# BRINGING IT BACK HOME ON THE CUYAHOGA

# GORGE DAM SEDIMENT REMOVAL, INNOVATIVE PROCESSING, AND BENEFICIAL USE DESIGN

ELEVENTH INTERNATIONAL CONFERENCE ON REMEDIATION AND MANAGEMENT OF CONTAMINATED SEDIMENTS
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# Introduction

Dam removal has become an **increasingly urgent global priority** due to:

- Aging infrastructure
- Flood safety issues (climate adaptation)
- Fluvial recreation demands
- Changing priorities in habitat/conservation management

Since 1912, nearly
**2,000**
dams have been removed in the United States.

More than
**76%**
of these dam removals have occurred within the past 25 years.

As of 2021,
**15,600+**

# Introduction

The **removal of sediment (often contaminated) from behind dams** is a necessary precursor to dam removal.

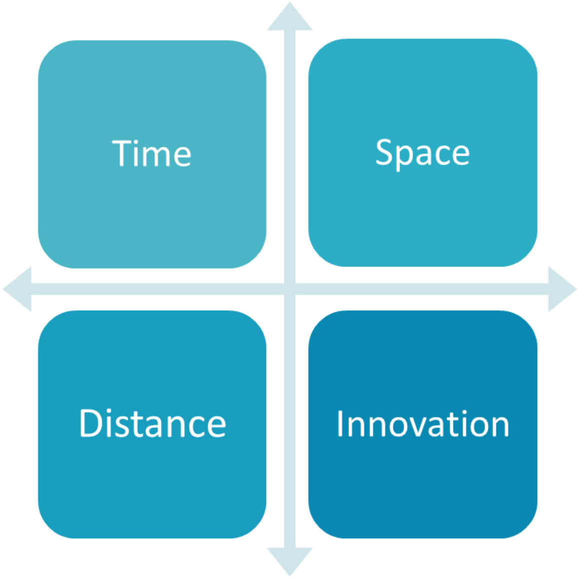
<u>4-D Challenges to Sediment Management</u>

**Time** - Project duration, regulatory timeframe, permitting window, volume accumulation, date of dam removal

**Space** - Limited working site access or area to accommodate sediment processing, project logistics

**Distance** - Landfill disposal, beneficial use sites, transportation logistics

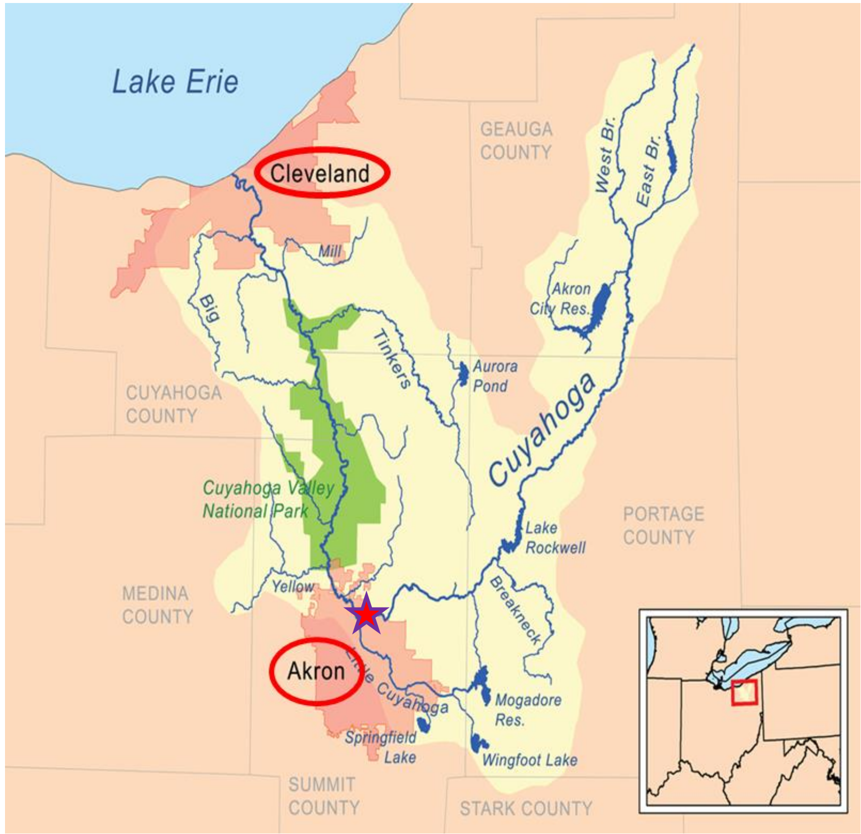
**Innovation** - "If you always do what you've always done, you will always get what you've always gotten"




This case study highlights the decision-making approach employed by Federal, State and Stakeholder partners to select the appropriate dredging and placement engineering design for a dam removal and river restoration project.

