

REINHOLD ENVIRONMENTAL®

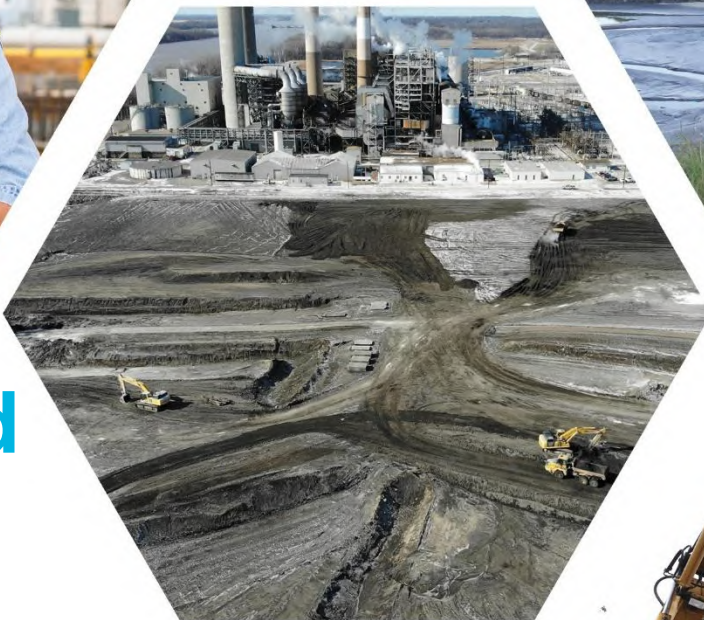


2022 Reinhold/PCUG Round Table Presentation

Hosted by Duke Energy in the Charlotte Sheraton/Le Meridien
Hotel, Charlotte, NC on June 27-28, 2022

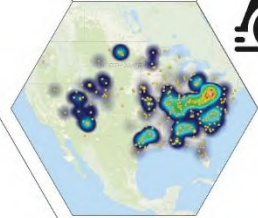
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KEEPING UP WITH COAL ASH



FirmoGraphs

ASH MART



CCR Excavation and Beneficial Use Approaches and Challenges

June 28, 2022

CCR Excavation and Beneficial Use Approaches and Challenges

- Defining Beneficial Use (BU)
- What is the Market Place?
- Defining the Right Application
- Getting Started
- Sample Project
- Best Practices/Lessons Learned
- Summary

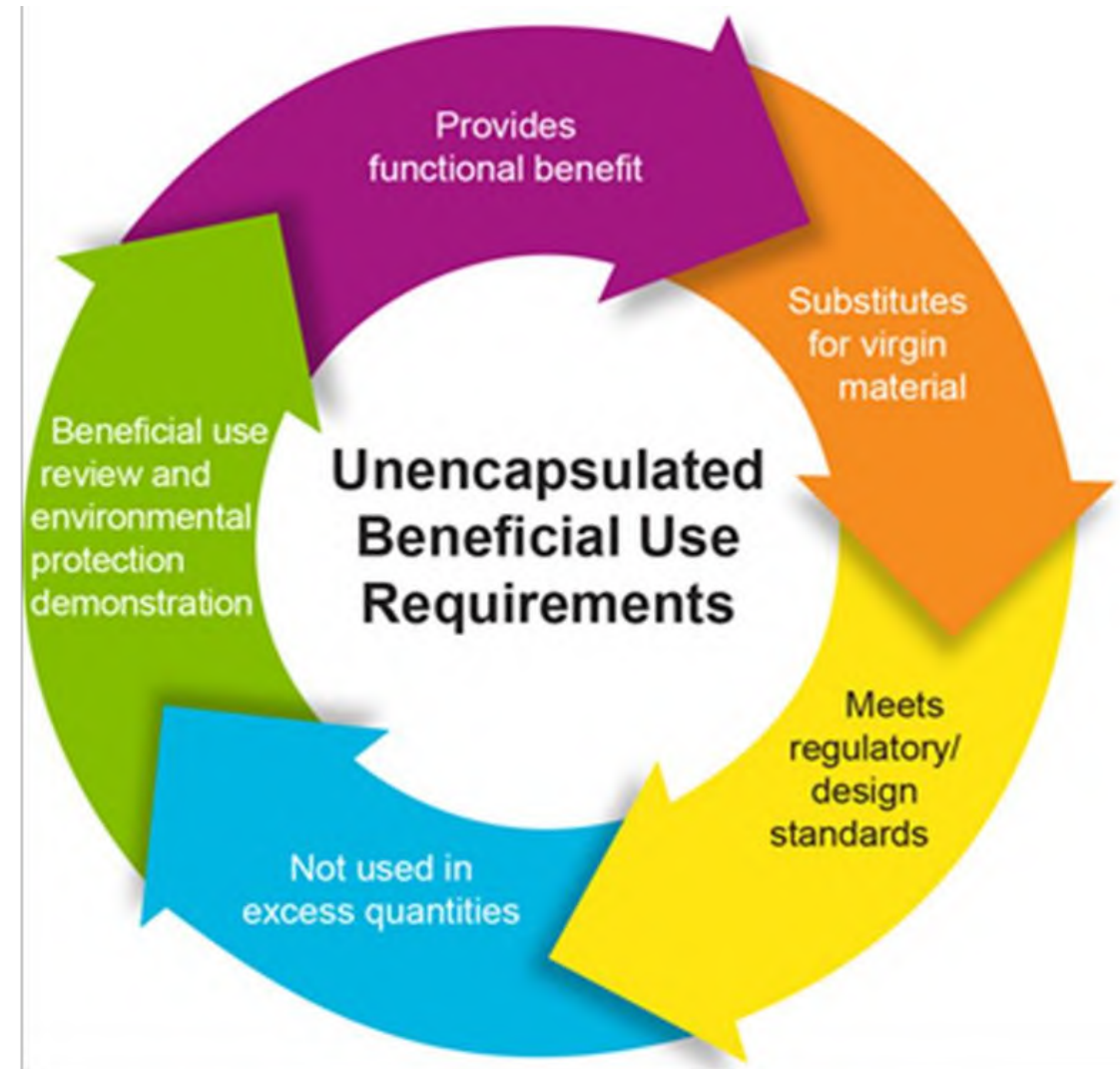
Defining Beneficial Use



Unencapsulated Beneficial Use

Unencapsulated uses include:

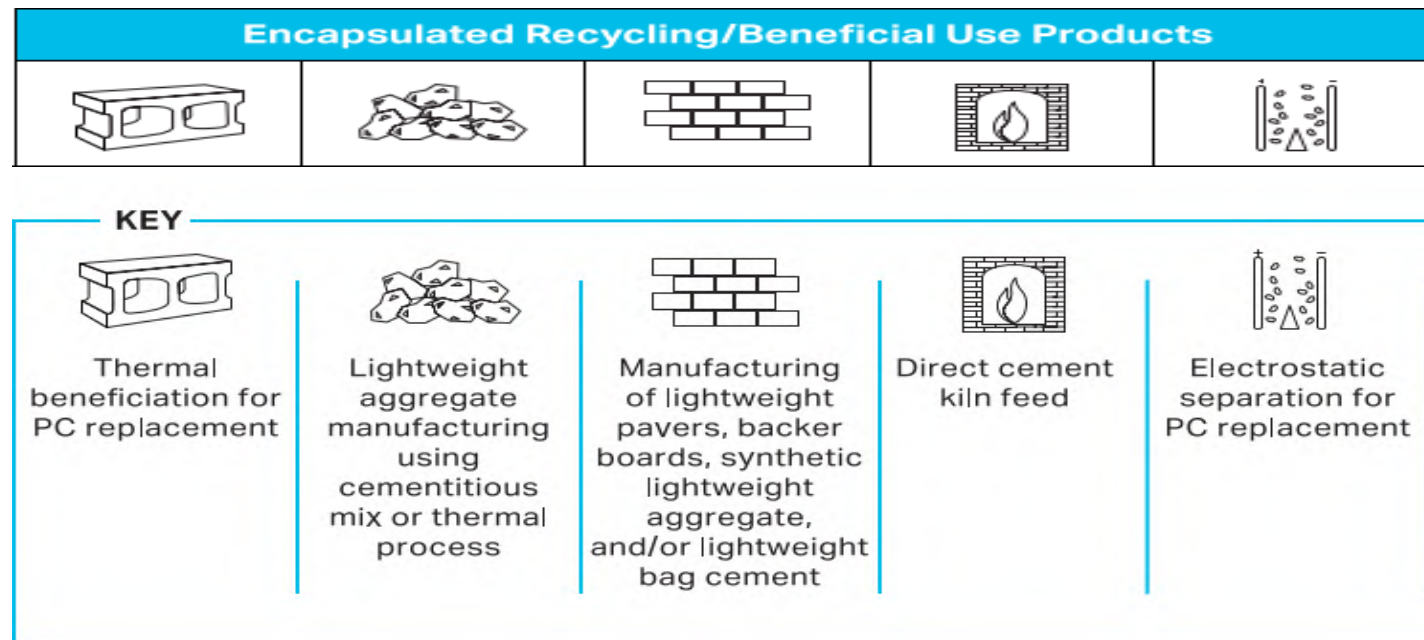
- flowable fill
- structural fill
- soil modification/stabilization
- waste stabilization/modification
- agriculture use as a soil amendment



Encapsulated Beneficial Use

For this presentation, Beneficial Use (BU) is defined as encapsulated applications under the CCR Rule. In addition, focus is on Fly Ash BU.

Encapsulation binds CCR into a solid (such as cement, brick, or wallboard), minimizing its mobilization into the environment



Example Applications of Fly Ash for PC and Concrete

What is the Market Place?



CCR Storage Nationwide

CCR Storage Areas: Surface Impoundments (SI) and Landfills (LF)

