WPCA/TVA Ash Pond Seminar
CBR vs CIP Considerations

September 18, 2019

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Agenda

The presentation will compare and contrast the two primary CCR Rule closure methods of Cap in Place (CIP)and Closure by Removal (CBR)

01 Ash Ponds are Unique

02 Defining CIP and CBR

03 Key Challenges and Considerations

04 Industry Trends

05 Closure Decisions

06 Conclusion

01
Ash Ponds are Unique

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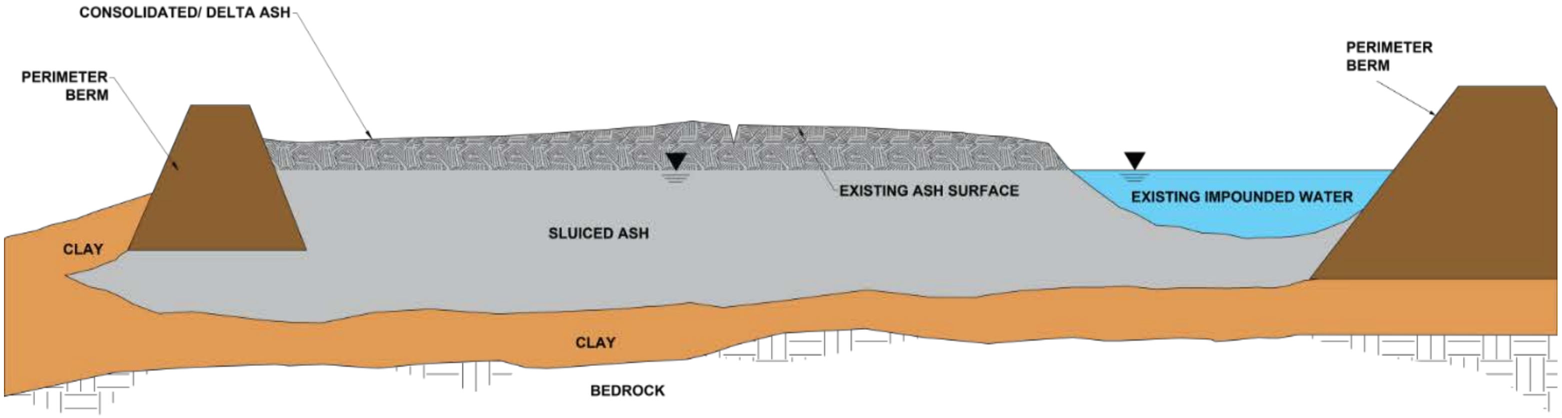
01 Ash Ponds
Existing Conditions

- Sluiced ash
- Impounded water
- High water content and (undrained) low shear strength
- Unstable surface for personnel or equipment access
- Significant construction and operation challenges



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01 Ash Ponds

Existing Conditions – Sluiced Ash

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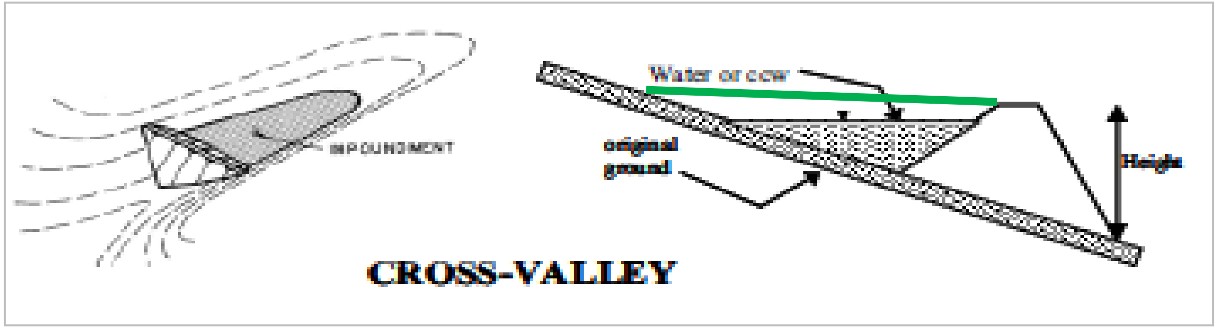
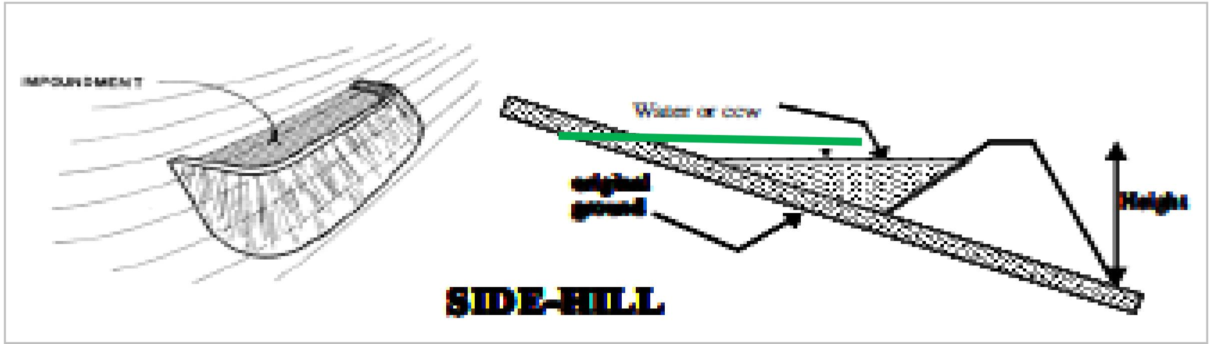
01 Ash Ponds

Existing Conditions

01 Ash Ponds
Construction Methods

- Two most common applications for historic ponds in the southeast





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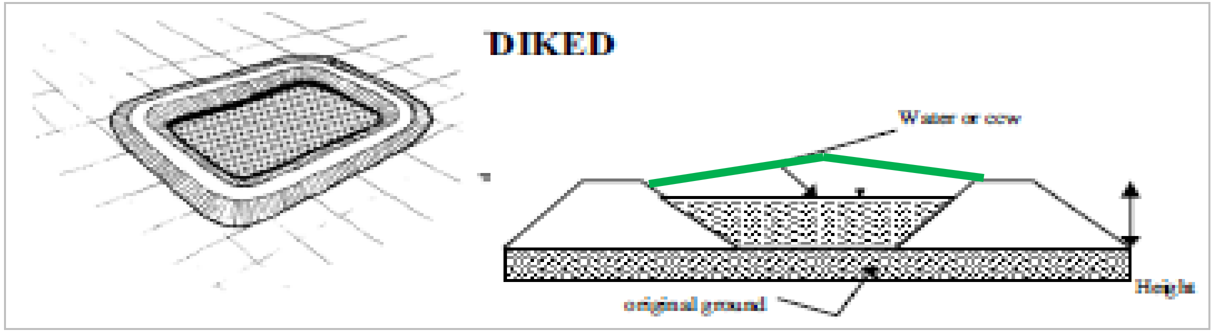
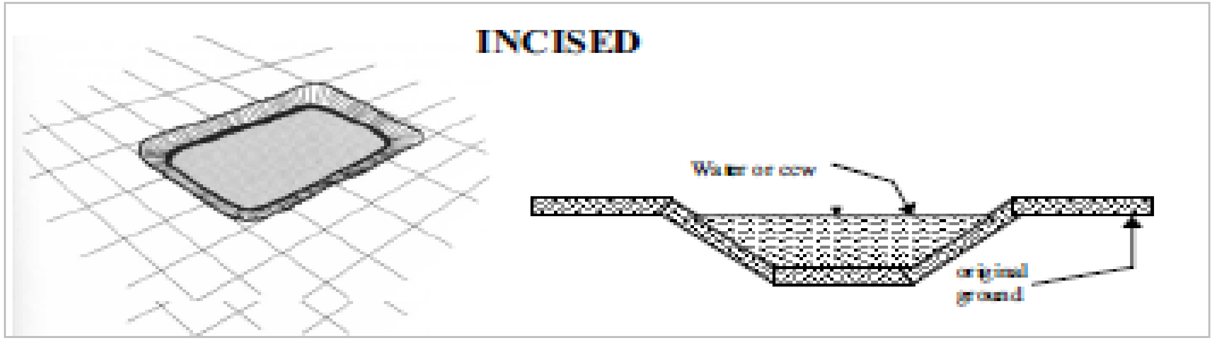
01 Ash Ponds
Construction Methods

- Application typically used for more recent pond construction in southeast





02
Defining CIP and CBR

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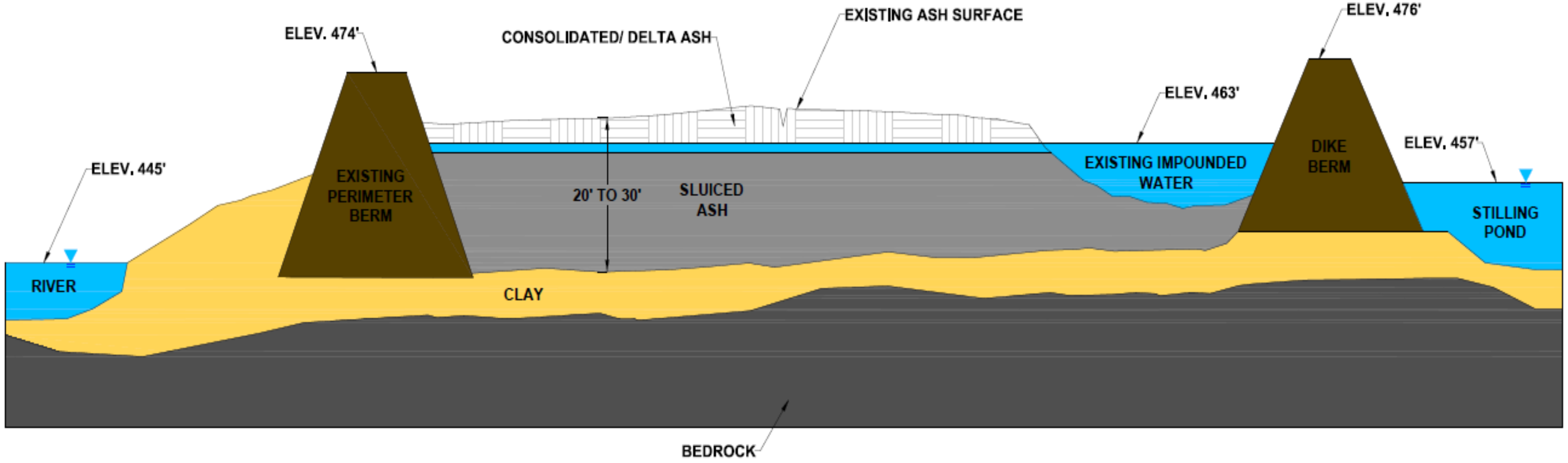
02 Cap in Place (CIP) and Closure by Removal (CBR)

Defining Closure

CCR Rule Options

Closure of a CCR unit must be completed either by leaving the CCR in place and installing a final cover system **(CIP)** or through removal of the CCR and decontamination of the CCR unit **(CBR)**.



Typical Ash Pond Section

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02 Cap in Place (CIP)

Defining Closure

CCR Rule Definition

When leaving CCR in place, the CCR unit is closed in a manner that will:

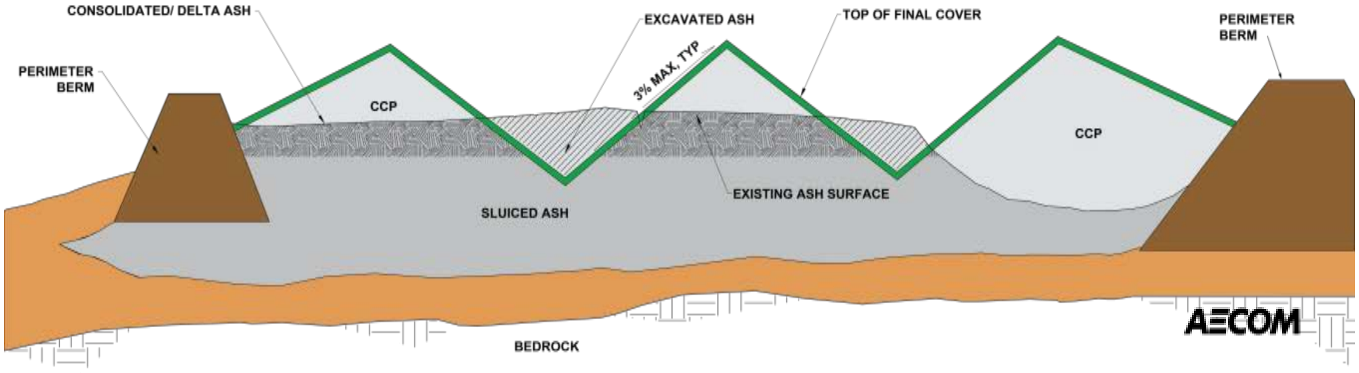
(i) **Control, minimize or eliminate, to the maximum extent feasible, post-closure *infiltration of liquids into the waste and releases* of CCR, leachate, or *contaminated run-off to the ground or surface waters* or to the atmosphere;**

(ii) Preclude the probability of future impoundment of water, sediment, or slurry;

(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.

