# Restoration and Rehabilitation of the Big Slackwater Section of the Historic C&O Canal Along the Potomac River

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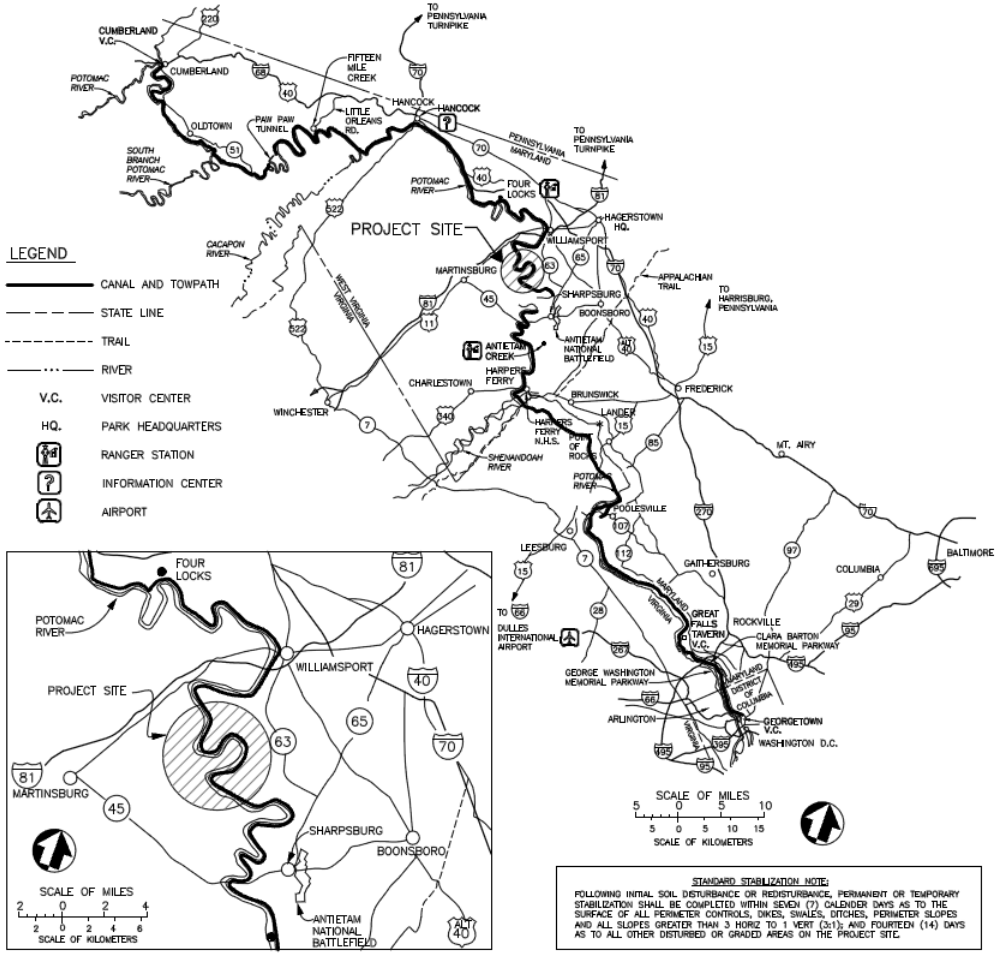