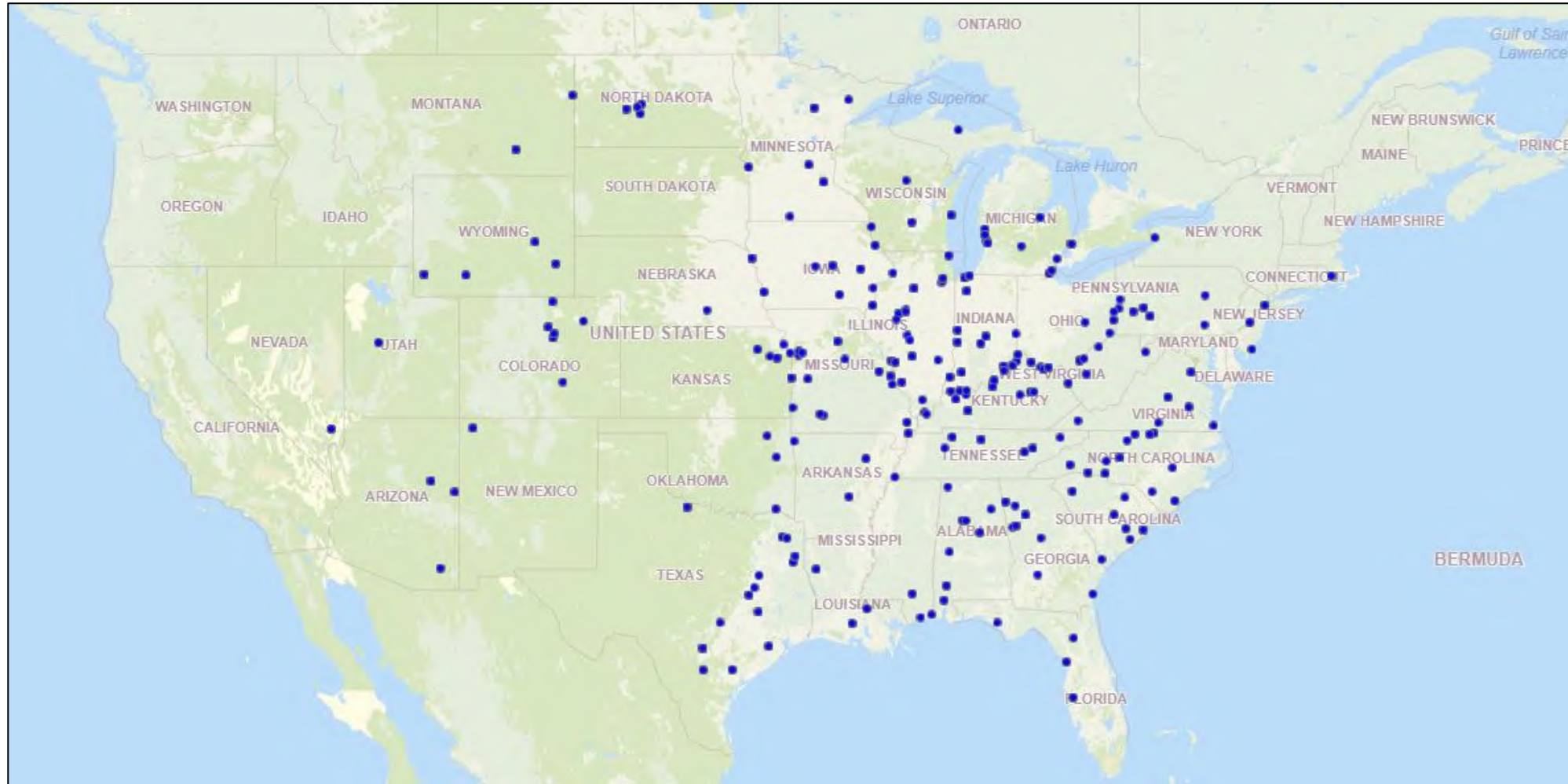
CCR by the Numbers

- 506 CCR SI
 - 407 Existing SI
 - 99 Inactive SI
- 236 CCR LF

~742 CCR units

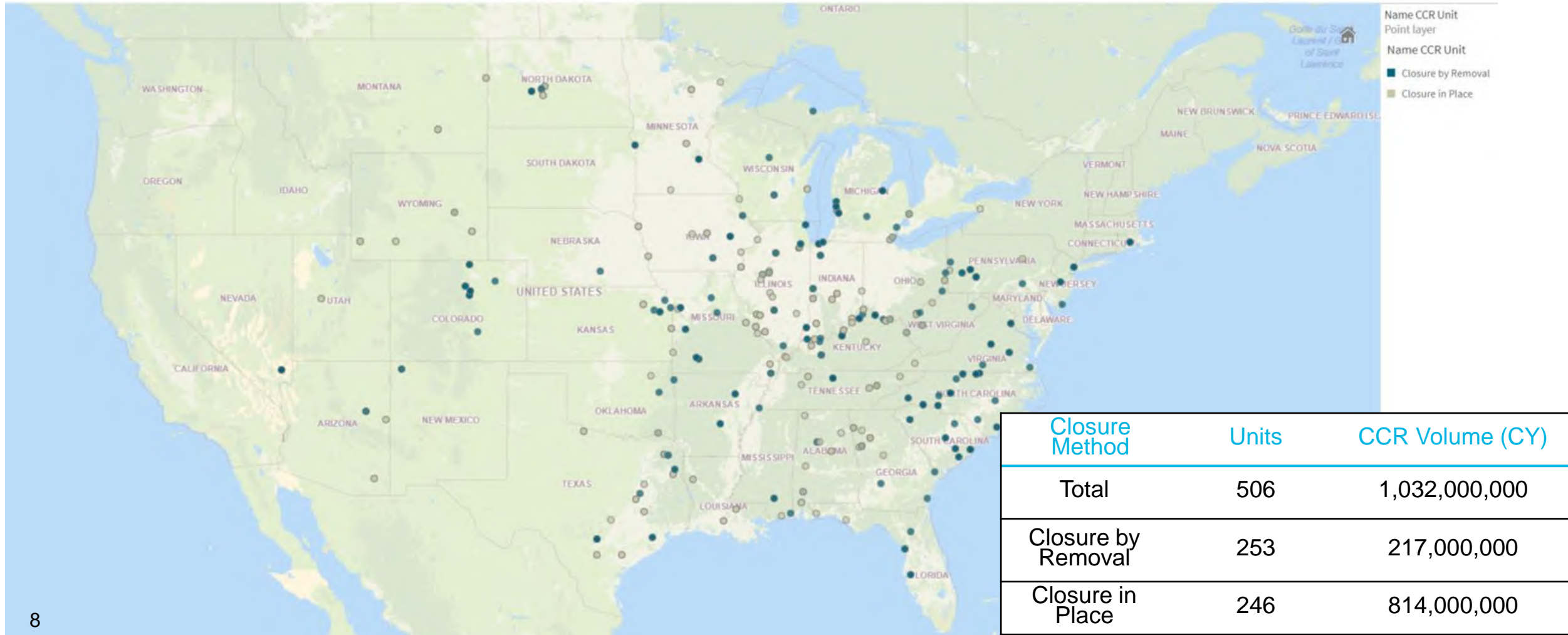
- 1.20B CY LF
- 1.03B CY SI

~2.2B CY CCR



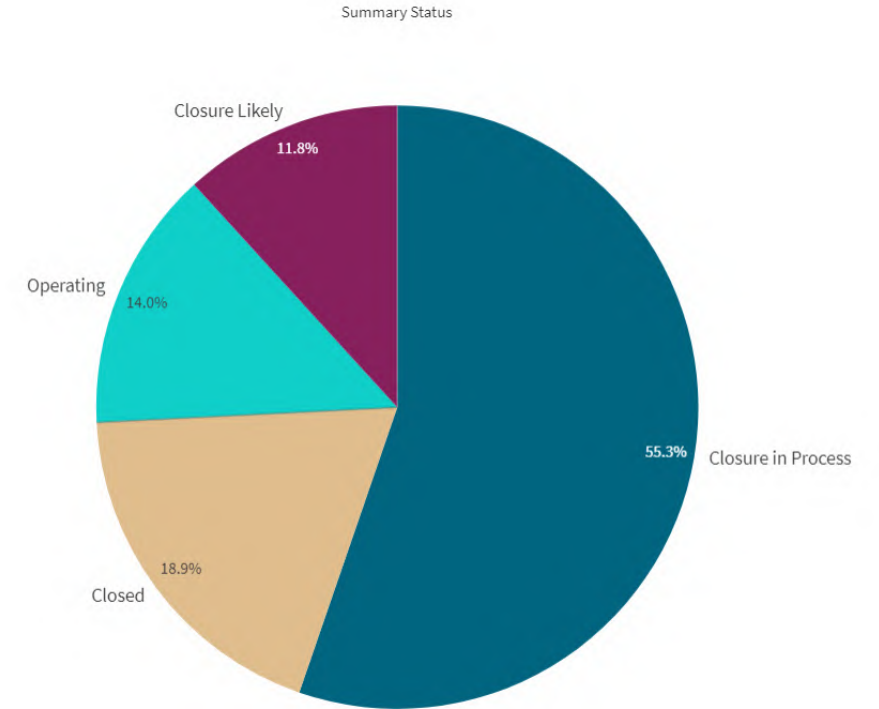
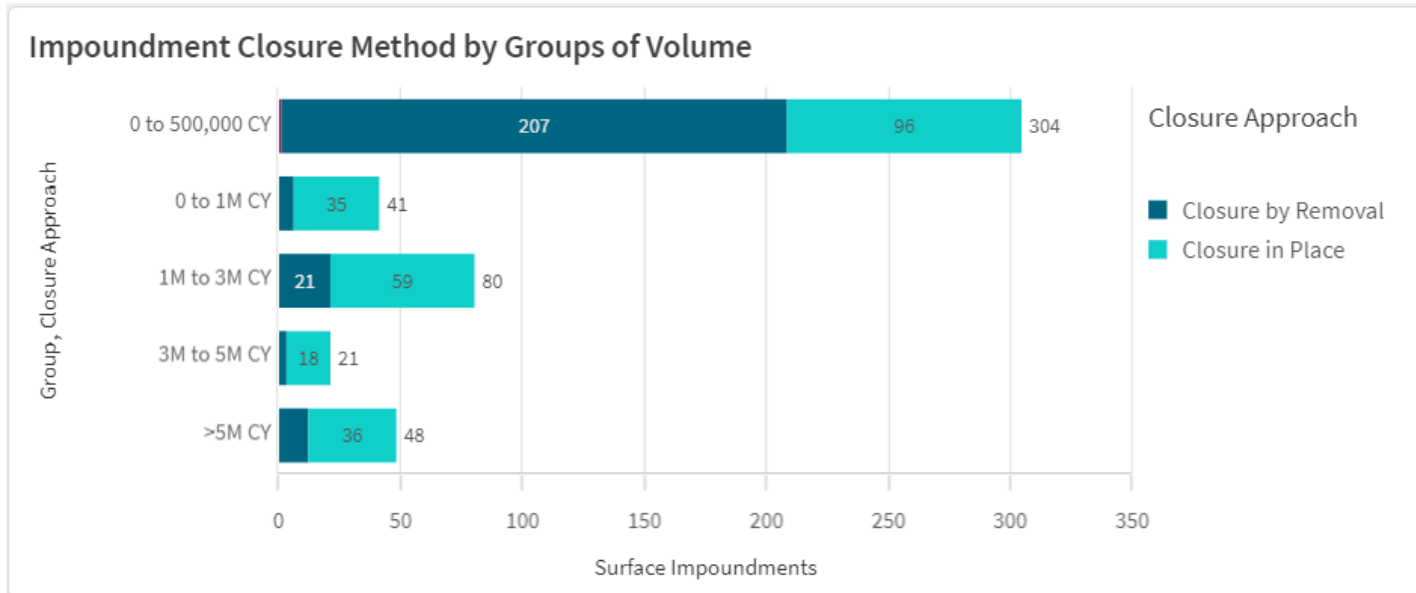
Industry Pond Closure Trends

Surface Impoundment Closures



Industry Pond Closure Trends

Existing SI Closure Method Summary (407 Impoundments)

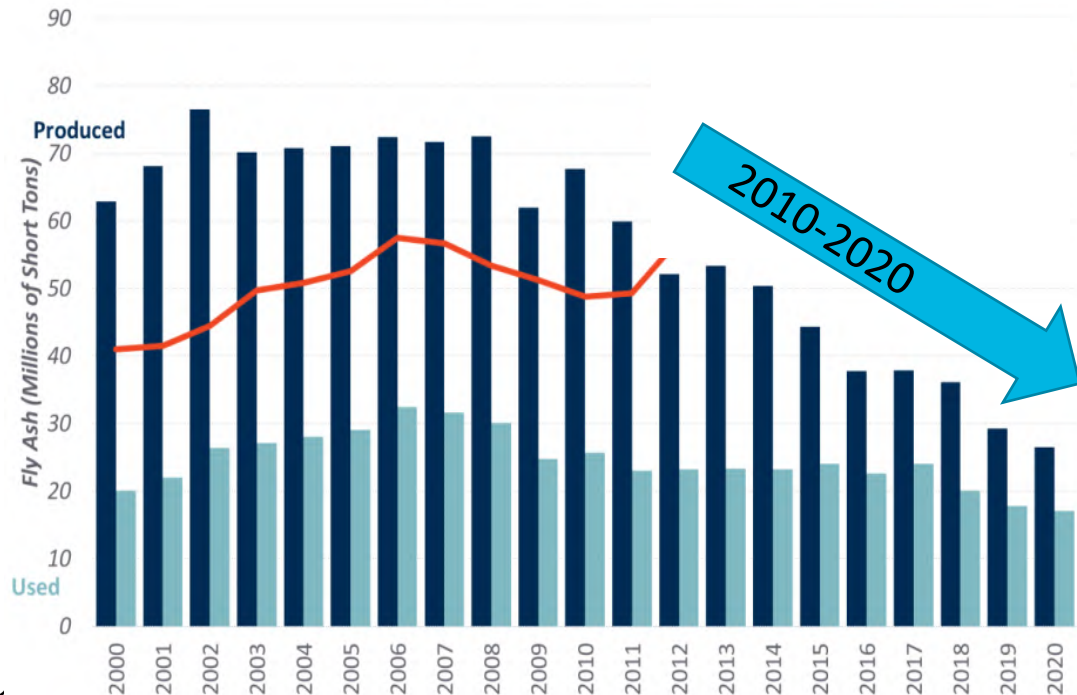


- 21% CBR (by Volume) and increasing
- 4,500+ acres CBR (by Area) and increasing
- 227 Existing SI's in process of closure (56%)

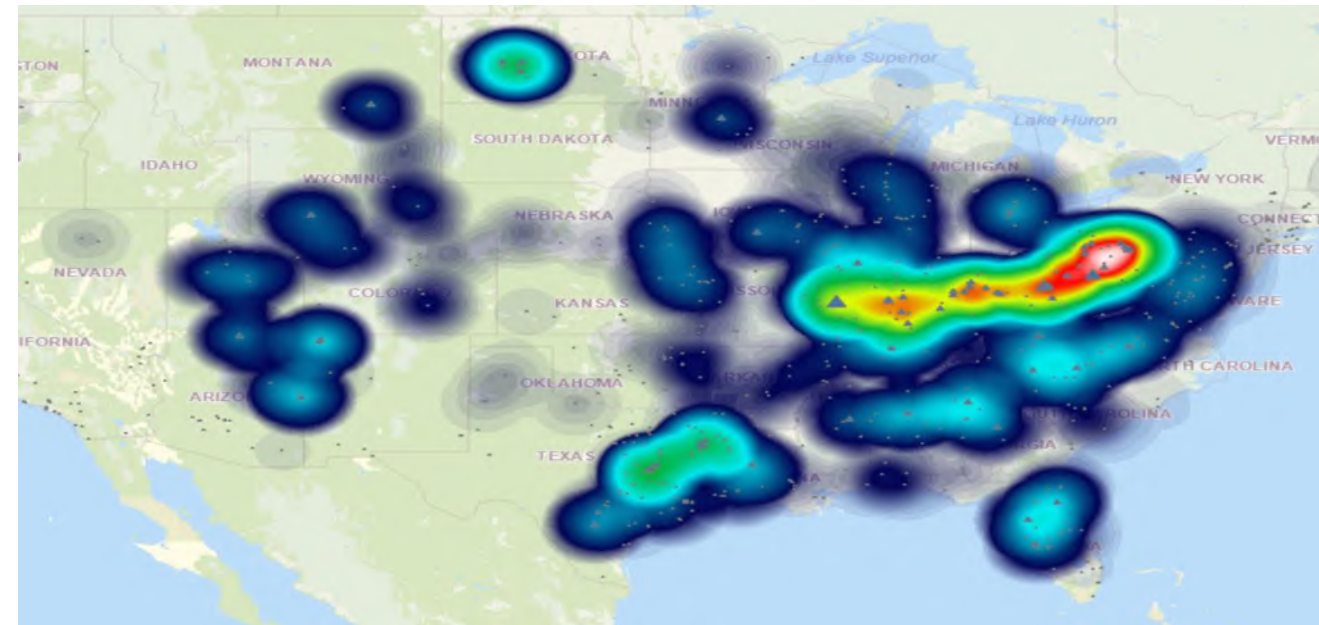
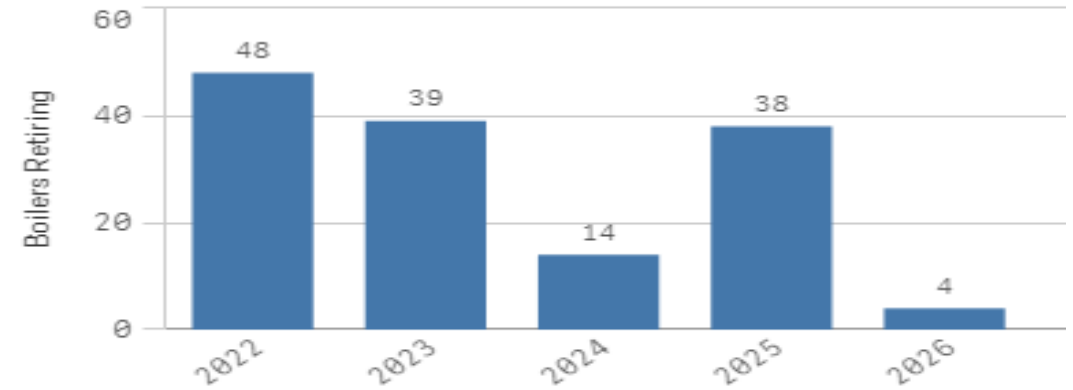
CCR Decline in Production

- From 2022 to 2026, we believe:
 - 140+ boilers are retiring at 91 plants
- Fly Ash Production reduced by 40M Tons from 2010-2020. Average of 4M Tons/Yr