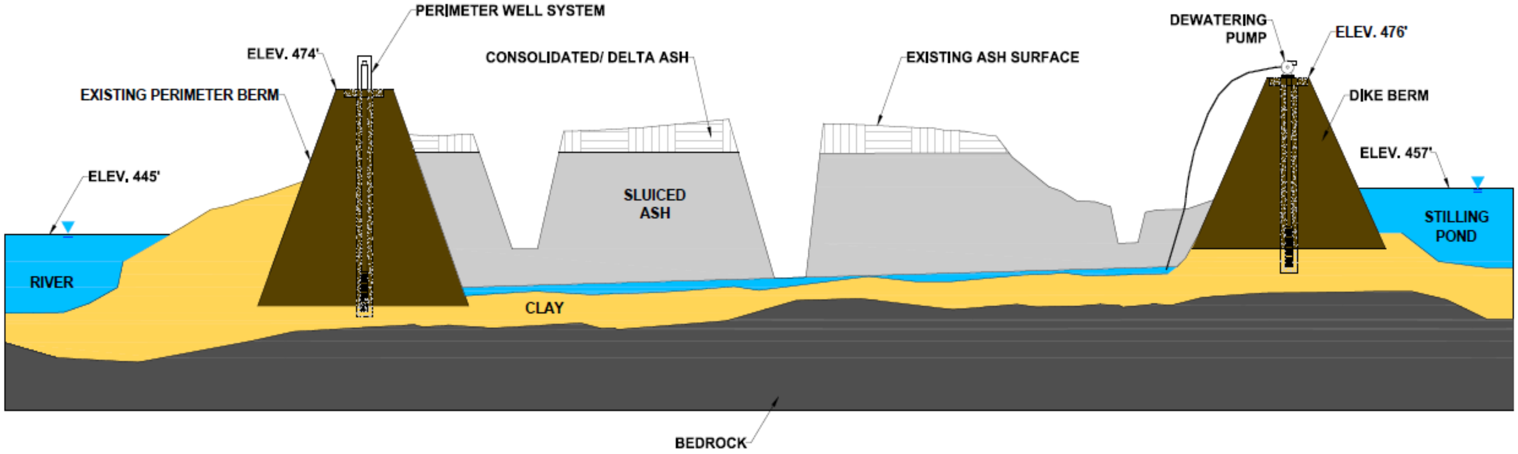


02 Closure by Removal (CBR)

Defining Closure

CCR Rule Definition

Closure of the CCR unit by **removing and decontaminating all areas affected by releases from the CCR unit**. CCR removal and decontamination of the CCR unit are complete when constituent concentrations throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standards



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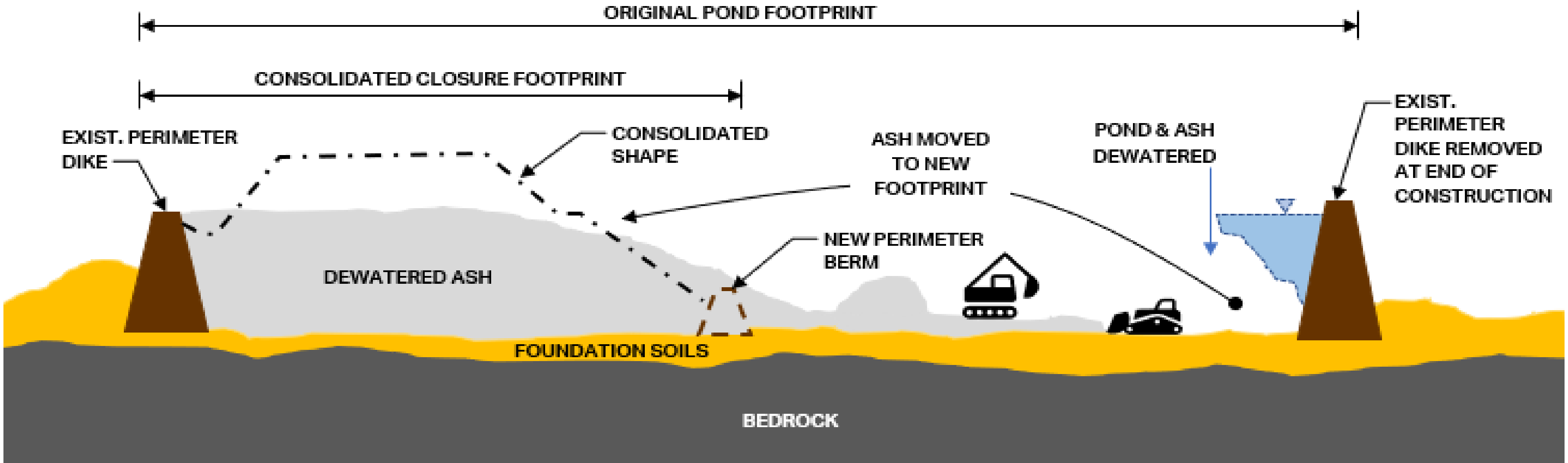
02 Hybrid Closure
Defining Closure

Definition

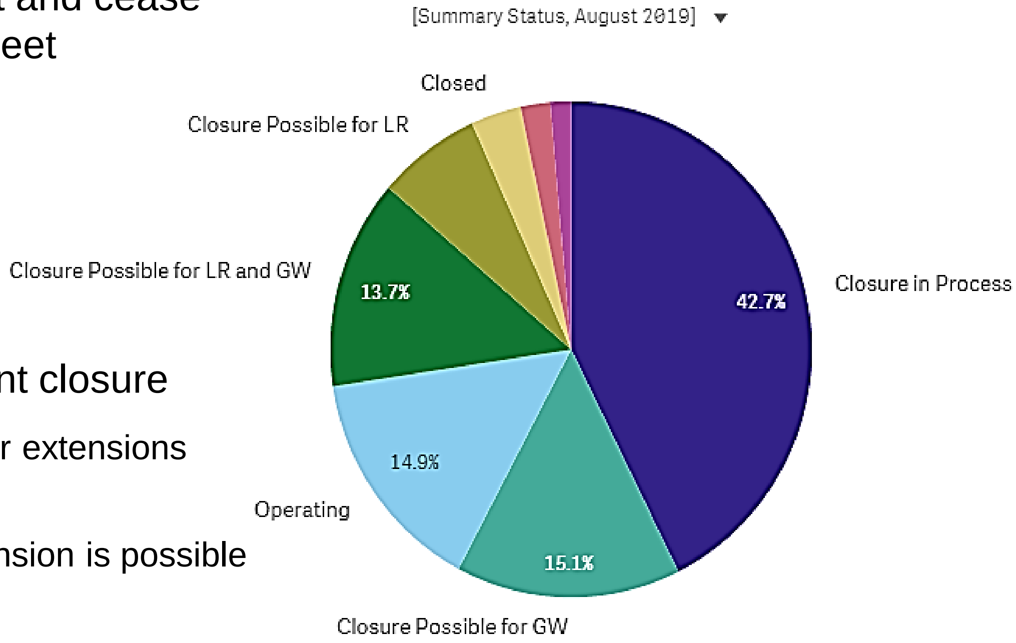
Combination of closure-by-removal (CBR) and cap-in-place (CIP) to reach a smaller "consolidated" closure footprint ("consolidate and close").



02 EPA CCR Rule
Defining Closure

CCR Rule Criteria

- Owner must initiate closure of the CCR unit and cease placing CCR within 6 months of failing to meet
  - Ceasing placing CCR
  - Slope stability (Oct 2016)
  - Location restrictions (Oct 2018)
  - Groundwater (October 2020)
- 5 years is allowed to complete impoundment closure
  - For Impoundments >40 acres → Up to 5, 2-year extensions possible
  - For impoundments <40 acres → 1, 2-year extension is possible



03
Key Challenges and Considerations

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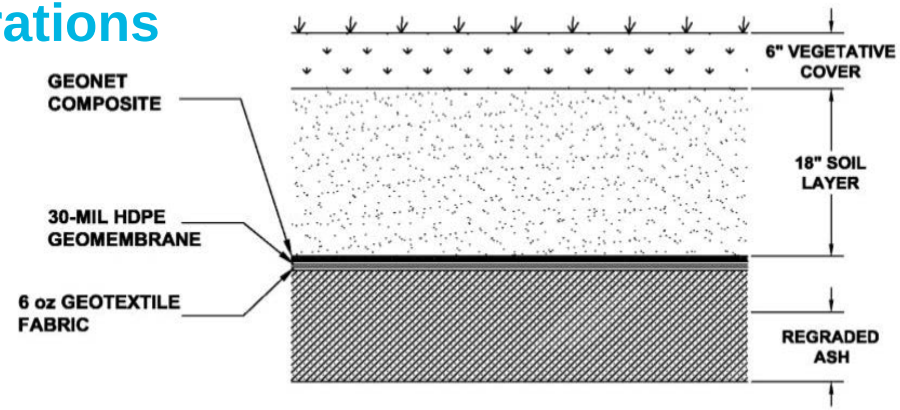
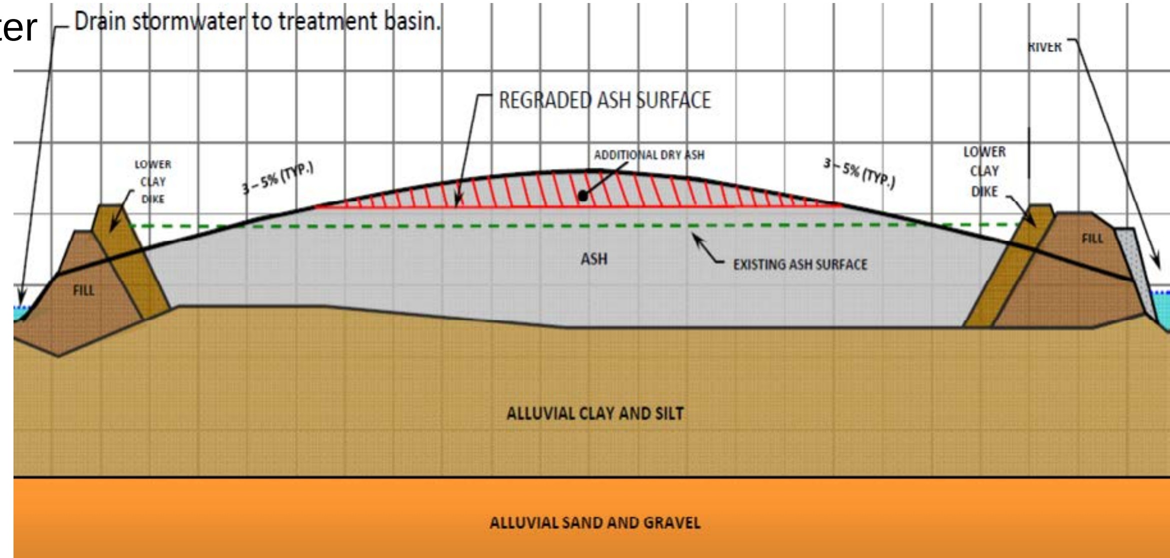
03 Key Challenges and Considerations

Cap in Place (CIP)

CIP

- Assess, stabilize and lower perimeter berms
- Remove and treat ponded water
- Construction dewatering and treatment
- Place and compact ash to achieve cover final cover grades
- Construct final cover and stormwater management features
- Accelerated schedule
- Typical Cost $200K- $600K/acre+



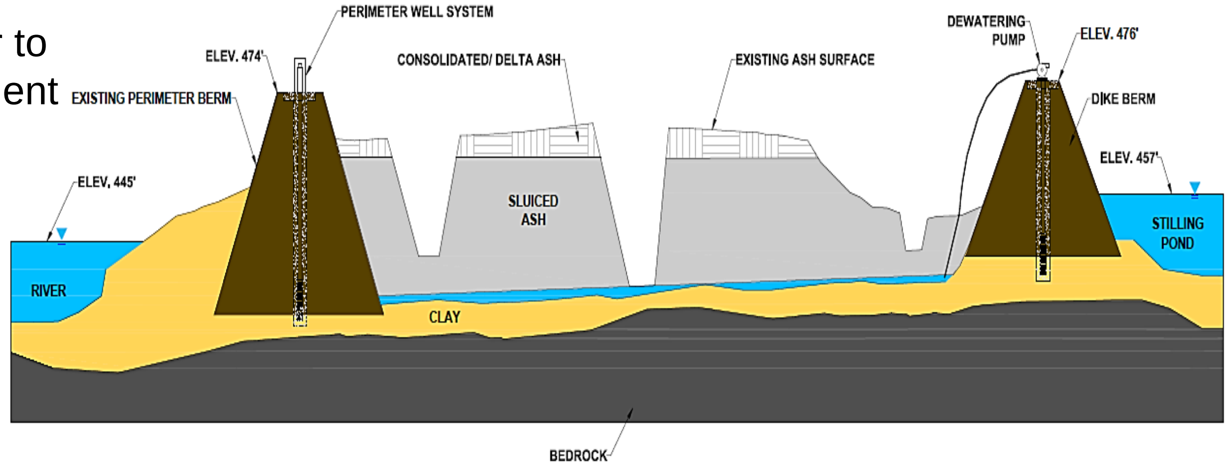


03 Key Challenges and Considerations

Closure by Removal

CBR

- Assess and stabilize perimeter berms
- Remove ponded and pore water to bottom of excavation and treatment
- Excavate ash
- Haul dry ash to lined facility/beneficiation
- Reclaim ash pond area
- Significant schedule extension typically 2x to 4x CIP
- Cost typically 3x to 10x CIP



Safe and effective CCR excavation is a challenge for all closure alternatives. The challenge is a function of the ash pond size and the type of closure selected.

