18TH GERALD A. LEONARDS LECTURE

Application of ~~Unconventional~~ Innovative Geotechnical Solutions

~~2020~~ ~~2021~~ 2022

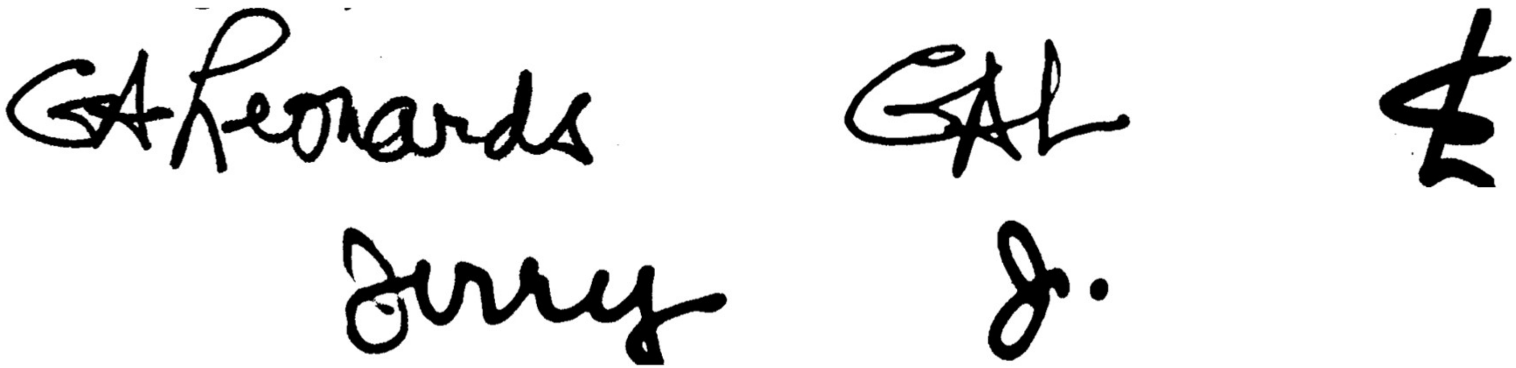
Rick Deschamps, PE, PhD, V.P. of Engineering

Prof. Leonards from My Perspective

- An Innovative Engineer – a practitioner > 150 challenging consulting jobs.
- All his research began as topics that were inadequately understood in practice.
- A relentless investigator – with his Sherlock Holmes approach to solving mysteries (failures).
- Unquenchable thirst for understanding.
- Tremendous breadth of knowledge.
- Sometimes frighting work ethic.
- Brusque and intimidating to some people.
- Caring.

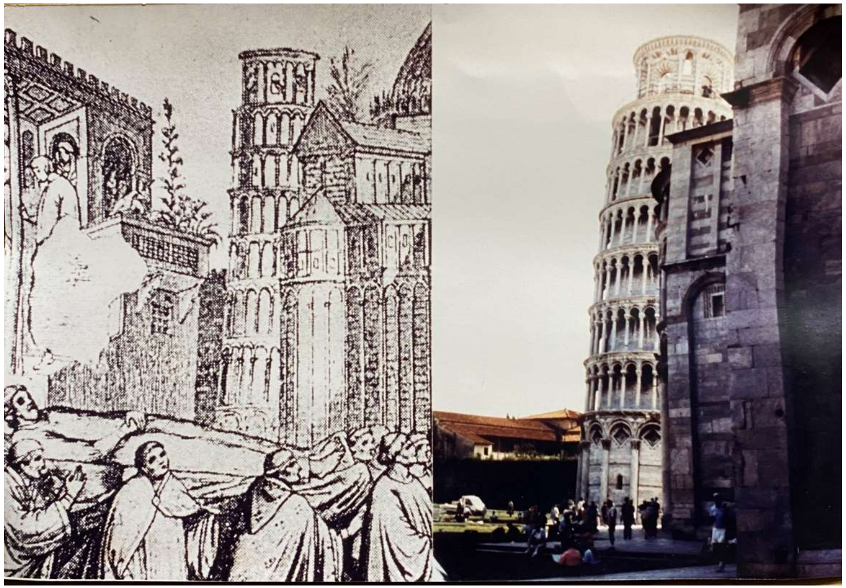
Prof. Leonards from My Perspective (cont.)

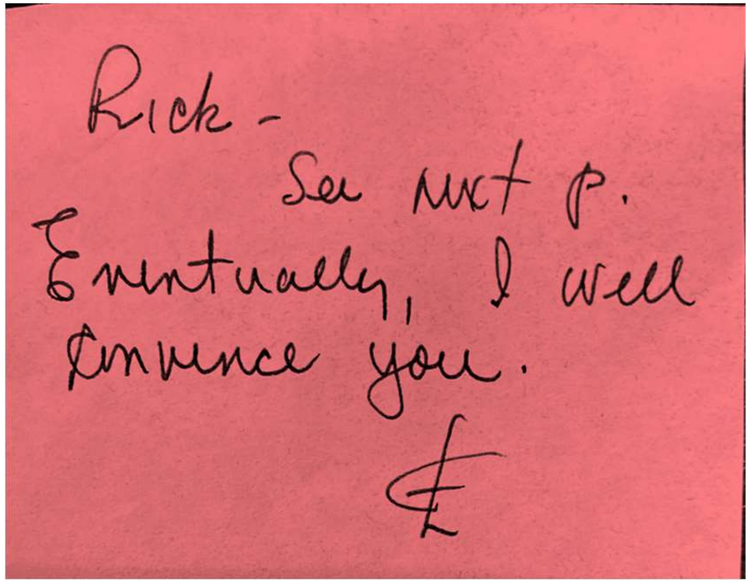
- He wrote many Discussions seeking a better understanding and this was often misunderstood.
- With all papers he’d send copies to 4 or 5 “experts” and invite them to discuss.
- His case histories class was amazing. He focused on concepts, not in facts.
- An avid letter writer to all his peers, former students and to the authors of papers he found of interest or when he wanted more detail.
- Long running debate-based correspondence with Ralph Peck, Vic Milligan, Carlos Santamarina, John Schmertmann, Bill Lambe and so many others.



Prof. Leonards from My Perspective (cont.)

- A prolific reader of all technical journals and research reports.
- I think the thing that resonated with me the most was that models are imperfect tools to guide us – not reality. Our judgement was equally important.
- On a personal note, we often played golf and we shared hotel rooms at conferences.





Prof. Leonards from My Perspective (cont.)

- Finally, it is hard to remember Jerry without also thinking of Milt Harr.
- Jerry, Milt and I had a cup of coffee at McDonalds most every day.

THOMAS D RICHARDS, JR

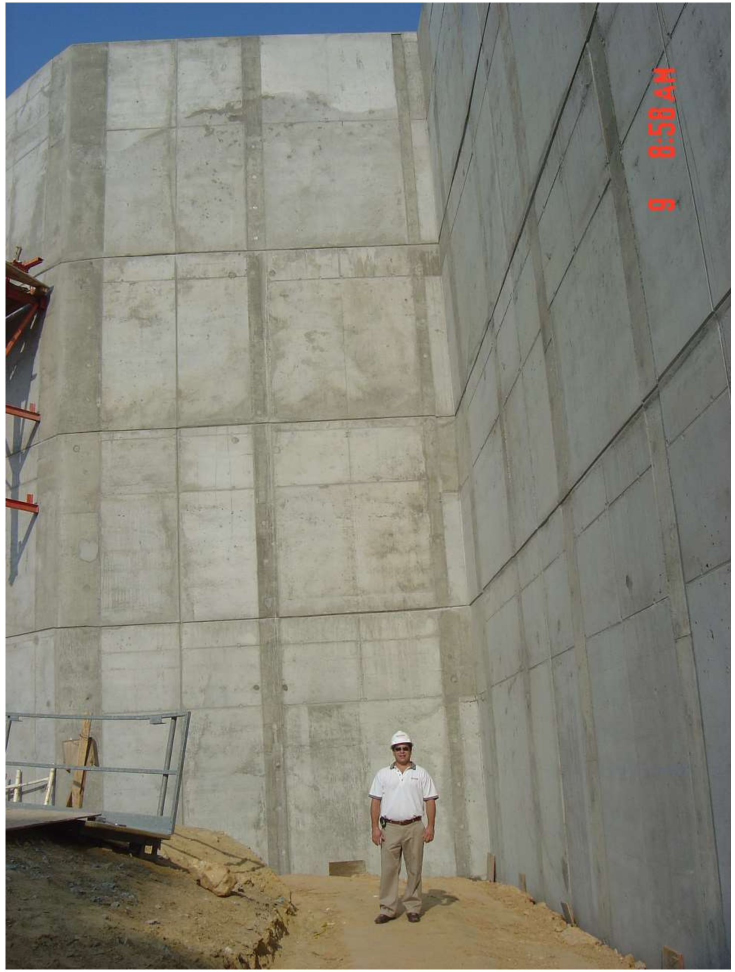
Outline

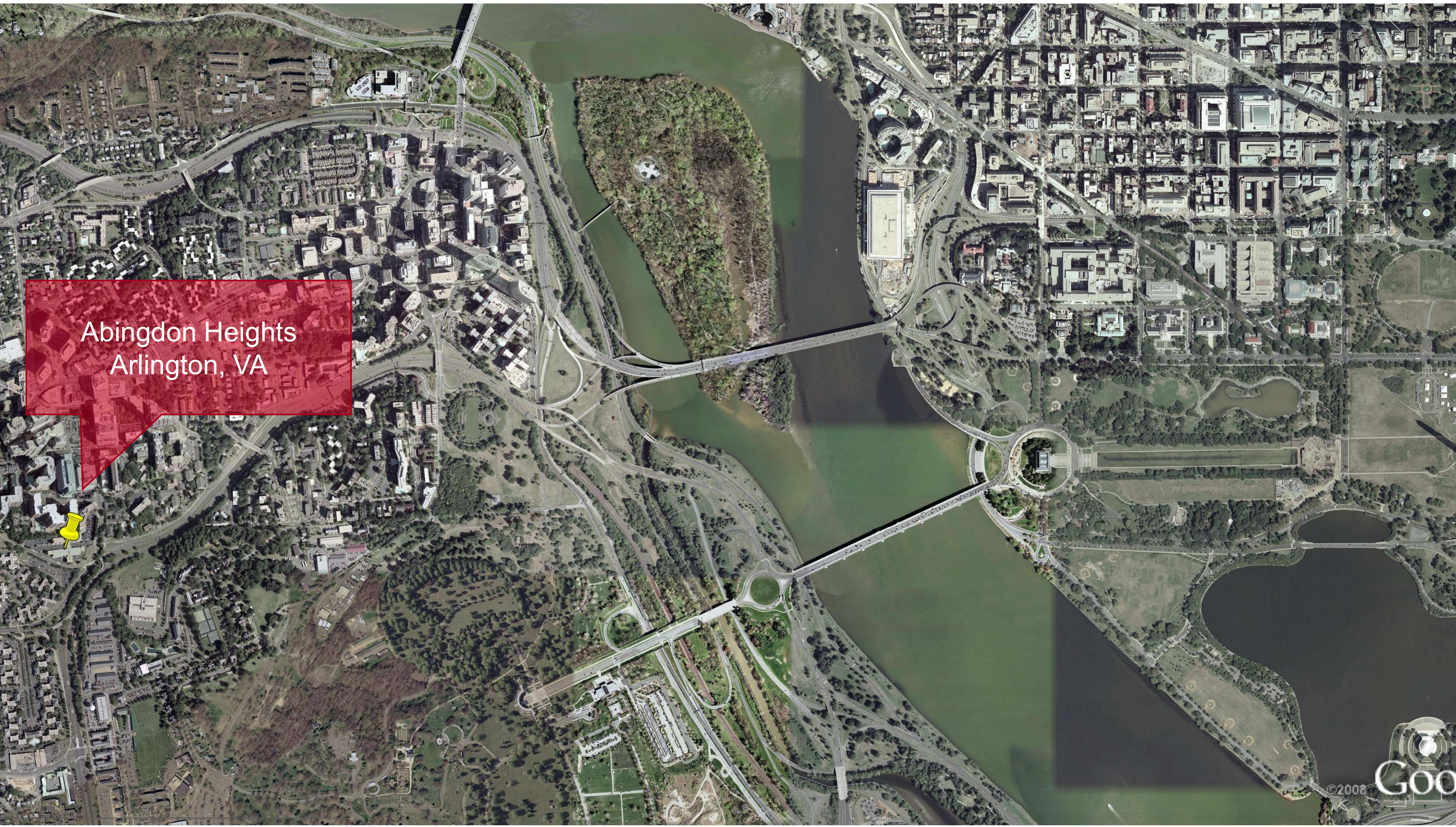
- Perquisites for Unconventional Design
- Case Histories
  - Abingdon Heights Cantilever Wall
  - Crookston Slope Stabilization
  - Portland CSO Storage Structure
  - Prairie du Sac Dam Rehabilitation

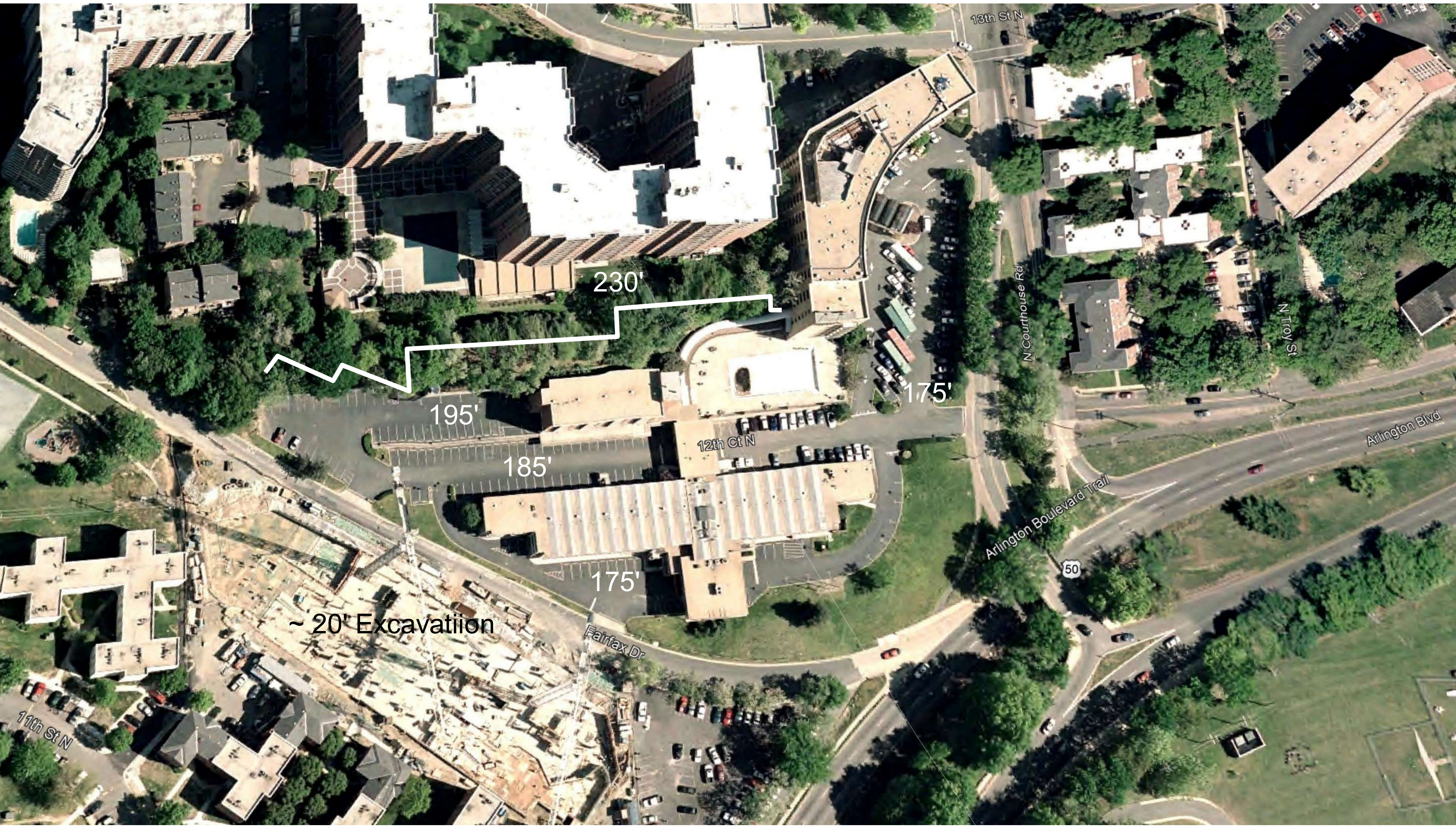
Unconventional Design Generally Requires:

- A motivated owner: significant reductions in cost, schedule or risk,
- An uncommon problem, where the best solutions have not yet evolved,
- Sufficient and reliable information,
- Enough time to really explore various options,
- Analytical tools, often numerical modeling, to provide credibility to the approach, and
- The eagerness and confidence to try something new.

