Navigation Lock Foundation Design in Complex Karst Geology At Chickamauga Dam

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US Army Corps of Engineers
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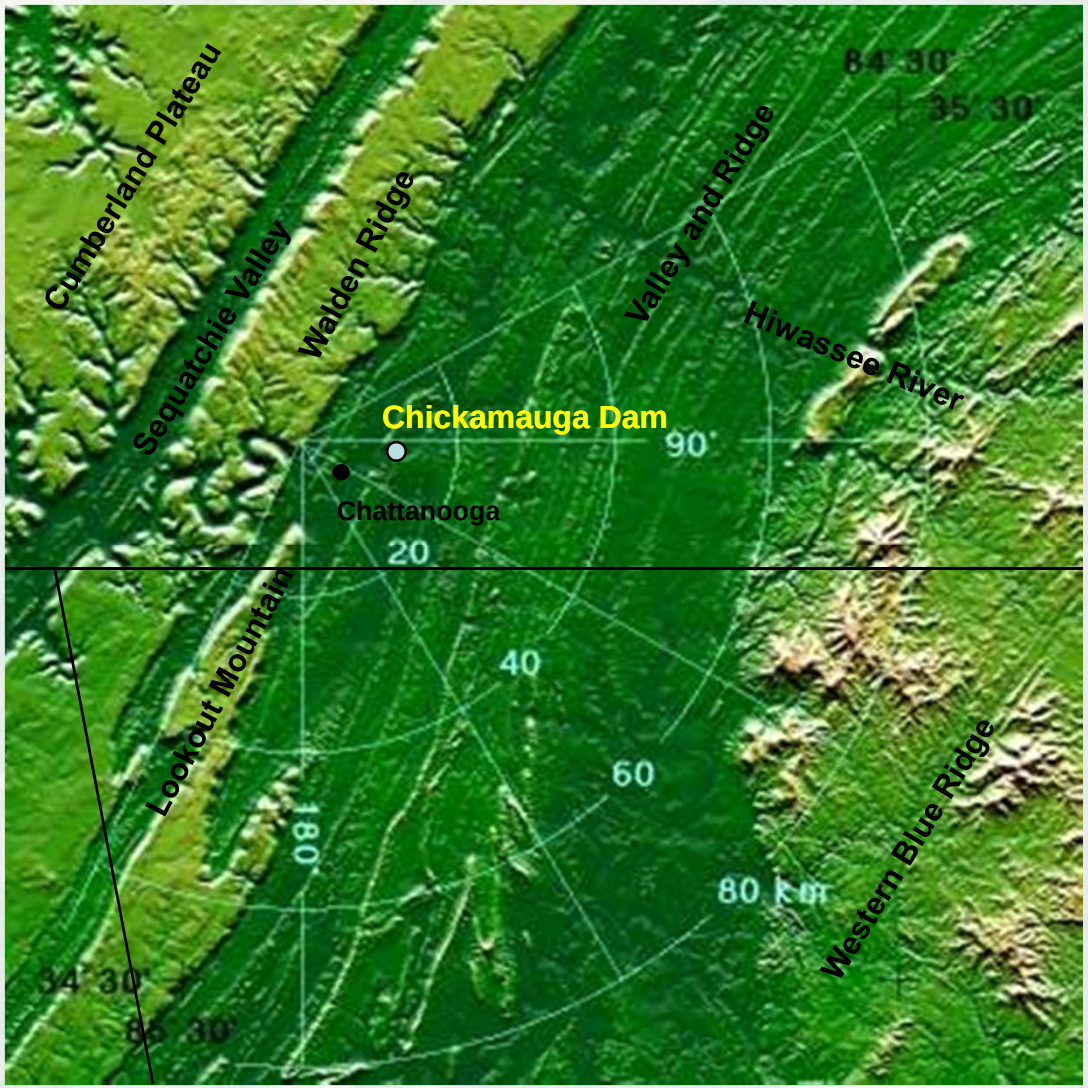
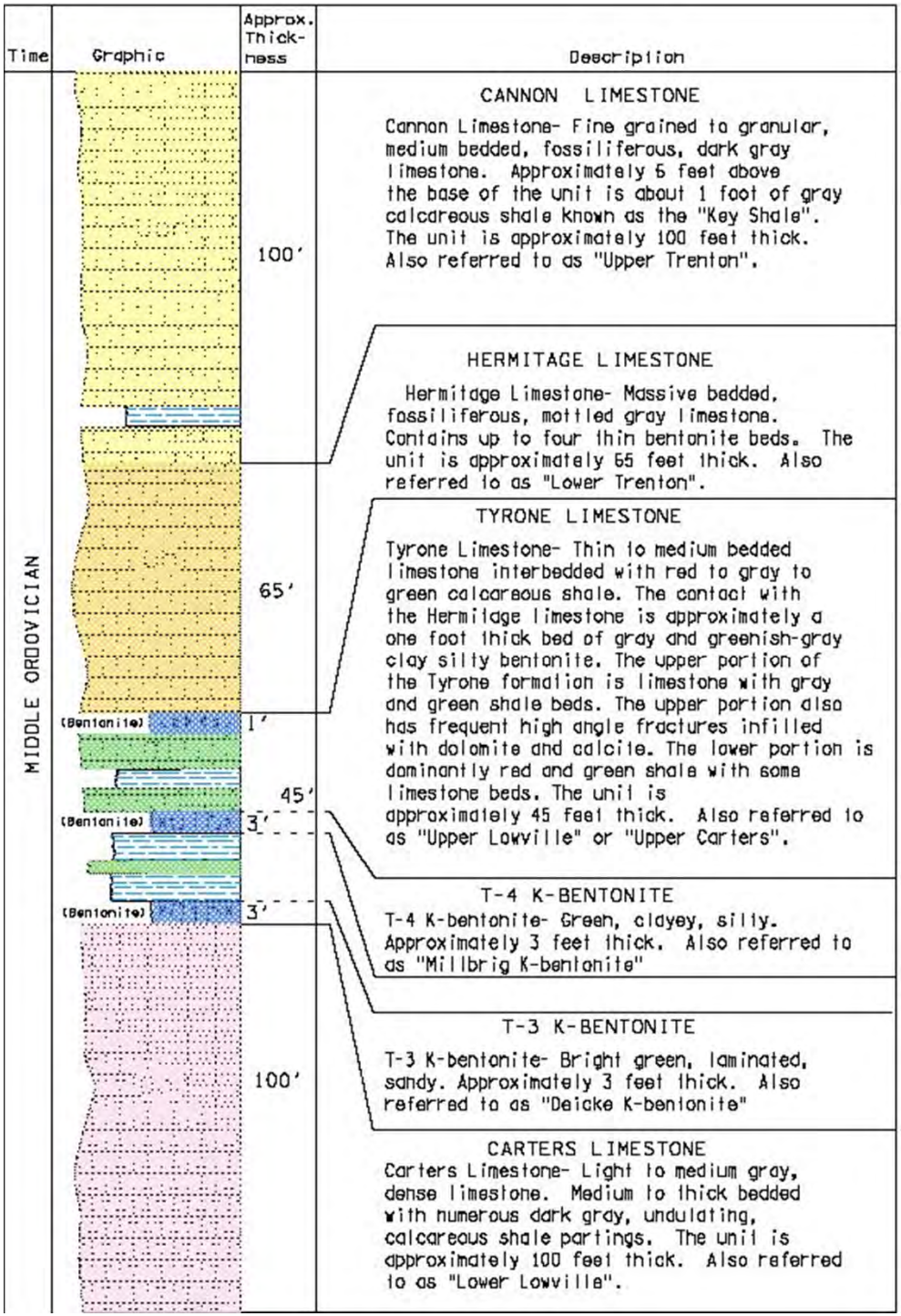
Acknowledgements

- Arcadis
- Ben C. Gerwick, Inc.
- Bergmann Assoc.
- Black & Veatch
- Inca Engineers, Inc.
- MWH

Cofferdam construction for the new Chickamauga Lock.