Fly Ash – Production and Use



Boiler Retirement Plans

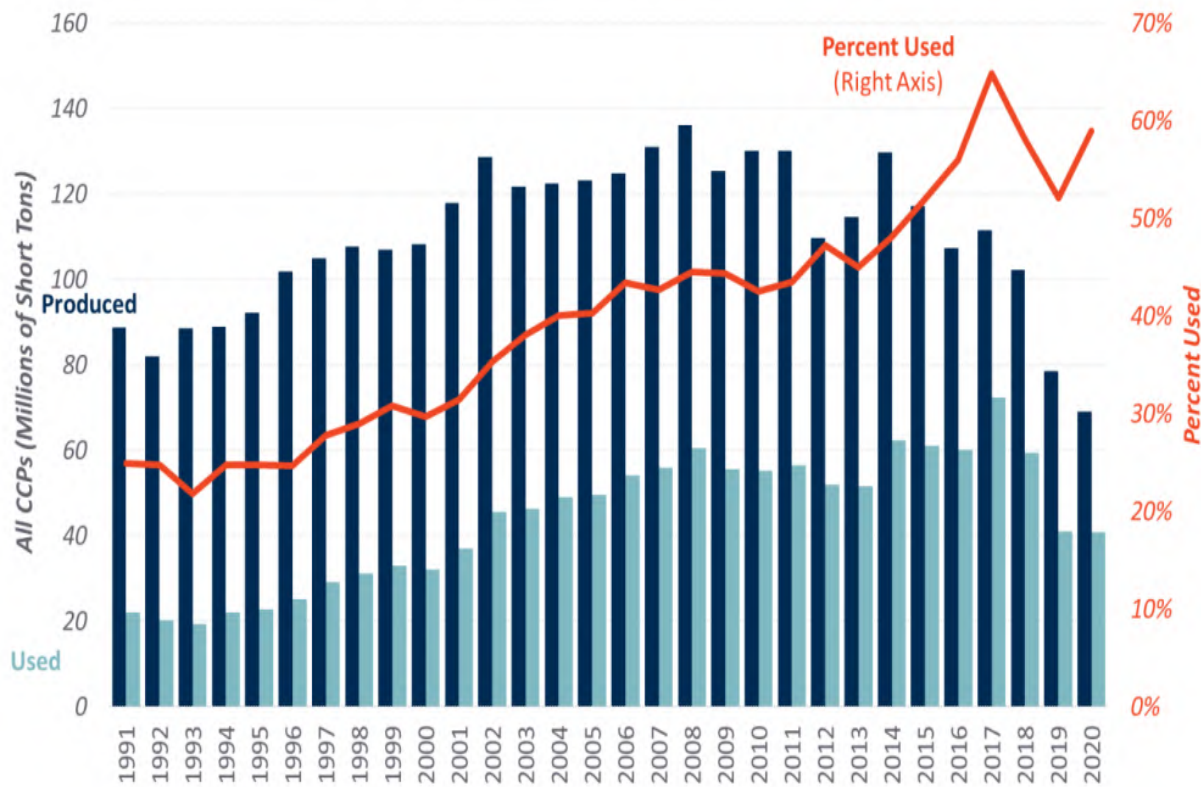


2018 CCR Production View of the U.S.

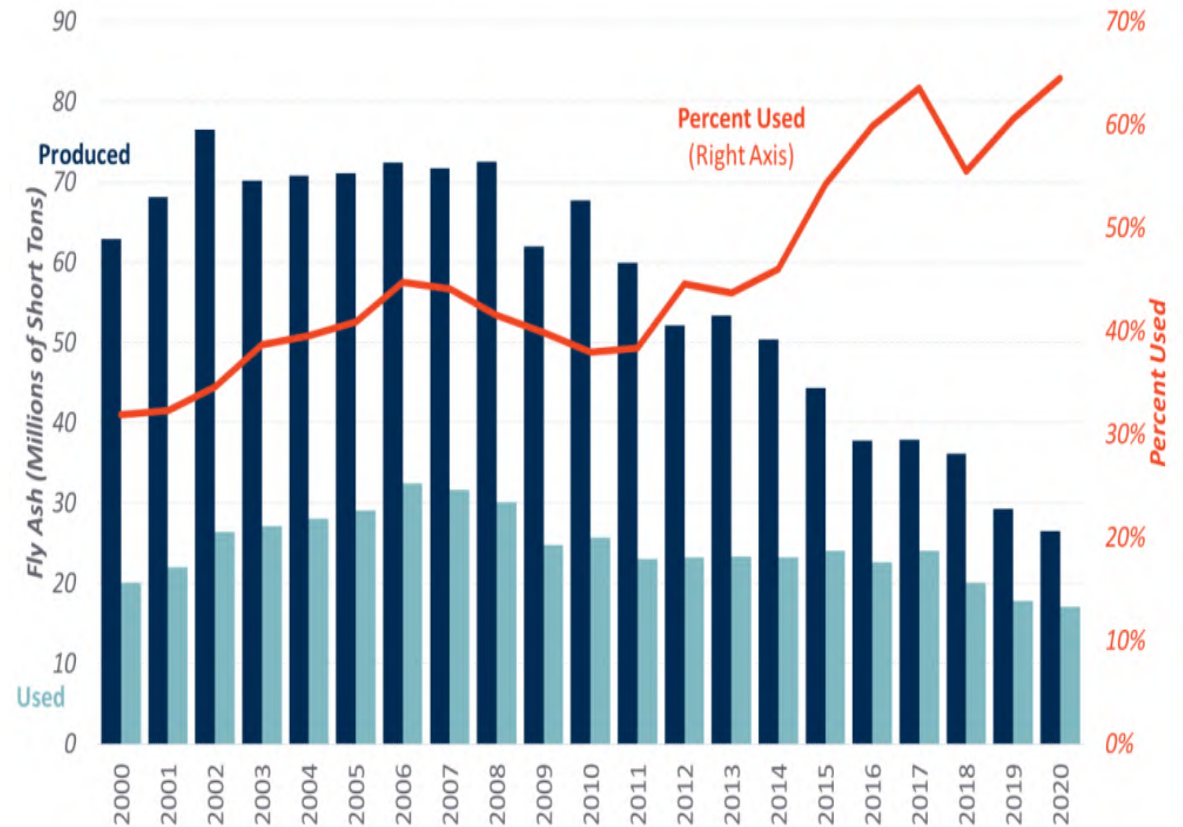
CCR Utilization in Beneficial Use

- CCR production continues to decline, while BU utilization remains around 60%

All CCPs Production and Use with Percent Used



Fly Ash – Production and Use

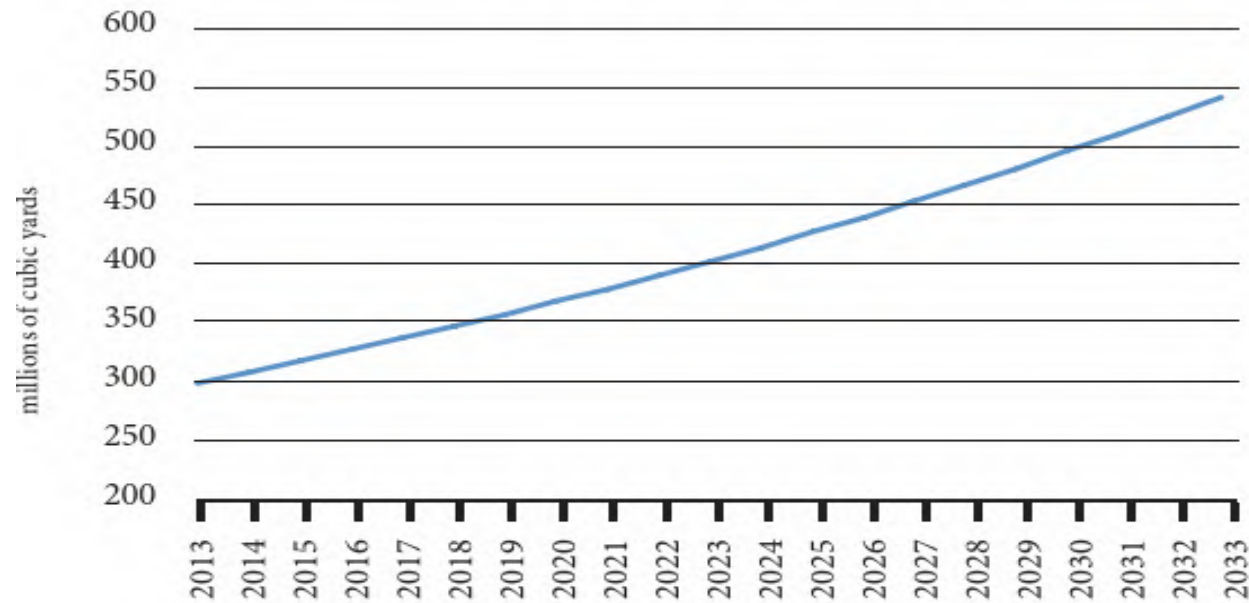


Note: Graphs obtained from ACAA

CCR Utilization and Concrete

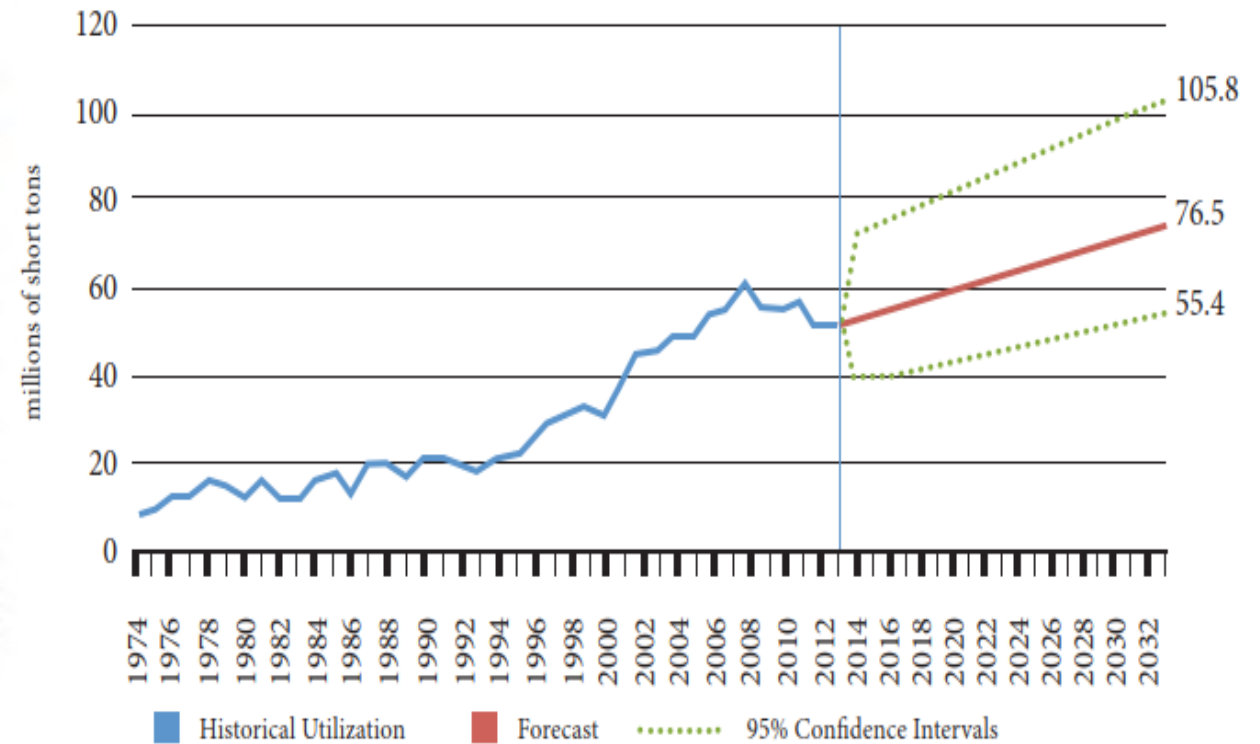
- Excluding the Pandemic, Ready Mix Concrete Demand Continues to Rise, Driving Fly Ash Utilization at a 20-30% Utilization Rate

FIGURE E-3: PROJECTED DEMAND FOR READY-MIXED CONCRETE WILL HELP DRIVE CCP UTILIZATION



Note: Graphs obtained from ACAA

FIGURE E-4: TOTAL CCP UTILIZATION IS EXPECTED TO INCREASE BY 48 PERCENT

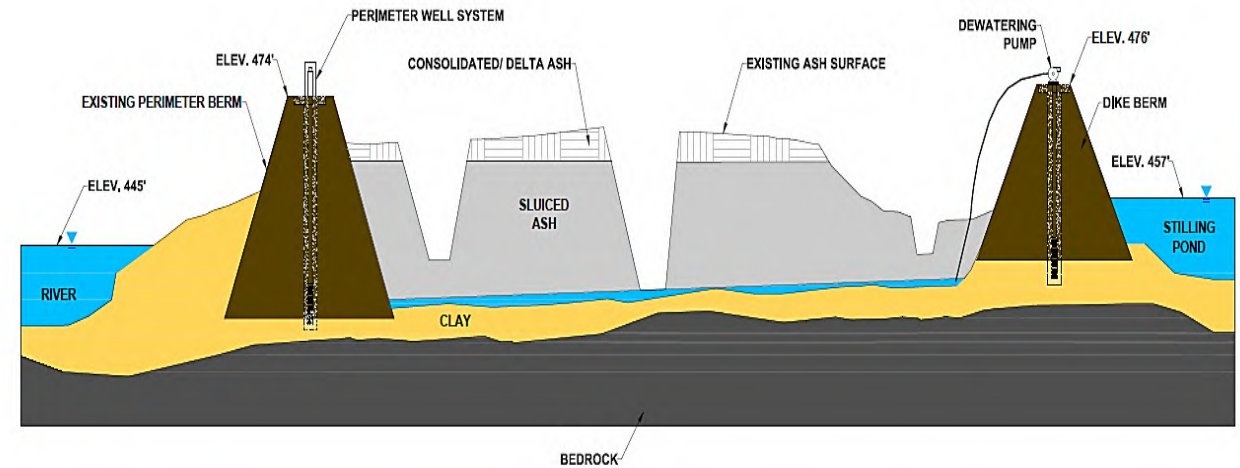
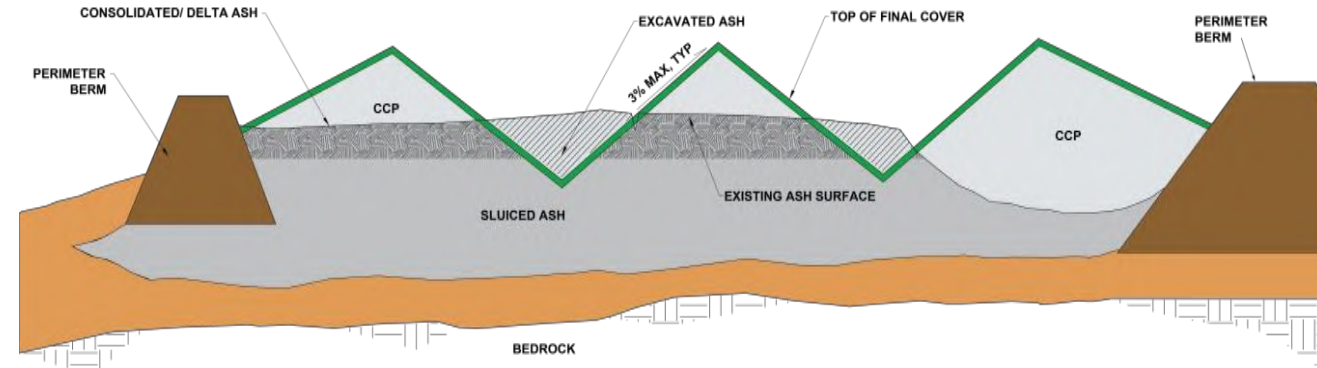


