Concentration

Groundwater discharged into the river will be diluted in the surface water flow. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model Gradient used to estimate the surface water and sediment concentrations is a steady-state model described in US EPA's indirect exposure assessment methodology (US EPA, 1998) and also used in US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals," referred to herein as the CCR risk assessment (US EPA, 2014). This model describes the partitioning of constituents between surface water, suspended sediments, and benthic sediments based on equilibrium partition coefficients (K_d values). It estimates the concentrations of constituents in surface water, suspended sediments, and benthic sediments at steady-state equilibrium at a theoretical location downstream of the discharge point after complete mixing of the water column. In our analysis, we used the K_d values provided in the US EPA CCR risk assessment for all of the COIs (US EPA, 2014, Table J-1). These coefficients are presented in Table A.2.

To be conservative, Gradient assumed that the constituents were not affected by dissipation or degradation once they entered the water body. The total water body concentration of the COI was calculated as follows (US EPA, 1998):

$$C_{wtot} = \frac{m_c}{V_f \times f_{water}}$$

where:

C_{wtot} = Total water body concentration of the COI (mg/L)
m_c = Mass discharge rate of the COI (mg/year)
V_f = Water body annual flow (L/year)
f_{water} = Fraction of the COI in the water column (unitless)

For the Kaskaskia River annual flow rate, Gradient conservatively used the low-flow (10^{th} percentile) discharge rate of about 606 cubic feet per second (cfs), or 5.4×10^{11} L/year, based on the daily mean discharge rates measured at the United States Geological Survey (USGS) gauging station at New Athens, Illinois (USGS Station 05595000) between 2009 and 2022 (USGS, 2022a). The surface water parameters are presented in Table A.3.

The fraction of COIs in the water column was calculated for each COI using the sediment/water and suspended solids/water partition coefficients (US EPA, 2014). The fraction of COIs in the water column is defined as follows (US EPA, 2014):

$$f_{water} = \frac{(1 + [K_{dsw} \times TSS \times 0.000001]) \times \frac{d_w}{d_z}}{\left([1 + (K_{dsw} \times TSS \times 0.000001)] \times \frac{d_w}{d_z}\right) + ([bsp + K_{dbs} \times bsc] \times \frac{d_b}{d_z})}$$

where:

K_{dsw}	=	Suspended sediment-water partition coefficient (mL/g)
K_{dbs}	=	Sediment-water partition coefficient (mL/g)
TSS	=	Total suspended solids in the surface water body (mg/L). Set equal to 84.5 mg/L based on the median suspended sediment concentration measured at the USGS gauging station at New Athens, Illinois (USGS Station 05595000) between 2015 and 2022 (USGS, 2022b).
0.000001	=	Units conversion factor
d_w	=	Depth of the water column (m). The depth of the water column was estimated as 2.74 m, based on bathymetry data for the Kaskaskia River near the Baldwin Power Plant (BPP) (Bist LLC, 2022).
d_b	=	Depth of the upper benthic layer (m). Set equal to 0.03 m (US EPA, 2014).
d_z	=	Depth of the water body (m). Calculated as $d_w + d_b$. Set equal to 2.77 m.
bsp	=	Bed sediment porosity (unitless). Set equal to 0.6 (US EPA, 2014).
bsc	=	Bed sediment particle concentration (g/cm^3). Set equal to 1.0 g/cm^3 (US EPA, 2014).

The fraction of COIs dissolved in the water column (f_d) is calculated as follows (US EPA, 2014):

$$f_d = \frac{1}{1 + K_{dsw} \times TSS \times 0.000001}$$

The values for the fraction of COI in the water column and other calculated parameters are presented in Table A.4.

The total water column concentration (C_{wcTot}) of the COIs, comprising both the dissolved and suspended sediment phases, is then calculated as follows (US EPA, 2014):

$$C_{wcTot} = C_{wtot} \times f_{water} \times \frac{d_z}{d_w}$$

Finally, the dissolved water column concentration (C_{dw}) for the COIs is calculated as follows (US EPA, 2014):

$$C_{dw} = f_d \times C_{wcTot}$$

The dissolved water column concentration (C_{dw}) was then used to calculate the concentration of COIs sorbed to suspended solids in the water column (US EPA, 1998):

$$C_{sw} = C_{dw} \times K_{dsw}$$

where:

C_{sw}	=	Concentration sorbed to suspended solids (mg/kg)
C_{dw}	=	Concentration dissolved in the water column (mg/L)
K_{dsw}	=	Suspended solids/water partition coefficient (mL/g)

In the same way, using the total water body concentration and the fraction of COI in the benthic sediments, the model derives the total concentration in benthic sediments (US EPA, 2014):

$$C_{bstot} = f_{benth} \times C_{wtot} \times \frac{d_z}{d_b}$$

where:

C_{bstot} = Total COI concentration in bed sediment (mg/L or g/m^3)
C_{wtot} = Total water body COI concentration (mg/L)
f_{benth} = Fraction of COI in benthic sediments (unitless)
d_b = Depth of the upper benthic layer (m)
d_z = Depth of the water body (m). Calculated as $d_w + d_b$.

This value can be used to calculate dry weight sediment concentration as follows:

$$C_{sed\text{-}dw} = \frac{C_{bstot}}{bsc}$$

where:

$C_{sed\text{-}dw}$ = Dry weight sediment concentration (mg/kg)
C_{bstot} = Total sediment concentration (mg/L)
bsc = Bed sediment bulk density. Used the default value of 1 g/cm^3 from US EPA (2014).

The total sediment concentration is composed of the sum of the COI concentration dissolved in the bed sediment pore water (equal to the concentration dissolved in the water column) and the COI concentration sorbed to benthic sediments (US EPA, 1998).

The COI concentration sorbed to benthic sediments was calculated as follows (US EPA, 1998):

$$C_{sb} = C_{dbs} \times K_{dbs}$$

where:

C_{sb} = Concentration sorbed to bottom sediments (mg/kg)
C_{dbs} = Concentration dissolved in the sediment pore water (mg/L)
K_{dbs} = Sediments/water partition coefficient (mL/kg)

For each COI, the modeled total water column concentration, dry weight sediment concentration, and concentration sorbed to sediment are presented in Table A.5.

Table A.1 Parameters Used to Estimate Groundwater Discharge to Surface Water

Groundwater Unit	Parameter	Name	Value	Unit
UGU	A	Cross-Sectional Area	5,940	m^2
UGU	i	Hydraulic Gradient	0.013	m/m
UGU	K	Hydraulic Conductivity	0.000032	cm/s
UA	A	Cross-Sectional Area	12,600	m^2
UA	i	Hydraulic Gradient	0.015	m/m
UA	K	Hydraulic Conductivity	0.000005	cm/s

Notes:
UA = Uppermost Aquifer or Bedrock Unit; UGU = Upper Groundwater Unit or PMP (Potential Migration Pathway).
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).
Cross-sectional area was estimated from Ramboll (2021).

Table A.2 Partition Coefficients

Constituent	Mean Sediment-Water Partition Coefficient (K_{dbs})		Mean Suspended Sediment-Water Partition Coefficient (K_{dsw})	
	Value (log_{10}) (mL/g)	Value (mL/g)	Value (log_{10}) (mL/g)	Value (mL/g)
Metals				
Arsenic	2.4	2.51E+02	3.9	7.94E+03
Boron	0.8	6.31E+00	3.9	7.94E+03
Lithium[a]	–	0	–	0
Radionuclides				
Radium-226+228	–	7.40E+03	–	7.40E+03

Notes:
Source: US EPA (2014).
(a) Lithium does not readily sorb to soils and sediments. Consequently, sediment concentrations were not modeled for this constituent (K_d was assumed to be 0).

Table A.3 Surface Water Parameters

Parameter	Name	Value	Unit
TSS	Total Suspended Solids	84.5	mg/L
V_{fx}	Surface Water Flow Rate	5.4×10^{11}	L/year
d_b	Depth of Upper Benthic Layer (default)	0.03	m
d_w	Depth of Water Column	2.74	m
d_z	Depth of Water Body	2.77	m
bsc	Bed Sediment Bulk Density (default)	1	g/cm^3
bsp	Bed Sediment Porosity (default)	0.6	–
M_{TSS}	TSS Mass per Unit Area[a]	0.23	kg/m^2
M_S	Sediment Mass per Unit Area[b]	30	kg/m^2

Notes:
CF = Conversion factor.
Source of default values: US EPA (2014).
(a) $M_{TSS} = TSS \times d_w \times CF1 \times CF2$.
(b) $M_S = d_b \times bsc \times CF3 \times CF4$.
CF1 = 1,000 L/m^3; CF2 = 1E-06 kg/kg; CF3 = 1E+06 cm^3/m^3; CF4 = 0.001 kg/g.

Table A.4 Calculated Parameters

COI	Fraction of COI in the Water Column (f_{water})	Fraction of COI in the Benthic Sediments ($f_{benthic}$)	Fraction of COI Dissolved in the Water Column ($f_{dissolved}$)
Metals			
Arsenic	0.38	0.62	0.60
Boron	0.96	0.04	0.60
Lithium	0.99	0.01	0
Radionuclides			
Radium-226+228	0.02	0.98	0.62

Note:
COI = Constituent of Interest.

Table A.5 Surface Water and Sediment Modeling Results

COI	Groundwater Concentration (mg/L or pCi/L)	Mass Discharge Rate (mg/year or pCi/year)	Total Water Column Concentration (mg/L or pCi/L)	Concentration Sorbed to Bottom Sediments (mg/kg or pCi/kg)
Metals				
Arsenic	0.014	1.5E+04	2.8E-08	4.3E-06
Boron	2.9	3.2E+06	6.0E-06	2.3E-05
Lithium	0.22	2.4E+05	4.6E-07	(a)
Radionuclides				
Radium-226+228	4.84	5.3E+06	9.9E-06	4.5E-02

Notes:
COI = Constituent of Concern; pCi/kg = Picocuries per Kilogram; pCi/L = Picocuries per Liter.
(a) Lithium does not readily sorb to soils and sediments. Consequently, sediment concentrations were not modeled for this constituent (K_d was assumed to be 0).

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Appendix B

Screening Benchmarks

Table B.1 Calculated Water Quality Standards Protective of Incidental Ingestion and Fish Consumption

Human Health COI	BCF[a] (L/kg-tissue)	Basis	MCL (mg/L)	RfD (mg/kg-day)	ADI[b] (mg/day)	Human Threshold Criteria		
						Water & Fish (mg/L)	Water Only (mg/L)	Fish Only (mg/L)
Arsenic	44	NRWQC (2002)	0.010	0.00030	0.020	0.022	2.0	0.023
Boron	1	(c)	NC	0.20	14	467	1,400	700
Lithium	1	(c)	NC	0.002	0.14	4.7	14	7.0

Notes:
ADI = Acceptable Daily Intake; BAF = Bioaccumulation Factor; BCF = Bioconcentration Factor; MCL = Maximum Contaminant Level; NC = No Criterion Available; NRWQC = National Recommended Water Quality Criteria; RfD = Reference Dose; US EPA = United States Environmental Protection Agency.

(a) BCFs from the following hierarchy of sources:
NRWQC (US EPA, 2002). National Recommended Water Quality Criteria: 2002. Human Health Criteria Calculation Matrix.
US EPA (2014). Human and Ecological Risk Assessment of Coal Combustion Residuals.
ORNL RAIS (ORNL, 2020). Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters.
(b) ADI based on the MCL is calculated as the MCL (mg/L) multiplied by a water ingestion rate of 2 L/day. In the absence of an MCL, the ADI was calculated as the RfD (mg/kg-day) multiplied by the body weight (70 kg).
(c) BCF of 1 was used as a conservative assumption, due to lack of published BCF.

Equations from IEPA (2019):

Consumption of Water and Fish

$$HTC = \frac{ADI}{W + (F \times BCF)}$$

Incidental Consumption of Water Only

$$HTC = \frac{ADI}{W}$$

Consumption of Fish Only

$$HTC = \frac{ADI}{F \times BCF}$$

Where:

Human Threshold Criteria (HTC)	Chemical-specific	mg/L
Acceptable Daily Intake (ADI)	Chemical-specific	mg/day
Fish Consumption Rate (F)	0.02	kg/day
Bioconcentration Factor (BCF)/ Bioaccumulation Factor (BAF)	Chemical-specific	L/kg-tissue
Water Consumption Rate (W)	0.01	L/day
Body Weight	70	kg
Target Cancer Risk (TCR)	1.0E-05	

Table B.2 Recreator Exposure to Sediment

COI	Relative Bioavailability (unitless)	Dermal Absorption Fraction (unitless)	Cancer: TRV: CSF $(mg/kg\text{-}day)^{-1}$	Cancer: TRV: Dermal CSF $(mg/kg\text{-}day)^{-1}$	Cancer: Child + Adult: Incidental Ingestion SL (mg/kg)	Cancer: Child + Adult: Dermal Contact SL (mg/kg)	Cancer SL (mg/kg)	Non-Cancer: TRV: RfD (mg/kg-day)	Non-Cancer: TRV: Dermal RfD (mg/kg-day)	Non-Cancer: Child: Incidental Ingestion SL (mg/kg)	Non-Cancer: Child: Dermal Contact SL (mg/kg)	Non-Cancer: Adult: Incidental Ingestion SL (mg/kg)	Non-Cancer: Adult: Dermal Contact SL (mg/kg)	Non-Cancer SL (mg/kg): Child	Non-Cancer SL (mg/kg): Adult	Recreator RSL Sediment (mg/kg)	Basis[a]
Total Metals																	
Arsenic	1	3.0E-02	1.5E+00	1.5E+00	8.1E+01	4.1E+02	6.8E+01	3.0E-04	3.0E-04	4.1E+02	4.4E+03	4.4E+03	8.0E+03	3.8E+02	2.8E+03	6.8E+01	c
Boron	1	NA	NC	NC	NC	NC	NC	2.0E-01	2.0E-01	2.7E+05	NA	2.9E+06	NA	2.7E+05	2.9E+06	2.7E+05	nc
Lithium	1	NA	NC	NC	NC	NC	NC	2.0E-03	2.0E-03	2.7E+03	NA	2.9E+04	NA	2.7E+03	2.9E+04	2.7E+03	nc

Notes:

COI = Constituent of Interest; CSF = Cancer Slope Factor; NC = No Criterion Available; RfD = Reference Dose; RSL = Regional Screening Level; SL = Screening Level; TRV = Toxicity Reference Value; US EPA = United States Environmental Protection Agency.

(a) Screening benchmark defined as the lower of the Screening Levels for cancer and non-cancer. The basis of the benchmark: c = based on cancer endpoint, nc = based on non-cancer endpoint.

Equations for Screening Benchmark and Screening Levels:

$$\text{Screening Benchmark} = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}}}$$

$$\text{Non-cancer } SL_{ing} = \frac{THQ * RfD}{Intake} \qquad \text{Cancer } SL_{ing} = \frac{TR}{Intake * CSF}$$

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * ABS} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * ABS * CSF}$$

Where:

Target Risk (TR)	1E-05	
Target Hazard Quotient (THQ)	1	
Reference Dose (RfD)	Chemical-specific	mg/kg-day
Dermal Absorption Fraction (ABS)	Chemical-specific	
Cancer Slope Factor (CSF)	Chemical-specific	mg/kg
Incidental Ingestions Screening Level (SL_{ing})	Chemical-specific	mg/kg
Dermal Contact Screening Level (SL_{derm})	Chemical-specific	mg/kg

Sediment – Ingestion (Chemical)

Intake Factor (IF) = $\frac{IR \times EF \times ED \times CF}{BW \times AT}$ =

		Non-Cancer: Child	Non-Cancer: Adult	Cancer: Child	Cancer: Adult	Basis
IF		7.3E-07	6.8E-08	6.3E-08	2.0E-08	
IR	Ingestion Rate (mg/day)	67	33	67	33	One-third of US EPA residential soil ingestion rate (Professional Judgment)
EF	Sediment Exposure Frequency (days/year)	60	60	60	60	2 days/week between April and October when air temperature >70°F (Professional Judgment)
ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2022b)
CF	Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2022b)
AT	Averaging Time (days)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2022b)

Sediment – Dermal Contact (Chemical)

Intake Factor (IF) = $\frac{SA \times AF \times EF \times ED \times CF}{BW \times AT}$ =

		Non-Cancer: Child	Non-Cancer: Adult	Cancer: Child	Cancer: Adult	Basis
IF		2.2E-06	1.2E-06	1.9E-07	3.6E-07	
SA	Surface Area Exposed to Sediment (cm^2/day)	1,026	3,026	1,026	3,026	Age weighted SA for lower legs and feet (US EPA, 2011b)
AF	Sediment Skin Adherence Factor (mg/cm^2)	0.2	0.2	0.2	0.2	Age weighted AF for children exposed to sediment (US EPA, 2011b)
EF	Sediment Exposure Frequency (days/year)	60	60	60	60	2 days/week between April and October when air temperature >70°F (Professional Judgment)
ED	Exposure Duration (years)	6	20	6	20	Default value for Resident (US EPA, 2022b)
CF	Conversion Factor (kg/mg)	0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)	15	80	15	80	Default value for Resident (US EPA, 2022b)
AT	Averaging Time (days)	2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2022b)

Appendix B

Supporting Information for the Closure Alternatives Analysis – Bottom Ash Pond at the Baldwin Power Plant

Prepared for

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CLOSURE ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT

BALDWIN POWER PLANT
BOTTOM ASH POND
(IEPA ID W1578510001-06)
Baldwin, Illinois

Prepared by

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DRAFT

May 25, 2023

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TABLES

1. INTRODUCTION AND BACKGROUND

Dynegy Midwest Generation, LLC (DMG) is the owner of the coal-fired Baldwin Power Plant (BPP) in Baldwin, Illinois. The BPP is currently active. DMG intends to complete closure of the Bottom Ash Pond (BAP) at the BPP (IEPA ID No. W1578510001-06, DMG CCR Unit ID 601, and National Inventory of Dams Number IL50721). Closure of the BAP will be performed under the relevant Illinois Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) [1] and the United States Environmental Protection Agency (USEPA) CCR Rule [2].

Part 845 requires a Closure Alternatives Analysis (CAA) to be completed, pursuant to the requirements of Section 854.710, to support the Closure Plan prepared pursuant to Section 845.720. The CAA for the BPP BAP will be performed by Gradient Corporation (Gradient). Geosyntec has prepared this Closure Alternatives Analysis Supporting Information Report (Report) to provide information requested by Gradient to support their preparation of the CAA.

1.1. Report Contents

The following information is contained within this report:

- **Section 1** includes the Introduction and Background;
- **Section 2** includes information related to closure-by-removal (CBR) including:
    - A feasibility evaluation of CBR using an onsite landfill (CBR-Onsite);
    - An evaluation of potential offsite landfills to receive the CCR for CBR-Offsite; and
    - A feasibility evaluation of CCR transportation for CBR-Offsite using over-the-road trucks, rail, and barges.
- **Section 3** includes an overview of construction activities that would occur for both CIP and CBR-Offsite;
- **Section 4** includes a project schedule for both CIP and CBR-Offsite; and
- **Section 5** includes estimates for construction material quantities, labor, vehicle miles, and equipment miles, for both CIP and CBR-Offsite.

2. CLOSURE-BY-REMOVAL INFORMATION

Section 845.710(c)(1) requires the evaluation of complete removal of CCR (e.g., CBR), and Section 845.710(c)(2) requires the CAA to identify if the Power Plant has a landfill that can accept the CCR, or if constructing an onsite landfill of sufficient capacity is feasible. Additionally, Section 845.710(c)(1) requires the evaluation of multiple modes of transportation of CCR, including rail, barge, and truck. This section includes evaluation of onsite landfill options, potential offsite landfills, and potential methods for transporting CCR to offsite landfills.

2.1. Evaluation of Onsite Landfill Options

2.1.1. Feasibility of New Onsite Landfill Construction

Areas inside the BPP Site boundaries were evaluated for suitable areas for the construction of a new onsite landfill for disposing of the approximately 3.8 million CY of CCR within the BAP. The Site was divided into multiple areas, Area 1 through Area 14, as shown in **Figure 1**. The potential feasibility of constructing a new landfill in each area is described below. Additionally, utility scale solar and battery energy storage facility are planned at the Site. Areas 1 through 5 are most likely to be impacted.

- Area 1 is approximately 141 acres in size and is located north of the BPP.
  - High voltage overhead electric runs diagonally from the northeast to the southwest corner and along the west side of Area 1.
  - The remaining area is intersected by multiple utility service right-of-ways (ROWs) for three high voltage electric lines leading to the switchyard at the BPP. These electric lines will likely remain in-service after the BPP is closed. Construction of a landfill in this area would likely require relocation of the utilities.
  - Therefore, small areas north to northwest (20 acres) and southeast (30 acres) of the utility service ROWs would not be large enough for construction of a landfill.
- Area 2 is approximately 160 acres in size and is located immediately east of the BPP, extending slightly south.
  - Area 2 contains two utility service ROWs, including high-voltage electric lines leading to the switchyard at the BPP. These utilities are assumed to be active and some are expected to remain active after electricity generation is ceased at BPP. Construction of a landfill in this area would likely require negotiations with the ROW holder and relocation of the utilities.
  - Approximately seven (7) acres of the northwest corner of Area 2 is within the 100-year floodplain of the Kaskaskia River.

- The west end of Area 2 was previously used for borrow soil.
- The southern portion of Area 2 may be used as borrow soil for the project.
- Therefore, there are no feasible locations for constructing a landfill within Area 2, due to borrow source plans and utility conflicts.

- Area 3 is approximately 77 acres in size and is located slightly southeast of the BPP.
  - Area 3 has been designated as borrow material for future construction activities at Baldwin and would need to be reserved for borrow soils for the construction of an onsite landfill.
  - Therefore, there are no feasible locations for constructing a landfill within Area 3, due to potential use as a borrow area.
- Area 4 is approximately 68 acres in size and is located immediately southeast of the BPP, directly south of Area 3.
  - Area 4 contains multiple utility service corridors and ROWs.
  - This area contains active farmland.
  - Therefore, there are no feasible locations for constructing a landfill within Area 4 due to conflicts with existing farmland and utility ROWs.
- Area 5 is approximately 112 acres and is located south of the BPP and immediately east of the BAP.
  - Existing infrastructure is situated in the northwest corner of Area 5.
  - Approximately 11 acres of the northeast corner of Area 5 is within the 100-year floodplain of the Kaskaskia River.
  - This area is intersected by the plant entrance road and other minor access routes.
  - This area is intersected by overhead power lines.
  - Therefore, there are no feasible locations for constructing a landfill within Area 5, due to the existing infrastructure.
- Area 6 is approximately 168 acres in size and is located immediately southwest of the Fly Ash Pond System (FAPS).
  - Area 6 is too narrow to contain the volume of CCR within the BAP.

- This area is intersected by multiple roadways that provide access around the BAP and to storage areas.
- This area is intersected by a railway in the southern portion and a railway along the eastern edge.
- Approximately eight (8) acres of the western portion of Area 6 is within the 100-year floodplain of the Kaskaskia River.
- Therefore, there are no feasible locations to construct a landfill in Area 6 due to size limitations and conflicts with existing infrastructure.

- Area 7 is approximately 230 acres in size and is located immediately south of the BAP.
  - Approximately 62 acres of the western portion of Area 7 is within the 100-year floodplain of the Kaskaskia River.
  - This area contains the closed FAPS and lagoon.
  - Therefore, there are no feasible locations for construction of a landfill within Area 7, due to the existing closure.
- Area 8 is approximately 177 acres in size and is located immediately south of the Cooling Pond.
  - Area 8 consists of the current BAP.
  - Approximately five (5) acres of the western portion of Area 8 is within the 100-year floodplain of the Kaskaskia River.
  - Therefore, there are no feasible locations for construction of a landfill within Area 8, due to the existing active BAP.
- Area 9 is approximately 103 acres in size and is located immediately west of the BAP.
  - Area 9 is being used as a borrow area and has limited capacity for a landfill.
  - Therefore, there are no feasible locations for a landfill within this area due to active and continued use of the area for borrow, as well as infeasible area for a landfill.
- Area 10 is approximately 88 acres in size and is located southwest of the BAP, between Areas 7 and 9.

  - Area 10 consists of the Secondary Pond and Tertiary Pond utilized as stormwater basin and discharge directly to NPDES Outfall 001. These ponds will be needed throughout construction.
  - Approximately 38 acres of Area 10 is within the 100-year floodplain of the Kaskaskia River.
  - Therefore, there are no feasible locations for construction of a landfill within Area 10, due to the floodplain and the existing stormwater basins.

- Area 11 is approximately 371 acres in size and is located immediately west of the Cooling Pond, extending to the north and south.
  - This area is a thin strip of land, running north to south along the west side of the Cooling Pond. It is too narrow to contain the volume of CCR within the BAP.
  - Approximately 104 acres of Area 11 is within the 100-year floodplain of the Kaskaskia River.
  - This area would be infeasible for a landfill, as it has insufficient storage capacity for CCR and part of it is within a floodplain

- Area 12 is approximately 2,052 acres in size and is located immediately north of the BAP.
  - Area 12 consists of the Cooling Pond, which is required to remain untouched. The Cooling Pond is leased to the Illinois Department of Natural Resources (IDNR) for public recreation. It is designated as a State Fish and Wildlife Area.
  - Approximately 1,387 acres of Area 12 are within the 100-year floodplain of the Kaskaskia River.
  - Therefore, there are no feasible locations for a landfill within this area due to the existing Cooling Pond.

- Area 13 is approximately 301 acres in size and is located immediately east of the southeast corner of the Cooling Pond.
  - This area contains the BPP and coal pile.
  - Approximately 44 acres of Area 13 is within the 100-year floodplain of the Kaskaskia River.
  - Remaining areas not occupied by structures, parking lots, or switchyards, are intersected by multiple utilities including no less than six high-voltage electric line

ROWs and one natural gas line ROW. Construction of a landfill would require negotiations with the ROW holders and relocation of the utilities.

  - Therefore, there are no feasible locations for a landfill within Area 13 due to existing infrastructure.

- Area 14 is approximately 42 acres in size and is located east of the Cooling Pond and north of Coal Pile.
  - The northern portion of Area 14 is intersected by high power overhead voltage.
  - Area 14 is too small of an area for CCR within the BAP.
  - Therefore, there are no feasible locations for constructing a landfill within Area 14, due to insufficient size to support a single landfill with adequate capacity to retain the volume of CCR within the BAP.

In summary, there are no feasible locations for constructing a landfill within the existing BPP Site boundary. Several locations have multiple conflicts related to potential 100-year floodplain impacts, current or former CCR surface impoundments, planned utility scale solar and battery energy storage facilities, existing utility corridors and Site roadways, planned future property uses, and/or DMG property boundaries. A landfill may be built on a 100-year floodplain; however, additional measures must be taken to meet flood insurance requirements.

2.2. Potential CBR-Offsite Receiving Landfills

Potential offsite landfills suitable for disposing of the approximately 3.8 million CY of CCR within and outside of the BAP were evaluated for landfills within Illinois and nearby Missouri, and Kentucky. Information on the landfills were obtained from IEPA's online Illinois Disposal Capacity Report [3], the Kentucky Energy and Environment Cabinet Solid Waste Branch's Annual Survey Report [4], and the Missouri Department of Natural Resources' Solid Waste Management Map [5].

Information on all landfills is provided in **Table 1** and the location of each evaluated landfill relative to the BPP is provided in **Figure 2.1 and Figure 2.2**.

2.2.1. Illinois Landfills

There are four landfills in Illinois that are currently accepting outside CCR and have the capacity needed for the closure. The two closest landfills, by road and rail miles, are the Cottonwood Hills Refuse Derived Fuel (RDF) Landfill and the North Milam Landfill, both owned by Waste Management Solutions. The most suitable option for transport by barge, based on proximity to the Site and nearby commercial or public barge terminals is also the North Milam Landfill. Two additional Landfills in Illinois that are currently accepting outside CCR, are the West End Disposal Facility and the Southern Illinois Regional Landfill.

- The Cottonwood Hills RDF Landfill, located in Marissa, Illinois, is located approximately 10 road miles and 13 rail miles from the Site and has 27,914,312 in-place CY of remaining capacity.

- The North Milam Landfill, located in East St. Louis, Illinois is located 44 road miles, 35 rail miles, and 80 river miles from the Site and has 10,167,052 in-place CY of remaining capacity.

- The West End Disposal Facility, located in Thompsonville, Illinois is located 49 road miles from the Site and has 12,059,699 in-place CY of remaining capacity.

- The Southern Illinois Regional Landfill, located in Desoto, Illinois is located 78 road miles from the Site and has 17,963,371 in-place CY of remaining capacity.

Out of the four landfills, the Cottonwood Hills RDF Landfill was selected as the preferred landfill because it is closer to the BPP at 10 one-way road miles versus more than 40 one-way road miles, thereby resulting in reduced hauling mileage. Each landfill is within approximately two miles of existing rail lines; however, none of the locations have an existing rail terminal capable of unloading CCR. These four landfills in Illinois were evaluated for potential use as receiving landfills for CBR-Offsite.

For evaluating the feasibility of barge transport of CCR (discussed in **Section 2.3.2**), landfills near navigable waterways and commercial or public port facilities were also evaluated. The North Milam Landfill in East St. Louis, Illinois was found to be nearest to a navigable river and an existing commercial bulk material handling terminal (Cahokia Marine Terminal), at approximately 6 miles by road from the Mississippi River and 80 miles by the Kaskaskia and Mississippi Rivers from the BPP. The North Milam Landfill has 10,167,052 CY of remaining permitted capacity, which is sufficient to dispose of the 3.8 million CY of CCR from the BAP.

2.2.2. Missouri Landfills

Landfills within Missouri were also evaluated at a cursory level; however, the closest landfill accepting outside CCR is approximately 126 miles from BPP (Lemons Landfill in Dexter, MO), versus 44 to 78 road miles for the evaluated landfills in Illinois. No landfills in Missouri were located near the Mississippi River. Therefore, the Missouri landfills were excluded from additional evaluation.

2.2.3. Kentucky Landfills

The closest landfill identified that accepts outside CCR is the West KY Landfill in Mayfield, Kentucky, which is 150 road miles from the Site. This landfill accepts CCR and has 5,013,470 CY of remaining permitted capacity, which is barely sufficient to accept the 3.8 million CY of CCR contained within and outside of the BAP. It is likely that the landfill will not want to use up their remaining capacity and therefore, the landfill was excluded from additional evaluation.

2.3. Potential CBR-Offsite Transportation Methods

Section 845.710(c)(1) requires CBR to consider multiple methods for transporting removed CCR, including using rail, barge, and trucks. An evaluation of each method is included within this section.

2.3.1. Transportation by Rail

The BPP currently has an established railroad line which borders the BPP, as well as two industrial service tracks branching off from the Site property. For CCR to be transported by rail, the railroad line would have to be modified to construct a spur/terminal and loading facility on the BAP side, which would increase the project schedule due to the need to coordinate with the railroad, complete design, permitting, and construction of the terminal. CCR would still need to be hauled by off-road haul trucks to the new onsite loading terminal and loaded into rail cars.

The Cottonwood Hills Landfill, located in Marissa, Illinois, is the closest landfill to the Site with capacity to accept CCR from the BAP and has nearby railways. However, a rail spur would need to be built for the unloading of CCR at this landfill.

While the Cottonwood Hills Landfill, North Milam Landfill, West End Disposal Facility, and Southern Illinois Regional Landfill are located within approximately five miles of existing rail lines, an existing terminal suitable for the unloading of CCR is not present near any of the landfills. A CCR unloading rail terminal would need to be constructed for the selected landfill which would increase the project schedule due to the need to acquire land for the terminal, coordinate with the railroad, complete design and permitting, and construct the terminal. Additionally, CCR would need to be hauled by truck from the new offsite unloading terminal to the landfill resulting in additional CCR handling and exposure to the surrounding environment near the offsite receiving landfill.

Furthermore, a direct rail route from the BPP to the West End Disposal Facility and the Southern Illinois Regional Landfill does not exist. Hauling CCR to the West End Disposal Facility or Southern Illinois Regional Landfill would involve approximately 84 and 92 miles, respectively, of hauling by rail on tracks owned by three separate rail lines (BNSF, Union Pacific Railroad [UP], and Canadian National Railways [CN]), as shown on **Figure 2.2**. A direct rail route from the BPP to the Cottonwood Hills RDF Landfill exists but would require a rail spur to be installed for unloading of CCR. The ability of CCR to be hauled over multiple lines and transferred from line to line is currently unknown.

Therefore, transporting CCR by rail is unlikely to be a viable option for the BPP BAP, due to the need to design, permit, and construct additional loading and unloading infrastructure, resulting in corresponding project schedule delays, and the distance and number of rail lines which the CCR would need to be transported over.

2.3.2. Transportation by Barge

2.3.2.1. CCR Loading at BPP

The BPP is located along the Kaskaskia River, a tributary of the Mississippi River. However, for CCR to be hauled by barge from the BPP, a new loading terminal would need to be constructed, thereby increasing the project schedule due to the need to complete design, permitting, and construction.

A barge terminal is located at the Kaskaskia Regional Port District Dock No. 2 (KRPD #2), which is located approximately four miles from the BPP. Use of this terminal would require negotiating an agreement with the terminal owner and/or operator. The terminal is currently being utilized to load CCR for another power producer in the vicinity; however, the amount of CCR being loaded onto barges is limited. The terminal will likely need to be modified to increase capacity to allow for multiple barges to be loaded simultaneously and to allow for stockpiling of CCR. This would require the design, permitting, and construction of improvements, thereby increasing the project schedule. CCR would still need to be hauled by truck to the loading terminal and unloaded, resulting in additional potential exposure to the surrounding environment.

Transporting CCR by truck will incur significant amounts of additional truck traffic on the public roads between the Site and the terminal (approximately 4 miles one-way) and would require 250,000 round trip truckloads on public roadways.

2.3.2.2. CCR Unloading Near Receiving Landfills

For evaluating the feasibility of barge transport of CCR, landfills near navigable waterways and commercial or public port facilities were also evaluated. The Cottonwood Hills Landfill, West End Disposal Facility, and Southern Illinois Regional Landfill are not located near a river, thereby making transporting CCR to any of them by barge infeasible. The North Milam Landfill is estimated to be the closest landfill to the Site accessible by river.

The North Milam Landfill is located approximately six (6) miles from an existing commercial bulk material handling terminal on the Mississippi River (Cahokia Marine Terminal) in East St. Louis, Illinois, which is approximately 80 miles by river from the BPP, as shown in **Figure 2.1**. To utilize the Cahokia Marine Terminal, an agreement would need to be negotiated with the terminal owner. It is unknown if this terminal is suitable for the unloading of CCR. If the terminal is not suitable, it would require design, permitting, and construction of improvements to allow CCR to be unloaded. Unloading and trucking of CCR at this location may also result in CCR exposure within an urban environment that is located within a community designated by the Illinois EPA to be an Environmental Justice Area [6]. Therefore, this landfill was not considered a feasible option for disposal of CCR and impacted soils within the BPP BAP.

Transporting CCR by barge would still require that CCR be hauled by truck from the unloading terminal to the landfill and unloaded, resulting in additional CCR handling and exposure to the surrounding environment and communities. Additionally, transporting CCR by truck will incur significant amounts of additional truck traffic on the public roads between the port and the chosen offsite landfill (approximately 6 miles one-way) would require 250,000 round trip truckloads on public roadways.

Therefore, transporting CCR by barge is unlikely to be a viable option for the BPP BAP, due to the need to design, permit, and construct additional loading and unloading infrastructure, resulting in corresponding project schedule delays. Additionally, the total truck loads for transportation to barge facilities would be twice as many, and the total hauling mileage would be the same, compared to transporting all of the CCR by truck to the closer Cottonwood Hills Landfill.

2.3.3. Transportation by Truck

The BPP borders Baldwin Road and intersects IL-18, IL-154, and IL-13, all of which are suitable for accommodating truck hauling traffic. The routes necessary to haul to the evaluated landfills are noted below:

- Cottonwood Hills RDF Landfill - Old Baldwin Road links the BPP to Risdon School Road, which intersects Risdon School Road. Risdon School Road links to Winter Road/State Route 49, which links Hillstown Road to the Cottonwood Hills RDF Landfill.

- West End Disposal Facility - IL-154 links the BPP to IL-148 which links to I-9 and IL-14. IL-14 becomes IL-34 in Benton, Illinois, which links the BPP to the West End Disposal Facility.

- Southern Illinois Regional Landfill - IL-154E links the BPP to State Route 4S which links to the Southern Illinois Regional Landfill.

- North Milam Landfill - Baldwin Road intersects IL-13W which links IL-15W and I-64W to Ohio Avenue. Ohio Avenue links BPP to the North Milam Landfill.

Potential travel routes between the BPP and: Cottonwood Hills RDF Landfill, North Milam Landfill, West End Disposal Facility, and the Southern Illinois Regional Landfill are provided in **Figure 2.1 and Figure 2.2**, respectively.

Transporting CCR by truck will not require the construction of additional loading or unloading infrastructure at either the receiving landfill or the BPP. CCR would be loaded into truck using heavy equipment at the BAP. CCR will then be unloaded at the receiving landfill by the truck directly. However, truck transportation may require upgrades or other infrastructure improvements to local roadways in order to accommodate increased traffic volumes (i.e., site entrances, signals, signage), both near BPP and near the receiving landfill. Because of ability to initiate trucking with installing a limited amount of new loading and unloading infrastructure at BPP and the receiving landfill relative to other options, transporting CCR by truck was considered to be a viable option for disposal of CCR and soils within the BPP BAP and was evaluated further, as discussed in **Section 4** and **Section 5**, below.

Transporting CCR by truck will result in significant amounts of additional truck traffic (250,000 loads) on the public roads between the Site and the offsite landfill (approximately 10 miles one-way). The rate of trucks entering or leaving the Site may be as rapid as approximately one truck every three minutes.

3. CLOSURE DESCRIPTION NARRATIVES

Section 845.720(a)(1)(A) requires narrative description of CCR impoundment closures to be prepared. Narrative descriptions have been prepared for both CIP and CBR-Offsite and are included within this section.

3.1. CIP

A narrative description of how the BAP will be closed in place is provided in **Section 2.1** of the BPP Closure Plan [7].

3.2. CBR-Offsite

A description of how CBR-Offsite alternative will be completed is as follows:

- The BAP will be unwatered by pumping free surface water to the nearby non-CCR secondary pond (non-CCR surface impoundment displayed in **Figure 1**) for ultimate discharge at NPDES Outfall 001.

- A temporary water management system will be constructed within the BAP, including ditches, sumps, and/or temporary stormwater detention basin(s). The system will maintain the BAP in an unwatered state by collecting contact stormwater during closure construction. Unwatering flows will be pumped to the ponding area behind the dam to be used as a settling pond, prior to being pumped to the non-CRR secondary pond for ultimate discharge at NPDES Outfall 001.

- CCR will be removed from the BAP using mass mechanical excavation techniques. Some of the CCR is expected to be saturated or nearly saturated, so mass excavation will include the use of dewatering trenches or other forms of passive dewatering (i.e., rim ditching or windrowing), as and if needed to lower the moisture content of the CCR via free liquid removal prior to handling. Free liquid is to be removed prior to loading onto trucks to facilitate acceptance at the offsite landfill. Dewatering flows will be pumped to the ponding area behind the dam for ultimate discharge at NPDES Outfall 001.

- The BAP bottom and side-slopes will be decontaminated by removing all visible CCR and an estimated depth of one foot of native soils beneath the CCR.

- CCR and excavated CCR-impacted native soils will be loaded into over-the-road dump trucks and hauled to the offsite receiving landfill. If the CCR is excessively dry prior to loading, it may be moisture-conditioned by spraying with water to reduce the potential for fugitive dust emissions at the barge unloading terminal and/or receiving landfill.

- Any observed CCR outside of the BAP boundary will also be excavated. An estimated depth of one foot of CCR-impacted native soils beneath the CCR will be excavated. Both the CCR and native soils will be disposed of in the offsite receiving landfill.

- Non-CCR within the existing BAP embankments will be excavated and used as backfill within the closure-by-removal footprint of the BAP to provide surface water drainage to the Outfall, as and if needed. Remaining portions of the perimeter dikes that are not utilized as borrow material will remain in-place.

- An embankment dam (BAP dam) is located southwest of the BAP. The dam will be notched, and post-closure stormwater flows from the BAP area through the dam will continue to flow to the Secondary Pond.

- Following excavation of the CCR from the consolidated area, the area will be graded to drain surface water. This area will be made to drain towards the notched dam and flow to the Secondary Pond.

- Disturbed areas will be restored by fertilizing and establishing vegetation. Vegetation will include upland species (e.g., grasses) in most areas, although species capable of growing in wet environments, and/or trees, and in the area of the BAP where CCR will be removed.

- Temporary stormwater best management practices (BMPs) such as erosion control blankets, straw wattles, detention basins, and/or check dams, will be used, as needed to reduce erosion during vegetation establishment.

- After vegetation is established, BMPs will be removed, and closure construction will be considered completed.

4. CONSTRUCTION SCHEDULES

Section 845.720(a)(1)(F) requires a schedule including all activities necessary to complete closure to be prepared. Schedules have been prepared for both CIP and CBR-Offsite and are included within this section. Schedules were prepared using estimates of task durations based on Geosyntec's experience, typical weather conditions at the site, likely production rates in CCR excavation and hauling based on site-specific considerations, and expected construction rates relative to estimated construction quantities.

4.1. CIP

The proposed closure completion schedule for CIP is provided in **Section 2.6** of the BPP Closure Plan [7].

4.2. CBR-Offsite

The proposed closure construction schedule for CBR-Offsite is provided in **Table 2**. The same schedule was utilized for transportation using trucks, as the construction duration is primarily based on daily production rates for onsite earthwork.

5. MATERIAL, QUANTITY, LABOR, AND MILEAGE ESTIMATES

Estimates of material quantities, total labor hours, and mileage were prepared for each alternative to support DMG in preparing the CAA. Estimates for CIP and CBR-Offsite using trucks were prepared utilizing the following approach:

- Major construction components and line-items were identified, in accordance with the narrative closure description (**Section 3**).
- Construction quantities were estimated based on volume estimates, area estimates, and proposed construction schedules (**Section 4**).
- For CIP, soil fill was assumed to come from an onsite borrow source located east of the BAP.
- RSMeans Heavy Construction Cost Data [8] (RS Means) was used to estimate the crew size, equipment description, and daily output associated with each line-item.
- For line-items where RSMeans data was not available, the crew size, equipment description, and daily output were estimated based on Geosyntec's experience, information from contractors, and/or information from material suppliers.
- Daily labor mobilization miles were estimated assuming an average one-way commute of 35 miles for each individual working onsite. The number of working days were estimated from the construction schedules (**Section 4**).
- Estimates of haul truck mileage were based on the assumed round-trip haul distance and dump truck size. All dump trucks were assumed to be filled to capacity.
- Estimates of material delivery miles were prepared based on Geosyntec's experience.

The detailed quantity, labor, and mileage estimates for CIP are provided in **Table 3** and **Table 4**, respectively. Similar information for CBR-Offsite with trucks is provided in **Table 5** and **Table 6**.

6. REFERENCES

[1] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Illinois Environmental Protection Agency, "Illinois Landfill Disposal Capacity Report," July 2022.

[4] Kentucky Energy and Environment Cabinet Solid Waste Branch, "Annual Survey Report," 2021.