Abingdon Heights, Arlington VA - 48.5 ft Cantilever Wall

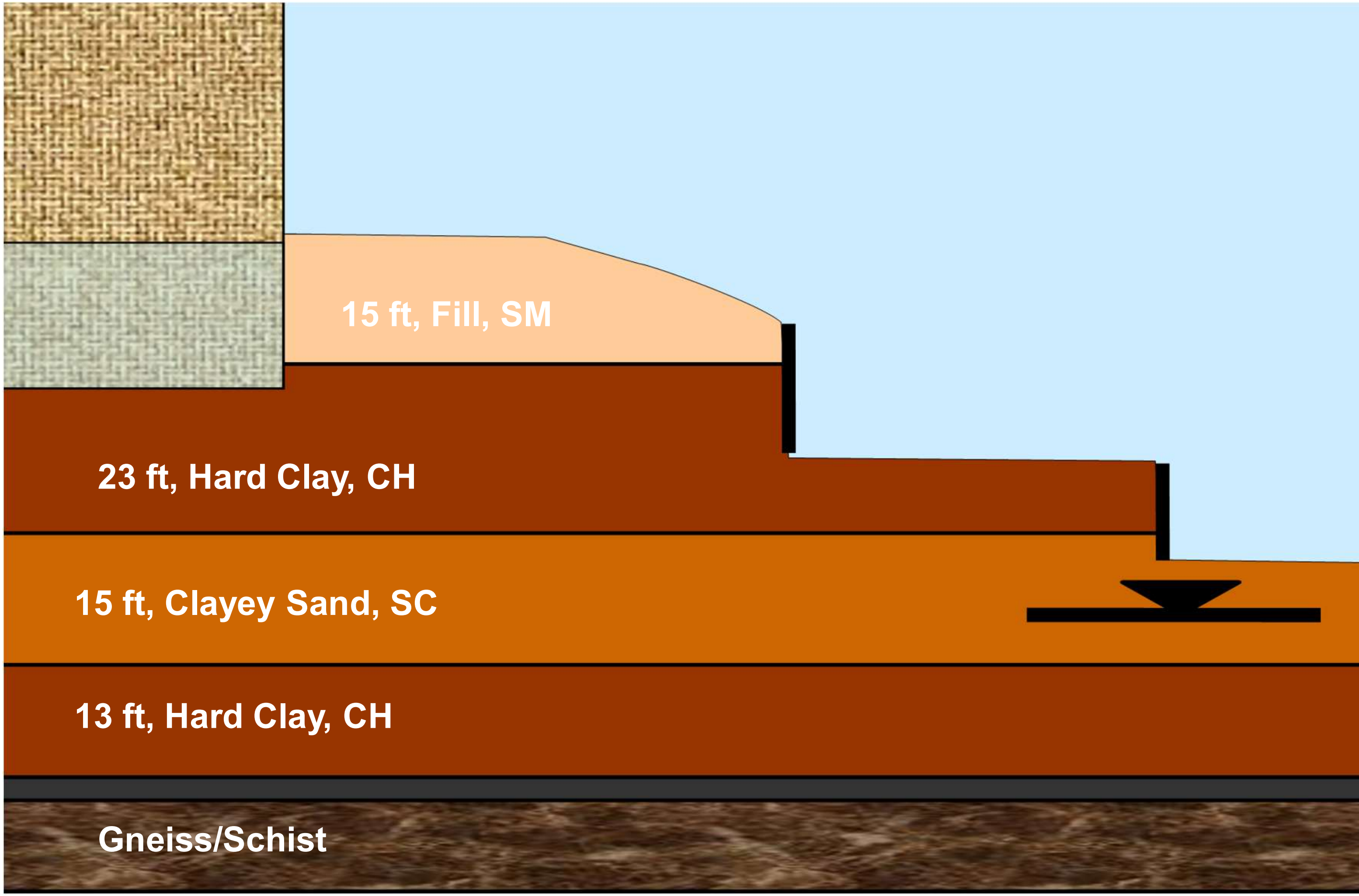



Abingdon Heights
Arlington, VA
©2008



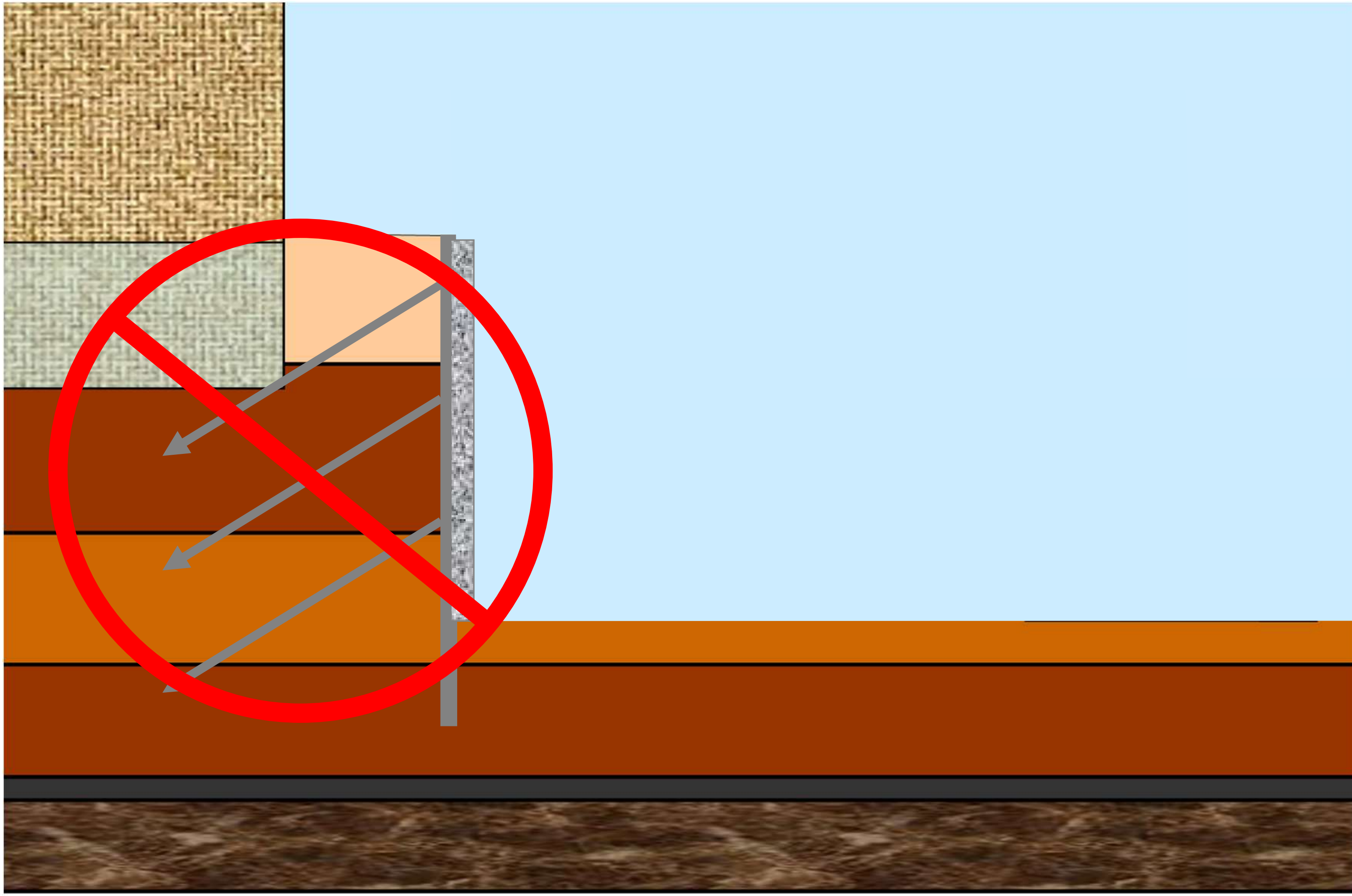
13th St N
230'
N Courthouse Rd
N Troy St
195'
175'
12th Ct N
185'
Arlington Blvd
Arlington Boulevard Trail
50
175'
~ 20' Excavatiion
Fairfax Dr
11th St N