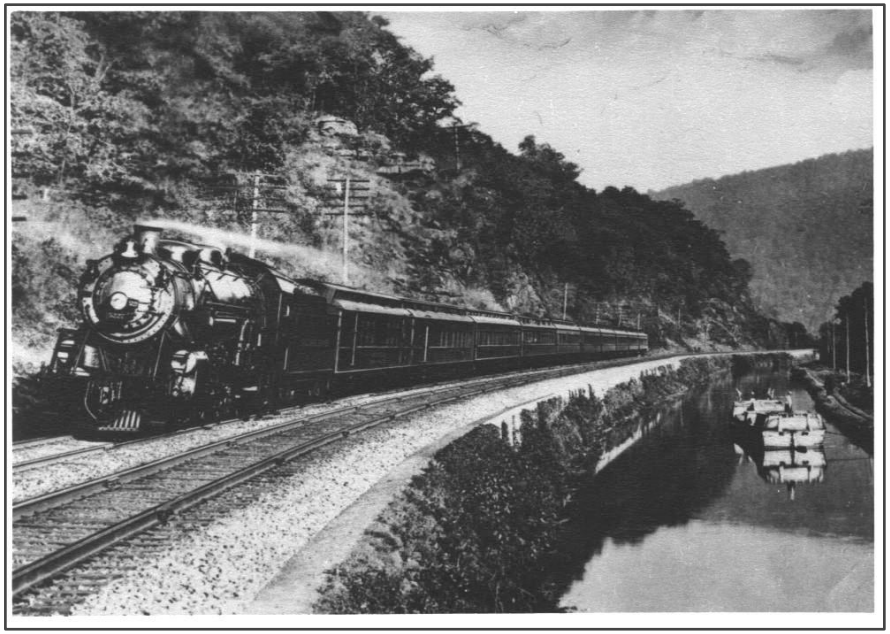
# History of the C&O Canal

- Importance of Waterways to Colonial America
  - Chesapeake Bay
  - Potomac un-navigable due to Piedmont.
- George Washington's Patowmack Company 1785.
- Erie Canal Success (1817-1825)

Photos courtesy of C&O National Historical Park

# History of the C&O Canal

- Construction on Chesapeake & Ohio Canal began July 4, 1828
  - 1831: Seneca, MD
  - 1834: Harpers Ferry, WV
  - 1839: Woodmont, MD
  - 1850: Cumberland, MD

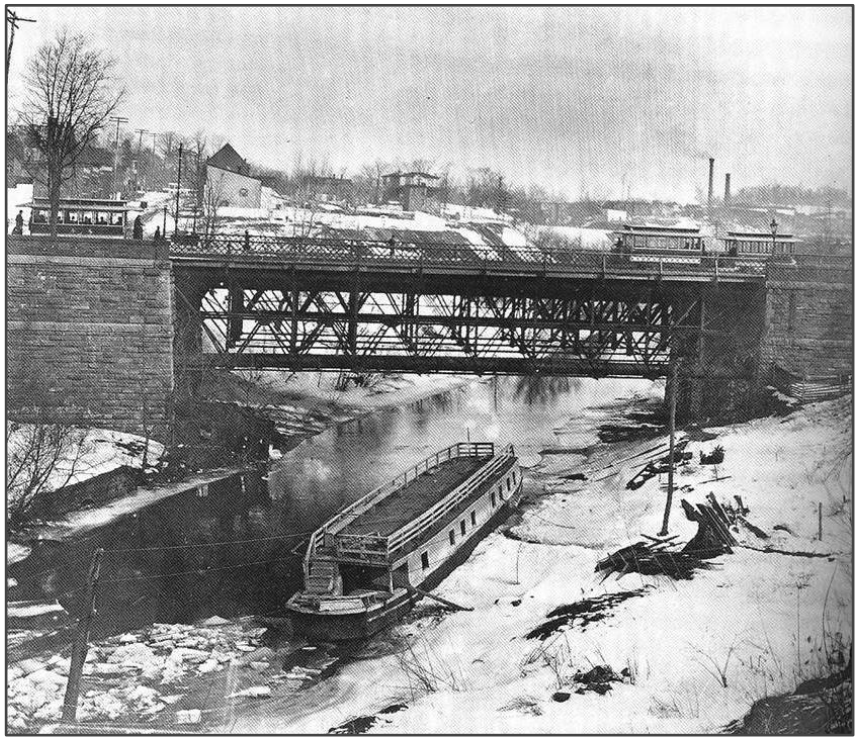


Photos courtesy of C&O National Historical Park

- Baltimore & Ohio Rail Road
  - Started at same time as C&O Canal
  - Completed in 1842 along same route and C&O canal.