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03 Key Challenges and Considerations

CIP and CBR Comparison

CIP

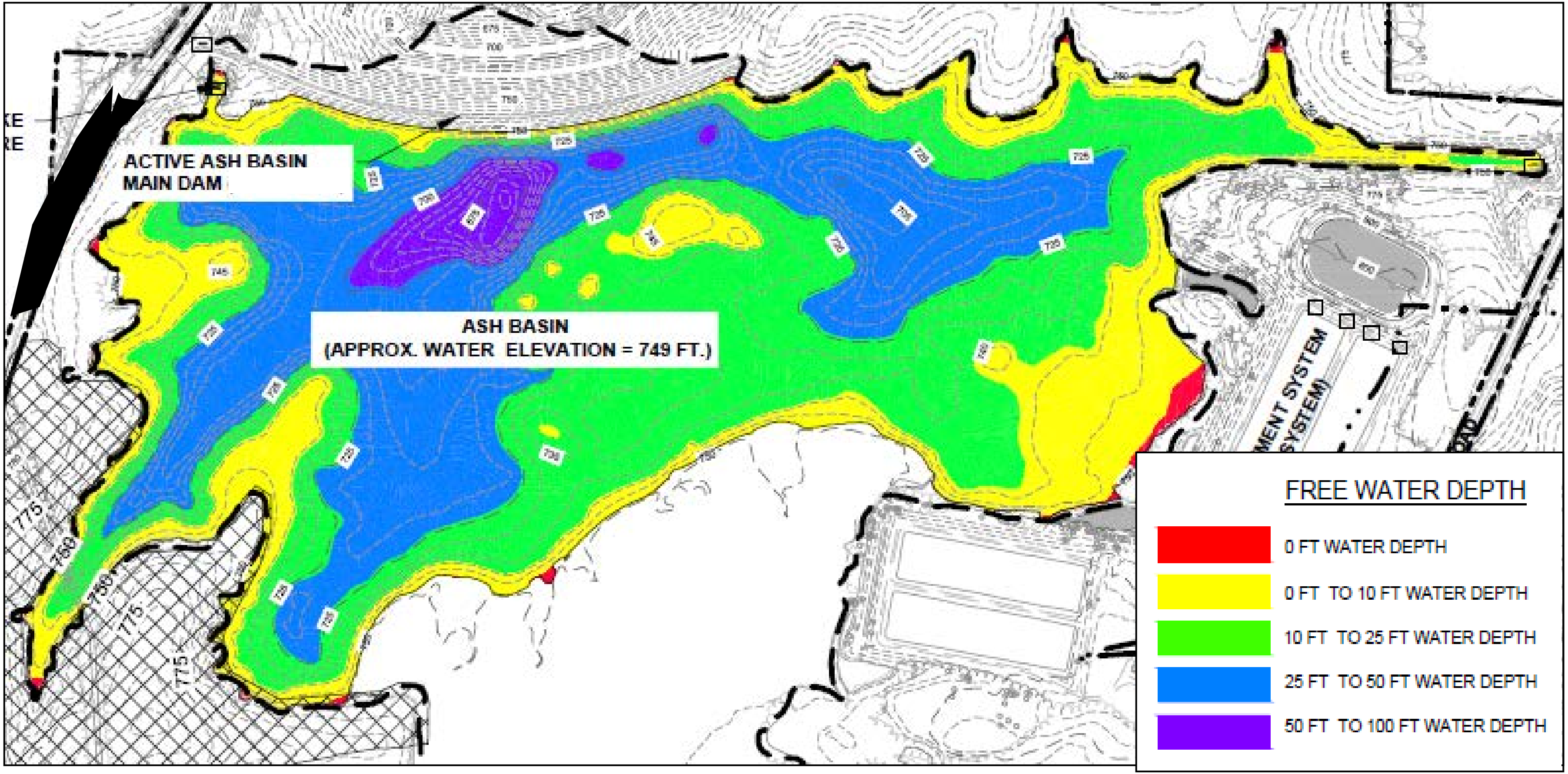
- Free water removal
- Pore water dewatering
- Groundwater and seepage
- Saturated ash
- Managing design storm event (Temporary and Permanent)
- Cap performance

CBR

- Free water removal
- Pore water removal
- Groundwater and seepage
- Ash removal and handling
- Managing design storm event (Temporary)
- Removal of earthen dikes and site restoration

03 Key Challenges

Free Water Removal – CIP and CBR



03 Key Challenges

Free Water Removal – CIP and CBR

Normal operations/decanting:

- Erosion of earthen dikes
- Erosion of newly exposed surfaces within the ponds
- Water quality, detention times for settling
- Disturbance of and re-suspension of fine sediments
- Sloughing / plastic flow of CCR

03 Key Challenges

Free Water Removal – CIP and CBR

- Height of lift over dam crest
- Depth of drawdown required
- Discharge flowrate required
- Water quality
- Access available at site
- Power sources available
- Dam embankment stability
- Inlet and outlet conditions, water depths, armoring, and debris
- Amount of operation and maintenance time available
- Availability of supporting equipment and cost
- Quantifying treatment volume needs and variations at the beginning may be an effective way to control costs.

03 Key Challenges

Free Water Removal – CIP and CBR

03 Key Challenges

Pore Water Dewatering and Removal CIP and CBR

Key Risks / Challenges

- Coordination with dewatering
- Specialty equipment and methods may be required
- Stability
  - Dams and dikes stability
  - CCR stability
  - Working face
  - Stockpiles, overfill
- Safety
  - Working in unstable ash
  - Working in water
  - Transportation

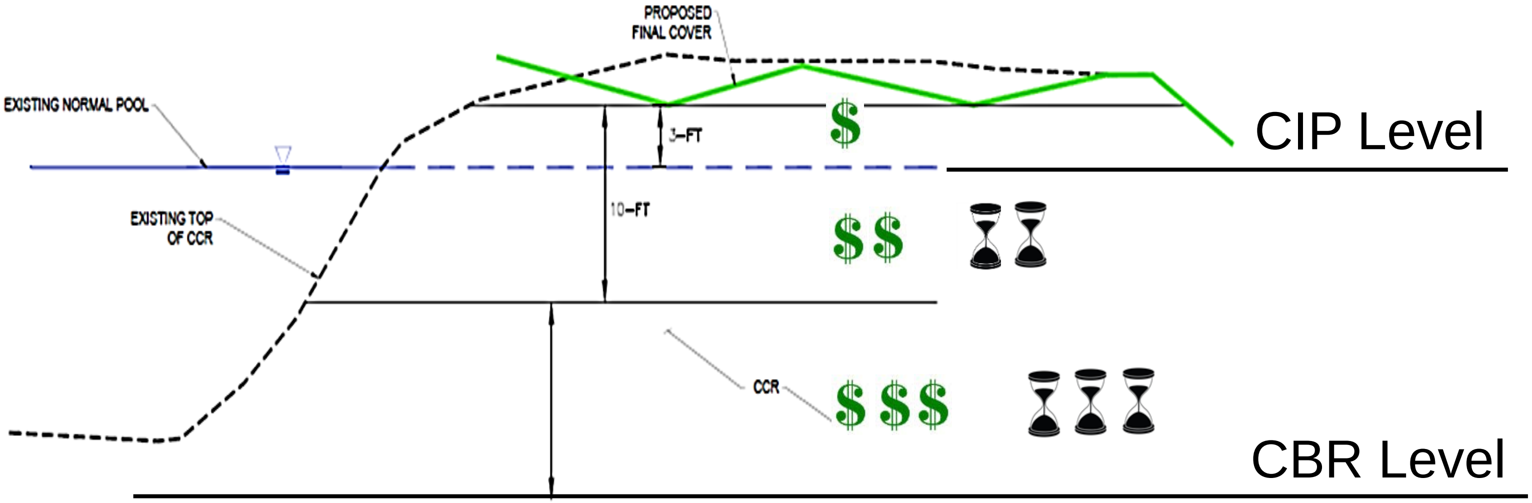
03 Key Challenges

Pore Water Dewatering and Removal CIP and CBR

- Passive Dewatering
  - Rim Ditches / Sumps
    - Time considerations
- Active Dewatering
  - Wellpoints
  - Deep Wells
  - Wick Drains / Preloading

03 Key Challenges

Pore Water Dewatering and Removal CIP and CBR



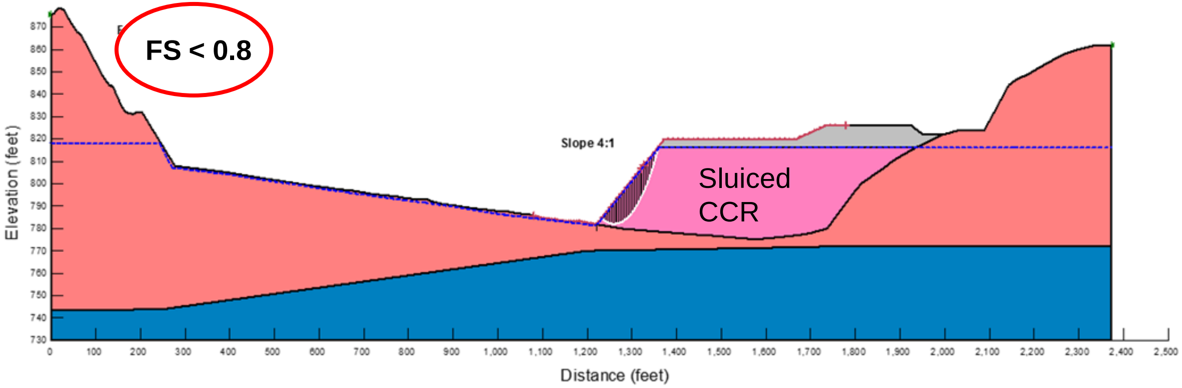
03 Key Challenges
Pore Water Removal - CBR

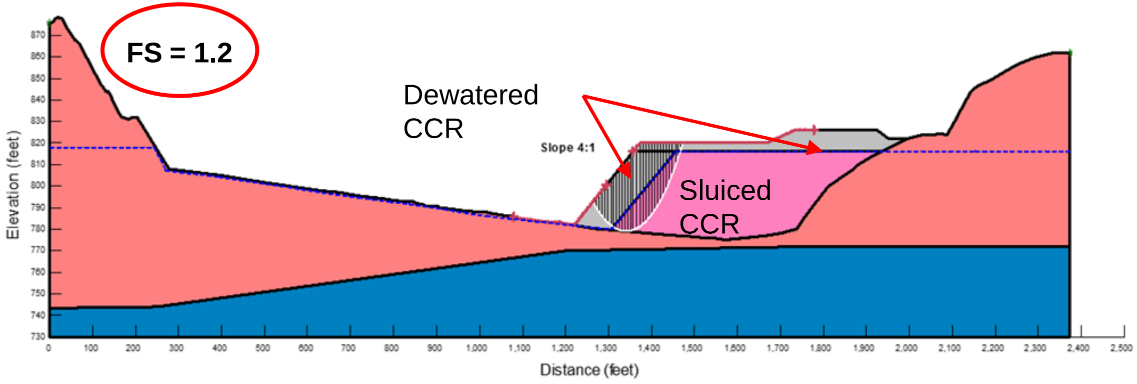
- Design and construction have to be very closely coordinated.
- Drawdown and maintain phreatic surface below CCR excavation slopes for slopes steeper than 5H:1V.
- Dewater CCR before constructing heavy duty roads or stockpiles.
- Build in the time needed to improve sluiced CCR for the closure schedule.
- Monitor the phreatic surface and communicate the results!

03 Key Challenges

Pore Water Removal - CBR

- Excavated CCR slopes must be very flat or could be unstable.
- For steeper slopes, specify minimum vertical and lateral extents of dewatering. Must be below toe of excavated slope.
- Monitoring required!





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03 Key Challenges

Pore Water Removal and Treatment - CBR

- Sampling of surface water and interstitial water to evaluate treatment for NPDES permit limits
- Sampling and analysis protocol
- Treatment duration
- Mobile packaged water treatment system capable of providing treatment
- Permanent system may be needed
- Adequate area for treatment, storage
- Treatment system design criteria: flowrate(s), influent physical/chemical characteristics, and required effluent quality
- Changes in water quality over time and with location within pond

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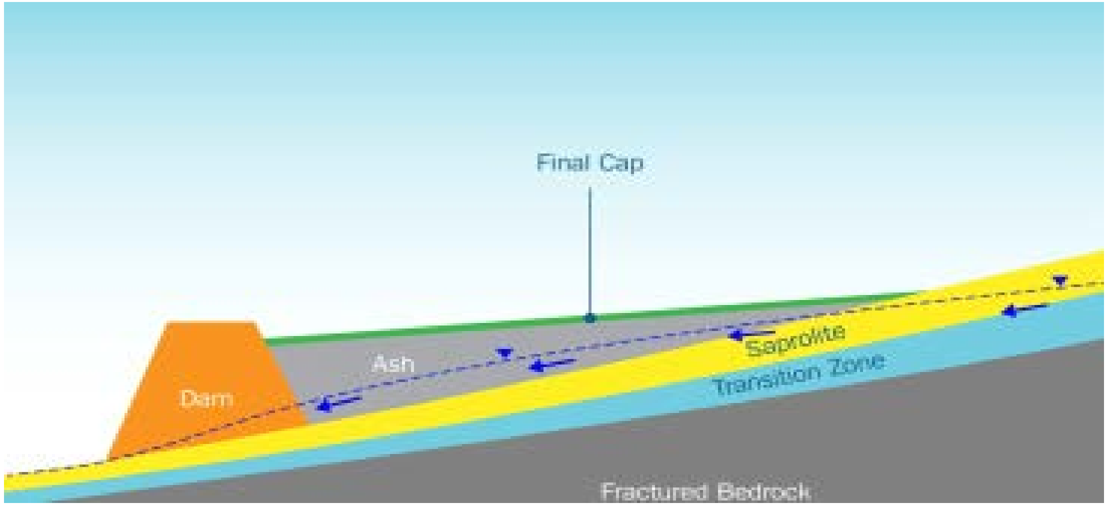
03 Key Challenges

Groundwater and Seepage CIP and CBR

- Groundwater means water below the land surface in a zone of saturation.



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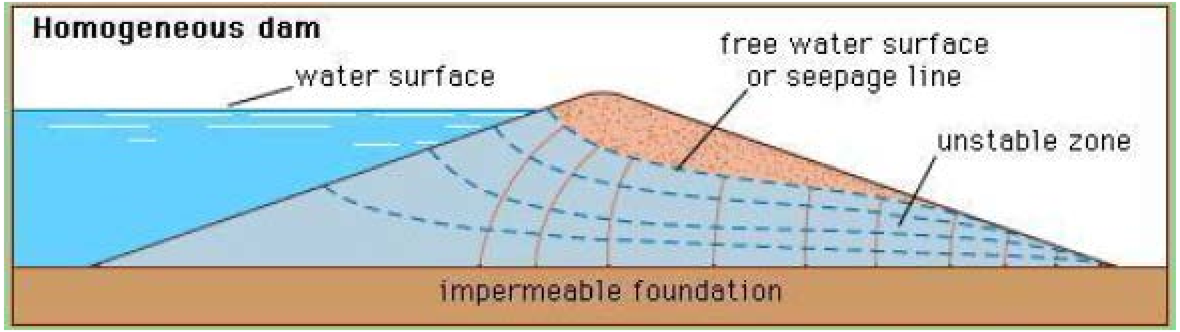
03 Key Challenges

Groundwater and Seepage CIP and CBR

- The normal passage of water through the embankment is known as seepage and it occurs naturally as water reaches the face of the dam through saturation of the soils