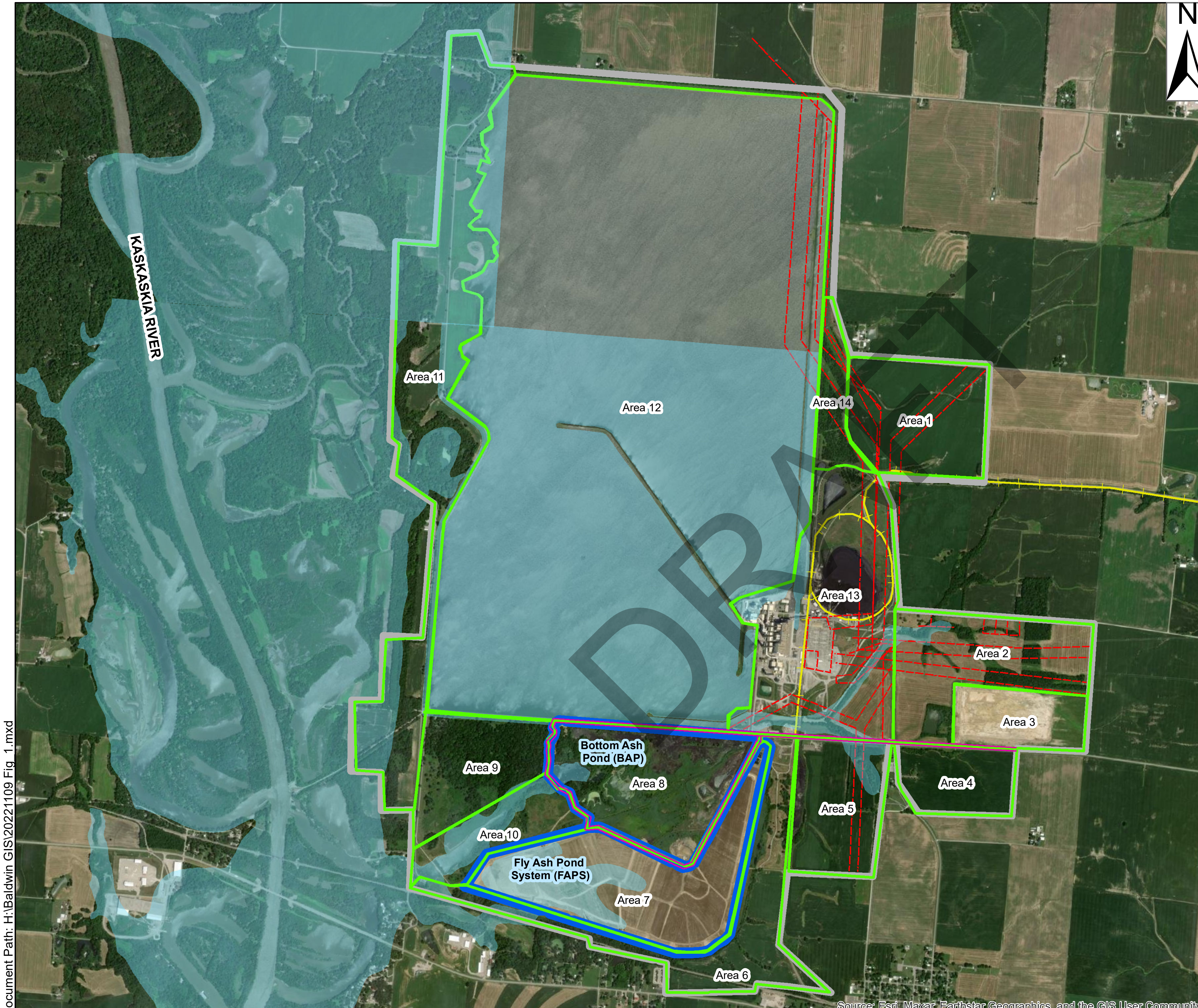
[5] Missouri Department of Natural Resources, "Missouri Solid Waste Management Map," [Online]. Available: https://modnr.maps.arcgis.com/apps/webappviewer/index.html?id=f261c6069e324f48a8cbc6ce74343f41. [Accessed 2022].

[6] Illinois Environmental Protection Agency, "Illinois EPA Environmental Justice Tracker," 2020. [Online]. Available: https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c. [Accessed 2022].

[7] Geosyntec Consultants, "Construction Permit Application, Baldwin Power Plant, Bottom Ash Pond," 2023.

[8] RSMeans, "Heavy Construction Costs with RSMeans Data," Gordian, 2022.

FIGURES



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Legend

- Onsite Transportation Route
- Potential Landfill Areas
- CCR Unit Boundary
- Appoximate Dynegy Midwest Generation Property Lines
- FEMA 100 Year Floodplain
- High Voltage Overhead Electric Line
- Baldwin Rail Spur

NOTES:
1. Property lines are approximate.
2. Private and public site utilities including, but not limited to, service electric lines, gas lines, hazardous liquid lines, water and sewer lines, telecommunication lines, plant utilities, and/or private utilities are not shown on this figure and shall be verified in the field prior to any site work.

The FEMA 100-year Flood Zone boundaries were taken from the FEMA FLood Map Service Center (https://msc.fema/gov/portal/home).

The prevailing wind direction was taken as the highest frequency by direction for the Sparta Community-Hunter Field Airport in Sparta, IL from windhistory.com

Prevailing Wind

DRAFT

0 1,000 2,000 4,000 Feet

Baldwin Power Plant

Dynegy Midwest Generation, LLC

Bottom Ash Pond Construction Permit Application

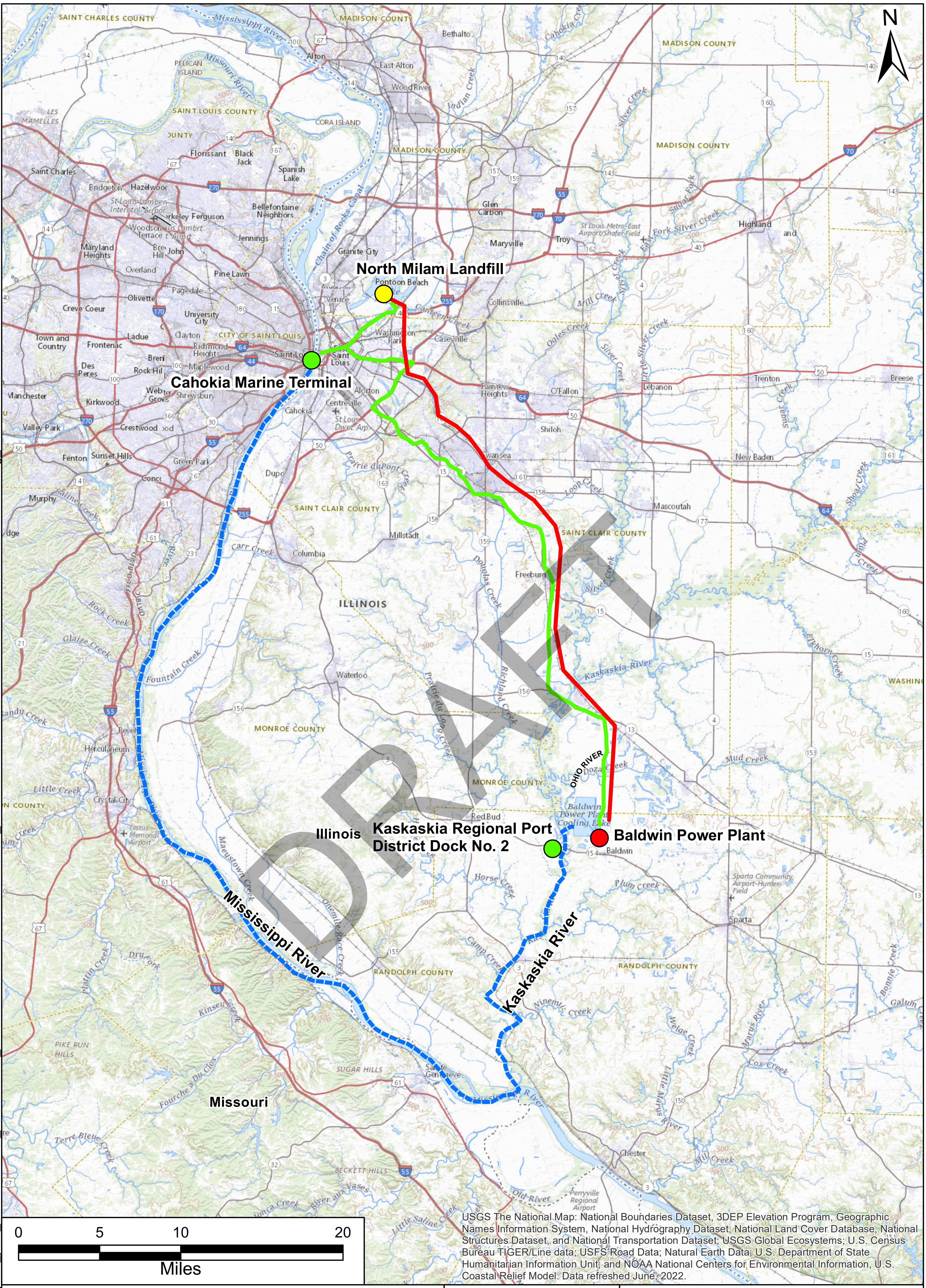
Site Location Map

GLP8050	MAY 2023

Geosyntec consultants

FIGURE 1

Document Path: H:\Baldwin GIS\20221109 Fig_1.mxd



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed June, 2022.

Legend

- Baldwin Power Plant
- Existing Barge Terminal
- Potential Offsite Landfill
- Potential Rail Haul Route
- Potential Truck Haul Route
- Potential Barge Haul Route

DRAFT

NOTES:
Some railroad right-of-ways no longer contain tracks. The potential rail haul route was selected to include right-of-ways with existing tracks, based on an evaluation of Google Earth imagery.

OFFSITE LANDFILL LOCATIONS AND TRANSPORTATION ROUTES

Geosyntec consultants

GLP8050	MAY 2023	FIGURE 2.1

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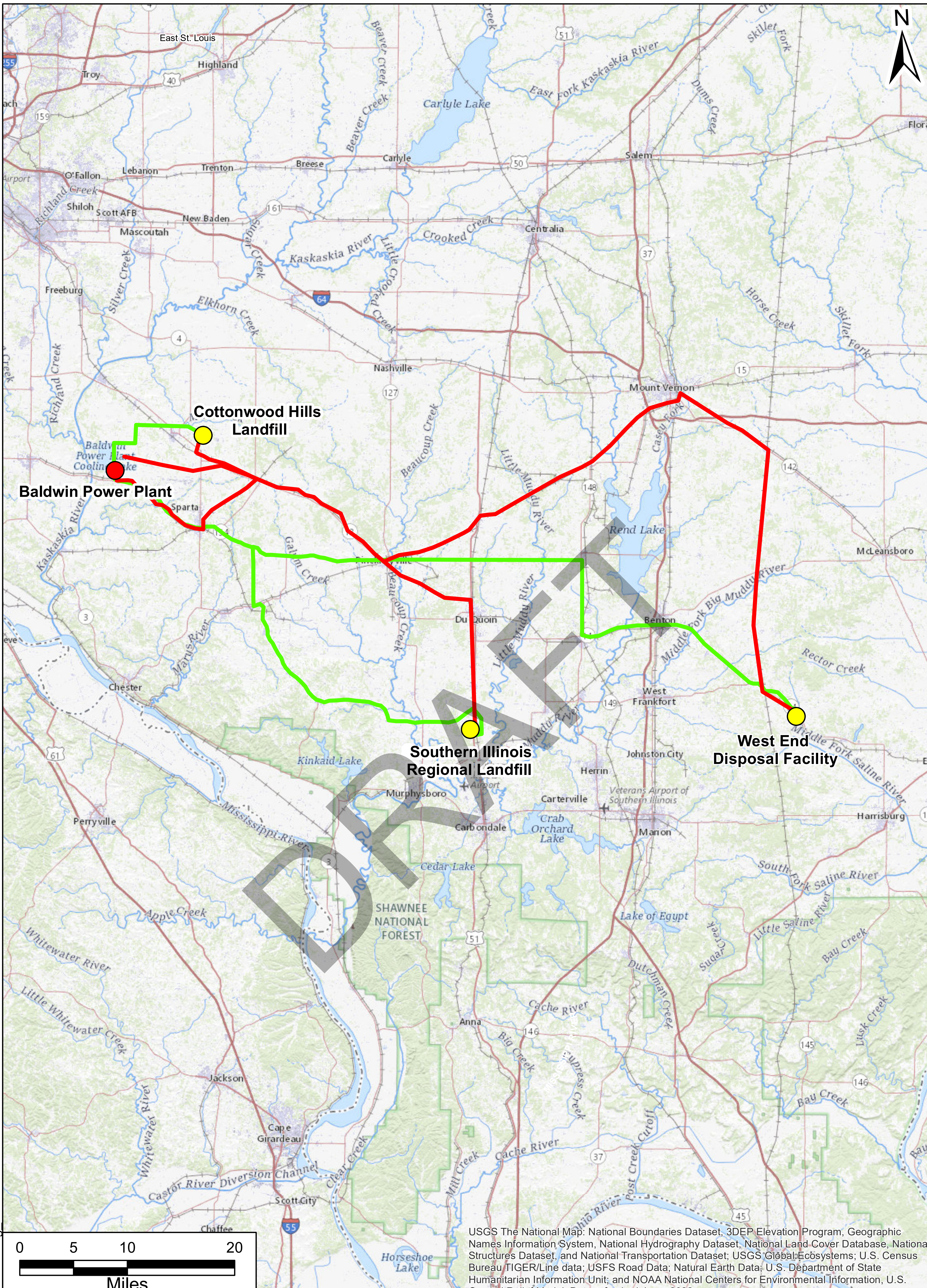

Legend

- Baldwin Power Plant
- Potential Offsite Landfill
- Potential Rail Haul Route
- Potential Truck Haul Route

DRAFT

NOTES:
Some railroad right-of-ways no longer contain tracks. The potential rail haul route was selected to include right-of-ways with existing tracks, based on an evaluation of Google Earth imagery.

OFFSITE LANDFILL LOCATIONS AND TRANSPORTATION ROUTES
SHEET 2 OF 2

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FIGURE 2.2

GLP8050

MAY 2023

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TABLES

Table 1: Offsite Landfill Information

Landfill Name	Owner	Location	One-Way Distance from Site (Miles)			Volume (in-place CY)	
			By Road	**By Rail**	**By Barge**	**2021 Five-Year Average Disposal** [3]	**Remaining Capacity Reported** [3], [4], [5]
Cottonwood Hills RDF	Waste Management Solutions	Marissa, IL	10	13	NE[3]	337,940	27,914,312
North Milam Landfill	Waste Management Solutions	East St. Louis, IL	44	35	80	2,375,868	10,167,052
Southern Illinois Regional Landfill, Inc.	Republic Services	DeSoto, IL	49	NE[4]	NE[3]	436,069	17,693,371
West End Disposal Facility	Waste Connections	Thompsonville, IL	78	NE[4]	NE[3]	139,833	12,059,699
Roxana Landfill LLC	Republic Services	Roxana, IL	54[1]	NE[1]	NE[1]	2,336,906	34,057,468 *(Does not accept outside CCR)*
Sioux Energy Center	AmerenUE	West Alton, MO	70[1]	NE[1]	NE[3]	Not Reported	15,035,276 *(Does not accept outside CCR)*
Lemons Landfill[2]	Republic Services	Dexter, MO	126	NE[4]	NE[3]	Not Reported	4,808,738
Waste Path Sanitary Landfill, LLC	Waste Path Sanitary Landfill, LLC.	Calvert City, KY	143[1]	NE[1]	NE[1]	Not Reported	572,049 *(Does not accept outside CCR)*
West KY Landfill	Jones Sanitation, LLC.	Mayfield, KY	150[2]	NE[2]	NE[2]	Not Reported	5,013,470

Notes:
[1]Not Evaluated due to not accepting outside CCR.
[2]Not Evaluated due to insufficient disposal capacity.
[3]Not Evaluated due to infeasible distance from river.
[4]Not Evaluated due to closer options by rail.

Table 2: Construction Schedule – CBR-Offsite

Milestone	Timeframe (Preliminary Estimates)
Agency Coordination, Approvals, and Permitting • Obtain state permits, as needed, for dewatering, water discharge, land disturbance, wetlands modifications, stream restoration, and dam modifications	6 to 12 months after Final Closure Plan Approval
Final Design and Bid Process • Complete final design of the closure and select a construction contractor.	12 to 16 months after Agency Coordination, Approvals, and Permitting

Dewater and Excavate CCR, Decontaminate CCR Unit
• Complete contractor mobilization, installation of stormwater BMPs, and unwatering of the BAP.
• Complete mass excavation of CCR and decontamination of the BAP.
    • It is assumed that no work will be performed for 17 weeks of each year due to holidays, weather, winter shutdowns, etc.
    • Haul CCR to offsite receiving landfill[1].
	86 to 127 months after necessary permits are issued[1]

Site Restoration • Seed and stabilize the BAP. • Complete contractor demobilization.	3 to 6 months after backfilling is complete
Timeframe to Complete Closure	9 to 13 years

Note: [1]This schedule assumes that CCR hauling to the offsite landfill may occur during weather delays that preclude excavation but do not preclude hauling.

Table 3 - Material Quantity - CIP (1 of 2)

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QUANTITY, LABOR, AND EQUIPMENT HOURS ESTIMATE
DYNEGY MIDWEST GENERATION, LLC - BALDWIN POWER PLANT
CONSOLIDATE AND CAP-IN-PLACE OF BOTTOM ASH POND

ITEM NO.	PRE-CONSTRUCTION	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Mobilization and De-Mobilization	LS	1	-	-	-	-	Percentage based on experience
	PRE-CONSTRUCTION ESTIMATED SUBTOTAL							
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Clear Vegetation	Acre	95	-	-	4,369	3,831	Removal of dense vegetation and trees.
	Unit Costs							
	Clear Trees	Acre	24	B7	0.7	1,614	1,076	311110100200: Clear and Grub Site, cut and ship medium trees to 12" diameter. Assume 25% of the clearing area.
	Heavy Vegetation	MSF	3,100	B84	9	2,756	2,756	320190191680: Mowing, mowing brush, tractor with rotary mower, heavy density.
3	Construction Soil Erosion & Sediment Controls	LS	1	-	-	1,218	209	Installation of silt fence, rock check dams, and straw wattles for temporary soil erosion and sediment control during construction.
	Unit Costs							
	Silt Fence	LF	7,000	B62	650	258	86	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high. Quantity assumes approximately 65 percent of the perimeter will require silt fencing.
	Rock Check Dams	EA	20	Sump Install	2	160	80	313713100100: Riprap, riprap and rock lining, random, broken stone, machine placed for slope protection. Crew altered based on experience. Unit rate increased by our experience with similar closure projects in IL. Assume 20 check dams constructed with 2 CY per check dam.
	Straw Wattles	LF	5,300	A2	1000	127	42	312514160705: Compost or Mulch Filter Sock, 9". Quantity assumed 1/acre (based on experience) for entire disturbed area and each being 30 ft long.
	Maintenance	MO - in use	42	2 Clab	1	672	0	Unit rate, Crew, and Daily Output based on experience.
4	Construction Facilities	MO - in use	42	-	-	-	-	Includes monthly costs associated with two office trailers, 5 storage trailers, and 8 portable toilets.
	Unit Costs							
	Office Trailer (x2)	MO - in use	42	-	-	-	-	015213200350: Office trailer, furnished, no hookups, 32' x 8', rent per month.
	Storage Trailers (x5)	MO - in use	42	-	-	-	-	015213201350: Storage boxes, 40' x 8', rent per month.
	Portable Toilet (x8)	MO - in use	42	-	-	-	-	015433406410: Rent toilet, portable chemical.
5	Extend or Lower Piezometers and Monitoring Wells	EA	10	2 Clab	4	40	0	Unit rate, Crew, and Daily Output based on experience.
6	Dust Control	DAY	245	B59	1	1,960	1,960	312323202510: Dust control, heavy; utlizing truck tractor and water tank trailer per RSMeans Crew B59. Quantity is assumed to be half of working days will need dust control. Daily Output assumed to 1, based on experience.
7	Haul Road Maintenance	DAY	98	B86A	1	784	784	312323202600: Haul road maintenance Quantity is assumed to be 1 day/week.
	SITE PREPARATION ESTIMATED SUBTOTAL					**8,370**	**6,780**	
ITEM NO.	**FREE LIQUIDS REMOVAL, UNWATERING, AND STORMWATER MANAGEMENT**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
8	Dewatering, Unwatering, and Stormwater Management for the Bottom Ash Pond	DAY	670	B10K	4	2,010	1,340	312319201100: Dewatering, pumping 8 hours, attended 2 hours per day, 6" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose. 312319201120: Add per additional pump - 3 additional pumps added. Quantity assumes 6 months of pumping prior to excavation and average of 3 days/week during construction.
	Unit Costs							
	Additional HDPE Piping	LF	4,900	-	-	-	-	221113780098: Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 10" diameter, DR11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting, or digging equipment.
9	Dewatering Sumps Installation	EA - in place	42	Sump Install	4	168	84	Unit Rate, Crew, and Daily Output based on experience. Materials include 24" corrugated HDPE pipe with geotextile wrapping, and 1 C.Y. of gravel backfill.
10	Excavate Process Flow Ditch	CY - in place	6,000	-	-	78	73	Assume 4,200 feet ditch excavated to be 3 feet deep, 10 feet wide with 3H:1V side slopes from the process inflow to the bottom ash pond dam.
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	6,600	B14B	5000	16	11	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling and Dumping Onsite of Material for Moisture Conditioning	CY - as excavated	6,600	B34G	850	62	62	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 1 mile. Unit rate and daily output extrapolated down to 10 min wait.
	DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT ESTIMATED SUBTOTAL					**2,300**	**1,500**	
ITEM NO.	**BOTTOM ASH POND CLOSURE**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
11	Demolish and Dispose of Facilities at the Pump Station and Sluice Pipes	LS	1	B14B	0.05	240	160	Unit rate, Crew, and Daily Output based on experience.
12	Excavation and Placement of CCR + 1 ft overdig within Consolidation Area	CY - in place	1,523,000	-	-	34,773	28,417	Quantity based on surface to surface calculation performed in AutoCAD.
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	1,668,700	B14B	5000	4,005	2,670	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated).
	Pushing Material to Excavator	CY - as excavated	834,350	B10B	5000	2,002	1,335	312323170020: Spread dumped material, no compaction, by dozer. Dozer support for excavation. Daily output edited to match excavation based on experience.
	Hauling and Dumping within BAP for Moisture Conditioning	CY - as excavated	1,668,700	B34G	850	15,705	15,705	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 1 mile. Unit rate and daily output extrapolated down to 10 min wait.
	Spreading/ Drying Moisture Conditioning	CY - as excavated	837,650	B10B	5000	2,010	1,340	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience. Quantity assumes 50% of volume requires moisture conditioning.
	Spreading Lifts	CY - as excavated	1,675,300	B10B	5000	4,021	2,680	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Compaction of Material	CY - in place	1,523,000	B10F	2600	7,029	4,686	312323235060: Compaction; Riding, vibrating roller, 12" lifts, 2 passes. RSMeans Crew is B10Y; altered to B10F based on experience. RSMeans unit rate halved for 24" lifts.
13	Notch the Dam and Movement of Fill for Regrading/Drainage	CY - in place	35,100	-	-	1,659	1,104	Excavation of dam fill and placement in CBR BAP for positive drainage to the notched dam.
	Unit Costs							
	Excavation and Loading of Material from Onsite Source	CY - as excavated	38,610	B14B	5000	93	62	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling of Material	CY - as excavated	38,610	B34G	714	433	433	312323206180: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 2 mile.
	Spreading of Material	CY - as excavated	38,610	B10B	5000	93	62	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Finish Grading of Material	SY	488,840	B11L	8900	879	439	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
	Compaction of Material	CY - in place	35,100	B10F	2600	162	108	312323235100: Compaction; Riding, vibrating roller, 12" lifts, 4 passes (RSMeans Crew is B10Y; altered to B10F based on experience)
14	Construct Geosynthetic Cover	SF - in place	3,701,000	-	-	5,778	340	Install geomembrane and geotextile cushion.
	Unit Costs							
	Geomembrane	SF - in place	3,701,000	B63B	87120	5,098	340	310519531200: Pond membrane lining systems HDPE, 100,000 S.F. or more, 60 mil thick, per S.F. Unit rate muliplied by 0.4 based on experience and likely use of 40mil geomembrane. Daily output edited based on experience.
	Geocomposite Drainage Layer	SF - in place	1,263,000	2 Clab	87120	232	0	Drainage layer for the perimeter slope areas. Unit rate based on experince with similar projects.
	Geotextile	SF - in place	2,438,000	2 Clab	87120	448	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength. Daily output edited based on experience.
15	Install Anchor Trench	LF	8,000	-	-	2,276	460	Install anchor trench for anchoring geosynthetics.
	Unit Costs							
	Excavation of Material	CY - as excavated	2,800	B11C	150	299	149	312316130050: Excavating, Trench or continuous footing, common earth with no sheeting or dewatering included, 1' to 4' deep, 3/8 C.Y. excavator
	Geomembrane	SF - in place	32,000	B63B	2500	1,536	102	310519531200: Pond membrane lining systems HDPE, 100,000 S.F. or more, 60 mil thick, per S.F. Unit rate muliplied by 0.4 based on experience and likely use of 40mil geomembrane. Daily output edited based on experience.
	Geotextile	SF - in place	32,000	2 Clab	2500	205	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength.
	Backfilling Material	CY - as excavated	2,800	B10R	400	84	56	312316133020: Backfill trench, F.E. Loader, wheel mtd., 1 C.Y. bucket, minimal haul
	Compacting Material	CY - in place	2,667	A1D	140	152	152	312323237040: Compaction, walk behind, vibrating plate 18" wide, 6" lifts, 4 passes
16	Placement of Onsite Protective Cover Soil	CY - in place	243,000	-	-	4,278	3,850	Place 18 inches of cover soil over geotextile cushion. Material assumed to come from onsite borrow/clean existing dike fill.
	Unit Costs							
	Excavation and Loading of Material from Onsite Source	CY - as excavated	267,300	B14B	5000	642	428	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling of Material	CY - as excavated	267,300	B34G	714	2,995	2,995	312323206180: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 2 mile.
	Spreading of Material for Regrading /Drainage	CY - as excavated	267,300	B10B	5000	642	428	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
17	Placement of Onsite Vegetative Soil	CY - in place	68,500	-	-	1,206	1,085	Place 6 inches of vegetative soil. Material assumed to come from onsite borrow.
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	75,350	B14B	5000	181	121	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling of Material	CY - as excavated	75,350	B34G	714	844	844	312323206180: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 2 mile.
	Spreading of Material	CY - as excavated	75,350	B10B	5000	181	121	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	BOTTOM ASH POND CLOSURE ESTIMATED SUBTOTAL					**50,200**	**35,400**	

Table 3 - Material Quantity - CIP (2 of 2)

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ITEM NO.	SITE RESTORATION	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
18	Establish Access Roads	LF	5,500	-	-	150	140	Construct gravel access roads on top of the final cover. Assumed to extend around entire cover perimeter.
	Unit Costs							
	Purchasing of Material	TON	2,751	-	-	-	-	Unit Rate provided by local supplier. Quantity assumes material is 125 pcf.
	Hauling of Material	CY	1,630	B34C	116	112	112	312323203070: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y.truck, 15 min wait/ld/uld., 35 MPH, cycle 30 miles
	Spreading and Compacting Material	SY	4,890	B32	4200	37	28	321123230400: Base course drainage layers, aggregate base course for roadways and large paved areas, bank run gravel, spread and compacted, 12" deep
19	Install Stormwater Letdowns	SF - in place	153,600	-	-	4,432	2,161	Install rip rap and geotextile in all stormwater letdowns for erosion protection. Each letdown assumed to be 5 ft wide, 2 ft deep with 3H:1V side slopes.
	Unit Costs							
	Purchase of Material	TON	12,672	-	-	-	-	Riprap rate provided by local supplier. Avg unit price for 150-400 lb riprap without hauling used. Quantity assumes material is 110 pcf.
	Hauling of Material	TON	12,672	B34C	116	874	874	Used cost est. provided by Columbia Quarry Company in Waterloo 10.26.22.
	Geotextile Placement	SF - in place	153,600	2 Clab	2500	983	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength.
	Rip Rap Placement	CY - in place	8,530	B12S	53	2,575	1,288	313713100200: Rip-rap and rock lining, random, broken stone, 18" minimum thickness, machine placed. Used bare labor estimate (50.51 per SY) and bare equipment estimate (44.79 per SY) for placing rip rap.
20	Install Stormwater Perimeter Ditch	SF - in place	310,000	-	-	4,157	1,968	Install rip rap and geotextile in all stormwater chutes for erosion protection. Each chute assumed to be 100 ft long and 20 ft wide.
	Unit Costs							
	Purchase of Material	TON	25,575	-	-	-	-	Riprap rate provided by local supplier. Avg unit price for 150-400 lb riprap without hauling used. Quantity assumes material is 110 pcf.
	Hauling of Material	TON	25,575	B34C	116	1,764	1,764	Used cost est. provided by Columbia Quarry Company in Waterloo 10.26.22. Previous model used a per CY cost: 312323203070: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y.truck, 15 min wait/ld/uld., 35 MPH, cycle 30 miles
	Geotextile Placement	SF - in place	310,000	2 Clab	2500	1,984	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength.
	Rip Rap Placement	CY - in place	25,575	B12S	1000	409	205	313713100200: Rip-rap and rock lining, random, broken sotn, 18" minimum thickness, machine placed. Used bare labor estimate (50.51 per SY) and bare equipment estimate (44.79 per SY) for placing rip rap.
21	Placement of Erosion Control Blankets (ECBs)	SF - in place	1,263,000	ECB	22500	1,347	449	Unit rate and Crew based on experience. Daily Output based on 312514160100: Rolled erosion control mats and blankets, plastic netting, stapled, 2" x 1" mesh, 20 mil. Quantity assumed to be 10% of disturbed area and unit rate multiplied by 0.5 based on experience.
22	Seed, Mulch, and Maintain Vegetated Surfaces	AC	177	-	-	1,870	1,870	Includes soil ammendments, upland seeding, and wetland planting for all disturbed areas.
	Unit Costs							
	Lime	MSF	7,700	B66	700	88	88	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader. Unit multiplied by 1.1 to account for soils possibly being void of nutrients.
	Fertilizer	MSF	7,700	B66	700	88	88	329113234150: Soil preparation, tructural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader. Unit multiplied by 1.1 to account for soils possibly being void of nutrients.
	Wetland Mix	MSF	900	B66	26	277	277	Unit rate, daily output, crew based on experience. Quantity assumes 20 acres of disturbed area.
	Grassland Mix	MSF	5,900	B66	52	908	908	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader. Quanity all disturbed areas minus wetland area, pollinator area, and 30 acres of ponds in BAP area.
	Pollinator Mix	MSF	900	B66	26	277	277	Unit rate, daily output, crew based on experience. Quantity assumes 20 acres of distubed area.
	Mulch	MSF	7,700	B65	530	232	232	329113160350: Mulching, Hay, 1" deep, power mulcher, large
	SITE RESTORATION ESTIMATED SUBTOTAL					**11,960**	**6,590**	

ITEM NO.	ENGINEERING AND CONSTRUCTION SUPPORT TASKS	Units	Quantity	Crew	Output	Labor Hours	Equipment Hours	Notes
23	Final Closure Design and Bid Support	LS	1	-	-	-	-	Unit Rate based on experience.
24	Engineering Support and CQA During Construction	LS	1	Eng	60 hrs/week	5,880	1,960	Unit Rate, Crew, and Output based on experience.
	ENGINEERING AND PERMITTING ESTIMATED SUBTOTAL					**5,880**	**1,960**	

NOTES:
1. LS = Lump Sum, AC = Acre, LF = Linear Foot, EA = Each, SY = Square Yard, MO = Month, YR = Year, CY = Cubic Yard, MSF = Thousand Sqaure Feet
2. RS Means refers to the 2022 online edition of RS Means Commercial New Construction. All unit rates refer to standard union labor in Carbondale, IL.
3. See schedule (Table 2) for assumptions regarding schedule for time unit quantities.

Table 4 - Labor, Equipment, and Mileage Estimate - CIP (1 of 2)

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Crew	Labor	Daily Labor Hours	Equipment	Daily Equipment Hours	Project Total Labor Hours	Project Total Equipment Hours
B84	Operator x1	8	Rotary Mower/Tractor	8	2,756	2,756
B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	258	86
B59	Truck Driver x1	8	Truck Tractor, 220 H.P. Water Tank Trailer, 5000 Gal	8	1,960	1,960
B86A	Operator x1	8	Grader, 30,000 lbs	8	784	784
B10K	Operator x1 Laborer x0.5	12	Centr. Water Pump, 6"	8	2,010	1,340
B14B	Operator x1 Laborer x0.5	12	Hyd. Excavator, 6 C.Y.	8	5,176	3,450
B10L	Operator x1 Laborer x0.6	12	Dozer, 80 H.P.	8	Not Used	Not Used
B21	Labor Foreman x 1 Skilled Worker x 1 Laborer x 1 Operator (crane) 0.5	28	S.P. Crane, 4x4, 5 ton	4	Not Used	Not Used
B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	8,949	5,966
B12F	Operator (crane) x 1 Laborer x 1	16	Hyd. Excavator, 0.75 C.Y.	8	Not Used	Not Used
B6	Laborer x 2 Operator (light) x 1	24	Backhoe Loader, 48 H.P.	8	Not Used	Not Used
A1D	Laborer x 1	8	Vibrating Plate, Gas, 18"	8	152	152
B10T	Laborer x 0.5 Operator (med.) x1	12	F.E. Loader W.M. 2.5 C.Y.	8	Not Used	Not Used
B10R	Laborer x 0.5 Operator (med) x 1	12	F.E. Loader W.M., 1 C.Y.	8	84	56
B63B	Labor Foreman x1 Laborer x2 Operator (light) x1 Geosynthetics Laborer x11	120	Loader, Skid Steer, 78 H.P.	8	6,634	442
B32	Laborer x1 Operator (med) x3	32	Grader, 30,000 lbs Tandem Roller, 10 ton Dozer, 200 H.P.	24	37	28
2 Clab	Laborer x2	16	None	0	4,564	0
B12S	Equip. Oper. (crane) x 1 Laborer x 1	16	Hyd. Excavator, 2.5 C.Y.	8	2,984	1,492
A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	127	42
B66	Operator (light) x1	8	Loader-Backhoe, 40 H.P.	8	1,638	1,638
B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) Flatbed Truck, Gas, 1.5 ton	16	232	232
A1F	Laborer x 1	8	Rammer/Tamper, Gas, 8"	8	Not Used	Not Used
B11C	Laborer x1 Operator (med) x1	16	Backhoe Loader, 48 H.P.	8	299	149
B13K	Operators (crane) x 2	16	Hyd. Excavator, .75 C.Y. x 2 Hyd. Hammer, 4000 ft-lb	16	Not Used	Not Used
B34G	Truck Driver x1	8	Dump Truck, Off Hwy., 50 ton	8	20,039	20,039
ECB	Laborer x3	24	Tractor	8	1,347	449
Hopper	Operator x1	8	Hyd. Excavator, 3.5 C.Y.	8	Not Used	Not Used
Sump Install	Laborer x1 Operator x1	16	Hyd. Excavator, 4.5 C.Y.	8	328	164
Trench	Laborer x3 Operator x2	40	Front End Loader, 10 C.Y. Dewind Machine 1000 H.P.	16	Not Used	Not Used
Grout/Concrete	Laborer x2 Truck Driver x1	24	Concrete Truck	8	Not Used	Not Used
Eng	Engineering Staff x1.2	10	Side by Side x1	4	5,880	1,960
B10F	Operator (med) x1 Laborer x0.5	12	Tandem Roller, 10, Ton	8	7,191	4,794
B10I	Operator (med) x1 Laborer x0.5	12	Diaphragm Water Pump, 4"	8	Not Used	Not Used
B34C	Truck Driver (heavy) x 1	8	Truck Tractor, 6x4, 380 H.P. x 1 Dump Trailer, 16.5 CY x 1	8	2,750	2,750
Pipe Liner	Laborer x 4 Operator x 1	40	Hyd. Excavator, 3.5 C.Y. Grouting Pump	16	Not Used	Not Used
B11L	Operator (med.) x 1 Laborer x 1	16	Grader, 30,000 lbs	8	879	439
B10W	Operator (med.) x 1 Laborer x 0.5	12	Dozer, 105 H.P.	8	Not Used	Not Used
B7	Laborer x 5 Operator (med) x 1	48	Brush Chipper, 12", 130 H.P Crawler Loader, 3 C.Y. Chain Saws, Gas, 36" Long x 2	32	1,614	1,076
B45	Operator (med) x1 Truck Driver(heavy) x 1	16	Tanker, 3000 gal Truck Tractor, 6x4, 380 H.P.	8	Not Used	Not Used
Note: Blue crew names were created by Geosyntec based on experience (not pulled from RSMeans).				**Totals**	78,700	52,200

Table 4 - Labor, Equipment, and Mileage Estimate - CIP (2 of 2)

Geosyntec consultants

Item	Quantity	Assumptions
Labor Total Hours	78,700	Per projected subtotal in cost estimate (Does not include contingency)
Duration of Onsite Construction in Days	490	Per Construction Schedule
Average Daily Crew Size	28	10 hour days (5 days per week)
Daily Labor Mobilization Miles	960,400	Average of 70 miles round trip per day
Vehicles Miles Onsite	23,177	1 mile round trip from gate to parking 5 miles per day for 2 CQA techs and Construction Supervisor 10% Contingency for site visitors (client and engineering support)
Equipment Mobilization Miles - Unloaded	29,400	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	29,400	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Daily Equipment Miles Onsite	629,160	Average of 21 of 28 crew members running equipment Assume 60 miles per piece of equipment 40 miles per day used for water truck 20 miles per day used for grader
Onsite Haul Truck Miles - Unloaded	25,108	34 CY Off Road Dump Truck 1 mile round trip per load
Onsite Haul Truck Miles - Loaded	25,108	34 CY Off Road Dump Truck 1 mile round trip per load
Offsite Haul Truck Miles - Unloaded	20,767	16.5 CY Dump Truck 2 mi cycle for imported materials
Offsite Haul Truck Miles - Loaded	20,767	16.5 CY Dump Truck 2 mi cycle for imported materials
Material Delivery Miles - Unloaded	25,000	100 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 250 miles away average
Material Delivery Miles - Loaded	25,000	100 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 250 miles away average

Table 5 - Material Quantity - CBR-Offsite-Truck Transportation

Geosyntec consultants

QUANTITY, LABOR, AND EQUIPMENT HOURS ESTIMATE
DYNEGY MIDWEST GENERATION, LLC - BALDWIN POWER PLANT
CLOSURE-BY-REMOVAL OF BOTTOM ASH POND

ITEM NO.	PRE-CONSTRUCTION	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Mobilization and De-Mobilization	LS	1	-	-	-	-	Percentage based on experience
	PRE-CONSTRUCTION ESTIMATED SUBTOTAL							
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Clear Vegetation	Acre	95	-	-	4,369	3,831	Removal of dense vegetation and trees.
	Unit Costs							
	Clear Trees	Acre	24	B7	0.7	1,614	1,076	311110100200: Clear and Grub Site, cut and ship medium trees to 12"diameter. Assume 25% of the clearing area.
	Heavy Vegetation	MSF	3,100	B84	9	2,756	2,756	320190191680: Mowing, mowing brush, tractor with rotary mower, heavy density.
3	Construction Soil Erosion & Sediment Controls	-	-	-	-	546	209	Installation of silt fence, rock check dams, and straw wattles for temporary soil erosion and sediment control during construction.
	Unit Costs							
	Silt Fence	LF	7,000	B62	650	258	86	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high. Quantity assumes approximately 65 percent of the perimeter will require silt fencing.
	Rock Check Dams	EA	20	Sump Install	2	160	80	313713100100: Riprap, riprap and rock lining, random, broken stone, machine placed for slope protection. Crew altered based on experience. Unit rate increased by our experience with similar closure projects in IL. Assume 20 check dams constructed with 2 CY per check dam.
	Straw Wattles	LF	5,300	A2	1000	127	42	312514160705: Compost or Mulch Filter Sock, 9". Quantity assumed 1/acre (based on experience) for entire disturbed area and each being 30 ft long.
4	Construction Facilities	MO - in use	137	-	-	-	-	Includes monthly costs associated with three office trailers, 10 storage trailers, and 8 portable toilets.
	Unit Costs							
	Office Trailer (x3)	MO - in use	137	-	-	-	-	015213200350: Office trailer, furnished, no hookups, 32' x 8', rent per month.
	Storage Trailers (x10)	MO - in use	137	-	-	-	-	015213201350: Storage boxes, 40' x 8', rent per month.
	Portable Toilet (x8)	MO - in use	137	-	-	-	-	015433406410: Rent toilet, portable chemical.
5	Abandonment of Piezometers and Monitoring Wells	EA	10	Grout/Concrete	4	60	20	Unit rate, Crew, and Daily Output based on experience.
6	Dust Control	DAY	935	B59	1	7,480	7,480	312323202510: Dust control, heavy; utlizing truck tractor and water tank trailer per RSMeans Crew B59. Quantity is assumed to be half of working days will need dust control. Daily Output assumed to 1, based on experience.
7	Haul Road Maintenance	DAY	374	B86A	1	2,992	2,992	312323202600: Haul road maintenance Quantity is assumed to be 1 day/week.
	SITE PREPARATION ESTIMATED SUBTOTAL					**15,450**	**14,530**	
ITEM NO.	**DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
8	Dewatering, Unwatering, and Stormwater Management for the Bottom Ash Pond	DAY	1,302	B10K	4	3,906	2,604	312319201100: Dewatering, pumping 8 hours, attended 2 hours per day, 6" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose. 312319201120: Add per additional pump - 7 additional pumps added. Quantity assumes 6 months of pumping prior to excavation and average of 3 days/week during construction.
	Unit Costs							
	Additional HDPE Piping	LF	14,600	-	-	-	-	221113780098: Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 10" diameter, DR11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting, or digging equipment.
9	Dewatering Sumps Installation	EA - in place	150	Sump Install	4	600	300	Unit Rate, Crew, and Daily Output based on experience. Materials include 24" corrugated HDPE pipe with geotextile wrapping, and 1 C.Y. of gravel backfill.
10	Excavate Process Flow Ditch	CY - as excavated	6,100	-	-	79	74	Assume 4,200 feet ditch excavated to be 3 feet deep, 10 feet wide with 3H:1V side slopes from the process inflow to the bottom ash pond dam.
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	6,710	B14B	5000	16	11	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling and Dumping Onsite of Material for Moisture Conditioning	CY - as excavated	6,710	B34G	850	63	63	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 1 mile
	DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT ESTIMATED SUBTOTAL					**4,600**	**3,000**	
ITEM NO.	**BOTTOM ASH POND CLOSURE**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
11	Demolish and Dispose of Facilities at the Pump Station and Sluice Pipes	LS	1	B14B	0.05	240	160	Unit rate, Crew, and Daily Output based on experience.
12	Excavation of CCR + 1 ft overdig	CY - in place	3,751,844	-	-	277,690	263,878	Quantity based on surface to surface calculation performed in AutoCAD.
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	4,120,318	B14B	5000	9,889	6,593	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket, 100% fill factor (assume 10% fluff factor from ground to excavated)
	Pushing Material to Excavator	CY - as excavated	4,120,318	B10B	5000	9,889	6,593	312323170020: Spread dumped material, no compaction, by dozer. Dozer support for excavation. Daily output edited to match excavation based on experience.
	Hauling and Dumping Onsite of Material for Moisture Conditioning	CY - as excavated	4,120,318	B34G	850	38,779	38,779	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 1 mile
	Spreading/ Drying Moisture Conditioning	CY - as excavated	2,063,514	B10B	5000	4,952	3,302	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Dust Control Moisture Conditioning Prior to Loading	CY - as excavated	619,054	B45	1888	5,246	2,623	312323239000: Water, 3000 gal. truck, 3 mile haul. Assume 30% of volume will need to be wetted.
	Loading of Material	CY - as excavated	4,127,028	B14B	5605	8,836	5,890	312316434420: Excavating, large volume projects; restricted loading trucks, loader, 95% fill factor, 6 C.Y. bucket (assume 10% fluff factor from ground to excavated)
	Hauling of Material Offsite	CY - as excavated	4,127,028	B34C	165	200,098	200,098	312323203080: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y.truck, 15 min wait/ld/uld., 40 MPH, cycle 20 miles.
	Landfill Tipping Fee	TON	4,735,765	-	-	-	-	Price based on four local landfills with an average unit weight of 85 pcf.
13	Notch the Dam and Movement of Fill for Regrading/Drainage	CY - in place	35,100	-	-	2,352	1,433	Excavation of dam fill and placement in CBR BAP for positive drainage to the notched dam. 313713100200: Rip-rap and rock lining, random, broken stone, 18" minimum thickness, machine placed. Used bare labor estimate (50.51 per SY) and bare equipment estimate (44.79 per SY) for
	Unit Costs							
	Excavation and Loading of Material	CY - as excavated	38,610	B14B	3230	143	96	312316435400: Excavating, large volume projects; excavation with truck loading; excavator, 4.5 C.Y. bucket, 95% fill factor (assume 10% fluff factor from ground to excavated)
	Hauling of Material	CY - as excavated	38,610	B34G	850	363	363	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld/uld., 15 MPH, cycle 1 mile
	Spreading of Material	CY - as excavated	38,610	B10B	3230	143	96	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Finish Grading of Material	SY	856,680	B11L	8900	1,540	770	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
	Compaction of Material	CY - in place	35,100	B10F	2600	162	108	312323235100: Compaction; Riding, vibrating roller, 12" lifts, 4 passes (RSMeans Crew is B10Y; altered to B10F based on experience)
	BOTTOM ASH POND ESTIMATED SUBTOTAL					**280,280**	**265,470**	
ITEM NO.	**SITE RESTORATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
14	Straw Wattle Ditch Checks	LF - in place	15,900	A2	1000	382	127	312514160705: Sediment Log, Filter Sock, 9". Quantity assumed 3/acre (based on experience) for entire disturbed area and each being 30 ft long.
15	Place Rip Rap and Geotextile Along Dam Notch	SF - in place	50,000	-	-	1,444	704	Placing 18 inches of riprap in the dam notch area to reduce erosion.
	Unit Costs							
	Purchase of Material	TON	4,125	-	-	-	-	Riprap rate provided by local supplier. Avg unit price for 150-400 lb riprap without hauling used. Quantity assumes material is 110 pcf.
	Hauling of Material	TON	4,125	B34C	116	284	284	Used cost est. provided by Columbia Quarry Company in Waterloo 10.26.22. Previous model used a per CY cost: 312323203070: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y.truck, 15 min wait/ld/uld., 35 MPH, cycle 30 miles
	Geotextile Placement	SF - in place	50,000	2 Clab	2500	320	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength. Assumed rip rap volume placed 2 ft thick to get area.
	Rip Rap Placement	CY - in place	2,780	B12S	53	839	420	313713100200: Rip-rap and rock lining, random, broken stone, 18" minimum thickness, machine placed. Used bare labor estimate (50.51 per SY) and bare equipment estimate (44.79 per SY) for placing rip rap.
16	Seed, Mulch, and Maintain Vegetated Surfaces	AC	177	-	-	1,870	1,870	Includes soil ammendments, upland seeding, and wetland planting for all disturbed areas.
	Unit Costs							
	Lime	MSF	7,700	B66	700	88	88	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader. Unit multiplied by 1.1 to account for soils possibly being void of nutrients.
	Fertilizer	MSF	7,700	B66	700	88	88	329113234150: Soil preparation, tructural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader. Unit multiplied by 1.1 to account for soils possibly being void of nutrients.
	Wetland Mix	MSF	900	B66	26	277	277	Unit rate, daily output, crew based on experience. Quantity assumes 20 acres of disturbed area.
	Grassland Mix	MSF	5,900	B66	52	908	908	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader. Quanity all disturbed areas minus wetland area, pollinator area, and 30 acres of ponds in BAP.
	Pollinator Mix	MSF	900	B66	26	277	277	Unit rate, daily output, crew based on experience. Quantity assumes 20 acres of distubed area.
	Mulch	MSF	7,700	B65	530	232	232	329113160350: Mulching, Hay, 1" deep, power mulcher, large
	SITE RESTORATION ESTIMATED SUBTOTAL					**3,700**	**2,700**	
ITEM NO.	**ENGINEERING AND CONSTRUCTION SUPPORT TASKS**	**Units**	**Quantity**	**Crew**	**Output**	**Labor Hours**	**Equipment Hours**	**Notes**
17	Final Closure Design and Bid Support	LS	1	-	-	-	-	Unit Rate based on experience.
18	Engineering Support and CQA During Construction	LS	1	Eng	60 hrs/week	22,440	7,480	Unit Rate, Crew, and Output based on experience.
	ENGINEERING AND PERMITTING ESTIMATED SUBTOTAL					**22,440**	**7,480**	

NOTES:
1. LS = Lump Sum, AC = Acre, LF = Linear Foot, EA = Each, SY = Square Yard, MO = Month, YR = Year, CY = Cubic Yard, MSF = Thousand Sqaure Feet
2. RS Means refers to the 2022 online edition of RS Means Commercial New Construction. All unit rates refer to standard union labor in Carbondale, IL.
3. See schedule (Table 2) for assumptions regarding schedule for time unit quantities.