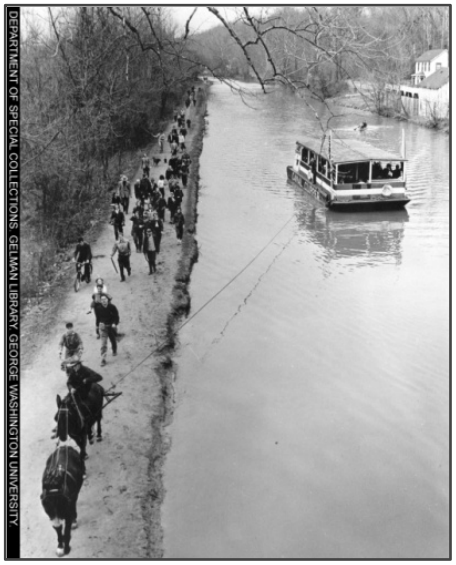
# History of the C&O Canal

- Transported Coal from Cumberland MD
- Trip took 4.5 Days from Cumberland to Georgetown (D.C).
- Mules towed 92 foot long barge loaded weight 120 tons.
- 540 boat trips a year peak performance.



Photos courtesy of C&O National Historical Park

# History of the C&O Canal

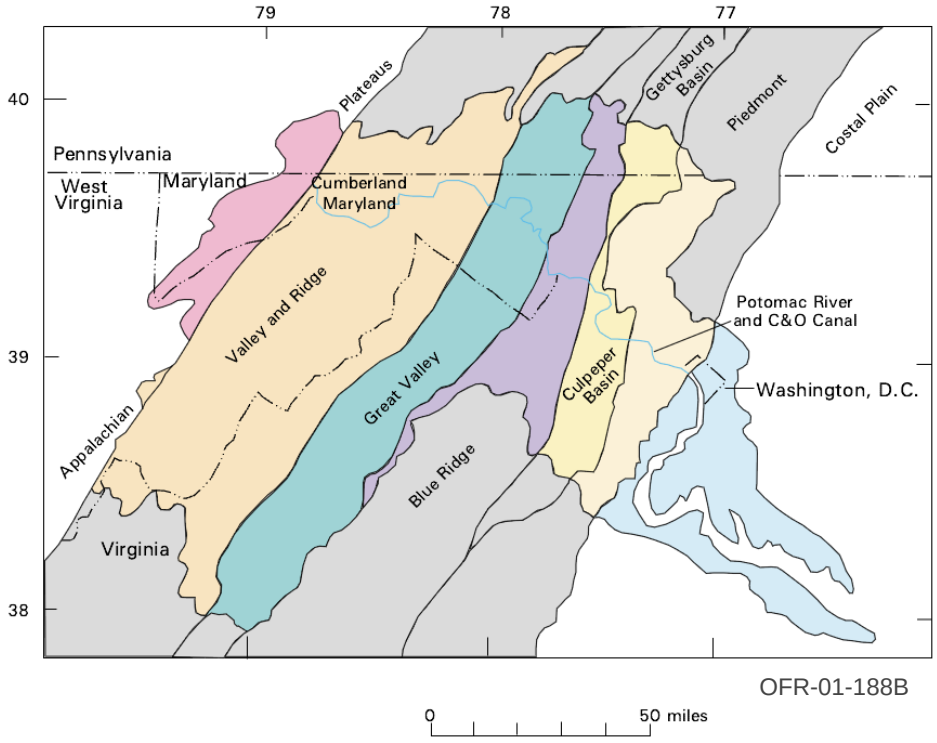


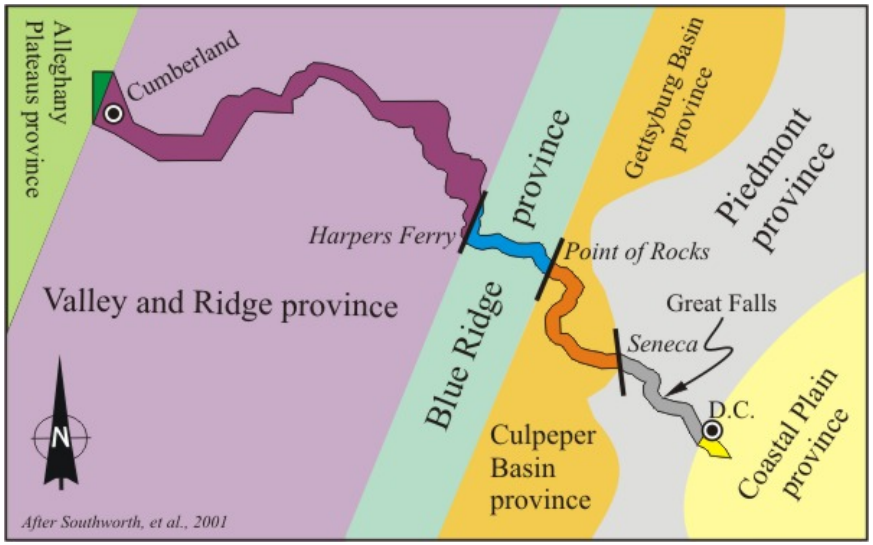

Photos courtesy of C&O National Historical Park

- Fall of the C&O Canal
  - Started with the 1889 Johnstown, PA Flood.
  - A series of large **floods** ruined the canal
  - No money to repair the damage
  - 1924: B&O Railroad bought and operated the canal until when floods damaged and drained parts of the Canal
  - U.S. Government was given the canal by B&O to overlook $2 Million in debt.
  - 1950: Justice William Douglas stopped the plan to turn it into a scenic highway.
  - 1961: Designated a National Monument by President Eisenhower.
  - 1971: Designated a National Park by President Nixon.