Design Concepts

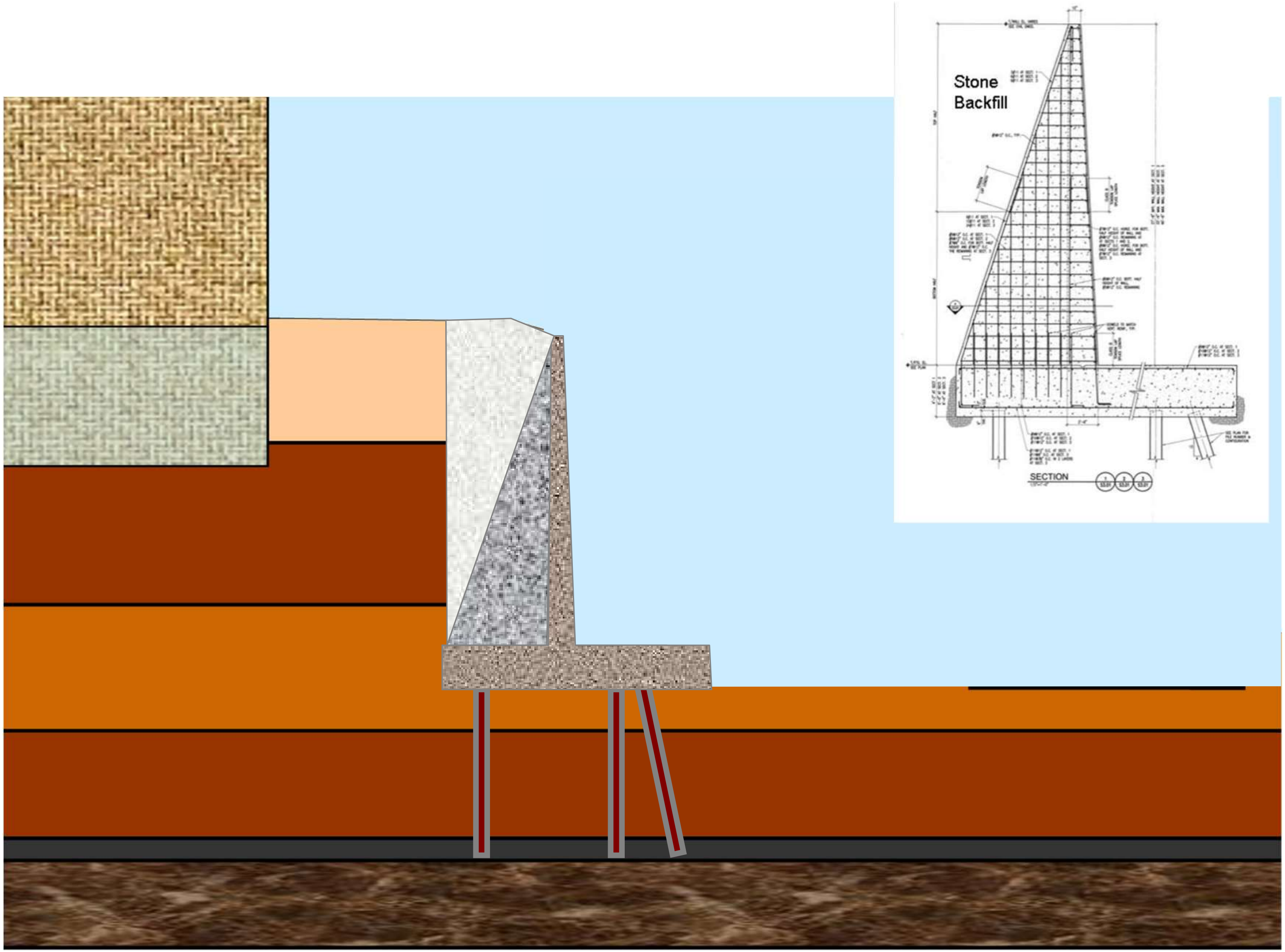


Design Concepts

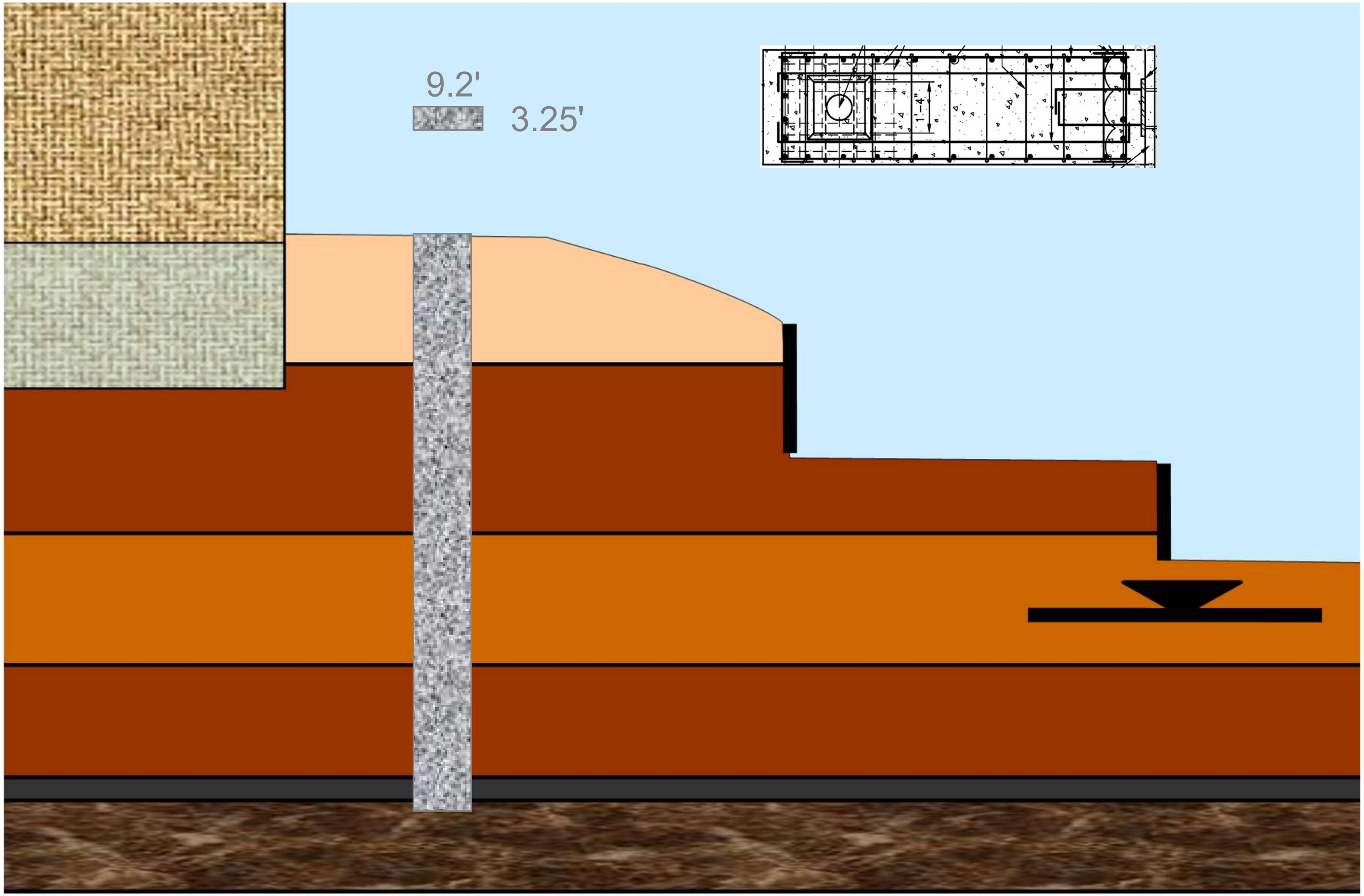
Most Economical Design



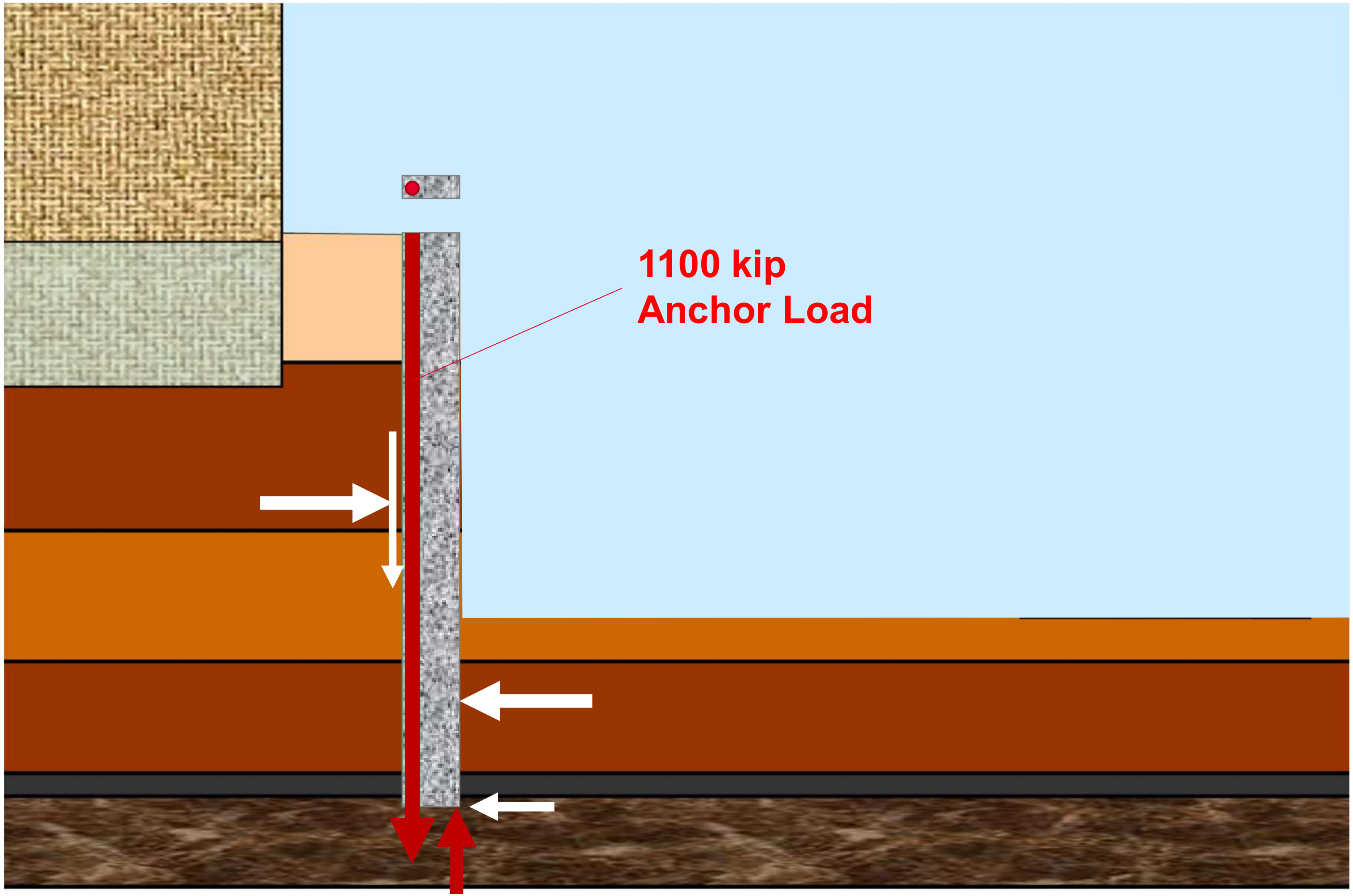
Original Design



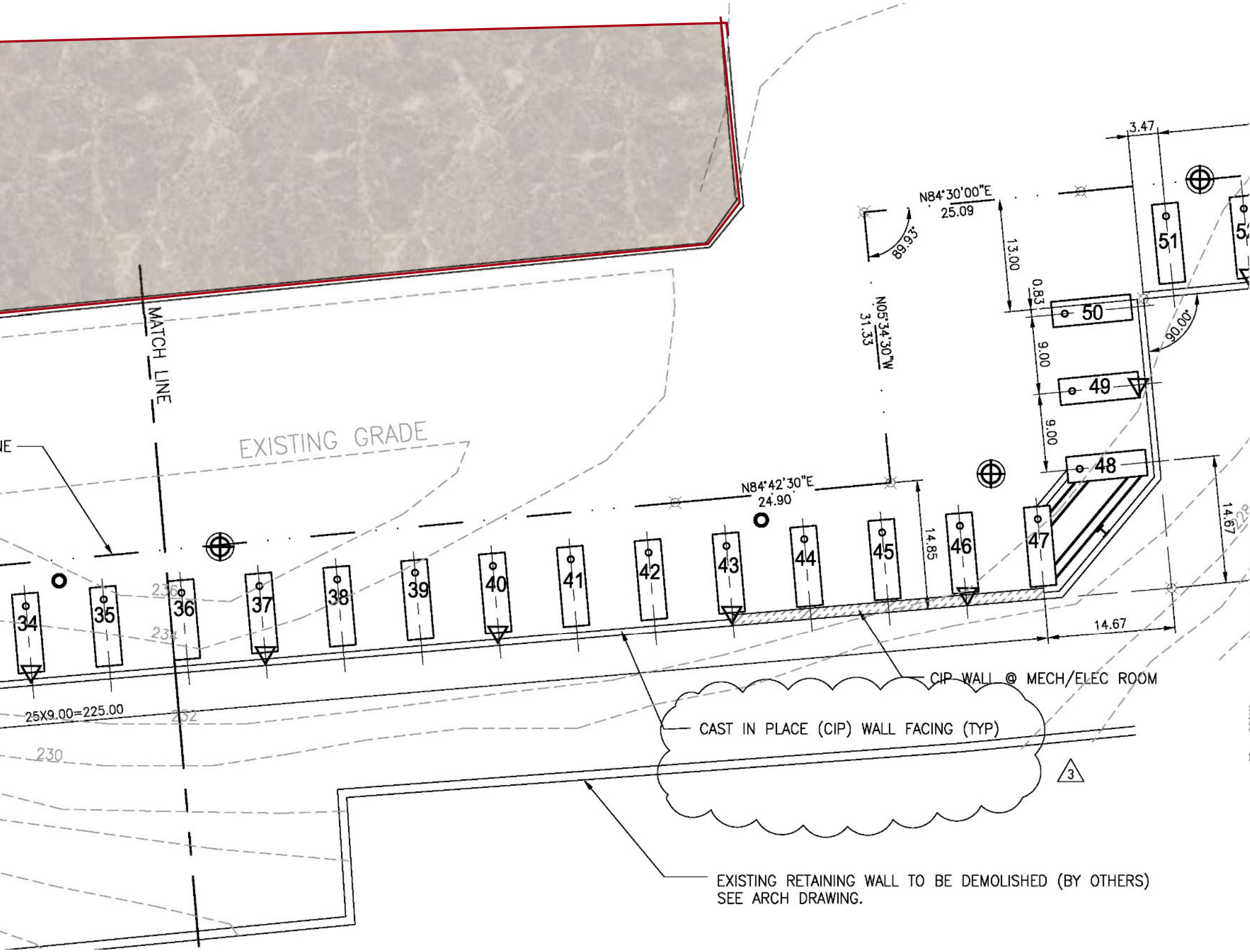
Alternative Design

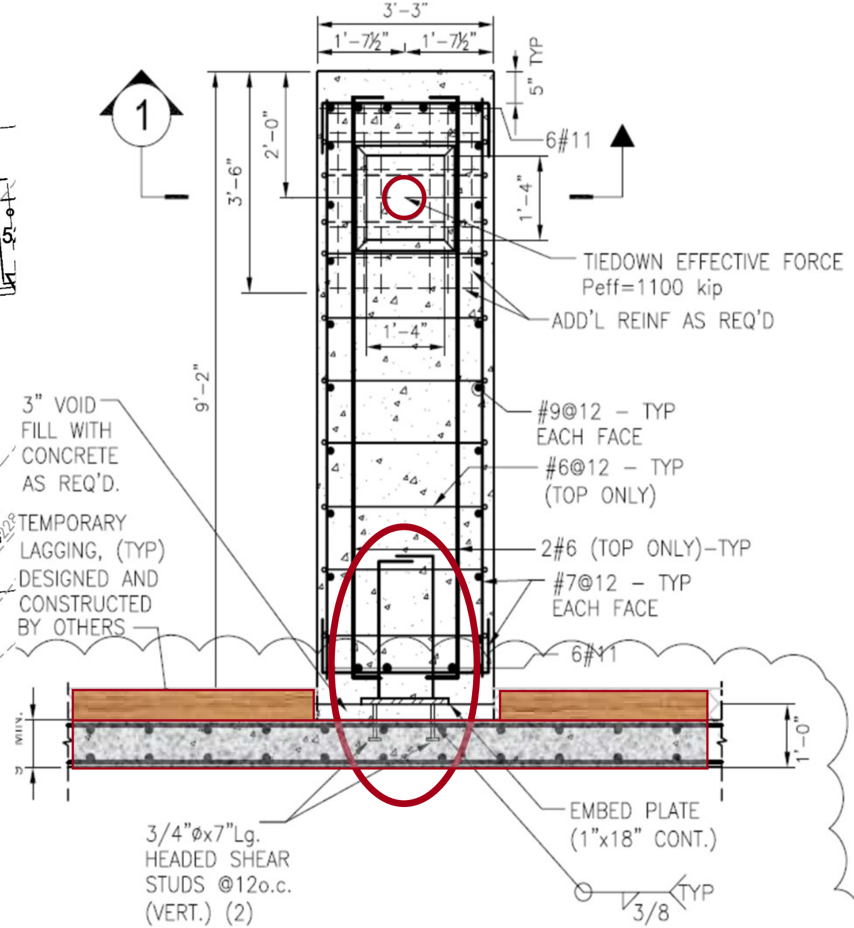


Alternative Design



Barrette Layout





Construction Phase

Stable Work Platform

Excavation

Excavation

Setting Cages

Setting Cages

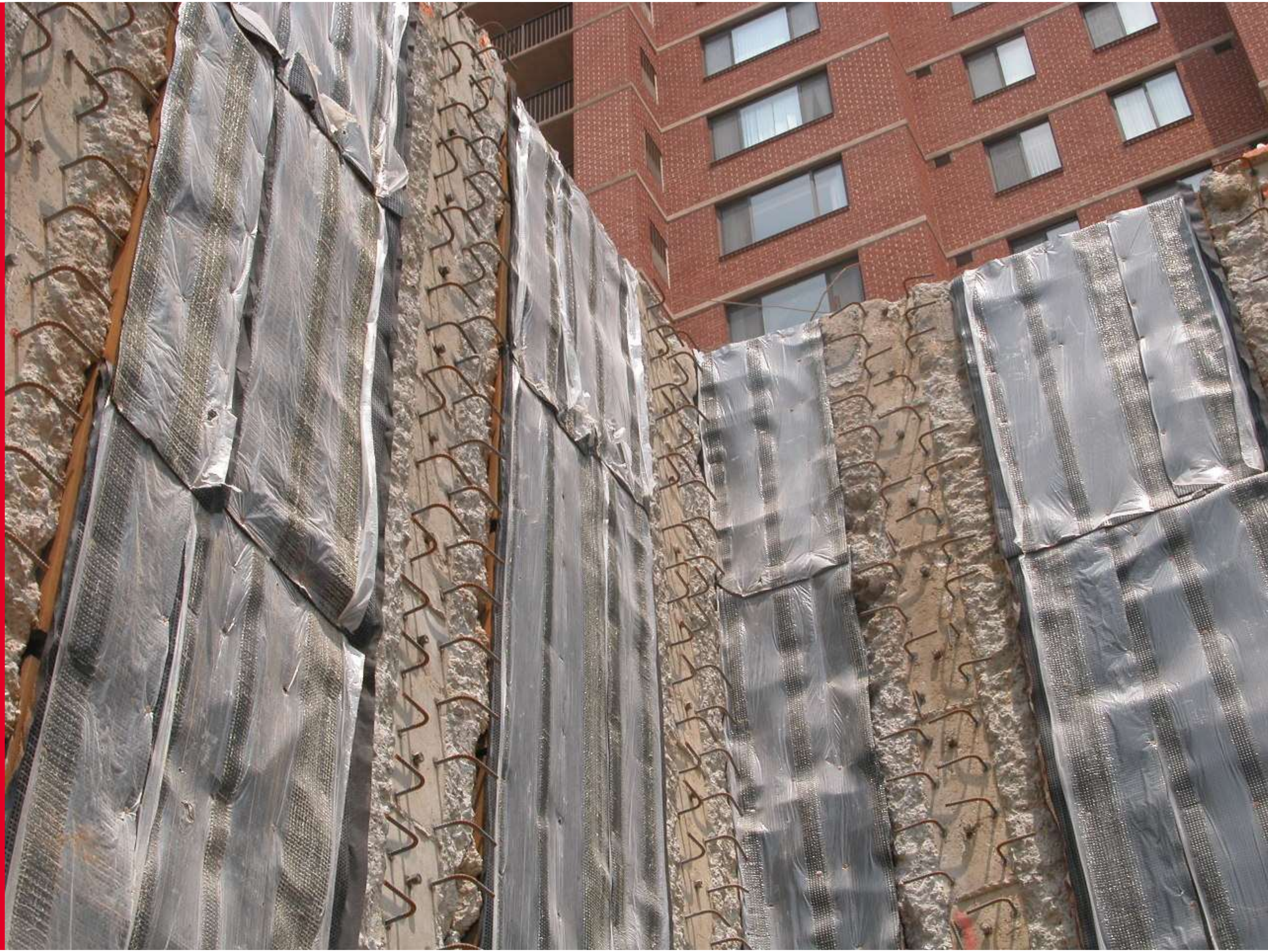
Concreting

Concreting

Tie- Down Anchors

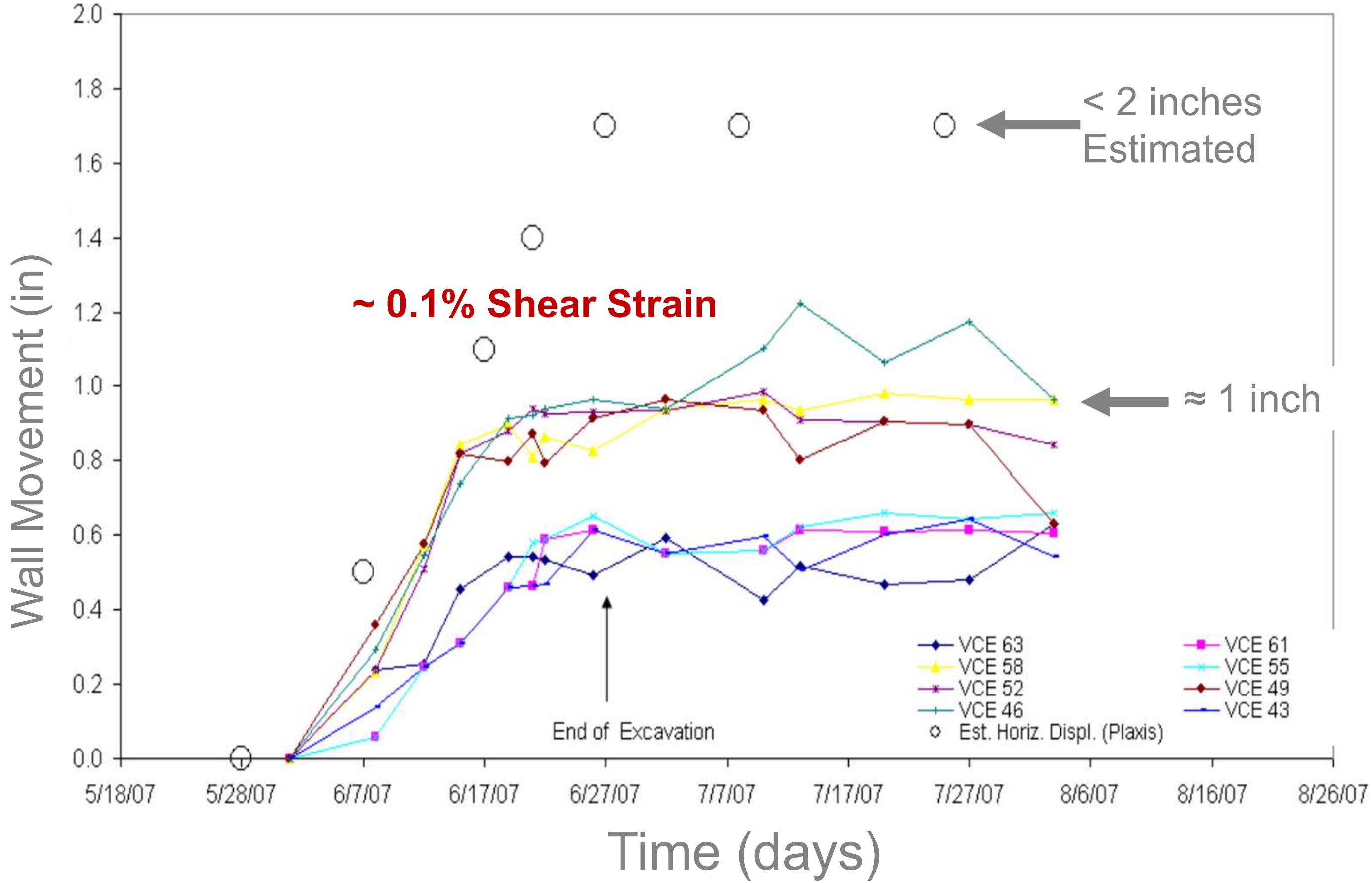
Anchor Stressing

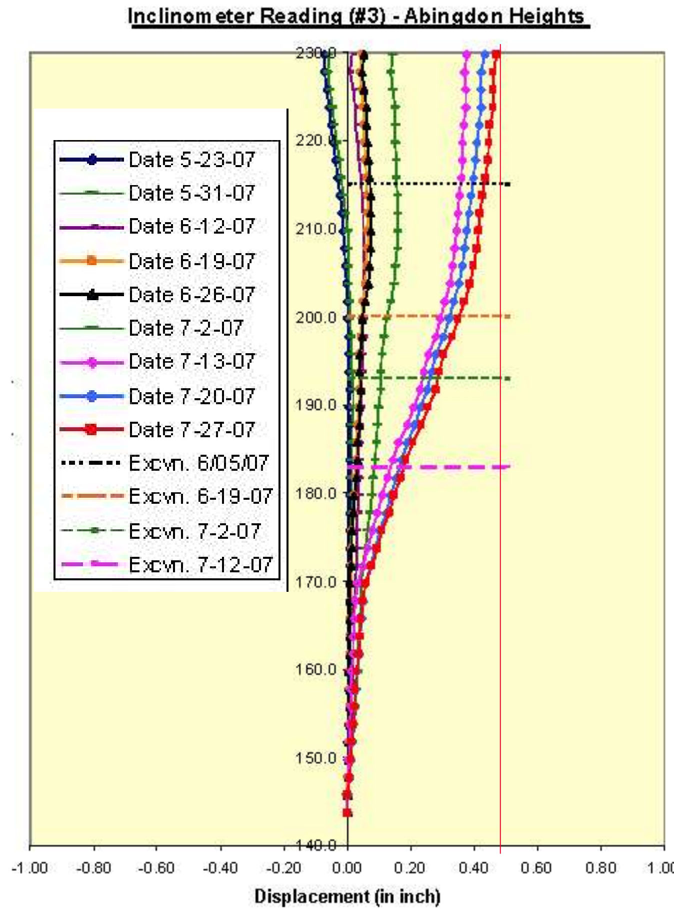
Lagging and Drainage



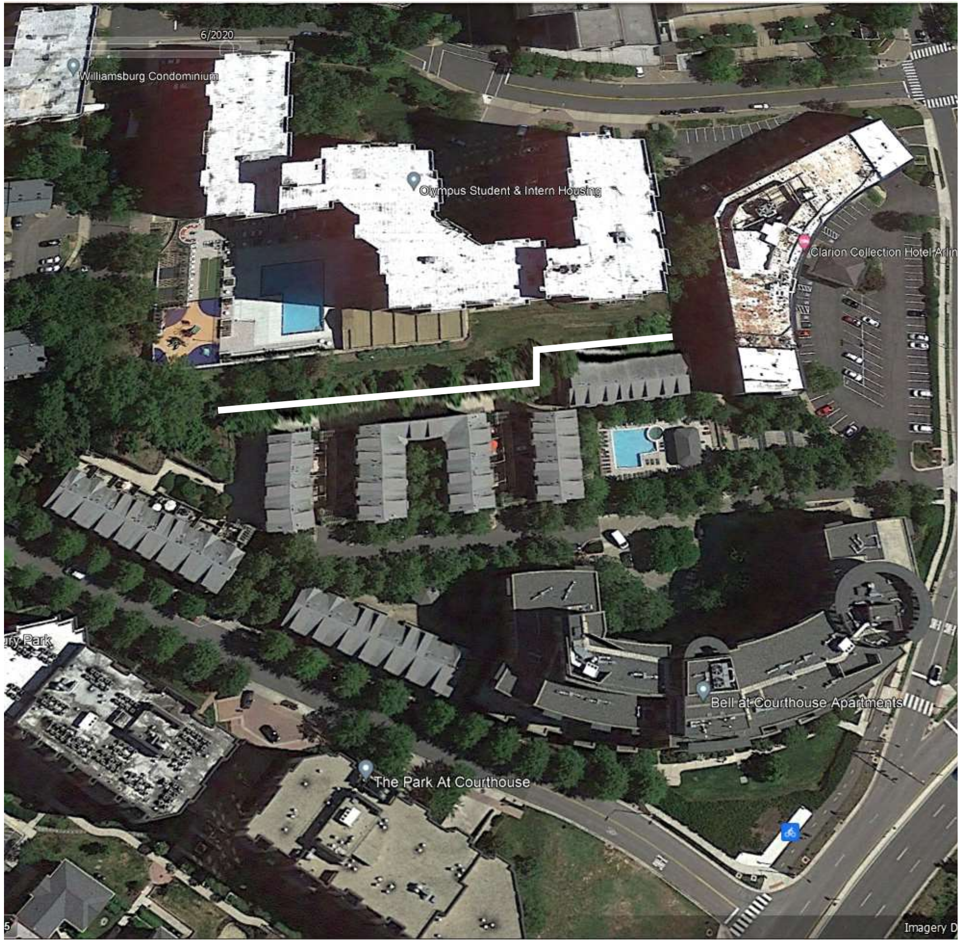
Cast-in-Place Concrete Facing

Monitoring Results





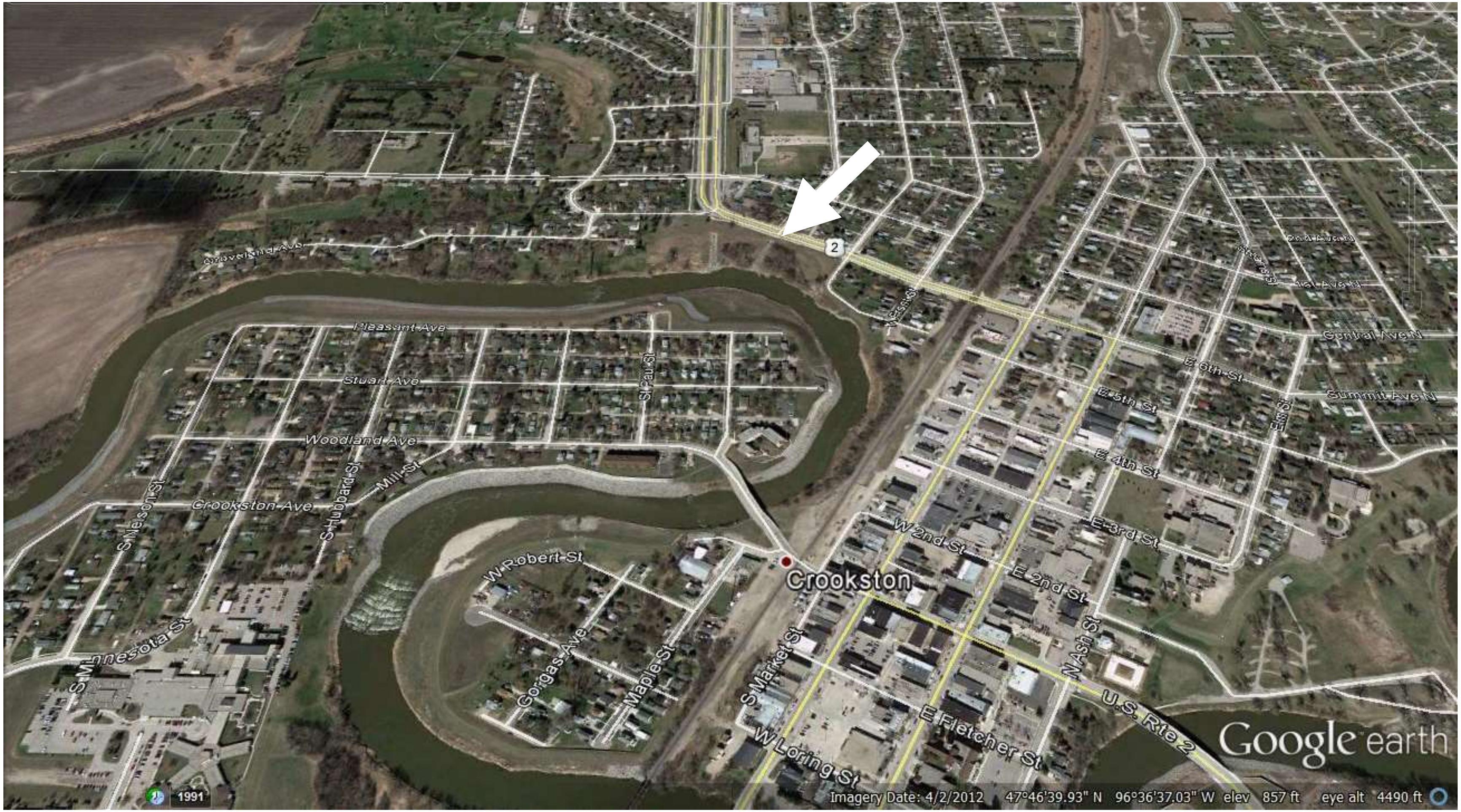
Final Conditions



Crookston, MN – Slope Stabilization