Chickamauga Dam lies within the Valley and Ridge Physiographic Province

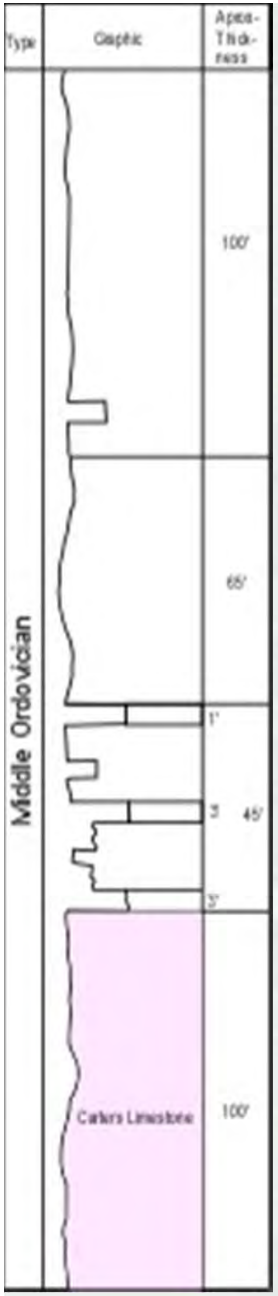


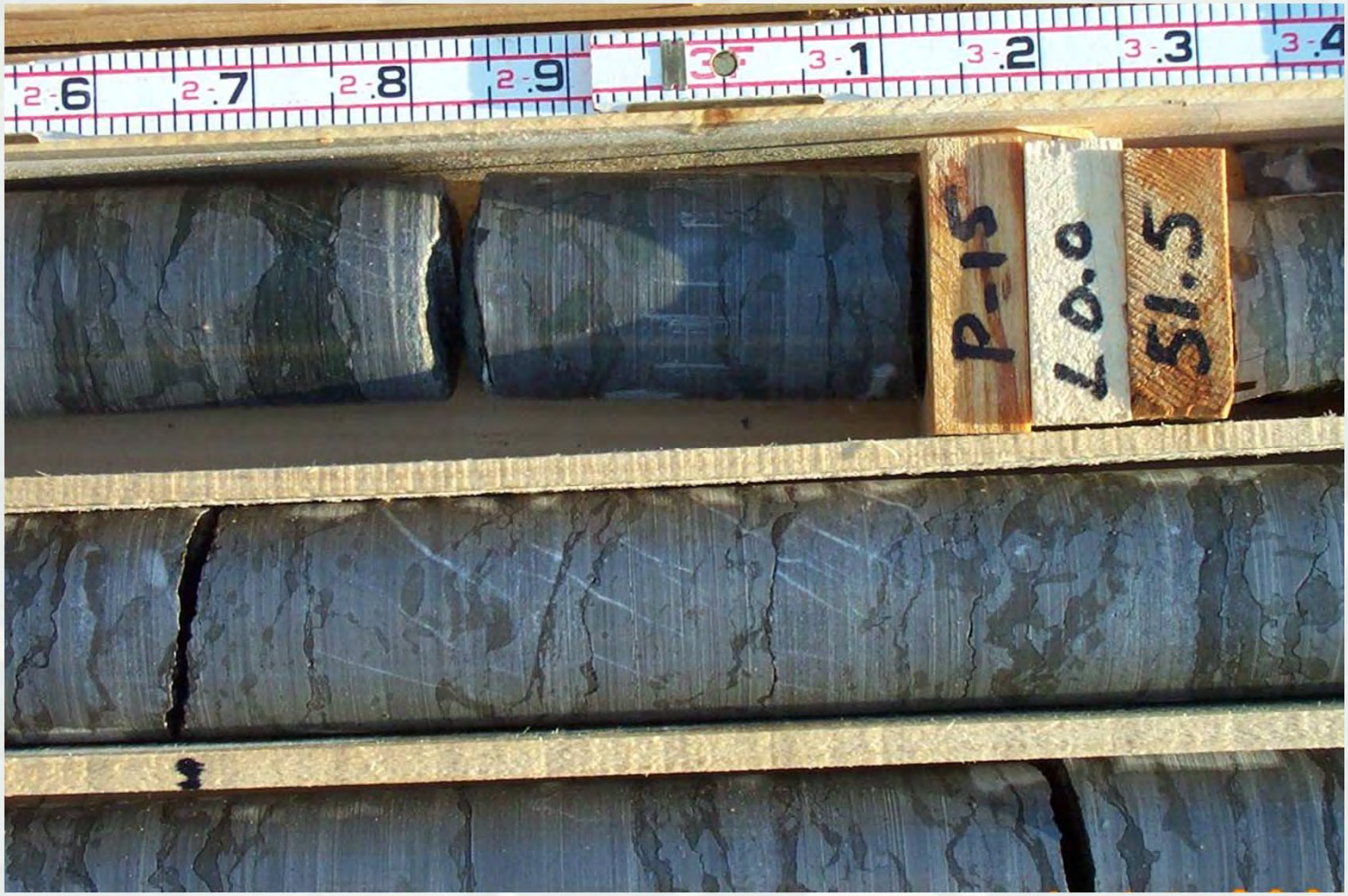
Site Stratigraphy

Compressive Strength

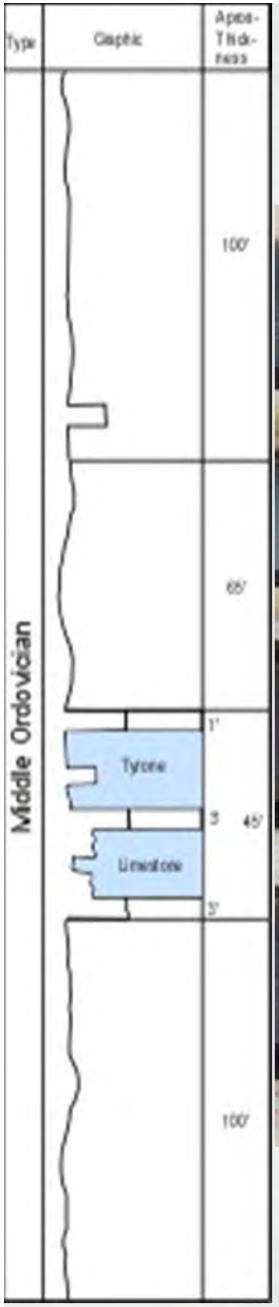
- **Cannon, upper – 10,000 psi**
- **Cannon, lower – 18,000 psi**
- **Hermitage – 11,000 psi**
- **Tyrone – 10,000 psi**
- **Carters – 14,400 psi**

Carters Fm


Type
Graphic
Appa-
Thick-
ness
Middle Ordovician
100'
65'
1'
3'
45'
3'
Carters Limestone
100'


2-.6
2-.7
2-.8
2-.9
3-.1
3-.2
3-.3
P-15
10.0
51.5

Tyrone Fm



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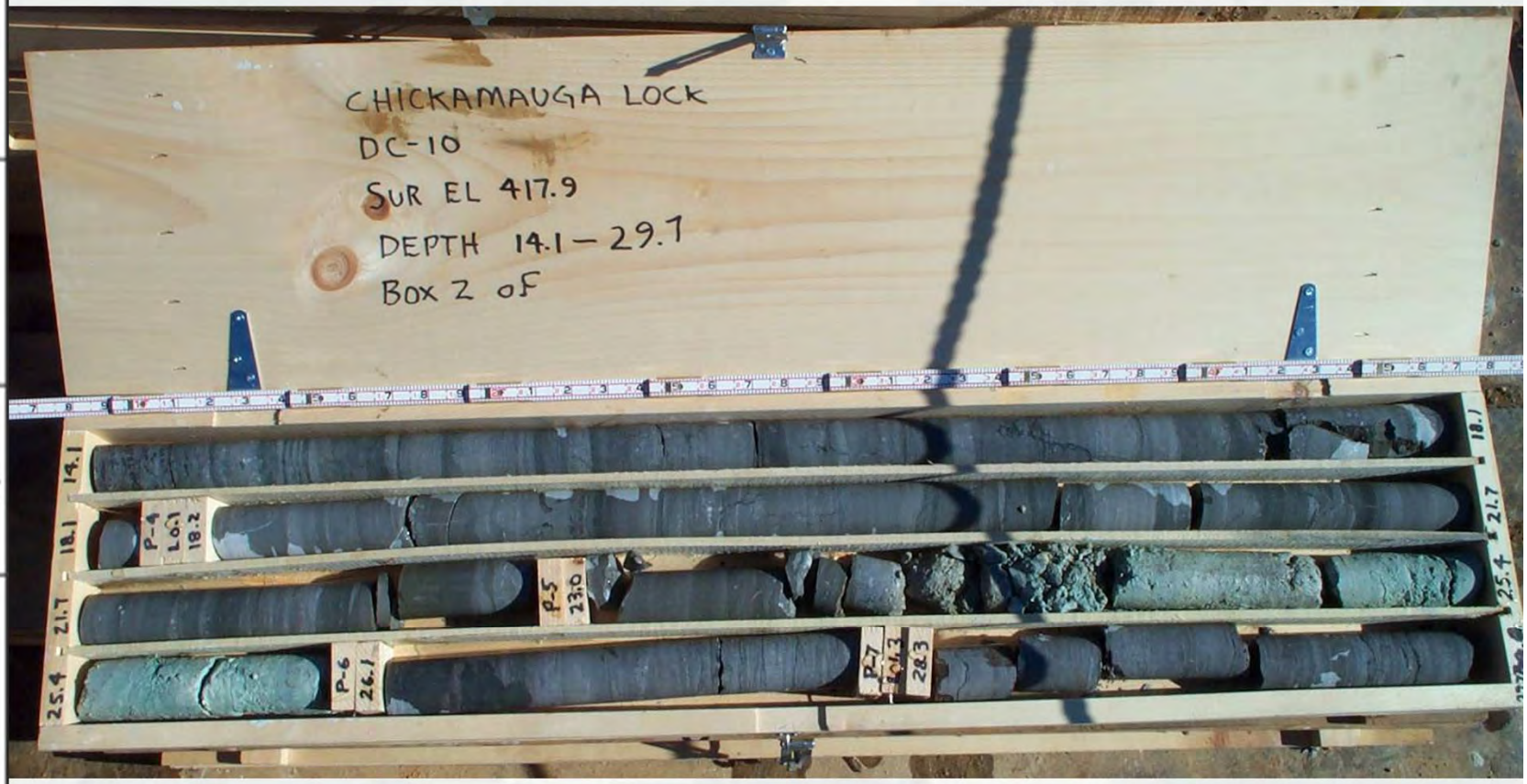
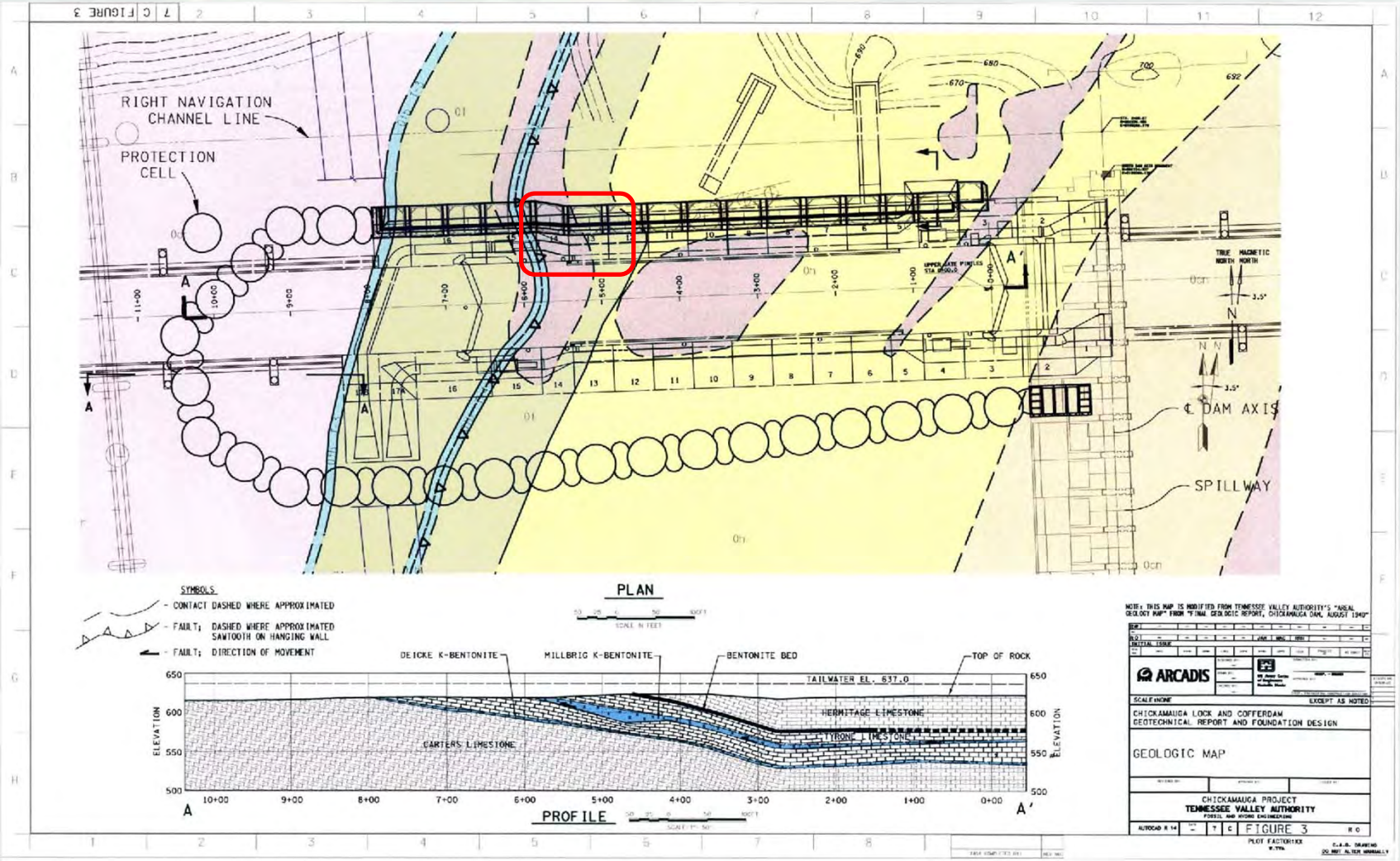
T-4 Bentonite in Tyrone Fm

