

September 9, 2021

**Analysis of**  
**Draft Closure / Post-Closure Permit for Coal Combustion Residuals**  
**Permit No. 057-026D (CCR)**

**Georgia Power Company**  
**Plant Hammond**  
**Surface Impoundment AP-3**

**1.0 PURPOSE AND SCOPE**

I completed an analysis of the Draft Closure / Post-Closure Care Permit for Coal Combustion Residuals (CCRs) (Draft Permit) issued by the Georgia Department of Natural Resources, Environmental Protection Division (EPD) for surface impoundment AP-3 at Plant Hammond.

The purpose of my analysis was to evaluate the Draft Permit relative to the standards established in Georgia Rules for Solid Waste Management 391-3-4-.10 (Georgia CCR Rule) and the United States Environmental Protection Agency (US EPA) standards established in 40 Code of Federal Regulation (CFR) Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (US EPA CCR Rule) that were incorporated by reference into the Georgia CCR Rule.

My analysis included a review of the following documents submitted by Georgia Power and approved by the EPD in conjunction with the Draft Permit, as provided by the Sierra Club:

1. Notice of the Opportunity for Public Comment (Public Notice).
2. Closure / Post-Closure Care Permit for CCR (Draft Permit).
3. Closure Drawings, Ash Pond 3 (AP-3), Inactive CCR Surface Impoundment, Stantec, May 2021 (Closure Drawings).
4. Closure Plan, AP-3 – Inactive Surface Impoundment, Stantec, May 2021 (Closure Plan).
5. Groundwater Monitoring Plan, Plant Hammond – Ash Pond 3 (AP-3), Geosyntec Consultants, January 2021 (Groundwater Monitoring Plan).
6. Construction Quality Assurance Plan, AP-3 – Inactive Surface Impoundment, Stantec, November 2018 (CQA Plan).

My analysis also included a review of other CCR Rule-required documents prepared by Georgia Power or on behalf of Georgia Power that were included on its publicly available website (<https://www.georgiapower.com/company/environmental-compliance/plant-list/plant->

[hammond.html](#)) or documents that were developed in support of its original EPD permit application. Those documents included:

1. Permit Application (Part B), AP-3 – Inactive Surface Impoundment, Stantec, November 2018 (Part B Application).
2. History of Construction, Plant Hammond Ash Pond 3 (AP-3), Stantec (History of Construction) included in the Part B Application and an amended 2019 version (History of Construction, Amended).
3. Liner Design Criteria, Plant Hammond Ash Pond 3 (AP-3), Stantec (Liner Design Criteria).
4. Location Restriction Demonstration, Unstable Areas, Plant Hammond Ash Pond 3 (AP-3) (Location Restriction Unstable Areas).
5. Location Restriction Demonstration, Placed Above the Uppermost Aquifer, Plant Hammond Ash Pond 3 (AP-3) (Location Restriction Uppermost Aquifer Placement).
6. 2020 Semi-Annual Groundwater Monitoring & Corrective Action Report, Plant Hammond Ash Pond 3 (AP-3), Geosyntec Consultants, February 2021 (2020 Semi-Annual Report).
7. Assessment of Corrective Measures Report, Geosyntec Consultants, December 2020 (ACM Report).

In addition to the documents discussed and cited above, my analysis also included a review of the Report of Safety Assessment, Coal Combustion Surface Impoundments, Plant Hammond, AMEC Earth & Environmental, Inc., December 2010 (2010 Safety Assessment); the Assessment of Corrective Measures Report, Plant Hammond Ash Pond 3, Geosyntec Consultants, December 2020 (ACM Report); and the Manual for Groundwater Monitoring, Environmental Protection Division, September 1991 (EPD 1991).

My analysis refers to the above-referenced documents to support opinions expressed in this analysis. Page numbers for those citations are given as PDF page number, not the actual page number of the document.

## **2.0 COMMENTS FOR THE RECORD**

This Section includes comments specific to the Draft Permit. My comments are directed to the actual documents submitted by Georgia Power, approved by the EPD, and made a part of the Draft Permit. My analysis also includes a review of other related documents that I obtained from public records to support my analyses.

### **2.1 Draft Permit and Public Notice**

1. Georgia Power submitted a Closure Plan to EPD when it submitted its application to obtain a permit. The Part B Application component of that application, which was submitted in November 2018, included a Closure Plan. Georgia Power had already completed closure of AP-3 in the second quarter of 2018,<sup>1</sup> prior to submitting its application to EPD. Georgia Power therefore closed AP-3 without prior approval and a permit from the EPD.

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<sup>1</sup> 2020 Semi-Annual Report at 3.

2. Paragraph 4 of the Draft Permit requires as part of the post-closure care period (30 years), that Georgia Power “maintain the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence...”. As discussed in **Section 2.2.1** in this analysis, AP-3 has a history of a sudden loss of CCR liquids beneath the impoundment and onto an adjacent Pisgah Baptist Church property. Georgia Power should be required to demonstrate that should another similar collapse occur in the future, the integrity and effectiveness of the final cover system will not be compromised.
3. Paragraph 5 of the Draft Permit states that Georgia Power is required to maintain a groundwater monitoring system in accordance with Georgia CCR Rule 391-3-4-.10. As such, the system must be in compliance with 40 CFR Parts, 90, 91, 93 through 98. As discussed in **Section 2.3** of this analysis, the groundwater monitoring system does not comply with the Georgia CCR Rule, the US EPA CCR Rule, or the Georgia EPD guidance document (1991) that was cited by Georgia Power in its Groundwater Monitoring Plan.
4. Paragraph 12 of the Draft Permit requires that Georgia Power initiate an Assessment of Corrective Measures (“ACM”) as specified in Georgia CCR Rule 391-3-4-.10 “if an Appendix IV constituent has been detected at a statistically significant level exceeding the groundwater protection standard or conditions indicate a threat to human health or the environment as determined by the Director”. The ACM has already been required because concentrations of constituents in groundwater were determined to be statistically significant in 2019. As a result, Georgia Power began an assessment monitoring program for additional constituents in August 2019.<sup>2</sup> Although an ACM Report was prepared in December 2020, Georgia Power had yet to select a remedy because additional data gathering, data analysis, and site-specific evaluations were apparently necessary.<sup>3</sup> Also, there is no indication that Georgia Power has selected a groundwater remedy as of the writing of this analysis.
5. Georgia Power was required in the Draft Permit to “select an interim measure (if applicable) and / or remedy as specified in Georgia CCR Rule 391-3-4-.10”. There is no indication that Georgia Power has initiated any such “interim measure” to remedy groundwater contamination – more than two years after first confirming groundwater contamination. This delay is unreasonable. Although Georgia Power claimed in the ACM Report that closure of AP-3 “is a source control measure that reduces the potential for migration of CCR constituents to groundwater”, CCRs remain saturated in the uppermost aquifer and will continue to leach constituents to groundwater, as discussed in **Section 2.2.2** of this analysis. The final cover system over AP-3 should not be considered an interim groundwater remedy.
6. As discussed in **Sections 2.2** and **2.3** of this analysis, leakage of CCR constituents from AP-3 into groundwater has already caused groundwater contamination, some of which has migrated off-property to the adjoining Pisgah Baptist Church and beyond the waste boundary in downgradient compliance wells near Cabin Creek. In fact, Georgia Power is still slowly determining the nature and extent of contamination.