Site Location and Geologic Setting

State Highway #2



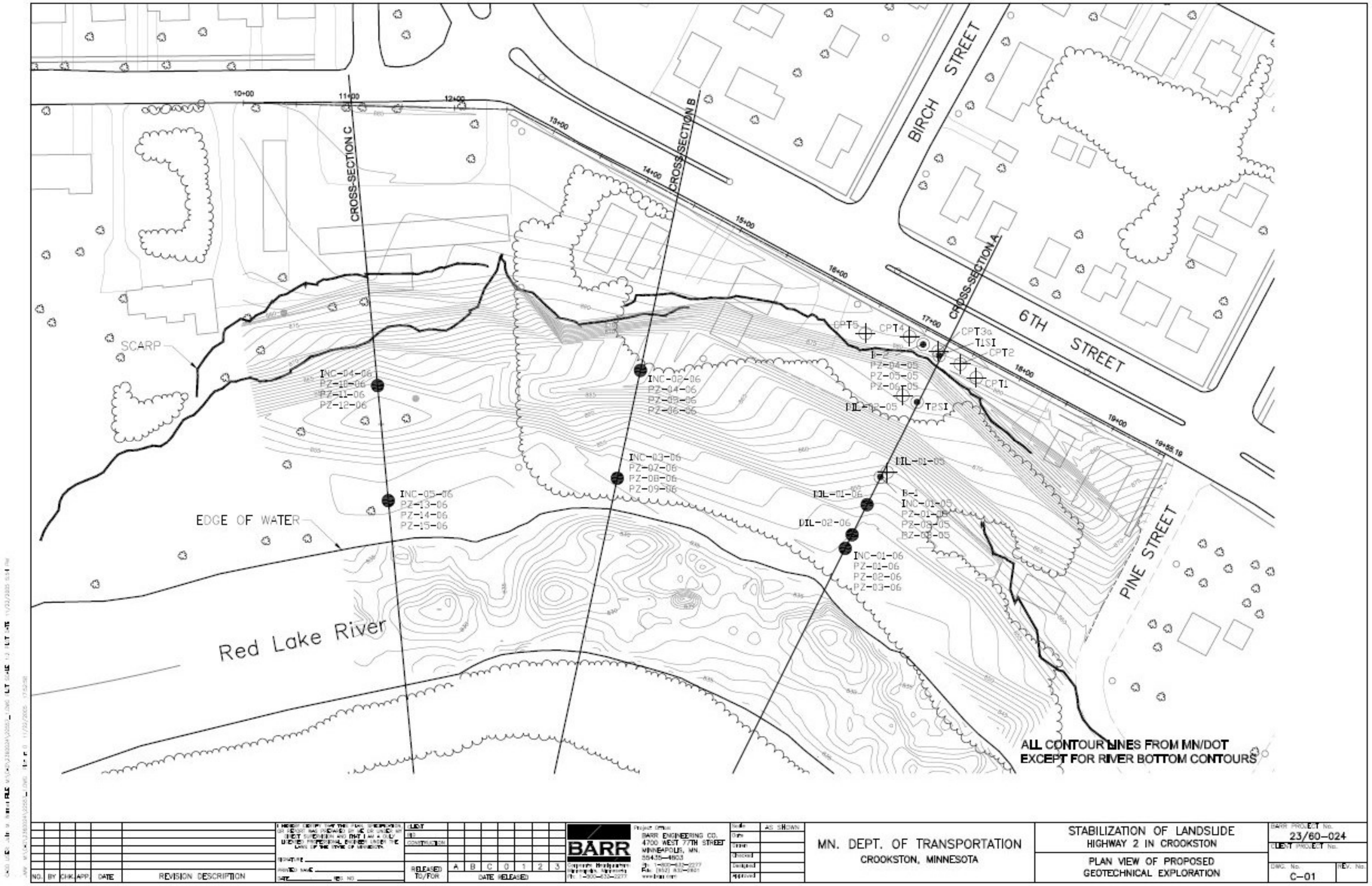
Moving Slide Threatening the Highway

1934 Slide

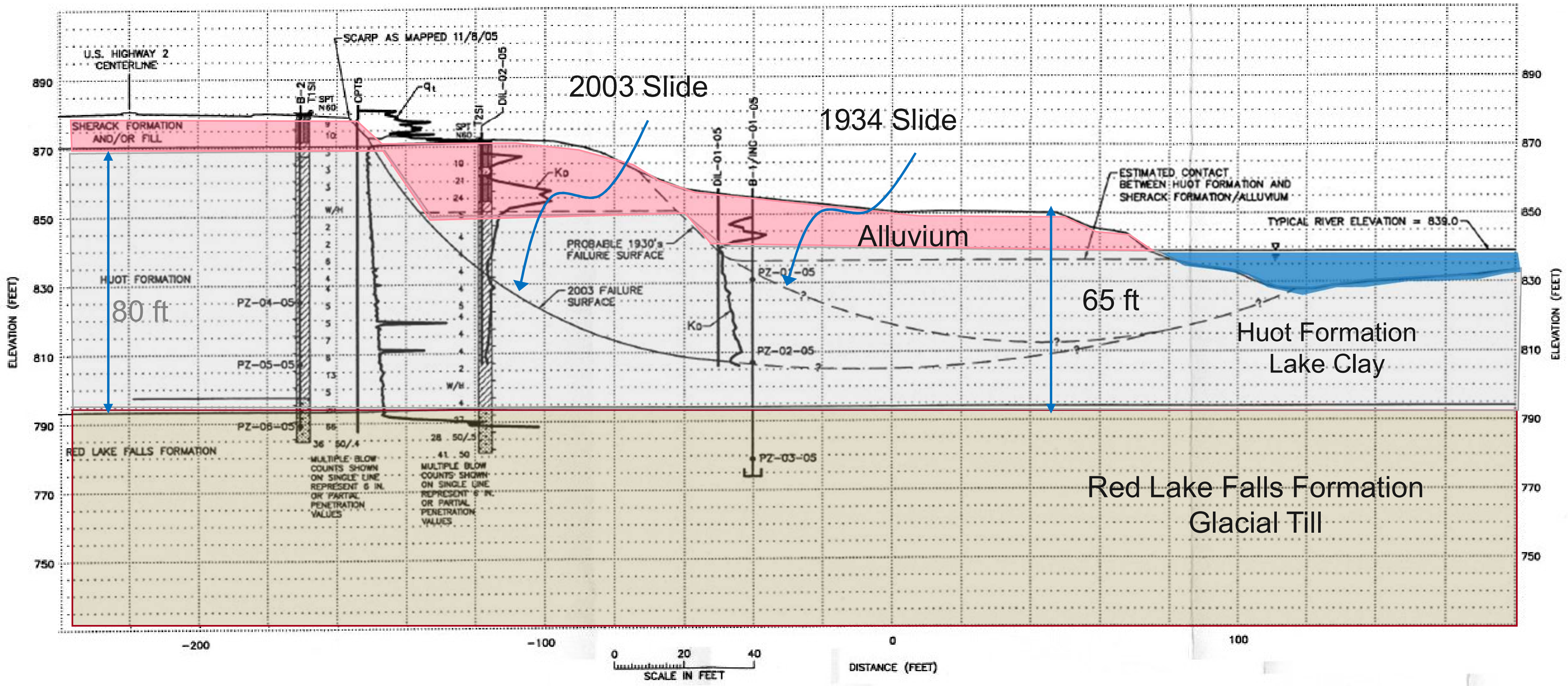
The 1934 DARKOW Landslide in Crookston, Minnesota — The Green Gables tourist center was established here by Paul and Dwight Darkow, later proprietors of the Country Club Motel, located in the same area. As picture indicates some of the Green Gables "took a drop."


2003 Slide

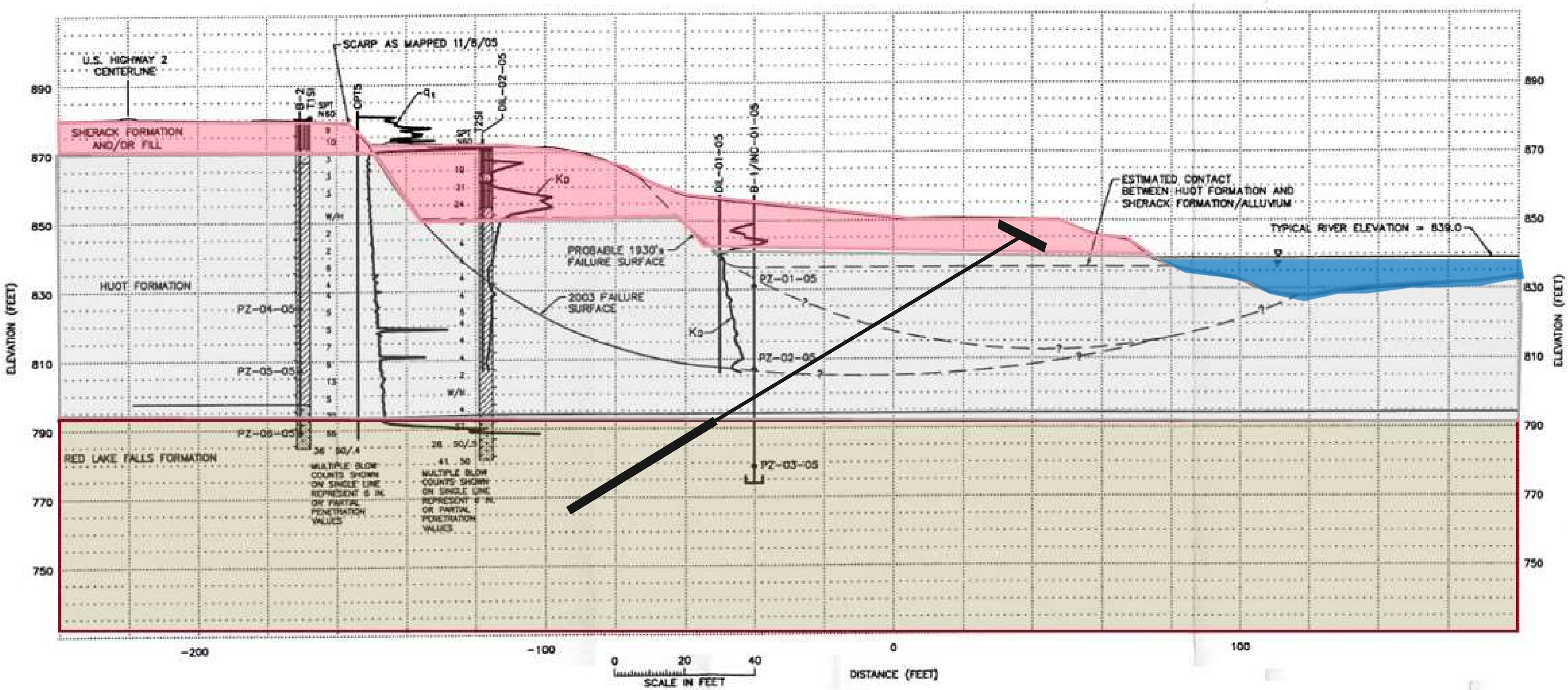
2004 Study by Barr Engineering



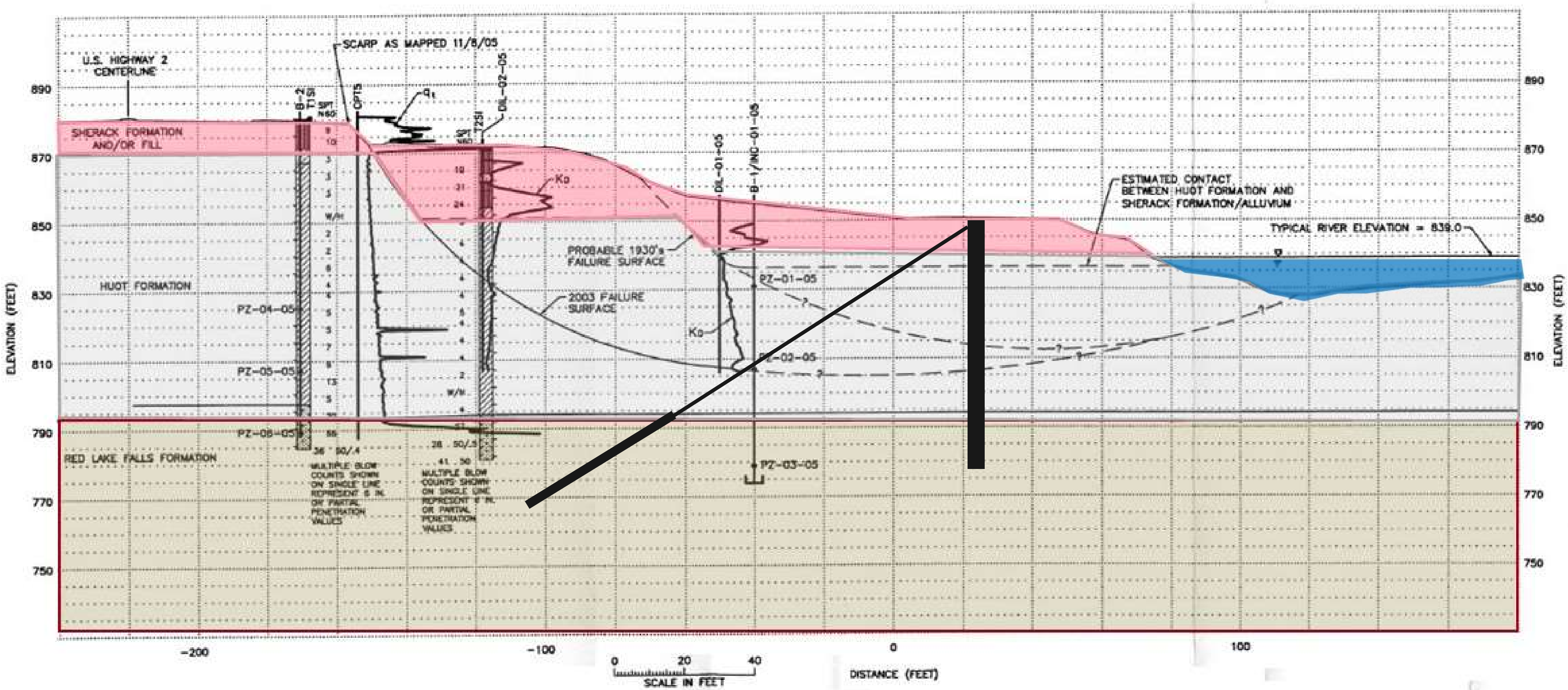
Cross Section "A"



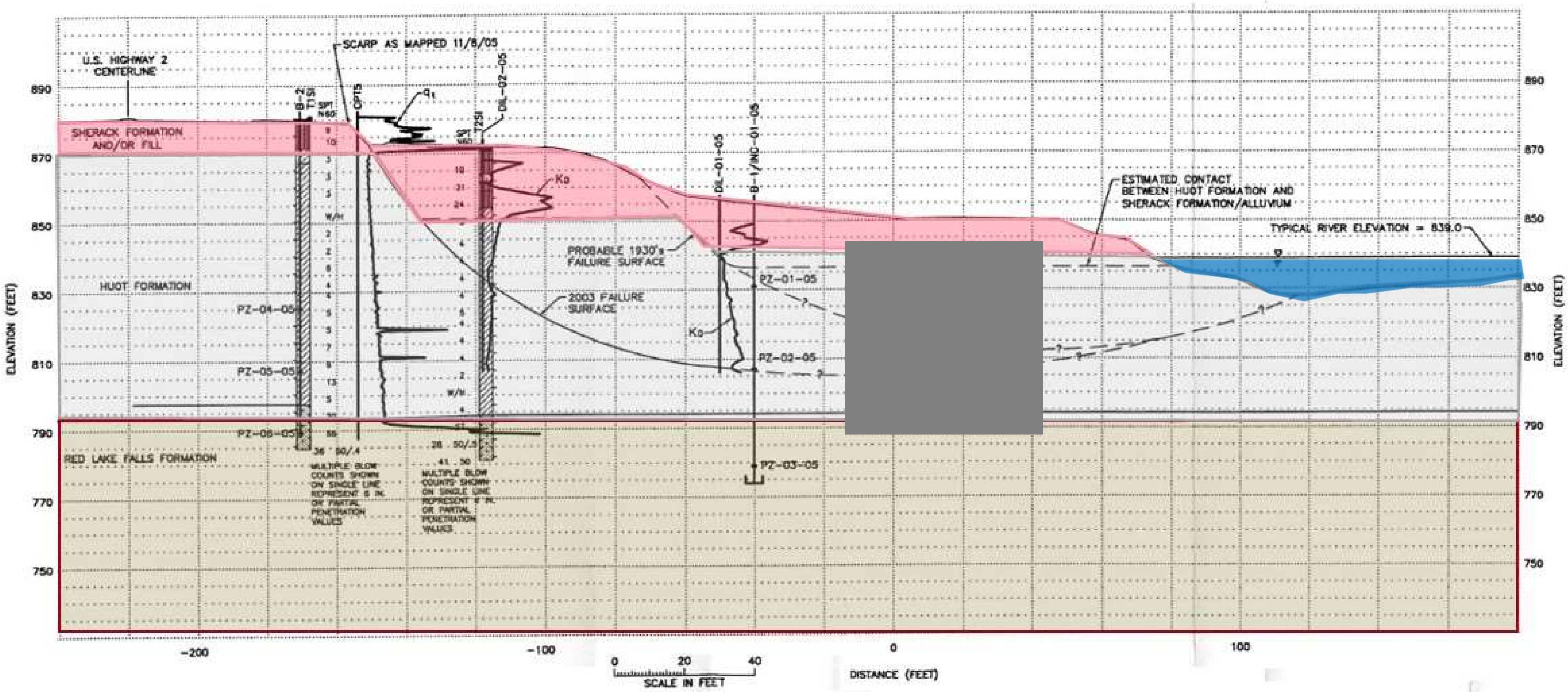
Stabilizing Methods Considered – Anchored Blocks



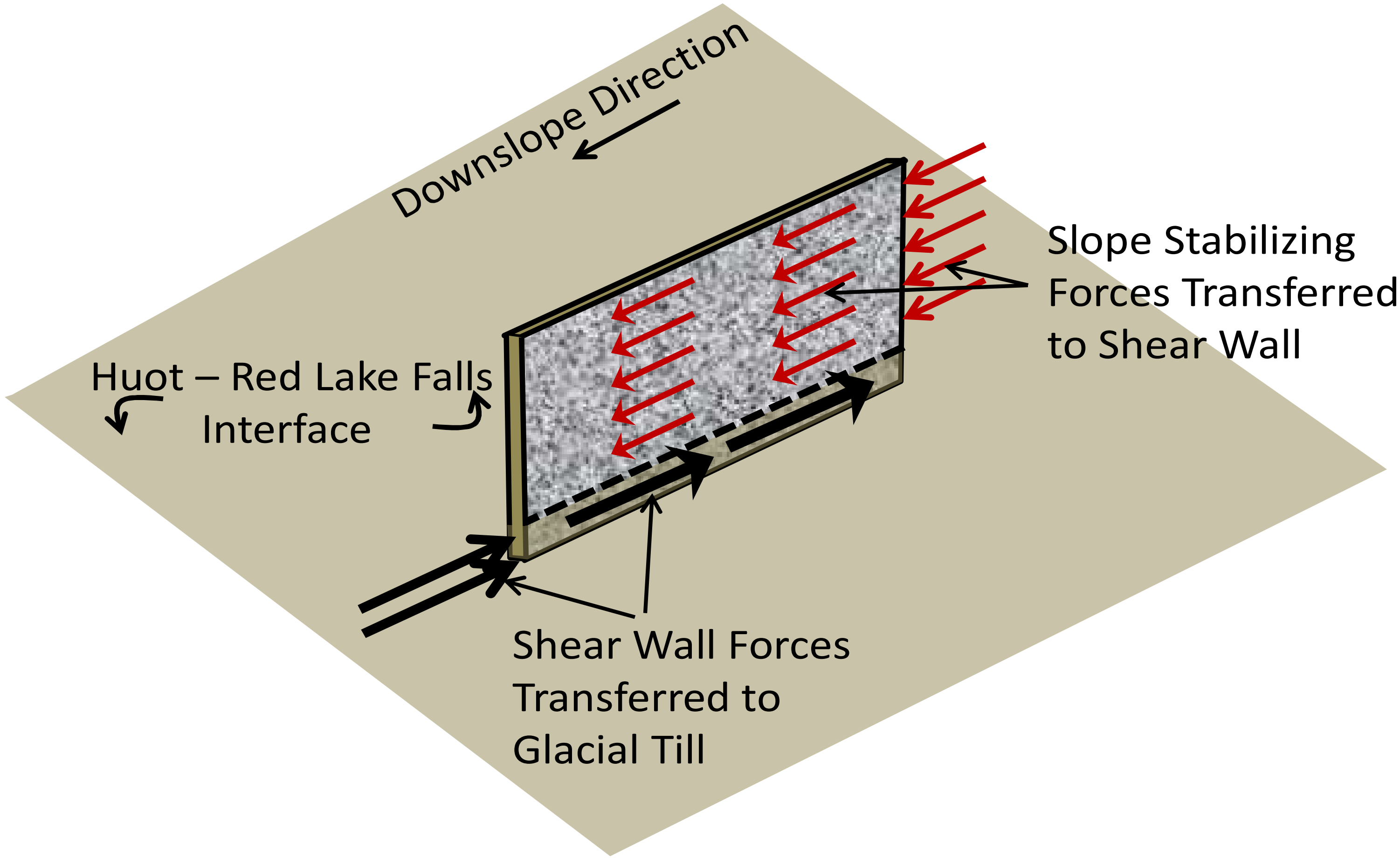
Stabilizing Methods Considered – Large Piles



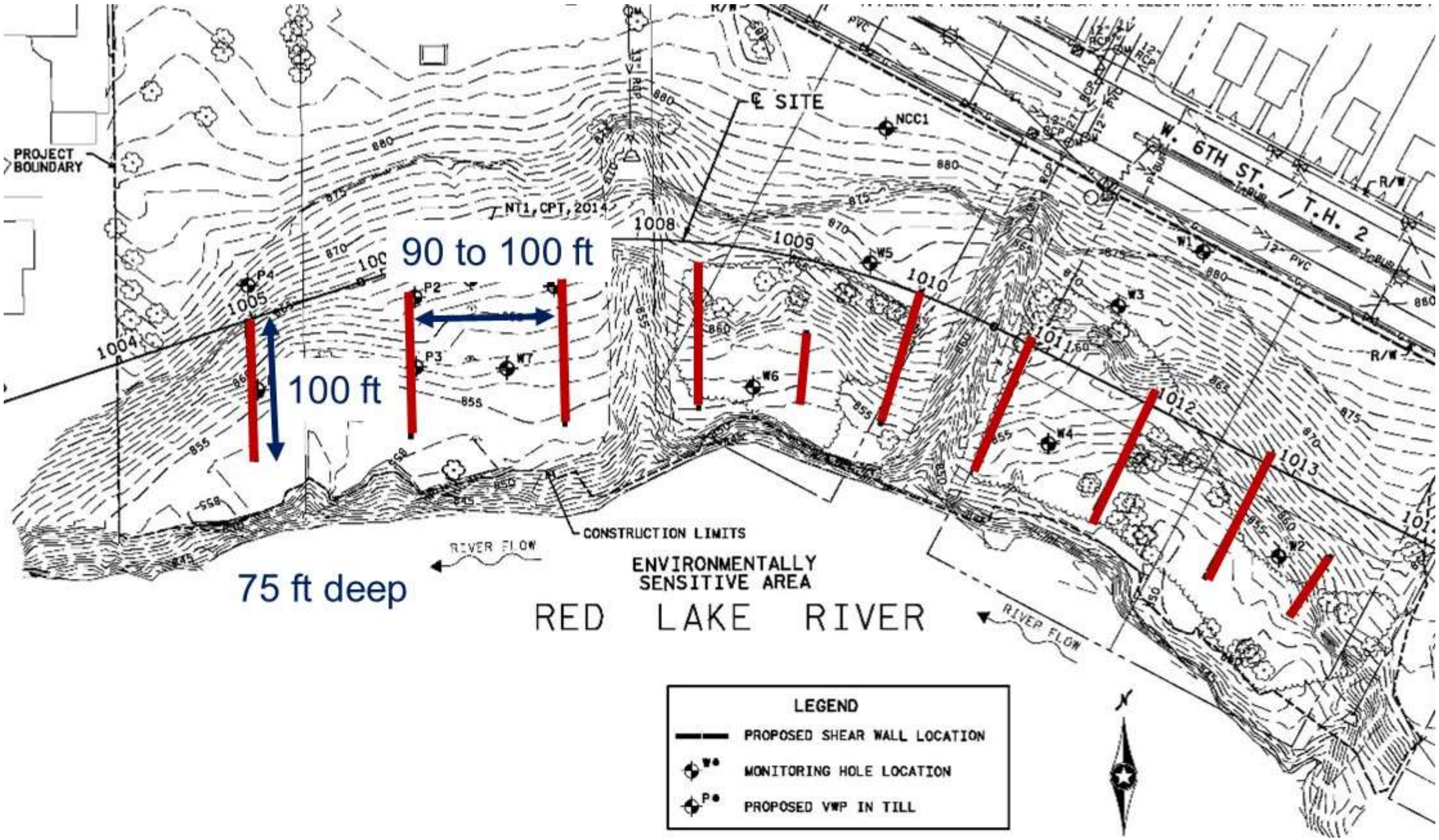
Stabilizing Methods Considered – Shear Walls