Table 6 - Labor, Equipment, and Mileage Estimate
CBR-Offsite-Truck Transportation
(1 of 2)

Geosyntec consultants

Crew	Labor	Daily Labor Hours	Equipment	Daily Equipment Hours	Project Total Labor Hours	Project Total Equipment Hours
B84	Operator x1	8	Rotary Mower/Tractor	8	2,756	2,756
B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	258	86
B59	Truck Driver x1	8	Truck Tractor, 220 H.P. Water Tank Trailer, 5000 Gal	8	7,480	7,480
B86A	Operator x1	8	Grader, 30,000 lbs	8	2,992	2,992
B10K	Operator x1 Laborer x0.5	12	Centr. Water Pump, 6"	8	3,906	2,604
B14B	Operator x1 Laborer x0.5	12	Hyd. Excavator, 6 C.Y.	8	19,124	12,749
1 Clab	Laborer x1	8	None	0	Not Used	Not Used
B34F	Truck Driver x1	8	Dump Truck, Off Hwy., 35 ton	8	Not Used	Not Used
B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	14,985	9,990
B10G	Operator x1 Laborer x0.5	12	Sheepsfoot Roller, 240 H.P.	8	Not Used	Not Used
B34D	Truck Driver (heavy) x 1	8	Truck Tractor, 6x4, 380 H.P. x 1 Dump Trailer, 20 CY x 1	8	Not Used	Not Used
B21C	Labor Foreman x1 Laborer x4 Operator (crane) x1 Operator (oiler) x1	56	Cutting Torches x2 Sets of Gasses x2 Lattice Boom Crane, 90 ton	8	Not Used	Not Used
B69	Labor Foreman x1 Laborer x3 Operator (crane) x1 Operator (oiler) x1	48	Hyd. Crane, 80 ton	8	Not Used	Not Used
C14A	Carpenter Foreman x1 Carpenters x16 Rodmen x4 Laborers x2 Cement Finisher x1 Operator (medium) x1	200	Gas Engine Vibrator Concrete Pump (small)	16	Not Used	Not Used
B63B	Labor Foreman x1 Laborer x2 Operator (light) x1	32	Loader, Skid Steer, 78 H.P.	8	Not Used	Not Used
B32	Laborer x1 Operator (med) x3	32	Grader, 30,000 lbs Tandem Roller, 10 ton Dozer, 200 H.P.	24	Not Used	Not Used
2 Clab	Laborer x2	16	None	0	320	0
B12S	Equip. Oper. (crane) x 1 Laborer x 1	16	Hyd. Excavator, 2.5 C.Y.	8	839	420
A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	509	170
B66	Operator (light) x1	8	Loader-Backhoe, 40 H.P.	8	1,638	1,638
B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) Flatbed Truck, Gas, 1.5 ton	16	232	232
B25B	Laborers x 8 Operators x 4	96	Asphalt Paver x 130 H.P. Tandem Rollers 10 ton x 2 Pneumatic Roller 12 ton	32	Not Used	Not Used
B10M	Laborer x.5 Operator (med) x1	12	Dozer, 300 H.P.	8	Not Used	Not Used
B13K	Operators (crane) x 2	16	Hyd. Excavator, .75 C.Y. x 2 Hyd. Hammer, 4000 ft-lb	16	Not Used	Not Used
B34G	Truck Driver x1	8	Dump Truck, Off Hwy., 50 ton	8	39,206	39,206
ECB	Laborer x3	24	Tractor	8	Not Used	Not Used
Dewater	Laborer x1	8	8" Diesel Pump	2	Not Used	Not Used
Sump Install	Laborer x1 Operator x1	16	Hyd. Excavator, 4.5 C.Y.	8	760	380
Grout/Concrete	Laborer x2 Truck Driver x1	24	Concrete Truck	8	60	20
Eng	Engineering Staff x1.2	10	Side by Side x1	4	22,440	7,480
B10F	Operator (med) x1 Laborer x0.5	12	Tandem Roller, 10, Ton	8	162	108
B14K	Operator (med) x1 Laborer x0.5	12	Front End Loader, 10 C.Y.	8	Not Used	Not Used
B34C	Truck Driver (heavy) x 1	8	Truck Tractor, 6x4, 380 H.P. x 1 Dump Trailer, 16.5 CY x 1	8	200,383	200,383
B14B	Operator (crane) x 1 Laborer x 0.5	12	Hyd. Excavator, 6 C.Y.	8	19,124	12,749
B11L	Operator (med.) x 1 Laborer x 1	16	Grader, 30,000 lbs	8	1,540	770
B10W	Operator (med.) x 1 Laborer x 0.5	12	Dozer, 105 H.P.	8	Not Used	Not Used
B7	Laborer x 5 Operator (med) x 1	48	Brush Chipper, 12", 130 H.P Crawler Loader, 3 C.Y. Chain Saws, Gas, 36" Long x 2	32	1,614	1,076
B45	Operator (med) x1 Truck Driver(heavy) x 1	16	Tanker, 3000 gal Truck Tractor, 6x4, 380 H.P.	8	5,246	2,623
Note: Blue crew names were created by Geosyntec based on experience (not pulled from RSMeans).				**Totals**	345,600	305,900

Table 6 - Labor, Equipment, and Mileage Estimate
CBR-Offsite-Truck Transportation
(2 of 2)

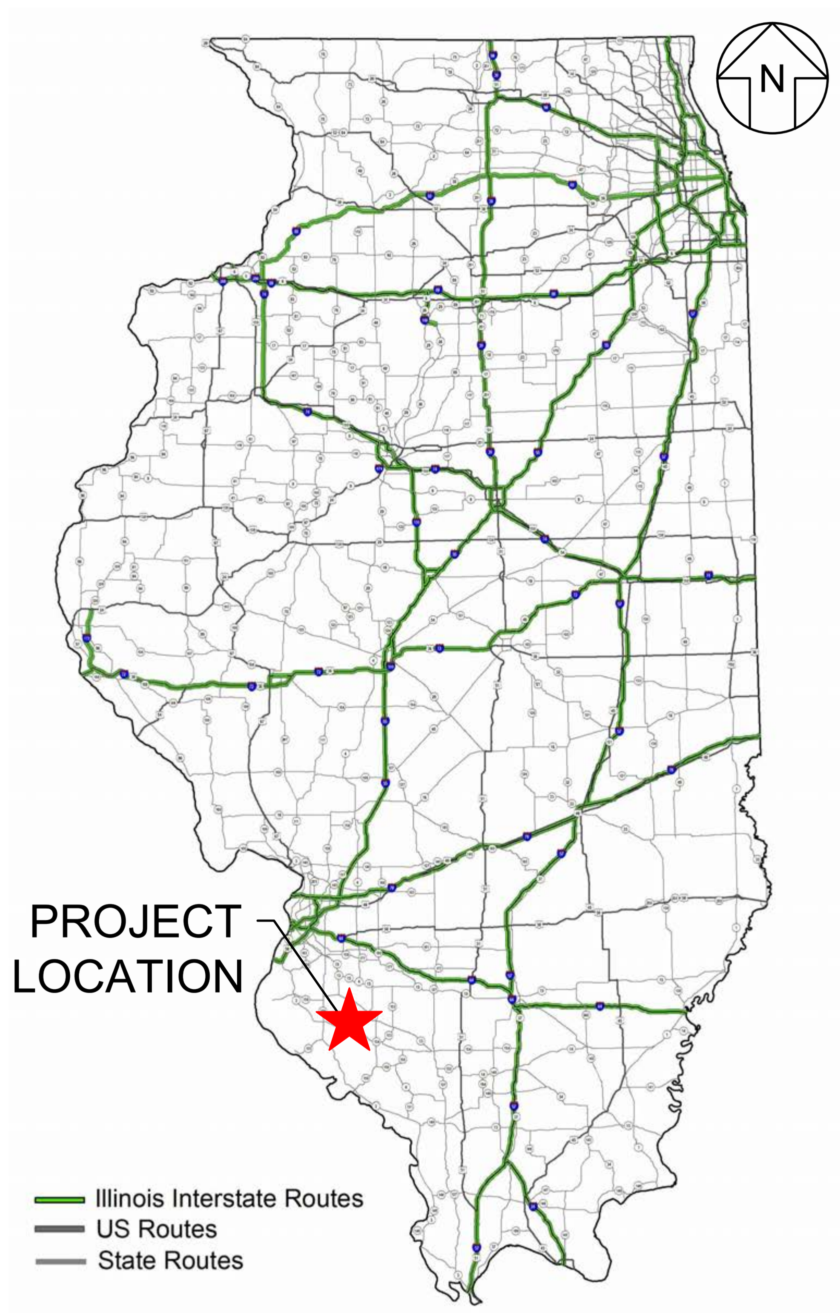
Geosyntec consultants

Item	Quantity	Assumptions
Labor Total Hours	326,500	Per projected subtotal in cost estimate (Does not include contingency)
Duration of Onsite Construction in Days	1,870	Per Construction Schedule
Average Daily Crew Size	20	10 hour days (5 days per week)
Daily Labor Mobilization Miles	2,618,000	Average of 70 miles round trip per day
Vehicles Miles Onsite	71,995	1 mile round trip from gate to parking 5 miles per day for 2 CQA techs and Construction Supervisor 10% Contingency for site visitors (client and engineering support)
Equipment Mobilization Miles - Unloaded	112,200	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	112,200	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Daily Equipment Miles Onsite	2,064,480	Average of 18 of 20 crew members running equipment Assume 60 miles per piece of equipment 40 miles per day used for water truck 20 miles per day used for grader
Onsite Haul Truck Miles - Unloaded	61,161	34 CY Off Road Dump Truck 1 mile round trip per load
Onsite Haul Truck Miles - Loaded	61,161	34 CY Off Road Dump Truck 1 mile round trip per load
Offsite Haul Truck Miles - Unloaded	5,002,458	16.5 CY Dump Truck 20 mi cycle for exported CCR
Offsite Haul Truck Miles - Loaded	5,002,458	16.5 CY Dump Truck 20 mi cycle for exported CCR
Material Delivery Miles - Unloaded	25,000	100 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 250 miles away average
Material Delivery Miles - Loaded	25,000	100 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 250 miles away average

ATTACHMENT B

Final Closure Plan Drawings and Material Specifications (Section 845.750)

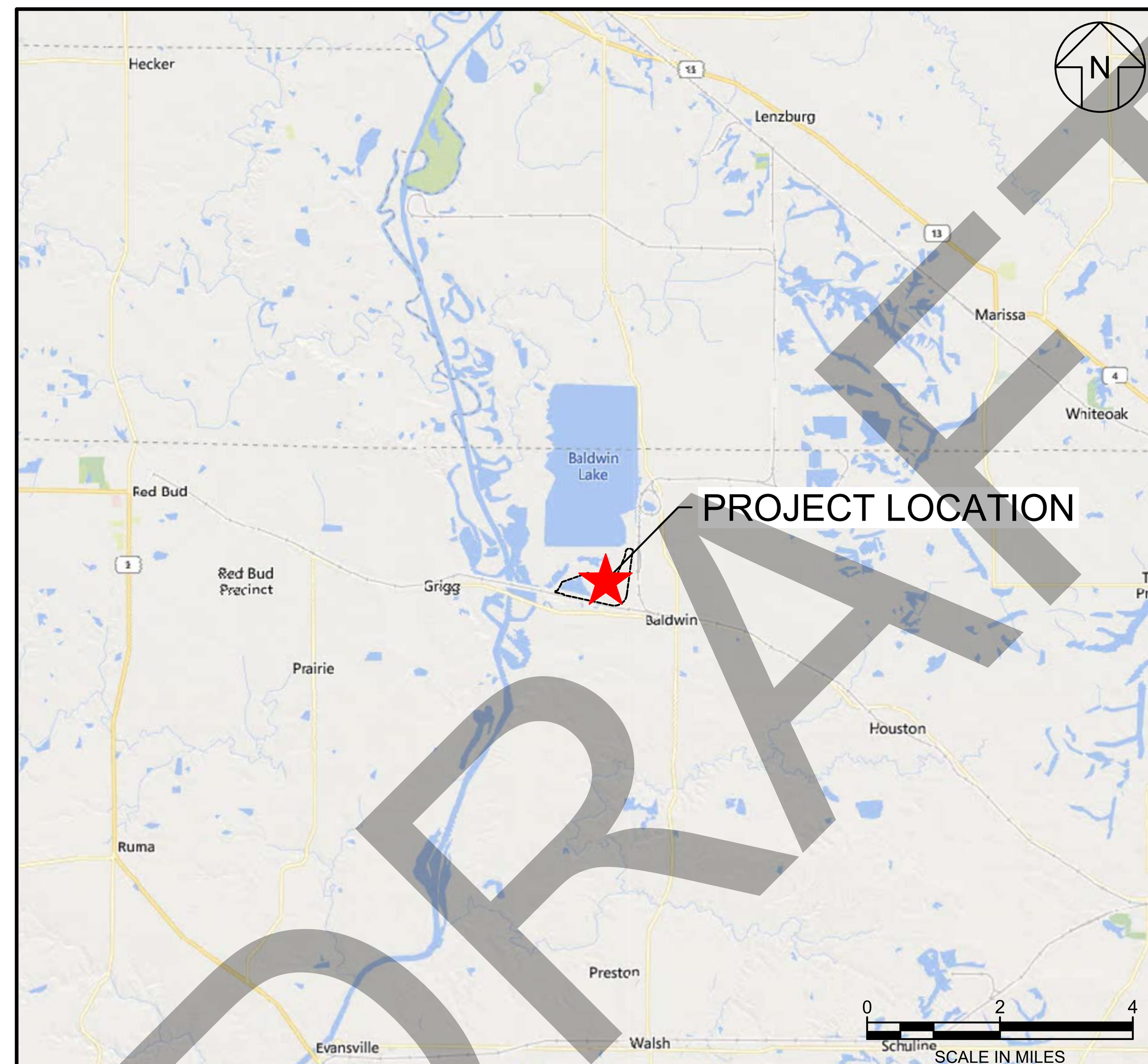
DYNEGY MIDWEST GENERATION, LLC
BALDWIN POWER PLANT
BALDWIN, ILLINOIS
BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION
CLOSURE DRAWINGS
PROJECT NO. GLP8050
JANUARY 2023



SOURCE: IDOT

STATE MAP

NOT TO SCALE



SOURCE: BING MAPS

LOCATION MAP

SITE MAP

DRAFT

4 / C-150 — DETAIL NUMBER; DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER — 4 / C-110 — DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

DETAIL TITLE
SCALE:
XREF:

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. C-400 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. C-300.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

DRAWING LIST

SHEET NO.	SHEET TITLE
G–100	COVER SHEET AND LOCATION MAP
G–110	EXISTING CONDITIONS
C–100	DEMOLITION, RELOCATION, AND ABANDONMENT
C–110	PHASE 1 FINAL GRADING PLAN
C–120	PHASE 2 FINAL GRADING PLAN
C–130	SECTIONS SHEET – 1 OF 2
C–140	SECTIONS SHEET – 2 OF 2
C–150	DETAILS AND MATERIAL SPECIFICATIONS – 1 OF 2
C–160	DETAILS AND MATERIAL SPECIFICATIONS – 2 OF 2
C–170	EROSION AND SEDIMENT CONTROL PLAN

FOR REVIEW PURPOSES ONLY
DESIGN DRAWINGS - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636-812-0800

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: COVER SHEET AND LOCATION MAP

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	01 - GLP8050 G-100
REVIEWED BY:	JPS	DRAWING NO.:	G-100
APPROVED BY:	TWW		

LEGEND

- 355 EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- IMPOUNDMENT BOUNDARY
- OE OVERHEAD ELECTRIC
- LAGOON DISCHARGE PIPE
- BAL-B006 BORINGS
- BAL-C034 CONE PENETRATION TESTS
- BAL-P007 PIEZOMETER
- XPW05 MONITORING WELLS

NOTES:

1. COORDINATES AND DIRECTIONS SHOWN IN THESE DRAWINGS WERE BASED ON THE ILLINOIS STATE PLAN COORDINATE SYSTEM (NAD83, IN US FEET). ELEVATIONS WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
2. EXISTING CONTOURS, AERIAL IMAGERY, AND WATER SURFACE ELEVATIONS FOR THE BAP AND IMMEDIATE SURROUNDING AREAS WERE TAKEN FROM "LUMINANT, DYNEGY MIDWEST GENERATION, LLC, BALDWIN ENERGY COMPLEX, DECEMBER 2020 TOPOGRAPHY", DATED MAY 20, 2021, BY INGENAE, LLC (2020 INGENAE SURVEY).
3. EXISTING CONTOURS FOR AREAS BEYOND THE LIMITS OF THE 2020 INGENAE SURVEY WERE TAKEN FROM LIDAR DATA PROVIDED BY THE ILLINOIS GEOSPATIAL CLEARINGHOUSE, ILLINOIS HEIGHT MODERNIZATION (ILHMP), ACCESSIBLE AT CLEARINGHOUSE.ISGS.ILLINOIS.EDU. THE IMAGERY WAS OBTAINED FOR RANDOLPH COUNTY AND WAS COLLECTED IN 2012.
4. EXISTING CONTOURS WERE SUPPLEMENTED FROM AERIAL SURVEYS OF THE ACTIVE PACEMENT AREAS FOR FLY ASH, BOTTOM ASH, AND ECONIMIZER ASH PROVIDED BY BORAL (2022).
5. EXISTING AERIAL IMAGERY FOR AREAS BEYOND THE LIMITS OF THE 2021 INGENAE SURVEY WERE OBTAINED FROM GOOGLE EARTH PRO IN 2022, AND THE IMAGERY WAS COLLECTED IN 2020.
6. APPROXIMATE PROPERTY LIMITS WERE TAKEN FROM THE RANDOLPH COUNTY, ILLINOIS ARCGIS HUB(HTTPS://GIS-RANDOLPH-COUNTY.HUB.ARCGIS.COM/) AND REPRESENT THE APPROXIMATE BOUNDARIES OF PARCELS OWNED BY DYNEGY MIDWEST GENERATION, LLC.
7. MONITORING WELL LOCATIONS WERE PROVIDED BY RAMBOLL (2022) AND PIEZOMETER LOCATIONS WERE OBTAINED FROM THE 30 PERCENT DESIGN DRAWINGS FOR THE FLY ASH POND SYSTEM AECOM (2016).
8. ALL OVERHEAD ELECTRIC LINE LOCATIONS ARE APPROXIMATE AND SHOULD NOT BE CONSIDERED COMPREHENSIVE. ADDITIONAL SURVEYS SHOULD BE PERFORMED PRIOR TO CONSTRUCTION TO VERIFY THE LOCATIONS OF ALL OVERHEAD AND BURIED UTILITIES. UTILITY LOCATIONS ARE ONLY SHOWN WITHIN THE PROPERTY LINES.
9. LIMITS FOR THE BAP WERE TAKEN FROM "LUMINANT, BALDWIN POWER PLANT, CCR FACILITY BOUNDARY EXHIBIT", DATED SEPTEMBER 7, 2021, BY INGENAE LLC (2021 INGENAE BOUNDARY SURVEY).
10. LOCATION OF UTILITIES, DISCHARGE PIPING, AND THE LAGOON DISCHARGE TO BE FIELD VERIFIED BY THE CONTRACTOR.

0 200 400
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
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TELEPHONE: 636-812-0800

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: EXISTING CONDITIONS

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT BALDWIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

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DESIGN BY: CL		DATE:	JANUARY 2023
DRAWN BY: DW		PROJECT NO.:	GLP8050
CHECKED BY: TWW		FILE:	02 - GLP8050 G-110
REVIEWED BY: JPS		DRAWING NO.:	
APPROVED BY: TWW			G-110

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LEGEND

- 355 — EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- IMPOUNDMENT BOUNDARY
- OE — OVERHEAD ELECTRIC
- LAGOON DISCHARGE PIPE
- APPROXIMATE AREA OF CLEARING
- FINAL HAUL ROAD (7 / C-150)
- LOD — LIMITS OF DISTURBANCE (LOD)
- XPW05 — MONITORING WELLS (6 / C-150)
- BAL-P007 — PIEZOMETERS (5 / C-150)

NOTES:

1. ITEMS IDENTIFIED AS TO BE REMOVED (TBR) SHALL BE COMPLETED IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL GUIDELINES IN APPROVED LANDFILLS. .
2. THE LAGOON DISCHARGE PIPE SHALL NOT BE REMOVED UNTIL THE PLANT HAS STOPPED OPERATION AND OWNER AUTHORIZATION.
3. CLEARING OF EXISTING VEGETATION SHALL BE COMPLETED PRIOR TO EXCAVATION FOR THE CCR MATERIALS.
4. OVERHEAD ELECTRICAL LINES SHALL NOT BE DISTURBED.
5. THE DAM SHALL NOT BE REMOVED UNTIL THE FINAL COVER SYSTEM IS COMPLETE.
6. PUMP STATION SHALL NOT BE REMOVED UNTIL THE FINAL COVER SYSTEM IS COMPLETE.
7. SLUICE LINES SHALL NOT BE REMOVED UNTIL THE BALDWIN POWER PLANT IS NO LONGER GENERATING POWER.

0 200 400
SCALE IN FEET

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DYNEGY MIDWEST GENERATION, LLC
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COLLINSVILLE, IL 62234 USA

TITLE: DEMOLITION, RELOCATION, AND ABANDONMENT

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT, BALDWIN, ILLINOIS

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DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
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REVIEWED BY:	JPS	DRAWING NO.:	C-100
APPROVED BY:	TWW		

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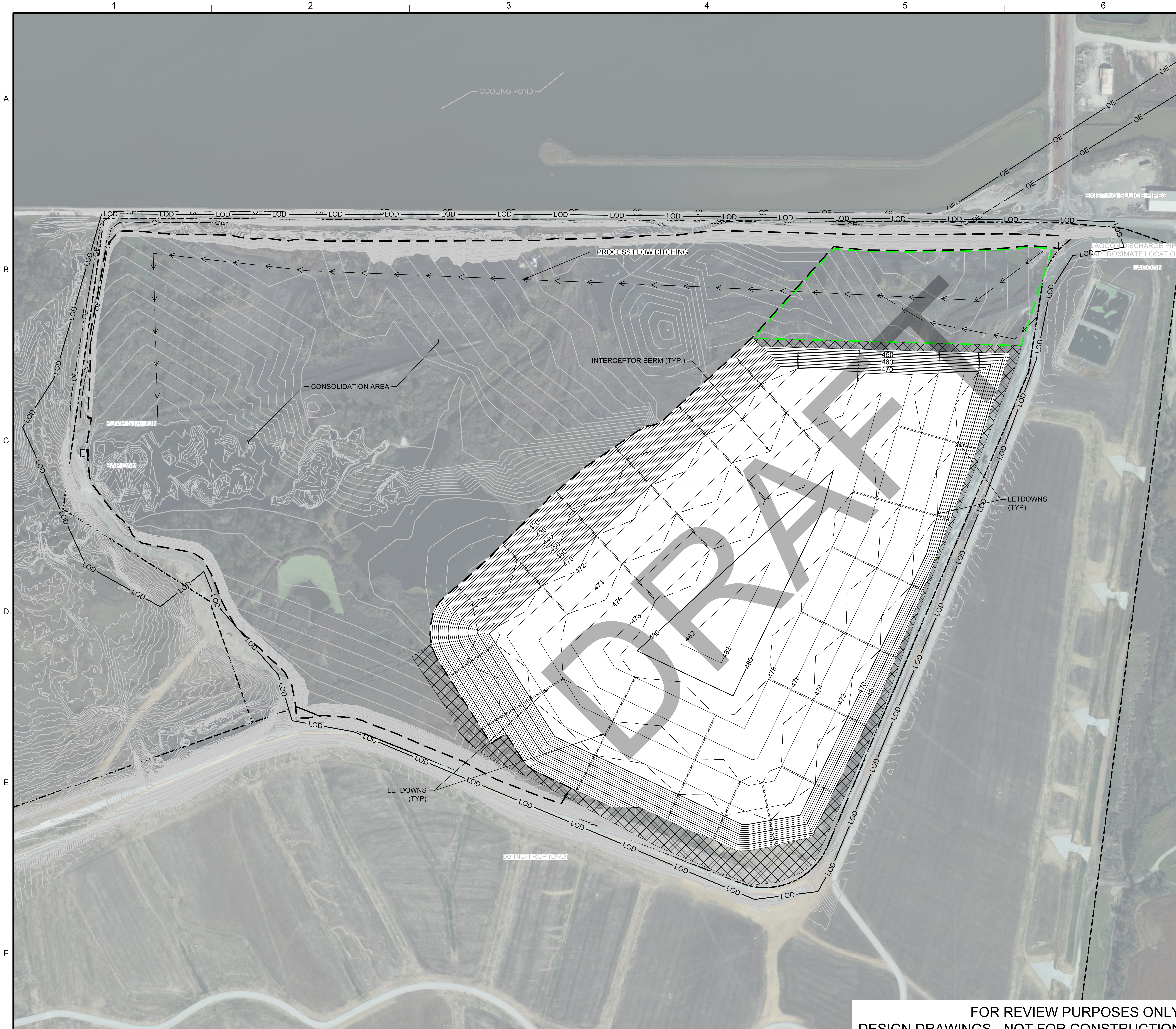
H:\BALDWIN BAP CP - GLP8050\900 - CAD\DRAWINGS\30PCT PERMIT SET\03 - GLP8050 C-100



LEGEND

420	EXISTING GROUND MAJOR CONTOUR (5')
	EXISTING GROUND MINOR CONTOUR (1')
	IMPOUNDMENT BOUNDARY
470	PROPOSED GRADING MAJOR CONTOURS (5')
472	PROPOSED GRADING MINOR CONTOURS (1')
	PROCESS FLOW DITCH
LOD	LIMITS OF DISTURBANCE (LOD)
	INTERCEPTOR BERM 12 / C-160
	PROCESS FLOW AND MATERIAL HANDLING AREA
	EDGE EXISTING GRADE
	LETDOWNS 9 / C-160, 10 / C-160
	PERIMETER DITCH 8 / C-160

NOTES:

1. PHASE 1 OF THE CLOSURE SHALL INCLUDE CONSOLIDATION OF CCR INTO THE FINAL COVER FOOTPRINT, CONSTRUCTION OF PERIMETER SLOPES AND FINAL COVER SYSTEM. THE CONTRACTOR SHALL RESERVE THE AREA NOTED FOR PROCESS FLOW AND MATERIAL HANDLING DURING OPERATIONS.
2. CONTRACTOR SHALL COORDINATE WITH THE PLANT AND NOT INTERFERE WITH ONGOING PROCESS FLOW AND PLACEMENT OR EXCAVATION FOR REUSE OF CCR MATERIALS UNTIL THE BPP CEASES POWER GENERATION IN MAY 2027.
3. THE CONTRACTOR SHALL OPERATE WITHIN THE "LOD" TO COMPLETE THE PROPOSED CLOSURE. CONTRACTOR SHALL EVALUATE AND IS SOLELY RESPONSIBLE FOR SAFE AND STABLE ACCESS OF EQUIPMENT ON THE CCR WITHIN THE "LOD".
4. CONTRACTOR SHALL FIELD LOCATE ALL EXISTING UTILITIES.
5. SELECT DEWATERING SHALL BE COMPLETED TO ALLOW FOR EXCAVATION OF THE CCR MATERIALS AND REMOVE FREE LIQUIDS FROM THE AREA TO BE CONSOLIDATED UTILIZING DEWATERING SUMPS AND DITCHES.
6. THE CONTRACTOR IS RESPONSIBLE FOR STORMWATER FLOWS DURING CONSTRUCTION AND SHALL ADHERE TO THE SITE SPECIFIC NPDES PERMIT. CONTACT STORMWATER AND DEWATERING WATER SHALL NOT FLOW OR BE PUMPED OUTSIDE OF THE LIMITS OF THE BAP EXCEPT THROUGH THE NDPES PERMITTED OUTFALL. THE CONTRACTOR SHALL UTILIZE THE EXISTING OUTFALL AT THE BAP DAM TO PUMP TO THE COOLING POND. PERIMETER DITCH ALIGNMENT IS APPROXIMATE AND WILL BE REFINED AT A LATER PHASE OF DESIGN.
7. STORMWATER COLLECTION AND MAINTENANCE OF THE STORMWATER BMPS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
8. CCR SHALL BE REMOVED FROM THE CONSOLIDATION AREAS TO AN ESTIMATED DEPTH OF APPROXIMATELY 1 FOOT BELOW THE ESTIMATED DEPTH OF CCR. VISIBLE CCR SHALL BE REMOVED, FINAL SUBGRADE SHALL BE VISIBLY INSPECTED BY A MEMBER OF THE CONSTRUCTION QUALITY ASSURANCE TEAM AFTER EXCAVATION. THE ACTUAL FINAL GRADES WILL BE DETERMINED IN THE FIELD DURING CCR REMOVAL CONSTRUCTION.
9. THE PROPOSED EXCAVATION GRADE IS BASED ON THE 1967 PRECONSTRUCTION SURVEY AND RECENT EXPLORATION INVESTIGATIONS TO IDENTIFY THE BOTTOM OF CCR.
10. GEOCOMPOSITE DRAINAGE LAYER SHALL BE INCLUDED IN ALL SLOPE AREAS 25% OR MORE STEEP.

0 200 400
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

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COLLINSVILLE, IL 62234 USA

TITLE: PHASE 1 FINAL GRADING PLAN

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

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DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	04 - GLP8050 C-110
REVIEWED BY:	JPS	DRAWING NO.:	C-110
APPROVED BY:	TWW		

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LEGEND

- EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- IMPOUNDMENT BOUNDARY
- PROPOSED GRADING MAJOR CONTOURS (5')
- PROPOSED GRADING MINOR CONTOURS (1')
- LIMITS OF DISTURBANCE (LOD)
- INTERCEPTOR BERM (12 / C-160)
- FINAL HAUL ROAD (7 / C-150)
- EDGE OF EXISTING GRADE
- LETDOWNS (9 / C-160, 10 / C-160)
- PERIMETER DITCH (8 / C-160)
- CAP TIE-IN TO FAPS

NOTES:

1. PHASE 2 OF THE CLOSURE SHALL INCLUDE FINAL GRADING IN THE CONSOLIDATION AREA AND COMPLETION OF CONSOLIDATION AND COVER SYSTEM IN THE NORTHERN AREA FOLLOWING THE DISCONTINUING OF POWER GENERATION AT THE PLANT.
2. THE CONTRACTOR SHALL OPERATE WITHIN THE "LOD" TO COMPLETE THE PROPOSED CLOSURE. CONTRACTOR SHALL EVALUATE AND IS SOLELY RESPONSIBLE FOR SAFE AND STABLE ACCESS OF EQUIPMENT ON THE CCR WITHIN THE "LOD".
3. SELECT DEWATERING SHALL BE COMPLETED TO ALLOW FOR EXCAVATION OF THE CCR MATERIALS AND REMOVE FREE LIQUIDS FROM THE AREA TO BE CONSOLIDATED UTILIZING DEWATERING SUMPS AND DITCHES.
4. THE CONTRACTOR IS RESPONSIBLE FOR STORMWATER FLOWS DURING CONSTRUCTION AND SHALL ADHERE TO THE SITE SPECIFIC NPDES PERMIT. CONTACT STORMWATER AND DEWATERING WATER,SHALL NOT FLOW OR BE PUMPED OUTSIDE OF THE LIMITS OF THE BAP EXCEPT THROUGH THE NDPES PERMITTED OUTFALL. THE CONTRACTOR SHALL UTILIZE THE EXISTING OUTFALL AT THE BAP DAM TO PUMP TO THE COOLING POND. PERIMETER DITCH ALIGNMENT IS APPROXIMATE AND WILL BE REFINED AT A LATER PHASE OF DESIGN.
5. STORMWATER COLLECTION AND MAINTENANCE OF THE STORMWATER BMPS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. CCR SHALL BE REMOVED FROM THE CONSOLIDATION AREAS TO AN ESTIMATED DEPTH OF APPROXIMATELY 1 FOOT BELOW THE ESTIMATED DEPTH OF CCR. VISIBLE CCR SHALL BE REMOVED, FINAL SUBGRADE SHALL BE VISIBLY INSPECTED BY A MEMBER OF THE CONSTRUCTION QUALITY ASSURANCE TEAM AFTER EXCAVATION. THE ACTUAL FINAL GRADES WILL BE DETERMINED IN THE FIELD DURING CCR REMOVAL CONSTRUCTION
7. THE PROPOSED EXCAVATION GRADE IS BASED ON THE 1967 PRECONSTRUCTION SURVEY AND RECENT EXPLORATION INVESTIGATIONS TO IDENTIFY THE BOTTOM OF CCR.
8. THE FINAL CLOSURE CAP WILL EXTEND TO THE LIMITS OF THE FLY ASH POND SYSTEM CAP TO THE EAST OF THE BAP. RESTORE EXISTING HAUL ROAD ON TOP OF FINAL CLOSURE CAP.
9. GEOCOMPOSITE DRAINAGE LAYER SHALL BE INCLUDED IN ALL SLOPE AREAS 25% OR MORE STEEP.

0 200 400
SCALE IN FEET

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DYNEGY MIDWEST GENERATION, LLC
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TITLE: PHASE 2 FINAL GRADING PLAN

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

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DESIGN BY:	CLL	DATE:	JANUARY 2023
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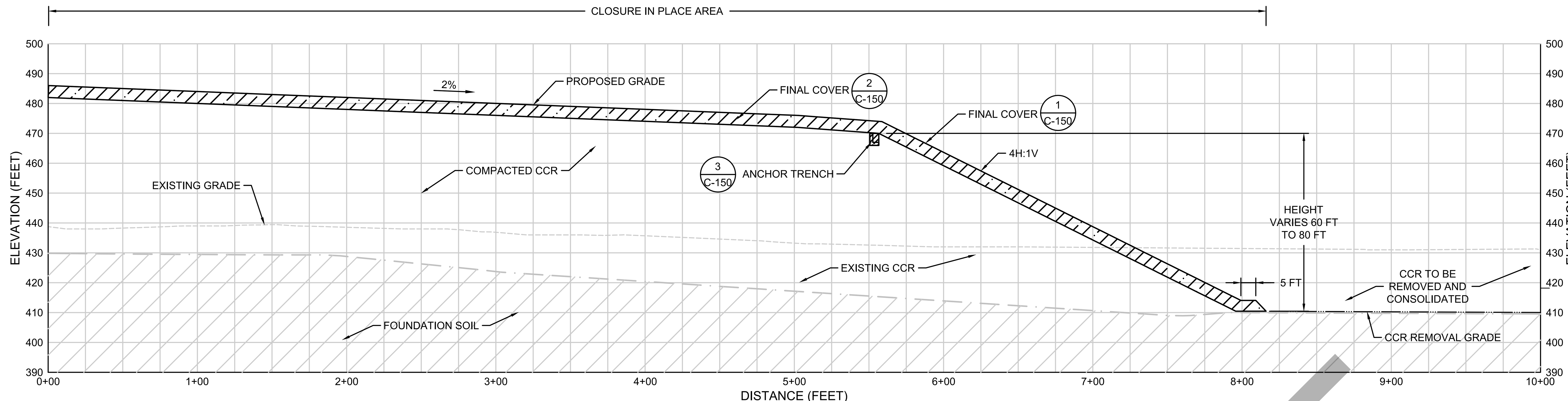
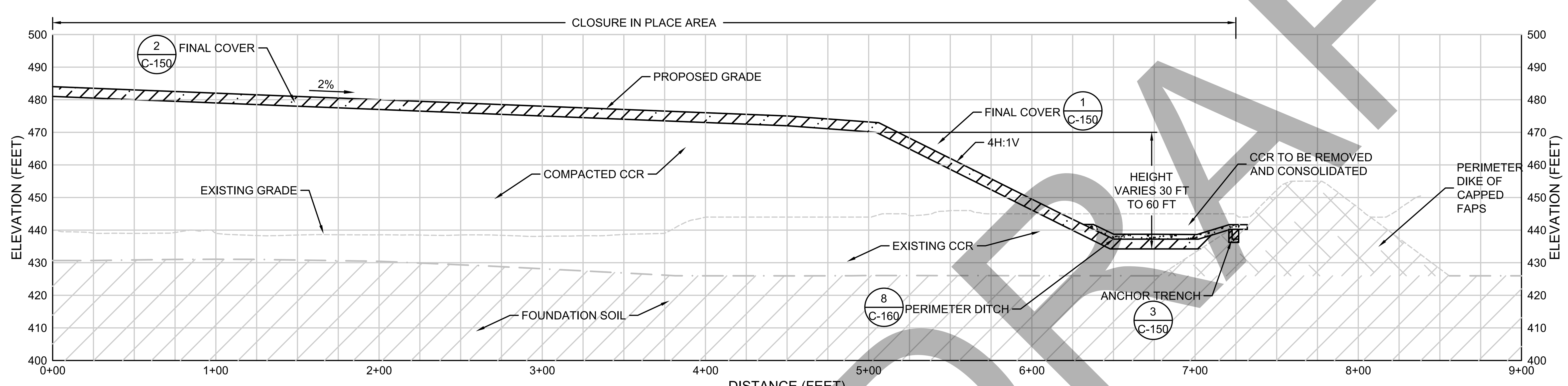
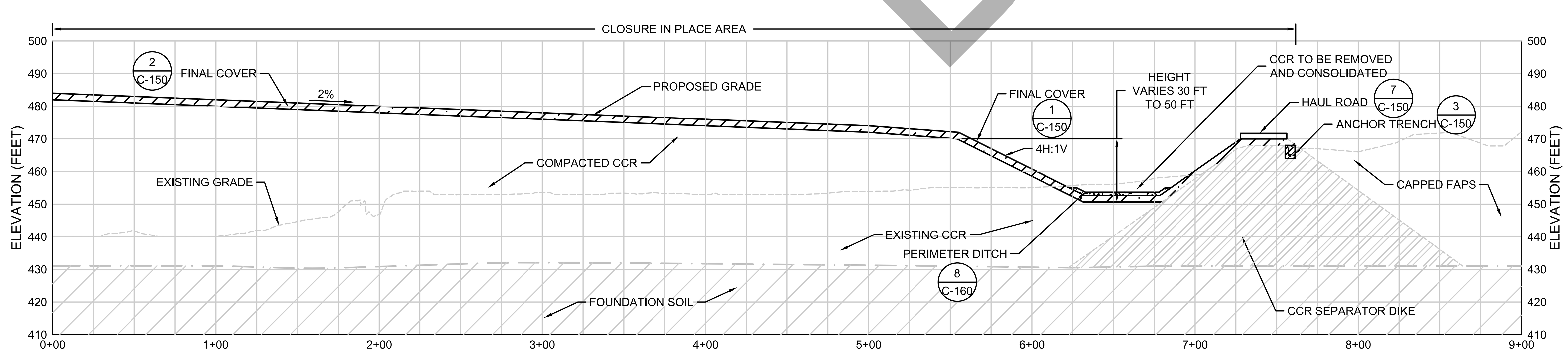


A PROFILE
HORIZONTAL: 1" =50'
VERTICAL: 1" =25'



B PROFILE
HORIZONTAL: 1" =50'
VERTICAL: 1" =25'



C PROFILE
HORIZONTAL: 1" =50'
VERTICAL: 1" =25'

LEGEND

- TOP OF FINAL COVER
- EXISTING GROUND SURFACE
- BOTTOM OF CCR
- PROTECTIVE COVER SOIL
- PERIMETER SOIL DIKE
- FOUNDATION SOIL
- CCR SEPARATOR DIKE

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REV	DATE	DESCRIPTION	DRN	APP

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1500 EASTPORT PLAZA DRIVE
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TITLE: SECTIONS SHEET 1 OF 2

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

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DATE

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DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	06 - GLP8050 C-130
REVIEWED BY:	JPS	DRAWING NO.:	C-130
APPROVED BY:	TWW		

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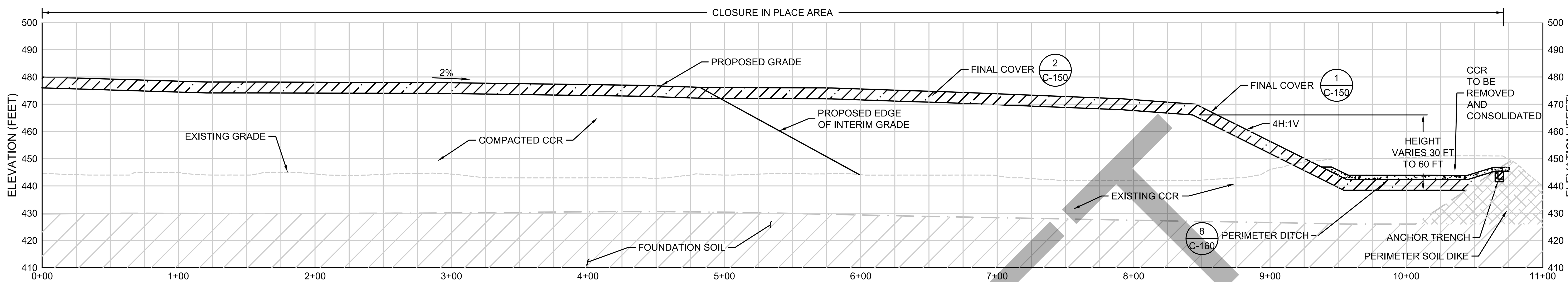