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<sup>2</sup> 2020 Semi-Annual Report at 12.

<sup>3</sup> ACM Report at 24.

7. As will be discussed in the subsequent Sections of my analysis, the Draft Permit allows Georgia Power to leave CCRs in-place in perpetuity – in violation of the US EPA and Georgia CCR Rule performance standards for closure-in-place, with CCRs remaining in contact with the uppermost aquifer, and in a geologically unstable karst environment. The final cover system for AP-3 should *not* be considered as a “generally-accepted good engineering practice” to allow CCRs to remain in-place indefinitely.

## 2.2 Closure Plan for Closure-in-Place

This Section evaluates Georgia Power’s closure-in-place method that it used to close AP-3. My analysis also evaluates documents prepared by or on behalf of Georgia Power in support of its decision to select closure-in-place.

### 2.2.1 Unstable Karst Geologic Conditions Exist Beneath AP-3

1. Georgia Power concluded in 2018 in the History of Construction in its Part B Application that no structural instability issues have been observed<sup>4</sup>, even though the record shows that a catastrophic leakage event (called “seepage” by Georgia Power) occurred in 1977. Further research for this analysis demonstrated the severity of that “seepage” event and the presence of a sinkhole(s) at AP-3. The facts associated with that event and those sinkhole conditions from a 2010 Report of Safety Assessment<sup>5</sup> prepared on behalf of Georgia Power, include:
  - In 1977, up to *one million gallons per day of CCRs were leaked from AP-3, some of which migrated onto the neighboring Pisgah Baptist Church property* [emphasis added] to the west. The location of the church is illustrated on **Figure 1**.
  - A subsurface investigation determined that the cause of the release was “removal of relatively impermeable material overlying the jointed bedrock”; the presence of “low to very high permeability” soil and / or bedrock materials below-ground; “low to very high permeability measurements in materials below the dike”; and “solution cavities” below the AP-3 dike.
  - An interoffice memo dated March 14, 1980 that a “sinkhole investigation” was performed and recommendations were submitted; however, there was “no documentation related to subsequent sinkhole repair or final disposition of the sinkhole issue”.
2. The only mention by Georgia Power of a sinkhole collapse or the “seepage” event in the Part B Application was near the end of the Application, in the History of Construction report included on Pages 1261 and 1272 (of 1290 pages).<sup>6</sup> A topographic map included in that Application from a land survey completed on October 15, 1979, a design drawing dated November 1979, and a construction detail of a “Plan of Proposed Sinkhole Repair” suggest that *another* sinkhole collapse had occurred requiring *another* repair – in addition to the 1977 collapse.<sup>7</sup>

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<sup>4</sup> History of Construction at 4.

<sup>5</sup> Hammond 2010 Dike Assessment at 62.

<sup>6</sup> Part B Application at 1261 and 1272.

<sup>7</sup> Part B Application at 1272.

3. Georgia Power failed to discuss the severity of the 1977 leakage or any other sinkhole repair(s) in the main body of the Part B Application or to discuss the severity or volume of CCRs that had been released. Georgia Power should have discussed the catastrophic release and sinkhole repair(s) in the Part B Application, the detailed mitigations completed for the collapse area, and what other mitigations have been implemented to prevent future collapses within the 25-acre footprint of AP-3.
4. According to the 2018 History of Construction prepared by Stantec on behalf of Georgia Power:
  - Just one month after AP-3 became operational (July 1977), “seepage was identified in the concrete drainage ditch along the toe of the west downstream slope”; AP-3 was “taken out of service”; an investigation was initiated in August 1977; and undefined “actions” were initiated to “address the issue” such that AP-3 was placed back into service in October 1977.<sup>8</sup>
  - A layer of highly weathered / fractured argillaceous limestone bedrock underlies the fill area of the dike, the native terrace alluvial soil, and residuum soil.<sup>9</sup> A more competent layer of limestone underlies the highly weathered zone. In summary, each of those soil and bedrock media have permeable and rapid groundwater flow capabilities.
  - Solution enlarged features exist in the bedrock; however, Stantec concluded “a comparison of solution features between borings does not indicate laterally continuous karst features within the bedrock”.<sup>10</sup>
  - Stantec concluded that “no dike stability issues were observed as a result of this seepage” and that “no structural instability issues have been observed for AP-3” [emphasis added].<sup>11</sup>
5. Clearly, a sinkhole collapse beneath AP-3 is a known “structural instability” issue of significant magnitude that should have been discussed in-depth. An amended September 2019 version of the History of Construction altered the above-discussion and conclusions regarding the section for “known record of structural instability”. Georgia Power concluded that the seepage was “due to wet-sluicing and the presence of a solution feature”; that the mitigation activity centered on lowering the water level in the impoundment and conversion to dry storage in 1982; and that no structural instability issues have been observed since that mitigation.<sup>12</sup> In the amended report, Georgia Power admitted that karst conditions were at least in part, responsible for the sinkhole collapse.
6. Just two months later in November 2019, Georgia Power remained largely silent on and downplayed the significance of the July 1977 seepage event, the 1977 repair, or the 1979 “proposed” sinkhole repair in its November 2019 Location Restriction Demonstration, Unstable Areas<sup>13</sup> determination (40 CFR Part 257.64 and Rule 341-3-4-.10 (3)) when it concluded that:

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<sup>8</sup> History of Construction at 4.

<sup>9</sup> History of Construction at 3.

<sup>10</sup> History of Construction at 3.

<sup>11</sup> History of Construction at 4.

<sup>12</sup> History of Construction, Amended at 4 and 5.

<sup>13</sup> Location Restriction Demonstration, Unstable Areas at 1.

- When discussing soil conditions, “there is *no known history* [emphasis added] of issues associated with settlement or differential settlement at AP-3” and “soil conditions in the vicinity and beneath AP-3 should not result in significant differential settlement.”
  - When discussing geologic conditions, the underlying limestone bedrock in the area “*may be potentially affected by karst*” [emphasis added] and the limestone “*is potentially affected* [emphasis added] by karst processes”.
  - Rock core samples “indicate the presence of discontinuous solution features, but do not suggest the presence of large, laterally continuous karst features such as caverns or sinkholes”.
  - The “documented water loss from AP-3 was related to “wet sluicing and the *likely presence of solution-enhanced joints and fractures* [emphasis added] in the underlying bedrock” and that those conditions “were mitigated with repair of the area of the water loss and conversion to dry handling operations at AP-3 in 1982”.
  - The final closure (i.e., closure-in-place) “including removal of free water and installation of a low permeable cover, further reduces the potential for adverse effects on the structural components of the unit”.
  - AP-3 is situated on a relatively flat site “that is not at risk from unstable natural slopes, mass movements, or erosive undercutting by the nearby surface water bodies at Cabin Creek or the Coosa River”.
  - “Dry handling of the CCR eliminates the addition of sluice water to the impoundment, removing the mechanism for erosion of foundation material into the underlying bedrock”.
  - “It is evident that recognized and generally-accepted good engineering practices have been incorporated into the design of the impoundment”, based upon the claimed “stable conditions” since 1977.
7. In my opinion, Georgia Power ignored and understated known karst risks and conditions above when it certified conditions for the required Unstable Areas determination required by both the US EPA CCR Rule and the Georgia CCR Rule. In response to Georgia Power’s conclusions regarding the absence of an Unstable Area, consider these rebuttal comments:
- There is a “known history” of catastrophic release of one million gallons *per day* [emphasis added] of CCR from AP-3 due to CCR loss through solution-enlarged conduits in bedrock underlying AP-3.
  - At least one significant sinkhole collapse and repair occurred in 1977 and another potential or probable collapse and repair occurred in 1979.
  - Solution-enlarged limestone bedrock conditions already exist beneath AP-3, as opposed to Georgia Power’s claim that the underlying limestone bedrock “*may be potentially affected by karst*” and “*is potentially affected by karst*” [emphasis added].