# Project Background

- Gorge Dam is the largest of 4 dams along the Cuyahoga River, between the cities of Akron and Cuyahoga Falls, Ohio.
- Constructed in 1914 for hydroelectric power and to provide cooling water for a coal power plant.
- The Cuyahoga River, has caught fire 14 times since 1868
  - 22 June 1969 fire helped spur the US Environmental Movement
    - Launched water pollution control activities & agencies:
      - USEPA (1970) and Ohio EPA (1972)
      - Clean Water Act (1972)
      - Great Lakes Water Quality Agreement (1972)
  - In popular culture:
    - ✓ Randy Newman – "Burn On"
    - ✓ REM – "Cuyahoga"
    - ✓ Great Lakes Brewing Co. – "Burning River Pale Ale"



# Project Background

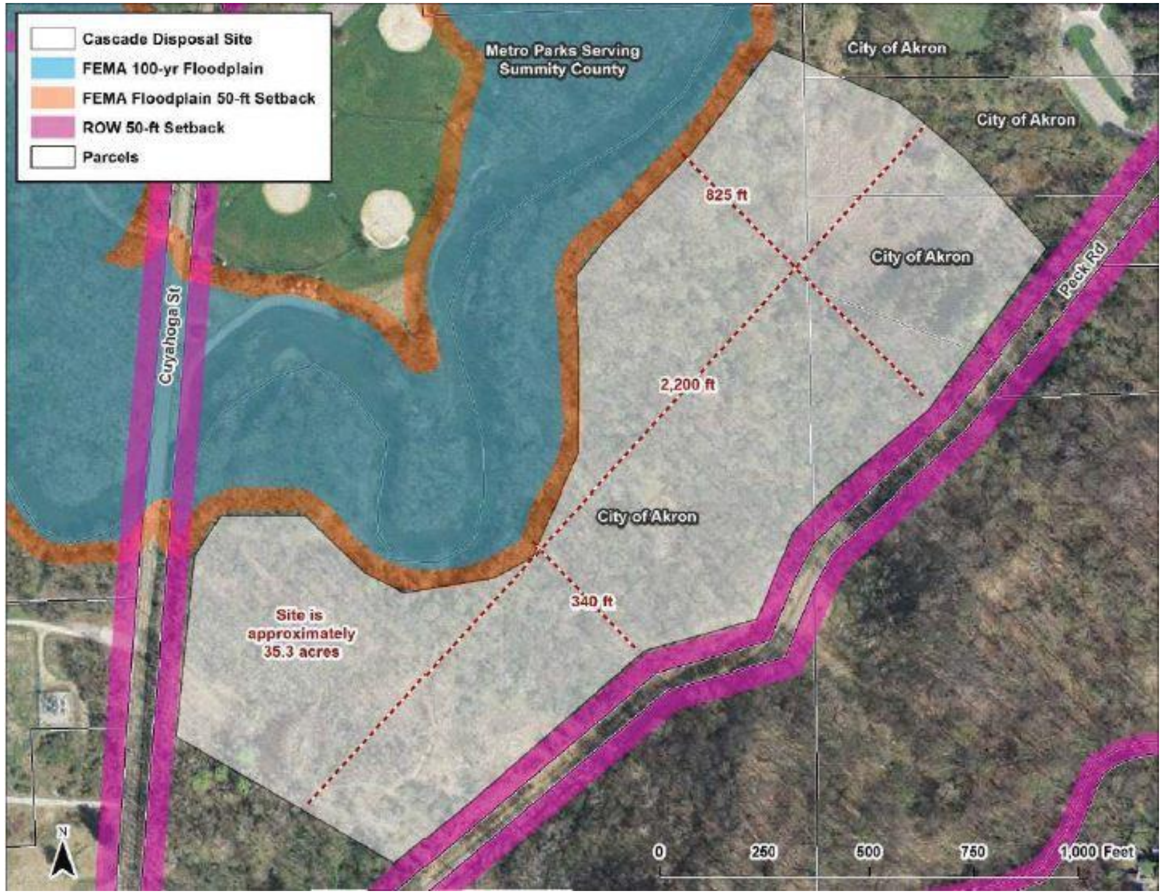
- Designated in 1985 as an Area of Concern (AOC) in the Great Lakes Basin
- In 2010, the USEPA Great Lakes Legacy Act (GLLA) authorized assessment of sediments in Gorge Dam pool
- Approximately **921,000 $yd^3$ (704,155 $m^3$)** of soft, contaminated sediments must be removed from the Gorge Dam pool (anticipated 2024) to facilitate dam removal – ultimately for restoration of the Cuyahoga River to a natural, free-flowing channel through the Cuyahoga Gorge
- Concentrations of organic and inorganic chemicals in the sediment behind the Gorge Dam have been observed at or above ecological thresholds, including **PAHs, pesticides, PCBs, and heavy metals**