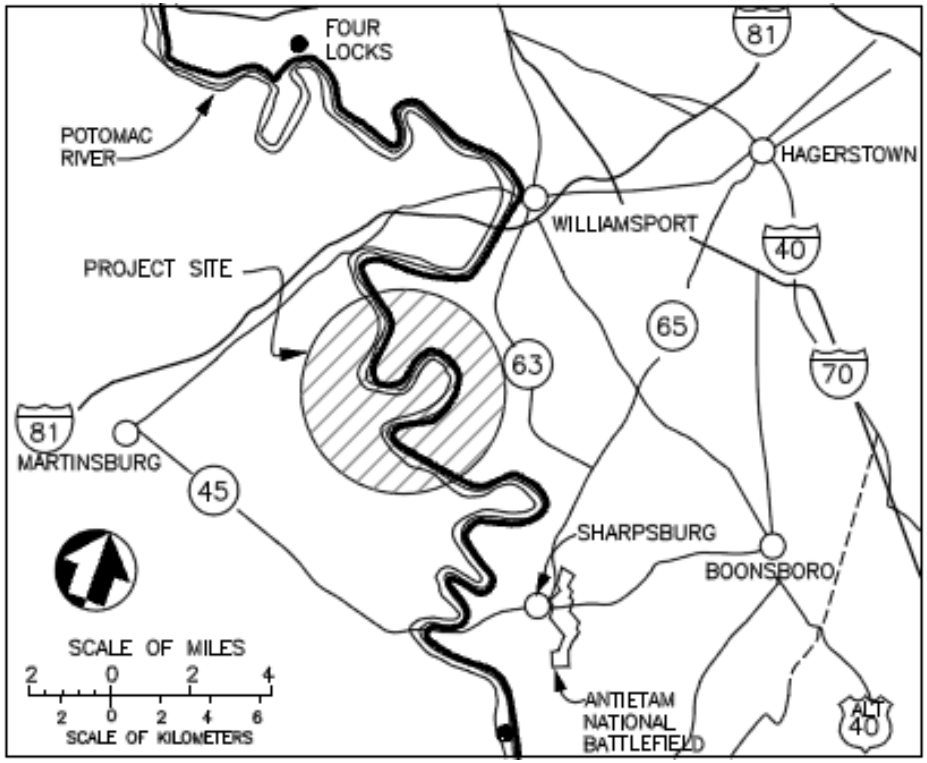
# Geologic Setting of the C&O Canal

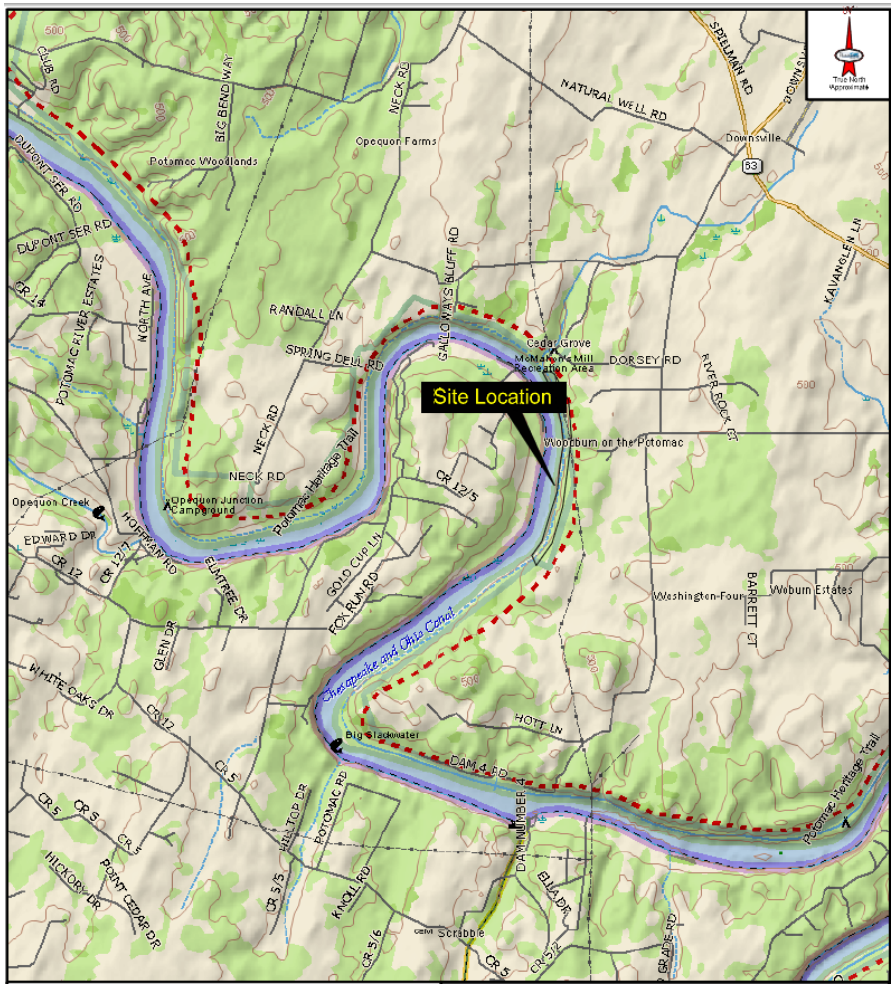
- Crosses five physiographic provinces (three major)
  - Coastal Plain – Piedmont (Potomac and Westminster Terrane, Culpepper Basin, Fredrick Valley, Blue Ridge)– Valley and Ridge – Appalachian Plateaus.