- Characteristically, solution-enlarged bedding planes and joints in the bedrock are *expected to be laterally discontinuous* [emphasis added] in a mature karst system, like what occurs at Plant Hammond, contrary to Georgia Power's claim that such discontinuous conditions support the *absence* [emphasis added] of a karst system.
- Georgia Power's claim that the "documented water loss" ("seepage" event) was due to a combination of wet sluicing and the "likely presence of solution-enhanced joints and fractures in the underlying bedrock" ignores the obvious – the *confirmed* [emphasis added] presence of solution-enlarged bedrock conduits that caused the 1977 collapse. Georgia Power's conclusion that an undefined "repair" was made of the area and conversion to dry handling operations in 1982 "mitigated" future collapse potential fails to consider that any such "repair" would have been localized at the assumed migration pathway where the leakage event was estimated to have occurred – not beneath the entire 25-acre footprint of AP-3. As a result, the remaining acreage beneath AP-3 remains "unrepaired".
- Georgia Power's claims that the removal of *free water* [emphasis added] and the installation of a low permeable cover will both further reduce the potential for "adverse effects on the structural components of the unit" are only partially correct. First, the claim incorrectly suggests that the only "water" (or leachate) that exists in AP-3 was (and *is*) the standing water at the surface in the impoundment. However, as the geologic cross sections in **Figures 2 and 3** illustrate, CCRs remain saturated in the uppermost aquifer at AP-3. While removing "free" or standing water at the ground surface might reduce the sinkhole collapse potential, that risk remains because of saturated CCRs present in the groundwater, the solution-enlarged conduits that occur in the bedrock, and groundwater elevations that will rise and fall with Cabin Creek and the Coosa River. That rise and fall of groundwater can "erode" or "undercut" the soil and CCRs from the *bottom-up* in clayey soils, causing sudden "cover collapse" sinkholes". Also, groundwater rise / fall and cohesionless soil properties can contribute to slow "cover subsidence" sinkhole formation. Those erosional and sinkhole collapse processes are illustrated in **Figure 4**. Both clayey and sandy granular soils exist above the solution-enlarged bedrock at AP-3. As a result, sinkholes can form beneath AP-3, regardless of construction of a final cover system.
- Georgia Power's claim that neither the Coosa River nor Cabin Creek can "undercut" AP-3 as its logic as to why sinkholes won't form in the future, fails to understand basic karst hydrogeology principles of cover collapse and cover subsidence sinkhole formation and the AP-3 conditions that could contribute to both processes that could result in contaminants being mobilized from the closed impoundment. "Undercutting" can occur from the bottom-up with the rise and fall of groundwater.
- The apparent absence of an *observed* [emphasis added] additional sinkhole collapses since the late 1970s does not mean that slow subsidence sinkholes are not occurring; that the risks for future collapses have been mitigated; or that another sudden sinkhole collapse is unlikely in the future. CCRs can be released quickly in a sudden collapse sinkhole scenario and also slowly in a cover subsidence scenario. Both collapse scenarios can result in significant loss of CCRs to groundwater and to off-site impacts.



8. In my opinion, the limestone bedrock described in the Part B Application is a mature karst aquifer with future collapse potential, contrary to the opinion of Geosyntec. Those conditions include large voids, no recovery during drilling, water loss during drilling, rods that were “dropped” during drilling, etc. Those conditions are illustrated and noted on the geologic cross sections (attached **Figures 2 and 3**) developed by Geosyntec and modified by me for this analysis. Geosyntec concluded the following geologic bedrock conditions exist at AP-3:<sup>14</sup>
  - “Generally solid with numerous bedding plane fractures or partings on the scale of millimeters or less”; however, solution enlarged openings in the bedrock along bedding planes and joints were reported in recent and previous investigations.
  - “Most of the features were noted in borings as filled with clay, mud, or other sediment” and that caliper records indicate “that the solution openings that are present do not typically extend more than several inches from the borehole”.
  - Rock cores collected during drilling indicate “the presence of discontinuous solution features, but do not suggest the presence of large, laterally continuous karst features such as caverns or sinkholes”.
  - The zone of highly weathered and fractured limestone that exists just beneath the residuum and alluvial terrace layers of soil beneath AP-3 “is the likely zone of predominant groundwater flow in the subsurface”.
9. Geosyntec’s conclusions above that the bedrock conditions do not represent significant karst conditions is incorrect, in my opinion. Mature karst systems are very heterogenous, and single or even multiple small diameter boreholes and borehole caliper measurements cannot be relied upon by Georgia Power to conclude that widespread karst conditions *do not* exist. The data collected by Georgia Power demonstrate the mature karst environment that exists beneath AP-3. Key karst conditions include:
  - As **Figures 2 and 3** illustrate, voids and zones of soft drilling or no recovery up to 20 feet were reported.
  - Voids in the bedrock were commonly filled with mud, clay, and sediment.
  - Widespread heterogeneous bedrock conditions were reported.
  - Variable groundwater flow conditions exist in the bedrock. Hydraulic conductivity measurements of the weathered bedrock zone ranged from  $5.1 \times 10^{-5}$  to  $2.4 \times 10^{-2}$  centimeters per second (cm/sec) and ranged from  $5 \times 10^{-5}$  to  $2.9 \times 10^{-3}$  cm/ sec for the limestone bedrock.<sup>15</sup>
  - The groundwater seepage velocity of the weathered bedrock portion of the uppermost aquifer was up to 3.8 feet per day, indicative of a nonporous media flow condition and a rapid,

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<sup>14</sup> Part B Application at 18 and 20.

<sup>15</sup> Part B Application at 19 and 20.



high-flow condition. Groundwater velocities in the solution-enlarged conduits in the deeper bedrock are likely to be even faster.

- While some bedrock core samples had high percent recoveries, others sometimes had zero percent recovery, indicating the heterogeneous conditions.

10. The cover system over AP-3 does not mitigate the unstable geologic conditions beneath AP-3. As such, the cover does not meet the Unstable Area location restriction requirement that AP-3 be constructed (and closed) with “generally accepted good engineering practices”. The unstable and saturated conditions beneath AP-3 will remain, even with the cover system. Also, the cover system will not prevent loss of soil or CCRs from the undercutting process beneath the impoundment due to the rise and fall of groundwater.