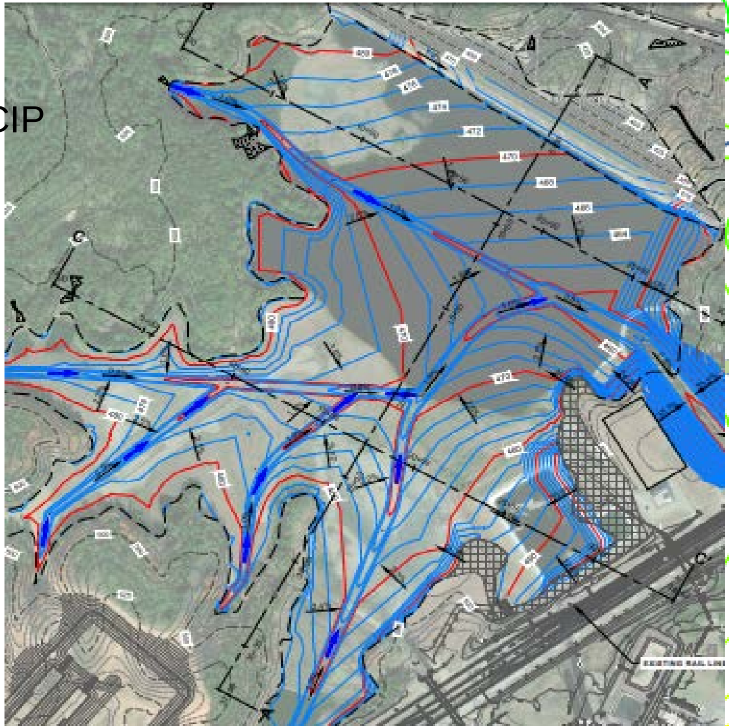


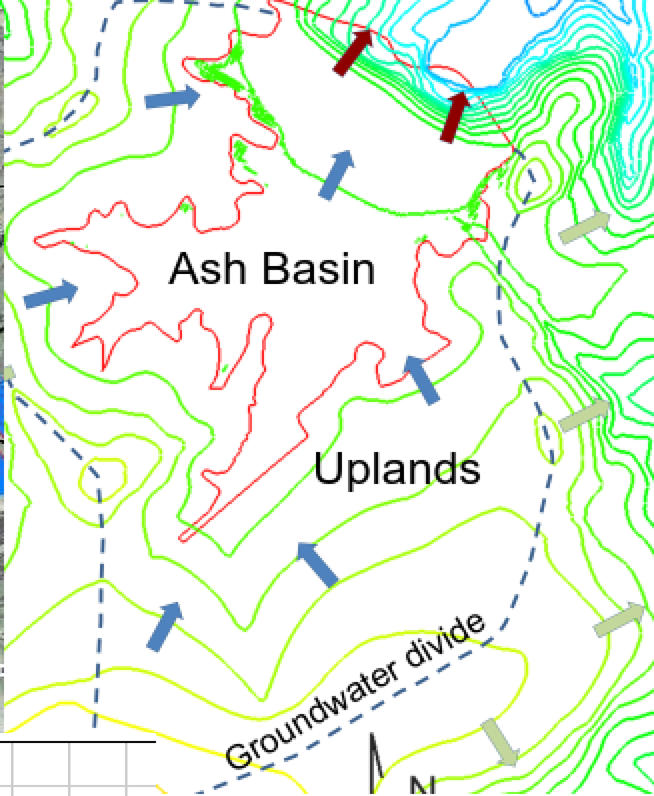
03 Key Challenges

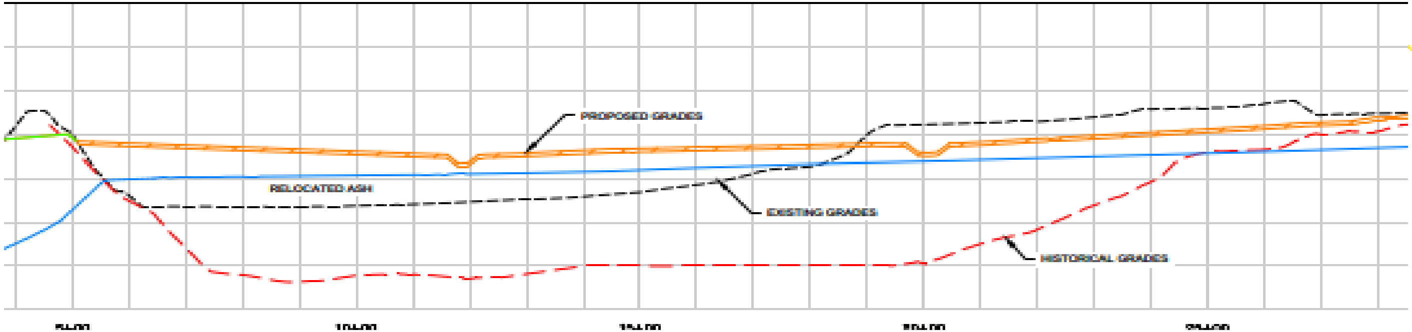
Groundwater and Seepage CIP

CIP

- Groundwater flow
- Recharge following closure
- Long-term flow and seepage potential







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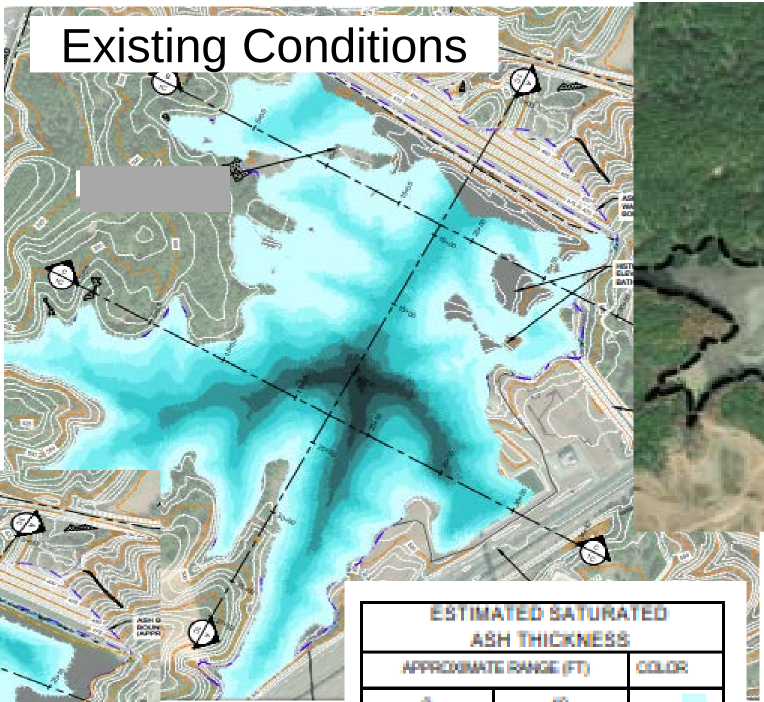
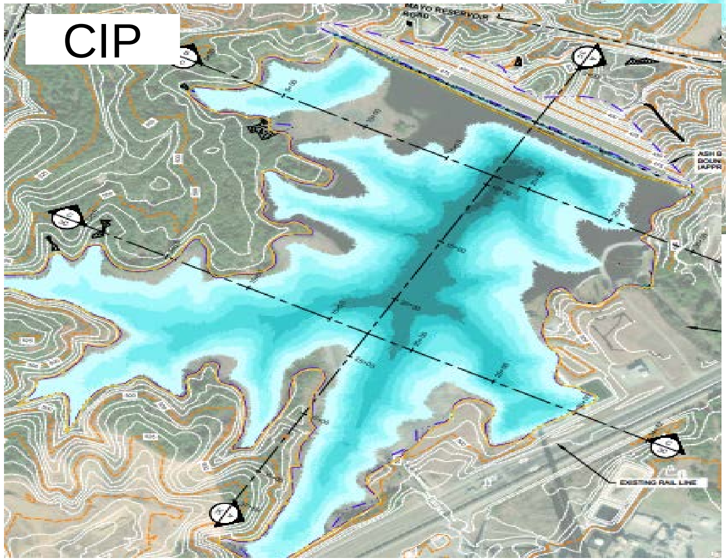
03 Key Challenges
Groundwater and Seepage CIP

CIP

- Removal of free water
- Reduction in ash saturation
- Saturation in historic feature locations



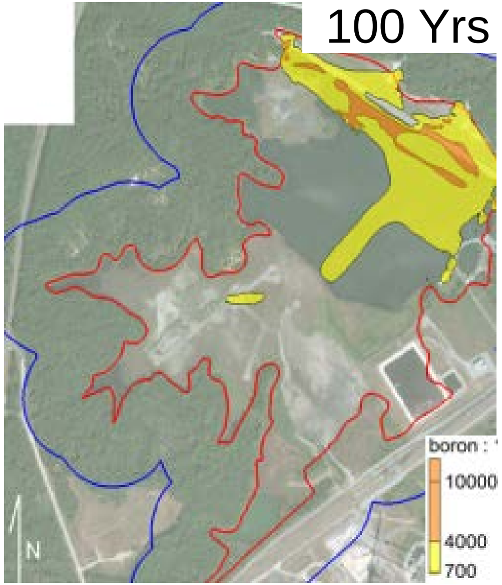


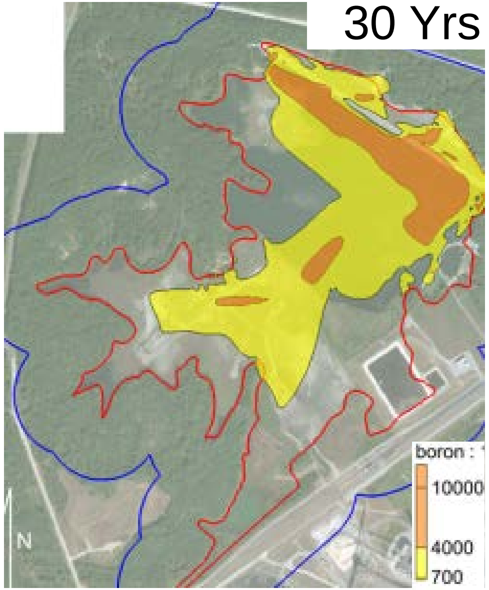
ESTIMATED SATURATED ASH THICKNESS		
APPROXIMATE RANGE (FT)		COLOR
0	10	
10	20	
20	30	
30	40	
40	50	
50	60	
60	70	
70	80	
80	90*	

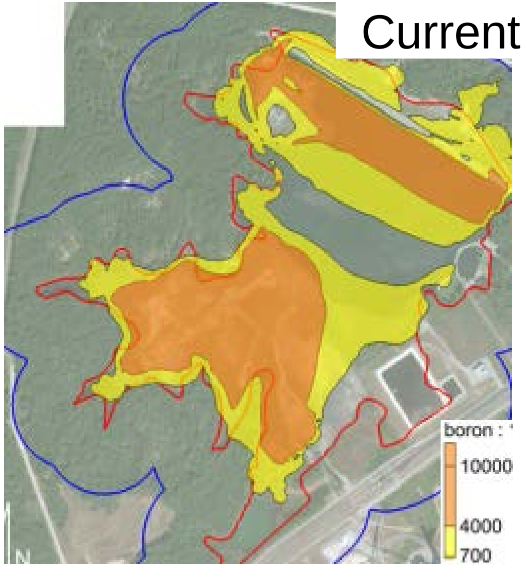
03 Key Challenges
Groundwater and Seepage CIP

CIP

- Value of basin groundwater models
- Changes in concentration with time
- Removal of pool







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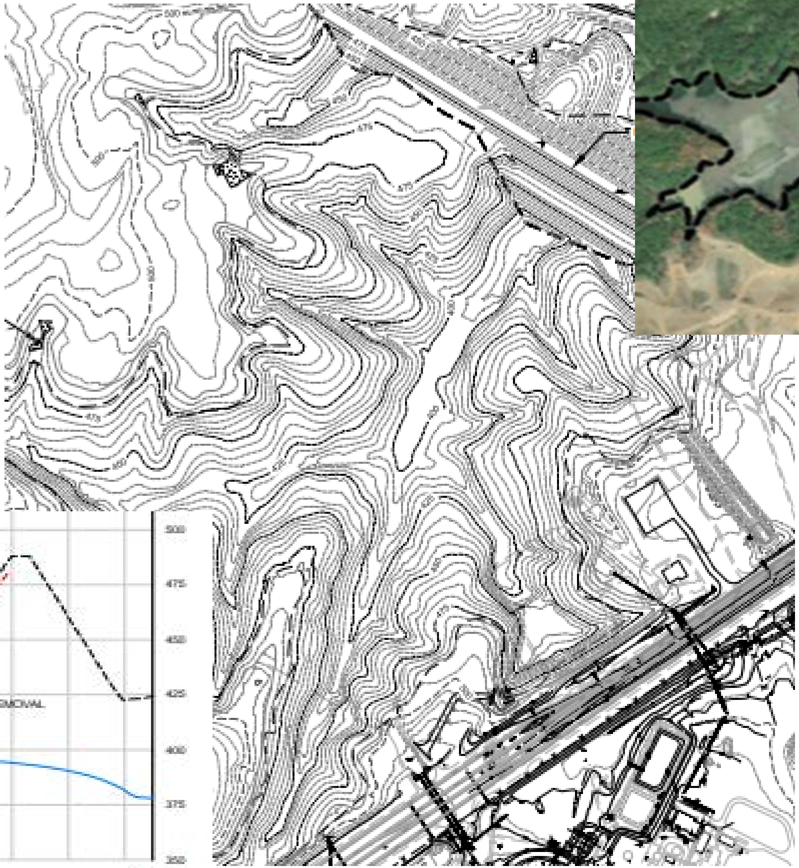
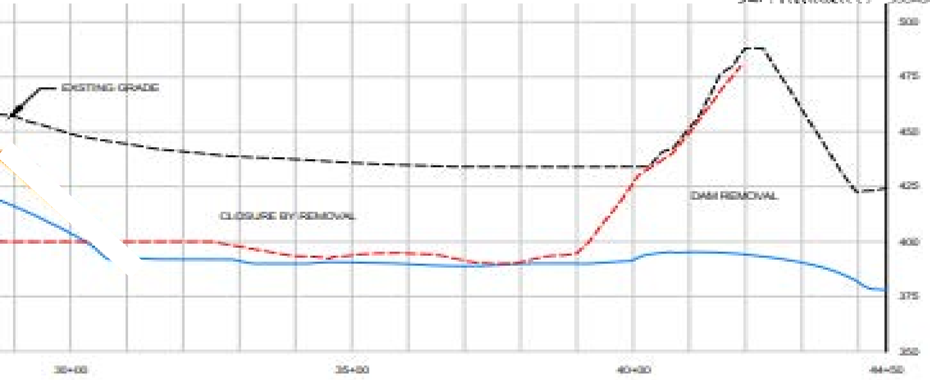
03 Key Challenges

Groundwater and Seepage CBR

CBR

- Groundwater flow
- Recharge following closure and restoration
- Long-term flow and seepage potential