# Project Objectives

- The project is being conducted under the auspices of the US Environmental Protection Agency (US EPA) Great Lakes National Program Office (GLNPO) along with project Stakeholders
- GLNPO has entered into a GLLA Project Agreement with the Ohio Environmental Protection Agency (Ohio EPA) and the City of Akron, the City of Cuyahoga Falls, and Summit Metro Parks (SMP)
  - The primary remedial objective is the **removal of contaminated sediments from the dam pool area that may pose an unacceptable risk to aquatic and human life.**
  - The primary restoration goal is to **remove remaining soft sediment deposits from the dam pool area and restore the free-flowing natural channel through the Cuyahoga Gorge**.
- Successful implementation will:
  - Increase fish habitat
  - Improve water quality, leading to improved habitat for fish, wildlife, and benthic life
  - Remove associated beneficial use impairments (BUIs) in the Cuyahoga River AOC
  - Facilitate recreation on the Cuyahoga

# Project Considerations

- The preferred Remedial Alternative outlined in the 2015 Feasibility Study included **hydraulic dredging of 832,000 yd$^3$ during a single construction season**, with sediment dewatering in geotextile dewatering bags and onsite weep water treatment.
- A 35-acre former landfill along Peck Road in the Chuckery Area of the Cascade Valley Park, adjacent to the Cuyahoga River, was identified as the final dredged material placement site.
- Dam demolition was proposed to occur during the same season to maintain bank and flow stabilities, avoid complications from spring/fall flood cycles and to facilitate hydraulic dredging.




*Feasibility Study Proposed Disposal Area (Source: 2015 FS (Tetra Tech 2015))*

# Design Approach


*Aerial image of Gorge Dam reservoir pool (Source: Google Earth)*

**Design warranted further consideration of:**

(A) the dam removal schedule

(B) the upland placement site construction timeline

(C) the time, space, and operational requirements for geotextile tube dewatering and water treatment

(D) operational and placement site space restrictions, and

(E) river water levels and access limitations

# Design Approach

| A) Dam Removal Schedule | B) Placement Site Construction Timeline | C) Time, Space, and Operational Requirements for Dewatering |
| --- | --- | --- |
| • Approximate drawdown rate of 2 to 3 feet per week (30WK).<br>• Dam removal progress contingent on dredging.<br>• Dredging progress contingent on dam removal.<br>• **Disassociate the two tasks.** | • Significant amount of site prep and materials to construct the dewatering pad.<br>• Shallow groundwater table, ponding water throughout the placement area.<br>• **Eliminate need of infrastructure.** | • Sediment contains a significant amount of silt, organics.<br>• Ability to go vertical with the geotextile bags requires stability of the underlying layer.<br>• **Mitigate risk of stability/impact on schedule.** |

| D) Operational Space Restrictions |
| --- |
| • Category 2 and Category 3 wetland impacts.<br>• 100-year floodplain limits.<br>• 72-inch CSO and the 48-inch sanitary sewer within placement area.<br>• Post construction aesthetics, ability to reshape/contour, restoration with trees and other native species |

# Design Approach

In consultation with US EPA and the primary Stakeholders, three changes to the preferred RA were included in the design:

1. Disposal Area Footprint
   - Avoid the Category 3 wetland and the 100-year floodplain.
   - Provide a minimum 100-foot access right-of-way for the 72-inch CSO and the 48-inch sanitary sewer.
   - Complete cover of all exposed onsite urban fill to the maximum extent practical.
   - Allow as much clearance/flood capacity as possible along the southern bank of the Cuyahoga River.
   - Prevent a major eyesore from Peck Road or Cuyahoga Street.
   - Allow complete re-naturalization of the area.