Defining the Right Application



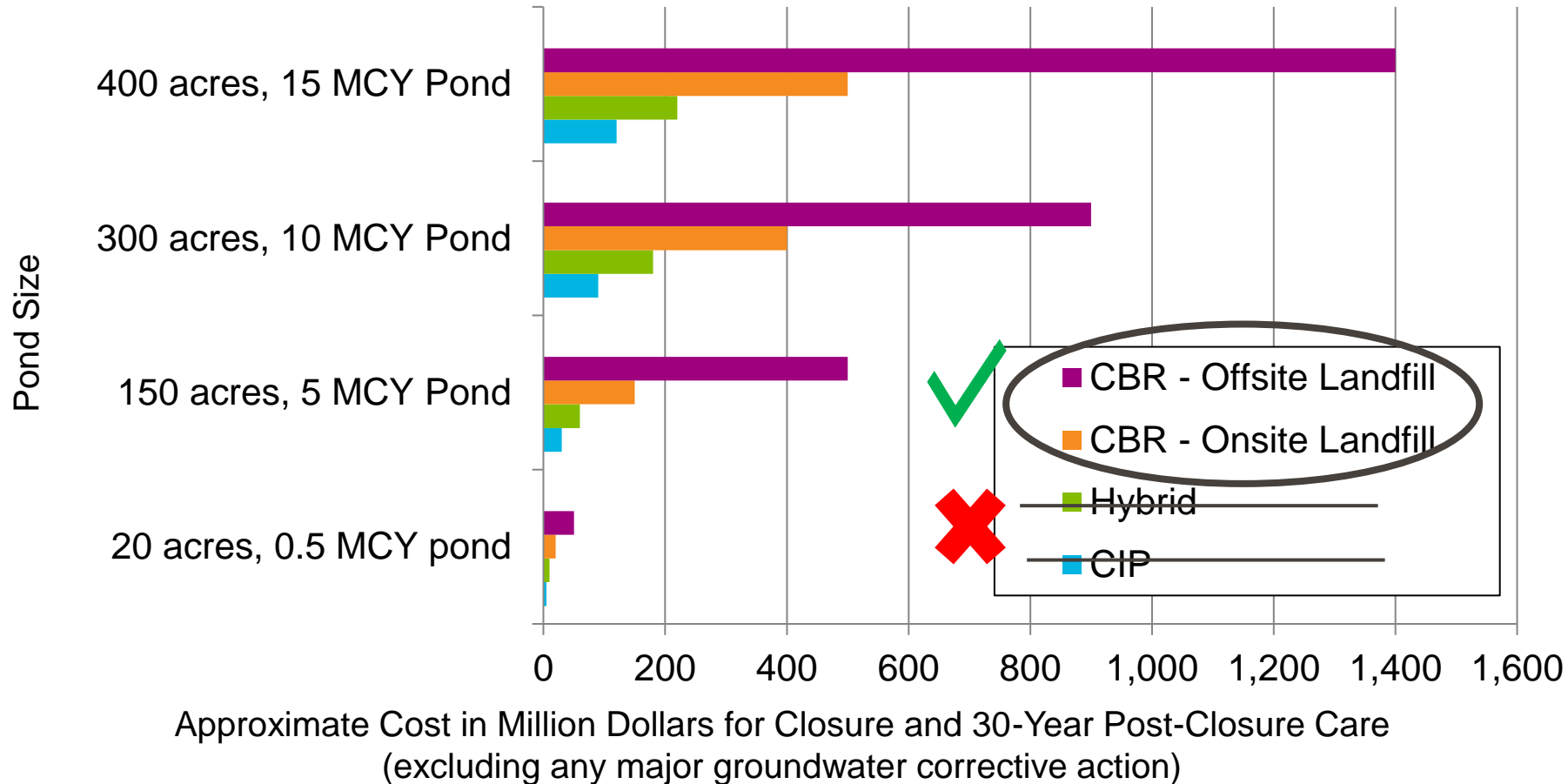
The Right Application

- Closure Method
CIP? CBR? Hybrid?
- Quantity of Material
How much? Access? Staging?
- Quality of Material
Is it uniform? Is it useable? Can it be made useable?
- History of Material
Variability? Precedence?
- Beneficial use Logistics
Local /regional users, transportation logistics
- Value vs. Disposal



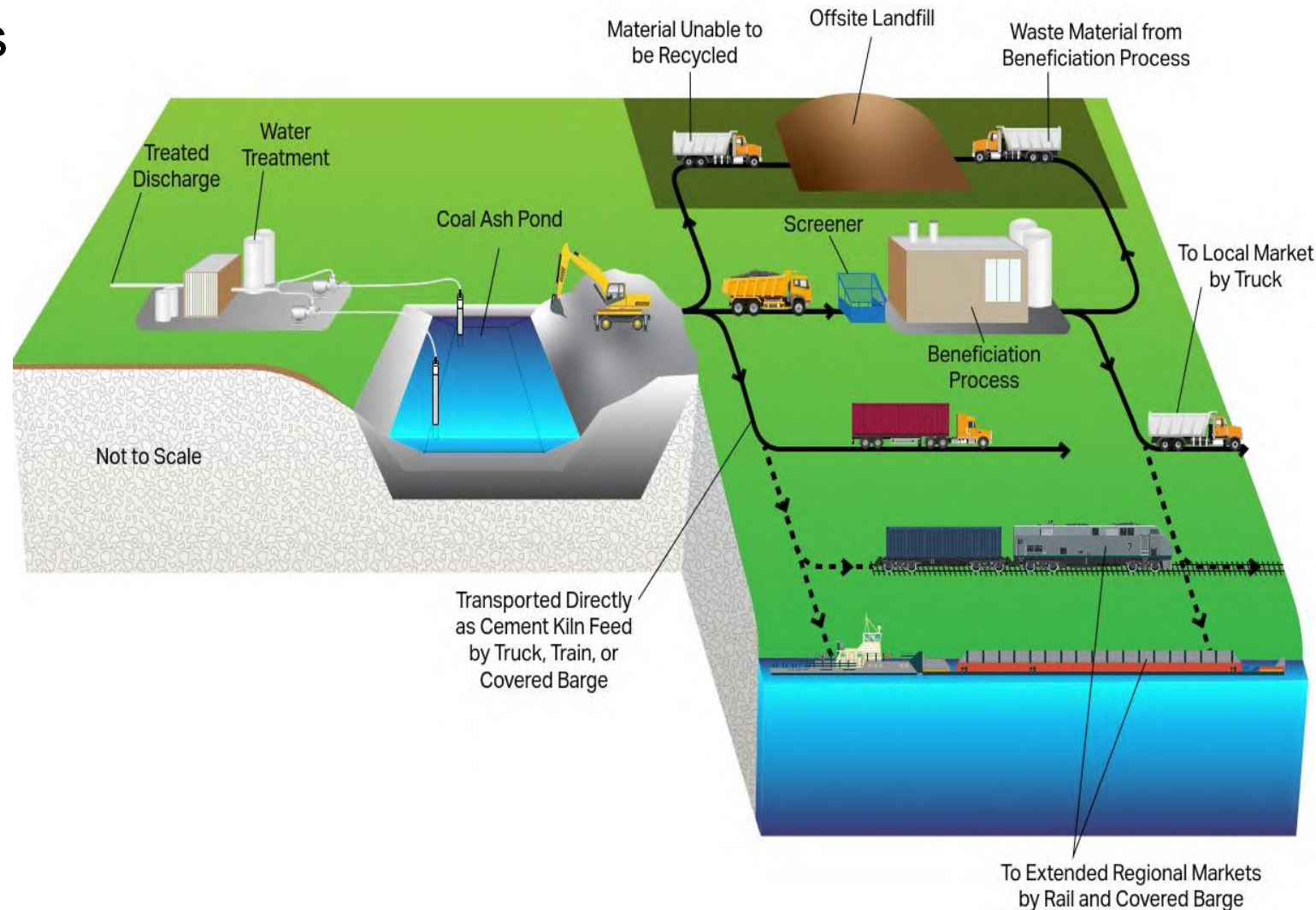
Preferred Applications

- Preferred closure applications typically include CBR with on-site or off-site landfill, due to large capital investment compared to CIP and Hybrid



Conveyance Options

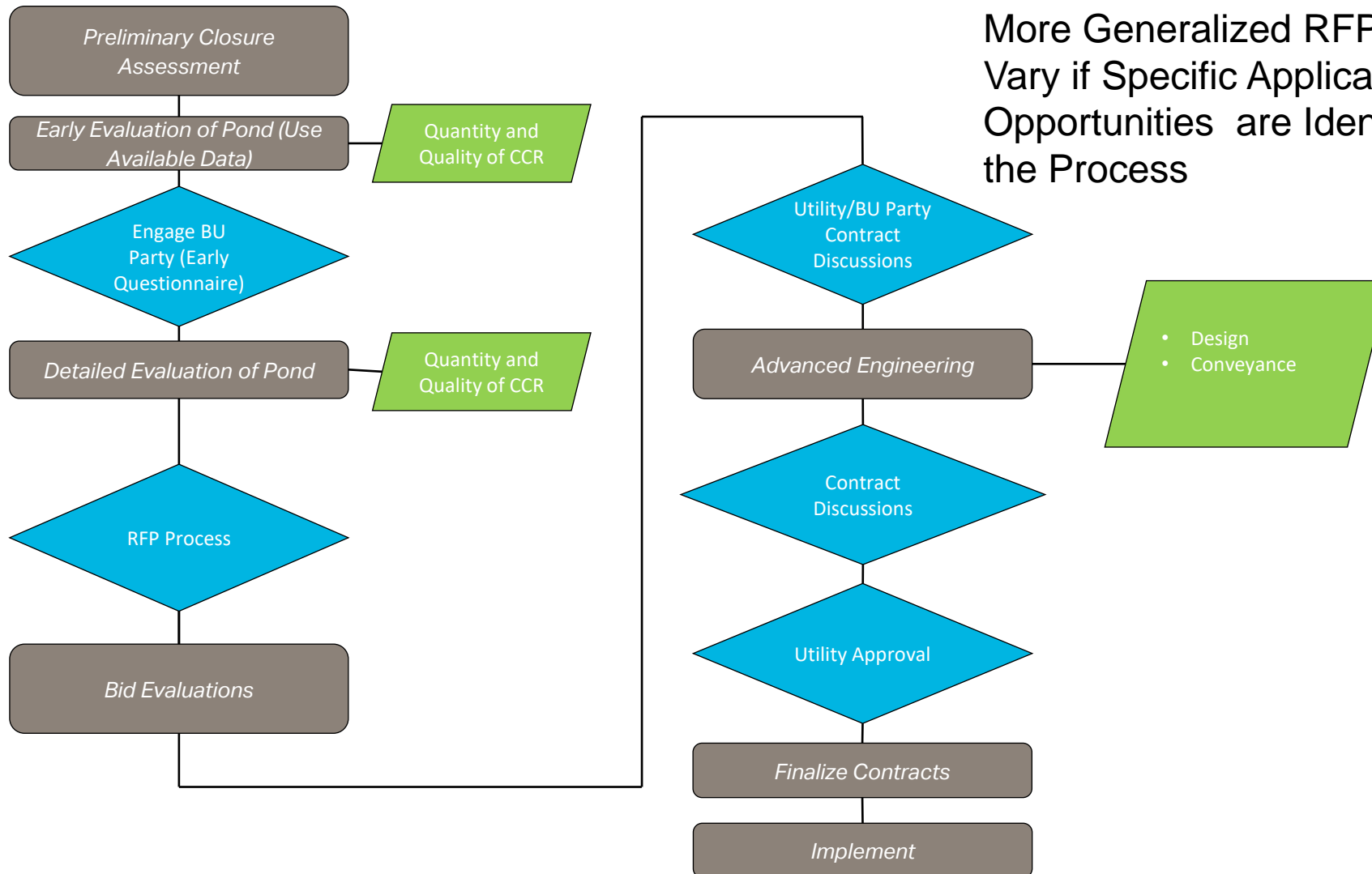
- Multiple Conveyance Options
 - Truck, rail, barge
 - Consider (1) Conveyance, (2) Storage, and (3) Emergency
 - Consider disruptions to intended operation
- Tied to Historic Coal Delivery Methods
- Site Specific Permit Restrictions
- Manage risk and maintain compliance



Getting Started

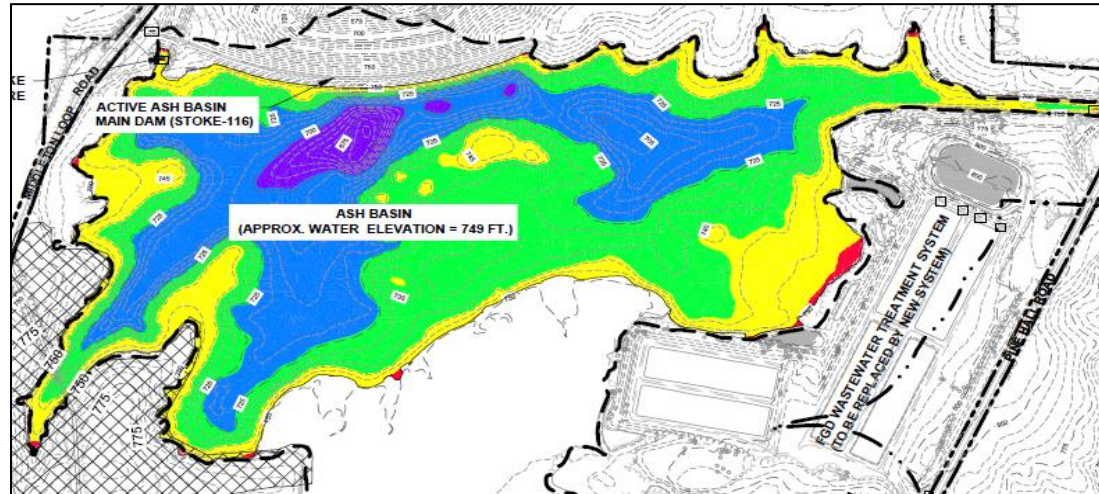


First Steps

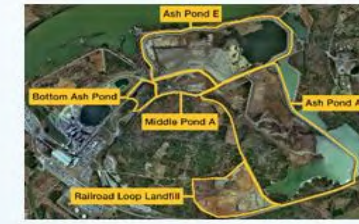


Initial Site Screening

- Historic Topo and As-Builts
- Volume Estimates
- Material Properties
- Production Material Database/Historic Use Can be used instead of ponded ash properties
- Utility Mapping



History of Construction Timeline



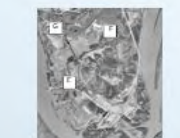
Pond A Spillway Improvements, Outer View Post-Construction, 2014