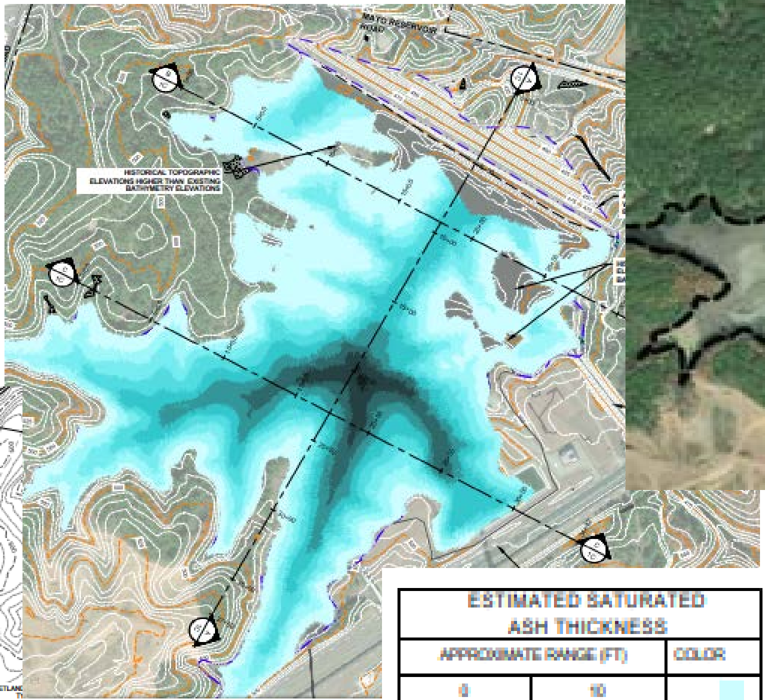


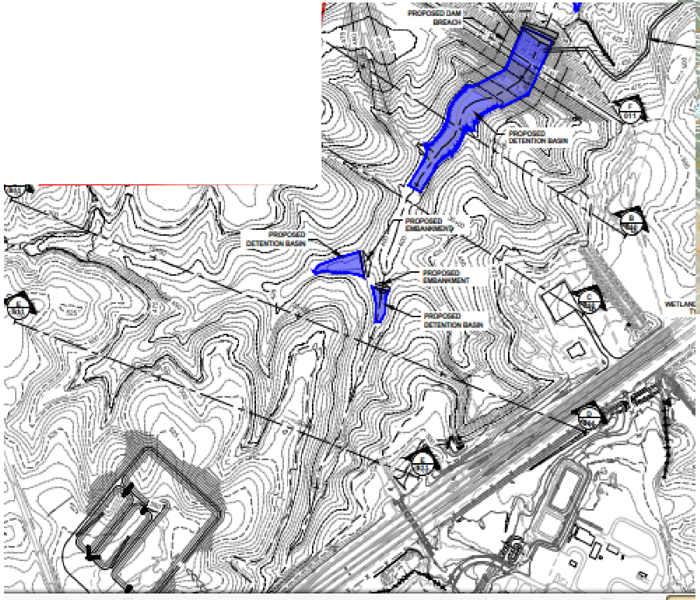
03 Key Challenges

Groundwater and Seepage CBR

CBR

- Removal of free water
- Removal of ash saturation
- Historic feature locations and water management





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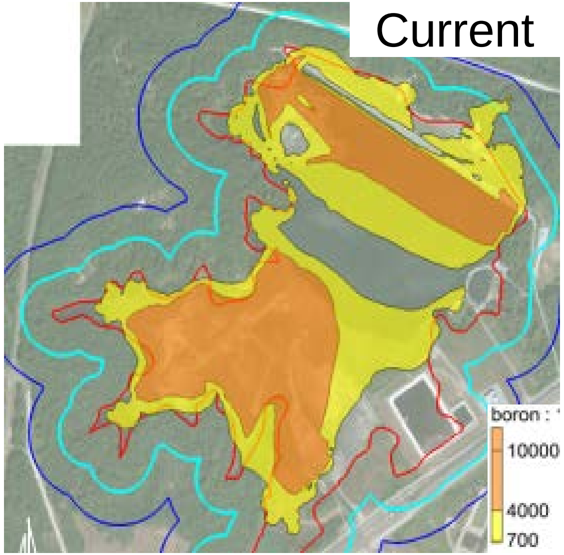
03 Key Challenges
Groundwater and Seepage CBR

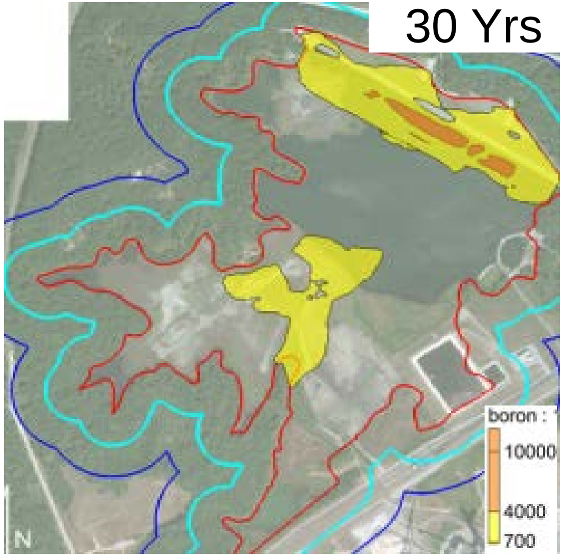
CBR

- Value of basin groundwater models
- Changes in concentration with time
- Removal of pool

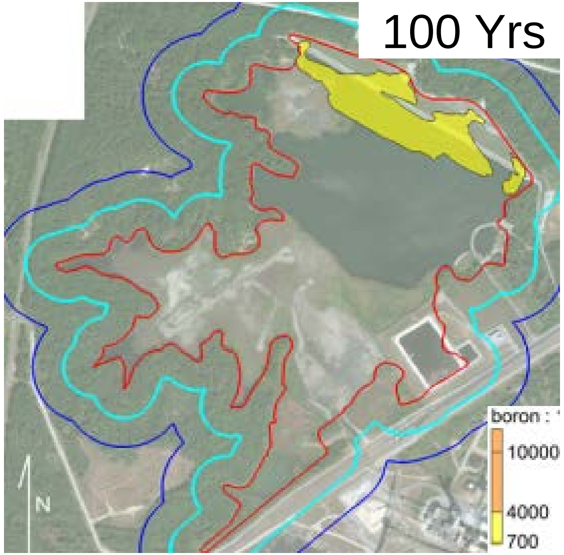
Current



30 Yrs



100 Yrs



03 Key Challenges
Saturated Ash/Ash Removal

- CCR below the pool elevation is typically saturated. (Plus capillary rise!)
- Typically very low shear strength
- Instability in “undrained” condition
- Further reduction if disturbed
- Shear strength “pretty good” if “drained”
- Impacts of low shear strength CCR during closure
  - Impacts safety
  - Limits access
  - Limits excavation slope angle and height
  - Limits ability to place additional material over it
- Stabilization of saturated CCR required prior to excavation or construction of supporting roads and stockpiles

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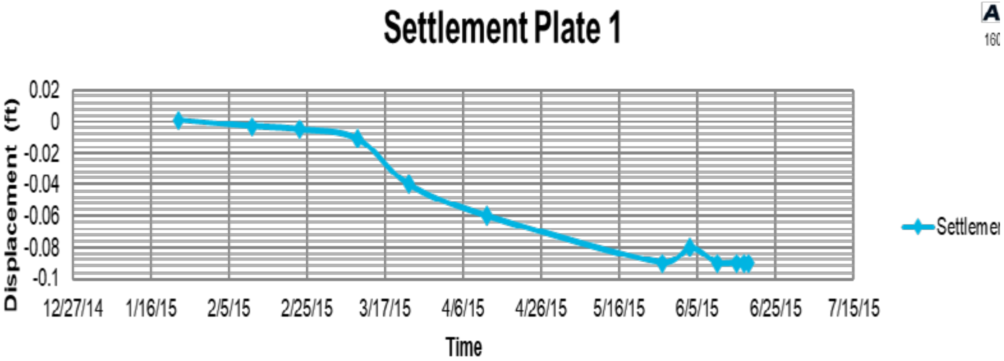
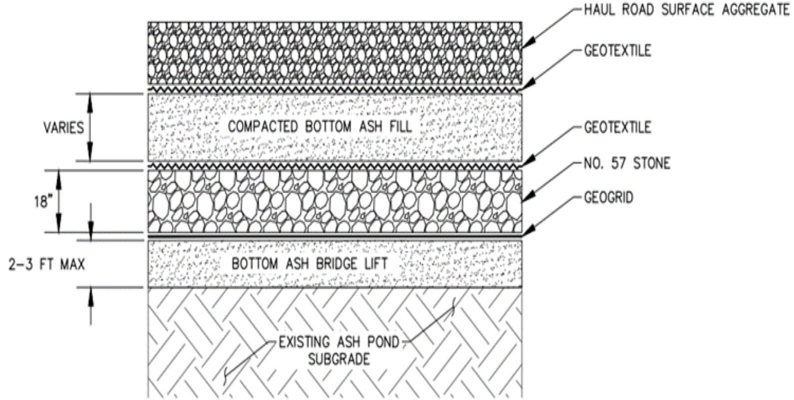
03 Key Challenges
Saturated Ash Stabilization CIP

CIP

- Sluiced bottom ash and fly ash material
- Construction over two former ash sluice channels
- Subgrade Stabilization installed over initial bridge lift of ash.
- Settlement plates to measure preloading of the ash subgrade prior to completing construction





03 Key Challenges

Ash Removal CBR

CBR

- Dry ash necessary for excavation and hauling
- Active dewatering systems preferred to maintain schedule
- Potential for steeper CCR cut slopes and more effective hauling
- Multiple handling to stockpile and dry excavated CCR for placement
    - Lower moisture to <35% for off site hauling
- Treatment potential for ash at bottom of excavation
- Borrow soils to grade base

03 Key Challenges

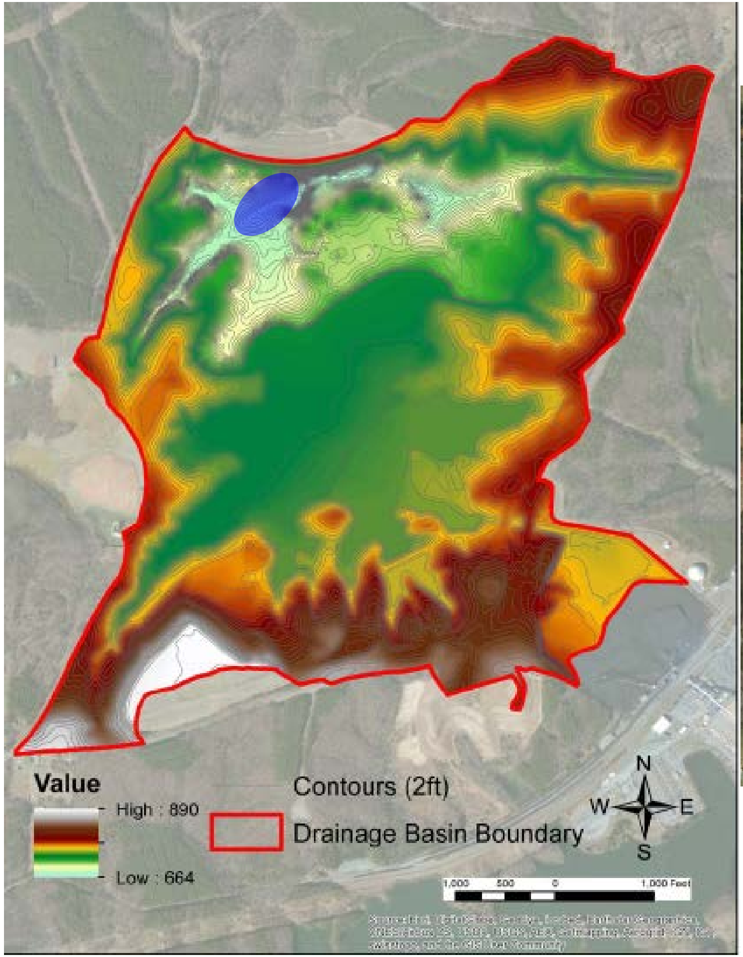
Ash Removal CBR – How Clean is Clean

- Multiple methods dependent upon state requirements
- Common approach is visual confirmation with removal of additional 6 inches to 1 foot below confirmed subgrade
- Alternative approaches include grid sampling procedure and testing for:
  - Percent Ash
  - Metals
  - Others

03 Key Challenges
Stormwater Management

Challenge

- Pond area 283 acres.
- Drainage area 683 acres (1.07 sq. miles), including the pond.
- Gravity diversion challenges