### 2.2.2 CCRs Remain Saturated and In Contact with the Uppermost Aquifer

1. Georgia Power constructed AP-3 in part, by excavating existing soil from within AP-3 to build the dike that surrounds the impoundment.<sup>16</sup> Geologic cross sections prepared on behalf of Georgia Power and included in the Part B Application illustrate that the uppermost aquifer extends *above the bottom of the impoundment and into the CCRs* [emphasis added].
2. AP-3 was constructed in 1973 and 1974 by excavating topsoil and excavating native *sandy, clayey, and gravelly soil* [emphasis added] from within AP-3 and also from an off-site borrow area to the north.<sup>17</sup> The important take-away is that permeable, low cohesion sandy and gravelly soils were prevalent; those soils were used to construct the dikes; and those permeable soils underlie portions of the impoundment. Such soils make CCR contaminant transport into groundwater easier and more rapid through the dikes and the bottom of AP-3.
3. Despite sluicing operations in AP-3 ending in the “early 1980s” and being converted to dry ash handling<sup>18</sup>, saturated CCRs remain nearly 40 years later,<sup>19</sup> as illustrated in **Figures 2 and 3** from actual borings drilled into AP-3. As a result, conversion to dry ash handling did not result in CCRs remaining “dry”. The final cover system that Georgia Power constructed over AP-3 in 2018 will not prevent the continued leaching of CCR constituents to groundwater because CCRs will remain saturated.
4. As clearly illustrated in **Figures 2 and 3** and as certified by Georgia Power, AP-3 does not meet the location restriction for Placement Above the Uppermost Aquifer (Rule 391-3-4-.10(3) and 257.60)<sup>20</sup> because the CCRs are located too close to (and within) the uppermost aquifer. Both the US EPA and Georgia CCR Rules require at least five-feet separation between the CCRs and the uppermost aquifer. Further, the 25-acre disposal unit was not constructed with a liner.<sup>21</sup> Without a liner and being so close to the uppermost aquifer, the groundwater has been especially prone to

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<sup>16</sup> History of Construction at 3.

<sup>17</sup> History of Construction at 2 and 3.

<sup>18</sup> 2020 Semi-Annual Report at 9.

<sup>19</sup> Part B Application at 33 through 37.

<sup>20</sup> Location Restriction Demonstration, Uppermost Aquifer Placement.

<sup>21</sup> Liner Design Criteria, AP-3, CCR website.

contamination since the impoundment became operational in 1977. Georgia Power did not begin sampling groundwater at AP-3 until August 2016<sup>22</sup> – nearly 40 years after CCRs were first disposed.

5. Georgia Power stated that closure of AP-3 was completed “in accordance with State CCR Rule 391-3-4-.10(7)(b)”, and closure included “dewatering and grading CCR within AP-3 to promote stormwater drainage and installing a geomembrane cover”. Georgia Power concluded that “AP-3 no longer impounds free water nor receives CCR or other wastestreams”; “this closure method has eliminated the future impoundment of water, sediment, or slurry”; and the closed impoundment contains 1,108,000 cubic yards of CCRs.<sup>23</sup> The closure already completed by Georgia Power did not meet the required technical performance to minimize or eliminate future leaching to groundwater or to prevent impoundment of leachate in either the Georgia CCR Rule or the US EPA CCR Rule.

### 2.2.3 Closure-in-Place Method Does Not Meet the Required Performance Standards

1. Georgia Power is relying upon construction of a final cover system to prevent infiltration of liquids into the CCRs, to prevent “potential releases of CCR from the unit”, to preclude the probability of future impoundment of water, to ensure slope and cover system stability, to minimize the need for further maintenance, and be constructed consistent with “generally accepted good engineering practices”.<sup>24</sup> In response to that comment, the cover system *will not* [emphasis provided] prevent potential releases of CCR from the unit because AP-3 is unlined; CCRs are saturated and in contact with the uppermost aquifer; and CCR constituents will continue to leach into groundwater – even with construction of a cover system. Also, leachate will remain impounded in the subsurface beneath the cap.
2. The only reported “dewatering” that occurred during closure of AP-3 was the removal of *stormwater* [emphasis added] “to provide a stable base for construction of structural fill material and the final cover system”.<sup>25</sup> The CQA Plan for the closure did not discuss any removal of water belowground from the saturated CCRS within AP-3, rather just removing “standing water” prior to constructing the geomembrane cover.<sup>26</sup> As such, Georgia Power did not pump or otherwise remove water or leachate that exists in AP-3. That leachate will continue to seep into the uppermost aquifer.
3. Georgia Power is required to meet the following closure-in-place performance standard at AP-3 according to both the Georgia CCR Rule (391-3-4-.10(7)(b)) and the US EPA CCR Rule (Par 257.102(d)):
  - i. *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;*
  - ii. *Preclude the probability of future impoundment of water, sediment, or slurry;*

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<sup>22</sup> 2020 Semi-Annual Report at 3.

<sup>23</sup> Closure Plan at 3 and 4.

<sup>24</sup> Closure Plan at 4.

<sup>25</sup> Closure Plan at 4.

<sup>26</sup> Construction Quality Assurance Plan at 13.

- iii. *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;*
  - iv. *Minimize the need for further maintenance of the CCR unit; and*
  - v. *Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.*
4. Closure-in-place completed at AP-3 in 2018 does not meet the required Georgia CCR Rule or US EPA CCR Rule performance standards because:
  - The final cover system will not prevent continued leaching of CCR constituents into the uppermost aquifer because the CCRs will remain saturated and in contact with the uppermost aquifer.
  - Although the cover system will reportedly reduce *vertical* [emphasis added] infiltration of precipitation into AP-3, it will not prevent *lateral inflow* [emphasis added] of the uppermost aquifer into the bottom of AP-3 where CCRs exist.
  - The water and slurry (collectively called “leachate”) within AP-3 will remain impounded beneath the final cover system.
  - The unstable karst geologic conditions have not been mitigated beneath the entire 25-acre impoundment and as such, there is a possibility that another significant loss of leachate could occur through the heterogeneous, highly weathered and solution-enlarged limestone bedrock of the karst aquifer beneath the impoundment.

As such, the cover system design should not be considered as a “generally-accepted good engineering practice” to allow CCRs to remain in-place indefinitely.
5. None of the documents included in Georgia Power’s application for closure-in-place include any predictive modeling of how much groundwater quality will improve over time with construction of the final cover system or when all groundwater quality criteria will be met. As a result, Georgia Power constructed a large, costly cover system without knowing if groundwater will improve.
6. Geosyntec concluded in its ACM Report that evaluated groundwater corrective measures, that the final cover system at AP-3 “provides a source control measure that reduces the potential for migration of CCR constituents to groundwater” and that the “source control at AP-3 is considered complete”. While the cover system will reduce vertical infiltration of precipitation into the CCRs, it will not prevent the continued leaching of CCR constituents into the shallow karst aquifer that is present in the CCRs in the 25-acre impoundment. Further, the cover system will not prevent lateral of inflow of groundwater into the CCRs in AP-3. As a result, the final cover does not qualify as “source control” to prevent or minimize contaminant migration to groundwater.
7. The Closure Drawings<sup>27</sup> and the CQA Plan<sup>28</sup> included with the Draft Permit both suggest that Georgia Power added significant quantities of CCRs on top of existing CCRs in AP-3 prior to closure,

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<sup>27</sup> Closure Drawings at 5 and 6.