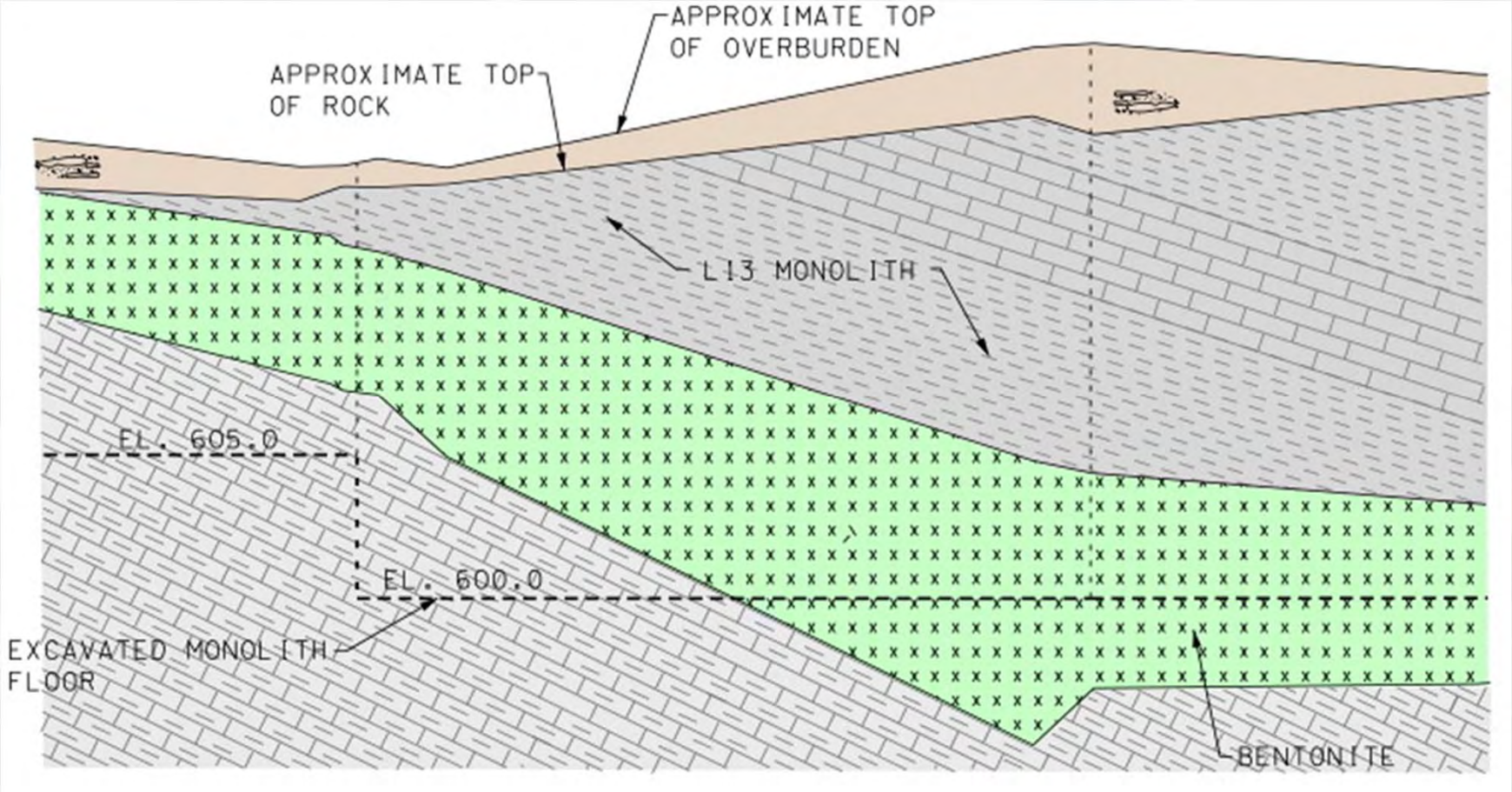


Hermitage Fm

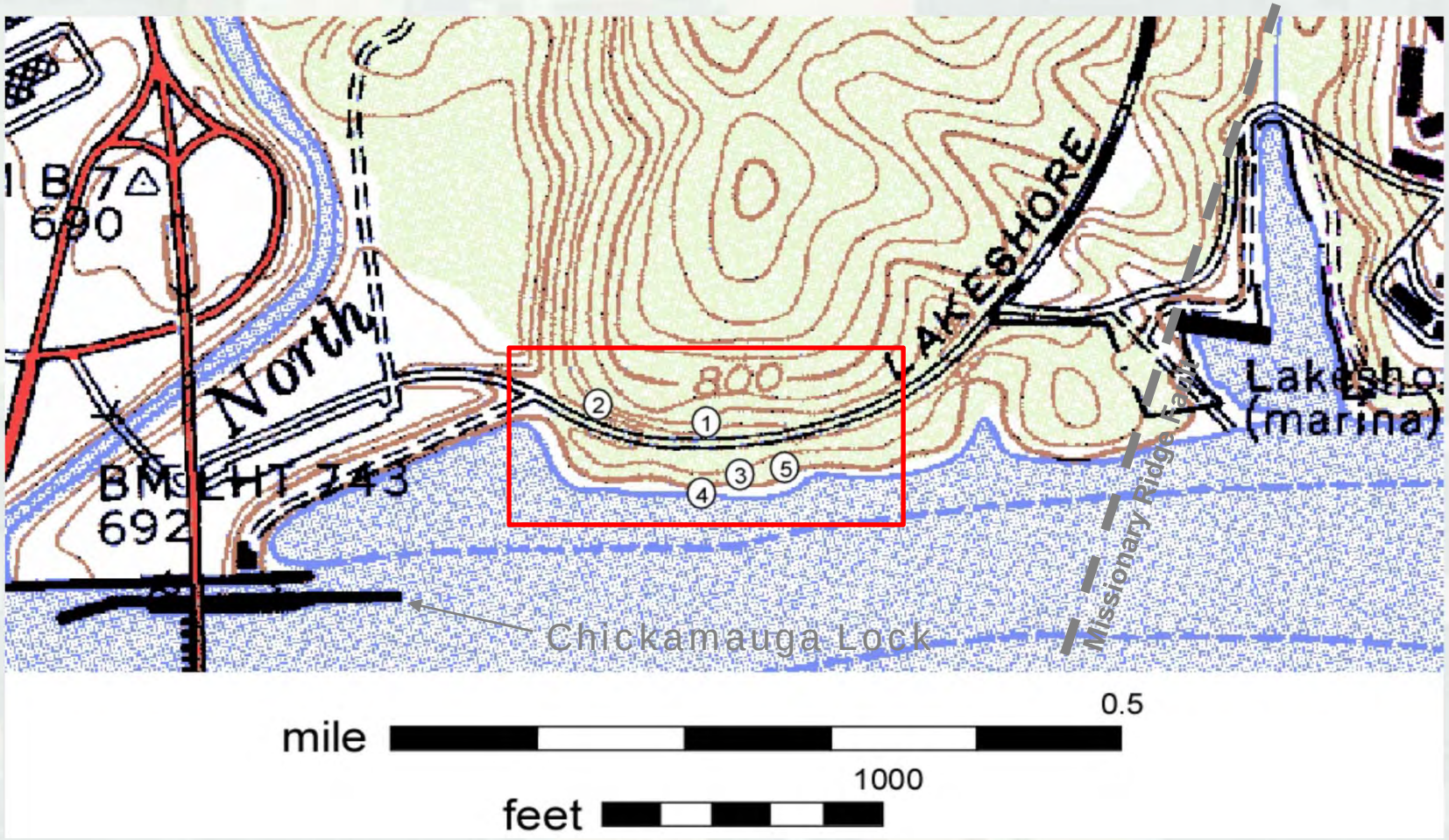


Geologic Map

Rocks strike 020 dipping to the southeast at 2-5 degrees at the surface, 40 degrees to vertical in some locations.