# Design Approach

In consultation with US EPA and the primary Stakeholders, three changes to the preferred RA were included in the design:

2. Mechanical Dredging
   - Does not require the lowering of the dam pool to mobilize dredging equipment under the Front Street bridge.
   - Will allow for removal of deeper sediments near the dam with existing dam pool water elevation.
   - Allows dredging to occur independent of dam deconstruction that would facilitate the lowering of the dam pool elevation to support hydraulic dredging.
   - Allows for a single pass for dredging.

# Design Approach

In consultation with USEPA and the primary Stakeholders, three changes to the preferred RA were included in the design:

3. Sediment Dewatering and Processing

- Given the constraints discussed above with the disposal area footprint, it is likely a new disposal area would need to be found or an expansion of the disposal area would be required to have enough room to use geotextile bags and treat the weep water.
- Screen out the debris.
- Sediment transported to placement area at a high solids concentration via pipeline to reduce impacts of trucking.
- Inline stabilization/solidification of sediments, such as Pneumatic Flow Tube Mixing (PFTM), to reduce truck impacts on Peck Road and mitigate dust concerns.
  - The sediment slurry enters the PFTM process where the density is measured,
  - The proper stabilization dosage (Portland cement and other binders, as necessary) is added to the sediment to stabilize and increase the ability to handle the material.
  - The SDM is pumped to the sediment disposal area and managed as a engineered flowable fill (beneficial use).
  - The stabilized sediment can be contoured as it begins to set up and harden.
- This alternate technology method allows the footprint of the disposal area to stay in the same general area identified in the FS but avoid impacts to the Category 3 wetland and utilities.

# Treatability Studies

Conducted to support engineering design analyses for the proposed final placement of amended dredged material.

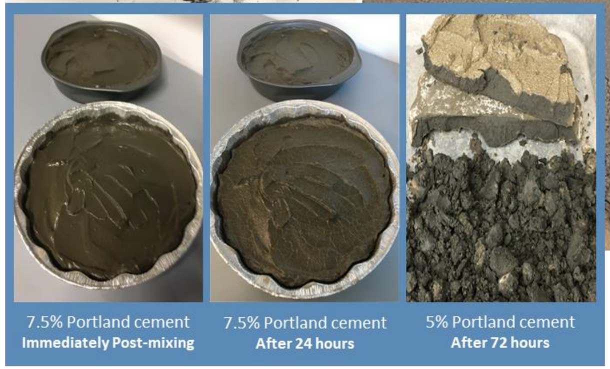
Multi Phase Approach:

- Phase I was focused on proving the conceptual feasibility of the PFTM approach using standard laboratory mix designs.
- Phase II involved a mix design and testing process tailored to the anticipated site activities and timelines needed for semicontinuous construction.
  - Tier 1: The purpose of this testing was to establish a reasonable upper bound on the PC dose that would provide a minimum UCS value of 20 pounds per square inch (psi) to support long-term strength.
  - Tier 2a: The purpose of this testing was to take several SDM blends from Tier 1 and screen various combinations of dose and drying times before compaction that would be feasible for construction rollout.
  - Tier 2b: Adopted a more modest approach to Tier 2a. The mellowing conditions were similar, but curing was simulated under closed conditions, consistent with the burial of fill lifts where direct evaporation is prevented.

Simulated drying in the laboratory cannot truly reproduce actual field conditions, though attempts are made to tailor drying conditions to expected field conditions in terms of temperature, humidity, etc.