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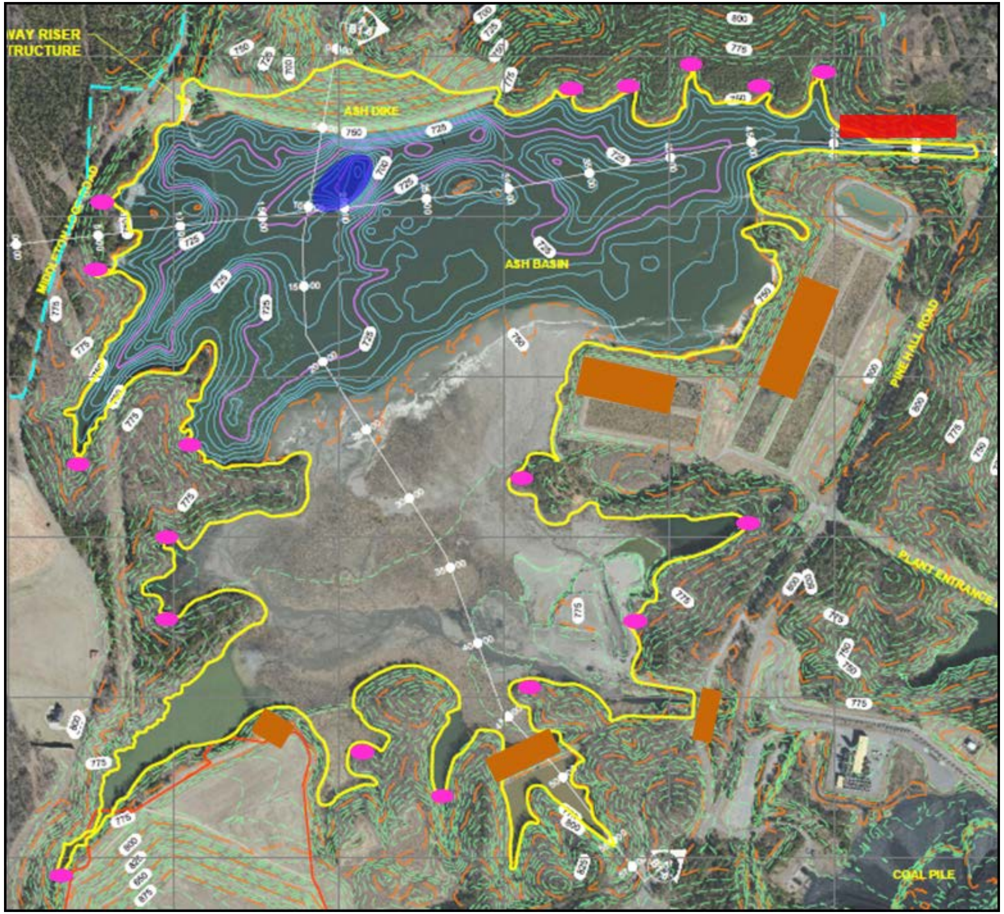
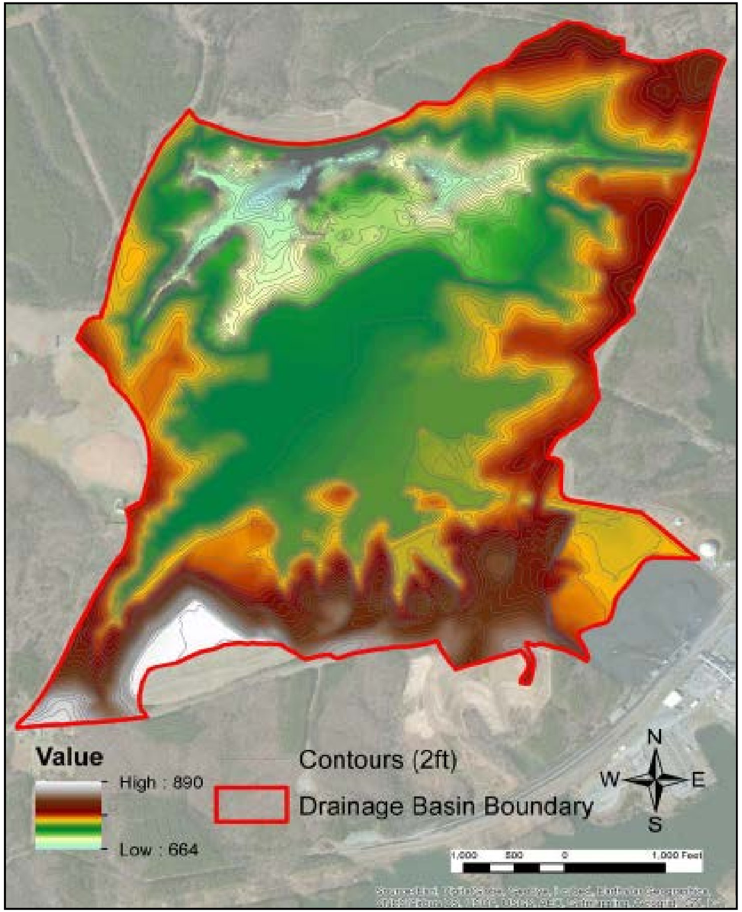
03 Key Challenges

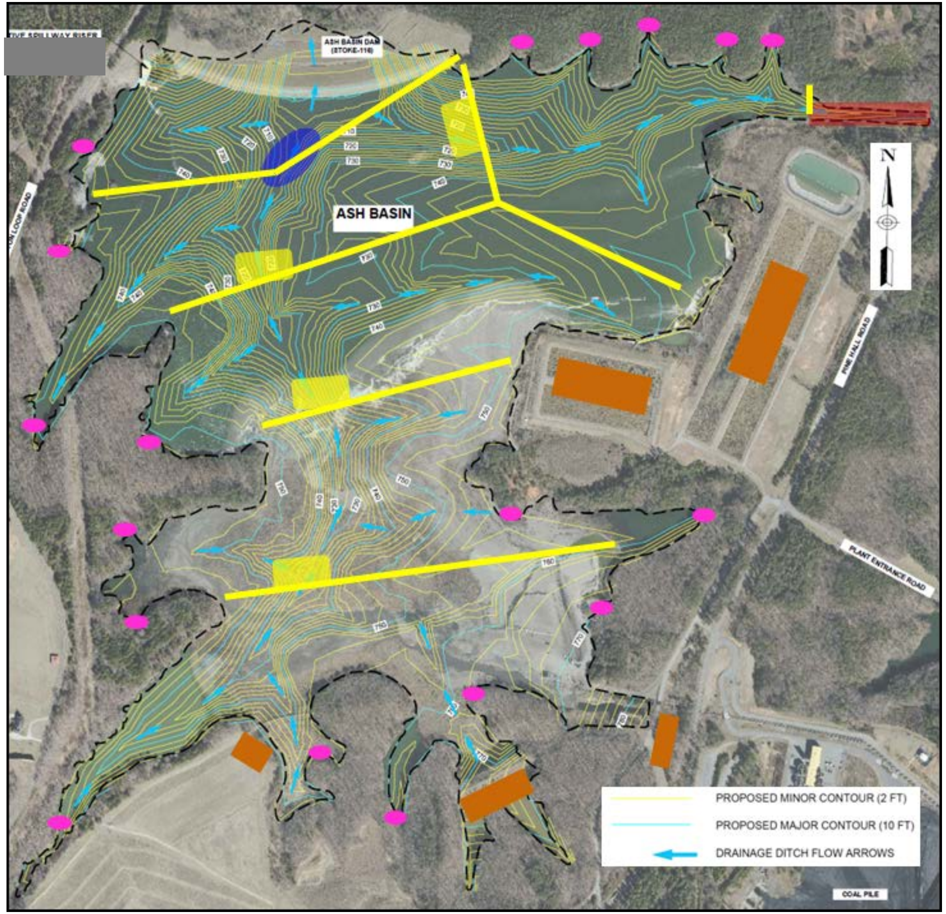
Stormwater Management





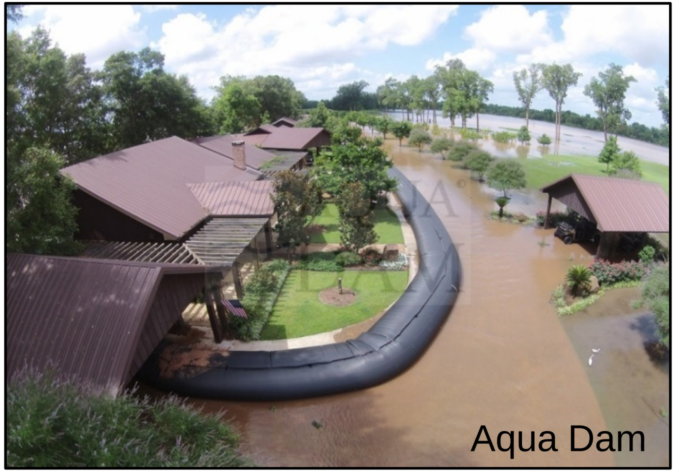
03 Key Challenges

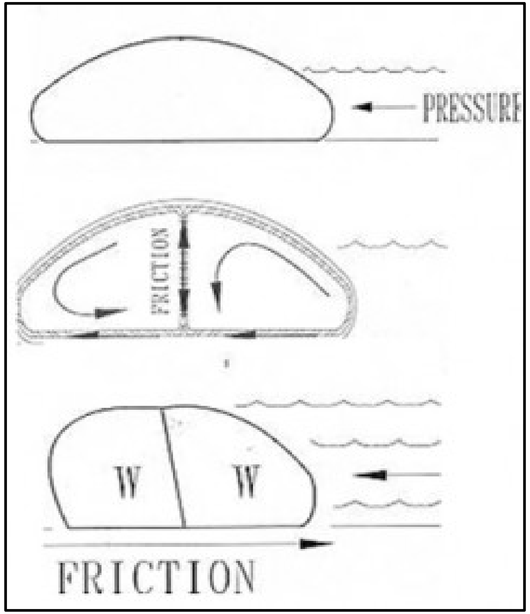
Stormwater Management



03 Key Challenges

Stormwater Management





Divert sheet flow by controlling perimeters and diverting to catch basins.

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03 Key Challenges

Stormwater Management

- **Goal:** to minimize overall cost by optimizing the volumes of “clean” stormwater that can be diverted and free water that must be treated.
- Develop phased alternatives involving storage/diversion of clean water and capture/treatment of free water.
- Conduct workshop with stakeholders to refine feasible alternatives.

- Conduct H&H modeling to estimate volumes of diverted or pumped stormwater and treated free water over the life of the closure for alternatives.
- Prepare rough order of magnitude (ROM) cost estimates for capital and operating expenses.

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04
Industry Overview

04 Industry Overview

Types of Impoundments

TOTALS:

ORGANIZATIONS: 69

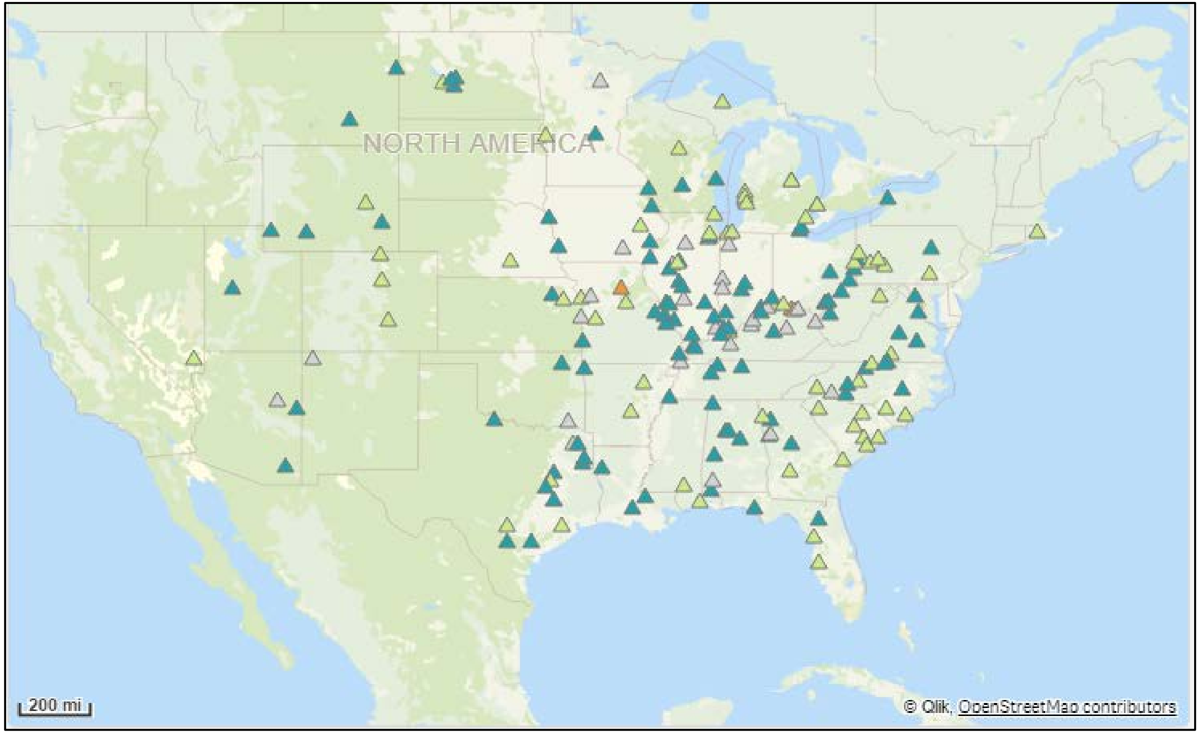
SITES: 196

CCR UNITS: 411

CCR VOLUME: 915M CY

AREA: 19K AC.

MAP OF CCR UNITS (PONDS) IN NORTH AMERICA



NOTE: Data compiled from publicly available sources and can not be independently verified. Only CCR Rule ponds included.

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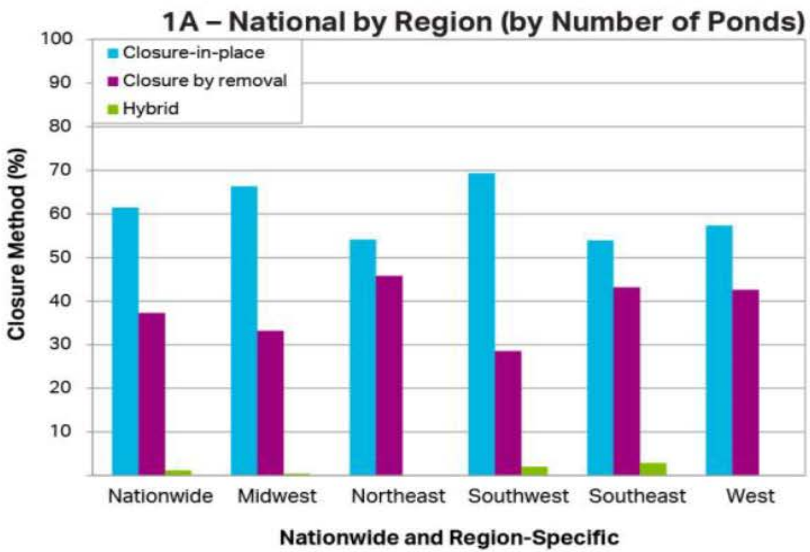
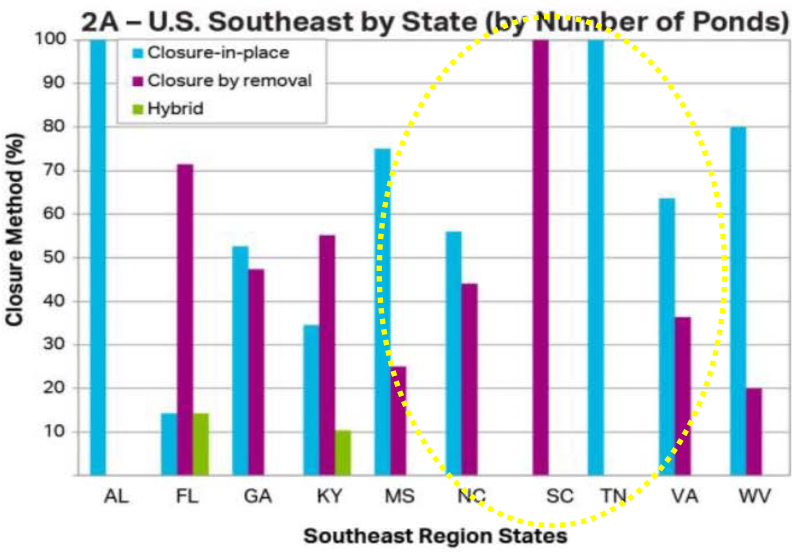
04 Industry Overview