2015 Aerial Photo



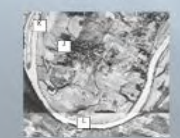
2008 Aerial Photo



1997 Aerial Photo

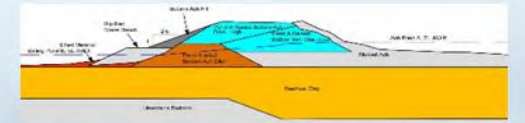


1971 Aerial Photo



1951 Aerial Photo

2016	A	TVA lowers the water surface elevation (WSE) in Ash Pond A by 5 feet and installs wave-wash protection in Ash Pond A to lowered water surface elevation. The pond's spillways are modified to maintain the lower WSE. TVA temporarily diverts the coal yard runoff ditches to Ash Pond A, to allow for similar modifications in Ash Pond C.
2014	B	In 2014, improvements were made to the divider dike including re-grading the downstream face of the Ash Pond A divider dike to a 2.5% slope.
2012	C	Ash Pond A was lowered by 2 feet in 2012 for an estimated 30% reduction in free water compared to 2006. New spillways are added to increase storm flow capacity and serve as primary spillways. Existing spillways are established for use as secondary spillways during storm events.
2010	D	In 2010, pond operations are modified to increase retention time. Ash Pond A receives bottom ash and fly ash dikes streams, while Ash Pond E receives only non-COI wastewater.
2008	E	Pond operations are modified to improve wastewater treatment in 2008. Bottom ash is discharged to Ash Pond A, and fly ash is discharged to Ash Pond E.
2005	F	In the early 1990s, dikes were constructed to separate Middle Pond A and Bottom Ash Pond.
1990	G	In 1990, a dike hole is repaired in the south side of Ash Pond A.
1988	H	In 1988, spillways are constructed for Ash Pond A. Also, the divider dike between Ponds A and C is raised to about 872.
1978	I	In 1978, divider dikes are constructed to create filling ponds. The dikes create a Pond Complex consisting of Bottom Ash Pond A, Fly Ash Pond C, and Stilling Ponds B, C, and D. These dikes are raised over time to increase pond storage capacity.
1970	J	Dikes A, B, and D were constructed to an elevation of 602 feet in 1969, and Ash Disposal Area 3 began operation in 1970.
1957	K	Galbath begins operation November 1955 with the first of four turbo-generating units. The second and third units begin operation in 1957, and the first and fourth units began operating in 1959.
1954	L	Construction of Galbath Coal Plant includes initial embankments for three ash disposal areas, including Ash Disposal Area 3, which include the area that now Ash Pond A, Middle Pond A, and the Bottom Ash Pond.
1953	M	Construction of Old Hickory Dam is completed in June 1954. The dam raises river elevations approximately 40 feet by 1957.
1951	N	Construction of Galbath Coal Plant begins in 1951.



Typical Ash Pond A Dike Cross Section



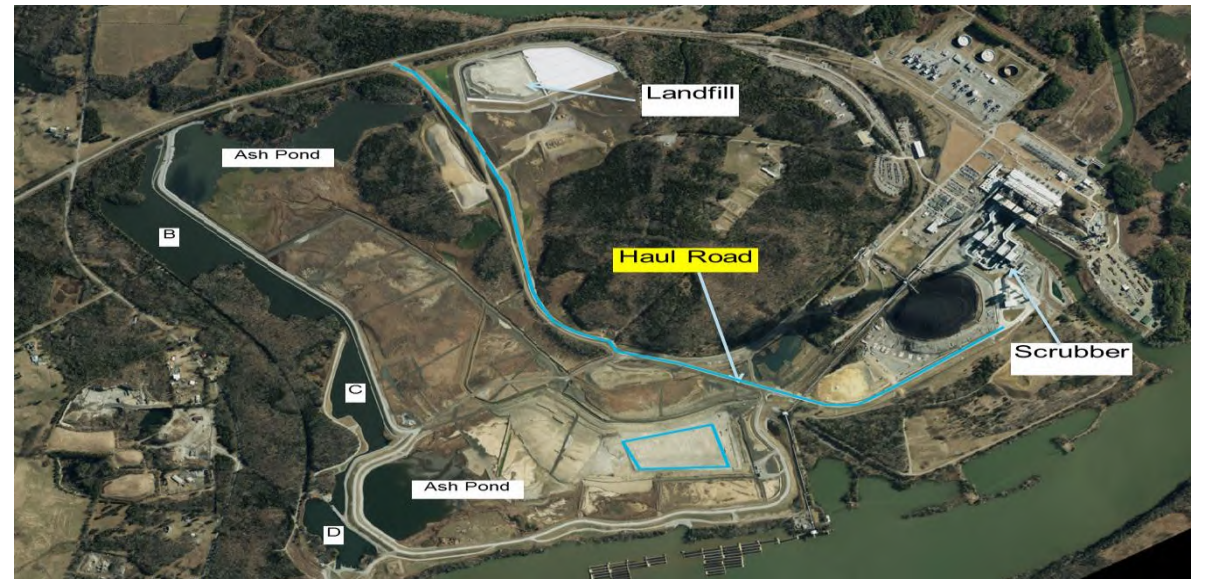
2004 Ash Disposal Area 3



Pond A Divider Dike Improvements, 2014

Early Evaluation

- Identify designated BU location (10-15 acres)
- Identify overall path (includes staging, transfer points, condition of CCR, etc.)
- Early questionnaires to the market may produce clear preference for sampling parameters



Ash Sampling

- Representative ash sampling and analysis
 - 1 boring per 5 to 10 acres (typical for screening)
 - DPT and Sonic Rig Sampling
 - Avoidance of Pool/Soft Areas
 - Specialized Equipment/Pads
 - Liners and Pond Bottom Considerations
 - Composite samples every 5 to 10' depth (typical for screening)
 - Chemical and physical analyses consistent with ASTM C618 (For Fly Ash), Can vary depending on application

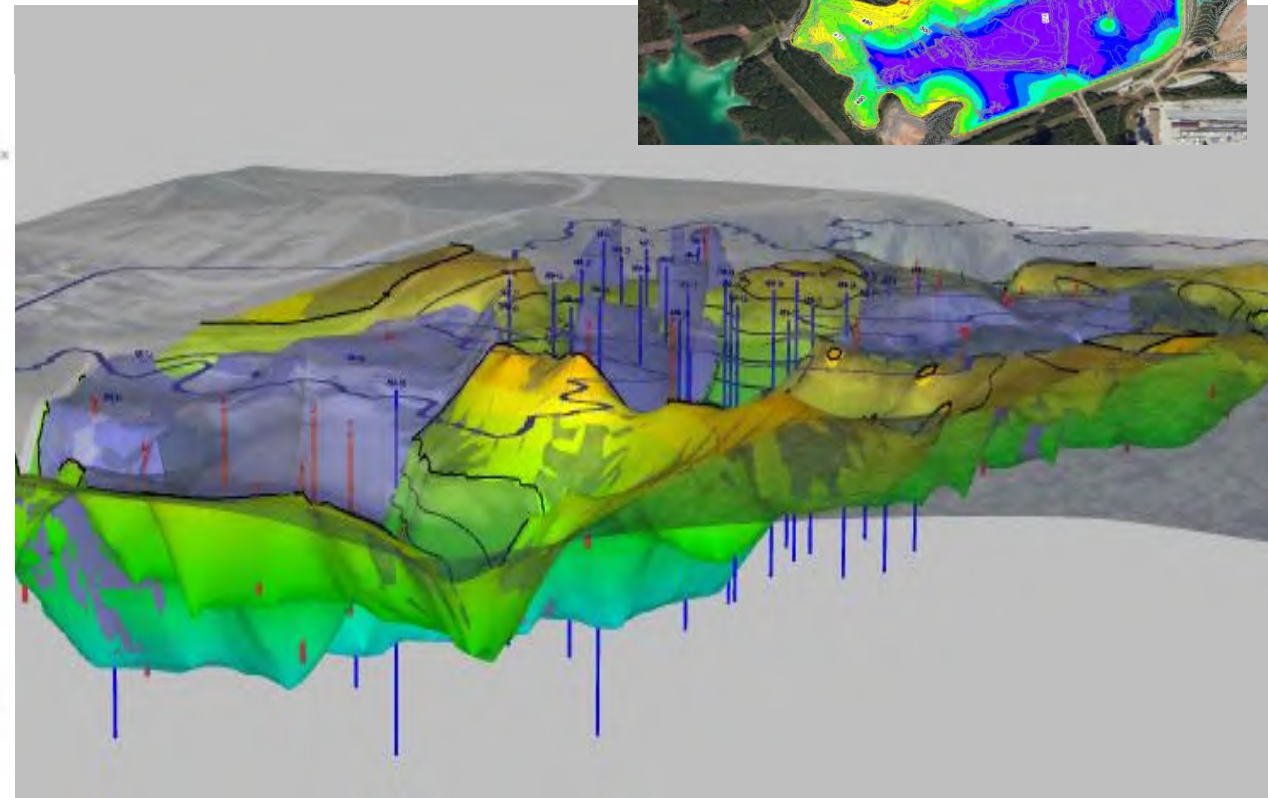
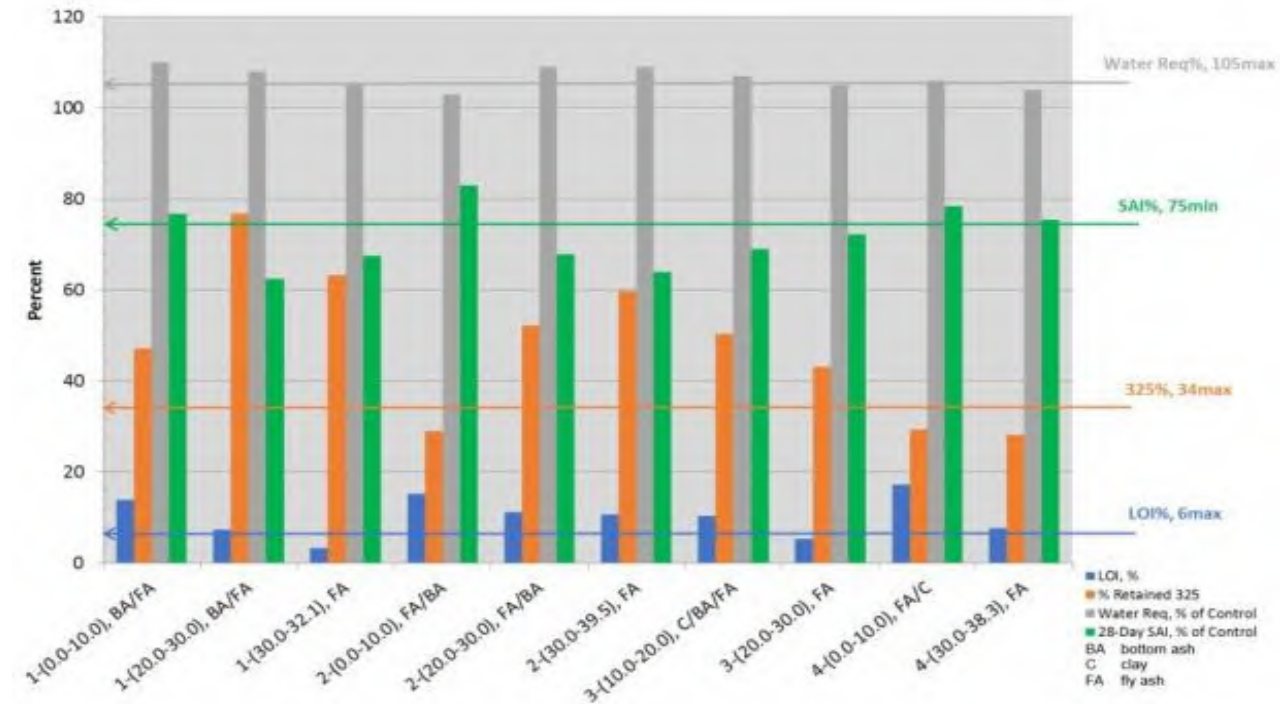
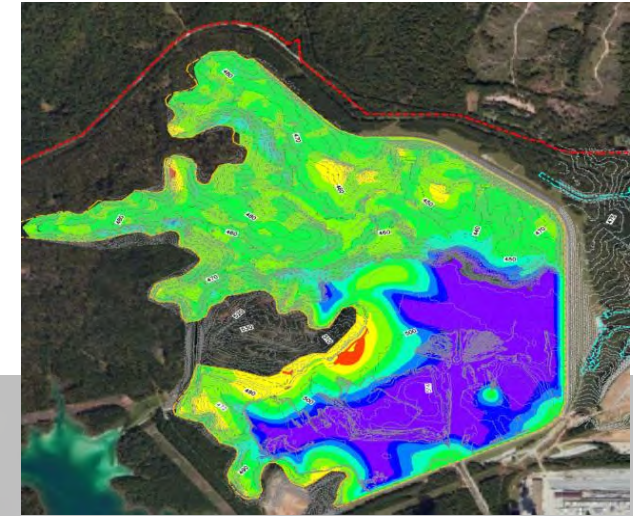


Parameter	Subparameter	ASTM C618 or ASTM C40 Criteria for Class F Ash
Chemical	Sum SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , wt%	Min 70%
	CaO, wt%	Class F Max 10%
	SO ₃ , wt%	Max 5%
	Moisture, wt% as received	Max 3%
	Moisture, wt% further processing	Max 30% ⁽¹⁾
	Moisture, wt% dried	Max 3%
	LOI, wt%	Max 6%
Physical	Soundness	Max ±0.8%
	% retained on #325 mesh	Max 34%
	Water required, % of control	Max 105%
	7-day SAI, % of control ⁽²⁾	Min 75%
	28-day SAI, % of control ⁽²⁾	Min 75%
	Organic impurities (color plate #)	Max #3

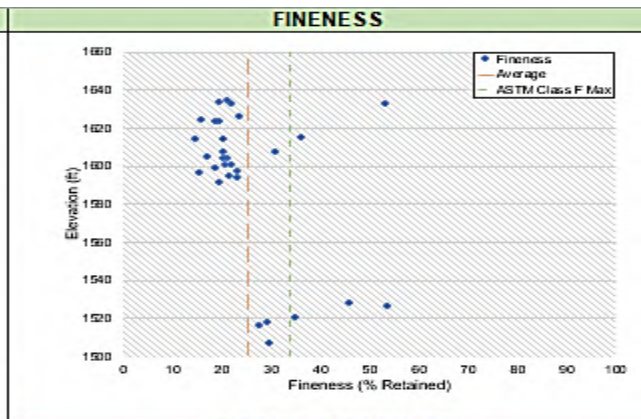
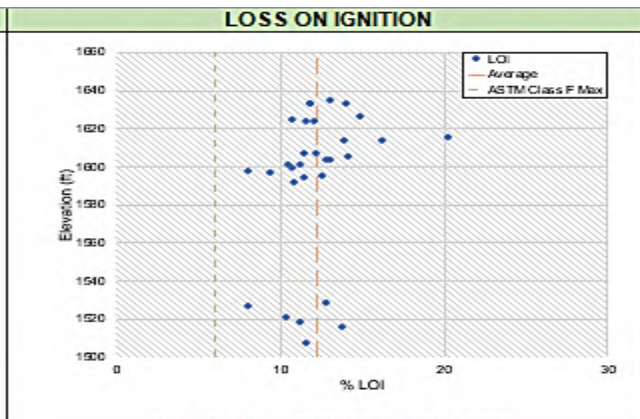
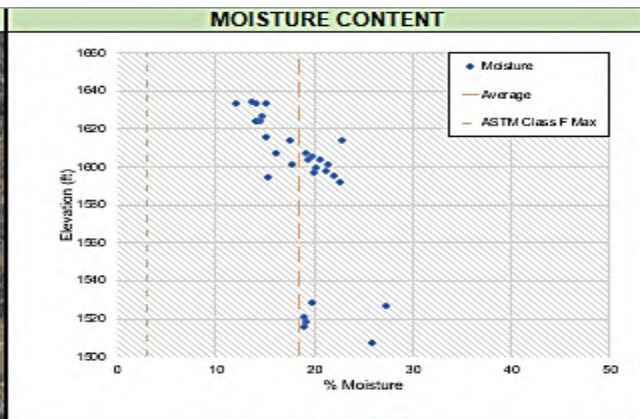