<sup>28</sup> Construction Quality Assurance Plan at 6 and 7.

calling that additional CCR “compacted ash fill” and “structural fill”. If confirmed, Georgia Power added even more CCRs into an unlined CCR unit that does not meet the required five-foot separation distance from the uppermost aquifer; has already contaminated groundwater; continues to leach contaminants into groundwater; and continues with indefinite storage of CCRs over a karst aquifer with solution-enlarged bedrock with a history of catastrophic leakage.

8. Georgia Power’s plan to construct a cover system over AP-3 will not minimize the need for further maintenance because of the unpredictable collapse potential of the unstable geologic conditions. Further, the cover system will not mitigate the unstable geologic conditions beneath the 25-acre former impoundment. Given that Georgia Power excavated soils from within AP-3 to construct the perimeter dike, there is even less naturally occurring soil to provide a buffer over highly weathered and fractured bedrock.
9. The cover system and closure do not meet “generally accepted good engineering practices” because the unstable and saturated conditions beneath AP-3 will remain, even with the cover system. The cover system will not prevent loss of soil from undercutting process from beneath the impoundment due to the rise and fall of groundwater.

### 2.3 Groundwater Monitoring Plan (and related documents)

1. As previously discussed in **Section 2.2.2**, Georgia Power constructed AP-3 too close to the uppermost aquifer, and the groundwater aquifer is present within the CCRs in the impoundment. Further, even though AP-3 was first used for disposal in 1977, groundwater monitoring system wells were not constructed until 2014 or 2016.<sup>29</sup> Groundwater contamination identified in 2019 resulted in increased monitoring conditions from normal “detection” monitoring to “assessment” monitoring.<sup>30</sup> Statistically significant concentrations of boron, calcium, sulfate, total dissolved solids, and molybdenum were reported in wells in the most recently available monitoring report.<sup>31</sup> Georgia Power was required to evaluate groundwater corrective measures in July 2020, yet still no interim or final measure has been selected.
2. The Georgia CCR Rule and the EPA CCR Rule both have performance standards for groundwater monitoring systems. The purpose of a groundwater monitoring well system is to detect contamination due to leakage from disposal areas and to enable corrective actions in a timely manner. Fundamentally, the monitoring system should be an early warning prior to contamination flowing away from AP-3.
3. Georgia Power stated that the Groundwater Monitoring Plan developed for AP-3 “meets the requirements of EPD rules and uses EPD’s Manual for Groundwater Monitoring as a guide” (September 1991).<sup>32</sup> Georgia Power determined that seven wells monitor upgradient conditions (HGWA-1, HGWA-2, HGWA-3, HGWA-43D, HGWA-44D, HGWA-45D, and HGWA-122), and five wells monitor downgradient conditions (HGWC-120, HGWC-121A, HGWC-124, HGWC-125, and HGWC-126).<sup>33</sup> The locations of those wells are illustrated on **Figure 1**.

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<sup>29</sup> 2020 Semi-Annual Report at 27.

<sup>30</sup> 2020 Semi-Annual Report at 3.

<sup>31</sup> 2020 Semi-Annual Report at 4.

<sup>32</sup> Groundwater Monitoring Plan at 4.

<sup>33</sup> Groundwater Monitoring Plan at 7.

4. Georgia Power installed additional downgradient groundwater delineation wells (MW-32, MW-39, MW-41, MW-46D) in 2019 and 2020. Georgia Power constructed those wells to further define downgradient contamination towards Cabin Creek. The locations of those wells are also illustrated on **Figure 1**. Groundwater sampling for 2020 demonstrated that molybdenum was reported above the Georgia CCR Rule groundwater standard in two of the recently installed wells (MW-32 and MW-39), which are located downgradient of AP-3 and closer to Cabin Creek than prior compliance wells.<sup>34</sup>
5. Georgia Power concluded that the uppermost aquifer at AP-3 “is an unconfined regional aquifer that occurs within the residuum and highly weathered and fractured bedrock.”<sup>35</sup> Ironically, none of the historical compliance wells monitored the soil (residuum and / or alluvial soil) portion of the aquifer nearest the bottom of AP-3. Instead, the original compliance monitoring wells were constructed mainly in bedrock, and only one downgradient well (HGWC-121A) monitors the soil / weathered bedrock interface. The well constructions specifics of the well system are identified below in Table 1<sup>36</sup> and are illustrated on **Figures 2 and 3** for some wells.

**Table 1. Well Construction Elevations**

Well No.	Top of Screen (ft. MSL <sup>37</sup> )	Bottom of Screen (ft. MSL)	Aquifer Material <sup>38</sup>	Cabin Creek (ft. MSL)
HGWC-120	548.83	538.83	Limestone	568 water level 564 bottom
HGWC121A	556.71	546.71	Residuum, Weathered Bedrock, Limestone	
HGWC-124	557.80	547.80	Weathered Bedrock	
HGWC-125	556.20	646.20	Weathered Bedrock	
HGWC-126	552.72	542.72	Weathered Bedrock, Limestone	
MW-32	559.30	549.30	Unknown	
MW-39	564.93	554.93	Unknown	
MW-41	563.29	553.20	Unknown	
MW-46D	513.92	503.92	Unknown	

6. My review of the well construction data and well layout indicates that the existing compliance well system is largely incomplete because of Georgia Power’s tendency to only monitor groundwater

<sup>34</sup> 2020 Semi-Annual Report at 21.

<sup>35</sup> Groundwater Monitoring Plan at 5.

<sup>36</sup> Groundwater Monitoring Plan at 29 and 2020 Semi-Annual Report at 27.

<sup>37</sup> feet mean sea level

<sup>38</sup> Part B Application at 29.

in bedrock. An incomplete monitoring system – and especially one that misses the portion of the aquifer nearest CCRs in the bottom of AP-3 – can under-report higher contaminant concentrations in the aquifer. Neither Georgia Power nor the EPD should assume that contaminant concentrations in the deeper portion of the aquifer monitored by Georgia Power represent the highest concentrations or represent contaminant concentrations in the shallow parts of the aquifer.

7. Only until recently in furtherance of evaluating contamination, has Georgia Power installed shallower “delineation” wells, but it is unclear if the new wells monitor shallow groundwater in the terrace and residuum soils. That zone should be monitored in hydraulically upgradient and downgradient directions. Soil boring and well data already demonstrate the existence of groundwater in that soil portion of the aquifer (e.g., wells P-18, P-21, P-5U)<sup>39</sup>, a zone that Georgia Power determined to be the uppermost aquifer. The geologic cross sections developed by Geosyntec – included as **Figures 2 and 3** of this analysis – also illustrate groundwater in the soil. This portion of the uppermost aquifer is influent to Cabin Creek, and the historical downgradient compliance well in this area (HGWC-120) was drilled too deep to monitor that interval.<sup>40</sup>
8. Georgia Power should be required to install a series of cluster wells around AP-3 to monitor all three aquifer zones: soil, highly weathered bedrock, and deeper bedrock in solution-enlarged preferential pathways. Georgia Power should also be required to include all recent “delineation” wells and “piezometers” used to gather water levels in its “compliance” monitoring system. Numerous such wells already exist but are not monitored.<sup>41</sup> Geophysics can be used to determine optimal locations for new wells to be installed in the higher conductive zones of bedrock, rather than relying on randomly placed wells.
9. Co-located cluster wells of different depths are needed to monitor changes in the groundwater quality by depth. CCR constituents and concentrations are commonly stratified by depth, based upon my experience evaluating groundwater monitoring systems for CCR disposal units across the United States. The uppermost portion of the uppermost aquifer closest to the wastes has a likelihood of higher contamination. As a result, the groundwater monitoring system should target this shallow interval. When a downward hydraulic gradient is suspected or is present, contamination can also migrate deeper, and as a result, deeper cluster wells are needed. Cluster wells are the industry standard to define the nature and extent of contamination by depth. Georgia Power’s past tendency to define the extent of contamination has been to drill additional *deeper* [emphasis added], randomly located compliance monitoring wells, rather than to focus on the shallow zone that is more likely to have the highest contaminant concentrations.
10. According to seepage velocity calculations made by Georgia Power, the maximum flow velocity is 3.8 feet per day.<sup>42</sup> However, that flow velocity likely under-reports the real maximum because Georgia Power assumed that the velocity was based upon porous media flow, not the more likely highest velocities in the fractured and the solution-enlarged conduits in the limestone bedrock. Seepage velocity calculations using Darcy’s Law cannot be used to calculate velocities in non-