Closure Summary by Number





- Closure In Place is the primary option nationwide and for all regions

- Closure By Removal percentages in the Southeast and Northeast are higher than other regions

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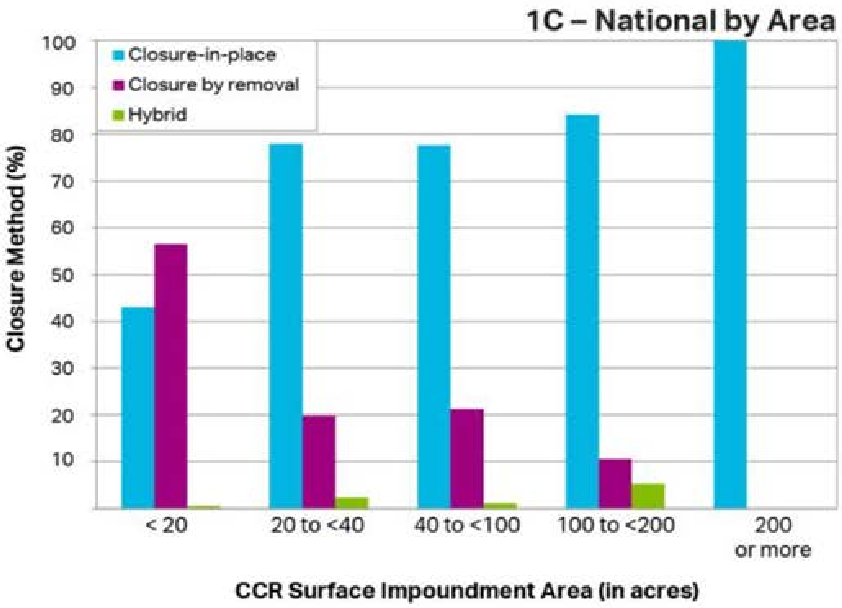
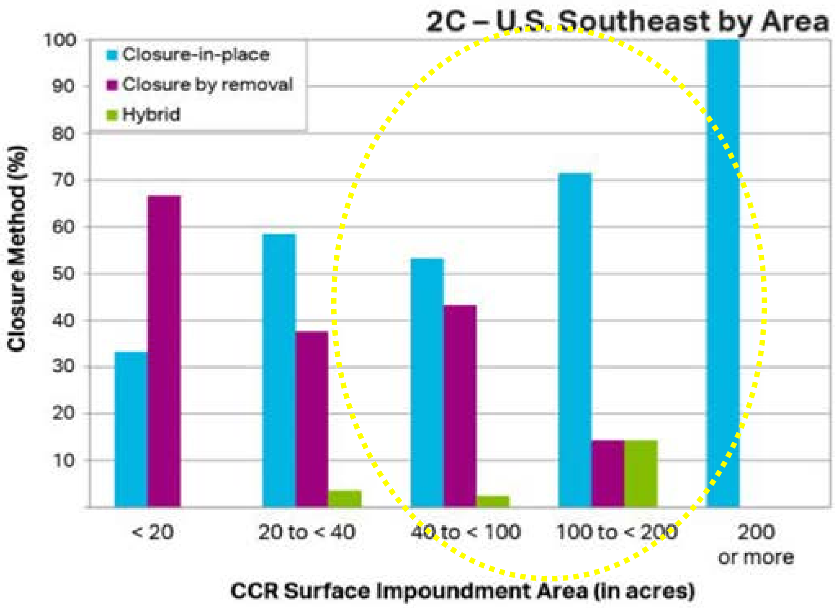
04 Industry Overview
Closure Summary by Area





- Closure In Place is the primary option nationwide and for all regions
- Closure By Removal percentage in the Southeast and Northeast are higher than other regions

NOTE: Data compiled from publicly available sources and can not be independently verified. Only CCR Rule ponds included.

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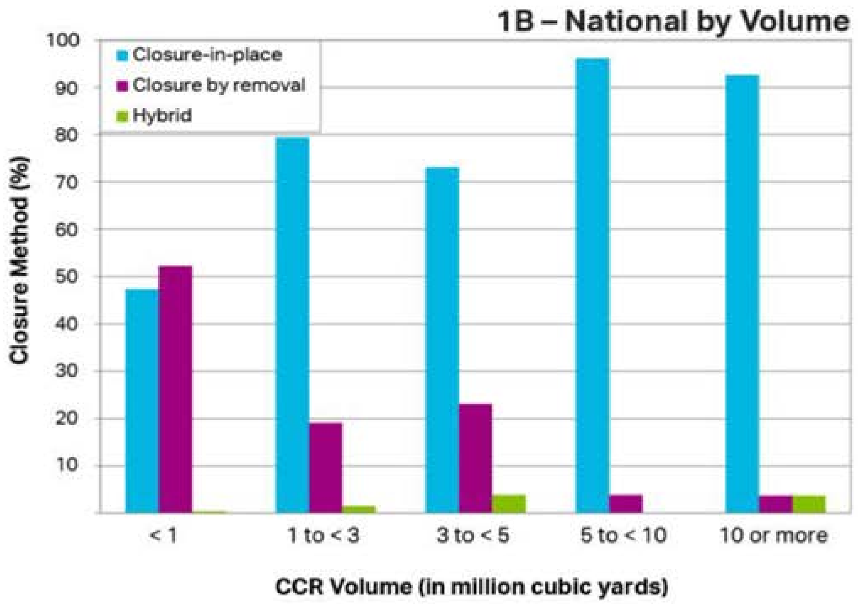
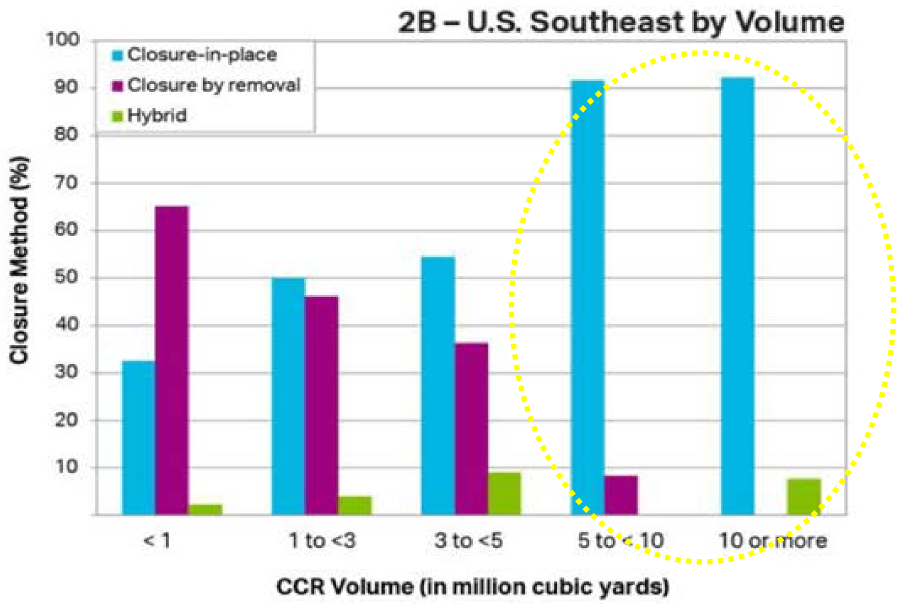
04 Industry Overview
Closure Summary by Volume





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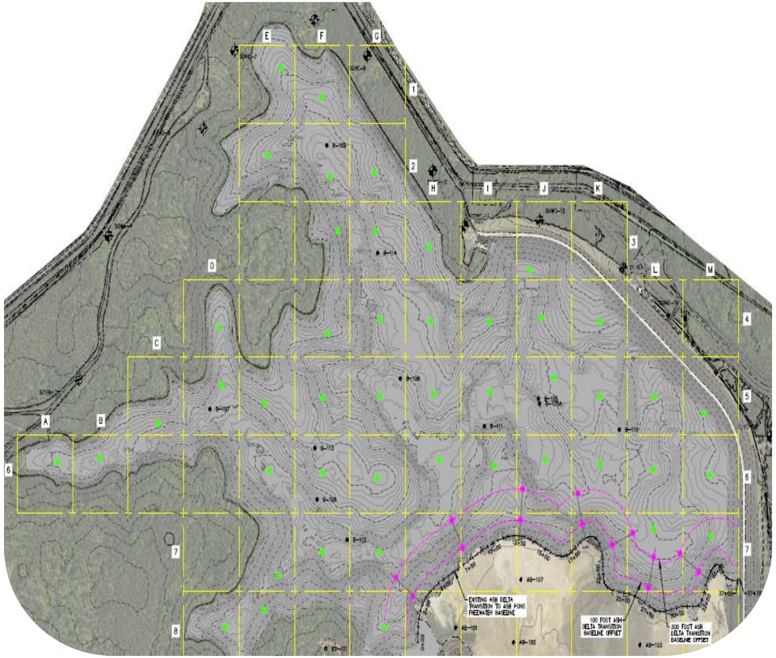
05
Closure Decisions

05 Closure Decisions

Key Objectives for Closure

- Meet **regulatory and legal requirements**
- **Monitoring and/or remediation** of **groundwater**
- **Reduce** current/future **environmental impacts**
- Provide long term function with a **minimum of maintenance**
- **Removal of free liquids**
- Effectively **manage surface water**
- Provide an effective **barrier against infiltration**
- Provide **stability** for the cap and dike system
- **Consolidate** CCRs (potential for beneficial use)



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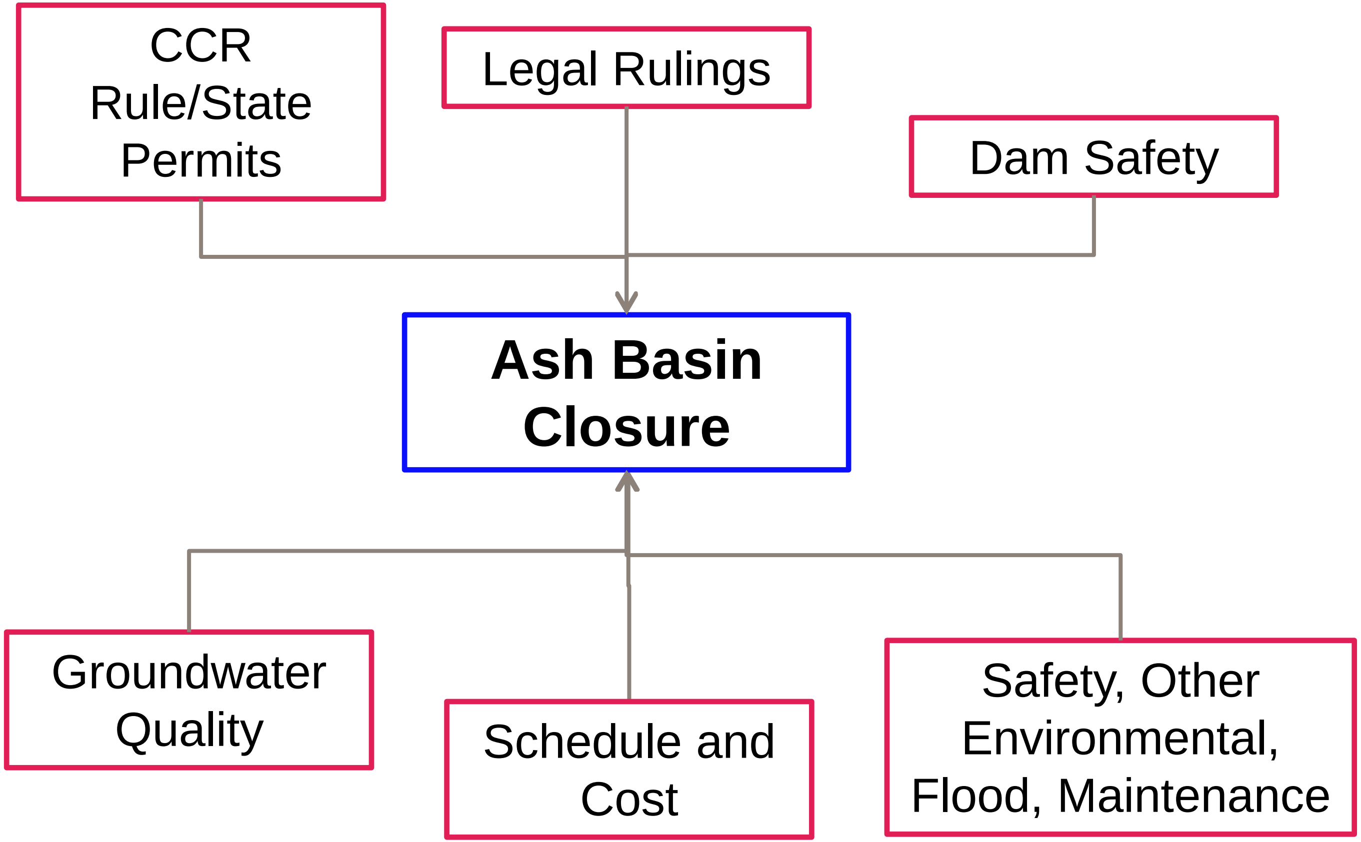
05 Closure Decisions