Ash Characterization

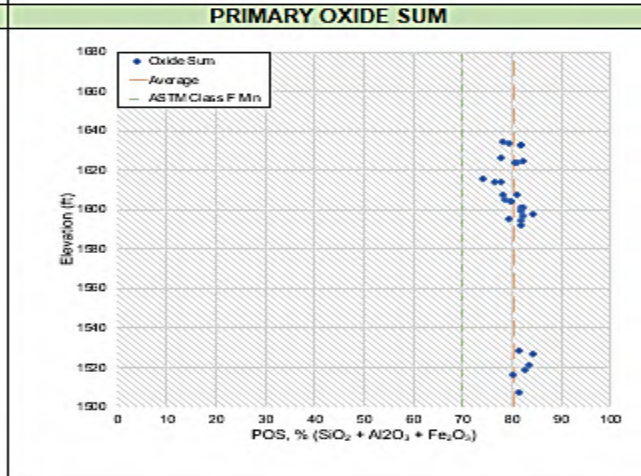
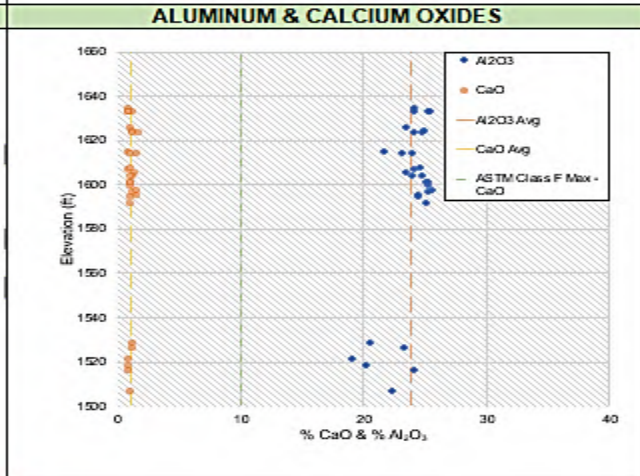
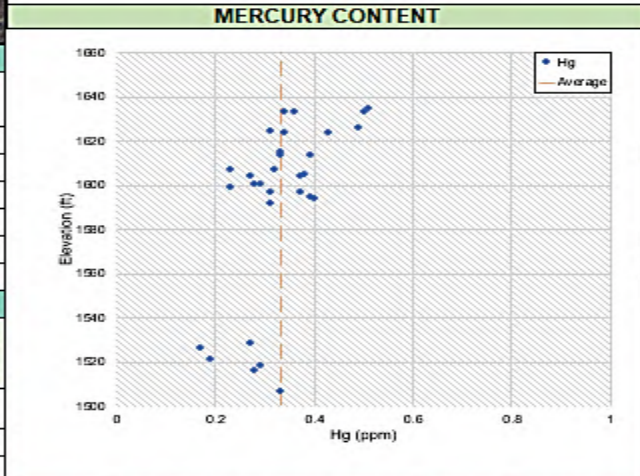
- Creating Isopach and Surface Maps for the CCRs
- Evaluate Results and Suitability
 - Comparison to Technology Requirements
 - 3D Visualization Tools
 - Prepare Dashboard



Ash Characterization - Dashboard



SITE & SAMPLING INFORMATION									
Location(s) on site									
Approx. Area (AC) / Volume (CY)	65 / 6,756,205								
Number of Borings	14								
Sample Elevation Range (ft)	1497.2' - 1637.9'								
Number of Samples Collected	41								
Number of samples tested	<table border="1"> <thead> <tr> <th>Moist.</th> <th>LOI</th> <th>Fine.</th> <th>Oxide</th> </tr> </thead> <tbody> <tr> <td>30</td> <td>30</td> <td>30</td> <td>30</td> </tr> </tbody> </table>	Moist.	LOI	Fine.	Oxide	30	30	30	30
Moist.	LOI	Fine.	Oxide						
30	30	30	30						



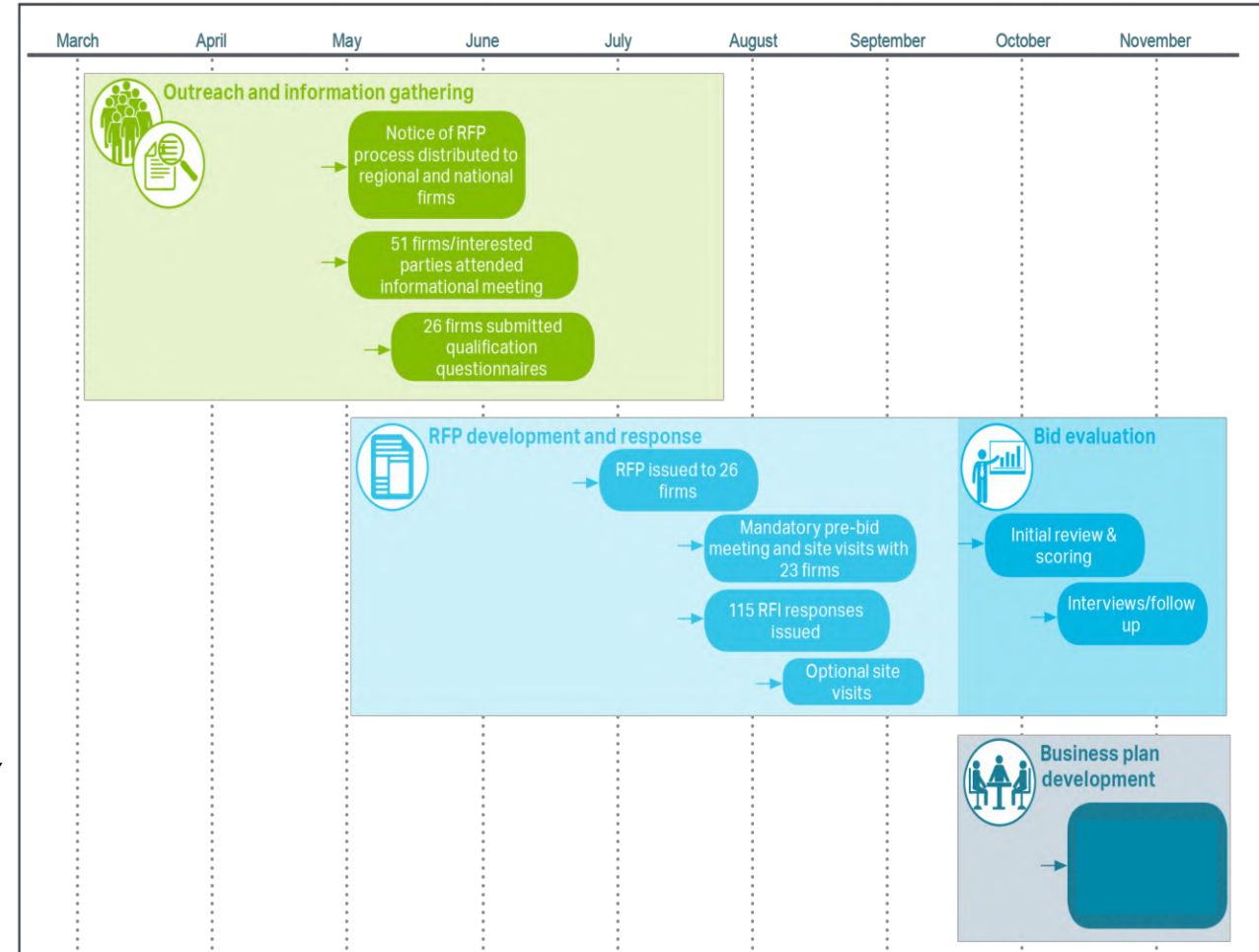
ASTM C618 CLASS F FLY ASH PROPERTIES				
Parameters	Subparameters	ASTM C618 or ASTM C40 Criteria	* Sample Meeting Strd.	* Sample Not Meeting Strd.
Chemical	Sum SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , wt%	Min 70%	30	0
	CaO, wt%	Class F Max 10%	30	0
	SO ₃ , wt%	Max 5%	30	0
	Moisture, wt% as received	Max 3%	0	30
	Moisture, wt% dried	Max 3%	0	30
	LOI, wt%	Max 6%	0	30
Physical*	Soundness	Max +/- 0.8%	20	0
	% retained on #325 mesh	Max 34%	25	5
	Water required, % of control	Max 105%	20	0
	7-day SAI, % of control	Min 75%	19	0
	28-day SAI, % of control	Min 75%	0	0

TYPICAL PROPERTIES FOR CEMENT KILN FEED				
CCR Properties for Beneficiation		Criteria	# Samples Meeting Strd.	# Samples Not Meeting
Moisture (%)		Max 20%	20	10
Particle Size		Max 1/2"	29	1
LOI		Max Avg. 15%	28	2
Aluminum Oxide (Al ₂ O ₃)		20-30%	29	1
Silicon Dioxide (SiO ₂)		40-55%	28	2
Iron (III) Oxide (Fe ₂ O ₃)		5-15%	30	0
Hg (ppm)		<0.7	30	0



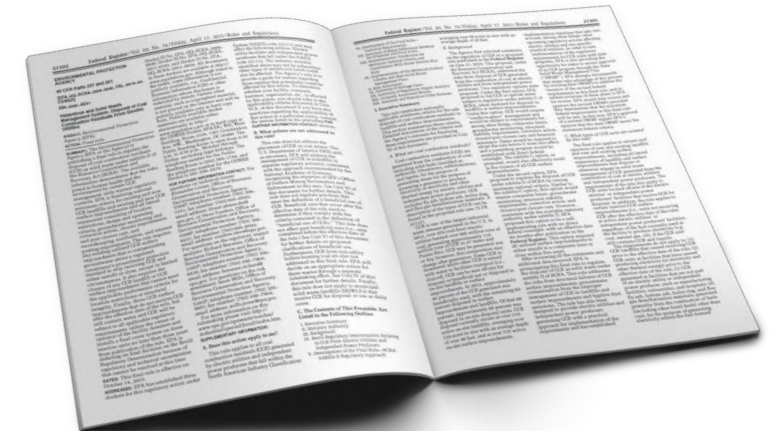
General RFP Overview

- Develop RFP package, including:
 - Quality/Quantity of material
 - Operating Conditions/Site Limitations
 - Infrastructure Improvements/Conveyance Methods
 - Harvesting Strategy (BU vs Excavating Contractor Roles)
 - As-Built Data
 - Drawing set including interpolation of bottom of pond using historic data and aerials
 - Typical RFP Documents
 - Detailed Bid Form (Excel); including total cost per Ton/CY
 - Technical Specifications, including relevant data for each site and min. requirements for BU Technologies
 - Supplemental info (T&C's, diversity, safety, financial evaluation)



RFP Considerations

- Quantity of material that will be accepted
 - Total and Annual minimum requirements
 - Assess engineering controls to achieve/improve
 - Determine engineering features to ensure no disruption of excavation (pads, etc.)
- Regulatory compliance considerations
 - Schedule
 - Permits
 - Site restrictions
 - Contact water management
- Processing and staging
 - How will processing be achieved (mechanical sorting, mixing, other), by BU or excavation Contractor
 - Where will staging occur (technical and regulatory assessments)
- Determination of point of compliance, frequency of checking
 - Who does the analysis (develop onsite lab or engage outside lab)
 - Engineering controls for point of compliance and frequency of checking
 - Approach to non-conforming materials (retest, mix, disposal)
 - If Disposal, existing on-site facility or off-site



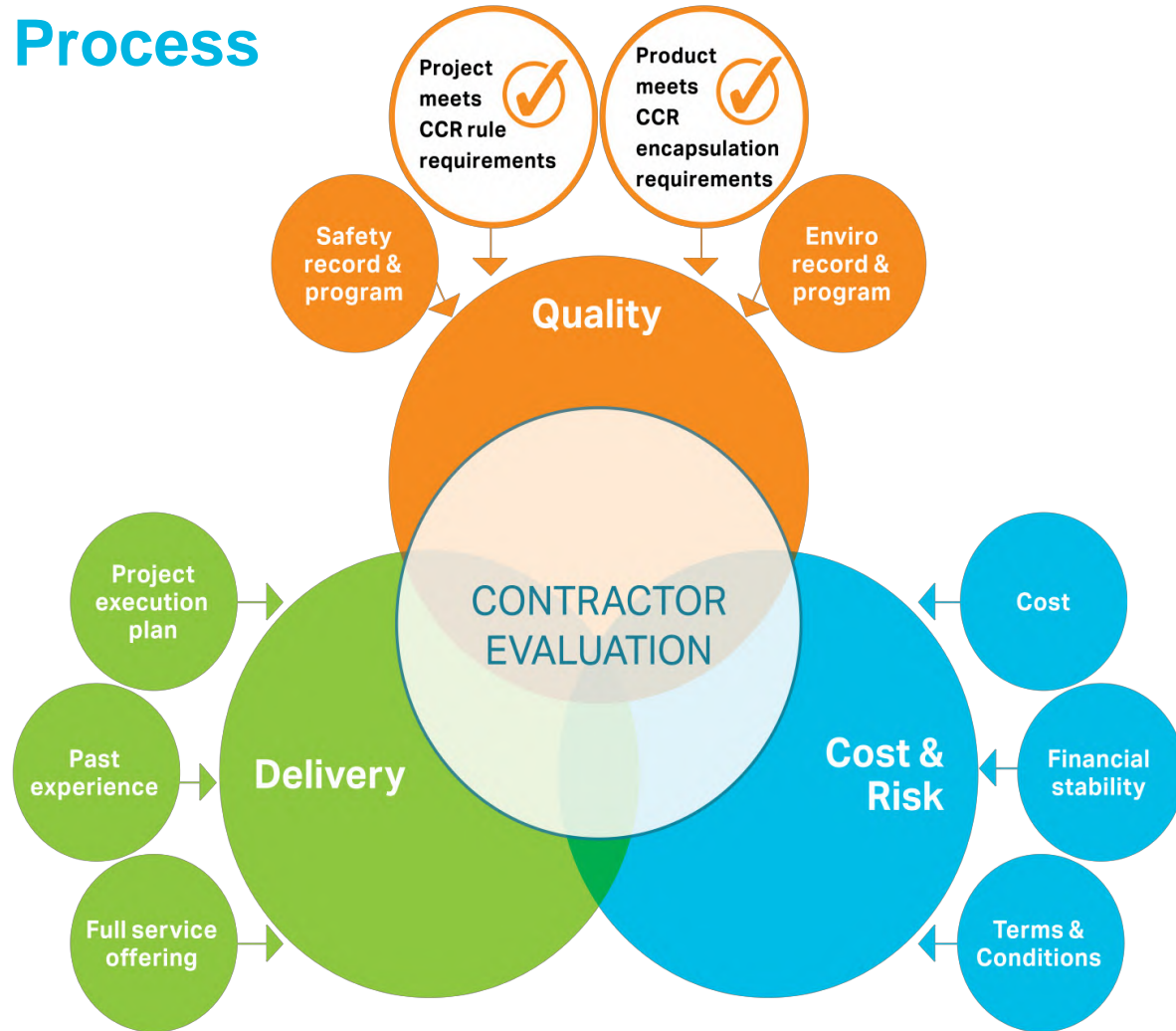
RFP Considerations

- Establishing key parameters for acceptance (quality and quantity)
 - Determine the parameters and thresholds early (and compare to site values)
 - Include location of sampling, methods of sampling, testing, timing (with respect to approval)
 - Who will be responsible for testing/reporting
- Conveyance evaluation
 - On-site and off-site conveyance considerations
 - Any limitations to truck, rail and/or barge access
 - Assess overall path on-site (includes staging, transfer points, condition of CCR, etc.)
 - Evaluate for risk mitigation and emergency planning
 - Optimize for performance (all scenarios)