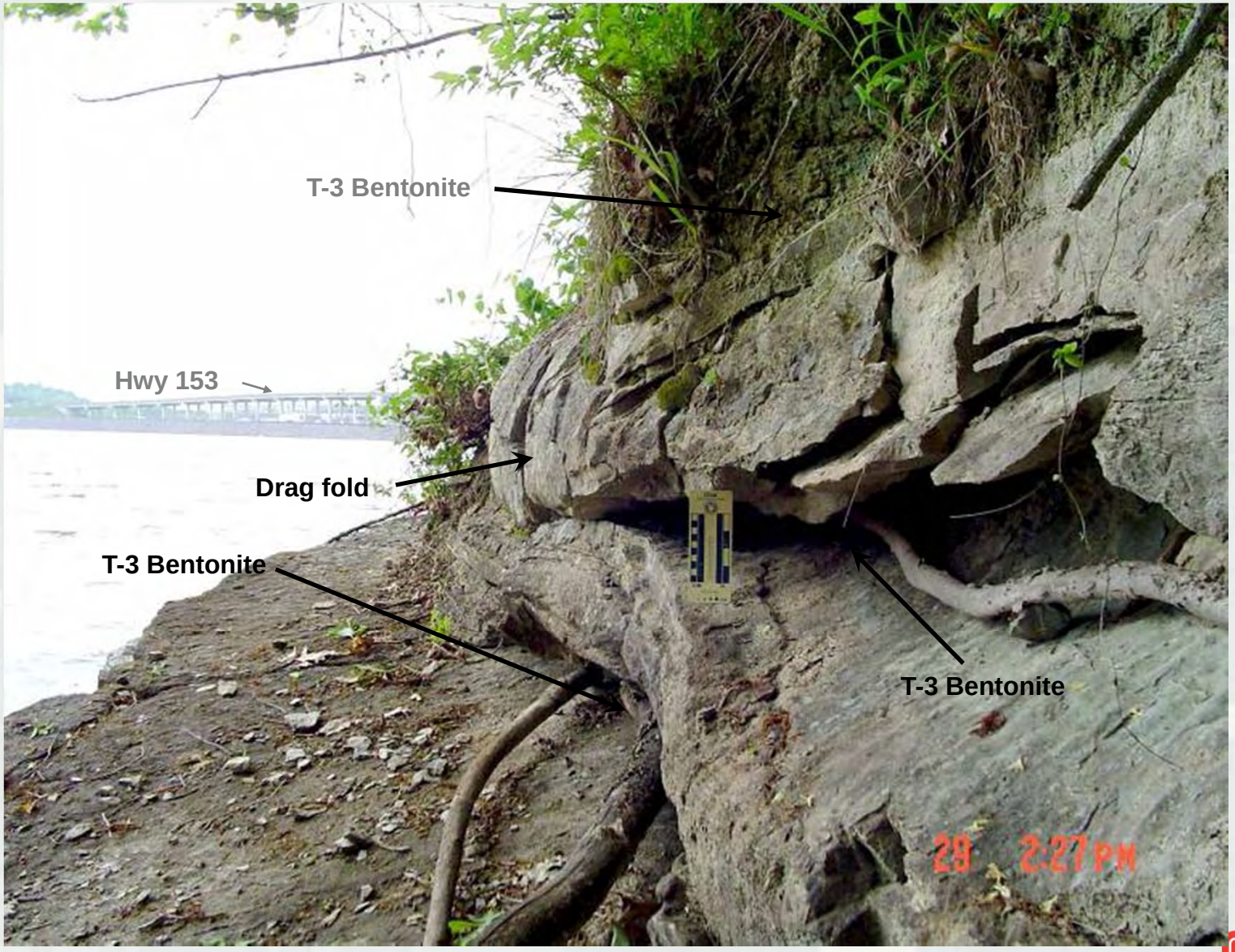


L-12 through L-14 geologic profile.



Sites of further field investigations upstream of Chickamauga Lock
Sites 1-5 bentonite, folding and faulting

Site 3 off of Lake Resort Drive upstream of the existing lock.



Site 4 upstream of existing lock.

Plate 3. Lock Excavation--Fault and Slickensided Surface. Lower Trenton Formation in Block 5 of Land Wall. Excavation on Left Side Through Bentonite Bed.

Original lock excavation cross cutting bentonite bed exposing fault and slickensided surface

Plate 2. Lock Excavation--Weathered Joints in Dipping Trenton Formation Looking East in Blocks 34 and 35.

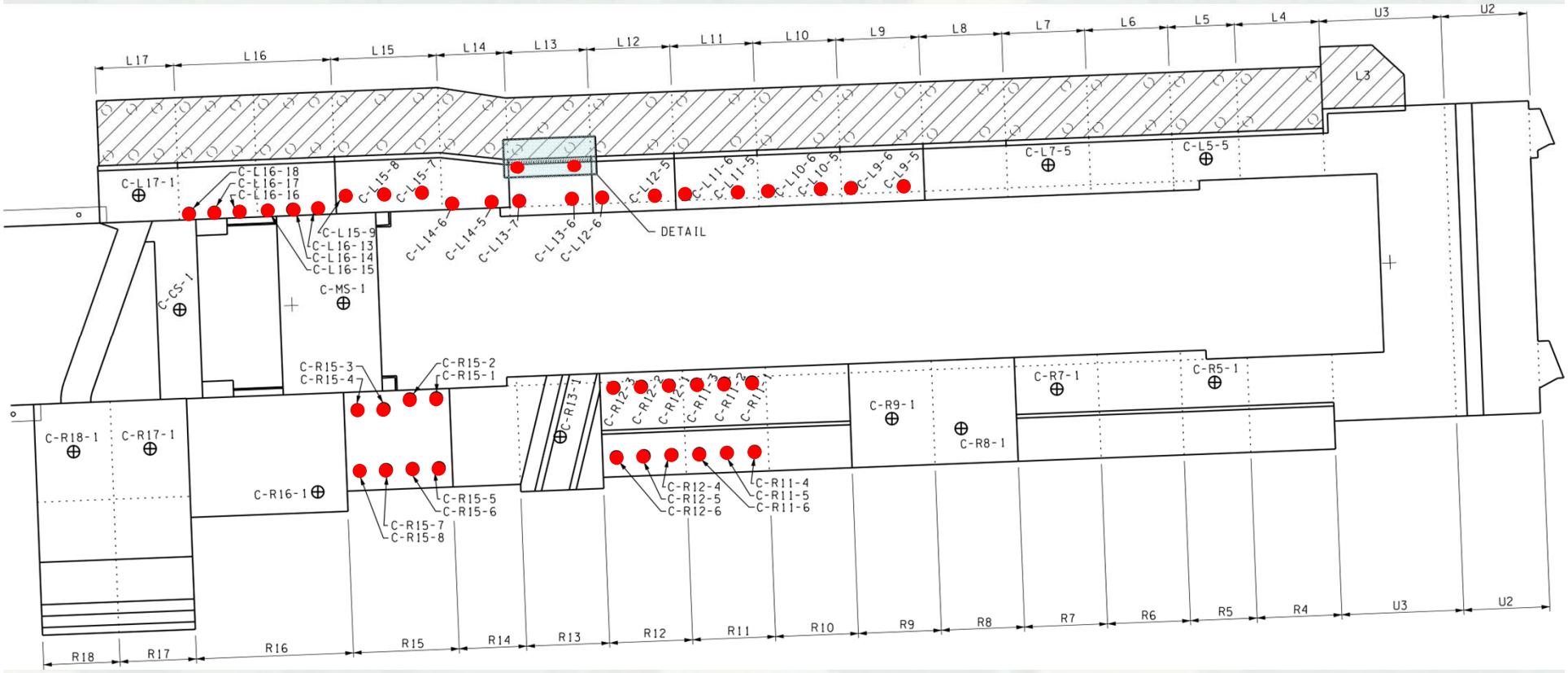
Highly weathered joints and solutioned cavities, looking east

Joint spacing as close as 2 feet is indicated by arrows
Two joint sets: 258-353 and 018-050
Vertical to near vertical dips with spacing from 2 to 9 feet

Design Solutions

- Design of Lock Monolith Foundations include:
  - Exploratory Drilling for Construction
  - Drilled Shaft Installation
  - Secant Wall Installation
  - Blasting, and Excavation
  - Foundation Drilling and Grouting
  - Excavation Stabilization

Drilled Shaft Location Plan



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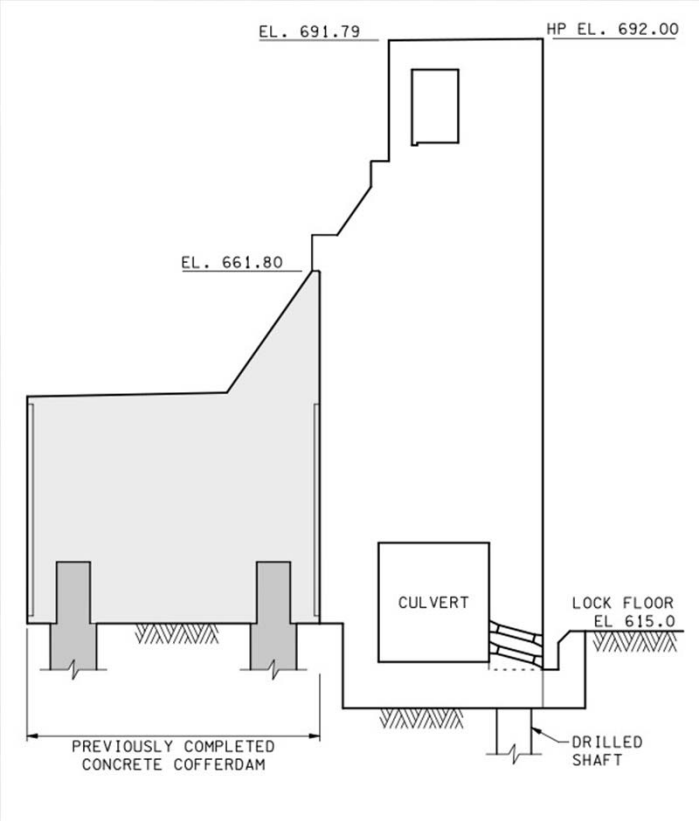
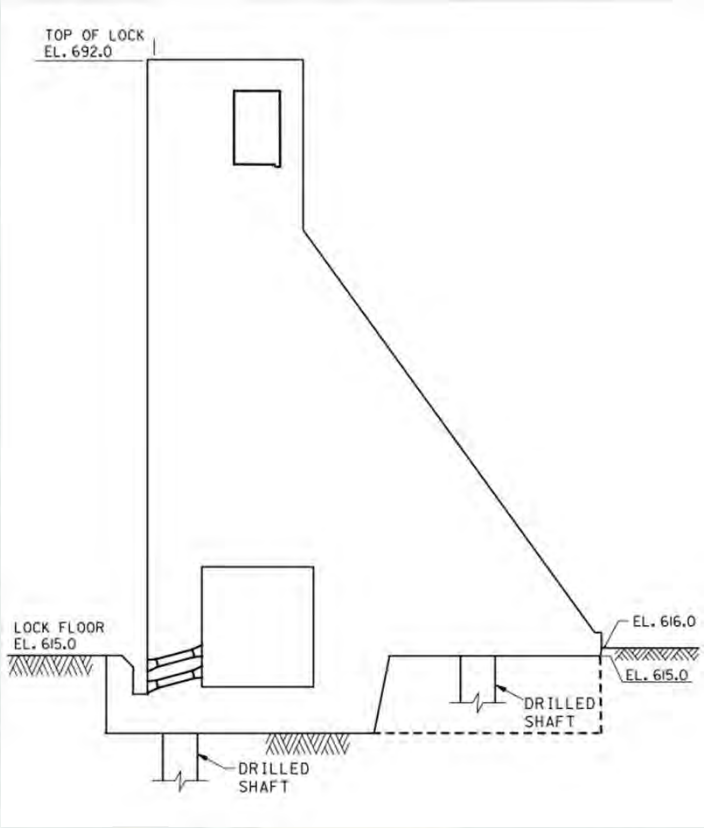