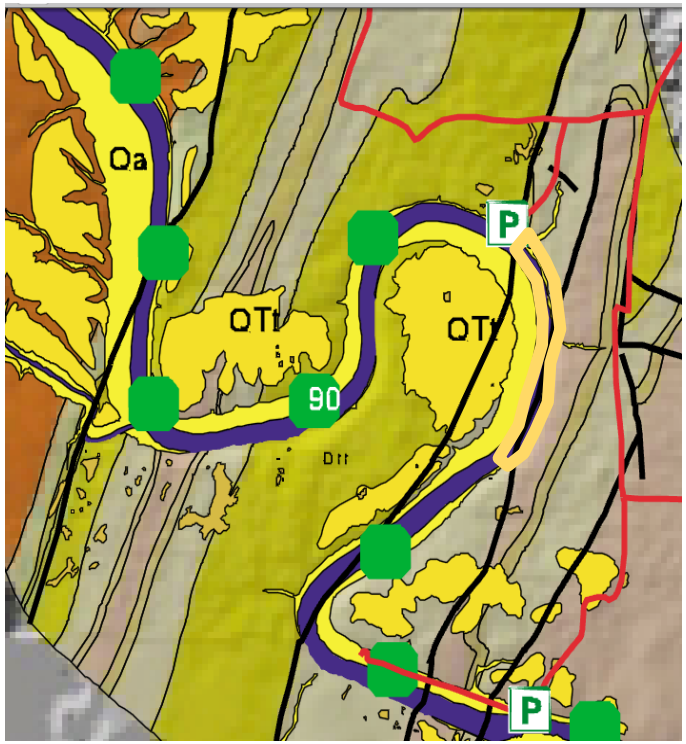
# Study Area: Big Slackwater




USGS Quadrangle: Williamsport, MD

# Conococheague Formation, a massive Upper Cambrian limestone

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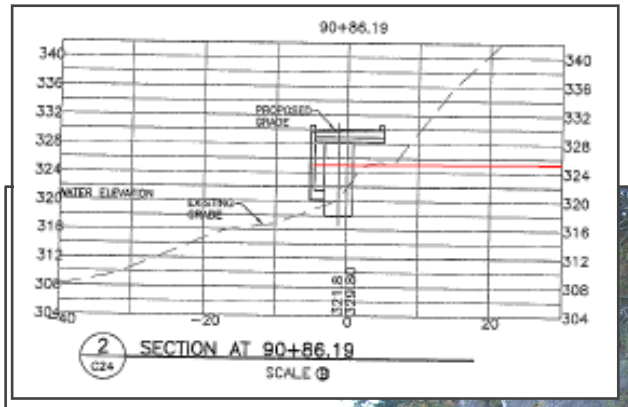
# Advanced Karst Topography