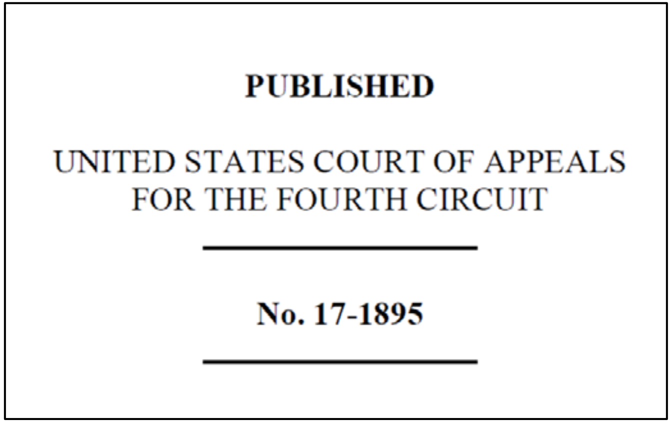
Decision Tree



05 Closure Decisions

Regulatory/Legal Drivers

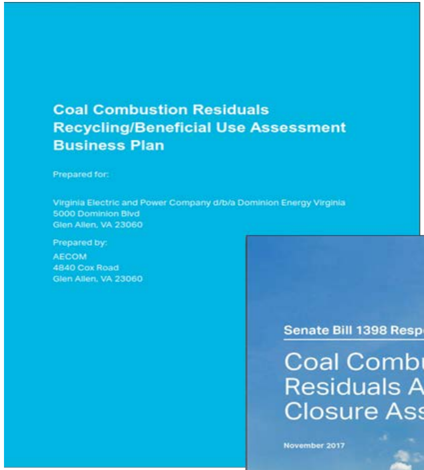
- USEPA CCR Rule
- State Regulations
- Targeted Legislation
- Litigation
- Some drivers have established timelines, others cannot be determined or planned for



PUBLISHED

UNITED STATES COURT OF APPEALS
FOR THE FOURTH CIRCUIT

No. 17-1895



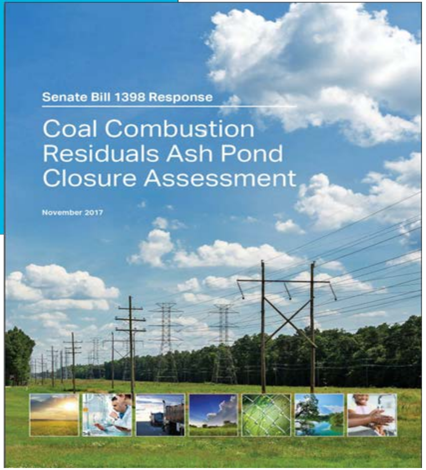
Coal Combustion Residuals Recycling/Beneficial Use Assessment Business Plan

Prepared for:

Virginia Electric and Power Company d/b/a Dominion Energy Virginia
5000 Dominion Blvd
Glen Allen, VA 23060

Prepared by:

AECOM
4840 Cox Road
Glen Allen, VA 23060



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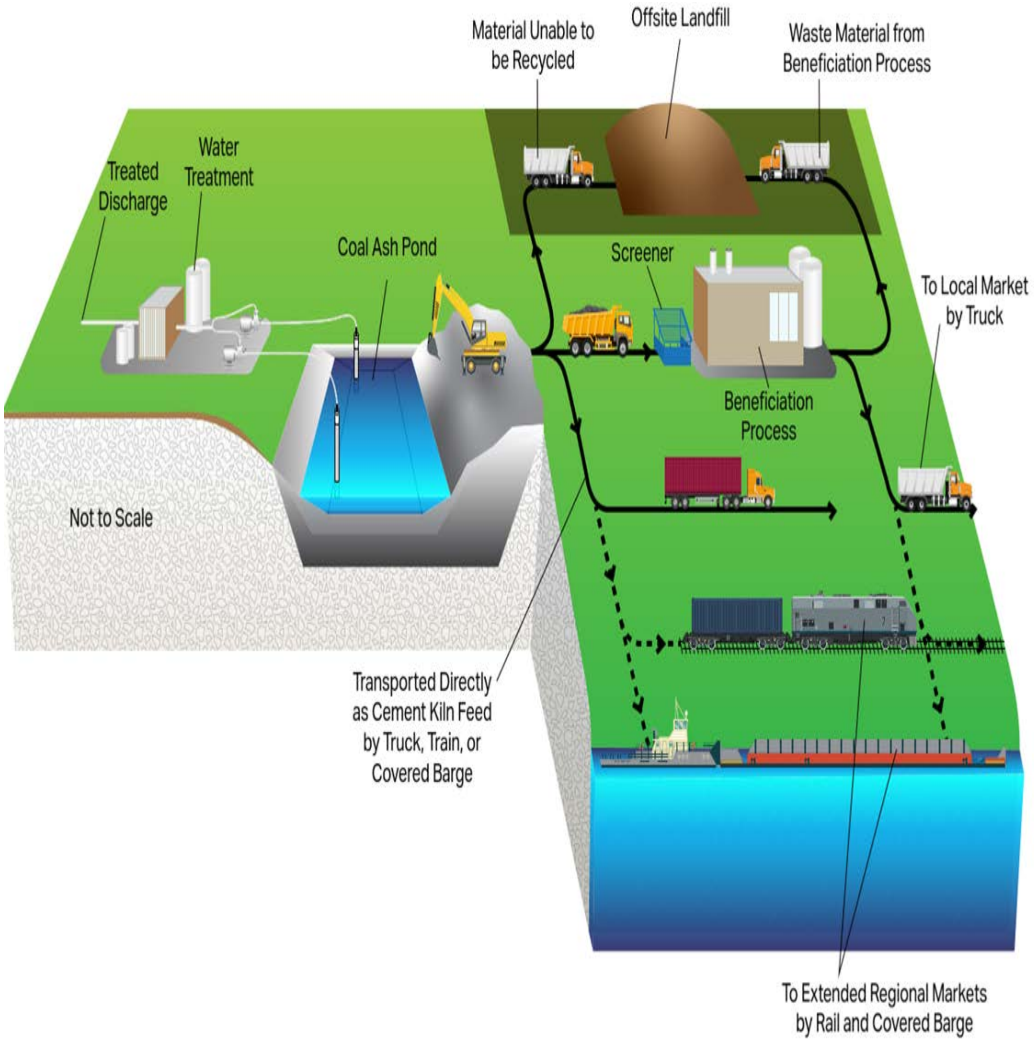
05 Closure Decisions

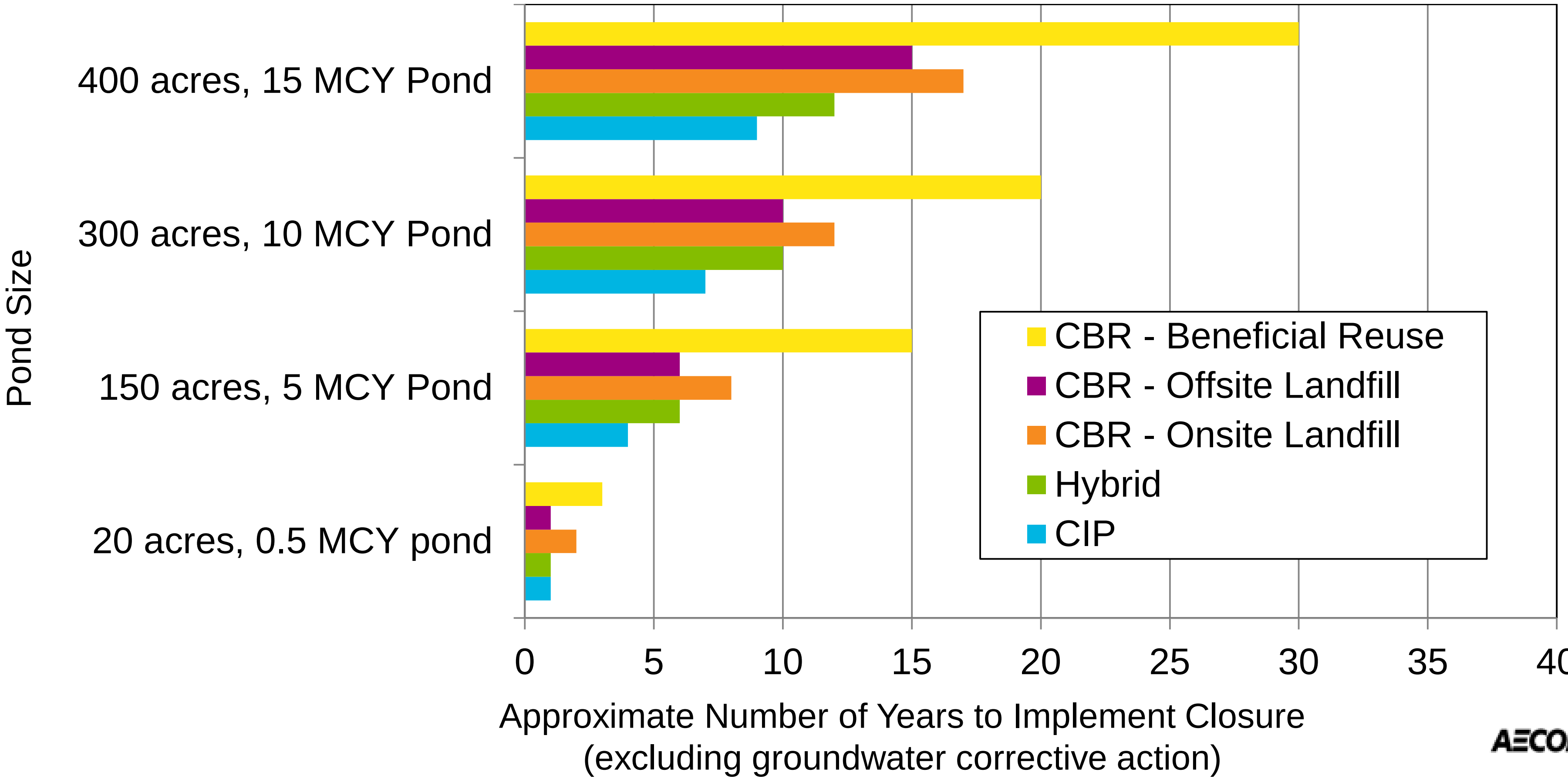
Other Key Drivers

- Safety Impacts
  - Construction workers
  - Pedestrians, drivers
- Community Impacts
  - Traffic and highway safety
  - Air emissions
  - Road and bridge degradation
  - Purchase and acquisition of undeveloped land for new disposal facility
  - Expand existing disposal facility
- Environmental Impacts
  - Groundwater
  - Dust
- Disposal facility development and operations
- Schedule Impacts
- Cost Impacts
- Durability of Final Cover
- “Other” Impacts



05 Closure Decisions

Closure Schedule



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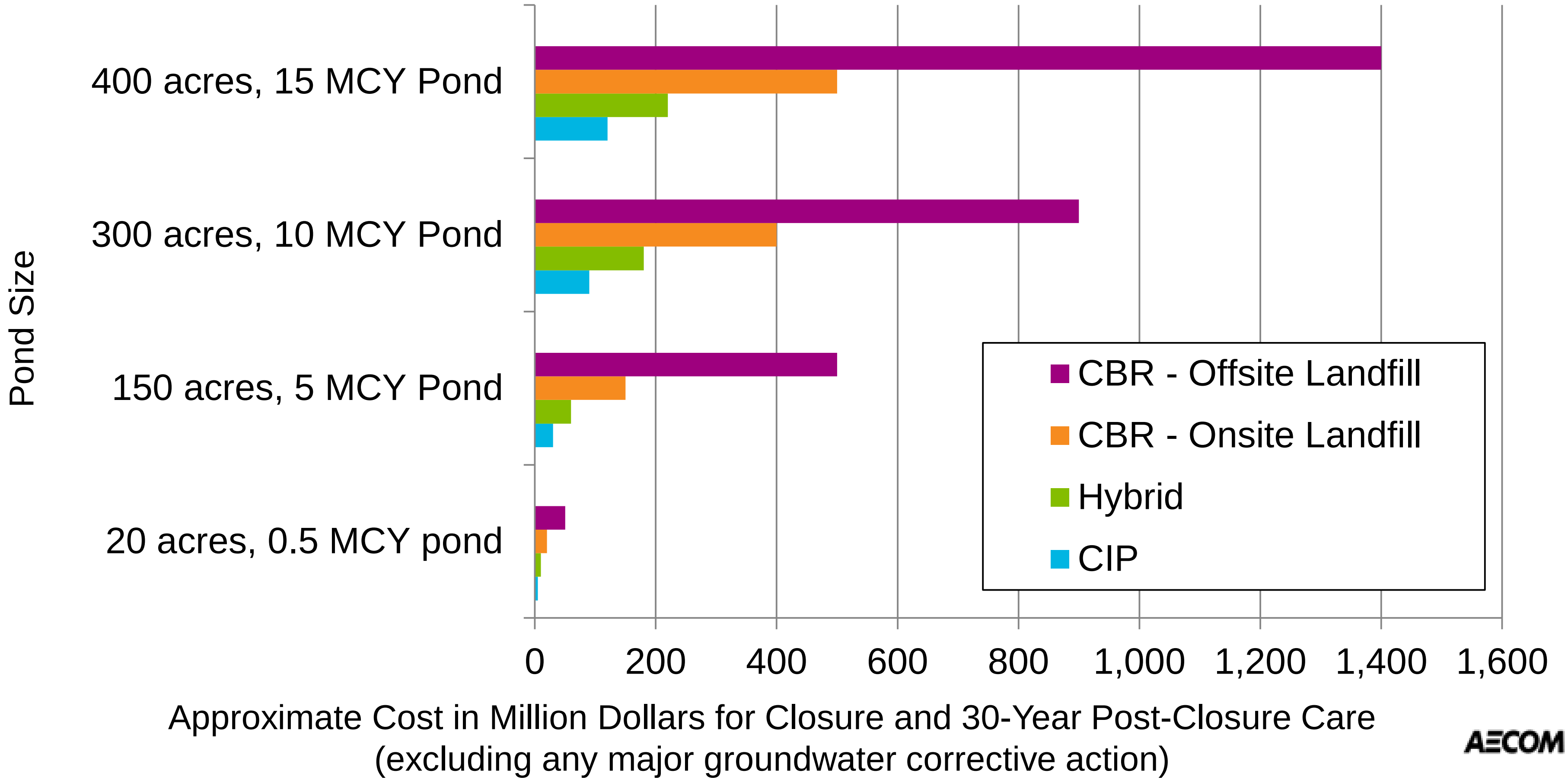
05 Closure Decisions
Closure Cost



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06
Summary

06 Summary

CIP Summary

- Legal/regulatory drivers likely dictate
- Groundwater significant consideration, modeling recommended
- Potential for reduction of saturated ash thickness should be considered
- Active construction dewatering recommended for stability, safety and schedule
- Potential groundwater remediation methods should be considered in long-term performance

CBR Summary

- Legal/regulatory drivers likely dictate
- Schedule and groundwater significant considerations for compliance
- Significant cost impact, should be weighed against potential long-term storage and groundwater impacts for CIP
- Active dewatering should be considered for stability, safety and schedule
- On-site landfill space critical to cost feasibility and minimizing public impacts

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Questions?

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