Load Transfer Mechanisms

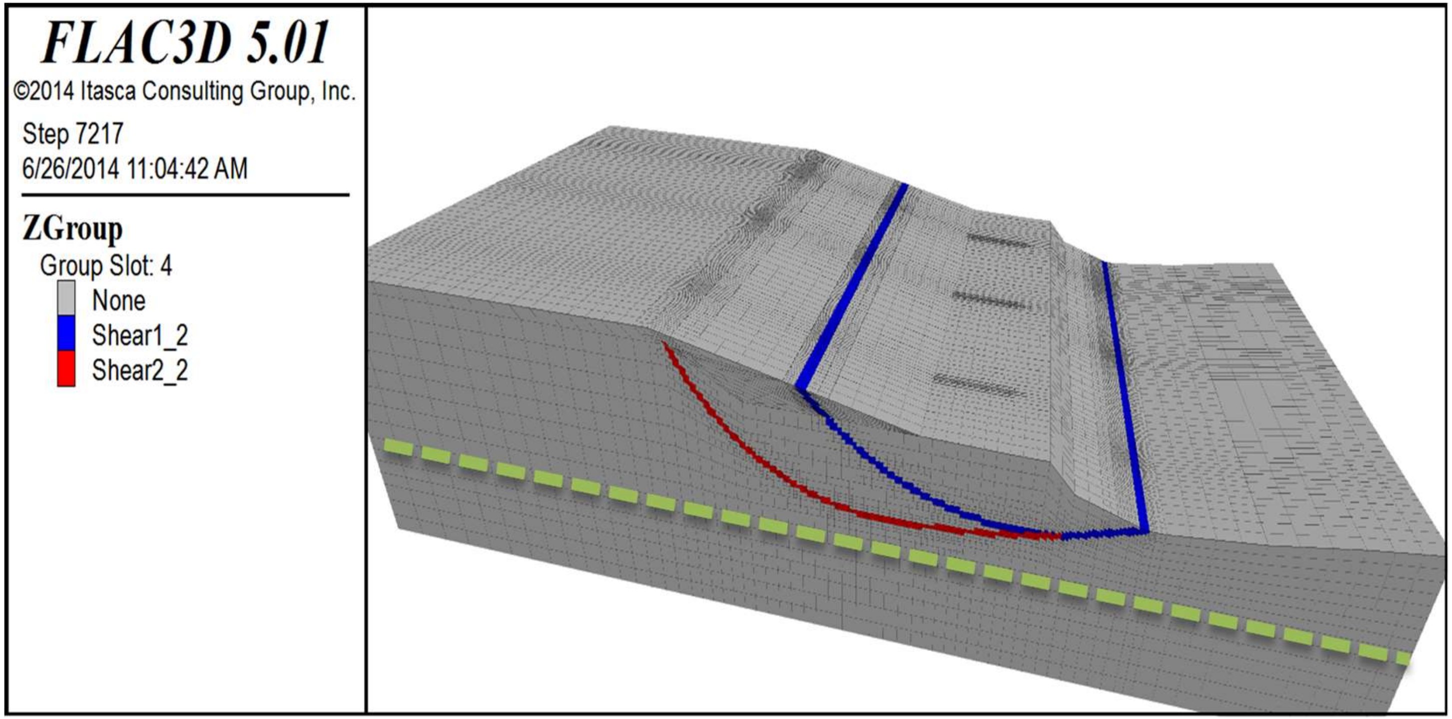


Shear Wall Layout



FLAC3D – Modeling of Shear Walls

- **Assess residual strength based on strength reduction.**
- **Evaluate stability improvements with shear walls.**
- **Confirm failure between walls does not control.**



Initial Site Conditions

Site Grading Prior to Construction

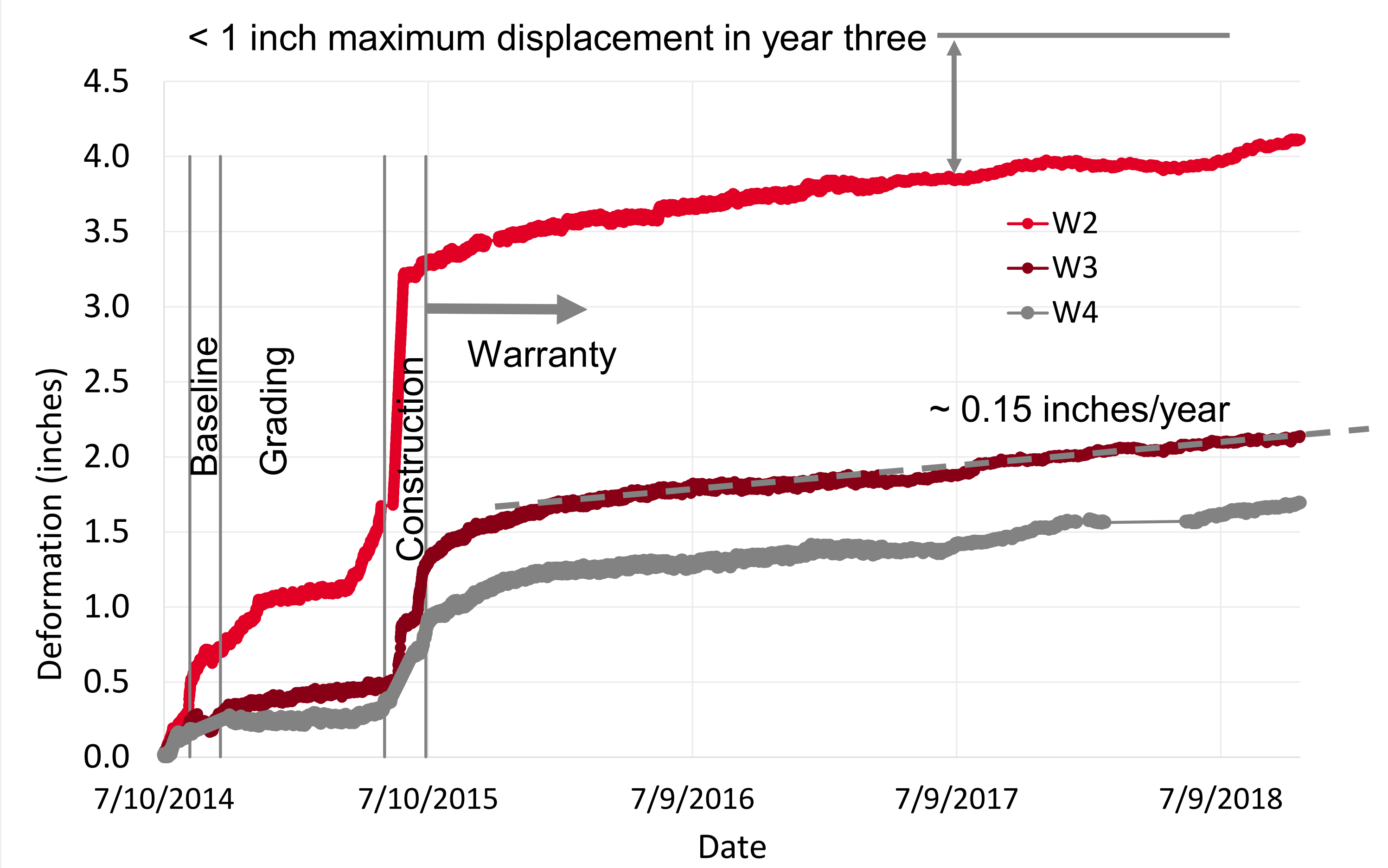
Monster Excavator – 100 ft Reach

Trench Excavation

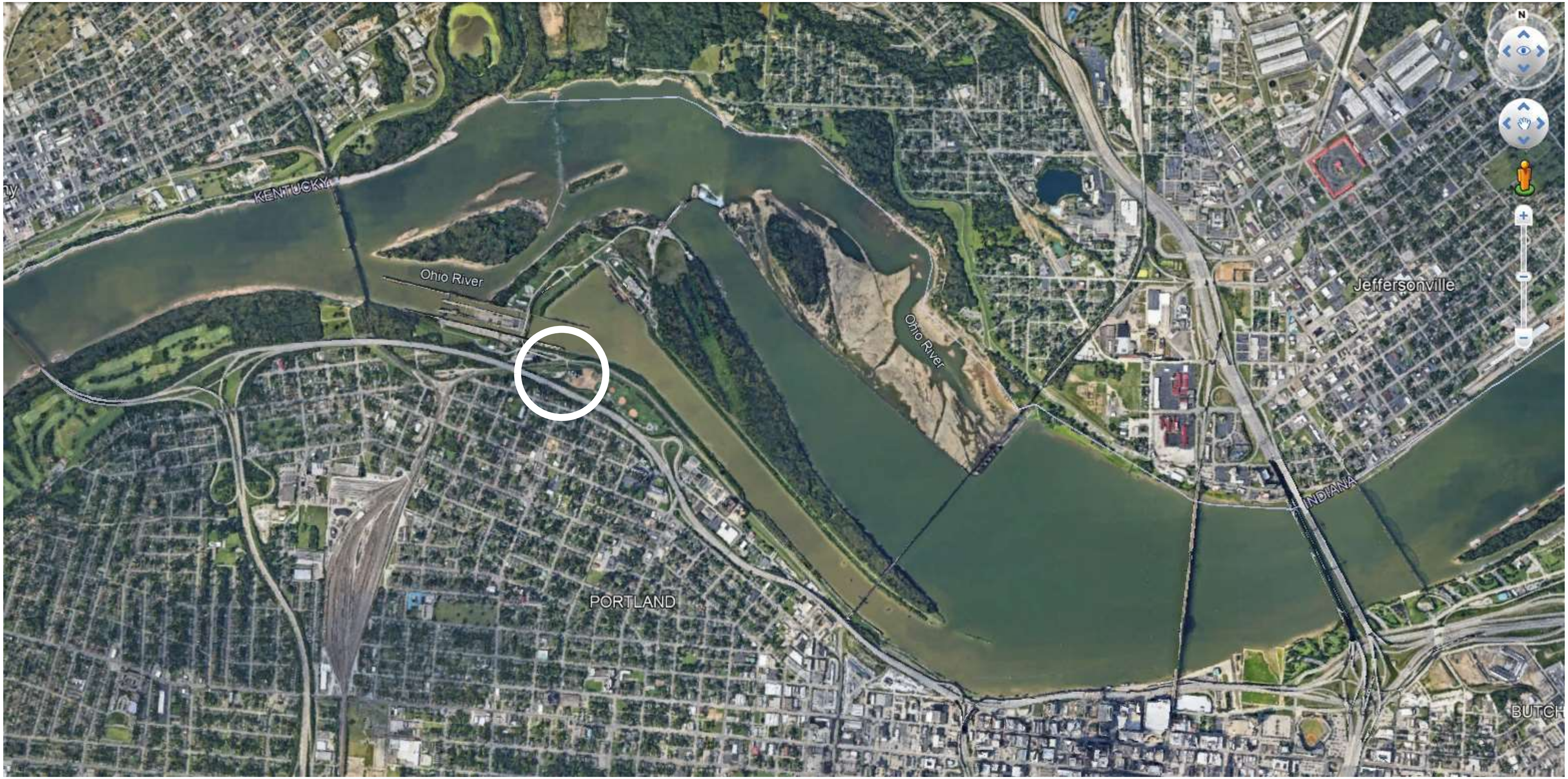
Clay Spoil

Plant

Deformation Chronology and Warranty



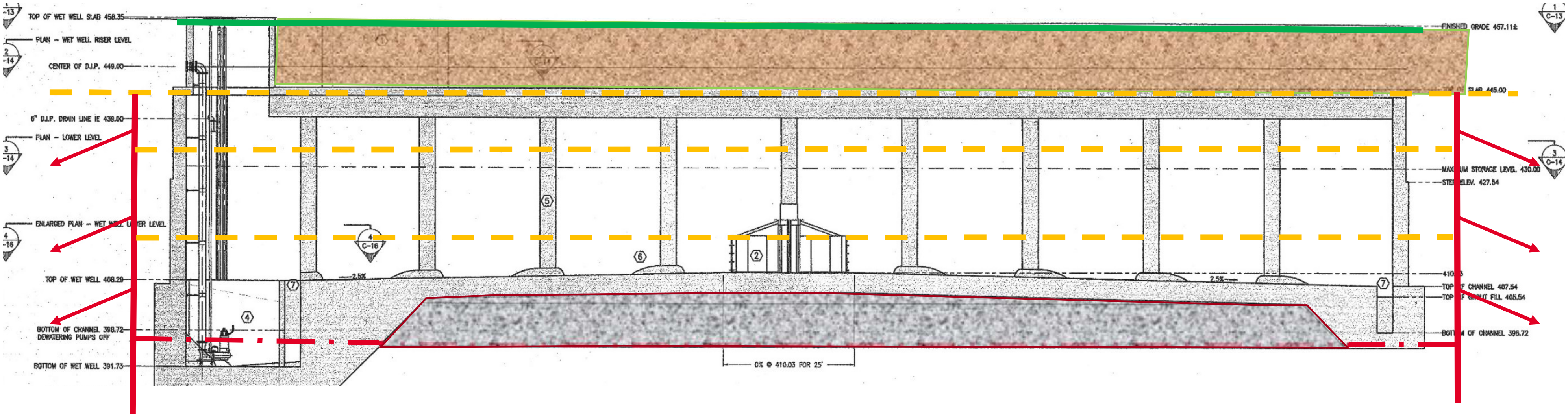
Louisville, KY - Portland CSO Shaft



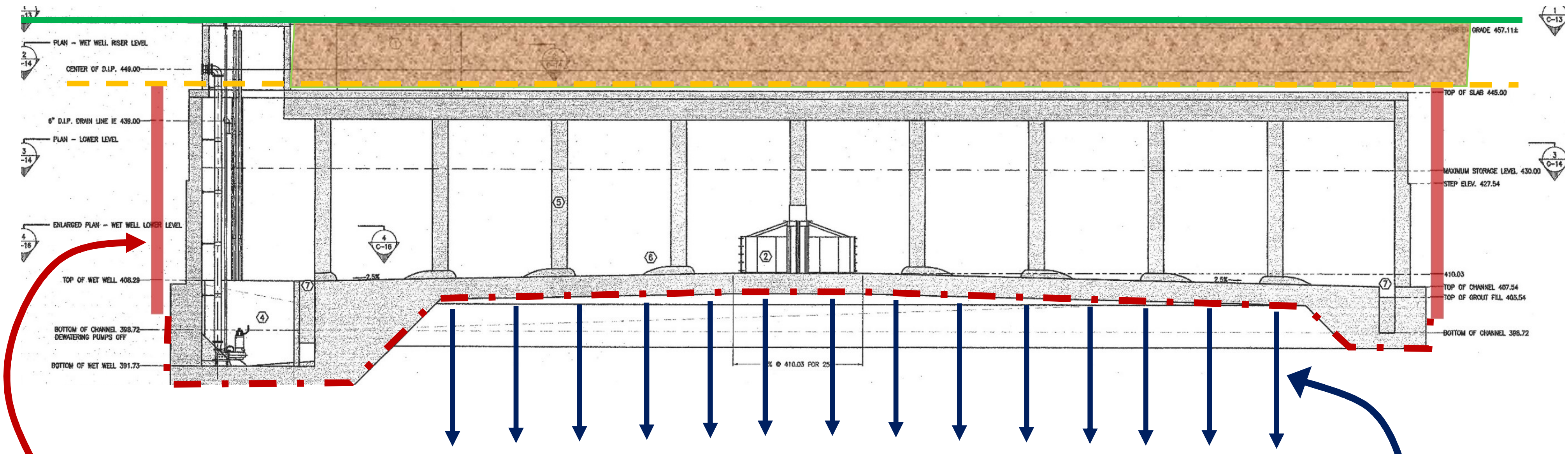

Ohio River
Existing Levee
Old Landfill

Louisville, KY - Portland CSO Shaft

Conventional Approach



Alternative Approach with Cost/Schedule Saving Measures

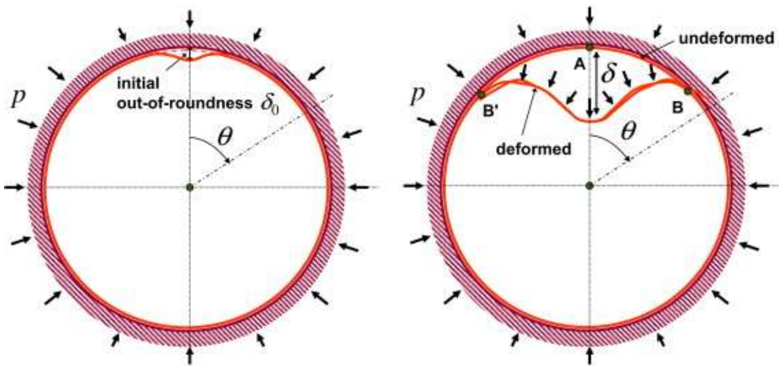


Wall provides permanent support

Anchors Replace Mass Concrete

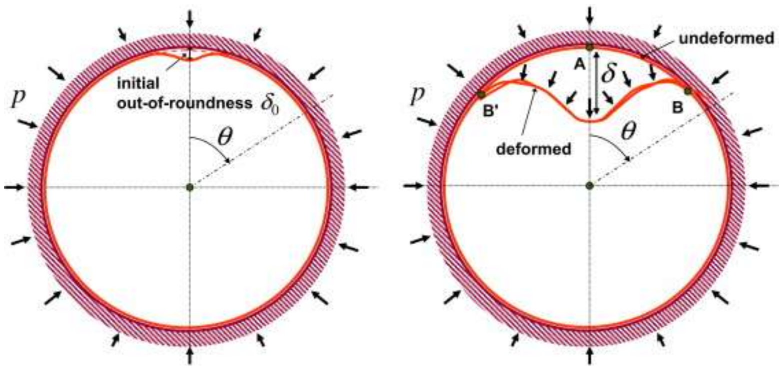
So, Why Didn't the Structure Buckle?

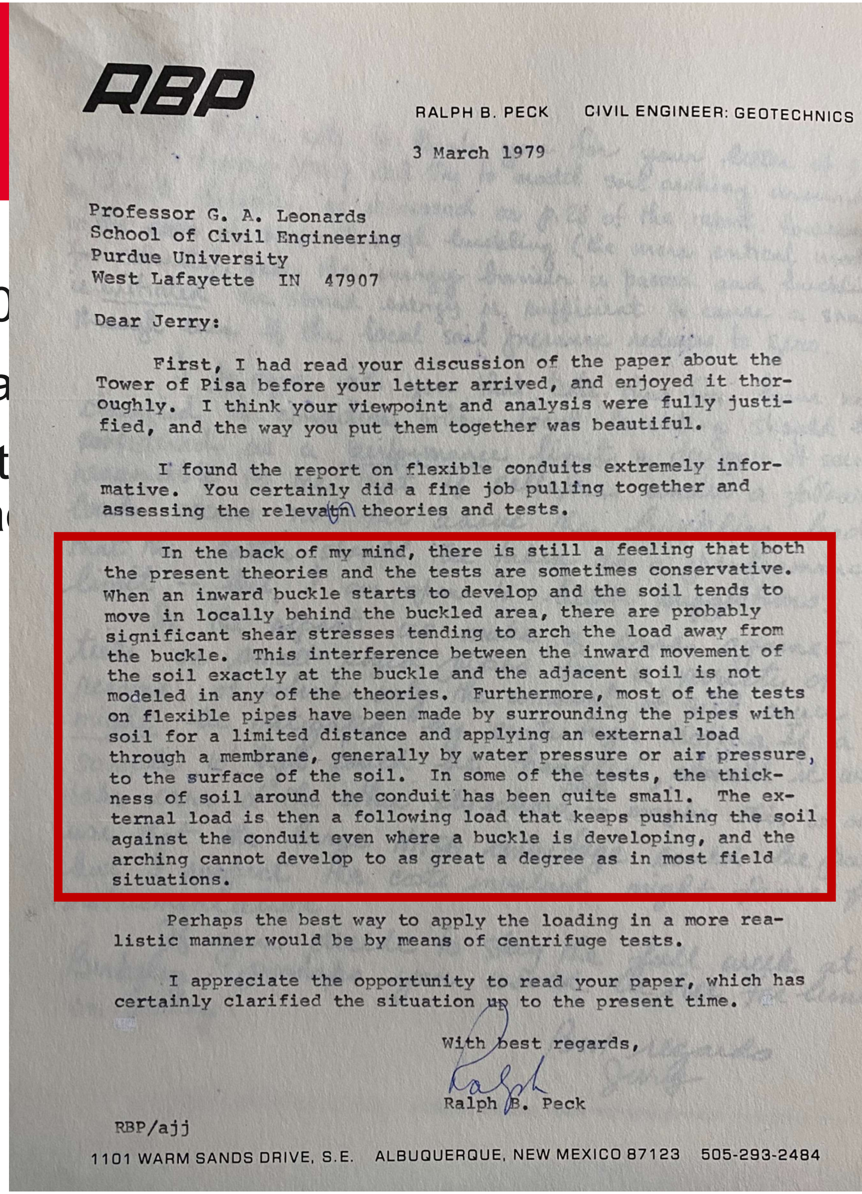
- The structure is categorized as thin-walled; d/t > 20, here it was 68.
- There are buckling models that predicted buckling at half this diameter.
- A basic difference is the soil stress is not a constant it varies with displacement and arching. An appropriate model is needed to approach a reasonable answer.