Integrated lock monolith, landside.

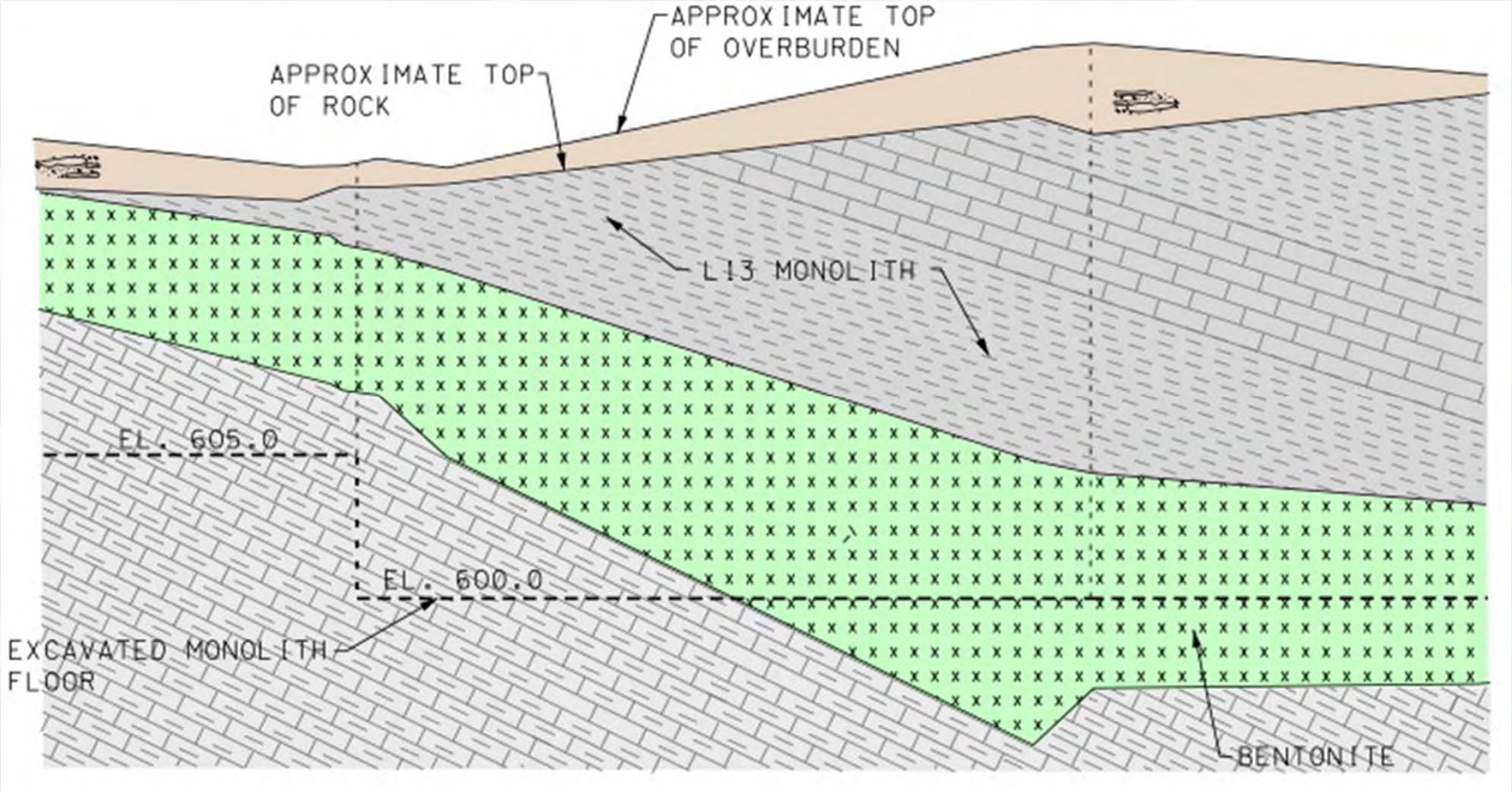
Riverside lock monolith.

Exploratory Drilling for Drilled Shaft Construction

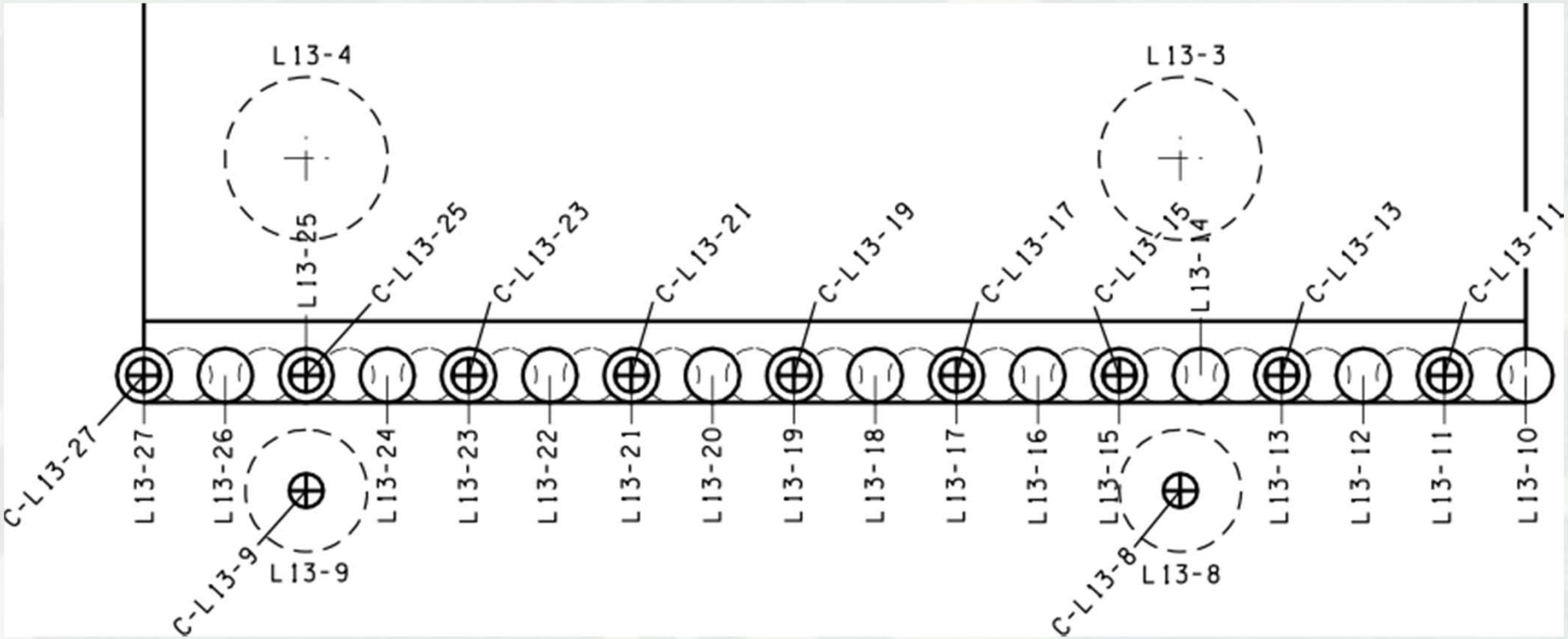
- One boring in center of structure to verify founding elevation conditions
- One boring at center of each drilled shaft to a depth of 10 feet below tip elevation
- HQ diameter vertical borings

Floating plant for cofferdam drilled shaft installation.