*Dredged Material Prior to Stabilization*

*Freshly-placed PDM*
*(8% Portland cement via Pneumatic Flow Tube Mixing)*




*Laboratory Comparison of PDM after 0 to 72 hours "curing"*

# Treatability Study Results

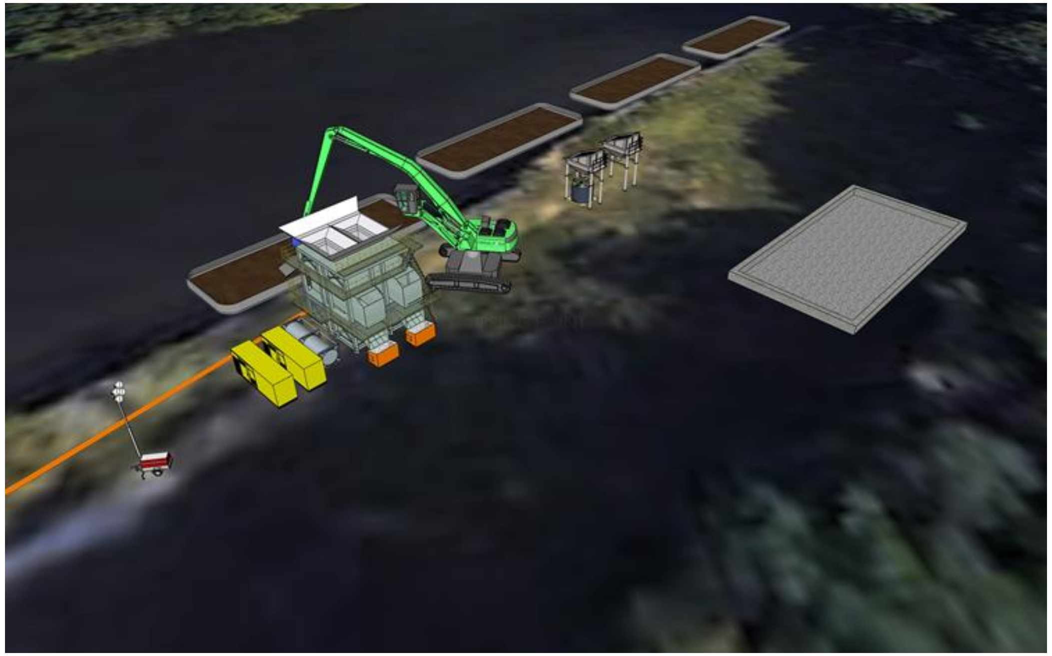
| Mix Design ID | Average MC (ASTM D 2216) % | | | | | | | | Average UCS (ASTM D 2166) lb/in$^2$ | | | | | | Tri-axial Shear (ASTM D4767) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Friction angle (ø; deg) | | Cohesion (c; psi) | |
| | MCi | As-mixed | 0-Day | 1-Day | 2-Day | 3-Day | 7-Day | 28-Day | 0-Day | 1-Day | 2-Day | 3-Day | 7-Day | 28-Day | total | effective | total | effective |
| Tier 2a | | | | | | | | | | | | | | | | | | |
| 5.0PC-72 | 138% | 127% | 85% | 56% | 44% | 26% | 4% | 3% | 4.4 | 40.8 | 60.2 | 91.1 | 135.6 | 143.3 | | | | |
| 7.5PC-48 | 138% | 124% | 84% | 53% | 20% | 10% | 4% | 4% | 8.7 | 42.4 | 49.7 | 63.8 | 71.4 | 53.6 | NT | | | |
| 10.0PC-48 | 138% | 120% | 81% | 62% | 34% | 17% | 4% | 4% | 9.0 | 33.9 | 46.4 | 53.9 | 61.7 | 45.2 | | | | |
| Tier 2b | | | | | | | | | | | | | | | | | | |
| 5.0PC-72 | 152% | 139% | 82% | | | | 79% | 75% | 7.8 | | | | 16.2 | 21.5 | 26.5 | 37.6 | 3.52 | 2 |
| 7.5PC-24 | 152% | 135% | 108% | | NT | | 102% | 92% | 1.8 | | NT | | 5.6 | 8.5 | 31.9 | 34.5 | 4.99 | 4.64 |
| 7.5PC-48 | 152% | 136% | 82% | | | | 78% | 72% | 8.6 | | | | 20.8 | 33.5 | 13.2 | 29.4 | 10.07 | 5.6 |

Tier 2a, wherein partial aeration under cool conditions was permitted for up to 3 days followed by open-drying after final compaction at room temperature with some airflow. This suggests that compacted lifts would be almost immediately accessible after compaction at relatively low PC doses, especially for thin, compacted lifts (such as 6 to 12 inches).