D PROFILE
HORIZONTAL: 1" =50'
VERTICAL: 1" =25'

LEGEND

- TOP OF FINAL COVER
- EXISTING GROUND SURFACE
- BOTTOM OF CCR
- PROTECTIVE COVER SOIL
- PERIMETER SOIL DIKE
- FOUNDATION SOIL

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REV	DATE	DESCRIPTION	DRN	APP

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TITLE: SECTIONS SHEET 2 OF 2

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT BALDWIN, ILLINOIS

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DESIGN BY:	CL	DATE:	JANUARY 2023
DRAWN BY:	DW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	07 - GLP8050 C-140
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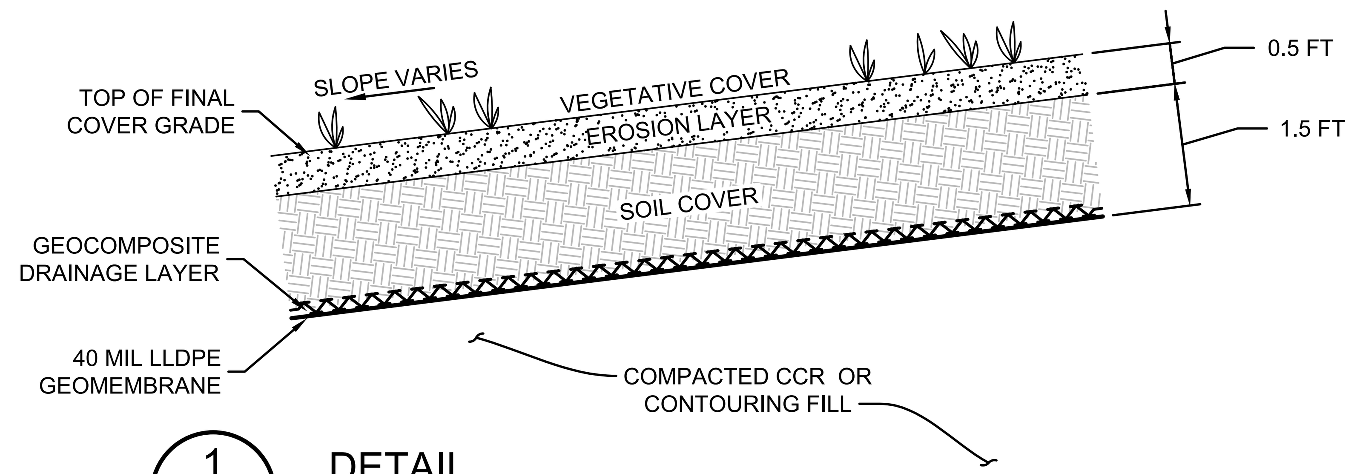
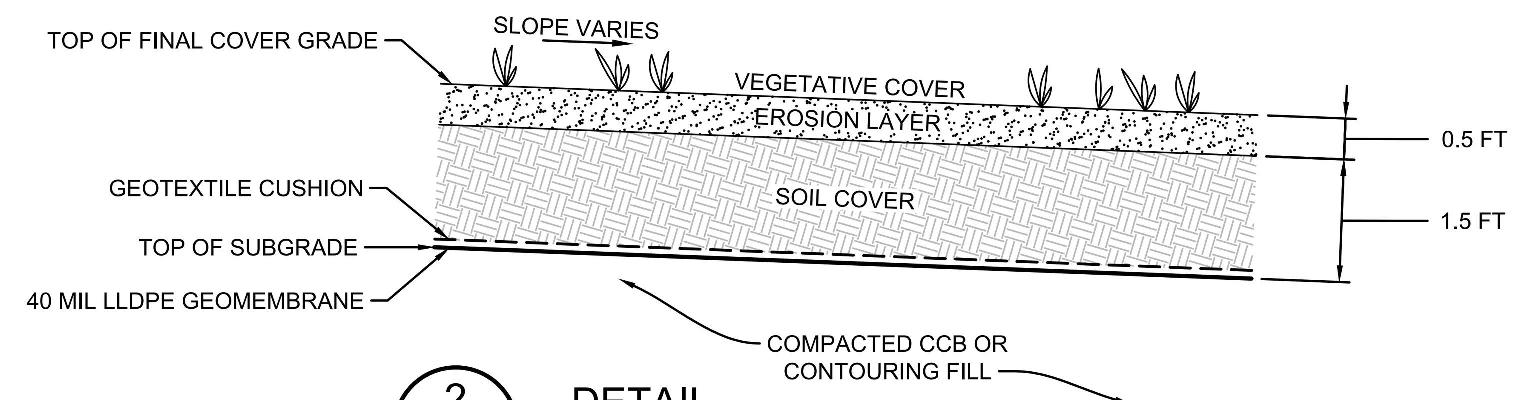
APPROVED BY:	TWW		

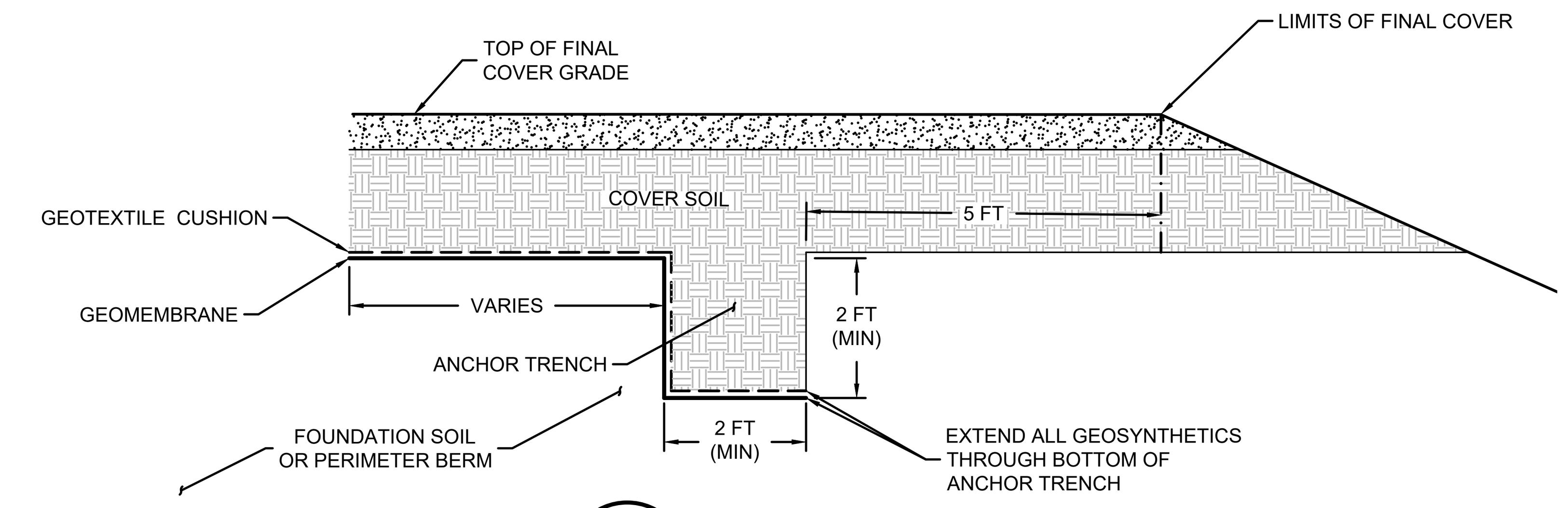
DRAFT



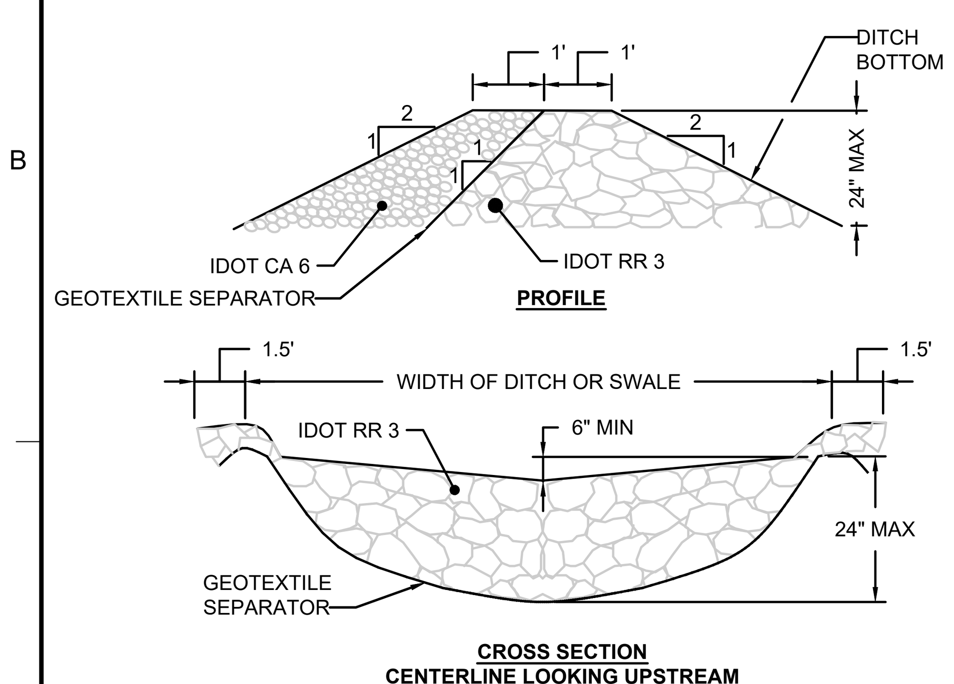
1 C-110 DETAIL
FINAL COVER SYSTEM WITH GEOCOMPOSITE DRAINAGE LAYER (4H:1V SLOPES)
SCALE: N.T.S.



2 C-110 DETAIL
FINAL COVER SYSTEM WITH GEOTEXTILE CUSHION (2% SLOPES)
SCALE: N.T.S.



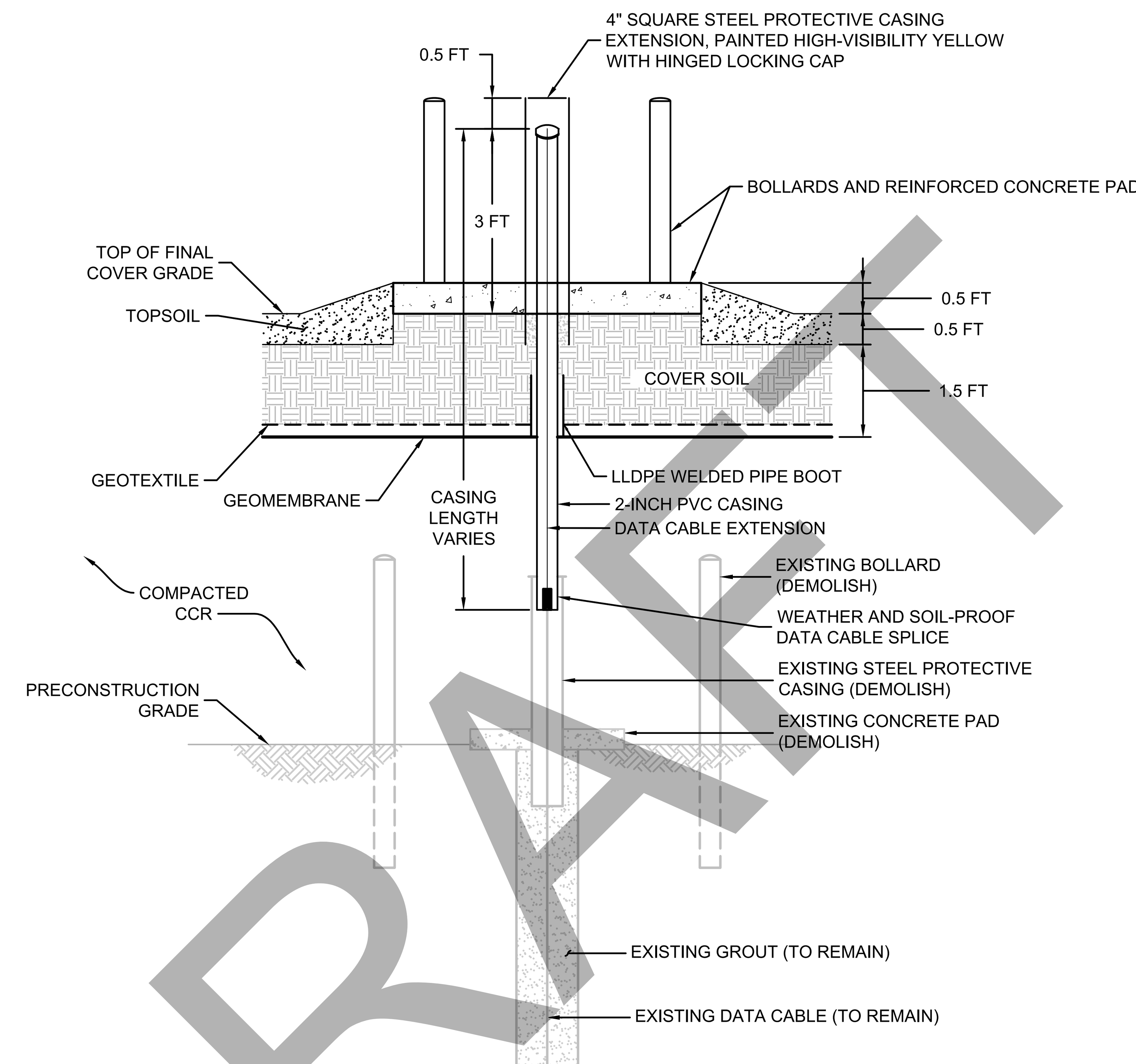
3 C-130 DETAIL
ANCHOR TRENCH
SCALE: N.T.S.



NOTES:

1. GEOTEXTILE SEPARATOR SHALL BE PLACED OVER THE CLEARED AREA PRIOR TO THE PLACING OF ROCK AND SHALL BE TOED IN 6 INCHES AT THE UPSTREAM EDGE.
2. PLACE AGGREGATE MOVING OUTWARD TOWARD CHANNEL EDGE. THE TOP OF THE CHECK DAM AT THE CHANNEL EDGE SHOULD BE AT LEAST 6 INCHES HIGHER THAN THE CENTER, CREATING A PARABOLIC OR TRAPEZOIDAL DOWNSTREAM OVERFLOW PROFILE.
3. FOR ADDED STABILITY, THE BASE OF THE DAM MAY BE KEYED 6 INCHES INTO THE SOIL.
4. SEDIMENT SHALL BE REMOVED WHEN THE SEDIMENT HAS ACCUMULATED TO ONE-HALF THE HEIGHT OF THE STONE BERM

4 C-170 DETAIL
ROCK CHECK DAM
SCALE: N.T.S.



NOTES:

1. THE LLDPE PIPE BOOT AND CLAMPS MAY BE OMITTED FOR PIEZOMETERS LOCATED OUTSIDE OF THE LIMITS OF THE FINAL COVER SYSTEM, AS A GEOMEMBRANE WILL NOT BE PRESENT IN THESE AREAS.
2. FOR PIEZOMETERS LOCATED IN AN ACTIVE SITE ROADWAY,THE ABOVE-GRADE PROTECTIVE CASING, BOLLARDS, AND CONCRETE PAD MAY BE SUBSTITUTED WITH A FLUSH MOUNT CASING AND A CONCRETE PAD AT LEAST 3 FT IN DIAMETER AND 6 INCHES IN THICKNESS. ALL OTHER DETAILS ARE TO REMAIN THE SAME.

5 C-150 DETAIL
VIBRATING WIRE PIEZOMETER EXTENSION
SCALE: N.T.S.

DRAFT

MATERIAL SPECIFICATIONS

1. CRUSHED STONE
CRUSHED STONE IS TO CONSIST OF A SCREENED GRAVEL MATERIAL CONFORMING TO THE IDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION SECTION 1004 REQUIREMENTS, GRADATION CA 6 UNLESS OTHERWISE NOTED.

2. TOPSOIL
TOPSOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE TOPSOIL IS TO:
-BE CLASSIFIED AS SC, CL, ML, OR OL (PER ASTM D2487), AND
-BE FERTILIZED, AS NECESSARY BASED ON AGRONOMIC TESTING, TO SUPPORT VEGETATION GROWTH AT THE SITE.

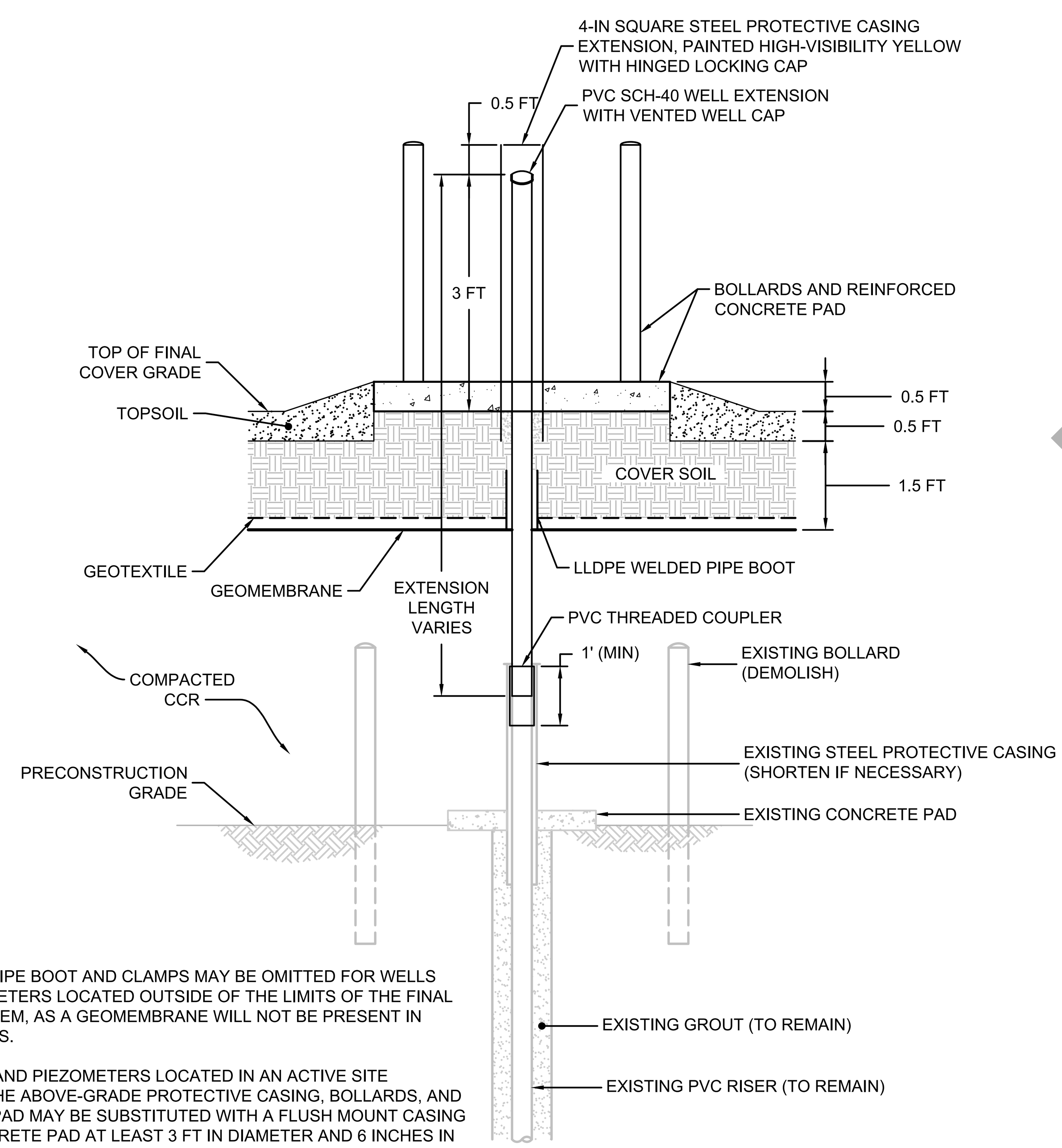
3. COVER SOIL
COVER SOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE COVER SOIL IS TO:
-BE CLASSIFIED AS A CL, CH, CL-CH, CL-ML, SC, OR SM (PER ASTH D2487), AND
-HAVE A MAXIMUM PARTICLE SIZE OF 1.5 INCHES (PER ASTM D422 OR D6943) FOR THE INITIAL 6 INCHES AND MAXIMUM PARTICLE SIZE OF 3 INCHES FOR THE REMAINDER.

4. COMPACTED CCR
COMPACTED CCR IS TO CONSIST OF COAL COMBUSTION RESIDUALS, RESIDUAL COAL, AND NATIVE SUBGRADE MATERIALS EXCAVATED FROM WITHIN THE LIMITS OF THE BAP AND SURROUNDING AREA. THE COMPACTED CCR IS TO:
-BE PLACED IN LOOSE LIFTS NOT TO EXCEED 2 FT IN THICKNESS.
-BE COMPACTED WITH AT LEAST 4 PASSES OF SMOOTH DRUM OR SHEEPSFOOT ROLLER, WITH COMPACTION VERIFIED VIA PROOF-ROLLING WITH A LOADED OFF-ROAD DUMP TRUCK UNTIL EXCESSIVE RUTTING GREATER THAN 4 INCHES DOES NOT OCCUR.

5. GEOTEXTILE (CUSHION AND SEPARATOR)
THE GEOTEXTILE IS TO CONSIST OF A NONWOVEN POLYPROPYLENE MATERIAL MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC INSTITUTE GRI-GT12(A) STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
-MINIMUM MASS PER UNIT AREA OF 16 OZ/YD^2 (PER ASTM D5261),
-MINIMUM GRAB STRENGTH OF 270 LB (PER ASTM D4632),
-MINIMUM TEAR STRENGTH OF 105 LB (PER ASTM D4533), AND
-MINIMUM PUNCTURE STRENGTH OF 725 LB (PER ASTM D6241).
GEOTEXTILE SEAMS ARE TO OVERLAPPED BY 1 FT DURING PLACEMENT AND EITHER MACHINE-SEWN OR THERMALLY BONDED TO ONE ANOTHER.

6. GEOMEMBRANE
THE GEOMEMBRANE IS TO CONSIST OF A LINEAR, LOW-DENSITY POLYETHYLENE (LLDPE) MATERIAL, TEXTURED ON BOTH SIDES, MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC RESEARCH INSTITUTE GM17 STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
-MINIMUM NOMINAL THICKNESS OF 40 MIL (PER ASTM D5994),
-MINIMUM ASPERITY HEIGHT OF 16 MIL (PER ASTM D7466),
-MAXIMUM SPECIFIC GRAVITY OF 0.939 G/ML (PER ASTM D792, OR ASTM D1505),
-MINIMUM TENSILE STRENGTH AT BREAK OF 60 LB/IN (PER ASTM D6693),
-MINIMUM ELONGATION AT BREAK OF 250% (PER ASTM D6693), AND
-MINIMUM PUNCTURE RESISTANCE OF 44 LB (PER ASTM D3895).
GEOMEMBRANE SEAMS ARE TO BE FUSION-WELDED; REPAIRS AND PENETRATIONS FOR PIPE BOOTS ARE TO BE EXTRUSION WELDED.

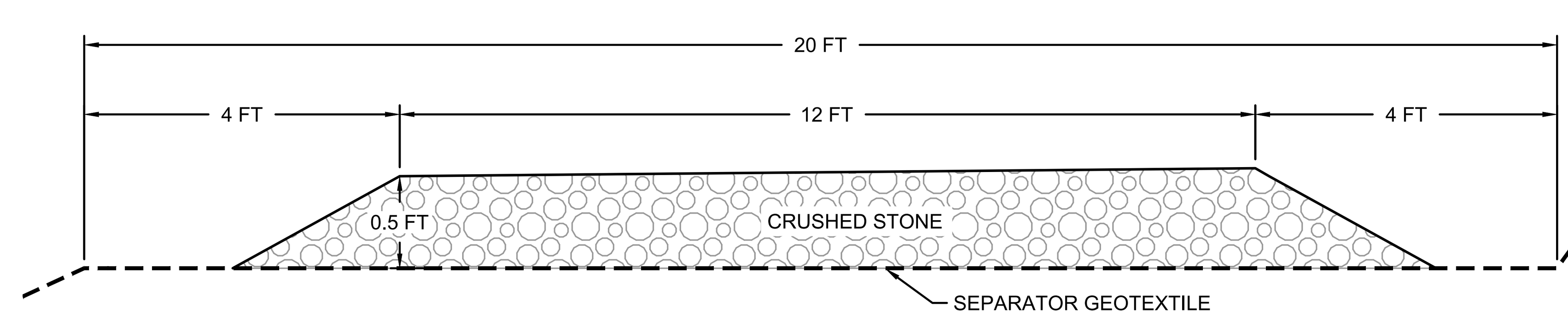
7. GEOCOMPOSITE DRAINAGE LAYER
THE GEOCOMPOSITE DRAINAGE LAYER IS TO CONSIST OF A POLYETHYLENE GEONET CORE WITH A NEEDLE-PUNCHED NONWOVEN GEOTEXTILE HEAT LAMINATED TO BOTH SIDES OF THE GEONET CORE, MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC RESEARCH INSTITUTE GM19 STANDARD SPECIFICATION AND WITH THE FOLLOWING REQUIREMENTS:
-MINIMUM POLYMER DENSITY OF 0.93 G/CUBIC CM (PER ASTM D792)
-MINIMUM NOMINAL OF 250 MIL (PER ASTM D5199)
-MINIMUM POLYMER OF 95 POLYESTER OR POLYPROPYLENE
-MAXIMUM APPARENT OPENING SIZE OF 0.15 MM (PER ASTM D4751)
-MINIMUM GRAB STRENGTH OF 260 LB (PER ASTM D4632)
-MINIMUM TEAR STRENGTH OF 100 LB (PER ASTM D4533)
-MINIMUM STATIC PUNCTURE STRENGTH OF 725 (PER ASTM D6241)
-MINIMUM TRANSMISSIVITY OF OF 0.0003 SQ M/SEC (PER ASTM D4716)



NOTES:

1. THE LLDPE PIPE BOOT AND CLAMPS MAY BE OMITTED FOR WELLS AND PIEZOMETERS LOCATED OUTSIDE OF THE LIMITS OF THE FINAL COVER SYSTEM, AS A GEOMEMBRANE WILL NOT BE PRESENT IN THESE AREAS.
2. FOR WELLS AND PIEZOMETERS LOCATED IN AN ACTIVE SITE ROADWAY,THE ABOVE-GRADE PROTECTIVE CASING, BOLLARDS, AND CONCRETE PAD MAY BE SUBSTITUTED WITH A FLUSH MOUNT CASING AND A CONCRETE PAD AT LEAST 3 FT IN DIAMETER AND 6 INCHES IN THICKNESS. ALL OTHER DETAILS ARE TO REMAIN THE SAME.

6 C-150 DETAIL
STANDPIPE PIEZOMETER AND MONITORING WELL EXTENSION
SCALE: N.T.S.



7 C-120 DETAIL
ACCESS ROAD
SCALE: N.T.S.

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DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: DETAILS AND MATERIAL SPECIFICATIONS - 1 OF 2

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

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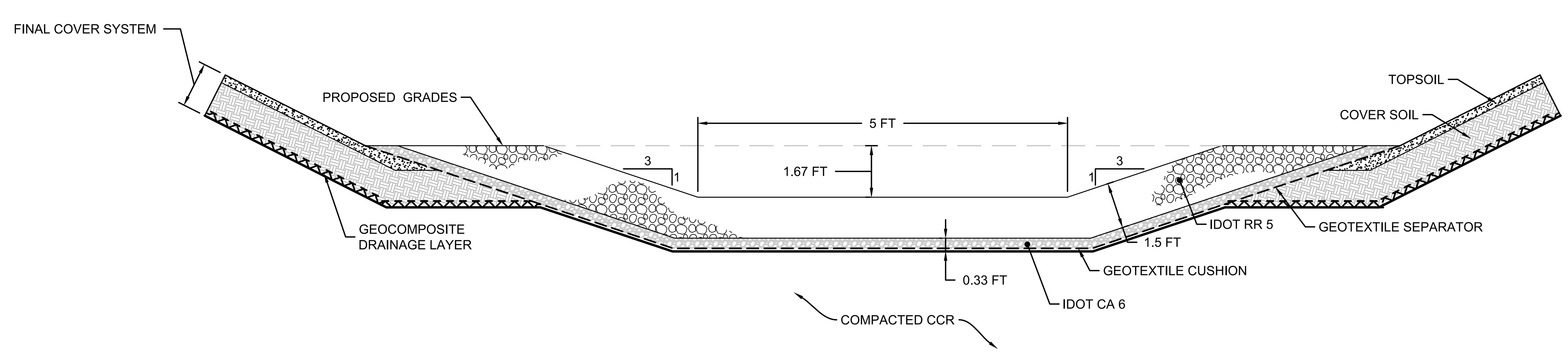
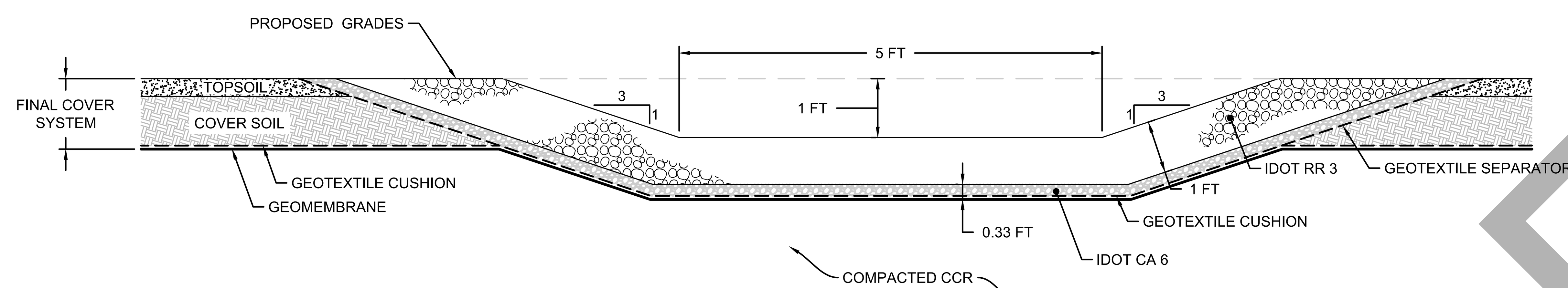
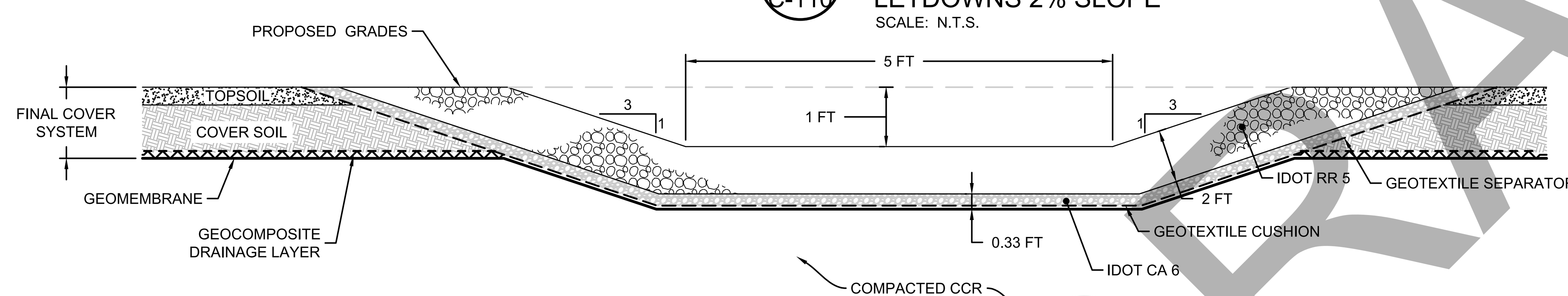
DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	08 - GLP8050 C-150
REVIEWED BY:	JPS	DRAWING NO.:	C-150
APPROVED BY:	TWW		



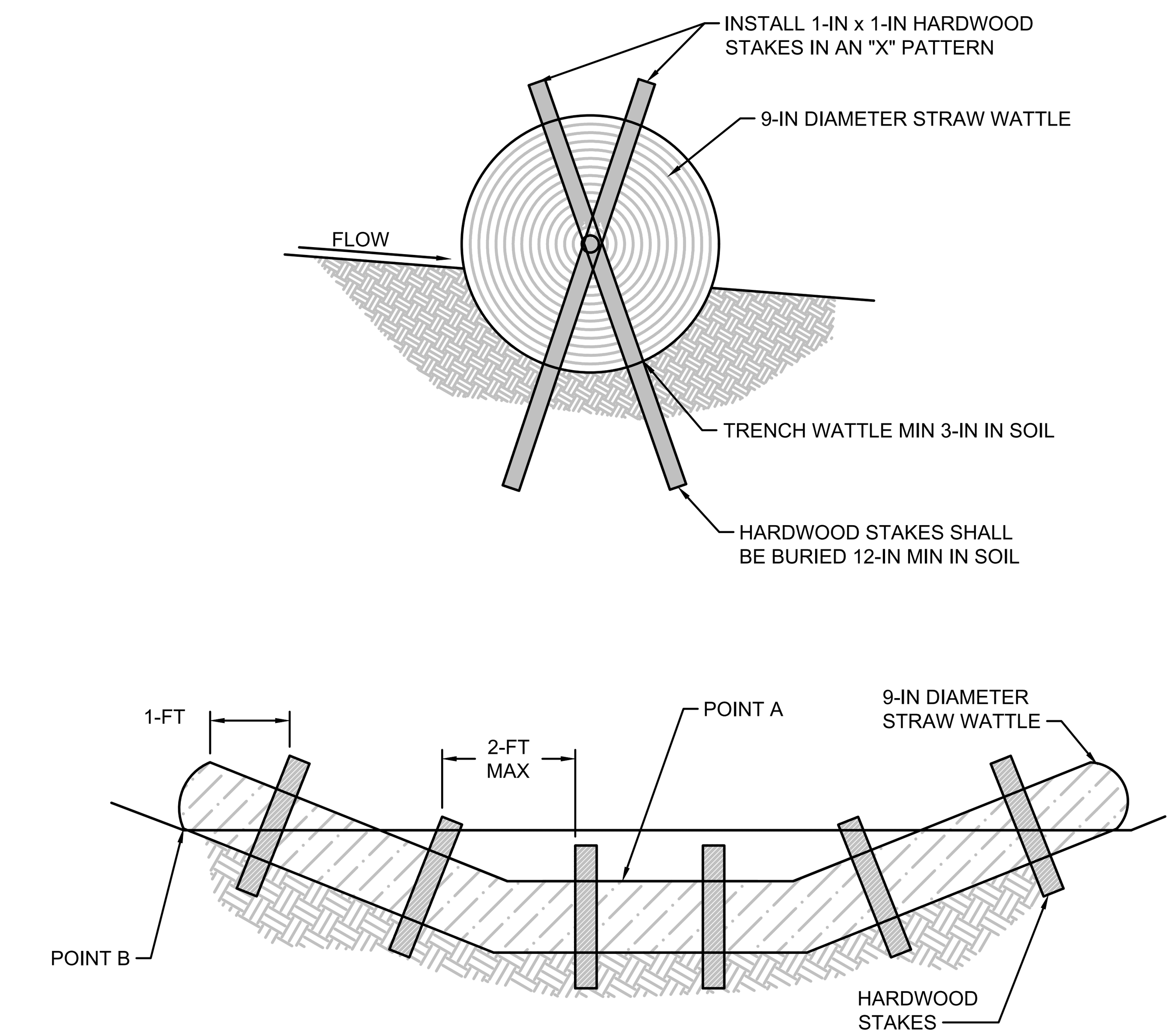
8 / C-110 DETAIL PERIMETER DITCH
SCALE: N.T.S.



9 / C-110 DETAIL LETDOWNS 2% SLOPE
SCALE: N.T.S.



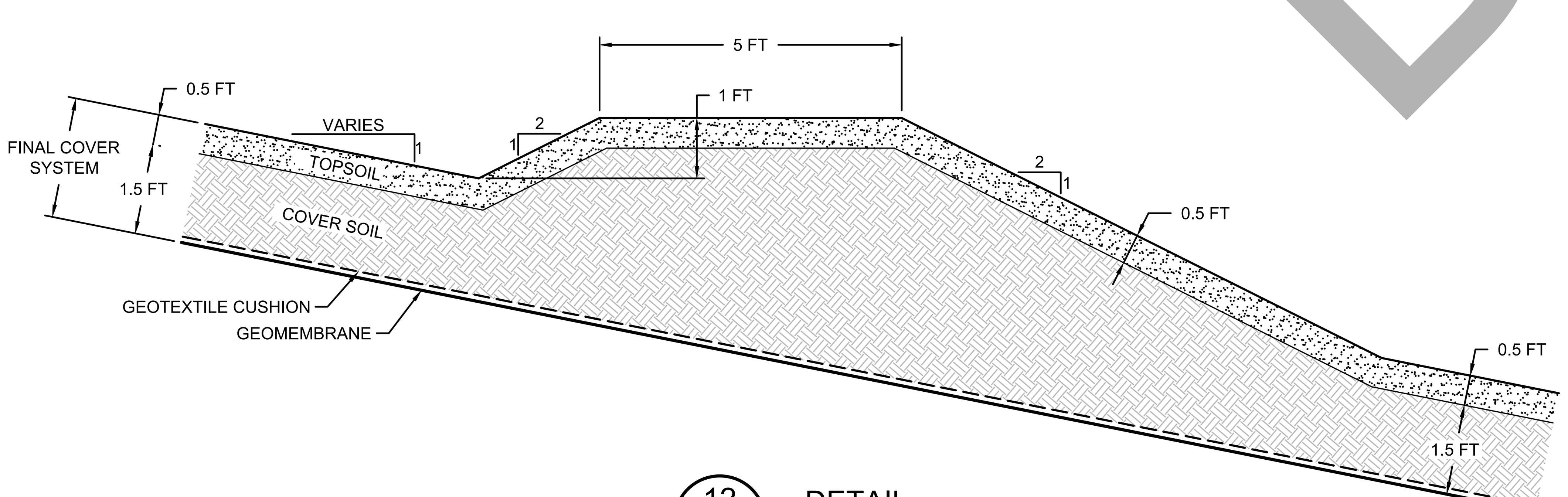
10 / C-110 DETAIL LETDOWNS 25% SLOPE
SCALE: N.T.S.



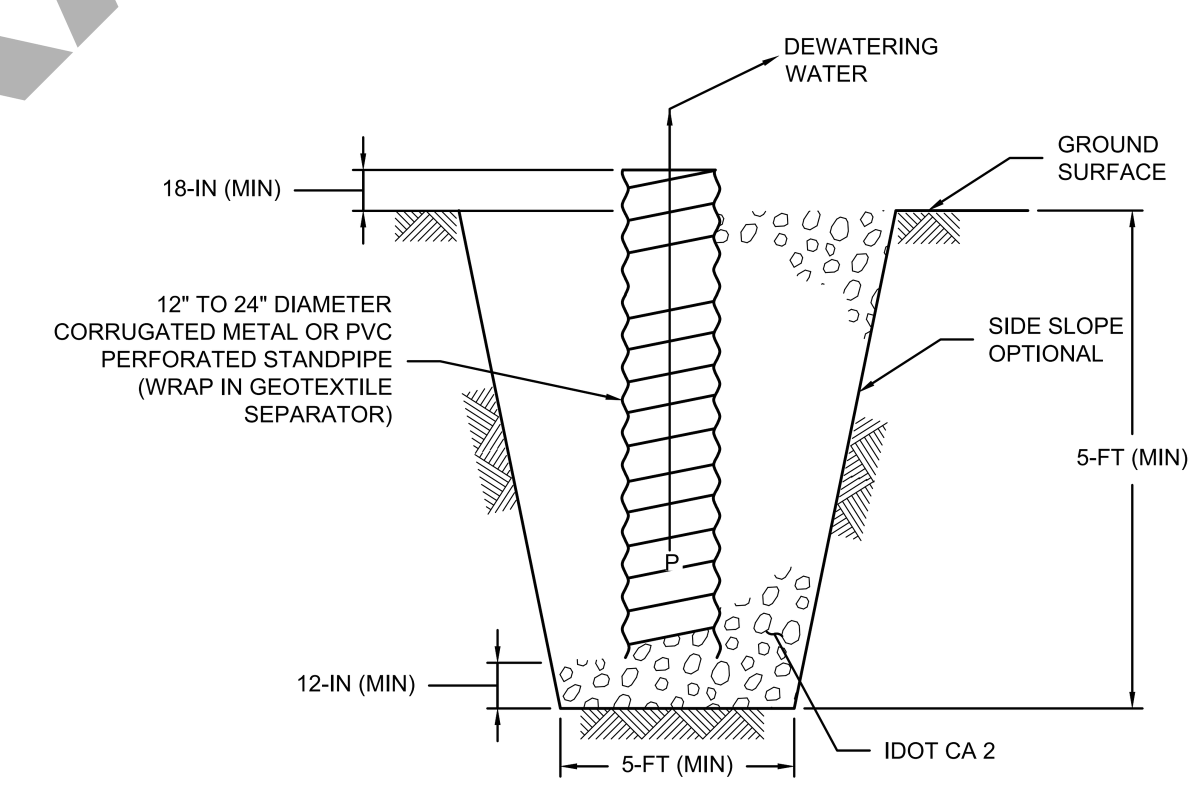
NOTES:

1. CONSTRUCT DITCH CHECK SO THAT "POINT A" IS A MINIMUM OF 3-IN LOWER THAN "POINT B".
2. PLACE DITCH CHECK PERPENDICULAR TO FLOW LINE OF DITCH.
3. CONSTRUCT DITCH CHECK SO THAT WATER DOES NOT FLOW AROUND THE ENDS OF OR UNDER THE DITCH CHECK.
4. REMOVE ACCUMULATED SEDIMENT WHEN SEDIMENT REACHES ONE-HALF THE HEIGHT OF THE DITCH CHECK.

11 / C-170 DETAIL STRAW WATTLE DITCH CHECK
SCALE: N.T.S.



12 / C-110 DETAIL INTERCEPTOR BERM
SCALE: N.T.S.



NOTES:

1. A BASE OF IDOT CA 2 SHALL BE PLACED IN THE PIT TO A MINIMUM DEPTH OF 12-IN BELOW THE STANDPIPE.
2. THE STANDPIPE SHALL EXTEND A MINIMUM 18-IN ABOVE THE LIP OF THE PIT; PONDED WATER SHALL NOT OVERTOP THE STANDPIPE BY ADJUSTING THE HEIGHT OF OF THE PIPE ABOVE THE SURFACE OF THE GROUND.
3. THE STANDPIPE SHALL BE WRAPPED IN GEOTEXTILE CUSHION MATERIAL.
4. THE MINIMUM DIMENSIONS OF THE SUMP PIT, IN PLAN, SHALL BE AT LEAST 5-FT DIAMETER.
5. "P" = PUMP

13 / C-160 DETAIL SUMP PIT
SCALE: N.T.S.

MATERIAL SPECIFICATIONS

- RIPRAP
  THE RIPRAP IS TO CONSIST OF A CRUSHED NATURAL LIMESTONE OR DOLOMITE MATERIAL AND CONFORMING TO THE ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, SECTION 281 REQUIREMENTS, CLASS A OR CLASS B QUALITY.