So, Why Didn't the Structure Buckle?

- The structure is categorized as thin-walled; d/t > 20
- There are buckling models that predicted buckling a
- A basic difference is the soil stress is not a constant arching. An appropriate model is needed to approa





RBP

RALPH B. PECK CIVIL ENGINEER: GEOTECHNICS

3 March 1979

Professor G. A. Leonards
School of Civil Engineering
Purdue University
West Lafayette IN 47907

Dear Jerry:

First, I had read your discussion of the paper about the Tower of Pisa before your letter arrived, and enjoyed it thoroughly. I think your viewpoint and analysis were fully justified, and the way you put them together was beautiful.

I found the report on flexible conduits extremely informative. You certainly did a fine job pulling together and assessing the relevant theories and tests.

In the back of my mind, there is still a feeling that both the present theories and the tests are sometimes conservative. When an inward buckle starts to develop and the soil tends to move in locally behind the buckled area, there are probably significant shear stresses tending to arch the load away from the buckle. This interference between the inward movement of the soil exactly at the buckle and the adjacent soil is not modeled in any of the theories. Furthermore, most of the tests on flexible pipes have been made by surrounding the pipes with soil for a limited distance and applying an external load through a membrane, generally by water pressure or air pressure, to the surface of the soil. In some of the tests, the thickness of soil around the conduit has been quite small. The external load is then a following load that keeps pushing the soil against the conduit even where a buckle is developing, and the arching cannot develop to as great a degree as in most field situations.

Perhaps the best way to apply the loading in a more realistic manner would be by means of centrifuge tests.

I appreciate the opportunity to read your paper, which has certainly clarified the situation up to the present time.