Bidder Evaluation Process

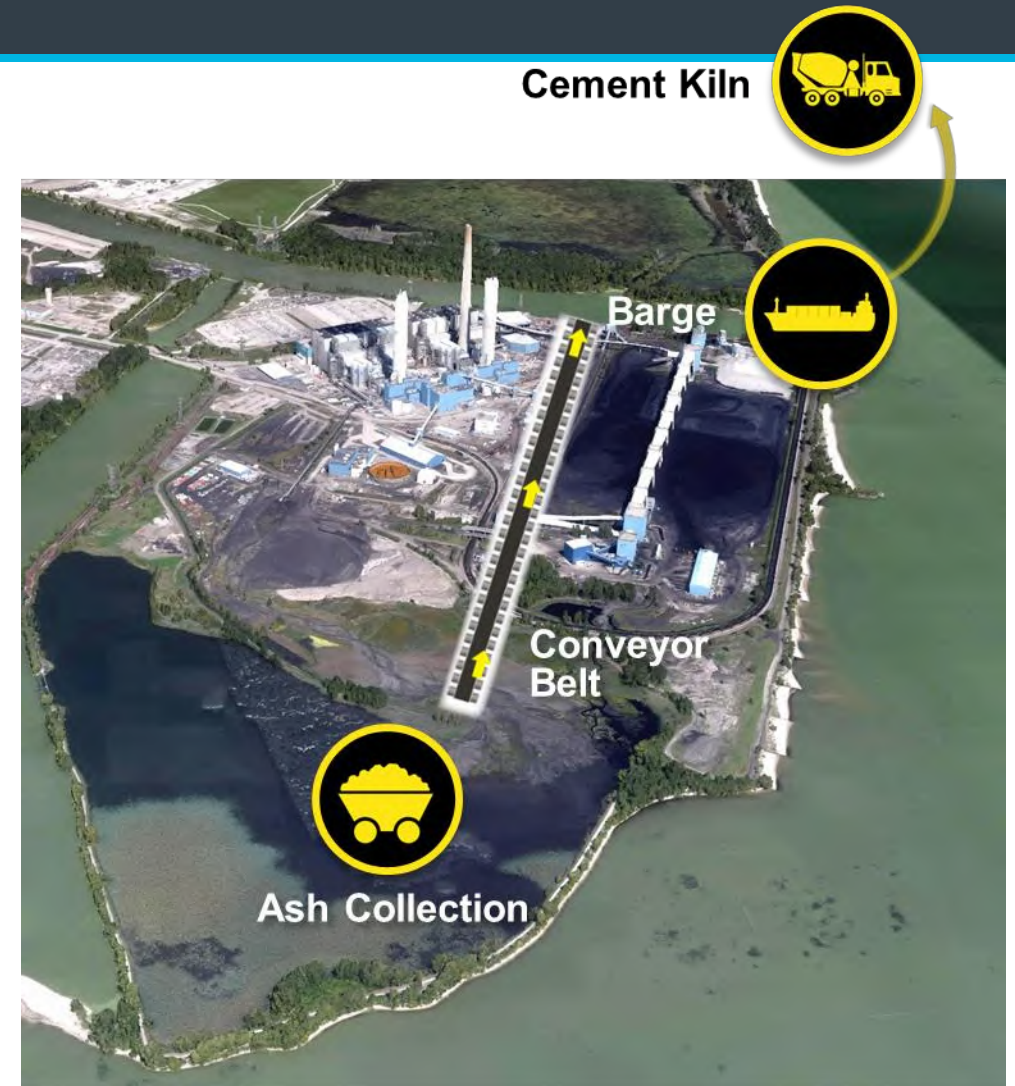
Bid Evaluation Process



Bidder Evaluation Process

Detailed evaluations of the following:

- Proposed Technology(s) – Often involves multiple for a site
- Material quality limitations (Moisture, Screening, LOI/TOC, Oxides, Metals)
- Market area and basis (Local/National)
- Transportation methods (One or multiple methods)
- Conversion and waste factors (Tons per CY - 1.1 to 1.3 Typical), (Waste – 10% to 35% Typical)
- Start-up and commissioning timeline (Typically 1 to >2 Yrs)
- Permitting requirements and timing
 - Addressing State specific requirements
- Annual recycling rate and total duration (300K to 800K Tons/Yr to market)
- Total Cost on a comparable CY/Ton basis
- Future sale credits, basis and guarantees (\$10 to \$60 per Ton)
- Overall compliance
- Risk and liability management
- Disruption to normal operations



BU Implementation

- Install Erosion and Sediment Control
- Construct BU Facility/Loading Facility
- Construct Infrastructure and Hauling/Conveyance
- Modify Pond Access Roads or Create with Stone and Grid
- CCR Construction
 - Dewatering and Excavation
 - Temporary Stacking
 - Moisture Conditioning
 - Screening/Blending
- Conformance Testing
- Haul/Convey to Loading Facility
- Processing and Distribution



Sample Project



Project/Site Information – Ash Basins

- 150 Acre/5.4M CY Ash Basin Complex
 - Basin 1 – 71 Acres/3.3M CY
 - Basin 2 – 58 Acres/1.6M CY
 - Basin 3 – 21 Acres/0.5M CY
- Closure by Removal Project
- Schedule: 2021 to 2032



Investigation

- 46 DPT's and 18 CPT's
- 1 DPT per 3.3 Acres
- Samples collected continuous at 5 ft int.
- Sample depths: 8 to 63 ft bgs
- 268 samples collected for testing
 - Grain Size/Hydrometer
 - Moisture Content
 - LOI
 - Sulphur
 - Specific Gravity

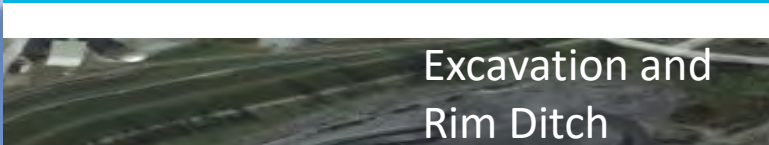


Beneficial Use Technology

- Carbon Burnout (CBO) Technology
- Key Ash Parameters for Optimal Performance
 - Avg. Moisture Content \leq 25%
 - Avg. LOI: 5.5 to 11%
 - Particle Size \leq 3/8 inch
 - Sulphur \leq 0.15%
- Provide 300,000 Tons/YR to Ready-Mix Market



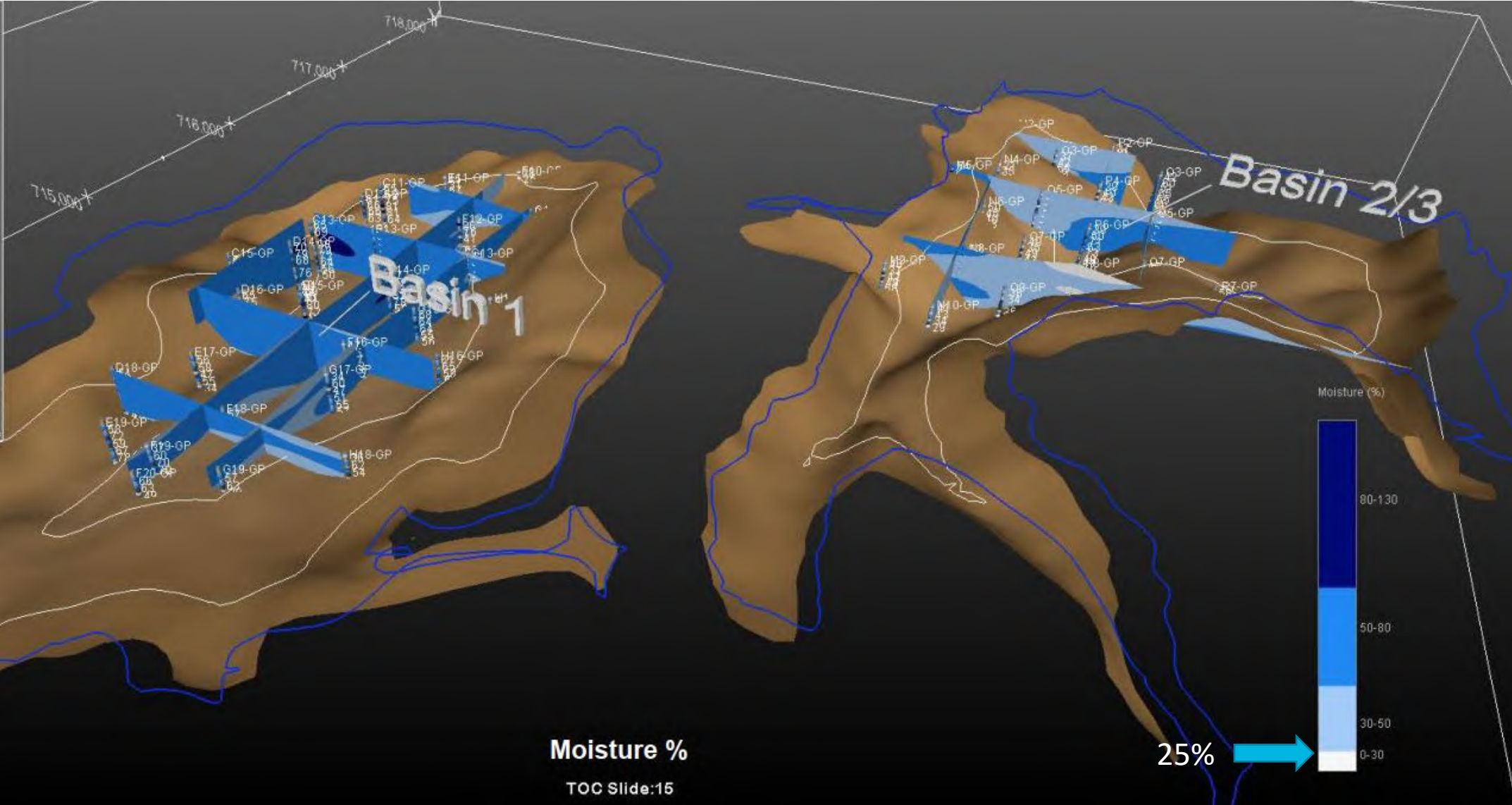
Beneficial Use Approach



Mapping to Optimize Performance - Moisture

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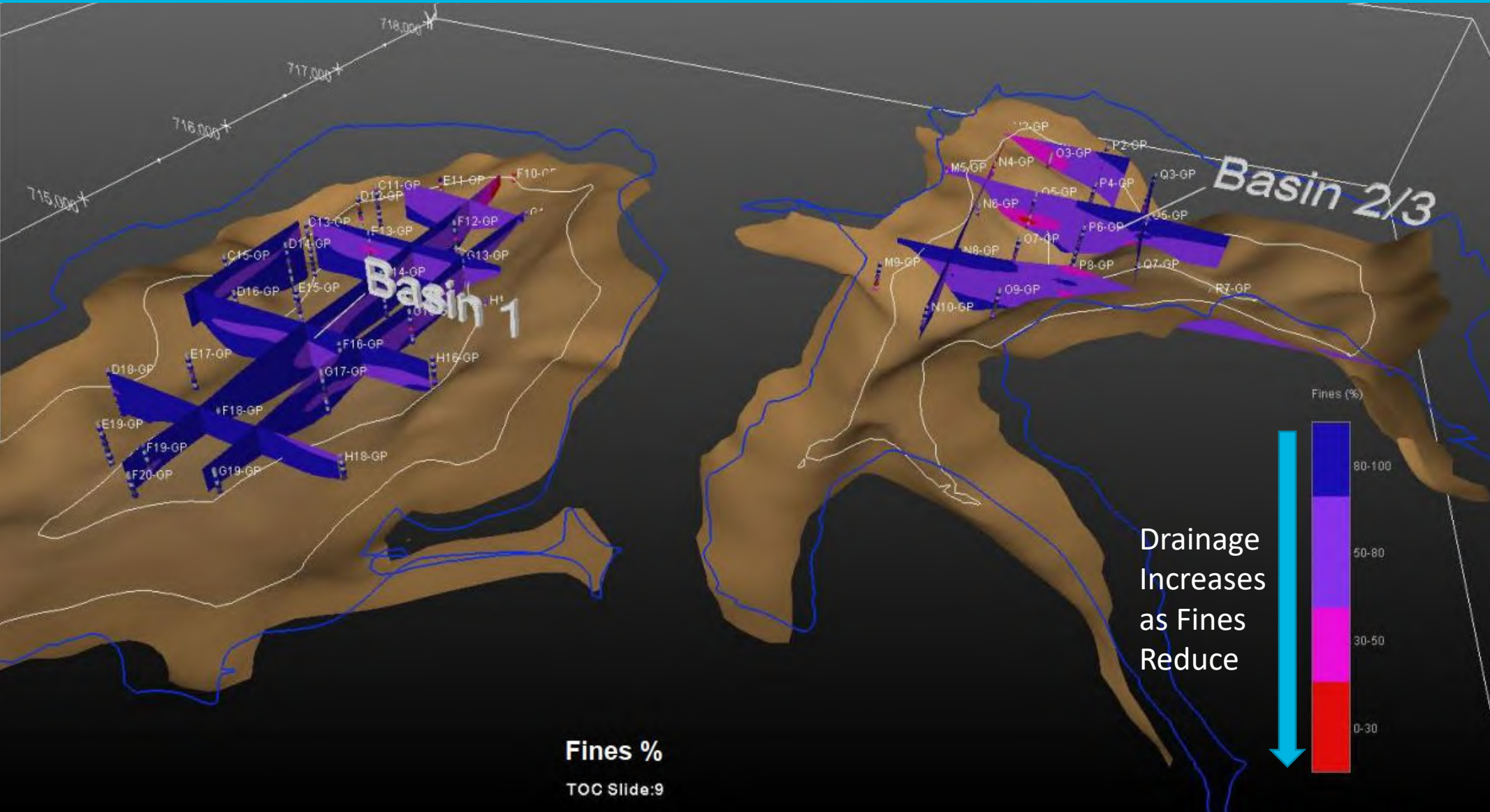
- 1) Site Surface Topo and Aerial with Borings
- 2) Ash Basin Grid and Estimated Bottom of Ash Surface with Borings
- 3) Boring by Ash Type
- 4) Volumetric Distribution of Ash with < 30% Fines Content
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Mapping to Optimize Performance – Fines Content