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TITLE: DETAILS AND MATERIAL SPECIFICATIONS - 2 OF 2

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

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DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	09 - GLP8050 C-160
REVIEWED BY:	JPS	DRAWING NO.:	C-160
APPROVED BY:	TWW		

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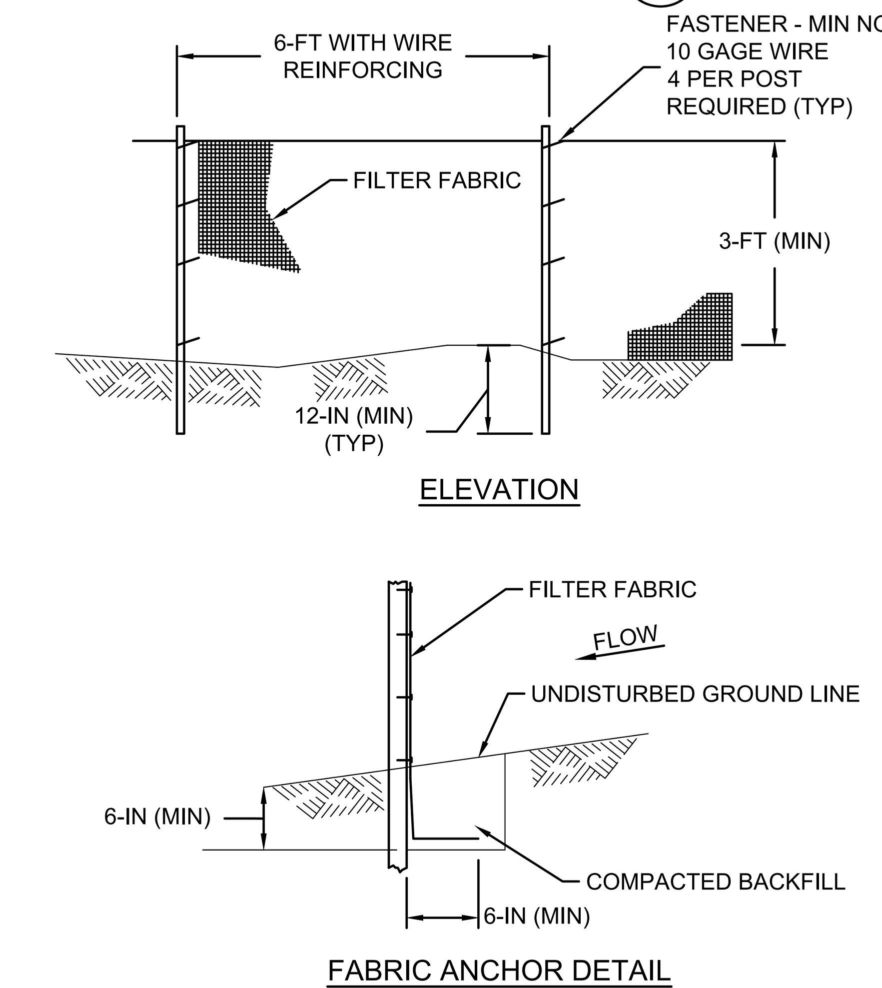
LEGEND

- EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- IMPOUNDMENT BOUNDARY
- PROPOSED GRADING MAJOR CONTOURS (5')
- PROPOSED GRADING MINOR CONTOURS (1')
- SILT FENCE (14 / C-170)
- STRAW WATTLE (11 / C-160)
- LIMITS OF DISTURBANCE (LOD)
- INTERCEPTOR BERM (12 / C-160)
- FINAL HAUL ROAD (7 / C-150)
- ROCK CHECK DAM (4 / C-150)



14 / C-170 DETAIL
SILT FENCE
SCALE: NTS

NOTES:

1. INSTALL ADDITIONAL SILT FENCE AND STRAW WATTLES AT ALL ENTRY POINTS FOR STORMWATER COLLECTION.
2. INSTALL ROCK CHECK DAMS IN THE PROCESS FLOW DITCH EVERY 200 FT.
3. INSTALL STRAW WATTLES AT CONCENTRATED FLOW AREAS.

0 200 400
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

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DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: EROSION AND SEDIMENT CONTROL PLAN

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

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DATE

DRAFT

DESIGN BY:	CLL	DATE:	JANUARY 2023
DRAWN BY:	DCW	PROJECT NO.:	GLP8050
CHECKED BY:	TWW	FILE:	10 - GLP8050 C-170
REVIEWED BY:	JPS	DRAWING NO.:	
APPROVED BY:	TWW		C-170

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ATTACHMENT C

Alternative Final Protective Layer Equivalency Demonstration (Sections 845.720(a)(1)(A) and 750(c)(2))

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Technical Memorandum

Date: May 25, 2023

To: Victor Modeer, P.E., DGE, Vistra on behalf of Dynegy Midwest Generation, LLC (DMG)

Copies to: Phil Morris, Rhys Fuller, Vistra on behalf of DMG

From: John Seymour, P.E., Geosyntec Consultants (Geosyntec)

Thomas Ward, P.E., Geosyntec

Subject: Proposed Alternative Final Protective Layer Equivalency Demonstration
Bottom Ash Pond, Baldwin Power Plant
Baldwin, Illinois
Geosyntec Project: GLP8050

PROPOSAL

An alternative final protective layer is proposed by Dynegy Midwest Generation, LLC (DMG) for the Bottom Ash Pond (BAP) surface impoundment that will be closed-in-place at the Baldwin Power Plant (BPP). The closure will be in accordance with Illinois Administrative Code (IAC) Part 845 Rule [1] (Part 845). Overall, the proposal will meet the requirements of Section 845.750(c)(2).

This Technical Memorandum presents a demonstration that a 2-foot-thick alternative final protective layer consisting of an 18-inch-thick soil layer and a 6-inch layer of topsoil provide equivalent or superior performance to the default protective layer set forth in Section 845.750(c)(2). The alternative final protective layer works in combination with an underlying low permeability (geomembrane) layer in place of the default three-foot thick, low permeability compacted earth layer required by Section 845.750(c)(1)(A). In addition, a cushion layer consisting of a geotextile or geocomposite drainage layer (25 percent slopes) is placed on top of the geomembrane prior to installation of the final protective layer. The combination of the above materials comprises the final "alternative final cover system".

A discussion of how the closure, including the proposed alternative final cover system discussed herein, meets the performance standards is contained in the Closure Plan [2], which includes the Closure Alternatives Assessment required by Section 845.710.

REQUIREMENTS OF SECTION 845

Section 845.750 provides requirements for both the final protective layer and underlying low permeability layer. They work in tandem to provide protection of groundwater and surface exposure conditions. A principal intention of the low permeability layer is to reduce the infiltration of liquid through the final cover system and into the CCR waste mass during post-closure conditions, in accordance with Section 845.720(a), which states in part:

> *The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will*:
>
> 1) *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate or contaminated run-off to the ground or surface waters or to the atmosphere;*

Specific default requirements for the final cover system are included in Section 845.750(c), which requires the final cover system to have either: 1) a three-foot thick soil low permeability compacted earth layer overlain by a three-foot-thick final protective layer (final protective layer), or 2) a geomembrane low permeability layer with a three-foot-thick final protective layer.

The specific Section 845.750(c)(2) design requirements for the final protective layer are as follows (emphasis added):

> *Standards for the Final Protective Layer: The final protective layer must meet the following requirements,* ***unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2)*** *and is approved by the Agency.*

Therefore, Section 845.750(c)(2) specifically allows the use of an alternate final protective layer as long as it provides an equivalent or superior performance to the default standards set forth in Section 845.750(c)(2), which are as follows:

> A) *Cover the entire low permeability layer;*
>
> B) *Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;*
>
> C) *Consist of soil material capable of supporting vegetation;*
>
> D) *Be placed as soon as possible after placement of the low permeability layer; and*
>
> E) *Be covered with vegetation to minimize wind and water erosion.*

The alternate design is only requesting an alternate to Section 845.740(c)(2)(B) related to the thickness of the of the final protective layer.

PROPOSED FINAL COVER SYSTEM SUMMARY

The proposed final cover systems will include:

- A low permeability layer consisting of a linear low-density polyethylene (LLDPE) geomembrane that is at least 40-mil in thickness, placed on a smooth CCR subgrade;
- A geotextile cushion; and
- A final protective layer consisting of 18 inches of protective cover soil with a 6-inch layer of topsoil capable of supporting vegetation.

The final protective layer will meet all Section 845.750(c)(2) criteria, will not need any supplemental engineering measures, and will be designed by a qualified professional engineer licensed in Illinois.

The concepts of the alternative cover system are illustrated on **Figure 1**.

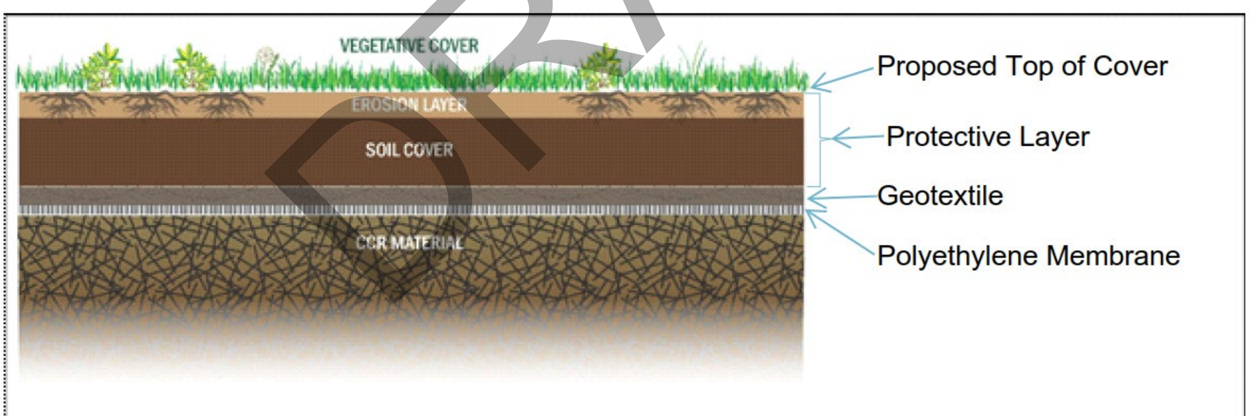

Figure 1: Proposed Alternative Final Cover System

DEMONSTRATION

The proposed alternate final protective layer will address the five requirements of Section 845.750 (c)(2)(A) to (E), as described in this section.

Section 845.750(c)(2)(A) Cover the entire low permeability layer

The final protective layer will horizontally cover the entire low-permeability layer, as indicated in the drawings in Attachment B of the Closure Plan [2]. Therefore, the use of the two-foot-thick final protective layer will meet the minimum requirements of Section 845 750(c)(2)(A) because it will completely cover the low-permeability layer.

Section 845.750(c)(2)(B) Be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer

The existing Part 845, which has the same requirements as Part 814 (closure rule for landfills), requires a three-foot-thick final protective layer to protect the underlying low permeability layer from freeze-thaw effects and root penetration. However, when a geomembrane is used as the low permeability layer it does not need these protections since it is not subject to the same impacts (i.e., causing an increase in hydraulic conductivity) as a compacted earth layer as discussed in more detail below.

A geomembrane low permeability layer will be used for the BPP BAP. Geomembranes have the following characteristics:

- Geomembranes do not have pores that can contain water and are therefore not susceptible to freeze-thaw damage that may reduce their performance as a low permeability layer and/or lead to degradation of the geomembrane.
    - Geomembrane panel strength and stiffness both increase with decreasing temperatures ([3], [4]). In 1996, the United States Bureau of Reclamation [5] (USBR) performed testing of both geomembrane panels and seams subjected to up to 500 freeze-thaw cycles, in both constrained and unconstrained conditions, with temperature cycles as severe as +30º C to -20º C.
    - The testing showed no changes in the strength of the geomembrane panels or seams. The USBR concluded that *"…there is simply "no change" in tensile behavior of geomembrane sheets or their seams after freeze-thaw cycling"*.
    - In 2013, the Geosynthetic Institute, upon reviewing the results of the USBR and other studies, concluded that *"the essential question often raised in this regard, i.e.,*

"will freeze-thaw conditions affect geomembrane sheets or their seam behavior," is answered with a resounding "NO"" [6].

- Geomembranes are not susceptible to grass plant root penetration because the geomembranes do not provide organic nutrients to plant roots and do not have pores or other areas where roots can enter the geomembrane.
  - Consequently, geomembranes are not a hospitable material that would either encourage root penetration or allow root penetration. Additionally, the geomembrane will be covered with a geotextile cushion or geocomposite drainage layer with a geotextile filter on top, which will provide an additional barrier to root penetration.

U.S. EPA research [7] states that *"A typical minimum thickness of the cover soil is 0.45 to 0.6 m…" (18 to 24 inches) thick "… for cover systems with hydraulic barriers"* (low permeability layer). This is particularly appropriate when using a geomembrane with low permeability which is not susceptible to any impact from freezing. U.S. EPA research also states that cover thickness design for root penetration into the low permeability layer is only a concern for compacted clay layers or geosynthetic clay barriers. This is when using an appropriate design of cover vegetation.

Therefore, the use of the two-foot-thick final protective layer will provide equivalent or superior performance to the requirements of Section 845.750 (c) (2) (B) when coupled with a geotextile cushion and a geomembrane low permeability layer, as geomembranes are not susceptible to freeze-thaw damage or root penetration as compared to a low permeability compacted earth layer.

Section 845.750(c)(2)(C) Consist of soil material capable of supporting vegetation.

The uppermost six inches of the final protective layer will consist of topsoil that is capable of supporting vegetation, which is the same requirement as the default (three-foot-thick) final protective layer. This is also consistent with the Federal CCR Rule, which requires a six-inch-thick "erosion" (topsoil) layer. Research [7] and Geosyntec's experience indicate topsoil layers are designed to have shallow-rooted grasses and most shallow-rooted grasses do not typically penetrate more than six inches into the subsurface. Shallow-rooted grasses will be specified based on recommendations from specialists at nurseries in the location of BPP and Illinois Department of Transportation guidelines. The topsoil layer will be fertilized and/or amended, as necessary, on a site-specific basis based on agronomical soil testing, to provide a growing medium for the vegetation that provides the required levels of nutrients and water storage during drought conditions.

Grass species will also be selected on a site-specific basis to minimize long-term vegetation maintenance, based on the climatic conditions at each site and the soil types. Vegetation will be established by applying seed and mulch and watering to establish the vegetation. Temporary erosion control measures will also be used during vegetation establishment to protect the topsoil layer from erosion. These measures may include erosion control blankets (ECBs), silt fences, hydroseeding, and/or other methods. The Post-Closure Care Plan includes the commitment to maintain the vegetation of the surface for the closed BPP BAP within the Construction Permit Application [8].

The 18-inches of the protective layer below the topsoil will consist of a soil type suitable for retaining moisture to provide additional support for vegetation during times of drought, and to support any grass species with roots that exceed six inches. Such soil types may include sandy clay loam, silty loam, silts, silty clays, lean clays, sandy clays, and/or sandy silts.

Therefore, the use of the two-foot-thick protective layer will meet the requirements of Section 845.750(c)(2)(C), as the final protective layer will utilize soil capable of supporting vegetation.

Section 845.750(c)(2)(D) Be placed as soon as possible after placement of the low permeability layer

The BPP BAP Closure Plan (Section 4.7.2 [2]) states that the geotextile and cover soil "…will be placed as soon as practical after the geomembrane has been deployed and both quality assurance and quality control testing has been performed on the geomembrane seams."

The use of a two-foot-thick protective layer will allow the final protective layer to be placed on top of the low permeability layer and vegetation to be established on top of the final protective layer sooner than if a three-foot thick final protective layer is used. This is due to the 33% reduction in earthwork volumes associated with the thinner two-foot-thick final protective layer.

Therefore, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845.750(c)(2)(D), by allowing the protective layer to be installed sooner than when using a three-foot-thick protective layer.

Section 845.750(c)(2)(E) Be covered with vegetation to minimize wind and water erosion.

The protective layer will be covered with vegetation to limit wind and water erosion, as noted in the discussion regarding Section 4.7.2 of the Closure Plan [2]. Additionally, the following design and engineering features, construction techniques, and maintenance procedures will be used to reduce the potential for wind and water erosion under both long-term conditions and during vegetation establishment.

- Design and Engineering Features
  - The final cover system will be gently sloped to direct surface water away from the impoundment. The final cover system grades will be approximately 2% over the majority of the BAP, although 25% (4 horizontal to 1 vertical [4H:1V]) grades will be used for heights of up to approximately 60 ft, to tie the final cover system into existing grades and reduce the overall height of the consolidated BAP. The final cover system will be keyed into the perimeter dikes, native foundation soils, or the existing FAPS cover, and access roads will be constructed on top of the final cover system. Beyond the final cover system, channels will direct surface water away from the BAP to the removed dam [Part 845.750(a)(2)].
  - The final cover system will include an anchor trench for the geosynthetic materials along the entire perimeter of the BAP to secure the final cover system into existing grades.
  - A stormwater management system consisting of armored ditches and letdown structures is included in the drawings within the Closure Plan [2] and will be constructed at percent designed to collect stormwater in a controlled manner and route it off the final cover system that will minimize infiltration into the CCR waste mass. The stormwater management system will minimize the overland flow distance between stormwater channels. Channels will be lined with an appropriate material, based on estimated stormwater velocities, to limit water erosion.
- Construction Techniques
  - The final protective layer is typically the most susceptible to wind and water erosion in the period between the placement of the protective layer and the establishment of vegetation. To reduce the potential for both wind and water erosion during this time, the following approaches will be utilized:
    - Temporary erosion and sediment controls (ESCs) will be installed to reduce the potential for erosion, such as erosion control blankets (ECBs), silt socks (e.g., straw wattles), silt fences, and other methods. These ESCs will be regularly inspected and maintained until vegetation is established.
    - The entire surface of the final protective layer will be stabilized during seeding and until vegetation is established. Coverings may consist of straw, mulch, hydroseeding binder, ECBs, or engineering growing media.

    - The final protective layer will be regularly inspected and maintained during vegetation establishment. Any areas that become eroded by wind and water will be repaired until vegetation is established to a suitable level over the surface of the final cover.

- Maintenance Procedures
    - During the post-closure care period, vegetation established on the final protective cover layer will be regularly maintained using a written and IEPA-approved maintenance program. The program will consist of regular mowing and inspections. Any bare areas or areas of erosion will be repaired by seeding and stabilizing the area, and observing the area until vegetation becomes re-established.
    - The final cover slopes will be approximately 2% over the majority of the BAP and 25% for heights of up to approximately 60 ft. These slopes experience less erosion in general, especially less than typical landfill covers sloped at predominately 25 to 33%. Typically, after three to five years, it is Geosyntec's experience that the cover vegetation becomes fully stabilized and experiences less erosion.

In conclusion, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845 750(c)(2)(E), using a robust program to support the establishment of protective vegetation, prevent and address any erosion that may occur during vegetation establishment, and monitor and maintain the vegetation during post-closure conditions.

ADDITIONAL CONSIDERATIONS

Infiltration Analysis

The use of the proposed two-foot-thick final protective layer, when coupled with a geomembrane low permeability layer, will also meet the criteria contained within Section 845.750 (a) (1). Section 845.750(a)(1) provides the following requirement:

> *Section 845.750(a)(1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*

Section 845.750(a)(1) is an important overall measure of the effectiveness of the final cover system because it requires control of post-closure infiltration of liquids through the final cover and into the waste and releases of CCR.

An infiltration was conducted by Ramboll, within the BPP BAP Construction Permit Application [8], to estimate post-closure liquid infiltration rates through both the default and the proposed alternate final cover systems at the BPP BAP. The infiltration analysis used the Hydrologic Evaluation of Landfill Performance (HELP) software promulgated by the USEPA [9]. The HELP model estimates the infiltration rates from the top of the cover, through the final protective layer and through the low permeability layer (either a geomembrane or the three-foot thick compacted earth layer). The results are included in **Appendix A**. The resulting estimated infiltration rates are provided in **Table 1**.

Table 1 - BPP BAP Final Cover Systems for Infiltration Analysis

Description	Low Permeability Layer[1]	Final Protective Layer	Infiltration Rate[2,3]
Proposed Alternative Final Cover System	40-mil Linear Low-Density Polyethylene (LLDPE) Geomembrane	2 ft of cover material, including, from bottom to top, a 16 oz nonwoven geotextile, 1.5 ft of silty clay and 0.5 ft of silty clay loam	0.00012 in/yr
Default Cover with Geomembrane Barrier	40-mil LLDPE Geomembrane	3 ft of cover material, including, from bottom to top, a 16 oz nonwoven geotextile, 2.5 ft of silty clay and 0.5 ft of silty clay loam	0.00011 in/yr
Default Cover with Compacted Earth Layer	3-ft thick compacted earth layer (1×10^{-7} cm/sec)	3 ft of cover material, including, from bottom to top, 2.5 ft of silty clay and 0.5 ft of silty clay loam	0.00083 in/yr

The BPP BAP analysis indicated that the performance of the proposed alternative final cover system with a geomembrane and a two-foot-thick final protective cover is equivalent the performance offered by the default final cover system utilizing a geomembrane with the default three-foot-thick protective layer and cushion layer.

Furthermore, the proposed alternative final cover system performance exceeds the performance of a final cover system using a three-foot-thick compacted earthen low permeability layer and a three-foot-thick final protective layer (a total cover thickness of six feet).

Environmental and Societal Benefits

The use of the proposed two-foot-thick final protective layer will provide the following additional environmental and societal benefits, relative to the default three-foot-thick final protective layer:

---

[1] All HELP run versions used a pinhole density of 1 hole per acre, installation defects of 1 hole/acre, and construction quality as "good".
[2] Infiltration is out the bottom of the low permeability layer.
[3] Infiltration rates provided as average percolation through the top and slopes of the cover systems reported in HELP model output files in Appendix A.

- The final cover system earthwork quantities will be reduced by 33%. This will result in a corresponding 33% reduction in the amount of onsite soil fill that needs to be excavated, hauled to the construction location, and placed. This provides multiple benefits, such as:
  - Reduced disruption to onsite areas caused by the excavation of fill materials and corresponding disturbance to the natural environment.
  - Reduced haul truck traffic on site access roadways, thereby reducing, air pollution, and carbon emissions.
  - Reduced earthwork effort during installation of the final cover system, thereby reducing air pollution and carbon emissions.
- Construction of the alternate final cover system can be completed faster than the default final cover, providing multiple benefits, such as:
  - Initiation of the reduction of infiltration at a sooner date than with the default final cover system.
  - Ceasing construction-related impacts to offsite residents (e.g., air pollution, carbon emissions) at a sooner date than otherwise possible.

SUMMARY

The proposed alternate final protective layer will:

- Provide equivalent or superior performance to the requirements of Section 845.750 (c)(2).
- Have a geotextile cushion layer, which is not required by Section 845.750, over the geomembrane that adds physical protection for the geomembrane.
- Have an equivalent infiltration rate with respect to infiltration through the default soil final cover system using a geomembrane barrier with three feet of cover soil, but a lower infiltration rate with respect to infiltration through the default soil final cover system with compacted earth low permeability layer and three feet of cover soil.
- Meet or exceed the same criteria for long term performance and all other requirements of Section 845.750(c)(2).
- Provide other benefits by reducing the amount of final cover earthwork by 33% for the BPP BAP.

REFERENCES

[1] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[2] Geosyntec Consultants, Inc., "Final Closure Plan for Bottom Ash Pond, Baldwin Power Plant," January 2023.

[3] A. L. Rollin, J. Lafleur, M. Marcotte, O. Dascal and Z. Akber, "Selection Criteria for the Use of Geomembranes in Dams and Dykes in Northern Climate," in *Proceedings of the International Conference on Geomembranes*, Denver, Colorado, 1945.

[4] D. E. Thorton and P. Blackall, "Report EPA-3-76-13: Field Evaluation of Plastic Film Liners for Petroleum Storage Areas in the Mackenzie Delta," Canadian Environmental Protection Service, 1976.

[5] A. I. Comer and Y. G. Hsuan, "Report R-96-03: Freeze-Thaw Cycling and Cold Temperature Effects on Geomembrane Sheets and Seams," U.S. Bureau of Reclamation, 1996.

[6] Y. G. Hsuan, R. M. Koerner and A. I. Comer, "GSI White Paper #28: Cold Temperature and Freeze-Thaw Cycling Behavior of Geomembranes and their Seams," Geosynthetic Institute, Folsom, Pennsylvania, 2013.

[7] United States Environmental Protection Agency, "(Draft) Technical Guidance For RCRA/CERCLA Final Covers," Office of Solid Waste and Emergency Response, Washington D.C., 2004.

[8] Geosyntec Consultants, Inc., "Construction Permit Application for Bottom Ash Pond, Baldwin Power Plant," 2023.

[9] T. Tolaymat and M. Krause, "Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual," United States Environmental Protection Agency, Washington, DC, 2020.

APPENDIX A: HELP MODEL OUTPUT

A-1: BAL BAP- 2-FT FINAL PROTECTIVE COVER SOIL, SLOPES

A-2: BAL BAP-3-FT FINAL PROTECTIVE COVER SOIL, SLOPE

A-3: BAL BAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL, SLOPES

A-4: BAL BAP- 2-FT FINAL PROTECTIVE COVER SOIL, TOP

A-5: BAL BAP-3-FT FINAL PROTECTIVE COVER SOIL, TOP

A-6: BAL BAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL, TOP

APPENDIX A-1

BAL BAP- 2-FT FINAL PROTECTIVE COVER SOIL, SLOPES

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Slopes **Simulated On:** 1/6/2023 7:23

DRAFT

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.3673	vol/vol
Effective Sat. Hyd. Conductivity	=	1.90E-06	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness	=	18	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.3948	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-06	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	25	%
Drainage Length	=	150	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	231.72	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.076	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	21.39	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	6.845	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	26.923	inches
Total Initial Water	=	26.923	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days

End of Growing Season (Julian Date)	=	285	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Slopes
Simulated on: 1/6/2023 7:24

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	3,234,836.6	100.00
Runoff	16.562	[3.613]	1,285,952.1	39.75
Evapotranspiration	24.541	[2.705]	1,905,475.7	58.90
Subprofile1				
Lateral drainage collected from Layer 3	0.5339	[0.485]	41,451.4	1.28
Percolation/leakage through Layer 4	0.000007	[0.000006]	0.5720	0.00
Average Head on Top of Layer 4	0.0002	[0.0002]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000007	[0.000007]	0.5716	0.00
Water storage				
Change in water storage	0.0252	[0.7492]	1,956.9	0.06

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-2

BAP BAP- 3-FT FINAL PROTECTIVE COVER

SOIL, SLOPES

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Slopes Def 1 **Simulated On:** 1/6/2023 6:43

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.3673	vol/vol
Effective Sat. Hyd. Conductivity	=	1.90E-06	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness	=	30	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.4013	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-06	cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	25	%
Drainage Length	=	150	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	231.72	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.076	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	21.39	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	6.845	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	31.855	inches
Total Initial Water	=	31.855	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days

End of Growing Season (Julian Date)	=	285	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Slopes Def 1
Simulated on: 1/6/2023 6:44

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	3,234,836.6	100.00
Runoff	16.562	[3.613]	1,285,952.1	39.75
Evapotranspiration	24.541	[2.705]	1,905,475.7	58.90
Subprofile1				
Lateral drainage collected from Layer 3	0.5339	[0.4914]	41,451.3	1.28
Percolation/leakage through Layer 4	0.000008	[0.000007]	0.6097	0.00
Average Head on Top of Layer 4	0.0002	[0.0002]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000008	[0.000007]	0.6123	0.00
Water storage				
Change in water storage	0.0252	[0.7766]	1,956.9	0.06

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-3

BAL BAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL, SLOPES

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Slopes Def 2 **Simulated On:** 1/6/2023 7:01

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
Silty Clay Loam
Material Texture Number 45

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.4002	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
Silty Clay
Material Texture Number 46

Thickness	=	30	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.4184	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 3
Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	231.72	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.0761	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	21.39	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	7.555	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	32.578	inches
Total Initial Water	=	32.578	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days
End of Growing Season (Julian Date)	=	285	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for: Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Slopes Def 2
Simulated on: 1/6/2023 7:02

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	3,234,836.6	100.00
Runoff	13.463	[3.65]	1,045,365.7	32.32
Evapotranspiration	27.904	[3.12]	2,166,632.0	66.98
Subprofile1				
Percolation/leakage through Layer 3	0.000937	[0.000527]	72.7	0.00
Water storage				
Change in water storage	0.2932	[0.6037]	22,766.1	0.70

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-4

BAL BAP- 2-FT FINAL PROTECTIVE COVER SOIL, TOP

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title:	BAL BAP CIP Cons Top		**Simulated On:**	1/6/2023 7:18

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.3673	vol/vol
Effective Sat. Hyd. Conductivity	=	1.90E-06	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness	=	18	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.3951	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-06	cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
16 oz Nonwoven Geotextile
Material Texture Number 43

Thickness	=	0.11	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	3.00E-01	cm/sec
Slope	=	2	%
Drainage Length	=	600	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	545.28	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.076	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	89.8	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	53.73	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	6.849	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	50.759	inches
Total Initial Water	=	50.759	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days

End of Growing Season (Julian Date)	=	285	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Top
Simulated on: 1/6/2023 7:19

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	8,125,655.5	100.00
Runoff	16.544	[3.658]	3,226,692.1	39.71
Evapotranspiration	24.605	[2.679]	4,798,963.4	59.06
Subprofile1				
Lateral drainage collected from Layer 3	0.4260	[0.3581]	83,079.3	1.02
Percolation/leakage through Layer 4	0.061216	[0.074113]	11,939.6	0.15
Average Head on Top of Layer 4	0.7474	[0.9614]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000239	[0.000259]	46.6	0.00
Water storage				
Change in water storage	0.0865	[0.7368]	16,874.2	0.21

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-5

BAP BAP- 3-FT FINAL PROTECTIVE

COVER SOIL, TOP

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAP CIP Cons Top Def 1 **Simulated On:** 1/6/2023 6:31

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam (Moderate)
Material Texture Number 26

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.3673	vol/vol
Effective Sat. Hyd. Conductivity	=	1.90E-06	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiC - Silty Clay (Moderate)
Material Texture Number 28

Thickness	=	30	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.4014	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-06	cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
16 oz Nonwoven Geotextile
Material Texture Number 43

Thickness	=	0.11	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	3.00E-01	cm/sec
Slope	=	2	%
Drainage Length	=	600	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	545.28	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.076	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	89.8	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	53.73	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	6.849	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	55.691	inches
Total Initial Water	=	55.691	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days

End of Growing Season (Julian Date)	=	285	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Baldwin, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35	44.8	49.4	61.2	72.7	82.1
84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAP CIP Cons Top Def 1
Simulated on: 1/6/2023 6:33

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	8,125,655.5	100.00
Runoff	16.510	[3.611]	3,220,169.2	39.63
Evapotranspiration	24.595	[2.679]	4,797,020.3	59.04
Subprofile1				
Lateral drainage collected from Layer 3	0.4546	[0.4005]	88,667.6	1.09
Percolation/leakage through Layer 4	0.075972	[0.113961]	14,817.6	0.18
Average Head on Top of Layer 4	0.9812	[1.5588]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000227	[0.000268]	44.2	0.00
Water storage				
Change in water storage	0.1013	[0.7462]	19,754.1	0.24

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-6

BAL BAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL, TOP

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: BAL BAP CIP Cons Top Def 2 **Simulated On:** 1/6/2023 7:12

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
Silty Clay Loam
Material Texture Number 45

Thickness	=	6	inches
Porosity	=	0.445	vol/vol
Field Capacity	=	0.393	vol/vol
Wilting Point	=	0.277	vol/vol
Initial Soil Water Content	=	0.3993	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
Silty Clay
Material Texture Number 46

Thickness	=	30	inches
Porosity	=	0.452	vol/vol
Field Capacity	=	0.411	vol/vol
Wilting Point	=	0.311	vol/vol
Initial Soil Water Content	=	0.4225	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 3
Type 1 - Vertical Percolation Layer (Waste)
Electric Plant Coal Bottom Ash
Material Texture Number 83

Thickness	=	545.28	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.0762	vol/vol
Effective Sat. Hyd. Conductivity	=	5.29E-04	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	89.8	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	53.73	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	7.665	inches
Upper Limit of Evaporative Storage	=	8.094	inches
Lower Limit of Evaporative Storage	=	5.394	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	56.628	inches
Total Initial Water	=	56.628	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	38.18	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	104	days
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Average Wind Speed	=	8	mph
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Note: Evapotranspiration data was obtained for Baldwin, Illinois

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2.421014	2.032335	4.330912	4.401604	4.511846	4.068128
4.023992	2.88724	2.952714	2.941943	4.289265	2.800511

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84.9	81.7	72.6	59.4	50.1	43.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 38.18/-89.85

Average Annual Totals Summary

Title: BAL BAP CIP Cons Top Def 2
Simulated on: 1/6/2023 7:13

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.66	[4.8]	8,125,655.5	100.00
Runoff	12.836	[3.593]	2,503,525.7	30.81
Evapotranspiration	28.338	[3.154]	5,527,044.6	68.02
Subprofile1				
Percolation/leakage through Layer 3	0.000716	[0.000461]	139.7	0.00
Water storage				
Change in water storage	0.4868	[0.607]	94,945.6	1.17

* Note: Average inches are converted to volume based on the user-specified area.

ATTACHMENT D

Hydrologic and Hydraulic Design of Stormwater Management System (Sections 845.750(a)(2) and (a)(4))

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: **Dynegy** Project: **Baldwin BAP Closure Plan** Project/ Proposal No.: **GLP8050** Task No. **02/02**

Title of Computations	**Cover System Hydrologic and Hydraulic Analysis Report**		
Computations by:	Signature		12/07/2022
	Printed Name	Shailendra Singh	Date
	Title	Senior Staff Professional	
Assumptions and Procedures Checked by: (Senior reviewer)	Signature		12/8/2022
	Printed Name	Megan Bender, P.E.	Date
	Title	Senior Engineer	
Computations Checked by:	Signature		12/07/2022
	Printed Name	Patrick VanDeWiele, P.E.	Date
	Title	Project Engineer	
Computations backchecked by: (Originator)	Signature		12/07/2022
	Printed Name	Shailendra Singh	Date
	Title	Senior Staff Professional	
Approved by: (PM or designate)	Signature		12/09/2022
	Printed Name	Thomas Ward, P.E.	Date
	Title	Senior Engineer	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	SS	Date:	07 12 22 (DD MM YY)	Reviewed by:	PV	Date:	07 12 22 (DD MM YY)
Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

TABLE OF CONTENTS

Written by:	SS	Date:	07 12 2022 (DD MM YY)	Reviewed by:	PV	Date:	07 12 2022 (DD MM YY)
Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

1. Introduction

This report documents the conceptual-level hydrologic and hydraulic analysis to support the 30% design of stormwater features for the Baldwin Fly Ash Pond Closure Plan. The project site is approximately 177 acres located in Baldwin, Illinois with 76 aces being closed in place.

The following sections describe the design approach, methodology, assumptions, results, and findings. Stormwater features analyzed include interceptor berms, rock chutes, and riprap aprons.

2. Design Approach

In accordance with the CCR Rule (USEPA, 2015) and the Illinois Part 845 Rule (IEPA, 2021) the stormwater features are designed to adequately manage a 100-year, 24-hour Soil Conservation Service (SCS) Type II storm event.

The following summarizes tools and methodology used in the hydrologic and hydraulic analysis:

- EPA SWMM 5.1 (US EPA, 2020) is a storm water management model used for planning, analysis, and design stormwater runoff, combined and sanitary sewers, and other drainage system.
- A Manning's flow calculator tool (NEH, 2010) was used to analyze hydraulic performance of interceptor berms.
- The National Resource Conservation Service (NRCS) rock chute design tool (Robinson et al., 1998) was utilized for sizing rock chute grade stabilization structures.

3. Assumptions and Analysis

The following sections present a summary of the performed analyses, along with an overview of the information relied upon and the associated assumptions.

3.1 Project Site Condition

3.1.1 Pre-Closure Topographic Survey

Site topographic surveys of existing (pre-closure) conditions were performed by Others in December 2020 and November 2021 as noted on the drawings.

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Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

3.1.2 Proposed Post-Closure Design

Proposed post-closure design will be permit-level design drawings, Bottom Ash Pond Construction Permit Application Closure Drawings, December 2022.

3.2 Hydrology

A hydrologic analysis was performed for the project site to assess and quantify the peak flow from site under 100-year 24-hr design storm event. The results of the hydrologic analysis were used as part of the hydraulic analysis to design the various stormwater features.

3.2.1 Drainage Areas

The final cover system is approximately 76 acres. The cover system consists of a 25% slope that wraps around the perimeter of the final cover system with 2% slope on top.

The final cover system was delineated into 23 drainage areas ranging from 1.4 acres to a maximum of 6.4 acres. The delineated drainage map is presented in Figure 1 of **Appendix A**.

The largest drainage area on the final cover system was determined to be Drainage Area No. 1 and was utilized as the *critical cover drainage area*. This *critical cover drainage area* of 6.4 acres is the largest and serves as the basis for design of all stormwater features within the cover system. This *critical cover drainage area* was further delineated into two subcatchments as shown in Figure 2 of **Appendix A** to model peak runoff from the area with 2% slope (Subcatchment -1) and 25% slope (Subcatchment -2).

The design of stormwater features that traverse the final closure area were based on cumulative flows from the *critical cover drainage area with 2% slope* and *25% slope*.

3.2.2 Rainfall Depth and Distribution

The National Oceanic Atmospheric Administration (NOAA) Atlas 14 provides precipitation frequency information for the U.S. states and territories. NOAA precipitation frequency estimates serve as standard practice for designing, building, and operating infrastructure to withstand the forces of heavy precipitation and floods.

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Rainfall depths used in this analysis were based on NOAA Atlas 14 (NOAA, 2006) Point Precipitation Frequency Estimates, as shown in **Appendix B**.

The rainfall distribution used in this analysis was SCS Type-II distribution, which is considered a conservative temporal distribution for a 24-hour duration storm event due to its peak rainfall intensity. The SCS distribution results in a greater peak flow as compared to other acceptable standardized distributions, such as Huff 3rd Quartile, as published in the Illinois State Water Survey (ISWS) Circular 173 (ISWS, 1990).

The Type II SCS 100-year, 24-hour event of 7.50 inches was used as the *design rainfall event* to size the proposed stormwater features.

3.2.3 Rainfall Runoff – Curve Number

To estimate stormwater runoff from the *design rainfall event*, the SCS curve number method was used in the SWMM model. A curve number (CN) is a numerical representation of the runoff potential of a watershed that is based on soil type, plant cover, imperviousness, interception, and surface storage (USDA, 1986).

The final cover system will include, from bottom to top, a geomembrane, geotextile, 1.5 feet of cover soil, 0.5 feet of topsoil, and a vegetative cover. For this analysis, based on assumed soil conditions, a single CN was determined from TR-55 manual (USDA, 1986) to represent the final cover system as follows:

- Post-closure Areas (CN=80)
  - Cover Type – Meadow
  - Hydrologic Condition – Fair
  - Hydrologic Soil Group – C/D

3.3 Hydraulics

The results of the hydrologic analysis were used as part of the hydraulic analysis to design the various stormwater features, that include interceptor berms, rock chutes and energy dissipation plunge pool. SWMM model generated peak discharges from *critical drainage areas,* and their corresponding sub-catchment, were utilized in this analysis.

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Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

3.3.1 Interceptor Berms

Interceptor berms with triangular cross-section will be used to intercept sheet and shallow concentrated flows from the final cover system. *Critical drainage area* described in **Section 3.2.1** were further delineated into subcatchments as part of the design process to determine the location, length, height, and longitudinal slope of the interceptor berms.

According to Manning's n for Channels (Chow, 1959), a Manning's roughness coefficient of 0.030 was used for excavated earthen channels with short grass and few weeds. Hydraulic analyses using the Manning's flow calculator tool (NEH, 2010) were performed to determine maximum intercept berm height required to adequately convey flow from sub-catchments to the corresponding rock chute, without overtopping.

3.3.2 Rock Chutes (Letdowns)

Rock chutes with trapezoidal cross-section will be used to collect flow from interceptor berms and adequately convey the peak discharges down steep slopes on the final cover system. Each Cover Rock Chute will discharge into an inlet depression that feeds into a culvert. Perimeter Slope Rock Chutes were designed to convey cumulative flow from both the contributing cover drainage area and interceptor berms.

The rock chute trapezoidal cross-section design consists of 3H:1V side slopes. Rock chutes were analyzed on longitudinal slopes no greater than 3H:1V. Hydraulic analyses using the NRCS rock chute design tool (Robinson et al., 1998) were performed to determine minimum chute depth to contain the *design storm event* and riprap lining (minimum D_{50} size and riprap layer thickness) to withstand erosive forces from the design storm event.

4. Results and Findings

4.1 Hydrologic Analysis

SWMM model simulated peak runoff from two critical drainage areas (subcatchment 1 with 2% slope and subcatchment-2 with 25% slope) for 100-year storm event is presented in **Table 1**.

Written by:	SS	Date:	07 12 2022 (DD MM YY)	Reviewed by:	PV	Date:	07 12 2022 (DD MM YY)
Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

Table 1. Simulated Peak Runoff for two subcatchments with 2% and 25% slopes

Subcatchment	Peak Runoff (cfs)	Cumulative Peak Runoff (cfs)
Subcatchment -1 (2% Slope)	31.0	31.0
Subcatchment -2 (25% Slope)	15.2	46.2

4.2 Interceptor Berm Design

The peak flow, maximum velocity, and maximum flow depth were evaluated for 2% and 25% slopes and is presented in **Table 2** below. Sub-catchment tributary to the interceptor berm and a schematic representation of the respective interceptor berm are presented in **Appendix C**.

Table 2: Key Parameters for Interceptor Berms

Surface Description	Peak Flow (cubic feet/second)	Max Velocity (feet/second)	Max Flow Depth (feet)
2% Cover Slope	31.3	2.5	0.7
25% Slope	15.3	3.4	1.2

Around the cover system's 2% slope, three set of interceptor berms will be tributary to a cover rock chute and one set of interceptor berms will be tributary to 25% slope rock chute. Since the maximum flow depth was 1.2 feet for the 25% slope, the berm height to adequately convey flow from subcatchments to the rock chute was determined to be set at 1.25-foot, across all slopes, for consistency. Figure 1 of **Appendix A** presents locations of all interceptor berms.

4.3 Rock Chute (Letdowns) Design

The rock chute design key parameters such as peak flow, slope, channel bottom width, and riprap lining D_{50} (minimum D50 size and riprap thickness) are presented in **Table 3** below. The inlet and outlet invert elevations, bottom and top widths, flow depths and riprap layer thicknesses are presented in **Appendix D.**

Table 3: Key Parameters for Rock Chutes

Surface Description	Peak Flow (cubic feet/second)	Channel Bottom Width (feet)	Riprap Lining D_{50} (inches)
On 2% Cover Slope	31.0	5.0	2.1
On 25% Cover Slope	46.2	5.0	11.8

A total of 19 rock chutes with a bottom width of 5 feet and a riprap lining D50 of 2.5 inches will adequately convey 100-year *design storm event* from 2% cover slope that will transition to rock chute with riprap lining D50 of 12 inches on 25% slope to convey the cumulative design storm from 2% and 25% slope areas. A total of 23 rock chutes with a bottom width of 5 feet and a riprap lining D50 of 12 inches will adequately convey cumulative flows from both 2% and 25% slope areas. Figure 1 of **Appendix A** presents locations of all rock chutes.

Written by:	SS	Date:	07 12 2022 (DD MM YY)	Reviewed by:	PV	Date:	07 12 2022 (DD MM YY)
Client:	Dynegy	Project:	Baldwin BAP Closure Plan	Project No.:	GLP8050	Task No.:	02/02

5. References

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National Oceanic and Atmospheric Administration (NOAA), 2006. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 4. Available on https://hdsc.nws.noaa.gov/hdsc/pfds/, access on November 10, 2022.

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Robinson, K.M., Rice, C.E., and Kadavy, K.C. 1988. Design of Rock Chutes. American Society of Agricultural Engineers, Vol. 41(3):621-626.