With best regards,

Ralph

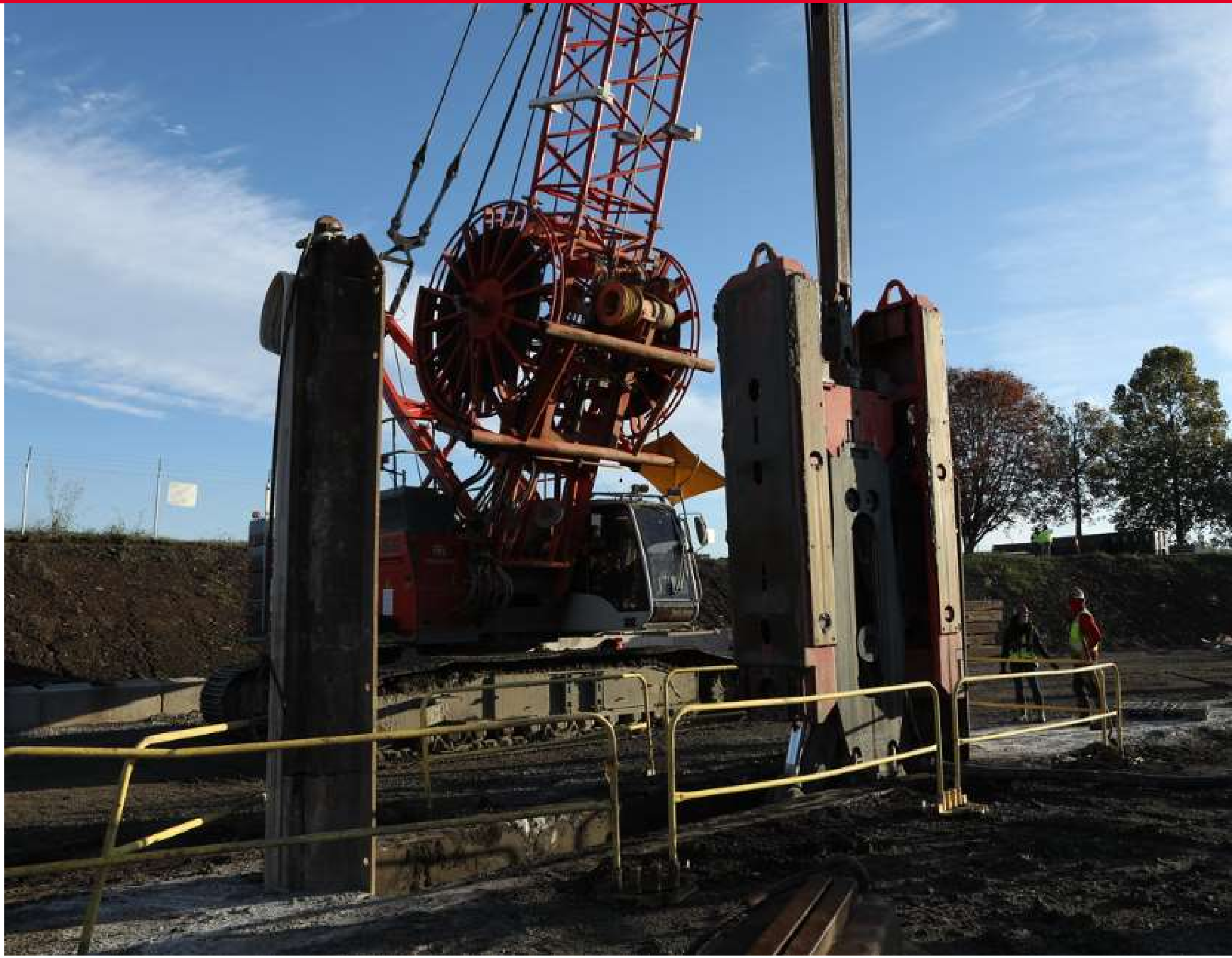
Ralph B. Peck

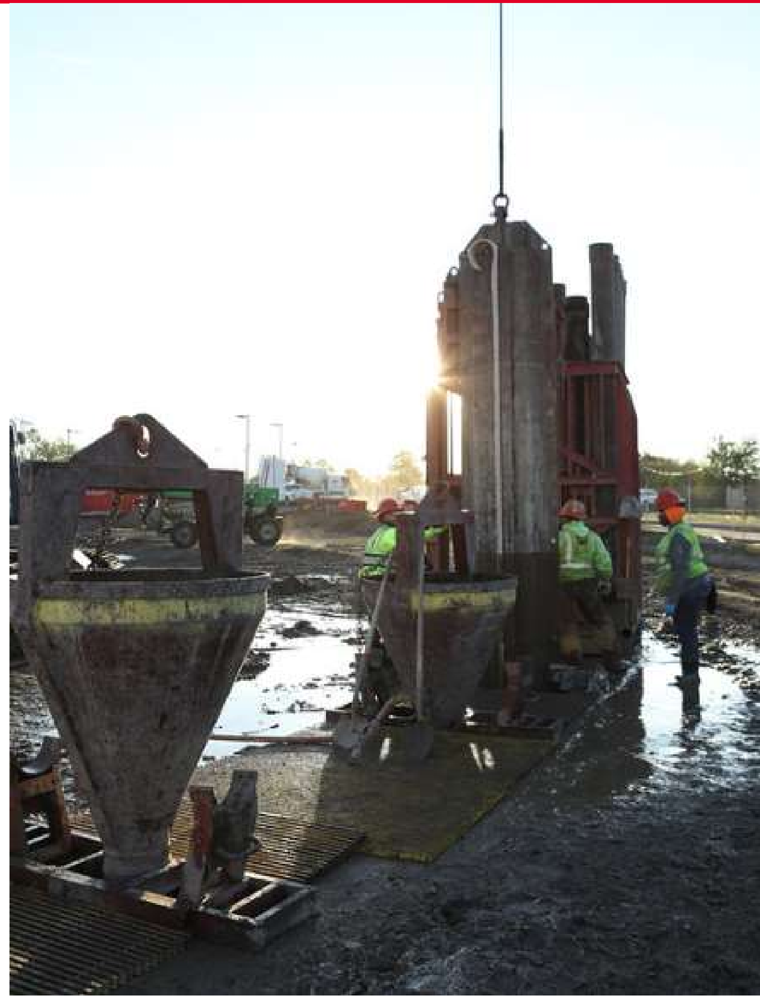
RBP/ajj

1101 WARM SANDS DRIVE, S.E. ALBUQUERQUE, NEW MEXICO 87123 505-293-2484

Guide Walls and Dwall Excavation

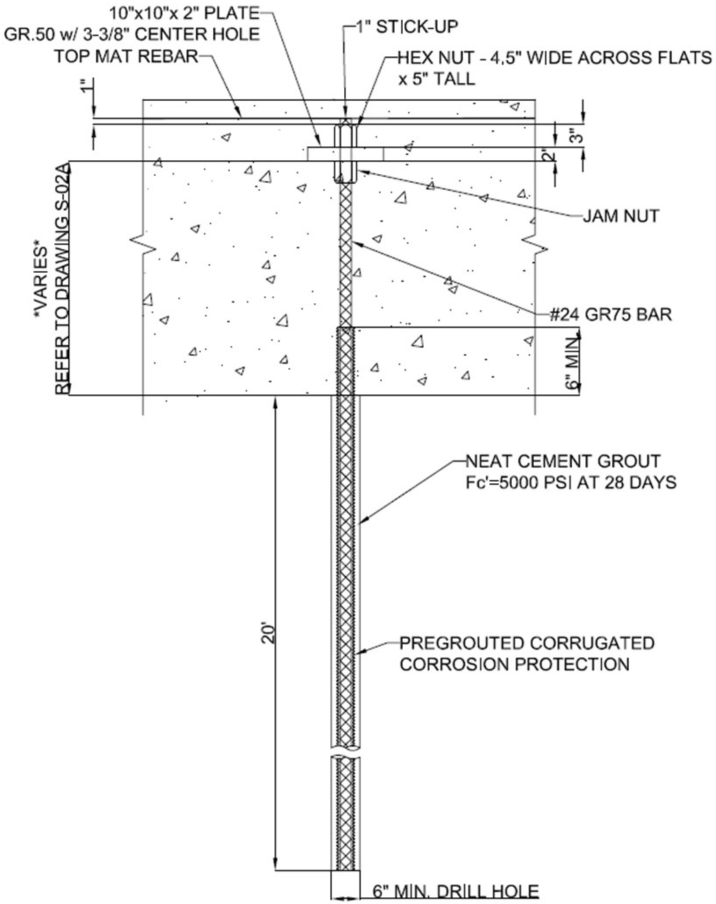
Panel Excavation

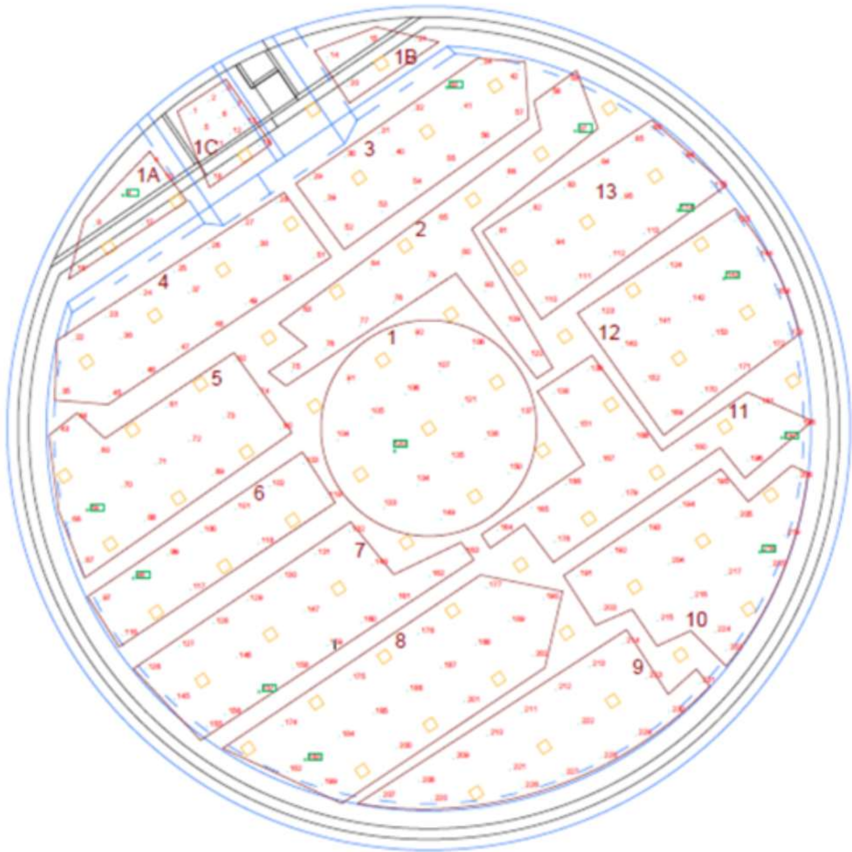




Placing Concrete

Tiedown Anchors Design

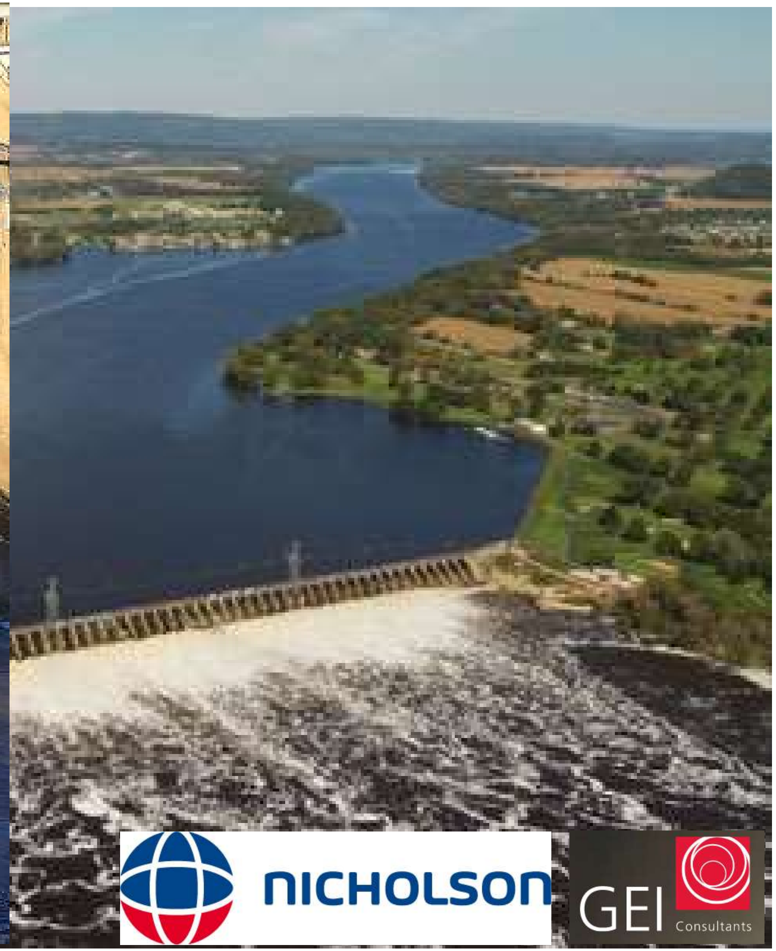




Tiedown Anchors Installation Overview

Tiedown Anchors Proof Testing

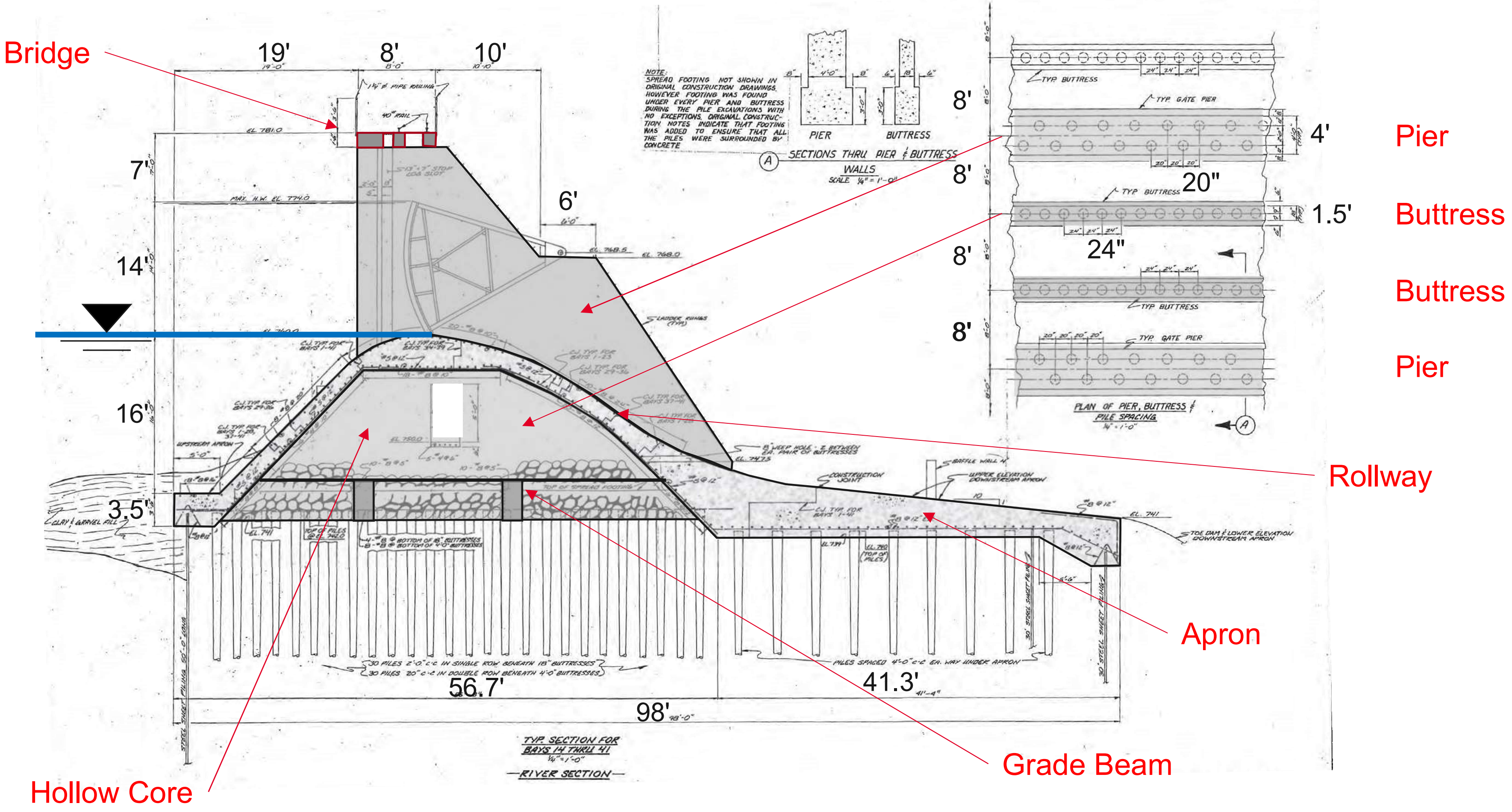
Prairie du Sac Dam, Wisconsin River, WI



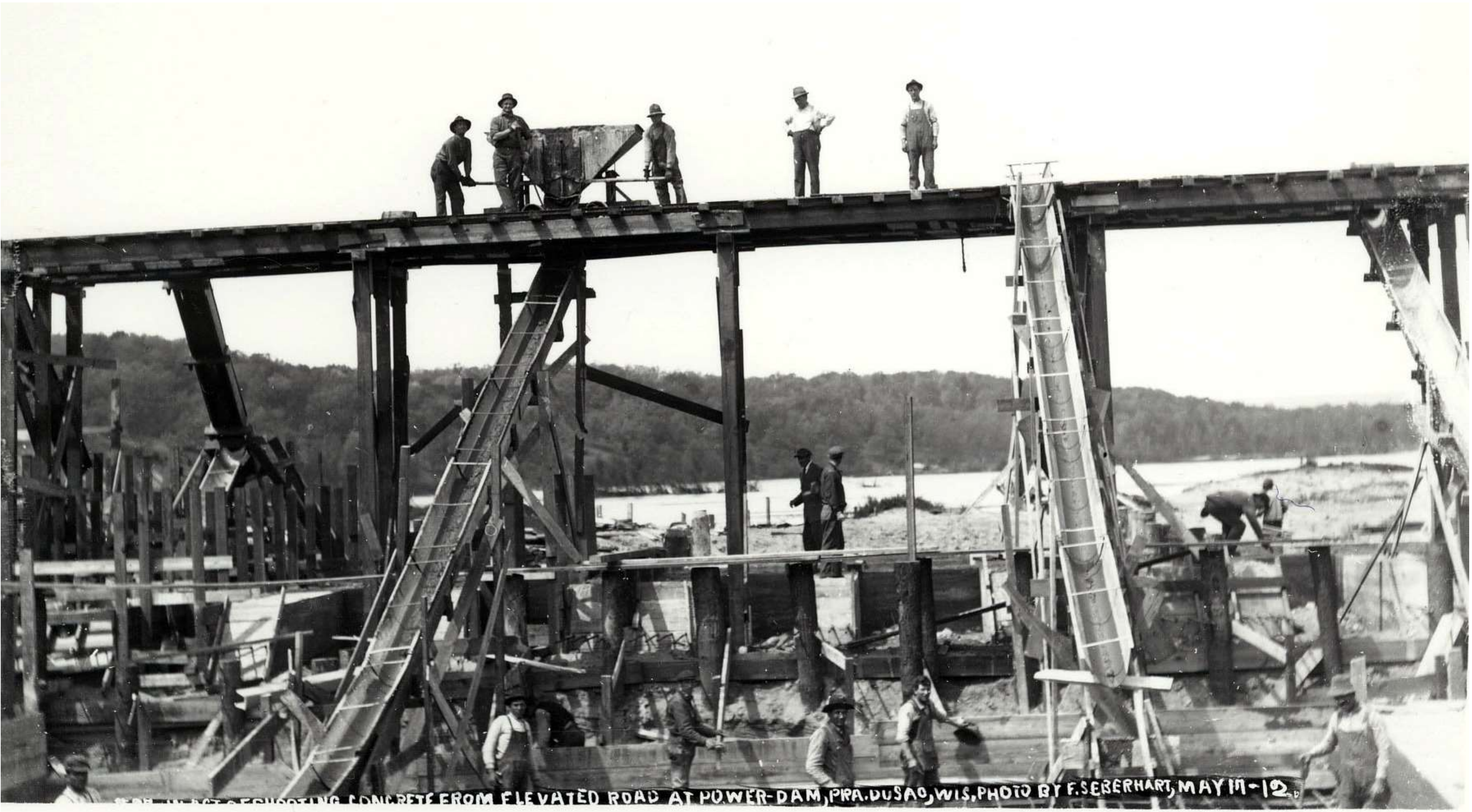
NICHOLSON

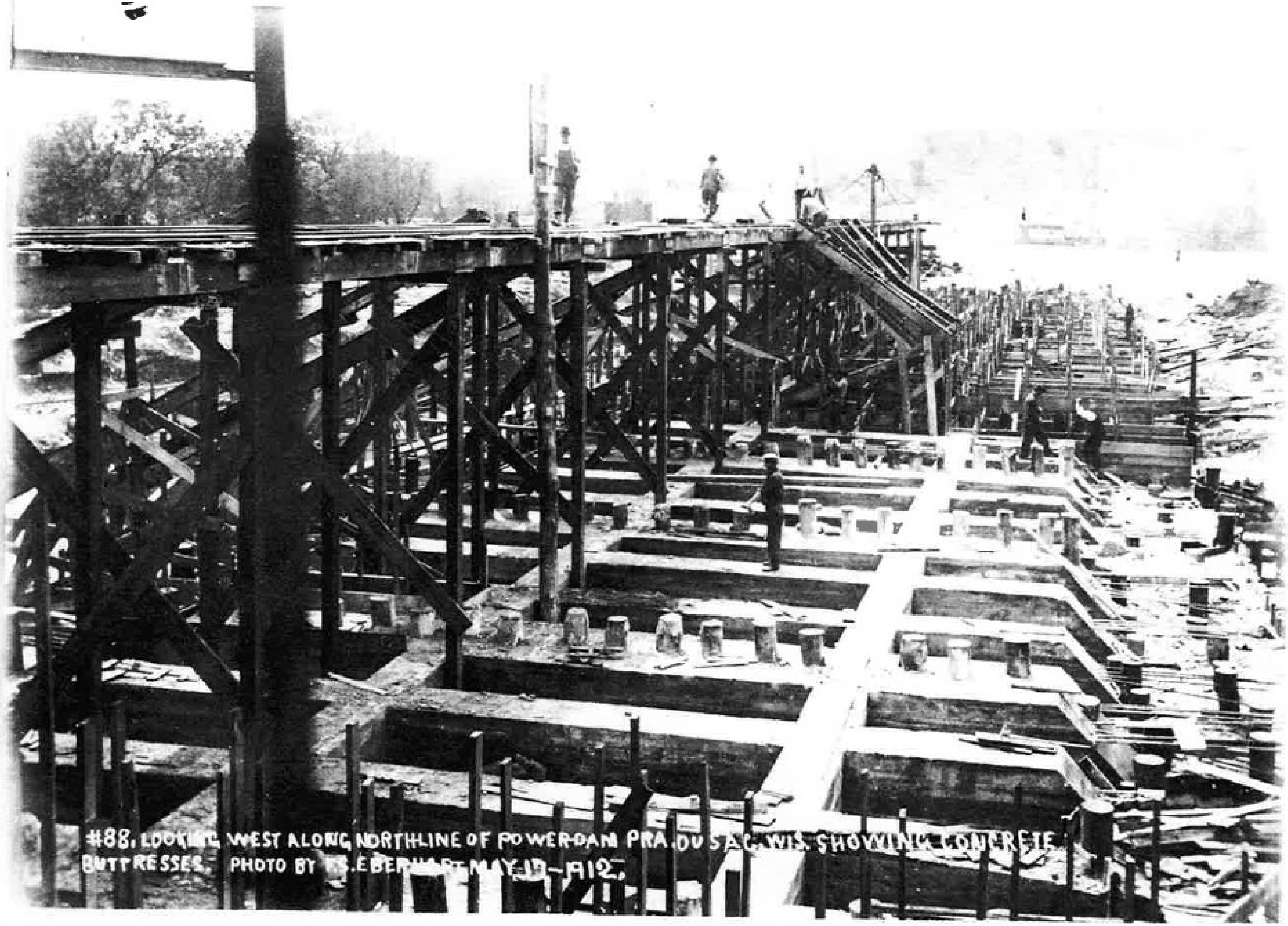
GEI Consultants

Dam Geometry



#84. FOUNDATION PILES, ELEVATED ROAD & CONCRETE SHOTS AT EAST END OF POWER-DAM
PRAIRIE DU SAC, WIS. PHOTO-BY F.S. EBERHART, MAY 17-1912.


CONCRETE FROM ELEVATED ROAD AT POWER-DAM, PRA.DUSAC, WIS, PHOTO BY F.SEBERHART, MAY 17-12

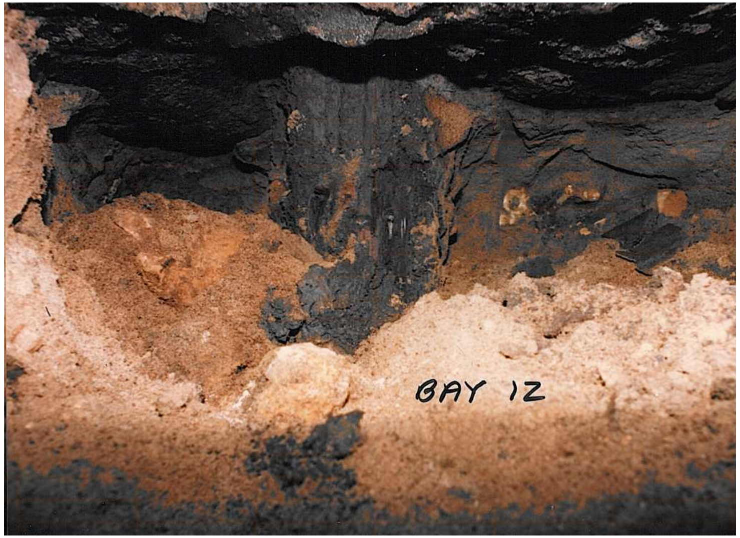


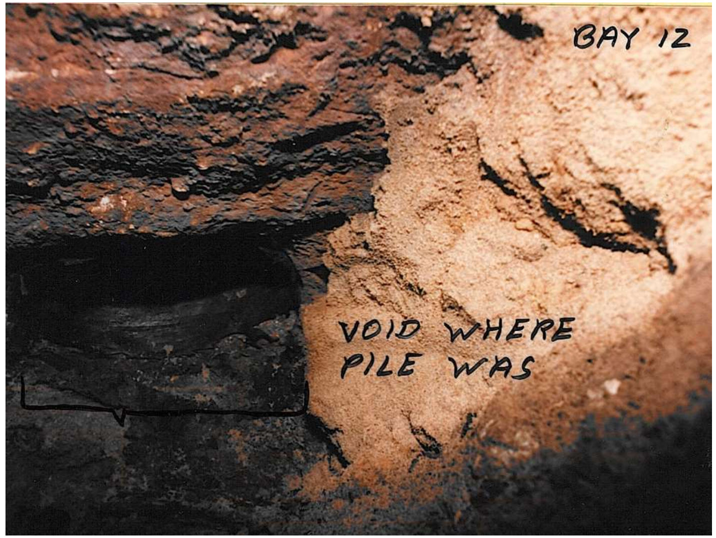
#88. LOOKING WEST ALONG NORTH LINE OF POWER DAM PRA. DU SAC, WIS. SHOWING CONCRETE BUTTRESSES. PHOTO BY H.S. EBERHART MAY 1?-1912.

#97. VIEW OF EAST END OF POWER-DAM "DOWN STREAM SIDE" PRA. DU SAC, WIS. PHOTO BY F.S. EBERHART, JUNE 30-1912.

Observation of Deteriorating Piles

Tailwater recession after construction exposed timber piles



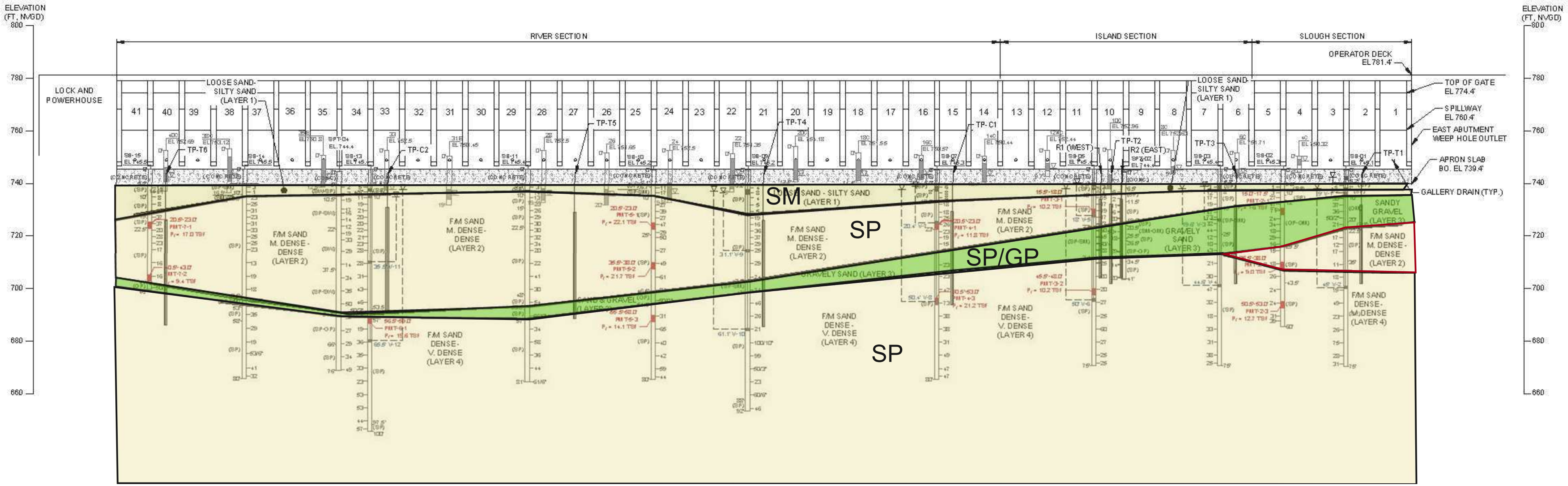


Pile deterioration could lead to differential settlement and cracking (no observable settlement to date)

Remediation Goals

- Minimize disturbance ("do no harm")
- Take up dam loads with no significant settlement or displacement
- Ensure no increase in uplift pressures
- Satisfy criteria for exit gradients and piping potential
- Meet FERC performance requirements, and provide long-term, reliable service

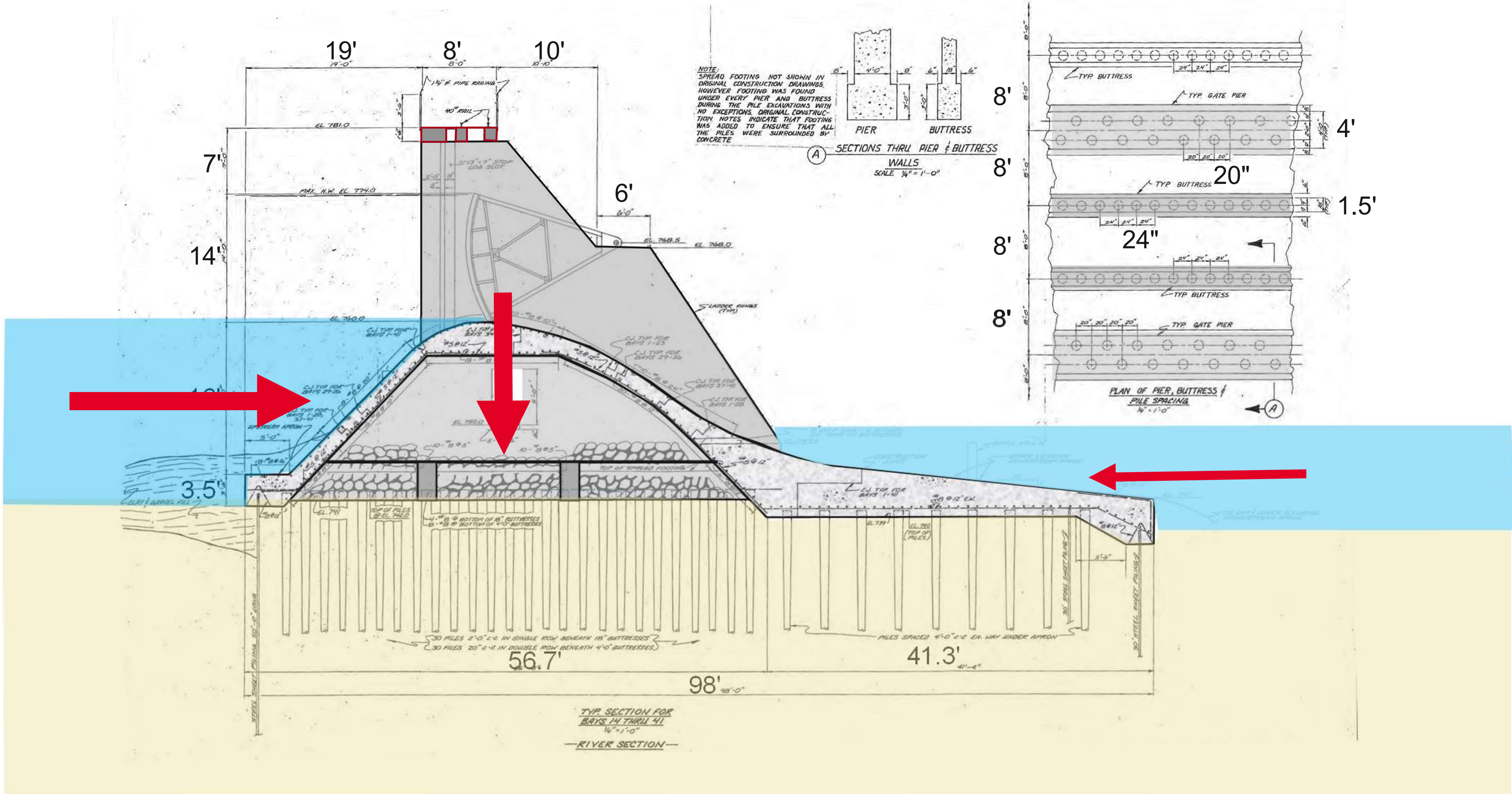
Subsurface Conditions



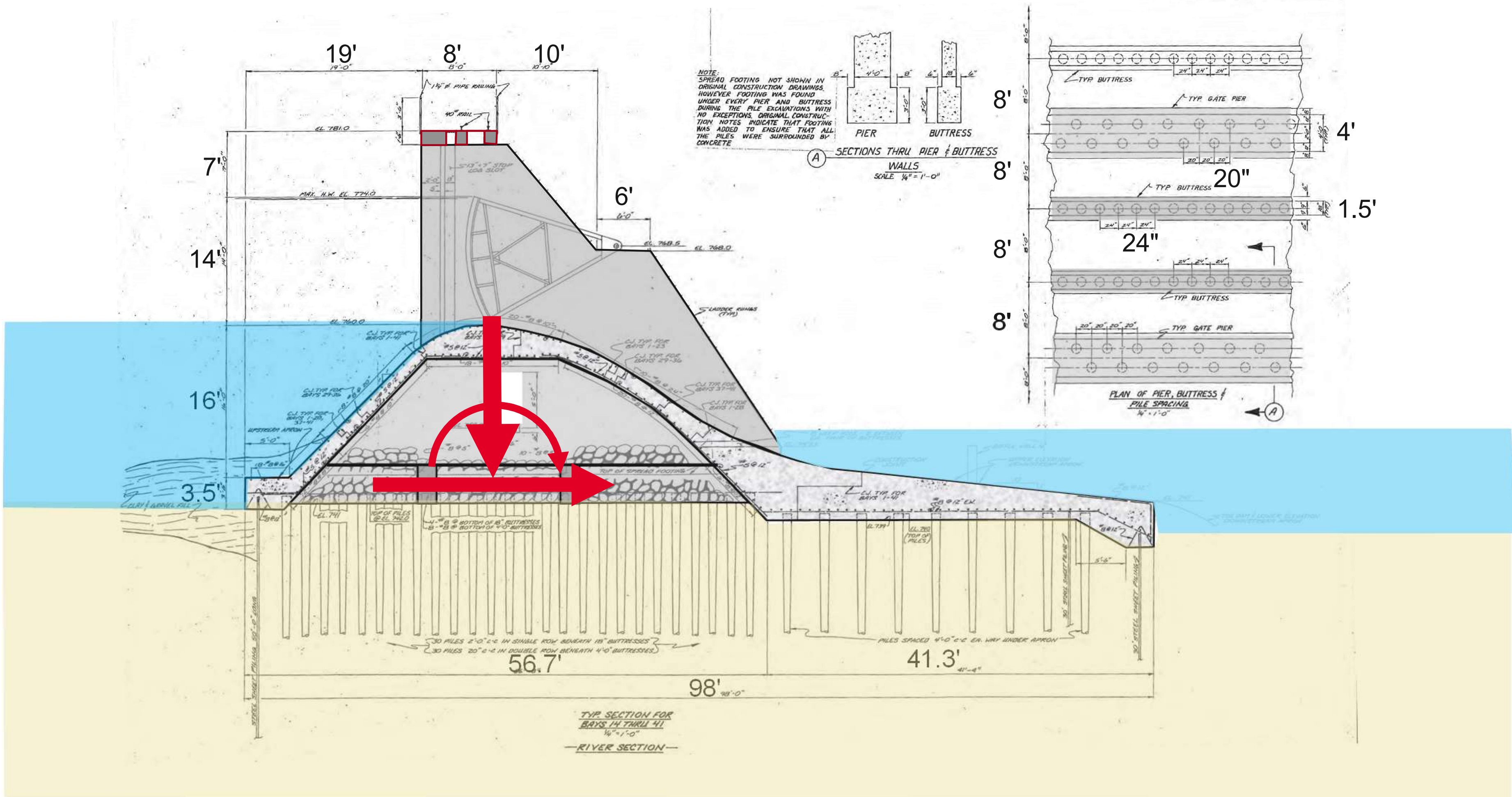
Other Challenges – Water

Other Challenges - Access

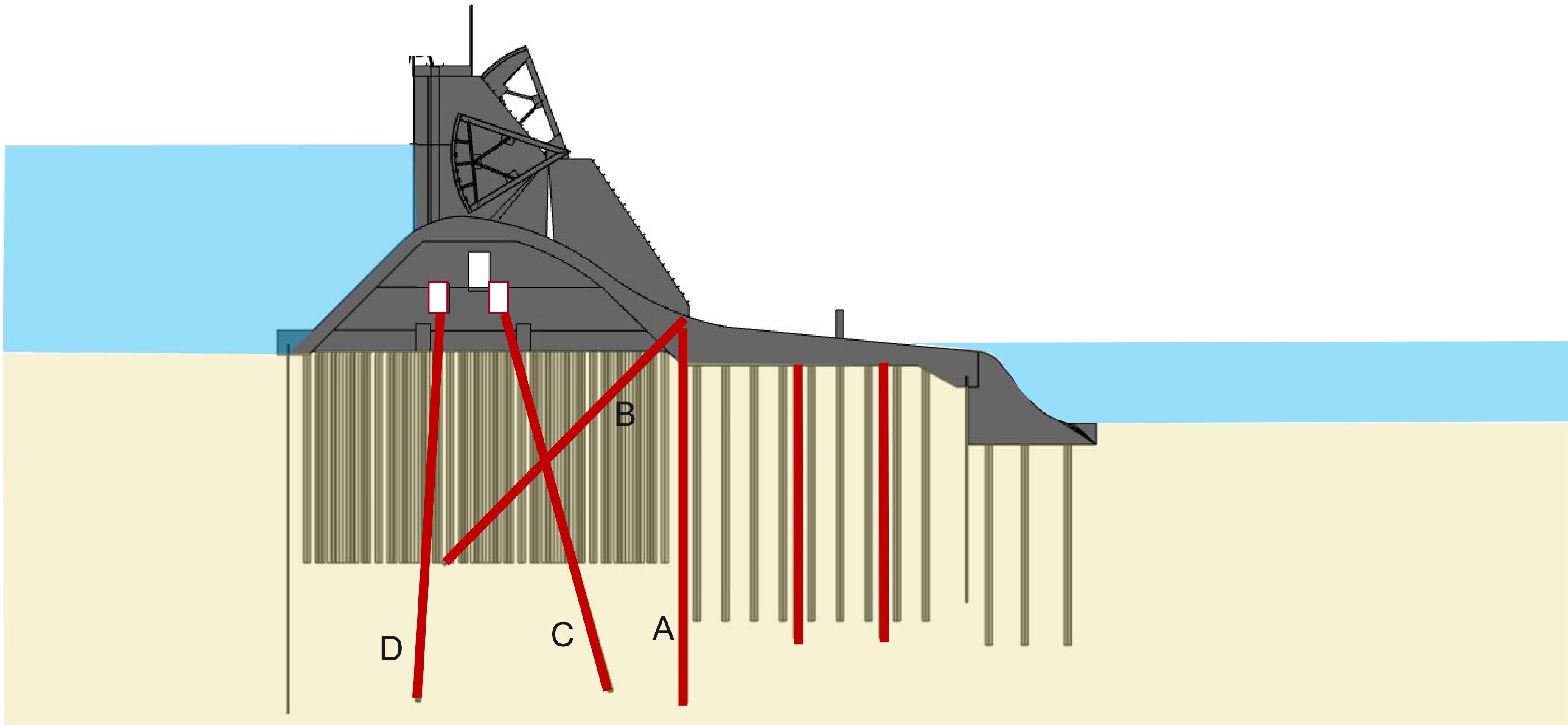
Design Approach – Gravity and Hydraulic Loads