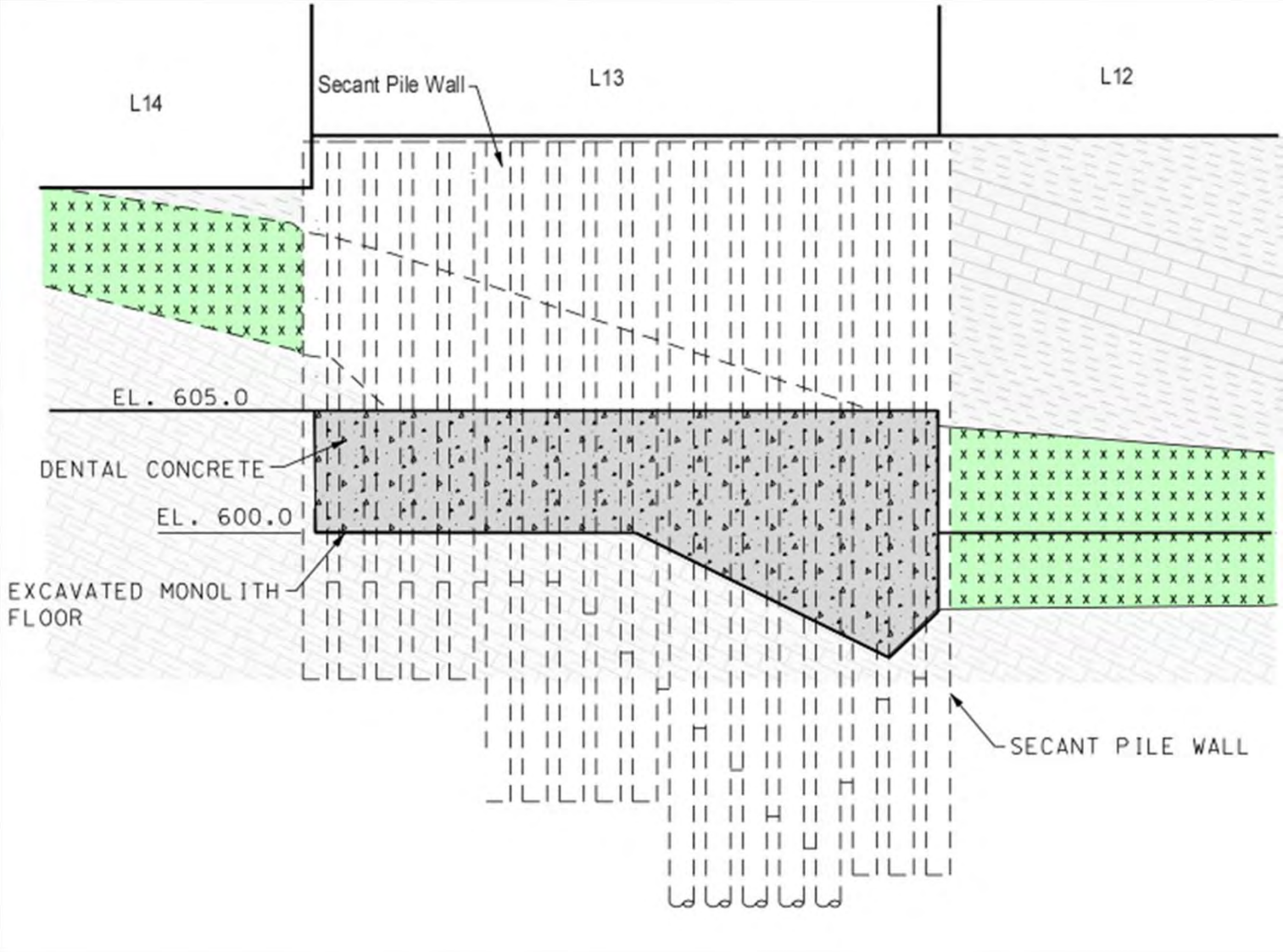
Structural steel for cofferdam drilled shafts.



L-12 through L-14 geologic profile.



L-13 Secant wall, plan view.

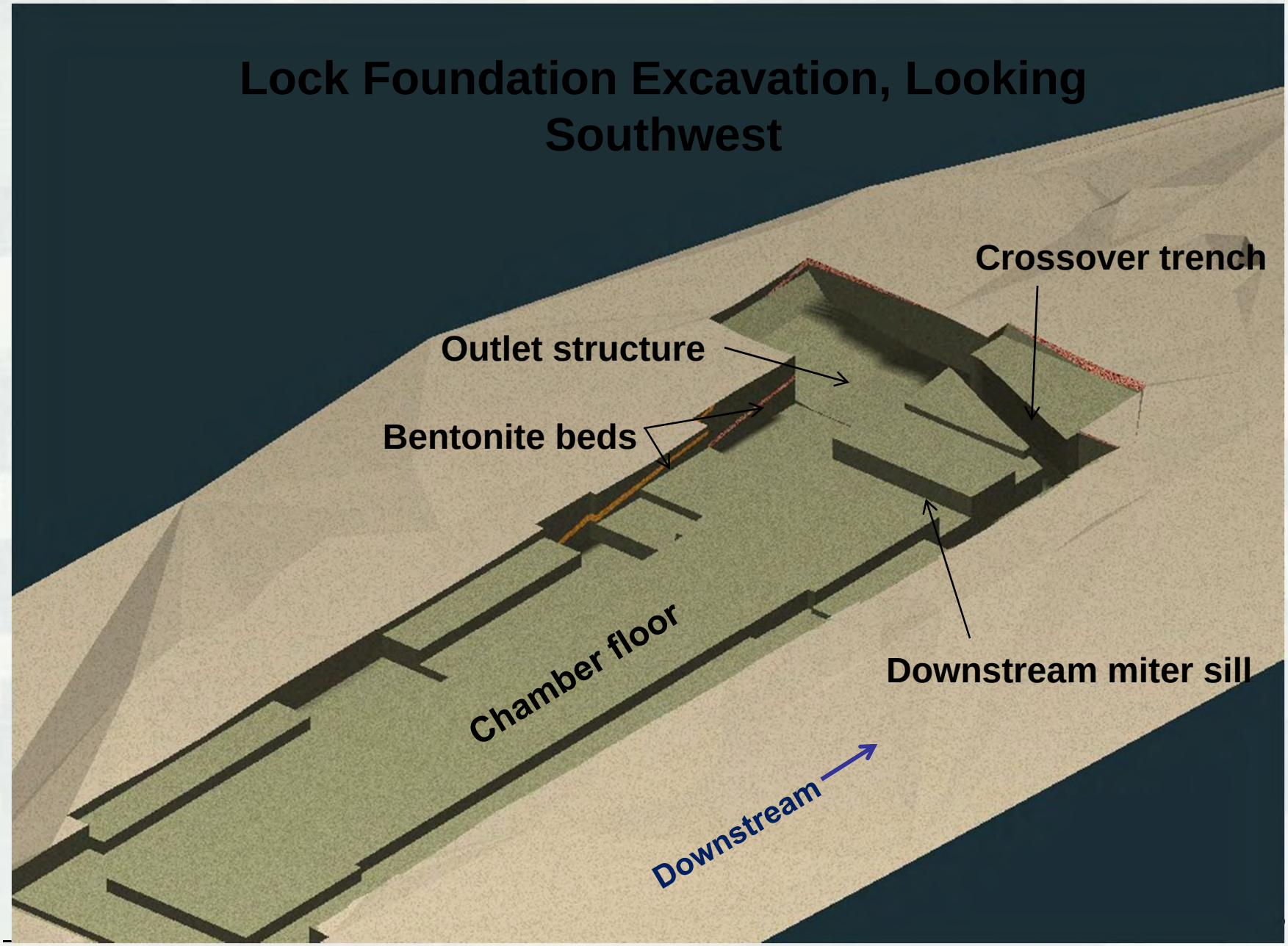


Secant wall construction at L-13.

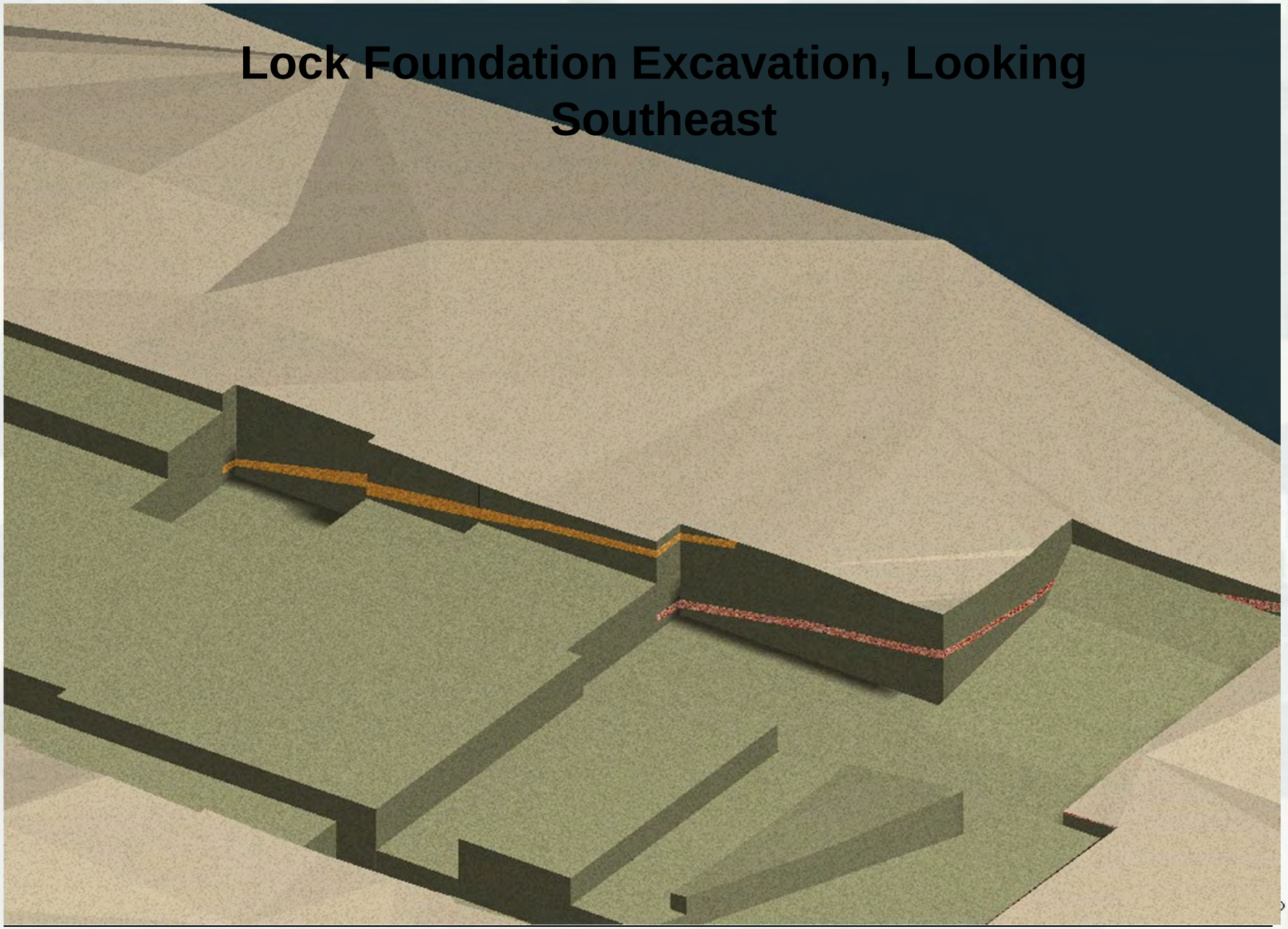
Blasting

- Blasting extremely important at this project
- Most major rock excavation will be accomplished by drilling and blasting
- Types of blasting; Pre-splitting, Pre-splitting at monolith joints, line drilling, production blasting
- Preblast survey conducted end of September of 2007
- Structures examined; TVA Power Management Facility, Chickamauga Lock, Dam and Powerhouse, the other facilities