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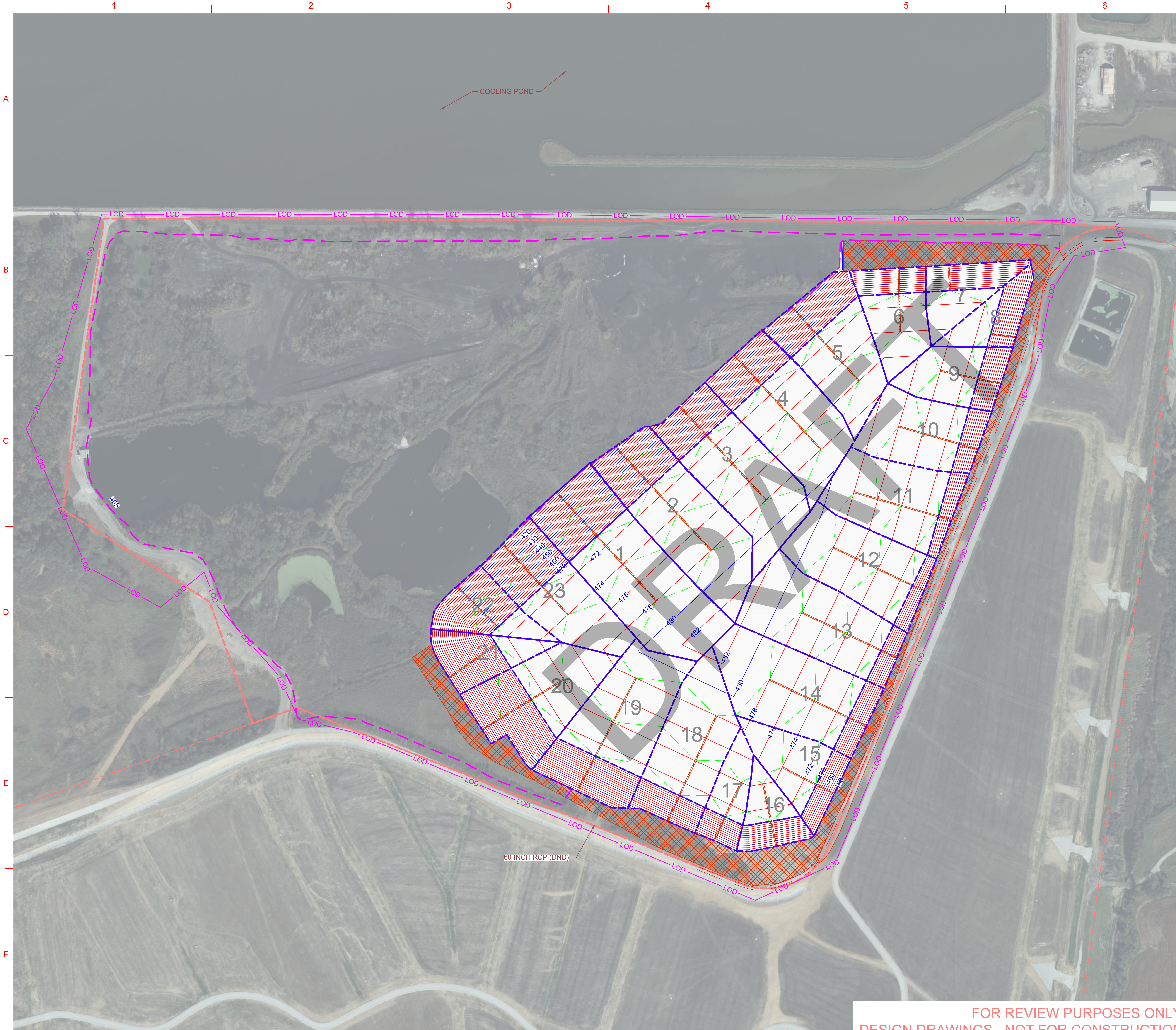
Appendix A – Drainage Area Maps



LEGEND

420	EXISTING GROUND MAJOR CONTOUR (5')
	EXISTING GROUND MINOR CONTOUR (1')
	IMPOUNDMENT BOUNDARY
470	PROPOSED GRADING MAJOR CONTOURS (5')
472	PROPOSED GRADING MINOR CONTOURS (1')
LOD	LIMITS OF DISTURBANCE (LOD)
	INTERCEPTOR BERM
	FINAL HAUL ROAD
	EDGE OF EXISTING GRADE
	ROCK CHUTES / LETDOWNS
	PERIMETER DITCH
	CAP TIE-IN TO FAPS
	DELINEATED DRAINAGE AREAS

NOTES:

1. PHASE 2 OF THE CLOSURE SHALL FOLLOWING THE DISCONTINUING OF POWER GENERATION AT THE PLANT.
2. THE CONTRACTOR SHALL OPERATE WITHIN THE "LOD" TO COMPLETE THE PROPOSED CLOSURE. CONTRACTOR SHALL EVALUATE AND IS SOLELY RESPONSIBLE FOR SAFE AND STABLE ACCESS OF EQUIPMENT ON THE CCR WITHIN THE "LOD".
3. SELECT DEWATERING SHALL BE COMPLETED TO ALLOW FOR EXCAVATION OF THE CCR MATERIALS FROM THE AREA TO BE CONSOLIDATED UTILIZING DEWATERING SUMPS AND DITCHES.
4. THE CONTRACTOR IS RESPONSIBLE FOR STORMWATER FLOWS DURING CONSTRUCTION AND SHALL ADHERE TO THE SITE SPECIFIC NPDES PERMIT. CONTACT STORMWATER AND DEWATERING WATER,SHALL NOT FLOW OR BE PUMPED OUTSIDE OF THE LIMITS OF THE BAP EXCEPT THROUGH THE NDPES PERMITTED OUTFALL. THE CONTRACTOR SHALL UTILIZE THE EXISTING OUTFALL AT THE BAP DAM. PERIMETER DITCH ALIGNMENT IS APPROXIMATE AND WILL BE REFINED AT A LATER PHASE OF DESIGN.
5. STORMWATER COLLECTION AND MAINTENANCE OF THE STORMWATER BMPS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. CCR SHALL BE REMOVED FROM THE CONSOLIDATION AREAS TO AN ESTIMATED DEPTH OF APPROXIMATELY 1 FOOT BELOW THE ESTIMATED DEPTH OF CCR. VISIBLE CCR SHALL BE REMOVED, FINAL SUBGRADE SHALL BE VISIBLY INSPECTED BY A MEMBER OF THE CONSTRUCTION QUALITY ASSURANCE TEAM AFTER EXCAVATION. THE ACTUAL FINAL GRADES WILL BE DETERMINED IN THE FIELD DURING CCR REMOVAL CONSTRUCTION
7. THE PROPOSED EXCAVATION GRADE IS BASED THE 1967 PRECONSTRUCTION SURVEY AND RECENT EXPLORATION INVESTIGATIONS TO IDENTIFY THE BOTTOM OF ASH.
8. THE FINAL CLOSURE CAP WILL EXTEND TO THE LIMITS OF THE FLY ASH POND SYSTEM CAP TO THE EAST OF THE BAP. RESTORE EXISTING HAUL ROAD ON TOP OF FINAL CLOSURE CAP.
9. GEOCOMPOSITE DRAINAGE LAYER SHALL BE INCLUDED IN ALL SLOPE AREAS 25% OR MORE STEEP.

0 200 400
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636-812-0800

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: DELINEATED DRAINAGE AREAS

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT BALDWIN, ILLINOIS

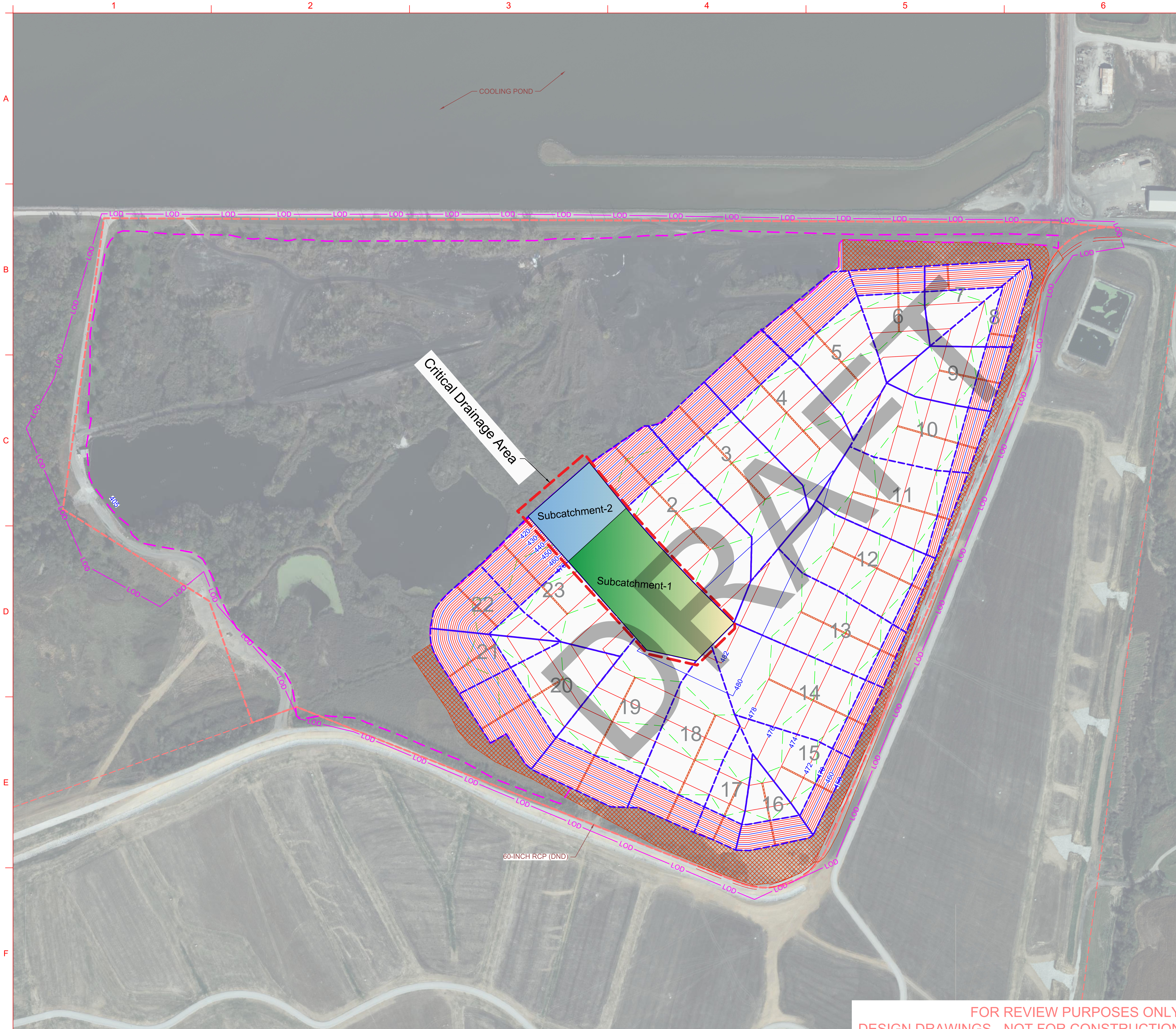
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:		DATE:	DECEMBER 2022
DRAWN BY:		PROJECT NO.:	GLP8050
CHECKED BY:		FILE:	05 - GLP8050 C-120
REVIEWED BY:		DRAWING NO.:	1
APPROVED BY:			



LEGEND

- 420 EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- IMPOUNDMENT BOUNDARY
- 470 PROPOSED GRADING MAJOR CONTOURS (5')
- 472 PROPOSED GRADING MINOR CONTOURS (1')
- LOD LIMITS OF DISTURBANCE (LOD)
- INTERCEPTOR BERM
- FINAL HAUL ROAD
- EDGE OF EXISTING GRADE
- ROCK CHUTES / LETDOWNS
- PERIMETER DITCH
- CAP TIE-IN TO FAPS
- CRITICAL DRAINAGE AREA
- SWMM SUBCATCHMENT 1
- SWMM SUBCATCHMENT 2

NOTES:

1. PHASE 2 OF THE CLOSURE SHALL FOLLOWING THE DISCONTINUING OF POWER GENERATION AT THE PLANT.
2. THE CONTRACTOR SHALL OPERATE WITHIN THE "LOD" TO COMPLETE THE PROPOSED CLOSURE. CONTRACTOR SHALL EVALUATE AND IS SOLELY RESPONSIBLE FOR SAFE AND STABLE ACCESS OF EQUIPMENT ON THE CCR WITHIN THE "LOD".
3. SELECT DEWATERING SHALL BE COMPLETED TO ALLOW FOR EXCAVATION OF THE CCR MATERIALS FROM THE AREA TO BE CONSOLIDATED UTILIZING DEWATERING SUMPS AND DITCHES.
4. THE CONTRACTOR IS RESPONSIBLE FOR STORMWATER FLOWS DURING CONSTRUCTION AND SHALL ADHERE TO THE SITE SPECIFIC NPDES PERMIT. CONTACT STORMWATER AND DEWATERING WATER SHALL NOT FLOW OR BE PUMPED OUTSIDE OF THE LIMITS OF THE BAP EXCEPT THROUGH THE NDPES PERMITTED OUTFALL. THE CONTRACTOR SHALL UTILIZE THE EXISTING OUTFALL AT THE BAP DAM. PERIMETER DITCH ALIGNMENT IS APPROXIMATE AND WILL BE REFINED AT A LATER PHASE OF DESIGN.
5. STORMWATER COLLECTION AND MAINTENANCE OF THE STORMWATER BMPS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. CCR SHALL BE REMOVED FROM THE CONSOLIDATION AREAS TO AN ESTIMATED DEPTH OF APPROXIMATELY 1 FOOT BELOW THE ESTIMATED DEPTH OF CCR. VISIBLE CCR SHALL BE REMOVED, FINAL SUBGRADE SHALL BE VISIBLY INSPECTED BY A MEMBER OF THE CONSTRUCTION QUALITY ASSURANCE TEAM AFTER EXCAVATION. THE ACTUAL FINAL GRADES WILL BE DETERMINED IN THE FIELD DURING CCR REMOVAL CONSTRUCTION
7. THE PROPOSED EXCAVATION GRADE IS BASED THE 1967 PRECONSTRUCTION SURVEY AND RECENT EXPLORATION INVESTIGATIONS TO IDENTIFY THE BOTTOM OF ASH.
8. THE FINAL CLOSURE CAP WILL EXTEND TO THE LIMITS OF THE FLY ASH POND SYSTEM CAP TO THE EAST OF THE BAP. RESTORE EXISTING HAUL ROAD ON TOP OF FINAL CLOSURE CAP.
9. GEOCOMPOSITE DRAINAGE LAYER SHALL BE INCLUDED IN ALL SLOPE AREAS 25% OR MORE STEEP.

0 200 400
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636-812-0800

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: CRITICAL DRAINAGE AREA

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:		DATE:	DECEMBER 2022
DRAWN BY:		PROJECT NO.:	GLP8050
CHECKED BY:		FILE:	05 - GLP8050 C-120
REVIEWED BY:		DRAWING NO.:	2
APPROVED BY:			

Appendix B – NOAA Precipitation Frequency Data

Location name: Baldwin, Illinois, USA*
Latitude: 38.2169°, Longitude: -89.8661°
Elevation: 429.54 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.414** (0.375-0.459)	**0.491** (0.446-0.543)	**0.584** (0.530-0.645)	**0.656** (0.594-0.725)	**0.752** (0.678-0.828)	**0.827** (0.743-0.911)	**0.902** (0.806-0.993)	**0.982** (0.873-1.08)	**1.09** (0.964-1.20)	**1.18** (1.03-1.30)
10-min	**0.644** (0.583-0.713)	**0.767** (0.697-0.848)	**0.907** (0.824-1.00)	**1.01** (0.917-1.12)	**1.15** (1.04-1.27)	**1.25** (1.13-1.38)	**1.36** (1.21-1.50)	**1.47** (1.30-1.61)	**1.61** (1.42-1.77)	**1.72** (1.51-1.89)
15-min	**0.789** (0.715-0.873)	**0.938** (0.852-1.04)	**1.11** (1.01-1.23)	**1.25** (1.13-1.38)	**1.42** (1.28-1.57)	**1.55** (1.39-1.71)	**1.69** (1.51-1.86)	**1.82** (1.62-2.00)	**2.01** (1.77-2.21)	**2.15** (1.88-2.37)
30-min	**1.04** (0.946-1.16)	**1.25** (1.14-1.39)	**1.53** (1.39-1.69)	**1.73** (1.57-1.91)	**2.01** (1.81-2.21)	**2.22** (1.99-2.44)	**2.44** (2.18-2.68)	**2.66** (2.37-2.93)	**2.97** (2.62-3.27)	**3.22** (2.82-3.54)
60-min	**1.27** (1.16-1.41)	**1.54** (1.40-1.70)	**1.91** (1.74-2.12)	**2.20** (1.99-2.43)	**2.60** (2.35-2.87)	**2.92** (2.62-3.22)	**3.26** (2.91-3.58)	**3.61** (3.21-3.97)	**4.11** (3.63-4.52)	**4.52** (3.96-4.98)
2-hr	**1.51** (1.36-1.68)	**1.83** (1.65-2.03)	**2.28** (2.06-2.52)	**2.65** (2.38-2.93)	**3.17** (2.84-3.49)	**3.60** (3.21-3.97)	**4.07** (3.62-4.48)	**4.58** (4.04-5.04)	**5.32** (4.66-5.85)	**5.94** (5.18-6.54)
3-hr	**1.63** (1.47-1.81)	**1.97** (1.78-2.18)	**2.46** (2.22-2.73)	**2.86** (2.58-3.17)	**3.45** (3.09-3.81)	**3.94** (3.52-4.35)	**4.47** (3.98-4.93)	**5.06** (4.48-5.57)	**5.94** (5.21-6.53)	**6.68** (5.82-7.35)
6-hr	**1.96** (1.79-2.17)	**2.37** (2.16-2.62)	**2.95** (2.69-3.27)	**3.44** (3.12-3.80)	**4.13** (3.73-4.55)	**4.73** (4.25-5.20)	**5.38** (4.80-5.91)	**6.09** (5.41-6.69)	**7.15** (6.29-7.86)	**8.07** (7.03-8.86)
12-hr	**2.34** (2.12-2.62)	**2.82** (2.55-3.15)	**3.49** (3.16-3.90)	**4.05** (3.66-4.51)	**4.86** (4.36-5.40)	**5.54** (4.94-6.14)	**6.27** (5.57-6.95)	**7.08** (6.25-7.84)	**8.27** (7.23-9.15)	**9.28** (8.06-10.3)
24-hr	**2.76** (2.55-3.02)	**3.32** (3.07-3.64)	**4.12** (3.80-4.51)	**4.79** (4.40-5.25)	**5.76** (5.24-6.33)	**6.59** (5.95-7.27)	**7.50** (6.69-8.31)	**8.51** (7.48-9.49)	**10.0** (8.61-11.3)	**11.3** (9.56-12.9)
2-day	**3.18** (2.93-3.47)	**3.84** (3.54-4.19)	**4.76** (4.39-5.20)	**5.50** (5.05-6.00)	**6.53** (5.95-7.14)	**7.38** (6.67-8.11)	**8.29** (7.41-9.16)	**9.27** (8.20-10.3)	**10.8** (9.40-12.2)	**12.2** (10.4-13.8)
3-day	**3.40** (3.15-3.70)	**4.11** (3.80-4.47)	**5.09** (4.70-5.53)	**5.86** (5.40-6.38)	**6.94** (6.34-7.57)	**7.82** (7.09-8.57)	**8.76** (7.86-9.66)	**9.77** (8.67-10.9)	**11.3** (9.84-12.7)	**12.6** (10.8-14.3)
4-day	**3.63** (3.37-3.93)	**4.38** (4.06-4.75)	**5.42** (5.02-5.87)	**6.22** (5.75-6.75)	**7.35** (6.73-7.99)	**8.26** (7.51-9.03)	**9.23** (8.32-10.2)	**10.3** (9.14-11.4)	**11.8** (10.3-13.2)	**13.0** (11.2-14.8)
7-day	**4.19** (3.89-4.52)	**5.04** (4.69-5.45)	**6.21** (5.77-6.71)	**7.12** (6.59-7.69)	**8.37** (7.69-9.07)	**9.39** (8.56-10.2)	**10.5** (9.44-11.5)	**11.6** (10.3-12.8)	**13.2** (11.6-14.8)	**14.5** (12.6-16.4)
10-day	**4.74** (4.41-5.10)	**5.69** (5.31-6.12)	**6.95** (6.46-7.47)	**7.93** (7.35-8.53)	**9.26** (8.54-9.99)	**10.3** (9.46-11.2)	**11.5** (10.4-12.5)	**12.6** (11.3-13.9)	**14.3** (12.6-15.9)	**15.6** (13.6-17.6)
20-day	**6.46** (6.05-6.90)	**7.71** (7.23-8.25)	**9.25** (8.66-9.89)	**10.4** (9.71-11.1)	**11.9** (11.1-12.8)	**13.1** (12.1-14.1)	**14.3** (13.1-15.4)	**15.4** (14.1-16.8)	**17.1** (15.4-18.8)	**18.3** (16.4-20.3)
30-day	**7.95** (7.46-8.46)	**9.46** (8.90-10.1)	**11.2** (10.5-11.9)	**12.5** (11.7-13.3)	**14.1** (13.2-15.1)	**15.4** (14.3-16.5)	**16.7** (15.4-17.9)	**17.9** (16.4-19.4)	**19.6** (17.8-21.4)	**20.9** (18.8-22.9)
45-day	**9.94** (9.38-10.5)	**11.8** (11.1-12.5)	**13.8** (13.1-14.6)	**15.3** (14.4-16.2)	**17.2** (16.2-18.3)	**18.7** (17.4-19.8)	**20.1** (18.7-21.4)	**21.4** (19.8-23.0)	**23.3** (21.3-25.2)	**24.7** (22.4-26.9)
60-day	**11.6** (11.0-12.3)	**13.8** (13.1-14.6)	**16.1** (15.2-16.9)	**17.8** (16.8-18.7)	**19.9** (18.8-21.1)	**21.6** (20.2-22.9)	**23.2** (21.6-24.7)	**24.8** (22.9-26.5)	**26.9** (24.6-29.0)	**28.5** (25.9-30.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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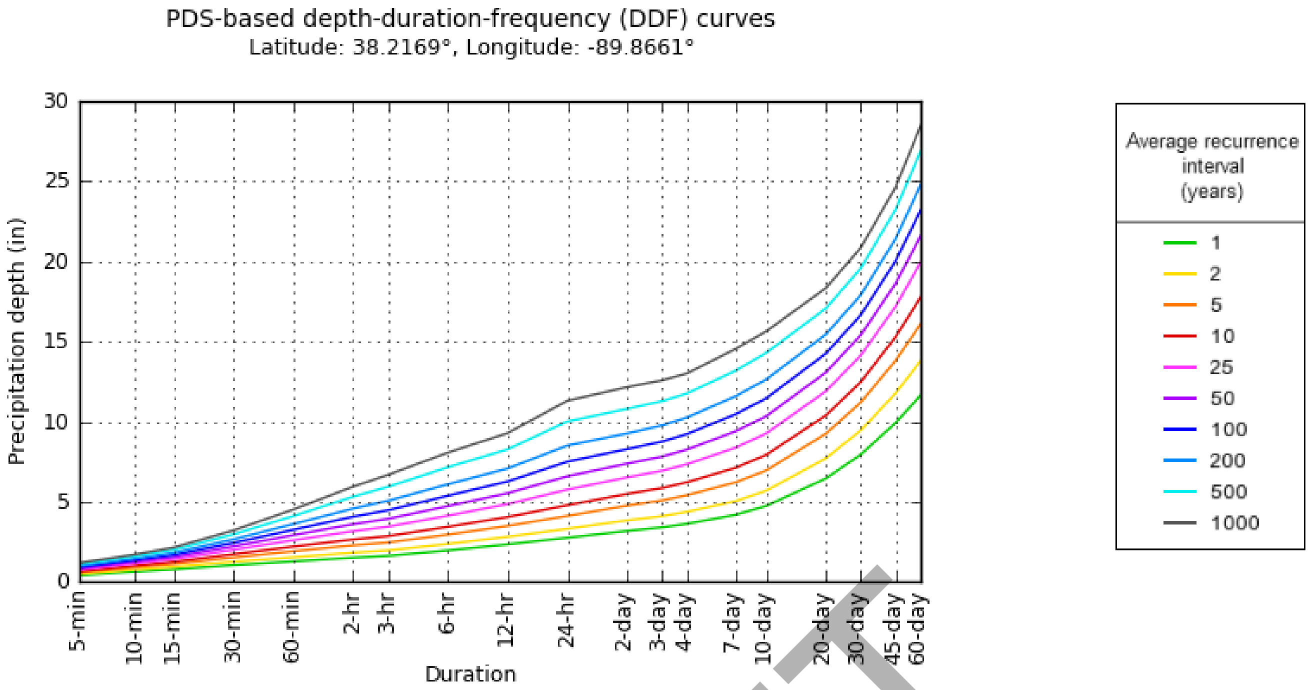
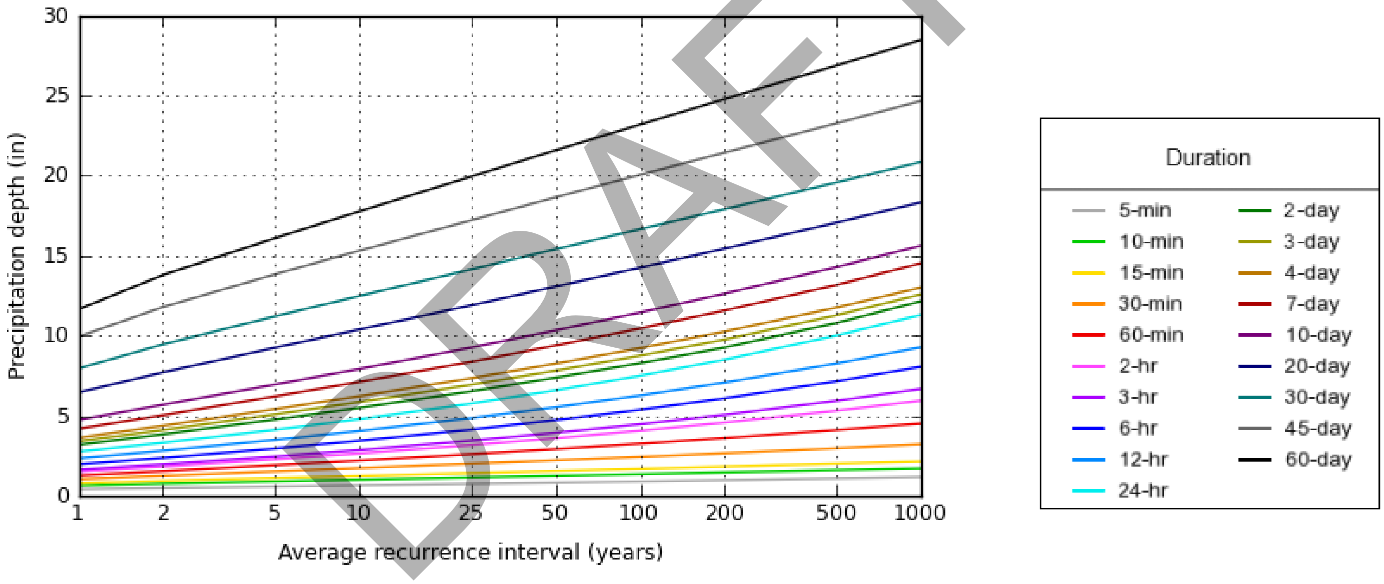
PF graphical





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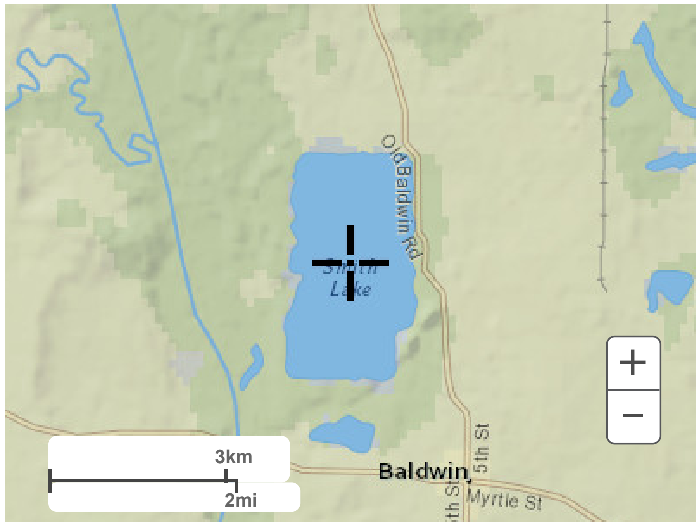
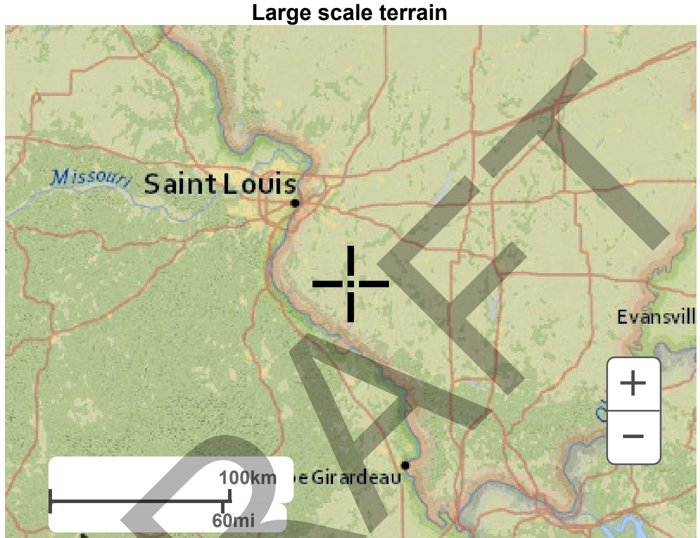
Maps & aerials

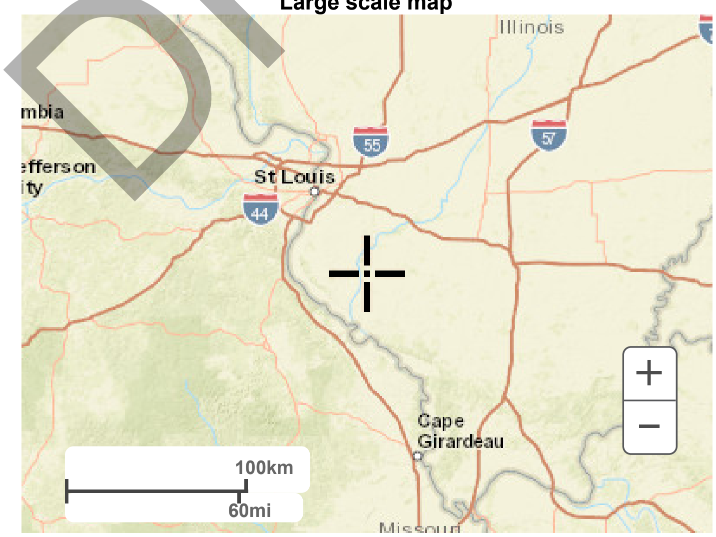
Small scale terrain



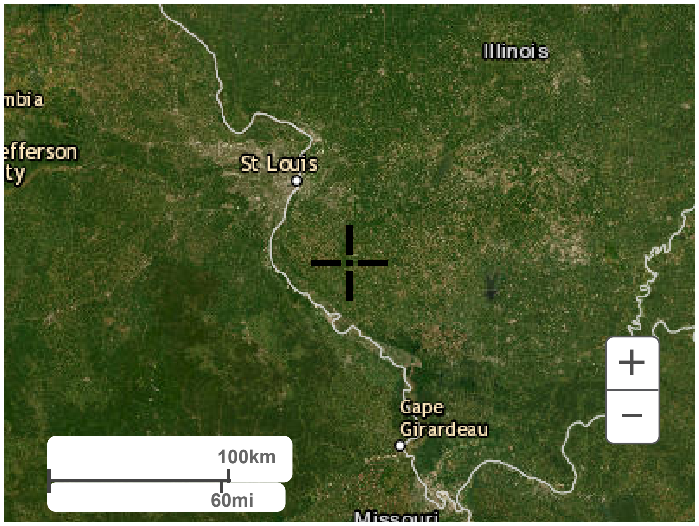
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Geosyntec consultants

Appendix C – Interceptor Berm Hydraulic Analysis

Geosyntec consultants
engineers | scientists | innovators

9300 W 110th Street
Overland Park, KS
TELEPHONE (913) 224-1056

JOB	Baldwin BAP CP		
SHEET NO.		OF	
CALCULATED BY	SS	DATE	11/17/2022
CHECKED BY		DATE	
SCALE			
DESCRIPTION	Interceptor Berm Design (on 2% Slope)		
	100-year, 24 hr. SCS Type II		

Drainage Area=	4.65 acres	0.0072656	square miles
Total Peak Discharge Qmax	31 cfs		

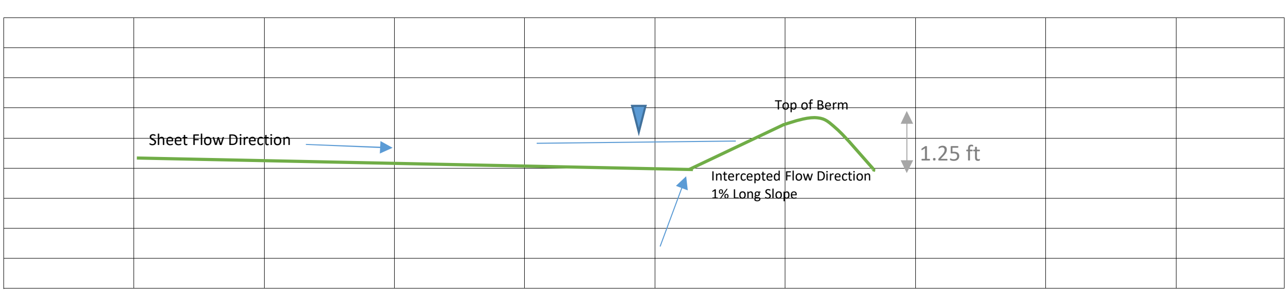
V-Ditch Design Parameters

Bottom Width, B =	0.00	ft	
Left Side Slope, Z1 =	50.00	horizontal :1 vertical	Cover Slope
Right Side Slope, Z2 =	2.00	horizontal :1 vertical	Berm Side Slope
Manning's Roughness Coeff., n =	0.030		
Longitudinal Channel Slope, So =	0.0100	ft/ft	

Depth of Flow	Top Width	Area of Flow	Wetted Perimeter	Hydraulic Radius	Channel Slope	Average Velocity	Discharge (Flow Rate)	Avg. Tractive Stress	Comments
Y	T	A	P	R=A/P		V	Q=AV	to	
ft	ft	ft2	ft	ft	ft/ft	ft/s	ft3/s	lb./ft2	
0.01	0.52	0.00	0.52	0.00	0.010	0.14	0.00	0.00	
0.07	3.51	0.12	3.53	0.03	0.010	0.52	0.06	0.02	
0.13	6.50	0.41	6.53	0.06	0.010	0.78	0.32	0.04	
0.18	9.49	0.87	9.53	0.09	0.010	1.00	0.87	0.06	
0.24	12.48	1.50	12.54	0.12	0.010	1.20	1.80	0.07	
0.30	15.47	2.30	15.54	0.15	0.010	1.39	3.20	0.09	
0.36	18.46	3.28	18.55	0.18	0.010	1.56	5.12	0.11	
0.41	21.45	4.42	21.55	0.21	0.010	1.73	7.64	0.13	
0.47	24.44	5.74	24.56	0.23	0.010	1.88	10.82	0.15	
0.53	27.43	7.23	27.56	0.26	0.010	2.04	14.72	0.16	
0.59	30.42	8.90	30.56	0.29	0.010	2.18	19.40	0.18	
0.64	33.41	10.73	33.57	0.32	0.010	2.32	24.92	0.20	
0.70	36.40	12.74	36.57	0.35	0.010	2.46	31.32	0.22	
0.70	**36.40**	**12.74**	**36.57**	**0.35**	**0.01**	**2.46**	**31.3**	**0.22**	**Design Q (Q100)**

Channel Flow

Velocity (ft/s)	2.46
Flow Length (ft)	200
Tc or Tt (hr)	0.02



Geosyntec consultants

engineers | scientists | innovators

9300 W 110th Street
Overland Park, KS
TELEPHONE (913) 224-1056

JOB	Baldwin BAP CP		
SHEET NO.		OF	
CALCULATED BY	SS	DATE	11/17/2022
CHECKED BY		DATE	
SCALE			
DESCRIPTION	Interceptor Berm Design (on 25% Slope)		
	100-year, 24 hr. SCS Type II		

Drainage Area	1.76000	acres	0.002750	square miles
Total Peak Discharge Qmax	15.20	cfs		

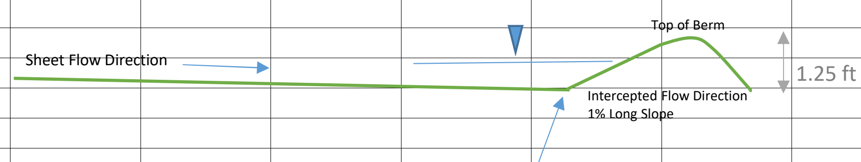
V-Ditch Design Parameters

Bottom Width, b =	0.00	ft	
Left Side Slope, Z1 =	4.00	horizontal :1 vertical	Cover Slope
Right Side Slope, Z2 =	2.00	horizontal :1 vertical	Berm Side Slope
Manning's Roughness Coeff., n =	0.030		
Longitudinal Channel Slope, So =	0.0100	ft/ft	

Depth of Flow	Top Width	Area of Flow	Wetted Perimeter	Hydraulic Radius	Channel Slope	Average Velocity	Discharge (Flow Rate)	Avg. Tractive Stress	Comments
Y	T	A	P	R=A/P		V	Q=AV	to	
ft	ft	ft2	ft	ft	ft/ft	ft/s	ft3/s	lb./ft2	
0.01	0.06	0.00	0.06	0.00	0.010	0.14	0.00	0.00	
0.11	0.67	0.04	0.70	0.05	0.010	0.69	0.03	0.03	
0.21	1.27	0.13	1.35	0.10	0.010	1.07	0.14	0.06	
0.31	1.88	0.29	1.99	0.15	0.010	1.39	0.41	0.09	
0.41	2.48	0.51	2.63	0.19	0.010	1.67	0.86	0.12	
0.51	3.09	0.79	3.27	0.24	0.010	1.93	1.53	0.15	
0.62	3.69	1.13	3.91	0.29	0.010	2.18	2.47	0.18	
0.72	4.30	1.54	4.55	0.34	0.010	2.41	3.70	0.21	
0.82	4.90	2.00	5.19	0.39	0.010	2.63	5.26	0.24	
0.92	5.51	2.53	5.83	0.43	0.010	2.84	7.18	0.27	
1.02	6.11	3.11	6.48	0.48	0.010	3.05	9.48	0.30	
1.12	6.72	3.76	7.12	0.53	0.010	3.24	12.19	0.33	
1.22	7.32	4.47	7.76	0.58	0.010	3.44	15.34	0.36	
1.22	**7.32**	**4.47**	**7.76**	**0.58**	**0.01**	**3.44**	**15.34**	**0.36**	**Design Q (Q100)**

Channel Flow

Velocity (ft/s)	3.44
Flow Length (ft)	200
Tc or Tt (hr)	0.02



Appendix D – Rock Chute Analysis

Rock Chute Design - Cut/Paste Plan

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Baldwin BAP CP **County:** Randolph, IL
Designer: Shailendra Singh **Checked by:**
Date: 11/16/2022 **Date:**

Design Values

D_{50} dia. = 2.5 in.
$Rock_{chute}$ thickness = 5.0 in.
Inlet apron length = 10 ft.
Outlet apron length = 3 ft.
Radius = 7 ft.
Will bedding be used? No

Rock Gradation Envelope

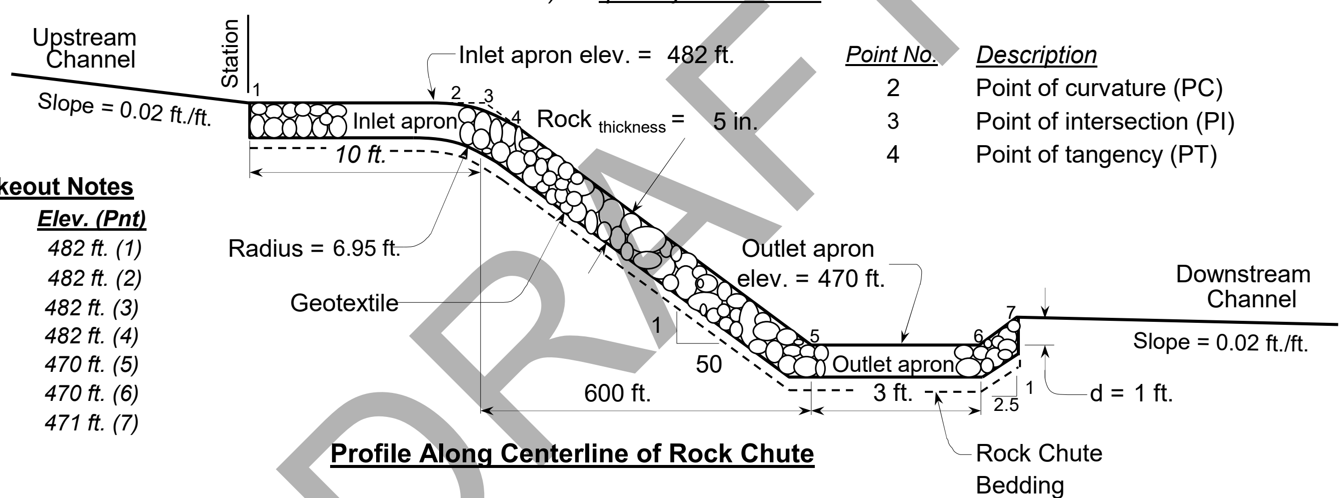
% Passing	*Diameter, in. (weight, lbs.)*
D_{100} ---------	4 - 5 (4 - 9)
D_{85} ---------	3 - 5 (2 - 6)
D_{50} ---------	3 - 4 (1 - 4)
D_{10} ---------	2 - 3 (1 - 2)

Coefficient of Uniformity, $(D_{60})/(D_{10})$ < 1.7

Quantities [a]

Rock = 149 yd^3
Geotextile (WCS-13)[b] = 1165 yd^2
Bedding = 0 yd^3
Excavation = 0 yd^3
Earthfill = 0 yd^3
Seeding = 0.0 acres

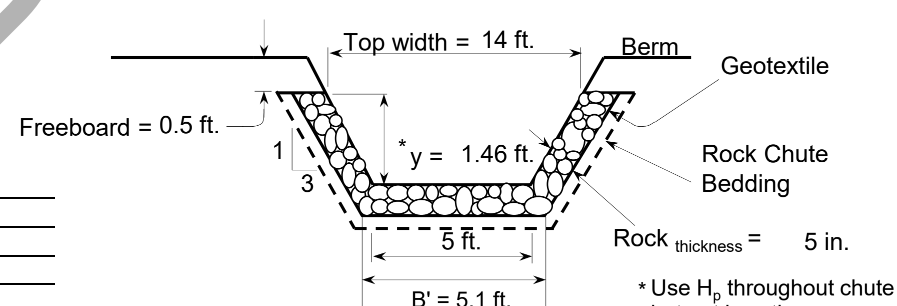
Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*



Profile Along Centerline of Rock Chute

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	482 ft. (1)
0+09.9	482 ft. (2)
0+10.0	482 ft. (3)
0+10.1	482 ft. (4)
6+10.0	470 ft. (5)
6+13.0	470 ft. (6)
6+15.5	471 ft. (7)



Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
DOT Light riprap Gradation

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Baldwin BAP CP
Randolph, IL County

		Date	
Designed	Shailendra Singh		File Name
Drawn			Drawing Name
Checked			
Approved			Sheet __ of __

Rock Chute Design - Cut/Paste Plan

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Baldwin BAP CP **County:** Randolph, IL
Designer: Shailendra Singh **Checked by:** ____________
Date: 11/16/2022 **Date:** ____________

Design Values		
D_{50} dia. =	12.0	in.
$Rock_{chute}$ thickness =	24.0	in.
Inlet apron length =	11	ft.
Outlet apron length =	15	ft.
Radius =	33	ft.
Will bedding be used?	No	

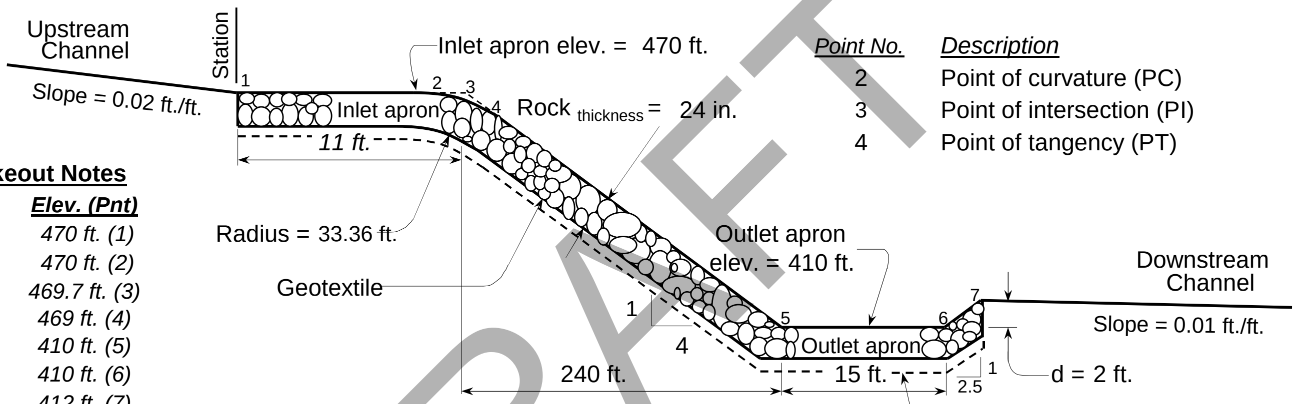
Rock Gradation Envelope

% Passing		*Diameter, in. (weight, lbs.)*
D_{100}	---------	18 - 24 (413 - 978)
D_{85}	---------	16 - 22 (269 - 713)
D_{50}	---------	12 - 18 (122 - 413)
D_{10}	---------	10 - 16 (63 - 269)

Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$

Quantities [a]		
Rock =	488	yd^3
Geotextile (WCS-13)[b] =	937	yd^2
Bedding =	0	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

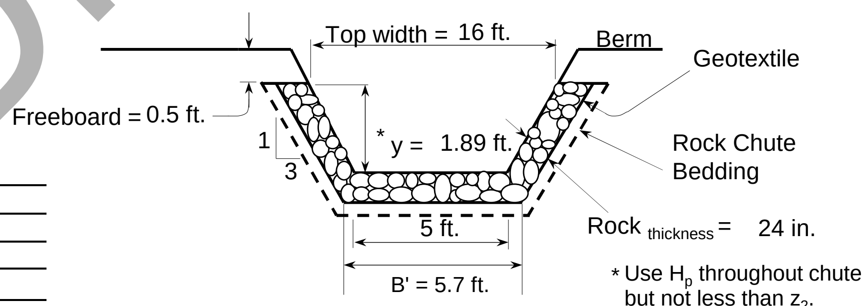
Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*



Stakeout Notes

Sta.	***Elev. (Pnt)***
0+00.0	*470 ft. (1)*
0+06.9	*470 ft. (2)*
0+11.0	*469.7 ft. (3)*
0+15.0	*469 ft. (4)*
2+51.0	*410 ft. (5)*
2+66.0	*410 ft. (6)*
2+71.0	*412 ft. (7)*

Profile Along Centerline of Rock Chute



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
DOT Extra Heavy riprap Gradation

Profile, Cross Sections, and Quantities

NRCS Natural Resources Conservation Service, United States Department of Agriculture	Baldwin BAP CP	Designed: Shailendra Singh	Date	File Name
	Randolph, IL County	Drawn		Drawing Name
		Checked		Sheet __ of __
		Approved		

ATTACHMENT E

Geotechnical Design of Slopes and Final Cover System (Sections 845.750(a)(3) and (a)(4))

May 2023

Geosyntec consultants

COMPUTATION COVER SHEET

Client: **Dynegy** Project: **Baldwin Power Plant Bottom Ash Pond Construction Permit** Project No.: **GLP8050**
Task No.: **02/04**

Title of Computations: **Geotechnical Calculations for Closure Design**

Computations by:
Signature
Printed Name: Isaiah Vaught, Zachary Fallert, P.E.
Title: Staff Professional, Engineer
Date: 01/19/2023

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Date: 01/23/2023

Computations backchecked by: (originator)
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Title: Staff Professional, Engineer
Date: 01/23/2023

Approved by: (PM or designate)
Signature
Printed Name: Thomas Ward, P.E.
Title: Senior Engineer
Date: 01/23/2023

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval
0		12/12/2022	IJV	ZJF, CPC	TWW
1		01/23/2023	IJV	ZJF, CPC	TWW

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LIST OF TABLES

1. PURPOSE

This calculation package, supporting the Coal Combustion Residual (CCR) Surface Impoundment Final Close Plan [1], presents geotechnical calculations in support of the construction permit application for the closure design of the Bottom Ash Pond (BAP) at the Baldwin Power Plant (BPP) in Baldwin, Illinois. The closure will define the BAP as a Closed CCR Impoundment (Impoundment) which consists of consolidating the former BAP footprint with a cover system. The analyses provided in this calculation package (Package) includes:

(i) A summary of the available data from geotechnical investigations completed at Baldwin by AECOM;

(ii) A summary of subsurface conditions, selected geotechnical design parameters, and seismic inputs developed by Geosyntec;

(iii) Global slope stability analyses considering post-closure conditions for static and seismic conditions;

(iv) Settlement analysis of the proposed Impoundment design; and

(v) Veneer stability analysis for the cover system design.