# Toe Path (Circa 1989)


# Value Engineering





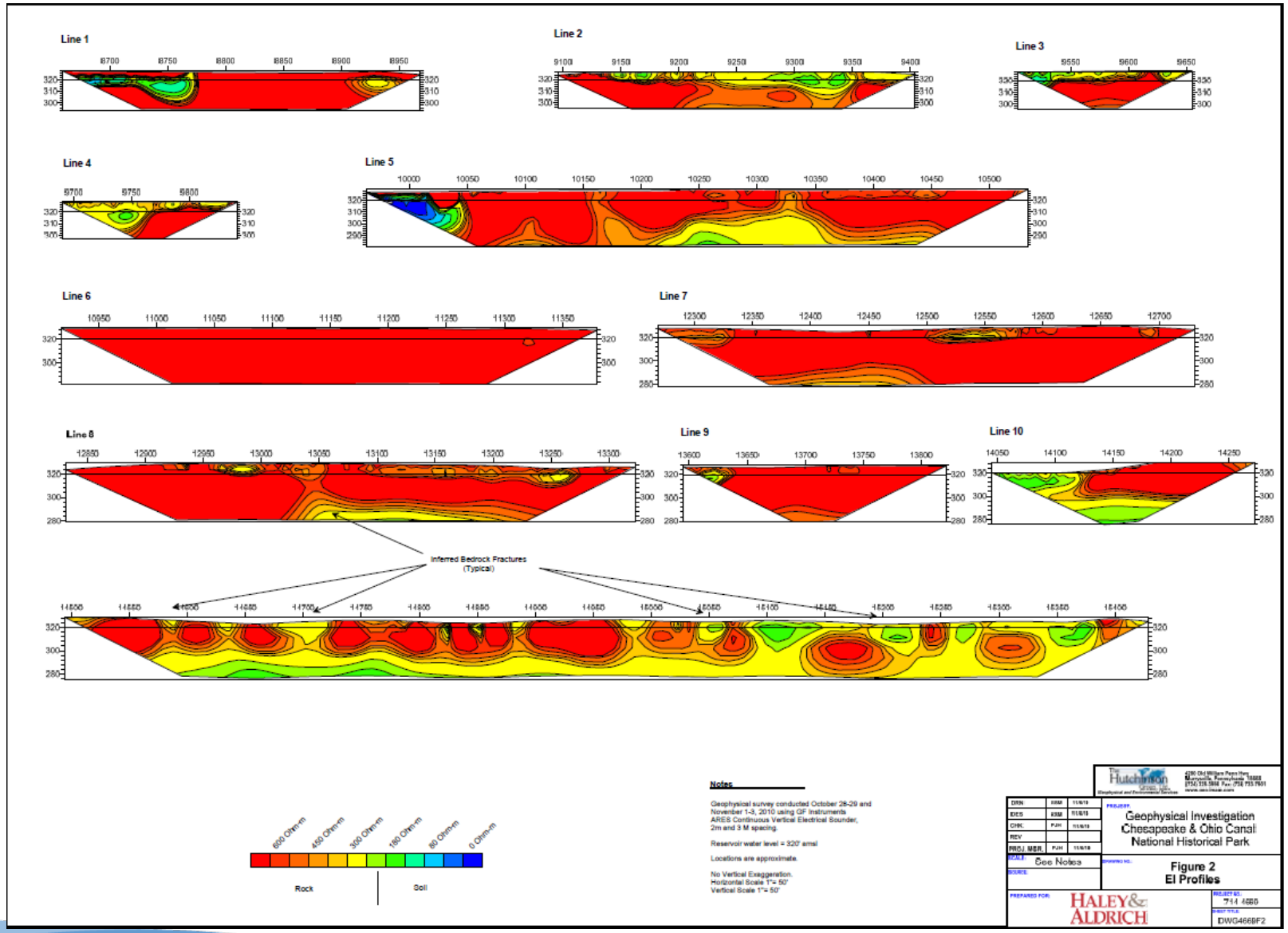


- Original Design
  - Rock Socketed Caissons
  - Difficulty in construction
- Value Engineering
  - Rock Anchored Spread footing
  - 8 Bridges
  - 121 Piers
  - Loads
    - Uplift, river flow, flood, ice flow

# Top of Rock

- Minimal Subsurface investigation.
- 4 borings, 4 test pits
- 2 mile long project
- Gaps in Information


# Bridging the information Gap:
## Electrical Resistivity



# Foundation Excavation

# Foundation Preparation



# Anchor Installation Issues

- Flooding stopping progress
- Hole collapse after drilling
- Highly eroded rock
- Fractures
- Solution cavities
- Artesian well conditions

# Rock Anchors

- 121 Piers (849 anchors total)
  - 7 Anchors per pier
    - 6 vertical
    - 1 angled down
  - Loads
    - Uplift, river flow, flood, ice

| Type I | Type II | Type III |
|---|---|---|
| • 1 in.<br>• 77 kips<br>• 20’ deep | • 1 3/8 in.<br>• 142 kips<br>• 28’ deep | • 1 ¾ in.<br>• 240 kips<br>• 40’ deep |

# Flooding

# Anchor Testing Issues

- Flooding
- Incorrectly calibrated jack
  - Load Cell Fix
- Two Failures.
  - 1: Manufacturing flaw
  - 2: Initial anchor failure
    - Redesign of Pier.

# Super Structure/ Jet Grouting


# Final Product

# Thanks!

- National Park Service
- Cianbro
- Richard Lawrie & Assoc.