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Mapping to Optimize Performance – LOI

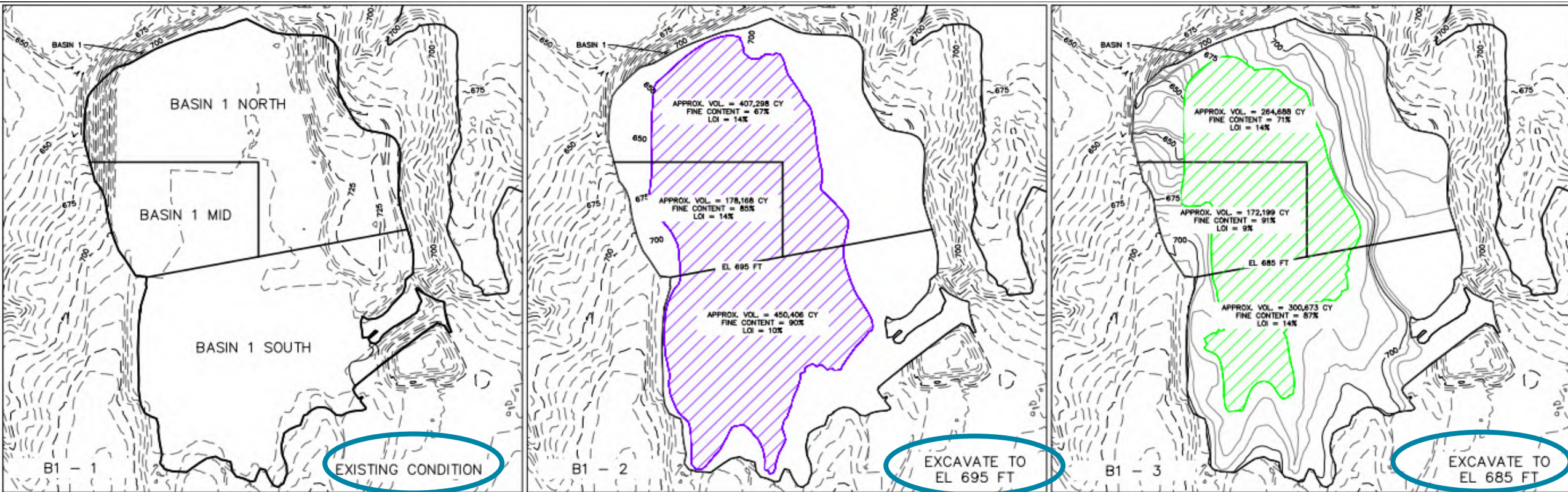
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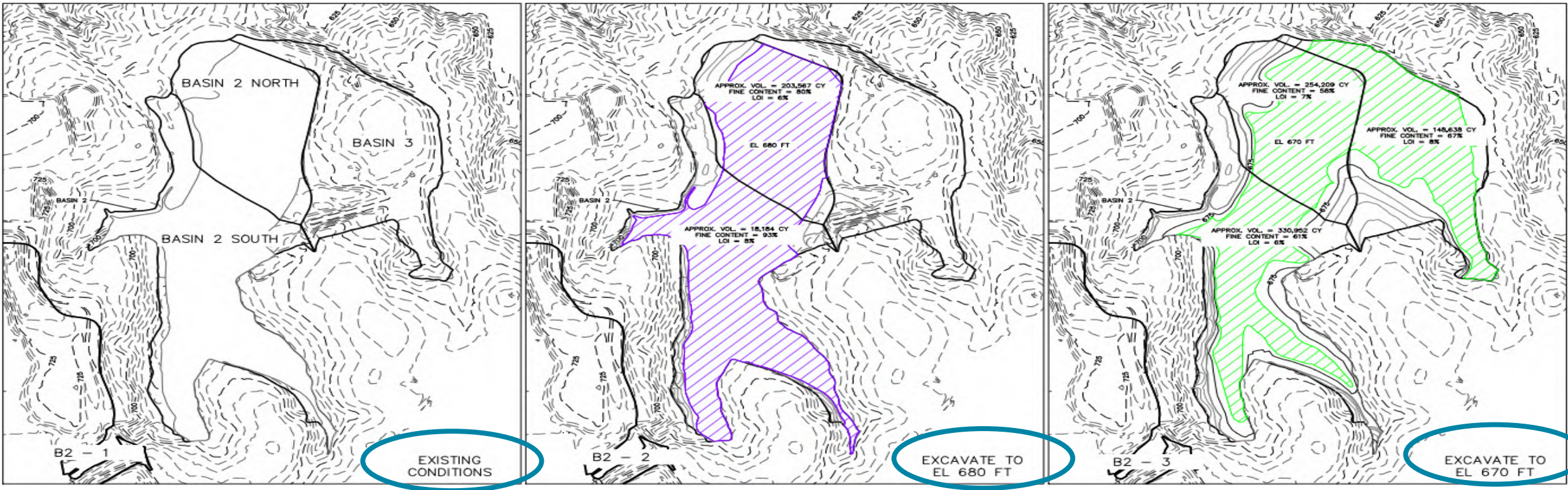
Blending Plans to Optimize Performance

- Developed Blending Plans for Basin 1
 - Broken into quadrants
 - Key parameters: Fines Content and LOI
 - Utilizing 10 ft deep excavations in layers



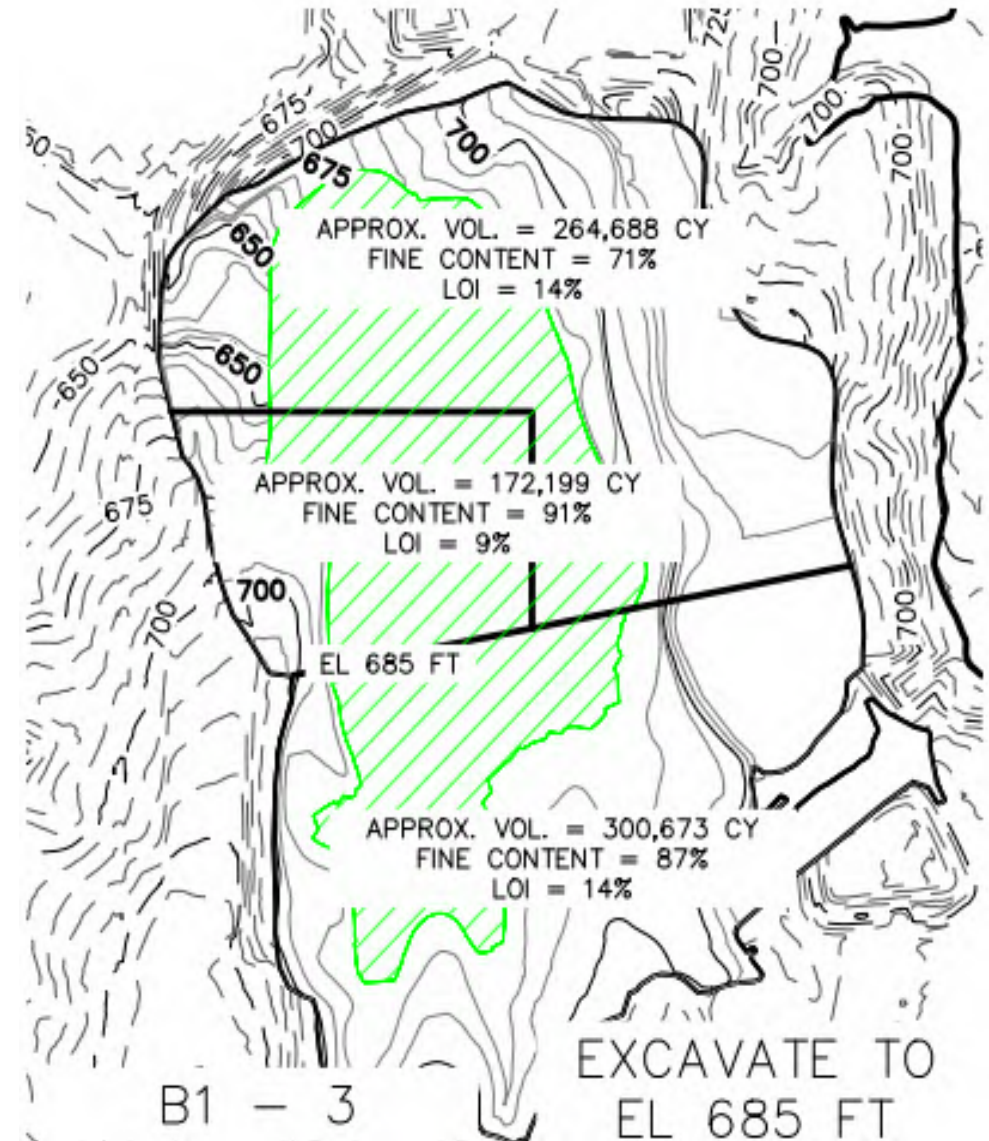
Blending Plans to Optimize Performance

- Developed Blending Plans for Basin 2/3
 - Broken into quadrants
 - Key parameters: Fines Content and LOI
 - Utilizing 10 ft deep excavations in layers



Blending Plans to Optimize Performance

Year		2025				
Feed Volume (CY)		400,000				
Feed Weight (Tons)		480,000				
Feed Moisture Content		28%				
Feed LOI Average		10%				
Product Weight (Tons)		298,500				
Elevation	Cut	Area	W2025	SP2025	SU2025	F2025
Top to El. 695	1st 10'	Basin 1N				
Top to El. 695	1st 10'	Basin 1M				
Top to El. 695	1st 10'	Basin 1S				
Top to El. 680	1st 10'	Basin 2N	75,000	50,000	25,000	25,000
Top to El. 680	1st 10'	Basin 2S				25,000
Top to El. 680	1st 10'	Basin 3				
El. 695 to El. 685	2nd 10'	Basin 1N				
El. 695 to El. 685	2nd 10'	Basin 1M	25,000			
El. 695 to El. 685	2nd 10'	Basin 1S		50,000	75,000	50,000
El. 680 to El. 670	2nd 10'	Basin 2N				
El. 680 to El. 670	2nd 10'	Basin 2S				
El. 680 to El. 670	2nd 10'	Basin 3				
Vol			100,000	100,000	100,000	100,000
LOI			7	10	12	11
FC			83	84	85	87



Best Practices / Lessons Learned



Best Practices/Lessons Learned

Understand Beneficial Use Options

- Engage BU providers early
- Be flexible on technologies
- Waste generation and disposal options

Maintain Competitive Environment

- Avoid having one path forward being the only path
- Flexibility in conveyance methods and schedule is important

Engage State and Permit Authorities Early

- Manage Schedule within Regulations
- Air and other long-lead permitting requirements
- Identify permitted and compliant waste disposal options



Best Practices/Lessons Learned

CCR Rule Compliance

- Meeting CCR Rule encapsulated beneficial use requirements
- 15-year maximum timeline per CCR Rule (>40 Acres)

Establishing key parameters for acceptance (quality, quantity, and condition)

- During testing, provide special attention to LOI/TOC, moisture, gradation, oxides, and strength activity index (pozzolanic reactivity). Most critical to Carbon Burnout and Cement Kiln applications.

Excavation Contractor

- Not a conventional excavation project
- Appropriate specifications for blending and compliance process
- Schedule driven by 3rd Party BU Contractor
- Anticipate non-standard excavation costs



Summary



Summary – The Value in BU

Can be Cost Effective

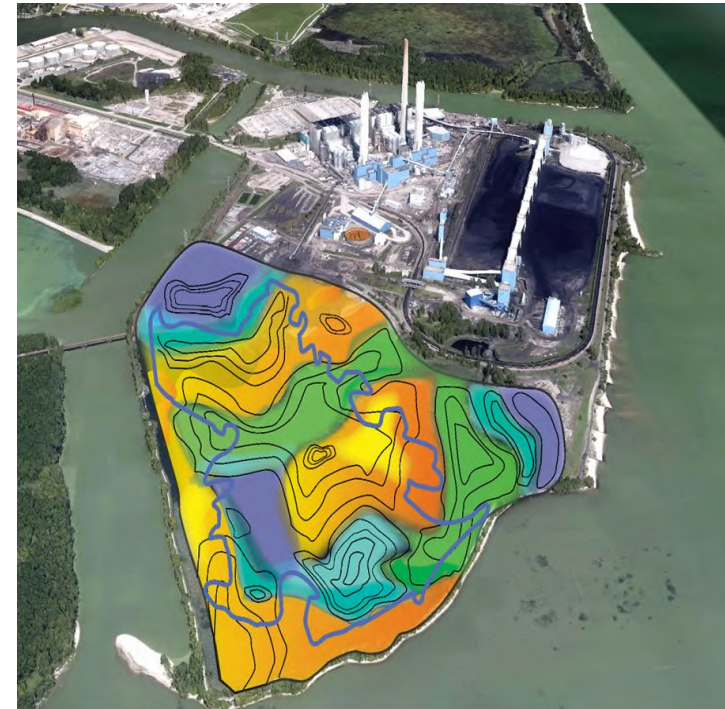
- Flexibility – the more flexible the site is to technologies, timing and transportation, the better the result
- Right Application - can be cost effective:
 - ✓ – CBR and Off-Site Disposal (BU - **\$30** to **\$100**/Ton) (LF \$50 to **\$100**/Ton Trans + Tipping Fee)
 - ✓ – CBR and On-Site Disposal (BU - **\$30** to \$100/Ton) (LF \$15 to **\$30**/Ton Construction and Disposal)

Environmental & public relations benefits

- Ash replaces clay & iron in cement mix, preserving natural resources
- Reduction of long-term environmental risk (encapsulation)

Potential for long-term BU at a site

- Utilize landfilled/stored materials as market demand increase
- Re-purpose conveyance and infrastructure improvements



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Thank You!

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