2. AVAILABLE DATA

In 2015, AECOM presented Dynegy with a 30% Design Data Report [2] and 30% Design Package [3], for the West, East, and Old East Ash Ponds at Baldwin. Relevant data to the BAP, including auger boring logs, CPT soundings, and laboratory testing, performed around the perimeter and interior of the BAP, was selected from the geotechnical exploratory program.

3. SUBSURFACE CONDITIONS AND MATERIAL CHARACTERIZATION

Geosyntec identified the following materials within, beneath, and around the BAP:

(i) Cover Soil,
(ii) Bottom Ash,
(iii) Loess,
(iv) Residual Clay, and
(v) Bedrock.

Each material is discussed below. Material properties used for analysis are summarized in **Table 1**.

Cover Soil

Cover Soil for the proposed Impoundment is assumed to have the same material properties as Residual Clay based on an on-site borrow material likely being used in the construction of the cover system.

Bottom Ash

The contents of the BAP mainly consist of disposed Bottom Ash from the adjacent power plant. The disposed Bottom Ash exists in a very loose to medium dense state. Properties for Bottom Ash are taken from AECOM's 30% Design [3], due to the lack of BAP-specific laboratory testing. The drained shear strength is modeled with an effective cohesion (c') of zero and an effective friction angle (ϕ') of 30 degrees. Unit weight for the Bottom Ash is modeled as 97 pounds per cubic foot (pcf). Bottom Ash is considered to be a freely-draining material; therefore, undrained shear strength properties were not used in modeling the Bottom Ash.

Closure of the BAP will involve a consolidated footprint (i.e. Bottom Ash being stacked within a smaller area). The Bottom Ash will be compacted and likely have an increased shear strength. Because the compaction effort and properties of compacted Bottom Ash are unknown at this time, Bottom Ash used as fill was conservatively assumed to have the same properties as existing Bottom Ash.

Loess

Originating from a wind-deposited silt, Loess has since weathered in place to a low plastic clayey silt or silty clay. The Loess generally has a medium stiff to stiff consistency. Properties for Loess are taken from AECOM's 30% Design [3]. The Loess is not included in the models for the global slope stability analyses, so no strength parameters are included in **Table 1**. Unit weight of Loess is modeled as 120 pcf for consolidation analysis.

Residual Clay

Residual Clay is derived from weathering of the shale bedrock. The clay is typically classified as lean or fat clay with consistency ranging from stiff to hard. Properties for Residual Clay were derived from available consolidated-undrained triaxial compression testing with pore pressure measurements (CIU) performed on samples obtained from the BAP; a total of nine tests were used. These tests were performed as part of a previous investigation by AECOM as presented in the Supplemental Technical Documents Report for the Fly Ash Pond System by Stantec [4]. Failure criteria for individual CIU specimens were defined as the peak obliquity limited to 10% axial strain, to consider the effects of strain incompatibilities, based on Geosyntec's experience. The CIU data reduction calculations and plots are provided in **Attachment A**.

Design friction angles were established by plotting effective stresses normal to the failure plane at failure, σ'_n, versus shear stress on the failure plane at failure, τ_{ff}. The design effective friction angle, ϕ', and effective cohesion, c', was assigned such that at least one-third of the plotted points fell below and two-thirds fell on or above the failure envelope.

Design undrained shear strength functions were established by plotting effective consolidation stress of the sample, σ'_c, versus shear stress on the failure plane at failure, τ_{ff}. The design undrained shear strength function was defined as a strength ratio such that shear strength increases with consolidation stress (e.g., S_u/σ'_{vc} ratio). The selected shear strength envelope corresponds to one-third of the plotted points being below the design envelope and two-thirds of the points above.

The drained strength for the Residual Clay is modeled with an effective cohesion (c') of 200 pounds per square foot (psf) and an effective friction angle (ϕ') of 32 degrees. The undrained strength is modeled with a minimum cohesion of 440 psf and a S_u/σ'_{vc} ratio of 0.50. The design unit weight of 120 pcf for the Residual Clay was taken from AECOM's 30% Design [3] due to the localized laboratory results being less conservative.

Bedrock

The bedrock encountered at the site is generally shale. There are beds of limestone and sandstone within the shale. The shale is considered a soft rock and contains a low plasticity clay. Bedrock is modeled with an infinite strength in the stability analyses.

4. GROUNDWATER CONDITIONS

The BAP is expected to be de-watered prior to or during excavation of Bottom Ash. Because of this, the existing groundwater condition is not used in the stability analysis. An assumed 2 foot groundwater recharge into the bottom of the BAP is modeled for the Long-Term and Pseudostatic Seismic Conditions, based on the January 2023 Groundwater Modeling Report by Ramboll [5]. Because the groundwater recharge is expected as a long-term condition, the groundwater for the Short-Term, End of Construction Condition is assumed at the top of Residual Clay, within the BAP extent. Outside the extent of the BAP, groundwater is assumed at the bottom of excavation, or an elevation of 410 feet.

5. SEISMIC ASSESSMENTS

Site Seismic Hazard Assessment

AECOM previously evaluated seismic hazards at Baldwin by performing a site-specific probabilistic seismic hazard assessment (PSHA) and one-dimensional (1D) dynamic response analysis [5] for the 2% probability of exceedance in 50-years earthquake event (e.g., 2,475-year return period). Within this evaluation, AECOM developed a unified hazard spectrum (UHS) for both the top-of-rock (based on the results of the PSHA) and top-of-ground (based on the results of the 1D dynamic response analysis using the PSHA as an input) for the site. A peak ground acceleration (PGA) of 0.36g (where g is the gravitational acceleration constant) and earthquake magnitude of 7.7 is used to represent the expected earthquake event and loading at the site.

There are different recommendations on selection of seismic coefficient (k_h) in pseudo-static analysis. Richardson [6], recommends using k_h equal to $0.5 \cdot \text{PGA}/g$ based on deformation analyses performed by Hynes-Griffin and Franklin [7], and their experience. The Hynes-Griffin and Franklin recommendation to halve the PGA to estimate k_h assumes a seismic deformation of up to three feet is tolerable for the slope. Using this recommendation, k_h of 0.18 was used in the pseudo-static seismic slope stability analysis. Vertical accelerations from seismic events were not considered in the seismic slope stability analysis because they are expected to be minimal compared to the horizontal accelerations.

The Bottom Ash and Residual Clay are assumed to not be susceptible to liquefaction because i) the Bottom Ash will be dewatered before being covered and freely drain any recharging groundwater (i.e. Bottom Ash will not be saturated), and ii) and the Residual Clay is fine grained (fine grained materials are generally not susceptible to liquefaction) and is heavily overconsolidated and exhibits strain hardening at large strains. Pore water raising within the CCR on the order of two feet is anticipated over the long-term based on groundwater modeling. It is anticipated that only two feet will be in contact with pore water. This will be further evaluated during final design phases.

6. GLOBAL SLOPE STABILITY

Global slope stability analyses for the Impoundment were performed using limit-equilibrium SLOPE/W, a two-dimensional (2D) slope stability software developed by GeoStudio [8], to calculate the factor of safety (FoS) of the perimeter dikes against global instability. One critical cross-section (discussed below) was selected to be analyzed utilizing Spencer's limit equilibrium method [9]. Circular slip surfaces defined using the entry-exit method, were evaluated with each critical slip surface being optimized into a non-circular slip surface. Factors of safety were calculated for the following loading conditions:

Long-Term Static Conditions: This loading condition corresponds to the state of the Impoundment under long-term, normal operating conditions assuming static groundwater levels remain similar to the bottom of excavation elevation. Drained shear strength, representing effective stress conditions, are used for all materials, as this condition corresponds to static conditions without application of loads inducing pore-pressure increases. The minimum acceptable FoS for this loading condition is 1.50, per the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].

End-of-Construction Conditions: This loading condition evaluates stability immediately following construction of the Impoundment and cover system, which are assumed to be constructed instantaneously. Undrained soil strengths are used in materials expected to behave in an undrained manner (clay-like materials) during construction loading, while drained soil strengths are used in materials expected to behave in a drained manner (freely-draining or sand-like materials) during construction loading. The minimum acceptable FoS for this loading condition is 1.30, per the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].

Pseudostatic Seismic Conditions: This loading condition corresponds to the stability of the Impoundment under short-term seismic loading conditions. This loading condition assumed peak drained shear strengths in materials above the modeled groundwater table (Cover and Bottom Ash). Reduced undrained shear and drained strengths to eighty percent peak strength are applied to Residual Clay and Bottom Ash beneath the groundwater level as recommended in Hynes-Griffin and Franklin [7]. The seismic loads are modeled using the estimated seismic coefficient, as discussed in Section 5. The minimum acceptable FoS for this loading condition is 1.00, per the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].

Selected Cross-sections

The North, East, and South slopes of the Impoundment will be buttressed by the existing splitter dike at Baldwin. Cross-section (A-A’) was analyzed because it corresponds to the tallest and steepest slope on the West side of the Impoundment with the toe lying in the BAP. The designed slope height is 44 feet and slope is 4 horizontal to 1 vertical (4H:1V). Loess was minimal in this cross section and therefore the Loess was combined with the Residual Clay. The section location is provided in **Attachment B.**

Results

The results of each of the design scenarios is presented in **Table 2**. Each calculated factor of safety exceeds minimum acceptable values. Graphical outputs from the slope stability analyses are provided in **Attachment B** for each of the design scenarios.

7. VENEER STABILITY

Veneer stability was analyzed to evaluate the potential for a failure along the interface between soil cover, geotextile, geomembrane, and subgrade that are part of the proposed final cover system. Veneer stability was analyzed utilizing spreadsheet calculations based on guidance from Giroud et. al. and Matasovic [12] [13] which are provided in **Attachment C**.

Two separate slopes, displayed on the figure in **Attachment C**, were analyzed including:

- 2% Slope: This analysis represents the top cap of the proposed closure grades of the consolidated BAP. The maximum height of a 2% slope was used, which was 14 ft.
- 4H:1V Slope: This analysis represents the 4H:1V slopes that connect the 2% slope to the surrounding excavated grades. The maximum height of a 4H:1V slope was used, which was 60 ft.

The following loading cases were analyzed for all slopes, except as noted above:

- Static: This case represents normal static conditions and uses the peak shear strength parameters for interface and soil properties. It is assumed that only the geotextile is saturated in this case. The minimum factor of safety was assumed to be 1.50, in accordance with the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].
- Saturated: This case is the same as the static case; however, it is assumed that the entire two feet of soil cover is saturated following an intense storm event. The minimum factor of safety was assumed to be 1.30, in accordance with the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].
- Seismic: This case assumes large-strain interface shear strength parameters, peak soil shear strength parameters, that only the geotextile is saturated, and the pseudostatic horizontal seismic coefficient is applied. The minimum factor of safety was assumed to be 1.00, in accordance with the USEPA CCR Rule [10] and the Illinois Part 845 Rule [11].
- Post-EQ: This case is the same as Seismic, except no pseudostatic horizontal seismic coefficient is applied. The minimum factor of safety was assumed to be

1.10, in accordance with the USEPA CCR Rule [8] and the Illinois Part 845 Rule [9].

Results

Interface shear strength parameters (interface adhesion and friction angle) were iterated such that all analyzed cases achieved an adequate factor of safety. Peak parameters were found to be reasonable based on Geosyntec's experience and guidance found in Koerner, et.al [14]. High-strain (i.e. residual) parameters were conservatively assumed to be 60% of peak parameters, also based on guidance in Koerner, et.al [14]. Resulting interface shear strength parameters and calculated veneer stability factors of safety are summarized in **Tables 3 and 4**, respectively.

8. CONSOLIDATION

Geosyntec analyzed three one-dimensional incremental consolidation tests performed on native clay materials at the BPP; one was performed on Residual Clay and two on Loess. These tests were performed as part of a previous investigation by AECOM as presented in the Supplemental Technical Documents Report for the Fly Ash Pond System by Stantec [4]. A summary of the tests results and consolidation parameters are provided in **Table 5**.

Maximum Past Pressure and Over-Consolidation Ratio

Maximum past pressures, or pre-consolidation stress (σ_p') was estimated for each consolidation test using the strain-energy method [15]. Design max past pressure for Loess was assumed to be the minimum obtained from the two tests on Loess.

Over-Consolidation Ratios (OCR) for each sample were then calculated by dividing the σ_p' by the estimated in situ stress of the sample. Both Residual Clay and Loess were found to be heavily overconsolidated with OCR ranging from 3 to 31.

Compressibility Ratios

Compression and recompression ratios ($C_{c\varepsilon}$ and $C_{r\varepsilon}$, respectively) for each sample were estimated by reconstructing the consolidation curves using the Schmertmann procedure as outlined by Coduto [16], using maximum past pressures estimated from the strain-energy method [15]. Design compression and recompression ratios for Loess were selected as the maximum values obtained from the two tests on Loess.

Coefficient of Consolidation

Coefficient of Consolidation (C_v) values were provided by the laboratory in the incremental consolidation test data. These values were compiled and plotted versus their respective vertical stresses. This data and plot are provided in **Attachment D** and indicates that c_v does not vary with stress within the clay materials. A design coefficient of consolidation was selected as the two-third percentile of the data, which is typical based on Geosyntec's experience.

Analysis Methodology

Primary consolidation in the native clay layers (Loess and Residual Clay) was estimated as this is expected to be the most significant source of settlement under the weight of the Bottom Ash fill for the closure. Secondary consolidation was not analyzed as it is expected to be negligible compared to the primary consolidation. Settlement of the existing Bottom Ash and proposed Bottom Ash fill was not considered as this consolidation is expected to occur rapidly and not contribute to post-construction settlement.

A conservative soil profile and fill regime was used in analysis utilizing the following:

- Borings around the perimeter of the BAP were considered. The most conservative boring (i.e. thickest loess and/or residual clay) was utilized.
- Some borings indicated glacial till clay, which due to a lack of data, was conservatively categorized as Residual Clay.
- The top of existing bottom ash was conservatively assumed to be the lowest elevation of existing bottom ash along the centerline of the closed Impoundment.
- The top of proposed Fill was assumed to be the highest point of the closed Impoundment (El. 497 ft).

Settlement due to primary consolidation (S_p) was calculated as follows [17]:

$$S_p = \frac{H_0}{1 + e_0}\left[C_r \log\left(\frac{\sigma'_p}{\sigma'_{v,0}}\right) + C_c \log\left(\frac{\sigma'_{v,f}}{\sigma'_p}\right)\right] \qquad (1)$$

where

H_0 = initial section height

e_0 = initial void ratio;

C_c = compression index;

C_r = recompression index;

$\sigma'_{v,0}$ = initial vertical effective stress;

$\sigma'_{v,f}$ = final vertical effective stress; and

σ'_p = preconsolidation stress.

Time required to reach an average degree of consolidation was estimated as follows [17]:

$$t = \frac{T_r \times H_d{}^2}{C_v} \qquad (2)$$

where

t = time to reach specified degree of consolidation;

T_r = unitless time factor; and

H_d = drainage distance.

The unitless time factor is dependent on the degree of consolidation. The unitless time factor for 80% degree of consolidation is 0.567. During consolidation, Water is not expected to flow into the bedrock during consolidation, so the foundation clays are considered to be singly-drained and the drainage distance is modeled as the total thickness of the Residual Clay and Loess layers.

Results

The total settlement of the foundation clays was estimated to be 14.3 inches; 0.6 inches of settlement is estimated for Residual Clay and 13.7 inches is estimated for Loess. The time required to achieve 80% of consolidation settlement was estimated as 27 months. Remaining settlement after 27 months was estimated to be approximately 2.9 inches. All calculations and results are provided in **Attachment D**.

9. CONCLUSIONS

This Package presents engineering calculations related to the geotechnical analysis in support of the closure design of the Impoundment at Baldwin Power Plant. Global stability was evaluated for the proposed Impoundment closure grades. Veneer stability was evaluated for three different slope grades that represent the expected slopes of the proposed final cover system. Maximum consolidation of foundation materials was estimated along with the estimated time for 80% of consolidation to occur.

All scenarios analyzed resulted in adequate factors of safety being achieved, indicating that the proposed Impoundment is not expected to have slope instabilities (global or veneer). All factors of safety were compared to minimum factors of safety provided by the USEPA CCR Rule [10]. All global stability outputs are provided in **Attachment B** and are summarized in **Table 2**. All veneer stability calculations are provided in **Attachment C** and are summarized in **Table 4**.

Settlement of the foundation clays under the maximum proposed fill is estimated to be approximately 14 inches, with approximately 11 inches of settlement occurring within 27 months of construction of the Impoundment. Settlement results indicate that much of the settlement will occur during construction, leaving an acceptable amount of settlement to occur post-construction.

10. REFERENCES

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Tables

Table 1: Material Properties Summary

Material	Design Unit Weight, γ_T (pcf)	Drained		Static Undrained	
		Cohesion, c' (psf)	Friction Angle, φ' (deg)	Undrained Shear Strength over Effective Consolidation Stress Ratio, S_u/σ'_{vc} (psf/psf)	Minimum Cohesion, c (psf)
Cover[2]	120	200	32	0.50	440
Bottom Ash	97	0	30	-[1]	-[1]
Residual Clay	120	200	32	0.50	440
Bedrock[3]	Infinite Strength				

Notes:
[1]These materials are freely draining and therefore are only modeled with drained strength parameters.
[2]Lab data not available for this material. Parameters assumed to match Residual Clay
[3]Bedrock is assumed to have infinite strength because critical slip surfaces are not expected to intersect the bedrock.

Table 2: Global Slope Stability Results

Scenario	F.S. Requirement	F.S. Result	PASS/FAIL
Drained, Long-Term	1.5	**2.26**	PASS
Undrained, Short-Term	1.3	**2.34**	PASS
Pseudostatic Seismic	1.0	**1.19**	PASS

Table 3: Interface Friction Properties

Design Unit Weight, γ_T (pcf)	Peak Parameters		Large-Strain Parameters (60% of Peak)	
	Cohesion, c' (psf)	Drained Friction Angle, φ' (deg)	Cohesion, c' (psf)	Drained Friction Angle, φ' (deg)
120	90	19	54	11

Table 4: Veneer Stability Results

Loading Condition	Factor of Safety		
	Minimum	2% Slope 14 ft Slope Height	4H:1V Slope 60 ft Slope Height
Unsaturated - Static	1.50	> 5.00	3.11
Saturated - Static	1.30	> 5.00	2.37
Unsaturated - Seismic	1.00	2.12	1.00
Unsaturated - Post Earthquake	1.10	> 5.00	1.92

Table 5: Consolidation Parameters

Boring ID	Sample Depth (ft)	Soil Unit	Recompression Index (C_r)	Virgin Compression Index (C_c)	Recompression Ratio, C_{re}	Compression Ratio, C_{ce}
BAL-B006	30-32	Residual Clay	0.006	0.119	0.004	0.085
BAL-B007	30-32	Loess	0.005	0.194	0.003	0.117
BAL-B026	35-37	Loess	0.035	0.154	0.028	0.121

Boring ID	Sample Depth (ft)	Soil Unit	Initial Void Ratio (eo)	Coefficient of Consolidation, C_v (ft^2/min)	Maximum Past-Pressure (psf)	OCR
BAL-B006	30-32	Residual Clay	0.398	4.3×10^{-4} Evaluated from combined data.	48055	31.3
BAL-B007	30-32	Loess	0.661		10923	8.9
BAL-B026	35-37	Loess	0.273		6144	2.7

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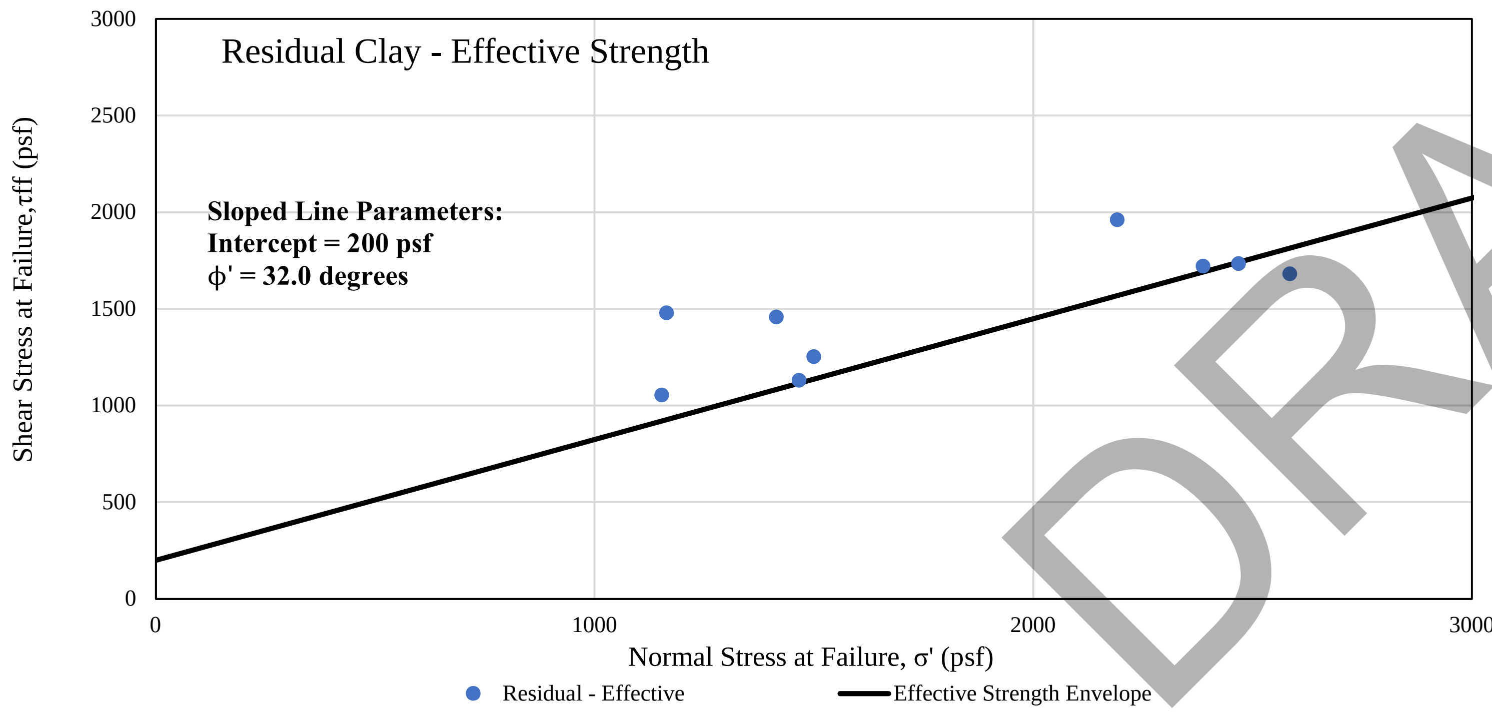
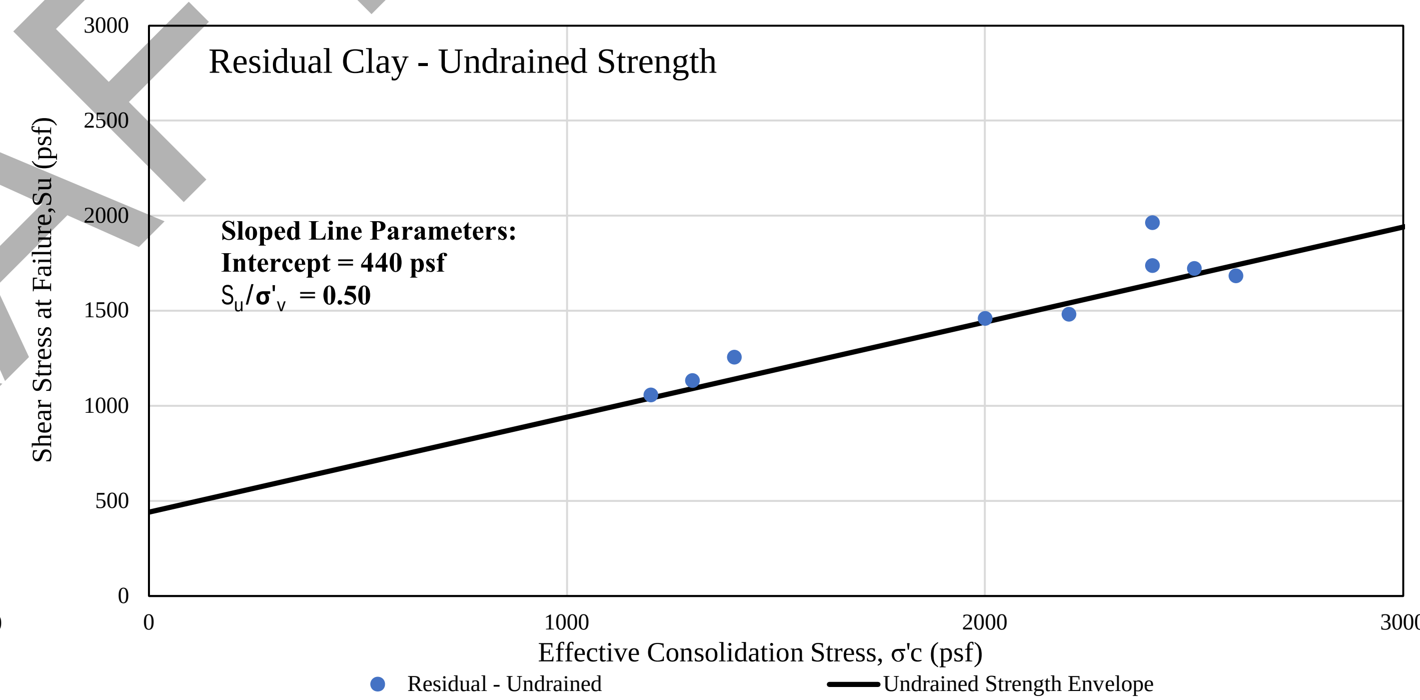
Attachment A
Material Analysis – Residual Clay

Investigation ID	Sample	Mid- Depth	Material	Sample Note	Consolidation Stress, σ'_c	Strain at Failure [2]	Obliquity	σ'_1 At Failure [2]	σ'_3 At Failure [2]	Deviator Stress	Effective Strength [3]			R-Strength [3]		Undrained Strength [1,3]	
											σ'	ϕ'	τ_{ff}	σ'_c	τ_{ff}	σ'_c	S_u
		ft			psi	%	psf/psf	psi	psi	tsf	psf	deg	psf	psf	psf	psf	psf
BAL-B006	ST-2A	30.3	Residual	Shelby	13.89	2.00	6.09	34.83	5.72	2.10	1415	46	1459	2000	1459	2000	1459
BAL-B006	ST-2C	31.0	Residual	Shelby	15.28	2.00	8.36	37.83	4.53	2.40	1164	52	1482	2200	1482	2200	1482
BAL-B006	ST-2D	31.5	Residual	Shelby	16.67	3.10	5.01	45.73	9.13	2.64	2191	42	1963	2400	1963	2400	1963
BAL-B022	ST-1A	10.6	Residual	Shelby	8.33	1.20	5.16	24.66	4.78	1.43	1153	42	1056	1200	1056	1200	1056
BAL-B022	ST-1B	11.2	Residual	Shelby	9.03	2.10	4.14	26.18	6.32	1.43	1467	38	1132	1300	1132	1300	1132
BAL-B022	ST-1C	11.7	Residual	Shelby	9.72	1.10	4.58	29.07	6.35	1.64	1500	40	1255	1400	1255	1400	1255
BAL-B024	ST-1A	20.7	Residual	Shelby	16.67	3.10	3.71	40.37	10.88	2.12	2468	35	1736	2400	1736	2400	1736
BAL-B024	ST-1B	21.3	Residual	Shelby	17.36	1.70	3.82	39.95	10.46	2.12	2387	36	1722	2500	1722	2500	1722
BAL-B024	ST-1C	21.9	Residual	Shelby	18.05	2.80	3.40	39.49	11.62	2.01	2585	33	1682	2600	1682	2600	1682

Notes: [1] Consolidated-Undrained Triaxial Compression Test.
[2] Point of failure is defined as peak obliquity (principal stress ratio) or at the 10% strain, whichever strain is less
[3] Shear strengths are reported based on the σ'-τff plots. Recommended by USACE, the envelope is drawn with approximately two-thirds of the points of tangency above the line and one-third below.





DYNEGY

BALDWIN POWER PLANT BOTTOM ASH POND

Triaxial Shear Testing Data Reduction - Undisturbed

GLP8050

Created By: Isaiah Vaught

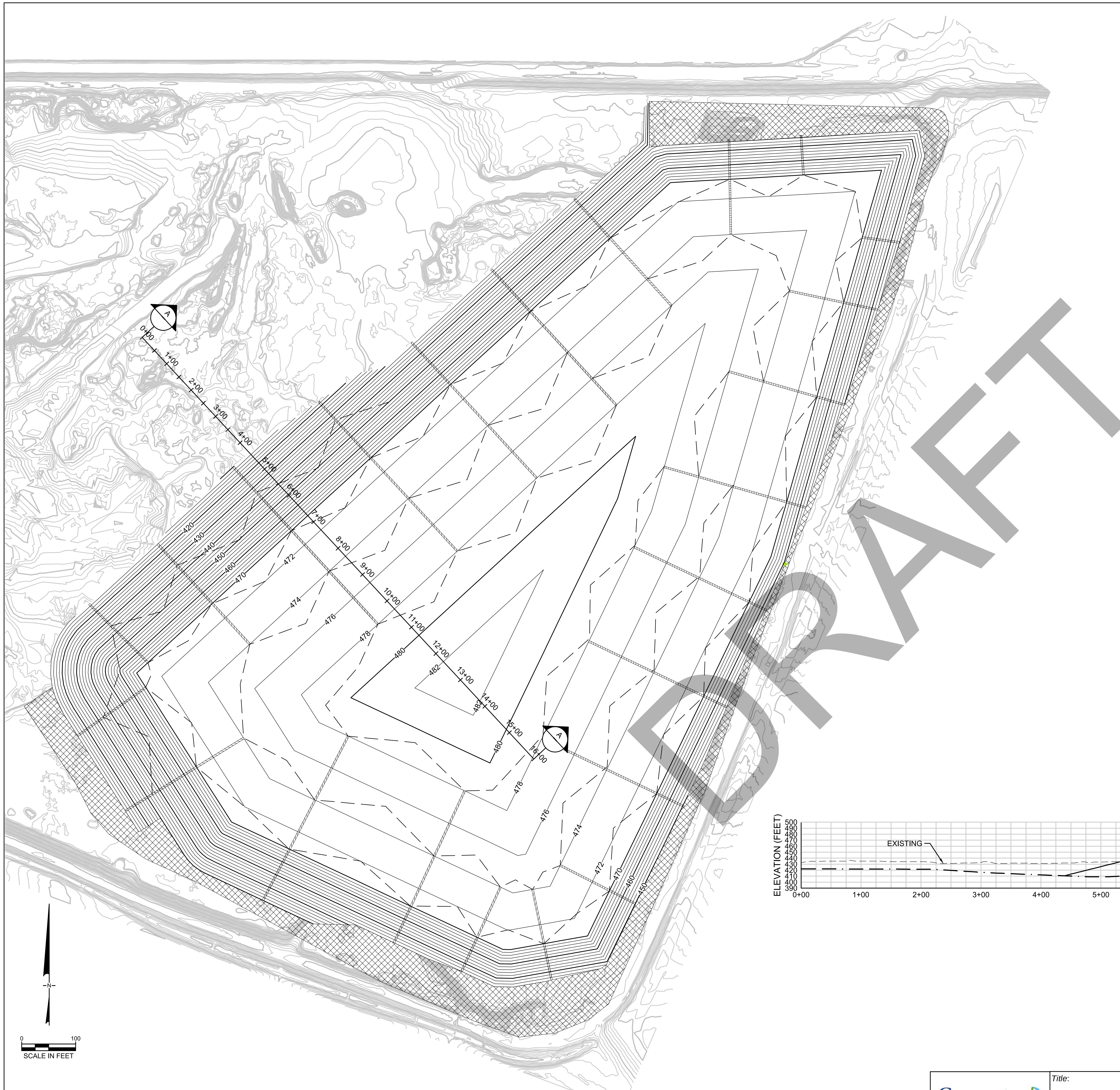
Checked By: Zachary Fallert

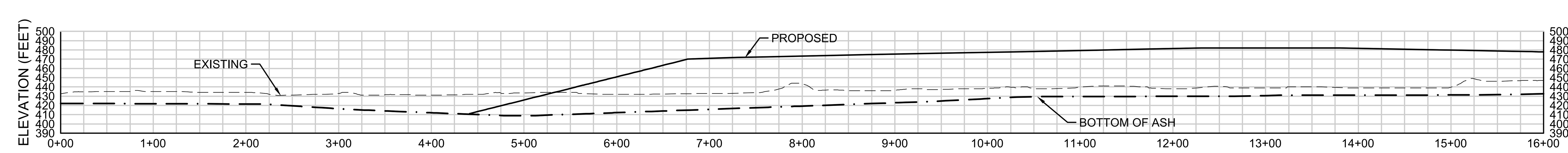
Date: 12/05/2022

Geosyntec consultants

Geosyntec consultants

Attachment B
Global Slope Stability Location and Results

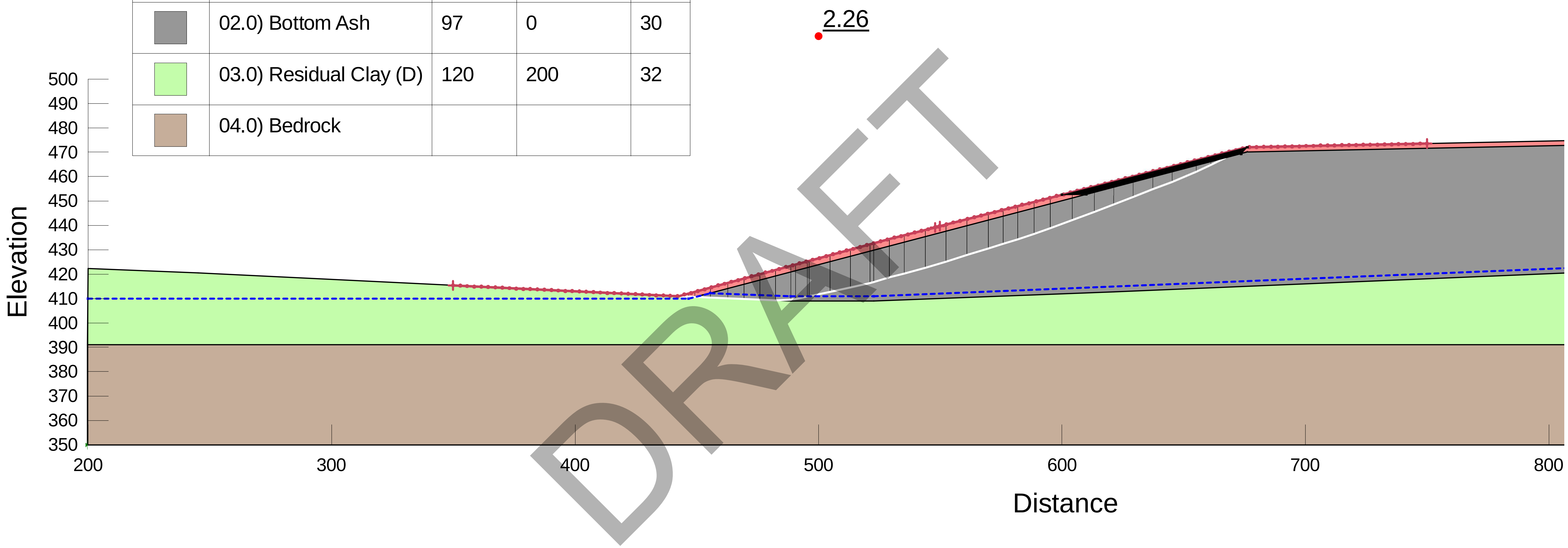




A PROFILE
HORIZONTAL: 1" =100'
VERTICAL: 1" =100'

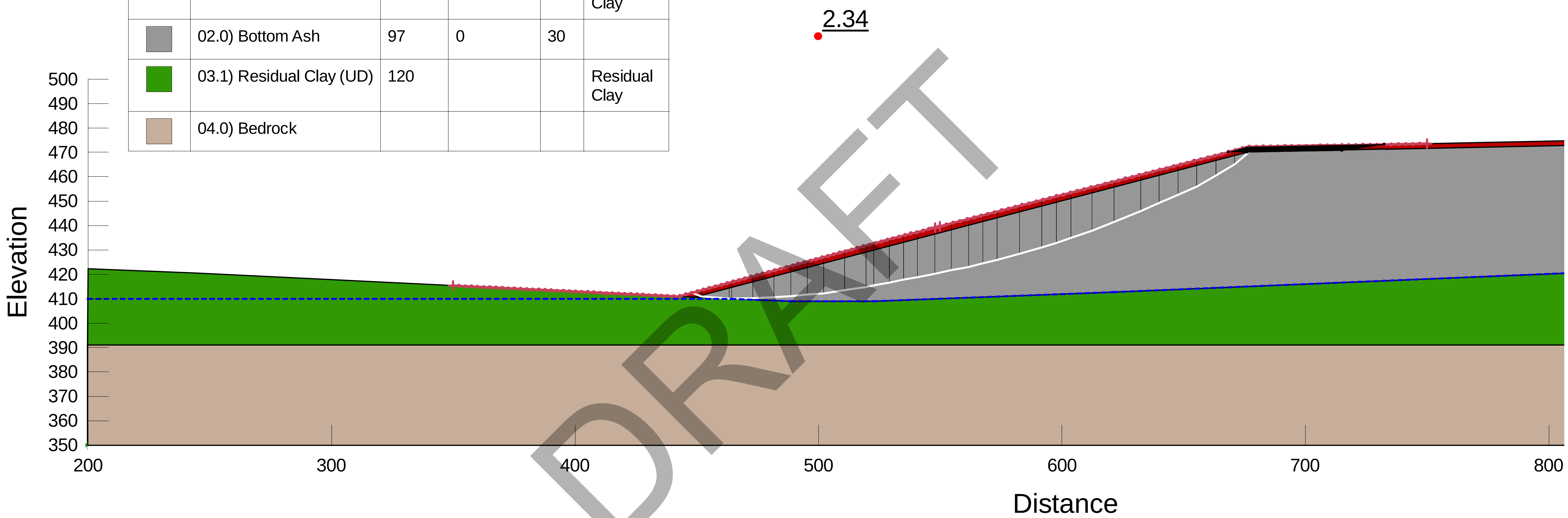
Geosyntec consultants	Title: Section A-A' - Plan and Profile View	Date: December 2022	FIGURE B-1
	Project: Baldwin Power Plant Bottom Ash Pond Closure	Author: IJV	

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	01.0) Cover (D)	120	200	32
	02.0) Bottom Ash	97	0	30
	03.0) Residual Clay (D)	120	200	32
	04.0) Bedrock			



Geosyntec consultants	*Title*: Section A-A' - Long-Term Condition	*Date*: January 2023	**FIGURE B-2**
	Project: Baldwin Power Plant Bottom Ash Pond Closure	*Author*: IJV	