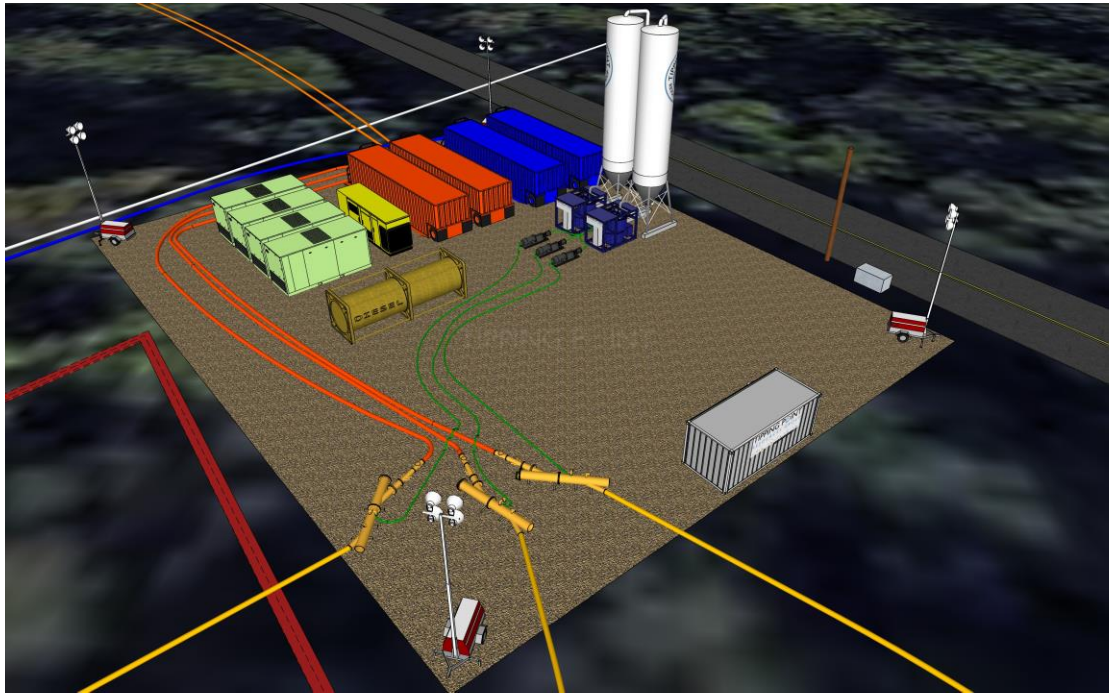
Tier 2b is probably closer to the field reality, where the evaporation potential of the as-completed SDM lifts is relatively modest. The data suggest that under closed curing conditions, said compacted lifts may still be accessible same day or 1 or 2 days thereafter.