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<sup>39</sup> Part B Application at 26.

<sup>40</sup> Part B Application at 34.

<sup>41</sup> Part B Application at 26 and 32.

<sup>42</sup> Part B Application at 21.

porous media flow of the fractured and solution-enlarged conduits in the bedrock because that calculation is only meant for porous media flow (e.g., in soil).

11. Georgia Power stated that the Groundwater Monitoring Plan “meets the requirements of EPD rules and uses EPD’s Manual for Ground Water Monitoring dated September 1991 as a guide”.<sup>43</sup> Although that guidance document is 30 years old, the well design and performance standards specified in the document still apply. As is discussed below, the monitoring system does not meet the EPD standards that Georgia Power intended the system to meet.
12. The 1991 Georgia EPD Manual states that cluster wells should exist if the aquifer is heterogeneous, as is typical in a karst geologic environment. The manual also states that “a key part of the operation of any land treatment, storage, or disposal facility should be a monitoring program which is designed to assess the impact of the system on ground-water resources.”<sup>44</sup> Also, according to the EPD Manual, a monitoring system is “required...to detect and quantify contamination, as well as measure the effectiveness of engineered disposal systems, and the effectiveness of corrective action for improperly sited or poorly operated sites.” The EPD has concluded these important facts:
  - “Poorly constructed wells and careless sample collection and analysis can yield widely varying test results.”<sup>45</sup>
  - “Downgradient wells must be located, screened, and sufficiently numerous to provide a *high level of certainty of constituents from the waste management unit(s) to the uppermost aquifer will be immediately detected* [emphasis added].”<sup>46</sup>
  - “There are situations where the owner / operator should have multiple wells at the same location” where the uppermost aquifer is heterogeneous with multiple interconnected aquifers, variable lithology, and discrete fracture zones, as examples.<sup>47</sup> These multiple-depth well configurations are called “cluster” wells.
13. In the same manner as the 1991 EPD guidance, both the US EPA CCR Rule<sup>48</sup> (Part 257.91) and the Georgia CCR Rule (Rule 391-3-4-.10(6)) specify the performance standard for a groundwater monitoring system where the owner “must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:
  - “Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit.”
  - “Accurately represent the quality of groundwater passing the waste boundary of the CCR unit.”

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<sup>43</sup> Groundwater Monitoring Plan at 4.

<sup>44</sup> EPD 1991 at 5.

<sup>45</sup> EPD 1991 Groundwater Manual at 5.

<sup>46</sup> EPD 1991 Groundwater Manual at 8.

<sup>47</sup> EPD 1991 Groundwater Manual at 10.

<sup>48</sup> 40 CFR Part 257.91



14. My evaluation of the groundwater monitoring system at AP-3 indicates that the system *does not meet* [emphasis added] the 1991 EPD, US EPA CCR Rule, or Georgia CCR Rule standards because:
- The existing compliance monitoring system wells were poorly constructed with most screened intervals deeper than the portion of the aquifer that exists in the soil – which is the portion of the uppermost aquifer nearest the CCRs and most likely to be contaminated. Although bedrock wells are also needed and have been a historical part of the monitoring system, the system has not historically monitored the shallowest portion of the aquifer nearest the bottom of AP-3 that is influent to Cabin Creek.
  - The compliance monitoring wells do not provide a “high level of certainty of constituents from the waste management unit(s) to the uppermost aquifer will be immediately detected”. This is due to bedrock wells that were randomly located laterally and with screen intervals that likely miss preferential pathway conduits that are another primary groundwater transport mechanism. Also, as previously discussed, compliance monitoring wells screened in the soil portion of the aquifer are largely absent. As a result, the wells do not provide a “high level of certainty” that contaminants will be “immediately detected”.
  - No co-located cluster wells exist or are sampled as part of the compliance monitoring program at AP-3 to monitor vertical changes in the heterogeneous aquifer. As a result, contaminant concentrations by depth have not been determined. Cluster wells are needed to define the nature and extent of contamination by location and depth.
15. Given that the groundwater monitoring wells will be sampled through the 30-year post-closure care period, the monitoring system must be sufficiently designed with hydraulically upgradient and downgradient wells over the life of that period. Another CCR impoundment (AP-1) exists south of AP-3 and between AP-3 and the Coosa River. Once that impoundment is fully dewatered and closed, in my opinion, the direction of groundwater flow at AP-3 will possibly also have a southerly flow component towards the Coosa River, in addition to the currently reported easterly flow towards Cabin Creek according to Georgia Power. As such, additional cluster wells should be installed along the southern edge of AP-3.
16. Georgia Power should be required to use geophysics to locate new wells in highly conductive zones and preferential pathways in the bedrock aquifer.
17. Georgia Power should be required to perform dye traces into the karst aquifer to determine the degree of connectivity with Cabin Creek and the Coosa River, groundwater flow velocities in the bedrock aquifer, and time of travel to the streams.
18. Georgia Power sampled Cabin Creek in July and December 2020 because of undefined “surface water features”<sup>49</sup> that it found downgradient of wells MW-32 and MW-39 near Cabin Creek while installing downgradient delineation well MW-41. Georgia Power determined that the presence of those features makes installation of additional horizontal delineation wells in that area “infeasible”<sup>50</sup>, without explaining why more wells were not feasible or what those features were.

<sup>49</sup> 2020 Semi-Annual Report at 13 and 21.

<sup>50</sup> 2020 Semi-Annual Report at 21.

Georgia Power's description of those features suggest that they are springs where the shallow portion of the aquifer emerges from the subsurface and flows into Cabin Creek. If such springs exist, Georgia Power should be required to sample them in conjunction with Cabin Creek as part of its permit for AP-3. Georgia Power should also be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit, if springs or similar discharges exist, because a discharge of leachate from AP-3 to a surface water is not allowed without a permit.