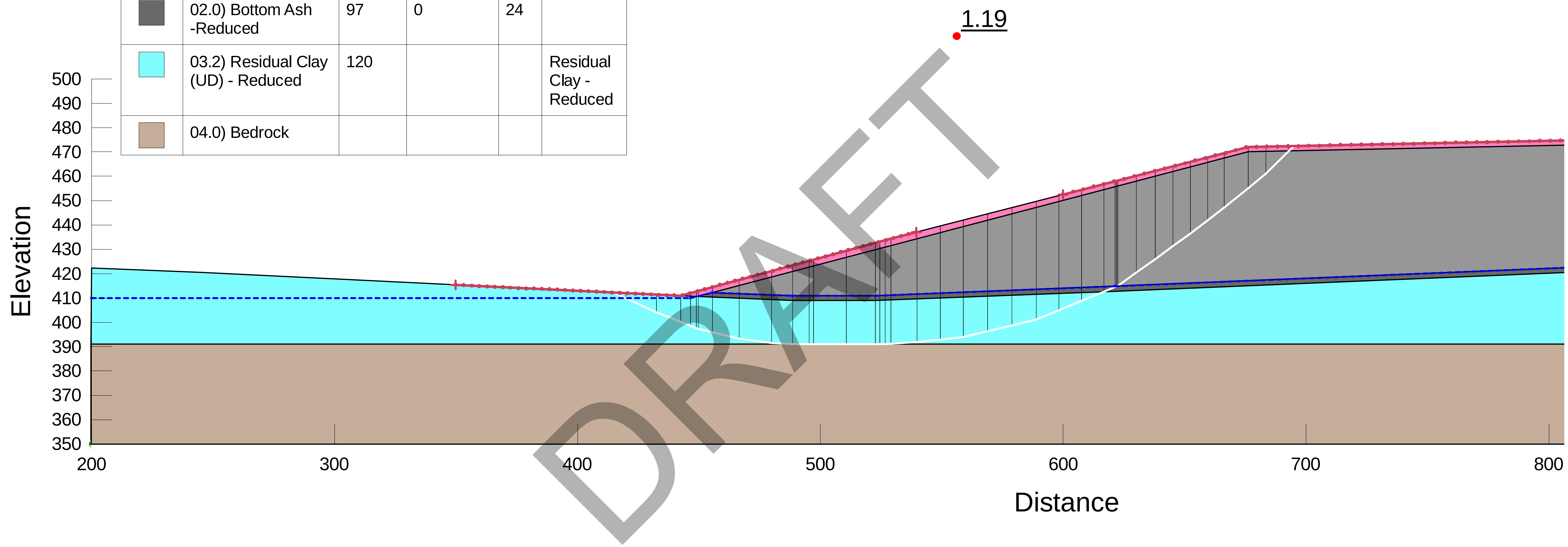
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Strength Function
	01.1) Cover (UD)	120			Residual Clay
	02.0) Bottom Ash	97	0	30	
	03.1) Residual Clay (UD)	120			Residual Clay
	04.0) Bedrock				



Geosyntec consultants

Title: Section A-A' - Short-Term, End of Construction Condition	*Date*: January 2023	**FIGURE B-3**
Project: Baldwin Power Plant Bottom Ash Pond Closure	*Author*: IJV	

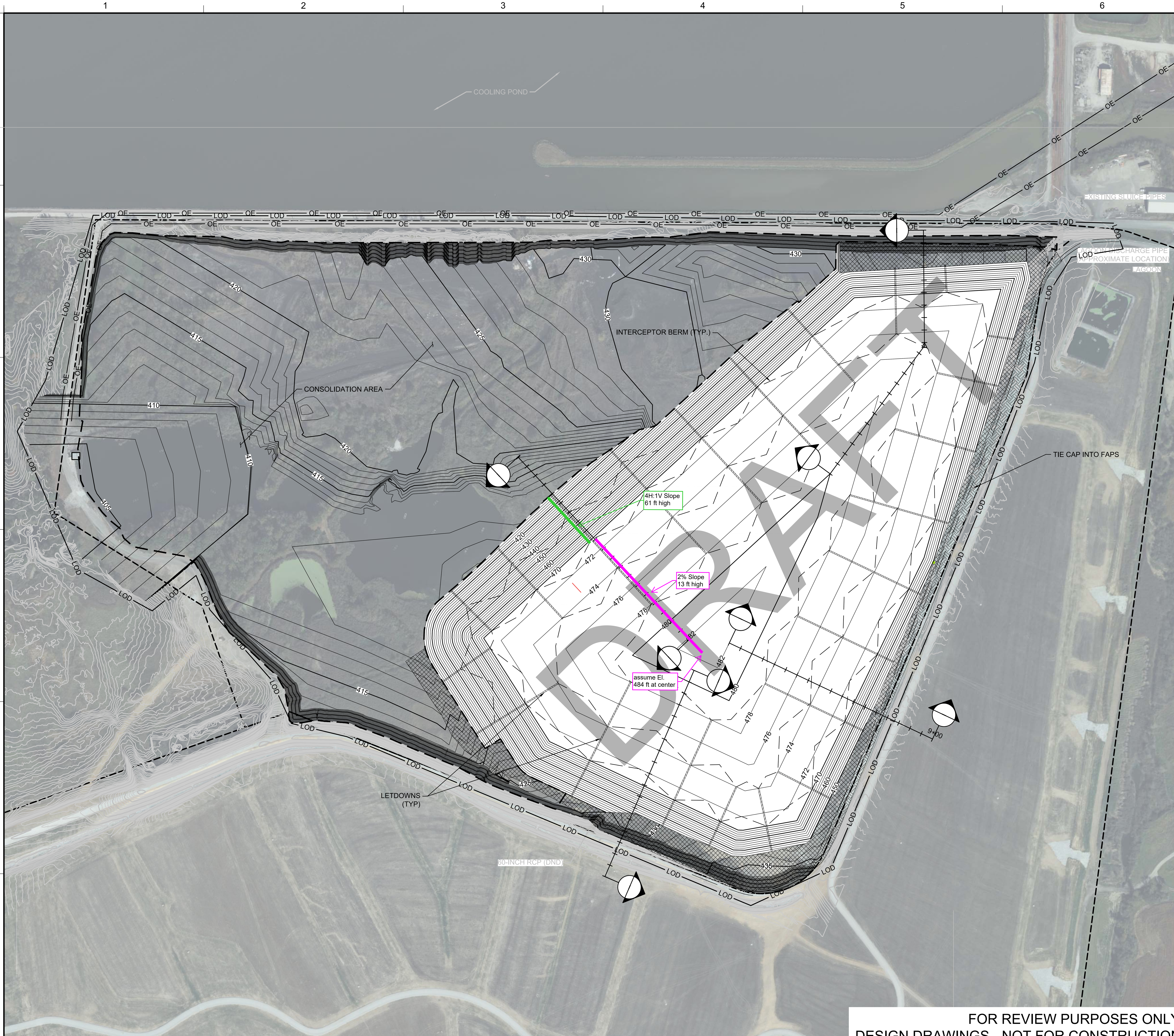
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Strength Function
Pink	01.2) Cover (UD) - Reduced	120			Residual Clay - Reduced
Light gray	02.0) Bottom Ash	97	0	30	
Dark gray	02.0) Bottom Ash -Reduced	97	0	24	
Cyan	03.2) Residual Clay (UD) - Reduced	120			Residual Clay - Reduced
Tan	04.0) Bedrock				



Geosyntec consultants

Title: Section A-A' - Pseudostatic Seismic Condition	*Date*: January 2023	**FIGURE B-4**
Project: Baldwin Power Plant Bottom Ash Pond Closure	*Author*: IJV	

Attachment C
Veneer Stability Results



LEGEND

420	EXISTING GROUND MAJOR CONTOUR (5')
	EXISTING GROUND MINOR CONTOUR (1')
	IMPOUNDMENT BOUNDARY
470	PROPOSED GRADING MAJOR CONTOURS (5')
472	PROPOSED GRADING MINOR CONTOURS (1')
LOD	LIMITS OF DISTURBANCE (LOD)
	INTERCEPTOR BERM
	FINAL HAUL ROAD
	EDGE OF EXISTING GRADE
	LETDOWNS
	PERIMETER DITCH
	CAP TIE-IN TO FAPS

PRELIMINARY BOTTOM ASH POND CONSOLIDATED CLOSURE DESIGN

EDITED AND ANNOTATED FOR VENEER STABILITY ANALYSIS

0 200 400
SCALE IN FEET

FOR REVIEW PURPOSES ONLY
DESIGN DRAWINGS - NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DRIVE, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636-812-0800

DYNEGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZA DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: PHASE 2 FINAL GRADING PLAN

PROJECT: BOTTOM ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: BALDWIN POWER PLANT
BALDWIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DRAFT

DESIGN BY:		DATE:	DECEMBER 2022
DRAWN BY:		PROJECT NO.:	GLP8050
CHECKED BY:		FILE:	05 - GLP8050 C-120
REVIEWED BY:		DRAWING NO.:	
APPROVED BY:			

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geotextile, geotextile-to-cover soil)
(Conversion of degrees to radians are performed for Excel spread sheet calculations)

2.0% (50H:1V slope) β =	1.15	degrees =	0.02	radians
Interface Friction, δ =	**19.0**	**degrees =**	0.33	radians
Interface Adhesion, a =	**90**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_w =	0.021	ft		
t_w^* =	0.021	ft		
Height of slope, h =	13.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	0.56	radians
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.000	g		

A	B	C	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$	$\tan\delta/\tan\beta$	[A/B] x C
238.690	240.000	17.216	17.122

D		E	F	G	
$[a/\sin\beta]$	D/B	$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$	t/h	E x F x G
4500.900	**18.75374963**	0.995	15.829	0.154	2.422

H	I	J	
1/B	$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$	ct/h	H x I x J
0.004	50.653	30.769	6.494

A'	B'	C'	D'	[A'+B'-C']/D'
$a/[\gamma_t \times t \times \cos^2(\beta)]$	$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$	$n_q \times \tan\beta \times \tan\phi$	$n_q + \tan\beta$	35.880
0.375	0.342	0.000	0.020	

FS (Static)
44.79

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
2% Slope - Unsaturated Static
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geotextile, geotextile-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

2.0% (50H:1V slope) β =	1.15	degrees =	*0.02*	*radians*
Interface Friction, δ =	**19.0**	**degrees =**	*0.33*	*radians*
Interface Adhesion, a =	**90**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_w =	2.000	ft		
t_w* =	2.000	ft		
Height of slope, h =	13.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56*	*radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.000	g		

A	*B*	*C*	
[γ_t x (t-t_w) + γ_b x t_w]	[γ_t x (t-t_w) + γ_{sat} x t_w]	tanδ/tanβ	[A/B] x C
115.200	240.000	17.216	8.264

D	
[a/sinβ]	D/B
4500.900	**18.75374963**

E	*F*	*G*	
γ_t x (t-t_w*) + γ_b x t_w*]/B	[tanϕ/(2sinβcos$^2\beta$)]/(1-tanβtanϕ)	t/h	E x F x G
0.480	15.829	0.154	1.169

H	*I*	*J*	
1/B	[1/(sinβcosβ)]/[1-tanβtanϕ]	ct/h	H x I x J
0.004	50.653	30.769	6.494

A'	*B'*	*C'*	*D'*	[A'+B'-C']/D'
a/[γ_t x t x cos^2(β)]	tanϕ x [1-(γ_w x t_w)/(γ_t x t)]	n_q x tanβ x tanϕ	n_q + tanβ	27.021
0.375	0.165	0.000	0.020	

FS (Static)
34.68

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
2% Slope - Saturated Static
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geotextile, geotextile-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

Assumed 40% reduction in interface shear strength

2.0% (50H:1V slope) β =	1.15	degrees =	*0.02*	*radians*
Interface Friction, δ =	**11.4**	**degrees =**	*0.20*	*radians*
Interface Adhesion, a =	**54.0**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_w =	0.021	ft		
t_w* =	0.021	ft		
Height of slope, h =	13.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56*	*radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.180	g		

A	*B*	*C*	
[γ_t x (t-t_w) + γ_b x t_w]	**[γ_t x (t-t_w) + γ_{sat} x t_w]**	**tanδ/tanβ**	**[A/B] x C**
238.690	240.000	10.082	10.027

D	
[a/sinβ]	**D/B**
2700.540	**11.25224978**

E	*F*	*G*	
γ_t x (t-t_w*) + γ_b x t_w*]/B	**[tanϕ/(2sinβcos$^2\beta$)]/(1-tanβtanϕ)**	**t/h**	**E x F x G**
0.995	15.829	0.154	2.422

H	*I*	*J*	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.004	50.653	30.769	6.494

A'	*B'*	*C'*	*D'*	**[A'+B'-C']/D'**
a/[γ_t x t x cos^2(β)]	**tanϕ x [1-(γ_w x t_w)/(γ_t x t)]**	**n_q x tanβ x tanϕ**	**n_q + tanβ**	2.124
0.225	0.201	0.001	0.200	

FS (Seismic)
2.12

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
2% Slope - Unsaturated Seismic
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geotextile, geotextile-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

Assumed 40% reduction in interface shear strength

2.0% (50H:1V slope) β =	1.15	degrees =	*0.02 radians*
Interface Friction, δ =	**11.4**	**degrees =**	*0.20 radians*
Interface Adhesion, a =	**54.0**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	13.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56 radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	*B*	*C*	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$	$\tan\delta/\tan\beta$	**[A/B] x C**
238.690	240.000	10.082	10.027

D	
$[a/\sin\beta]$	**D/B**
2700.540	**11.25224978**

E	*F*	*G*	
$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$	t/h	**E x F x G**
0.995	15.829	0.154	2.422

H	*I*	*J*	
1/B	$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$	ct/h	**H x I x J**
0.004	50.653	30.769	6.494

A'	*B'*	*C'*	*D'*	**[A'+B'-C']/D'**
$a/[\gamma_t \times t \times \cos^2(\beta)]$	$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$	$n_q \times \tan\beta \times \tan\phi$	$n_q + \tan\beta$	21.281
0.225	0.201	0.000	0.020	

FS (Post-EQ)
30.19

Baldwin Bottom Ash Pond Closure Design

Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations

2% Slope - Unsaturated Post Earthquake

GLP8050

Created By: Zachary Fallert

Checked By: Isaiah Vaught

Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)
(Conversion of degrees to radians are performed for Excel spread sheet calculations)

4H:1V slope β =	14.04	degrees =	*0.24*	*radians*
Interface Friction, δ =	**19.0**	**degrees =**	*0.33*	*radians*
Interface Adhesion, a =	**90**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_w =	0.021	ft		
t_w* =	0.021	ft		
Height of slope, h =	61.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56*	*radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.000	g		

A	*B*	*C*	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$	tanδ/tanβ	**[A/B] x C**
238.690	240.000	1.377	1.370

D		*E*	*F*	*G*	
[a/sinβ]	**D/B**	$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]$/B	$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$	t/h	**E x F x G**
371.080	**1.54616461**	0.995	1.622	0.033	0.053

H	*I*	*J*	
1/B	$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$	ct/h	**H x I x J**
0.004	5.037	6.557	0.138

A'	*B'*	*C'*	*D'*	**[A'+B'-C']/D'**
$a/[\gamma_t \times t \times \cos^2(\beta)]$	$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$	$n_q \times \tan\beta \times \tan\phi$	$n_q + \tan\beta$	2.964
0.398	0.342	0.000	0.250	

FS (Static)
3.11

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
4H:1V Slope - Unsaturated Static
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

Parameter	Value	Unit		
4H:1V slope β =	14.04	degrees =	*0.24*	*radians*
Interface Friction, δ =	**19.0**	**degrees =**	*0.33*	*radians*
Interface Adhesion, a =	**90**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_{w} =	2.000	ft		
t_w* =	2.000	ft		
Height of slope, h =	61.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56*	*radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.000	g		

A	*B*	*C*	
[γ_t x (t-t_w) + γ_b x t_w]	**[γ_t x (t-t_w) + γ_{sat} x t_w]**	**tanδ/tanβ**	**[A/B] x C**
115.200	240.000	1.377	0.661

D	
[a/sinβ]	**D/B**
371.080	**1.54616461**

E	*F*	*G*	
γ_t x (t-t_w*) + γ_b x t_w*]/B	**[tanϕ/(2sinβcos$^2\beta$)]/(1-tanβtanϕ)**	**t/h**	**E x F x G**
0.480	1.622	0.033	0.026

H	*I*	*J*	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.004	5.037	6.557	0.138

A'	*B'*	*C'*	*D'*	**[A'+B'-C']/D'**
a/[γ_t x t x cos^2(β)]	**tanϕ x [1-(γ_w x t_w)/(γ_t x t)]**	**n_q x tanβ x tanϕ**	**n_q + tanβ**	2.255
0.398	0.165	0.000	0.250	

FS (Static)
2.37

Baldwin Bottom Ash Pond Closure Design

Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations

4H:1V Slope - Saturated Static

GLP8050

Created By: Zachary Fallert

Checked By: Isaiah Vaught

Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

Assumed 40% reduction in interface shear strength

Parameter	Value	Unit		
4H:1V slope β =	14.04	degrees =	0.24	radians
Interface Friction, δ =	**11.4**	**degrees =**	0.20	radians
Interface Adhesion, a =	**54.0**	**psf**		
Thickness of soil above geomembrane, t =	**2.00**	**ft**		
Thickness of Saturation (water) t_w =	0.021	ft		
t_w* =	0.021	ft		
Height of slope, h =	61.0	ft		
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**		
Effective Unit Weight, γ_b =	57.60	pcf		
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf		
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	0.56	radians
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**		
Seismic Coeffecient, k_s =	0.180	g		

A	B	C	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$	$\tan\delta/\tan\beta$	[A/B] x C
238.690	240.000	0.807	0.802

D	
$[a/\sin\beta]$	D/B
222.648	**0.927698766**

E	F	G	
$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$	t/h	E x F x G
0.995	1.622	0.033	0.053

H	I	J	
1/B	$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$	ct/h	H x I x J
0.004	5.037	6.557	0.138

A'	B'	C'	D'	[A'+B'-C']/D'
$a/[\gamma_t \times t \times \cos^2(\beta)]$	$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$	$n_q \times \tan\beta \times \tan\phi$	$n_q + \tan\beta$	1.001
0.239	0.201	0.009	0.430	

FS (Seismic)
1.00

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
4H:1V Slope - Unsaturated Seismic
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Inputs in purple.

Analysis of all interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)
(Conversion of degrees to radians are performed for Excel spread sheet calculations)
Assumed 40% reduction in interface shear strength

Parameter	Value	Units	Radians
4H:1V slope β =	14.04	degrees =	*0.24 radians*
Interface Friction, δ =	**11.4**	**degrees =**	*0.20 radians*
Interface Adhesion, a =	**54.0**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	0.021	ft	
t_w^* =	0.021	ft	
Height of slope, h =	61.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**120.0**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**32.0**	**degrees =**	*0.56 radians*
Cohesion of Soil Above Geomembrane, c =	**200**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	B	C	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$	$\tan\delta/\tan\beta$	[A/B] x C
238.690	240.000	0.807	0.802

D		E	F	G	
$[a/\sin\beta]$	D/B	$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$	t/h	E x F x G
222.648	**0.927698766**	0.995	1.622	0.033	0.053

H	I	J	
1/B	$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$	ct/h	H x I x J
0.004	5.037	6.557	0.138

A'	B'	C'	D'	[A'+B'-C']/D'
$a/[\gamma_t \times t \times \cos^2(\beta)]$	$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$	$n_q \times \tan\beta \times \tan\phi$	$n_q + \tan\beta$	1.758
0.239	0.201	0.000	0.250	

FS (Post-EQ)
1.92

Baldwin Bottom Ash Pond Closure Design
Baldwin Power Plant - Baldwin, IL

Geosyntec consultants

Veneer Slope Stability Calculations
4H:1V Slope - Unsaturated Post Earthquake
GLP8050
Created By: Zachary Fallert
Checked By: Isaiah Vaught
Date: 12/12/2022

Geosyntec consultants

Attachment D
Consolidation Parameters and Results

Boring ID	BAL-B006
Shelby ID	ST-2B
Shelby Depth (ft)	30-32
Soil Unit	Residual Clay

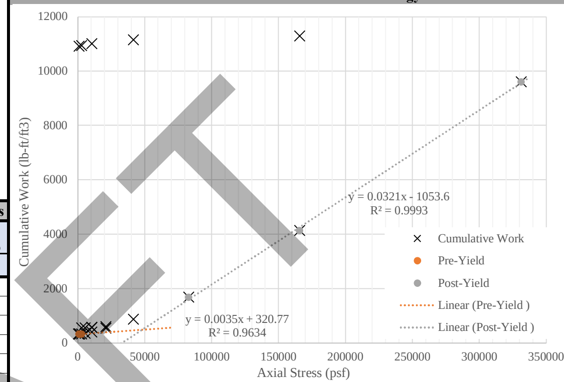
Sample In Situ Effective Stress (psf)	1535

Data Input				Strain-Energy Calculations and Plotting Points					Void Ratio Plotting Points	
Axial Stress	**Axial Stress**	**Axial Strain**	**Void Ratio**	**Delta Work**	**Cumulative Work**	**Pre-Yield**	**Post-Yield**	**Slope**	**Pre-Yield Void Ratio**	**Post-Yield Void Ratio**
psf	**tsf**	**%**	**e**	**lb-ft/ft^3**	**lb-ft/ft^3**	**lb-ft/ft^3**	**lb-ft/ft^3**		**e**	**e**
324	0.162	0.04	0.398	324.00	324.00					
646	0.323	-0.06	0.399	-0.49	323.51	323.51		0.00	0.3990	
1294	0.65	0.04	0.398	0.99	324.50	324.50		0.00	0.3980	
2580	1.3	0.32	0.394	5.46	329.96	329.96		0.00	0.3940	
5180	2.6	0.78	0.387	18.00	347.97			0.01		
10340	5.2	1.49	0.378	54.63	402.60			0.01		
20800	10.4	2.40	0.365	142.31	544.91			0.01		
10340	5.2	2.57	0.362	26.16	571.06			0.00		
2580	1.3	2.28	0.366	-18.48	552.59			0.00		
5180	2.6	2.30	0.366	0.74	553.32			0.00		
10340	5.2	2.44	0.364	10.86	564.19			0.00		
20800	10.4	2.63	0.362	29.27	593.46			0.00		
41400	20.7	3.52	0.349	274.92	868.38			0.01		
82800	41.4	4.83	0.331	814.13	1682.52		1682.52	0.02		0.3310
165600	82.8	6.80	0.303	2451.71	4134.22		4134.22	0.03		0.3030
331200	165.6	9.00	0.272	5472.25	9606.48		9606.48	0.03		0.2720
165600	82.8	9.68	0.263	1684.15	11290.63			-0.01		
41400	20.7	9.54	0.265	-143.86	11146.76			0.00		
10340	5.2	9.00	0.272	-140.47	11006.29			0.00		
2580	1.29	7.91	0.288	-70.61	10935.68			0.01		
646	0.323	6.59	0.306	-21.16	10914.52			0.01		

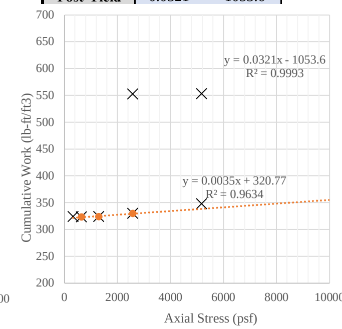
Geosyntec consultants

Baldwin Bottom Ash Pond Closure Design			
Baldwin Power Plant - Baldwin, IL			
1-D Consolidation Test Data Processing			
Boring ID: BAL-B006		Authored By:	Zachary Fallert
Sample ID: ST-2B		Checked By:	Isaiah Vaught
Project No. GLP8050		Date:	12/5/2022

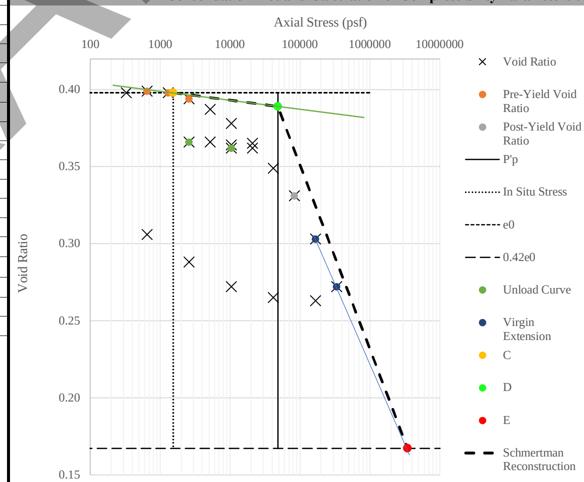
Strain-Energy Plot and Calculation of P'p



Line	**Slope**	**Intercept**	**P'p (psf)**
Pre-Yield	0.0035	320.77	**48054.9**
Post-Yield	0.0321	-1053.6	



Consolidation Plot and Calculation of Compressibility Parameters using Schmertmann's Method



Unload Curve Data Points	
e	**Stress (psf)**
0.3620	10340
0.3660	2580

Schmertman Reconstruction		
Line or Point	**e**	**Stress (psf)**
P'_p	0.3980	48054.9
Vertical Line	0.1672	48054.9
In Situ Stress	0.3980	1535.4
Vertical Line	0.1672	1535.4
e_0	0.3980	1
Horizontal Line	0.3980	1000000
$0.42e_0$	0.1672	1
Horizontal Line	0.1672	10000000
C	0.3980	1535.4
D	0.3890	48054.9
E	0.1672	3460000

Settlement Parameters	
$C_{r\varepsilon}$	0.004
$C_{c\varepsilon}$	0.085
P'_p (psf)	48055
OCR	31.3
Consolidation State	Significantly Over-Consolidated

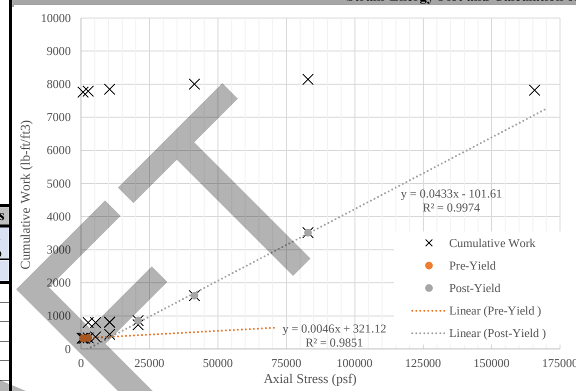
Boring ID	BAL-B007
Shelby ID	ST-1C
Shelby Depth (ft)	30-32
Soil Unit	Loess

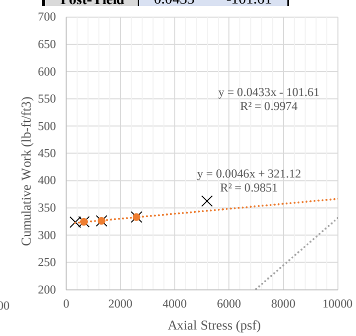
Sample In Situ Effective Stress (psf)	1223

Data Input				Strain-Energy Calculations and Plotting Points					Void Ratio Plotting Points	
Axial Stress	Axial Stress	Axial Strain	Void Ratio	Delta Work	Cumulative Work	Pre-Yield	Post-Yield	Slope	Pre-Yield Void Ratio	Post-Yield Void Ratio
psf	tsf	%	e	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$		e	e
324	0.162	0.04	0.661	324.00	324.00					
646	0.323	0.14	0.659	0.49	324.49	324.49		0.00	0.6590	
1294	0.65	0.34	0.656	1.91	326.40	326.40		0.00	0.6560	
2580	1.3	0.68	0.650	6.70	333.10	333.10		0.01	0.6500	
5180	2.6	1.44	0.637	29.53	362.62			0.01		
10340	5.2	2.49	0.620	81.56	444.18			0.02		
20800	10.4	4.32	0.590	284.00	728.18			0.03		
10340	5.2	4.82	0.581	78.63	806.81			-0.01		
2580	1.3	4.67	0.584	-10.08	796.73			0.00		
5180	2.6	4.68	0.584	0.39	797.12			0.00		
10340	5.2	4.82	0.581	11.33	808.45			0.00		
20800	10.4	5.10	0.577	43.91	852.36		852.36	0.00		0.5770
41400	20.7	7.55	0.536	759.77	1612.13		1612.13	0.04		0.5360
82800	41.4	10.61	0.485	1899.02	3511.15		3511.15	0.05		0.4850
165600	82.8	14.07	0.428	4307.26	7818.40			0.05		
82800	41.4	14.34	0.423	331.61	8150.02			0.00		
41400	20.7	14.10	0.427	-147.18	8002.84			0.00		
10340	5.2	13.52	0.437	-151.34	7851.50			0.00		
2580	1.3	12.57	0.453	-61.18	7790.32			0.01		
646	0.32	10.90	0.480	-26.99	7763.34			0.01		

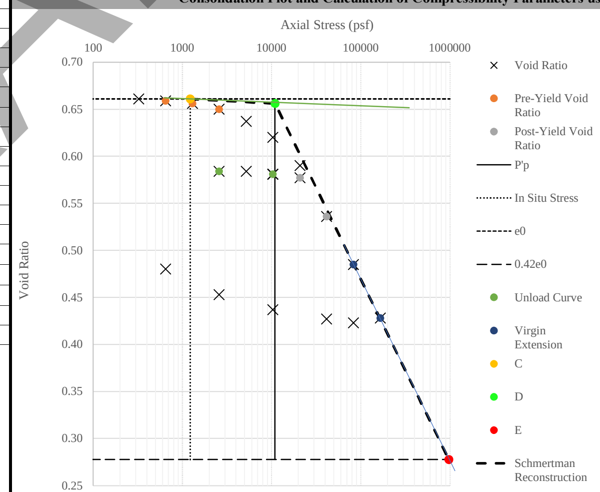
Strain-Energy Plot and Calculation of P'p

Line	Slope	Intercept	P'p (psf)
Pre-Yield	0.0046	321.12	10923.3
Post-Yield	0.0433	-101.61	





Consolidation Plot and Calculation of Compressibility Parameters using Schmertmann's Method



Unload Curve Data Points	
e	Stress (psf)
0.5810	10340
0.5840	2580

Schmertman Reconstruction		
Line or Point	e	Stress (psf)
P'_p	0.6610	10923.3
Vertical Line	0.2776	10923.3
In Situ Stress	0.6610	1222.8
Vertical Line	0.2776	1222.8
e_0	0.6610	1
Horizontal Line	0.6610	1000000
$0.42e_0$	0.2776	1
Horizontal Line	0.2776	10000000
C	0.6610	1222.8
D	0.6560	10923.3
E	0.2776	970000

Settlement Parameters	
$C_{r\varepsilon}$	0.003
$C_{c\varepsilon}$	0.117
P'_p (psf)	10923
OCR	8.9
Consolidation State	Significantly Over-Consolidated

Geosyntec consultants

Baldwin Bottom Ash Pond Closure Design			
Baldwin Power Plant - Baldwin, IL			
1-D Consolidation Test Data Processing			
Boring ID: BAL-B007		Authored By:	Zachary Fallert
Sample ID: ST-1C		Checked By:	Isaiah Vaught
Project No. GLP8050		Date:	12/5/2022

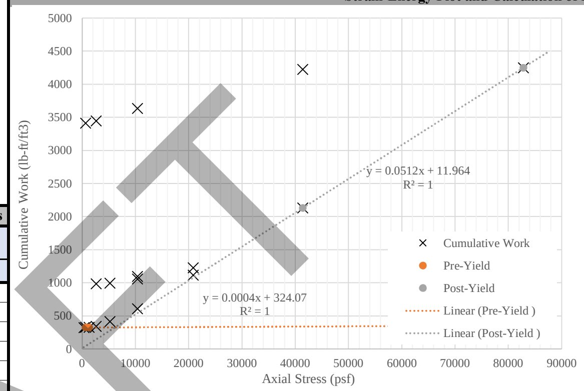
Boring ID	BAL-B026
Shelby ID	ST-2C
Shelby Depth (ft)	35-37
Soil Unit	Loess

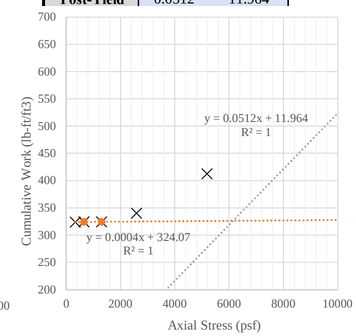
Sample In Situ Effective Stress (psf)	2257

Data Input				Strain-Energy Calculations and Plotting Points					Void Ratio Plotting Points	
Axial Stress	Axial Stress	Axial Strain	Void Ratio	Delta Work	Cumulative Work	Pre-Yield	Post-Yield	Slope	Pre-Yield Void Ratio	Post-Yield Void Ratio
psf	tsf	%	e	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$	$lb\text{-}ft/ft^3$		e	e
324	0.162	-0.06	0.650	324.00	324.00					
646	0.323	0.01	0.648	0.31	324.31	324.31		0.00	0.6480	
1294	0.65	0.03	0.648	0.24	324.55	324.55		0.00	0.6480	
2580	1.3	0.85	0.635	15.73	340.28			0.01		
5180	2.6	2.70	0.604	71.90	412.18			0.03		
10340	5.2	5.23	0.562	196.56	608.74			0.04		
20800	10.4	8.49	0.509	506.65	1115.39			0.05		
10340	5.2	8.35	0.511	-21.18	1094.21			0.00		
2580	1.3	6.63	0.539	-111.18	983.03			0.01		
5180	2.6	6.92	0.534	11.45	994.48			0.00		
10340	5.2	7.72	0.521	61.46	1055.94			0.01		
20800	10.4	8.79	0.504	167.69	1223.63			0.02		
41400	20.7	11.71	0.456	907.19	2130.82		2130.82	0.04		0.4560
82800	41.4	15.12	0.399	2118.85	4249.67		4249.67	0.05		0.3990
41400	20.7	15.08	0.400	-24.84	4224.83			0.00		
10340	5.2	12.80	0.438	-590.09	3634.73			0.02		
2580	1.3	9.90	0.485	-187.60	3447.13			0.02		
646	0.3	7.57	0.524	-37.47	3409.66			0.02		

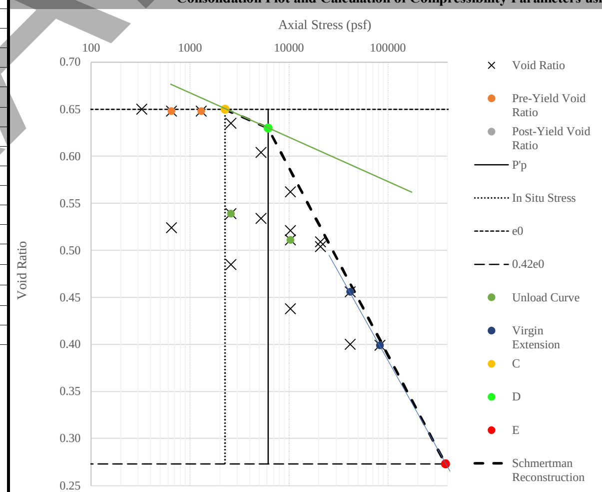
Strain-Energy Plot and Calculation of P'p

Line	Slope	Intercept	P'p (psf)
Pre-Yield	0.0004	324.07	6143.8
Post-Yield	0.0512	11.964	





Consolidation Plot and Calculation of Compressibility Parameters using Schmertmann's Method



Unload Curve Data Points	
e	Stress (psf)
0.5110	10340
0.5390	2580

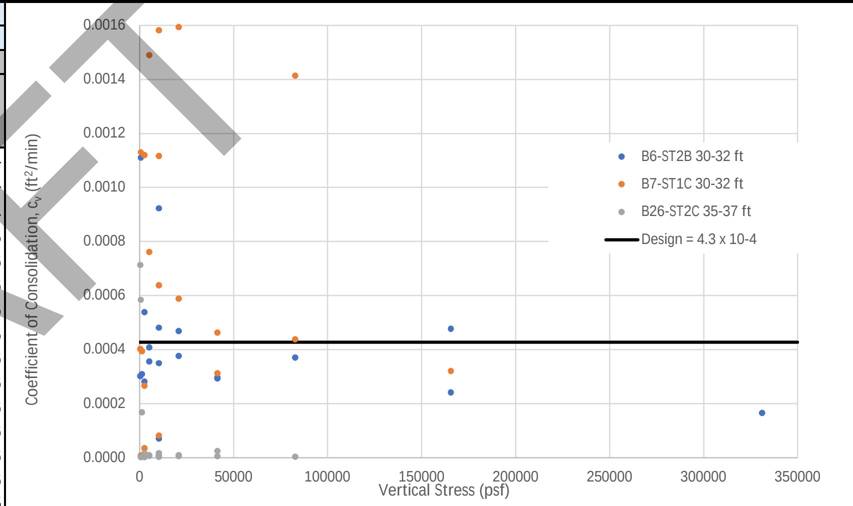
Schmertman Reconstruction		
Line or Point	e	Stress (psf)
P'_p	0.6500	6143.8
Vertical Line	0.2730	6143.8
In Situ Stress	0.6500	2257.0
Vertical Line	0.2730	2257.0
e_0	0.6500	1
Horizontal Line	0.6500	1000000
$0.42e_0$	0.2730	1
Horizontal Line	0.2730	10000000
C	0.6500	2257.0
D	0.6300	6143.8
E	0.2730	380000

Settlement Parameters	
$C_{r\varepsilon}$	0.028
$C_{c\varepsilon}$	0.121
P'_p (psf)	6144
OCR	2.7
Consolidation State	Significantly Over-Consolidated

Geosyntec consultants

Baldwin Bottom Ash Pond Closure Design			
Baldwin Power Plant - Baldwin, IL			
1-D Consolidation Test Data Processing			
Boring ID: BAL-B026		Authored By:	Zachary Fallert
Sample ID: ST-2C		Checked By:	Isaiah Vaught
Project No. GLP8050		Date:	12/5/2022

B6-ST2B				B7-ST1C				B26-ST2C			
30-32 ft				30-32 ft				35-37 ft			
B6-ST2B 30-32 ft				B7-ST1C 30-32 ft				B26-ST2C 35-37 ft			
Vertical Stress tsf	**Vertical** Stress psf	Cv ft²/yr	Cv ft²/min	Vertical Stress tsf	**Vertical** Stress psf	Cv ft²/yr	Cv ft²/min	Vertical Stress tsf	**Vertical** Stress psf	Cv ft²/yr	Cv ft²/min
0.162	324	1.59E+02	3.02E-04	0.162	324	2.11E+02	4.02E-04	0.162	324	3.75E+02	7.13E-04
0.323	646	5.83E+02	1.11E-03	0.323	646	5.94E+02	1.13E-03	0.323	646	3.07E+02	5.84E-04
0.647	1294	1.63E+02	3.09E-04	0.647	1294	2.07E+02	3.94E-04	0.647	1294	8.79E+01	1.67E-04
1.29	2580	2.83E+02	5.38E-04	1.29	2580	5.88E+02	1.12E-03	1.29	2580	8.72E+00	1.66E-05
2.59	5180	2.14E+02	4.08E-04	2.59	5180	4.00E+02	7.61E-04	2.59	5180	4.43E+00	8.43E-06
5.17	10340	1.84E+02	3.49E-04	5.17	10340	3.35E+02	6.38E-04	5.17	10340	3.55E+00	6.75E-06
10.4	20800	1.98E+02	3.76E-04	10.4	20800	3.09E+02	5.88E-04	10.4	20800	2.70E+00	5.14E-06
5.17	10340	4.85E+02	9.23E-04	5.17	10340	5.87E+02	1.12E-03	5.17	10340	8.67E+00	1.65E-05
1.29	2580	1.48E+02	2.81E-04	1.29	2580	1.40E+02	2.66E-04	1.29	2580	1.93E+00	3.67E-06
2.59	5180	1.87E+02	3.55E-04	2.59	5180	7.83E+02	1.49E-03	2.59	5180	3.41E+00	6.49E-06
5.17	10340	2.53E+02	4.81E-04	5.17	10340	8.31E+02	1.58E-03	5.17	10340	4.42E+00	8.41E-06
10.4	20800	2.46E+02	4.68E-04	10.4	20800	8.37E+02	1.59E-03	10.4	20800	4.85E+00	9.23E-06
20.7	41400	1.56E+02	2.96E-04	20.7	41400	2.43E+02	4.63E-04	20.7	41400	2.45E+00	4.66E-06
41.4	82800	1.95E+02	3.70E-04	41.4	82800	2.30E+02	4.37E-04	41.4	82800	1.87E+00	3.56E-06
82.8	165600	1.27E+02	2.41E-04	82.8	165600	1.68E+02	3.20E-04	20.7	41400	1.27E+01	2.41E-05
165.6	331200	8.70E+01	1.65E-04	41.4	82800	7.43E+02	1.41E-03	5.17	10340	1.28E+00	2.44E-06
82.8	165600	2.51E+02	4.77E-04	20.7	41400	1.64E+02	3.12E-04	1.29	2580	6.36E-01	1.21E-06
20.7	41400	1.54E+02	2.93E-04	5.17	10340	4.29E+01	8.16E-05	0.323	646	4.42E-01	8.40E-07
5.17	10340	3.69E+01	7.02E-05	1.29	2580	1.81E+01	3.43E-05				
1.29	2580	7.82E+00	1.49E-05	0.323	646	4.16E+00	7.91E-06				
0.323	646	2.44E+00	4.64E-06								



Geosyntec consultants

Baldwin Bottom Ash Pond Closure Design			
Baldwin Power Plant - Baldwin, IL			
1-D Consolidation Test Data Processing			
Boring ID -	Authored By:	Zachary Fallert	
Sample ID -	Checked By:	Isaiah Vaught	
Project No. GLP8050	Date:	12/5/2022	

Summary of Consolidation Testing Data Processing Results

Boring ID	Sample Depth (ft)	Soil Unit	Initial Void Ratio (eo)	Recompression Index (C_r)	Virgin Compression Index (C_c)	Recompression Ratio, C_{re}	Compression Ratio, C_{ce}	Coefficient of Consolidation, C_v (ft^2/min)	Maximum Past-Pressure (psf)	OCR
BAL-B006	30-32	Residual Clay	0.398	0.006	0.119	0.004	0.085	Evaluated from combined data. Set to upper 2/3 percentile = $4.3x10^{-4}$	48055	31.3
BAL-B007	30-32	Loess	0.661	0.005	0.194	0.003	0.117		10923	8.9
BAL-B026	35-37	Loess	0.273	0.035	0.154	0.028	0.121		6144	2.7
Average			0.444	0.016	0.156	0.012	0.108	4.0E-04	21707	14
Max			0.661	0.035	0.194	0.028	0.121	1.6E-03	48055	31
Min			0.273	0.005	0.119	0.003	0.085	8.4E-07	6144	2.7

Initial Condition	
GWT Elevation	434
Unit	Elevation (ft)
	434
Existing Ash	
	425
Loess	
	404
Residual Clay	
	395
Shale	

Final Condition	
GWT Elevation	408
Unit	Elevation (ft)
	497
New Fill	
	434
Existing Ash	
	425
Loess	
	404
Residual Clay	
	395
Shale	

Evaluate Critical Soil Profile			
Boring ID	Soil Elevations (ft)		
	Top of Loess	Top of Till/Residual	Bottom of Soils
B005	NA	417.0	402.0
B006	NA	428.3	403.3
B007	423.0	408.0	393.0
B008	424.7	403.7	394.7
B009	NA	407.0	397.0
B026	428.0	418.0	403.0
B027	NA	433.5	409.5

Till assumed to be the same as Residual Clay due to lack of data.
B008 conservatively used for calcualtions (thickest soil and loess).
Lowest existing surface elevation assumed for top of existing ash.
Highest point on closure design assumed for top of fill.

Calculation Soil Units	Soil Properties					
	Re-Compression Ratio	Compression Ratio	Max. Past Pressure (psf)	Unit Weight (pcf)	Calculation Elevation (ft)	Thickness (ft)
New Fill	Assumed Negligible Compression			100	-	63
Existing Ash	Assumed Settlement Will Occur During Construction			97	-	9.32
Loess Top Half	0.028	0.121	6144	120	419.43	10.5
Loess Bottom Half	0.028	0.121	6144	120	408.93	10.5
Residual Clay Top Half	0.004	0.085	48055	120	401.43	4.5
Residual Clay Bottom Half	0.004	0.085	48055	120	396.93	4.5

Calculation Soil Units	Initial Stresses (psf)			Final Stresses (psf)		
	Total	Pore Pressure	Effective	Total	Pore Pressure	Effective
Loess Top Half	1534	909	625	7834	0	7834
Loess Bottom Half	2794	1564	1230	15394	0	15394
Residual Clay Top Half	3694	2032	1662	9994	410	9584
Residual Clay Bottom Half	4234	2313	1921	16834	691	16143

Calculation Soil Units	Settlement (in)		
	Recom-pression	Virgin Com-pression	Total
Loess Top Half	3.5	1.6	5.1
Loess Bottom Half	2.5	6.1	8.5
Residual Clay Top Half	0.3	0.0	0.3
Residual Clay Bottom Half	0.3	0.0	0.3
Total Settlement (in)	6.6	7.7	**14.3**

Time Rate Check	
Degree of Consolidation, U (%)	80
Time Factor, T_v	0.567
Coefficient of Consolidation, C_v (ft^2/min)	4.3E-04
Time for U in Loess (months)	**27**
Estimated Remaining Settlement (in)	**2.9**

Baldwin Bottom Ash Pond Closure Design	
Baldwin Power Plant - Baldwin, IL	
1-D Consolidation and Time Rate Calculations	
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Project No. GLP8050	

Geosyntec consultants