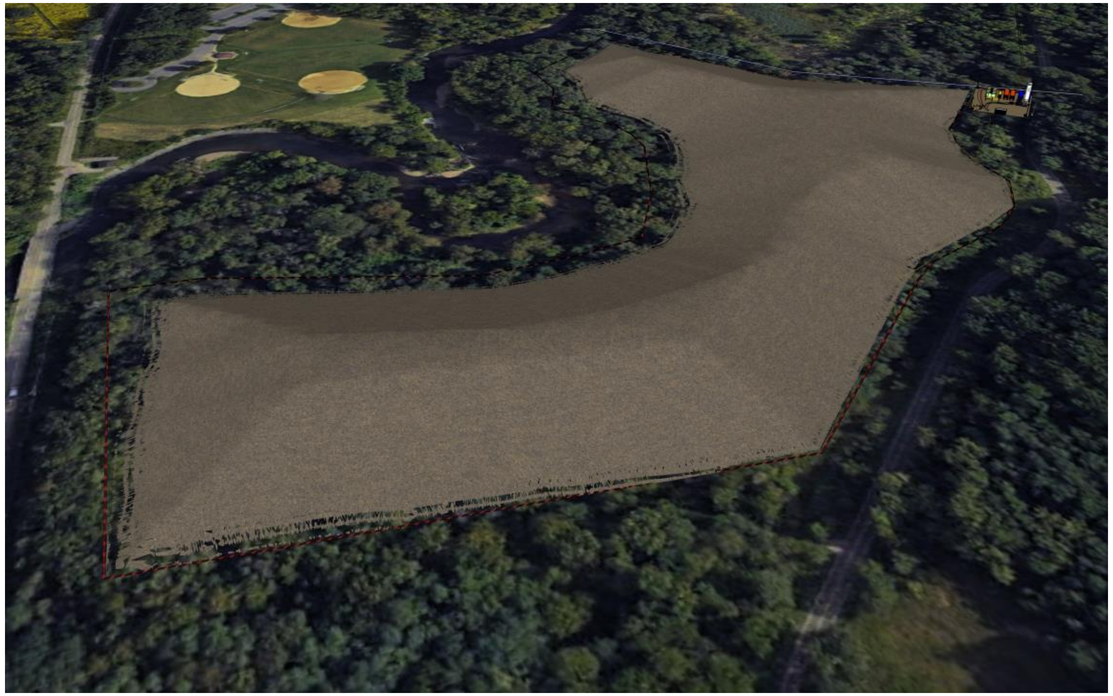
# Preliminary Design

- **Mechanical dredging**, screening, and sediment transport via HDPE pipeline
- **Sediment stabilization/solidification** via Pneumatic Flow Tube Mixing (PFTM) using Portland cement (and other binders as necessary) to produce a flowable engineered fill
- **Beneficial use of stabilized sediment:**
  - Engineered fill for landscape contouring
  - Subsequent ecological restoration with native grass and tree species



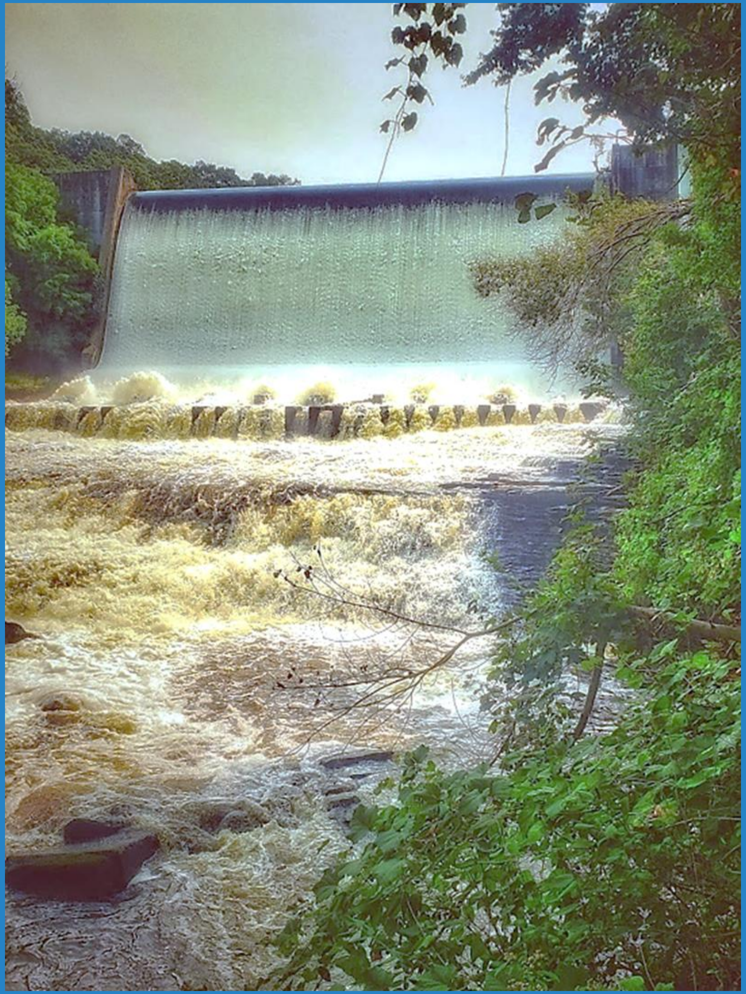
# Preliminary Design



# Conclusions

- Design engineers and project Stakeholders considered key parameters in pursuit of the Gorge Dam project goals and objectives.
- Historically successful solutions, such as geotextile tube dewatering, would not be sufficient to effectively balance project and Stakeholder needs.
- Early and up-front consideration of sediment placement and re-use opportunities (**“removal-to-reuse” approach**) helped to limit the inadvertent disqualification of sediment management and beneficial use alternatives as the design evolved.
- Demonstrated the importance of early and ongoing treatability testing to support project design. Used to assess an initial dosing and processing strategy, but ongoing site operations will provide the best data sets for optimizing the innovative PFTM operating conditions and construction sequencing in an iterative mode.



# Thank you for your attention.

## Additional Questions? Please Contact: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