19. Georgia Power initiated a "proactive" surface water sampling program of Cabin Creek in July 2020 because of the undefined surface water features near MW-41. Georgia Power sampled an upstream location and a location near MW-41, as illustrated on **Figure 1**. While sampling Cabin Creek is a good idea, Georgia Power's downgradient sample location fails to monitor a large portion of the Creek where contaminated shallow groundwater would discharge into Cabin Creek, as also illustrated on **Figure 1**. EPD should require Georgia Power to monitor Cabin Creek surface water quality as a condition of its permit. Georgia Power should be required to analyze those samples for both US EPA Appendix III and IV constituents and Georgia CCR Rule constituents. Cabin Creek sampling locations should include at a minimum, an upstream location, a location just downstream of the confluence with the "surface water features", and another downstream within the expected zone of groundwater inflow into Cabin Creek, as illustrated on **Figure 1**.
20. In summary, the groundwater monitoring system at AP-3 does not meet the required Georgia CCR Rule, US EPA CCR Rule, or EPD guidance document performance standards to identify contamination in the complex geologic setting at the former impoundment. Further, there are indications that unpermitted discharges of leachate to surface water exist and that the impact on the receiving streams has not yet been defined.

### Qualifications of the Commentor

I graduated from Western Kentucky University (WKU) in 1985 with a Bachelor of Science of Environmental Engineering Technology. My professional experience includes over 30 years as an environmental consultant. I am a Licensed Professional Geologist in the State of Tennessee, a Registered Professional Geologist in the State of Georgia, and a Licensed Professional Geologist in the State of New York. I have extensive education in karst geology from WKU – one of the world's leading geoscience universities with hydrogeology coursework that is focused on karst. My professional experience regarding karst geology is also extensive, having performed multiple geologic investigations in dense karst environments in Kentucky, Tennessee, and Missouri.

My specific experience for CCR-related projects involves numerous years performing coal combustion related investigations at approximately 100 disposal sites located across the United States, with a particular emphasis in these Southeastern states: Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, and Tennessee. I was also actively involved in efforts to respond to the Tennessee Valley Authority Kingston, Tennessee CCR impoundment collapse in 2008, and I have been extensively involved in various CCR-related projects since that time. I have testified as a coal combustion waste and hydrogeologic subject matter expert in State court, Federal court, and before the North Carolina Utilities Commission.

I have conducted hydrogeologic investigations related to the closing of surface impoundments and the siting and design of municipal and industrial waste landfills; developed closure plans for industrial landfills; designed and implemented groundwater monitoring programs for industrial and municipal landfills; and completed investigations to define the nature and extent of environmental contamination.

I have also published peer-reviewed technical investigation papers involving soil, groundwater, and surface water associated with industrial waste contamination at national trade association conferences. My most recent peer-reviewed paper involves CCR disposal and contaminant fate / transport in a karst environment in Tennessee. That paper was accepted for presentation at the upcoming United States Geological Survey (USGS), Karst Interest Group workshop in October 2021 ([https://www.usgs.gov/mission-areas/water-resources/science/karst-interest-group-kig-2021-workshop?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/mission-areas/water-resources/science/karst-interest-group-kig-2021-workshop?qt-science_center_objects=0#qt-science_center_objects)). I have also lectured at regional environmental law conferences.

*Mark A. Quarles*

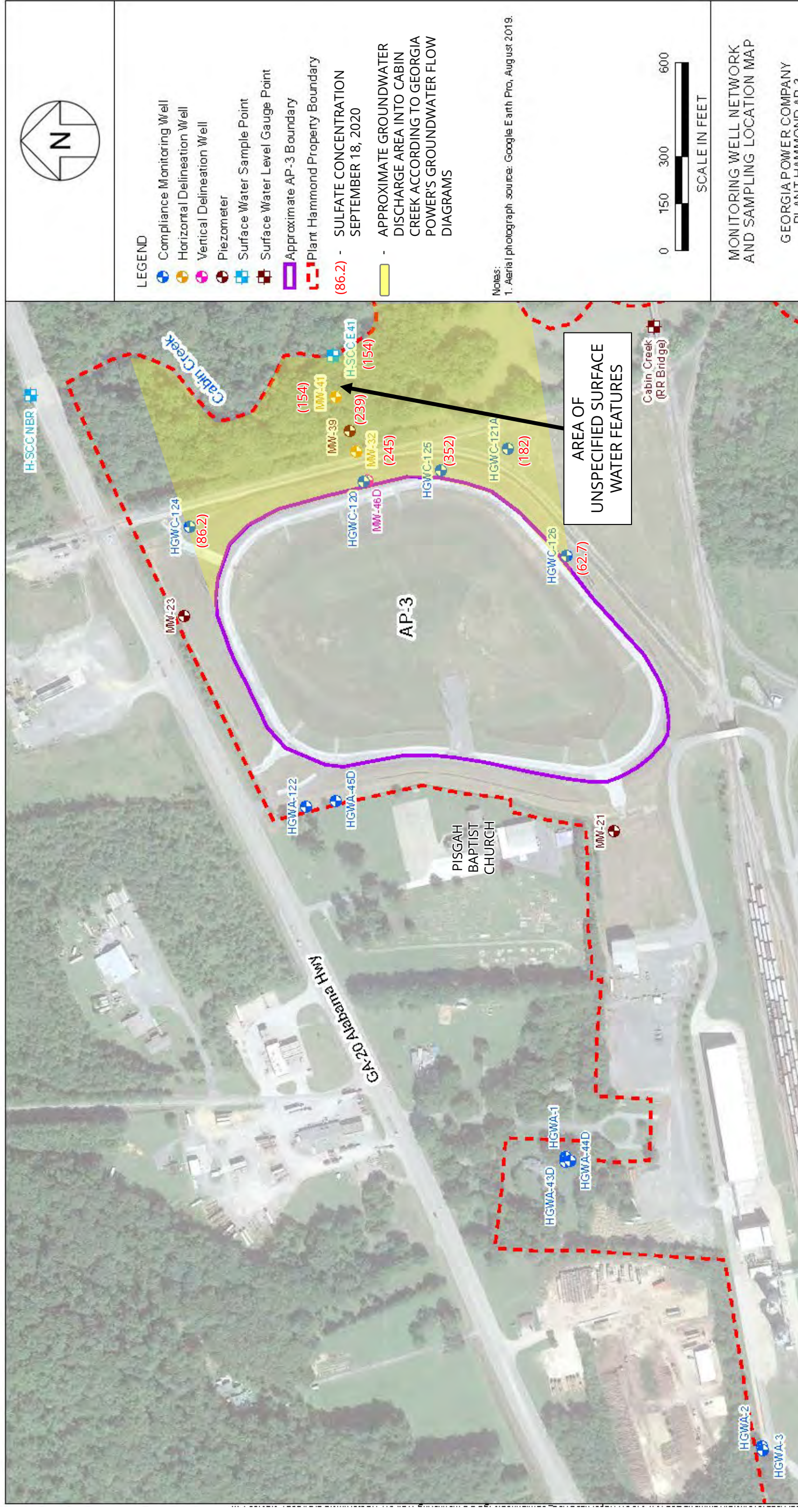
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Mark A. Quarles, P.G.  
Georgia Professional Geologist No. 002266