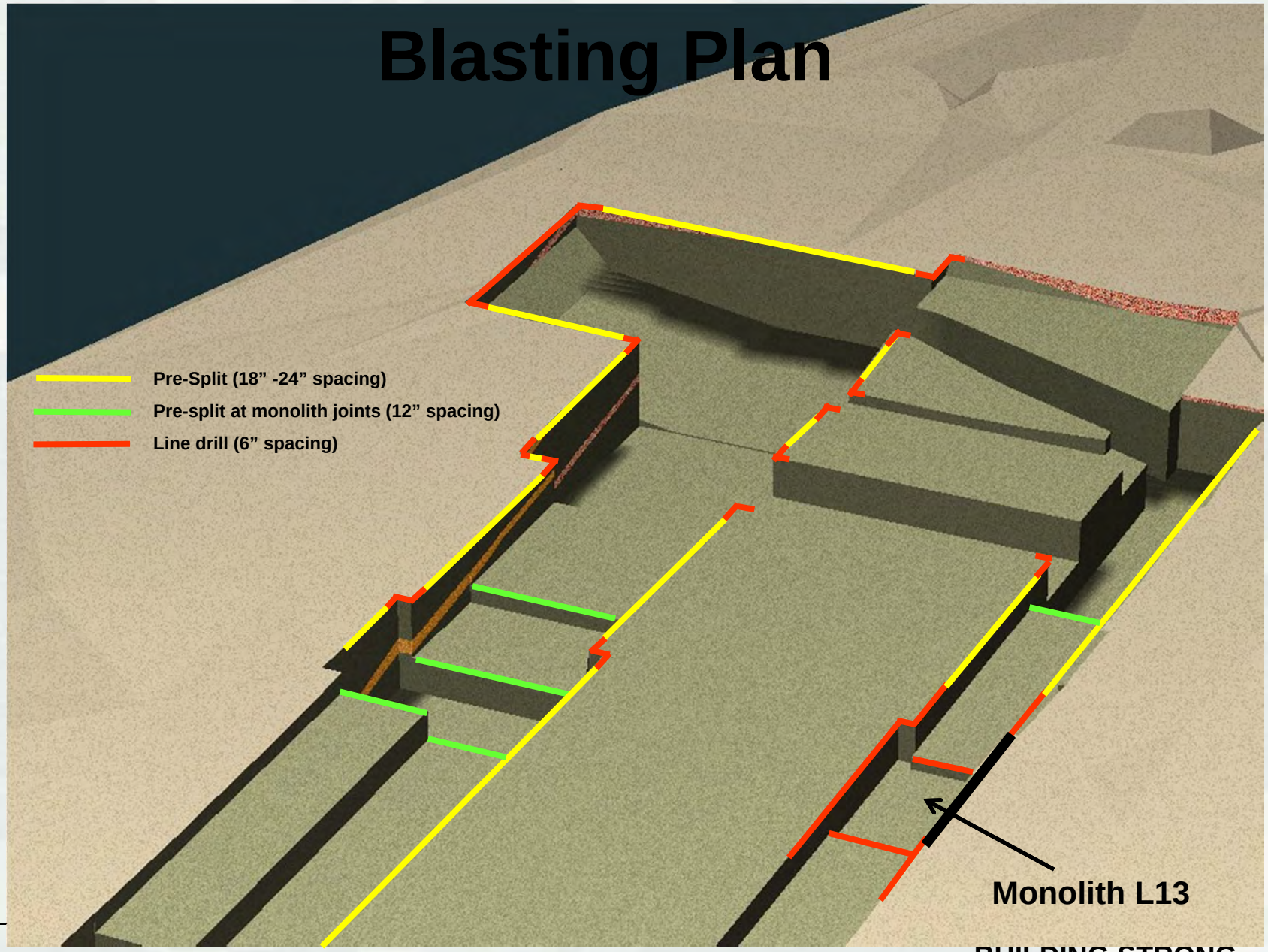
Lock Foundation Excavation, Looking Southwest



Lock Foundation Excavation, Looking Southeast



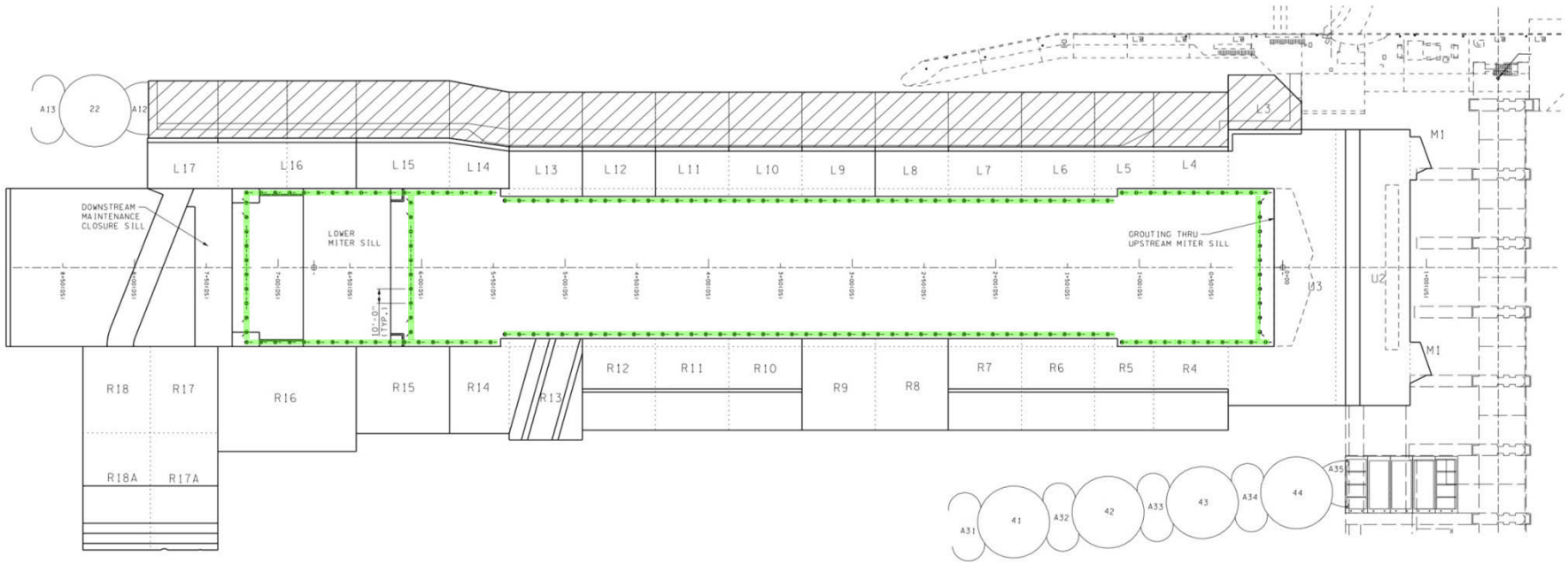
Blasting Plan



Foundation Drilling and Grouting

- Grouting needed to minimize leakage
  - Operational condition
  - Maintenance condition
- Seepage analysis performed to evaluate grout curtain effectiveness
- Single line grout curtain placed with holes drilled on 10 foot centers, 30 degrees from vertical.
- Contingency in quantities for split spacing to be applied as needed.