## FIGURES



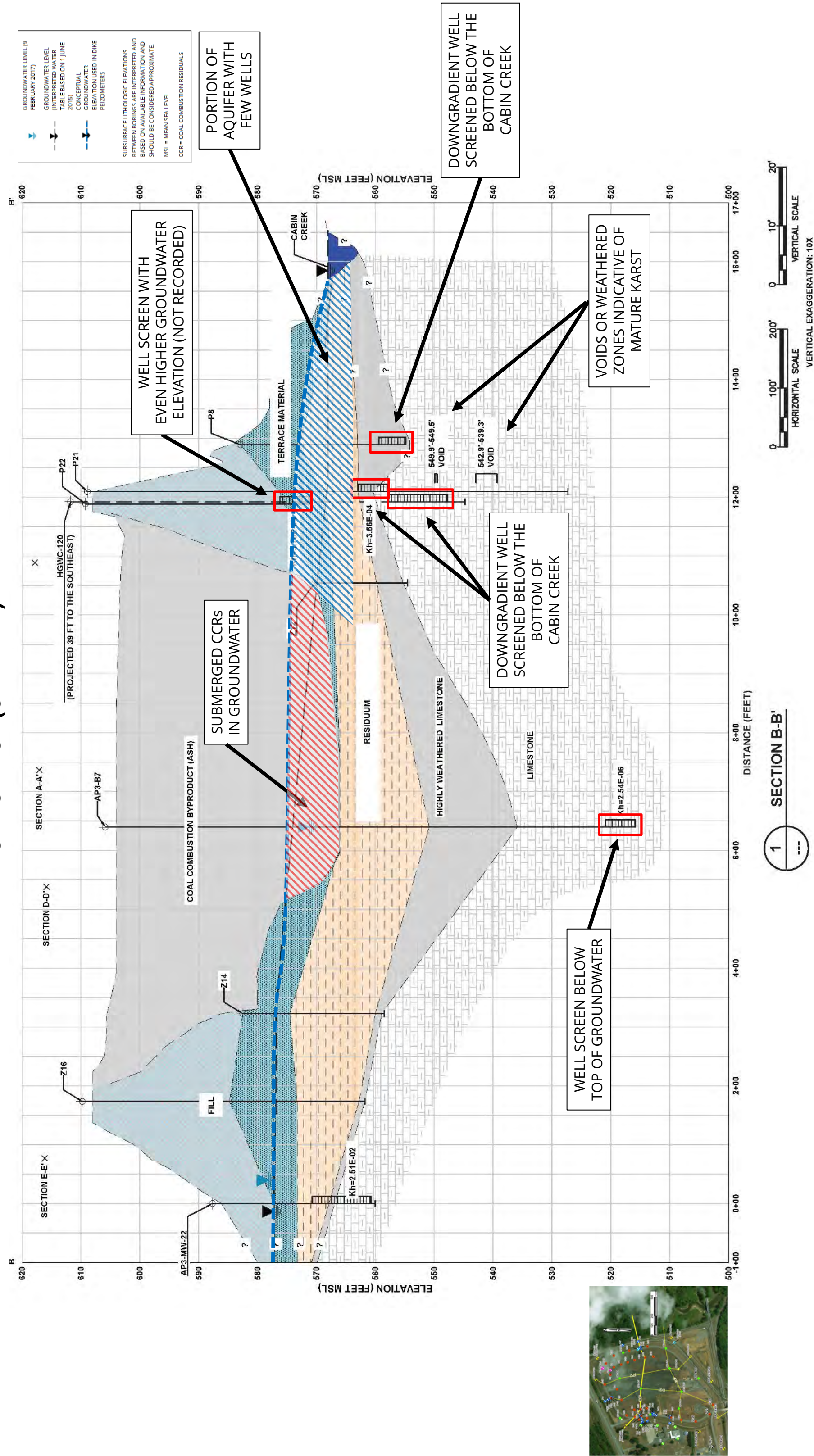








WEST-TO-EAST (CENTRAL)



SOURCE: PERMIT APPLICATION (PART B), GEORGIA POWER, NOVEMBER 2018, FIGURE 2-3B



PROJECT NO:	R2112856
CREATED BY:	BGS 08.20.2021
CHECKED BY:	MQ 08.20.2021
APPROVED BY:	JTB 09.09.2021

FIGURE 3, CROSS SECTION,  
WEST-TO-EAST (CENTRAL)



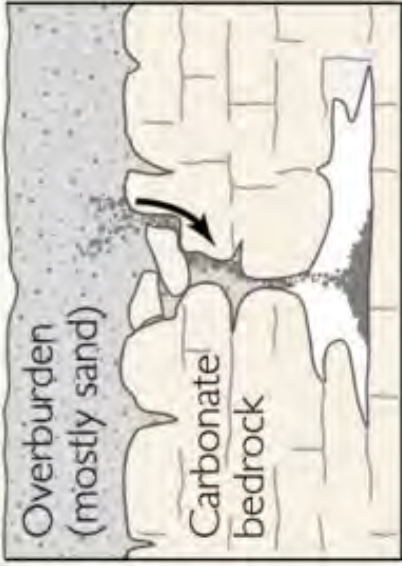
# Cover-Subsidence Sinkhole

Granular sediments spall into secondary openings in the underlying carbonate rocks.

A column of overlying sediments settles into the vacated spaces (a process termed "piping").

Dissolution and infilling continue, forming a noticeable depression in the land surface.

The slow downward erosion eventually forms small surface depressions 1 inch to several feet in depth and diameter.

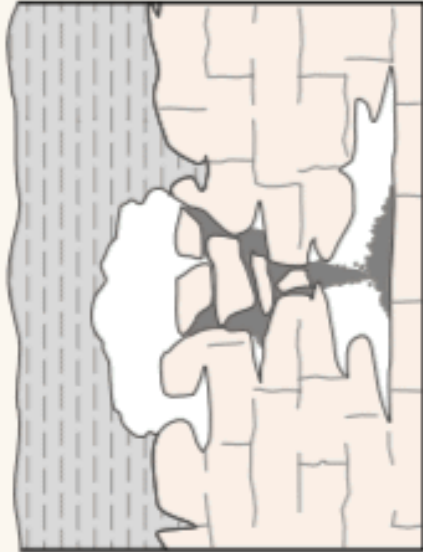
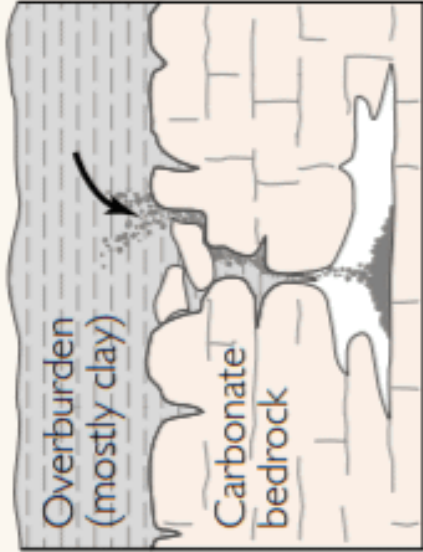


# Cover-Collapse Sinkhole

Sediments spall into a cavity. As spalling continues, the cohesive covering sediments form a structural arch.

The cavity migrates upward by progressive roof collapse.

The cavity eventually breaches the ground surface, creating sudden and dramatic sinkholes.



SOURCE: UNITED STATES GEOLOGICAL SURVEY, WATER SCIENCE SCHOOL, SINKHOLES, AVAILABLE AT: [https://www.usgs.gov/special-topic/water-science-school/science/sinkholes?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/sinkholes?qt-science_center_objects=0#qt-science_center_objects)