Foundation Grouting Plan



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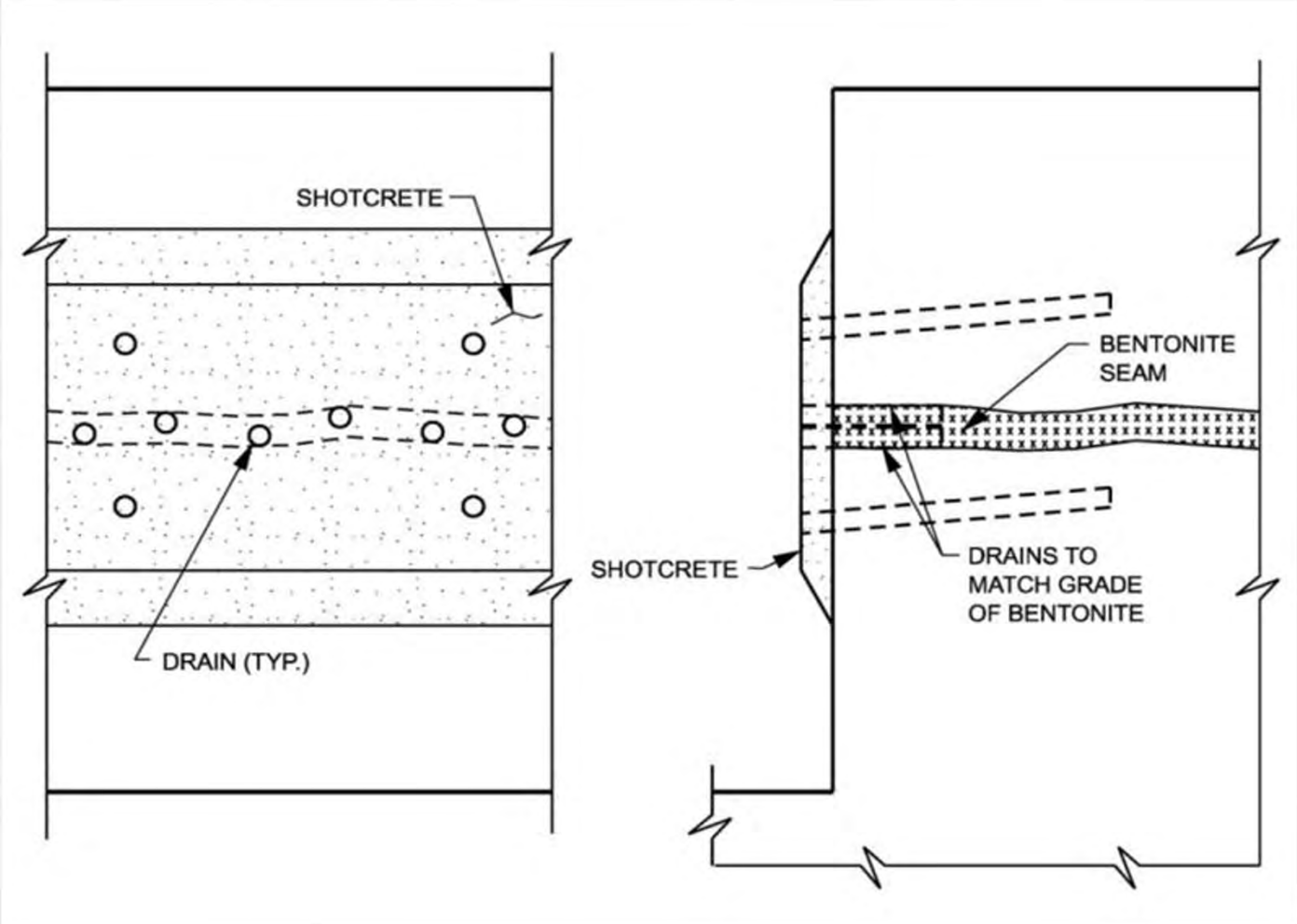
Excavation Stabilization

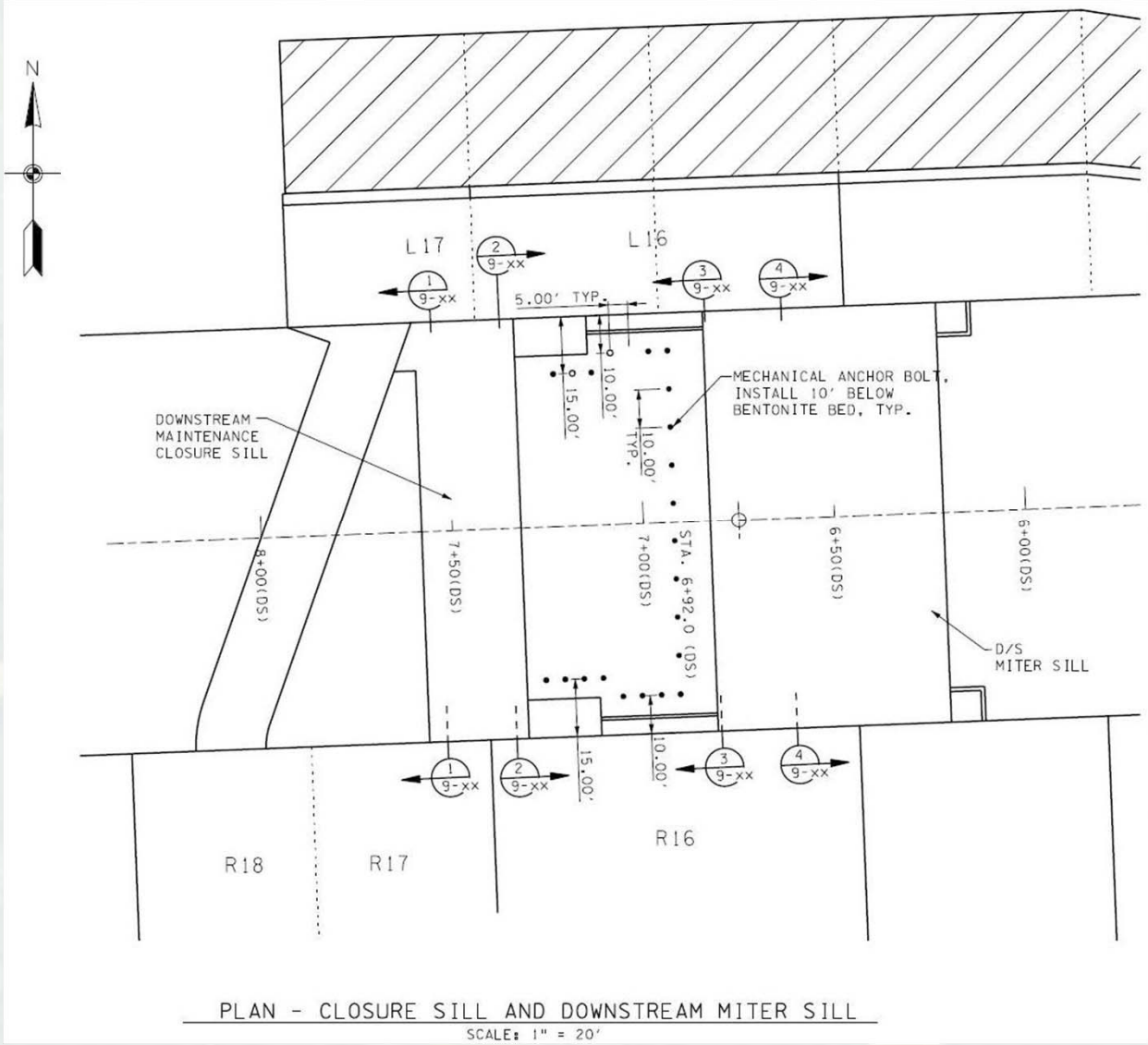
Rock Bolts And Shotcrete

- Closely spaced joints, bedding planes dipping into excavation and bentonite beds make slope failures possible.
- Rock bolts, shotcrete, drains and limits on excavation employed to maintain excavation stability.
- Rock bolts consist of 15’, 20’ 25’ and 30’ vertical and angled mechanical bolts for the excavation.
- Large stranded anchors are to be installed at the toe of the cellular coffercells to maintain stability of cofferdam during excavation.

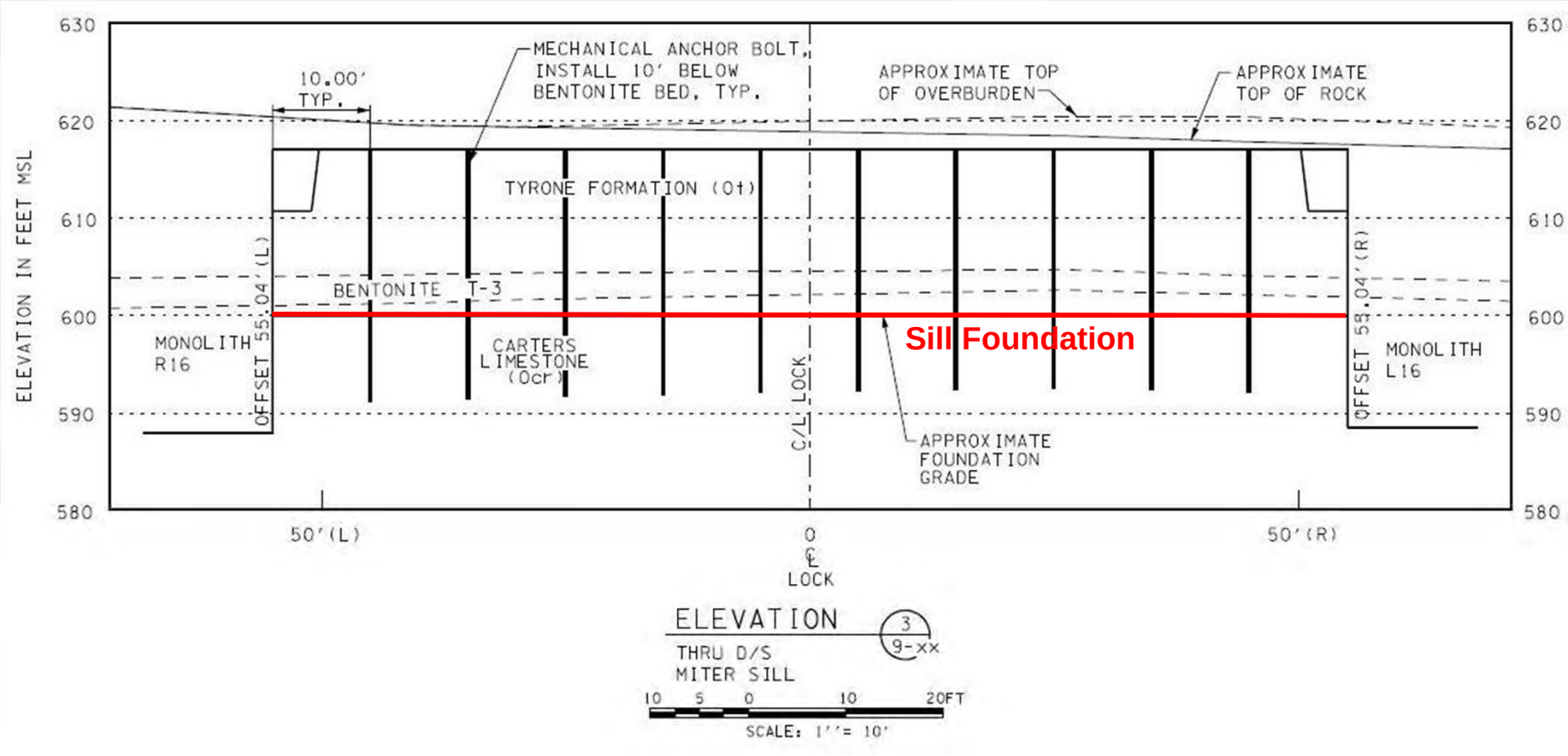
Shotcrete Application and Drain installation



Rock Bolts at D/S Miter Sill, Plan



Rock Bolts at D/S Miter Sill, Section




Questions?