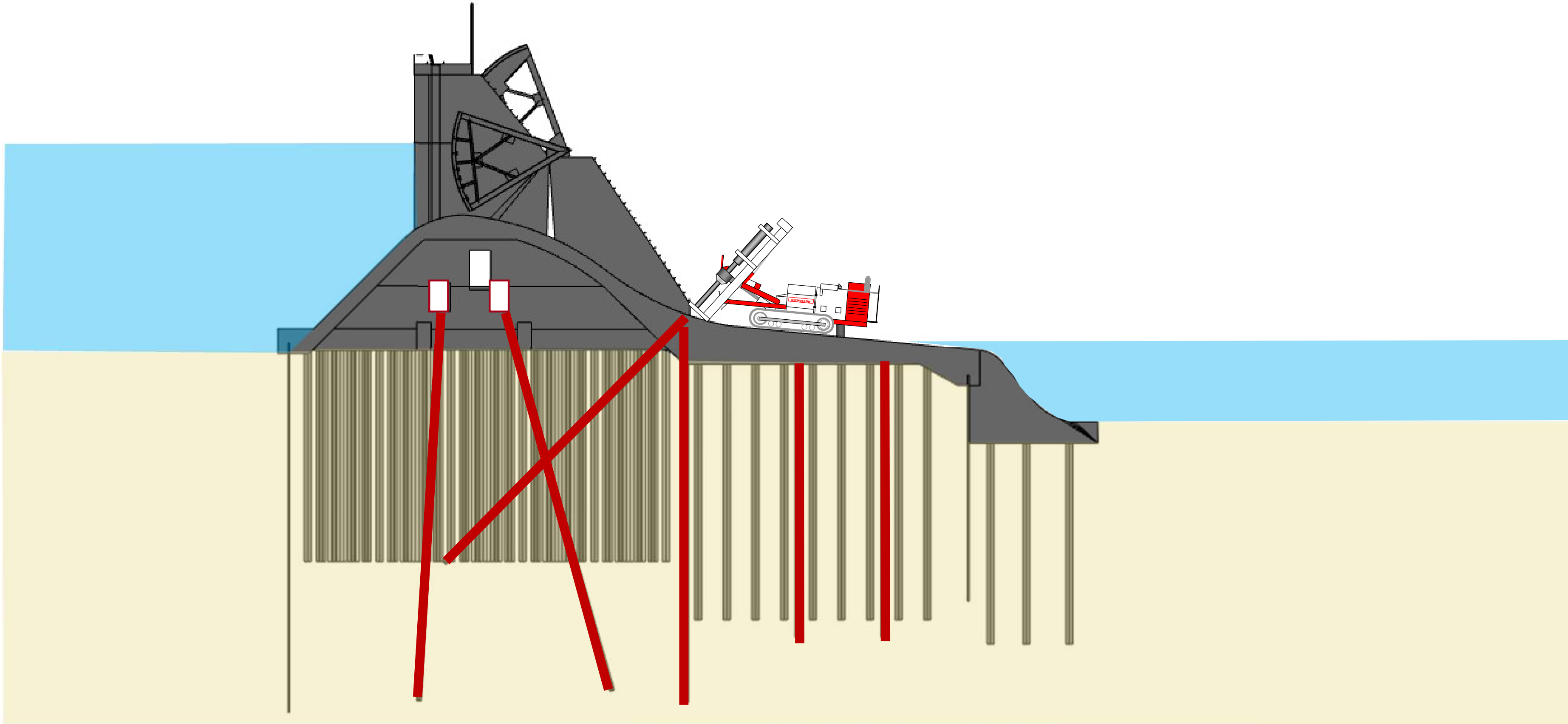
Design Approach – Determine Resultant Loads



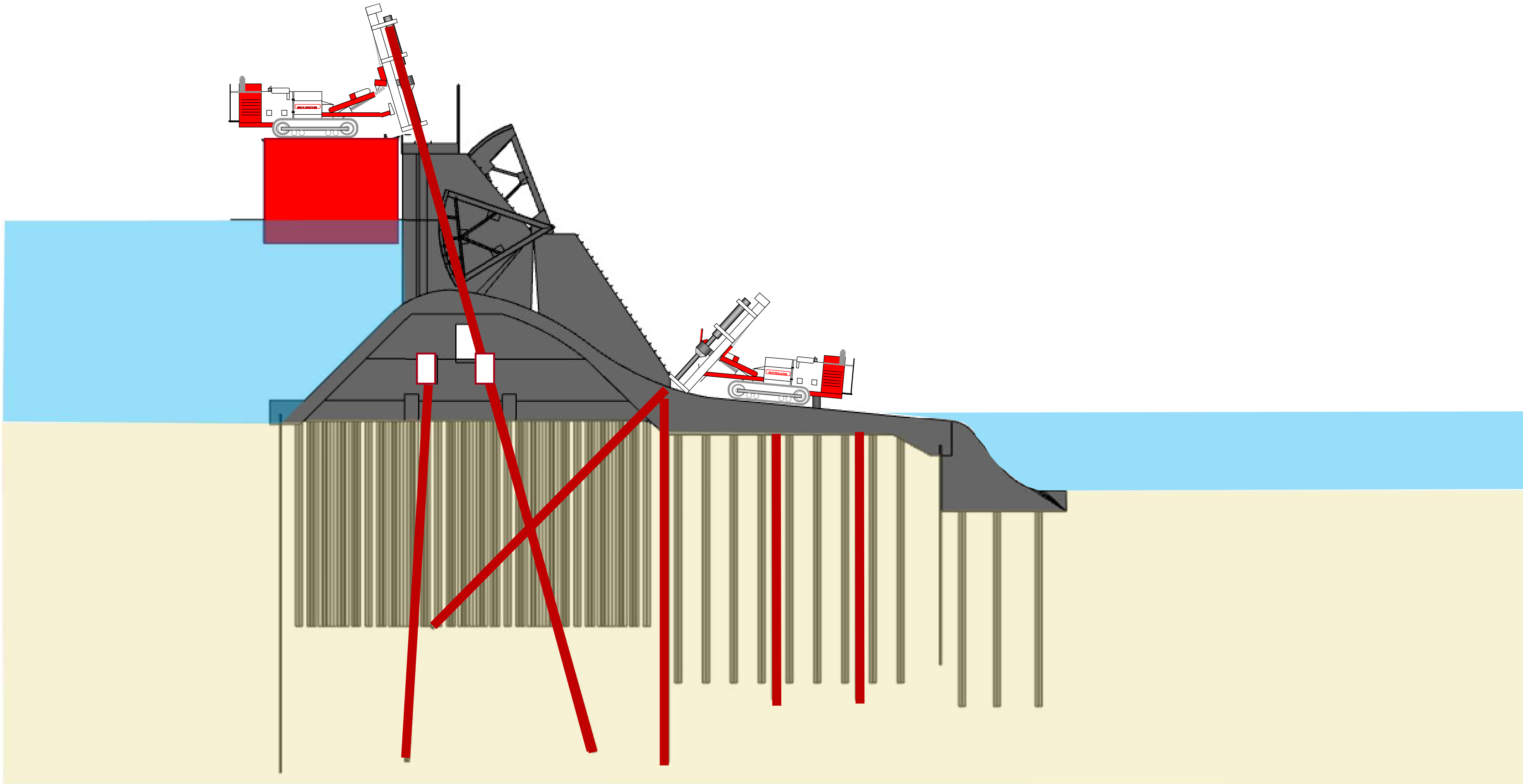
Design Approach – Install Micropiles



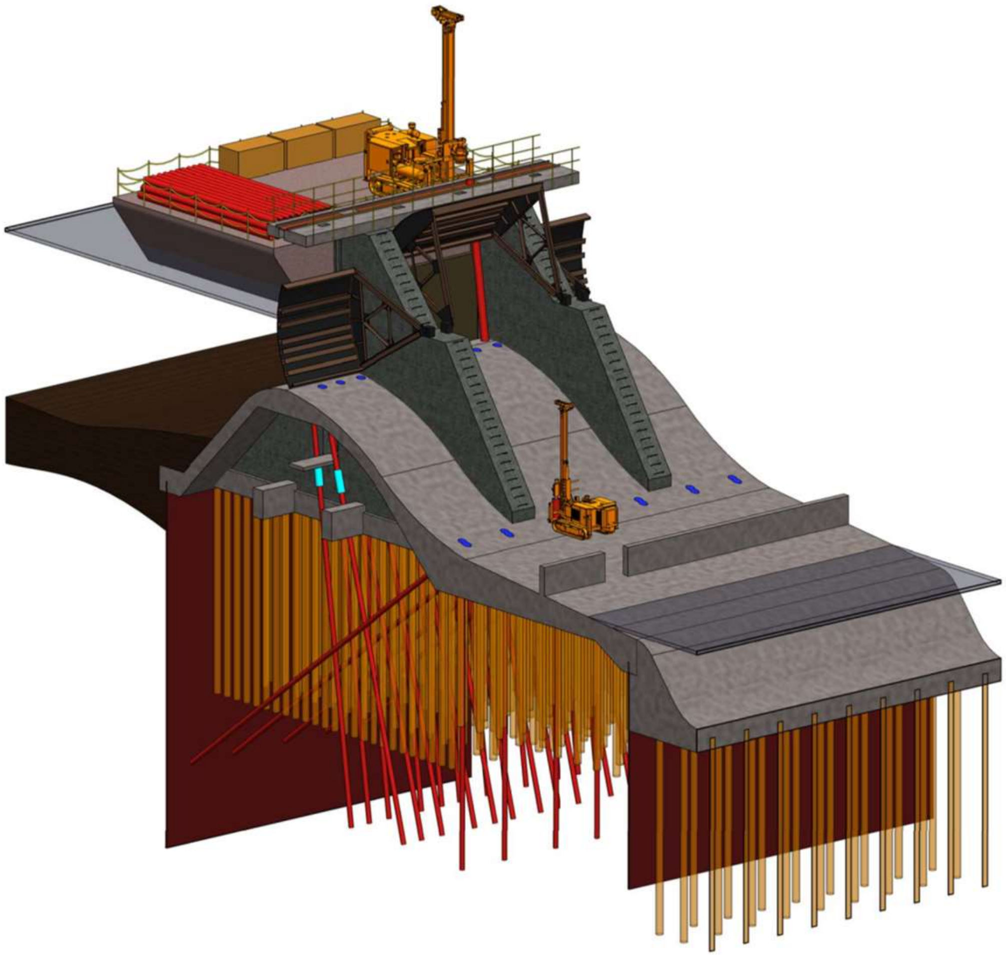
Construction Approach

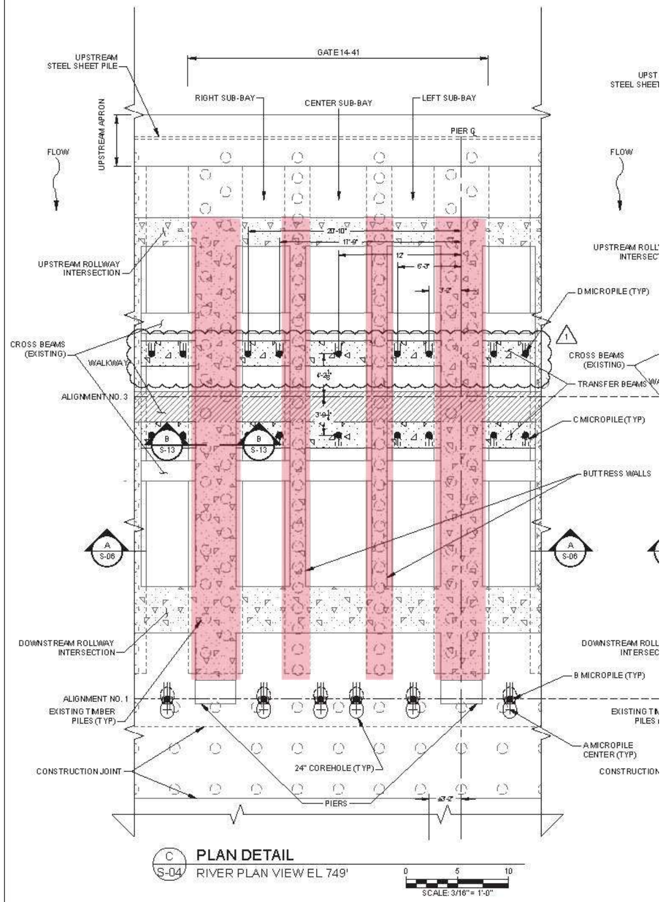


Construction Approach



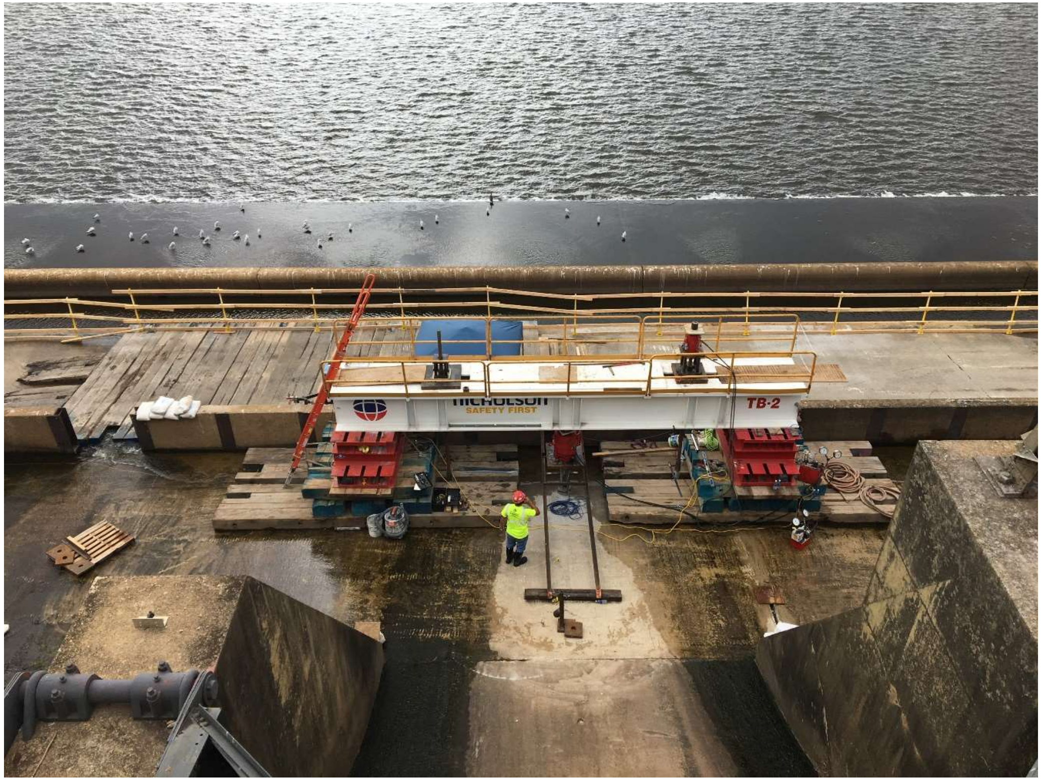
Construction Approach (cont.)



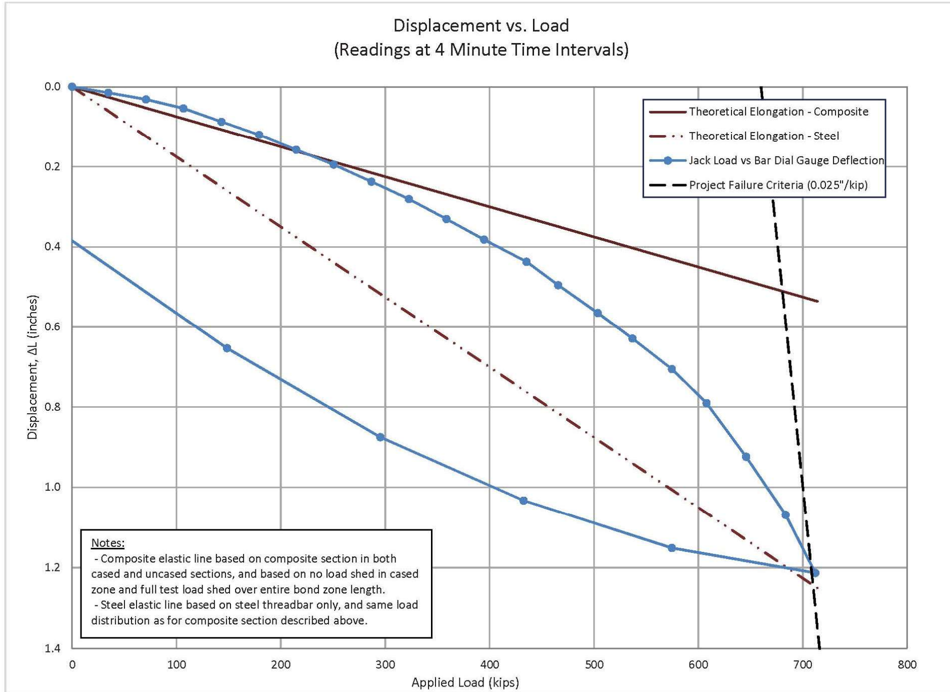


Extensive Test Program (2017)

- Goal of 0.25 inches of movement at design load of 300 kips.
- Piles tested to 80 psi bond stress without failure with post-grouting.

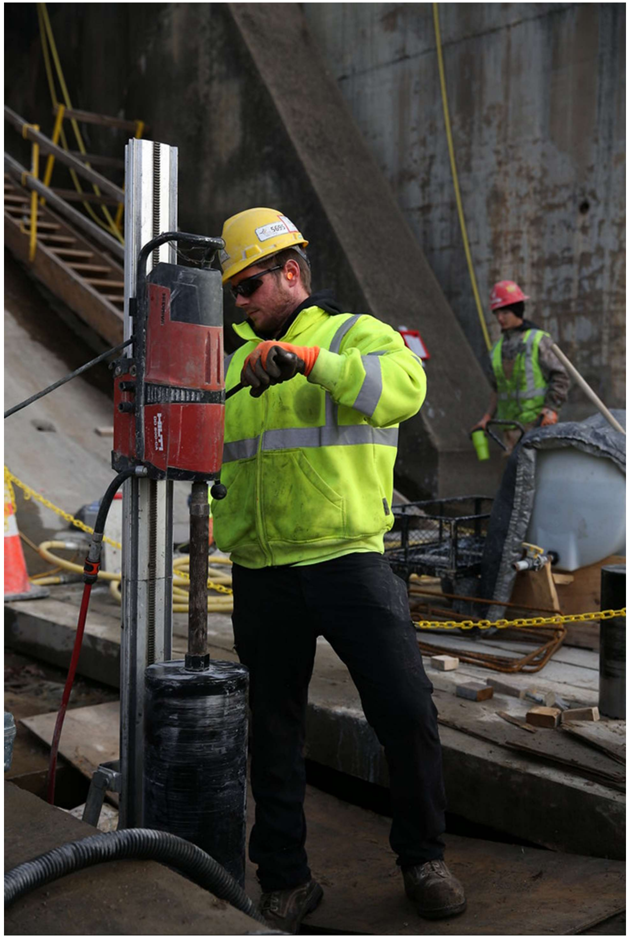


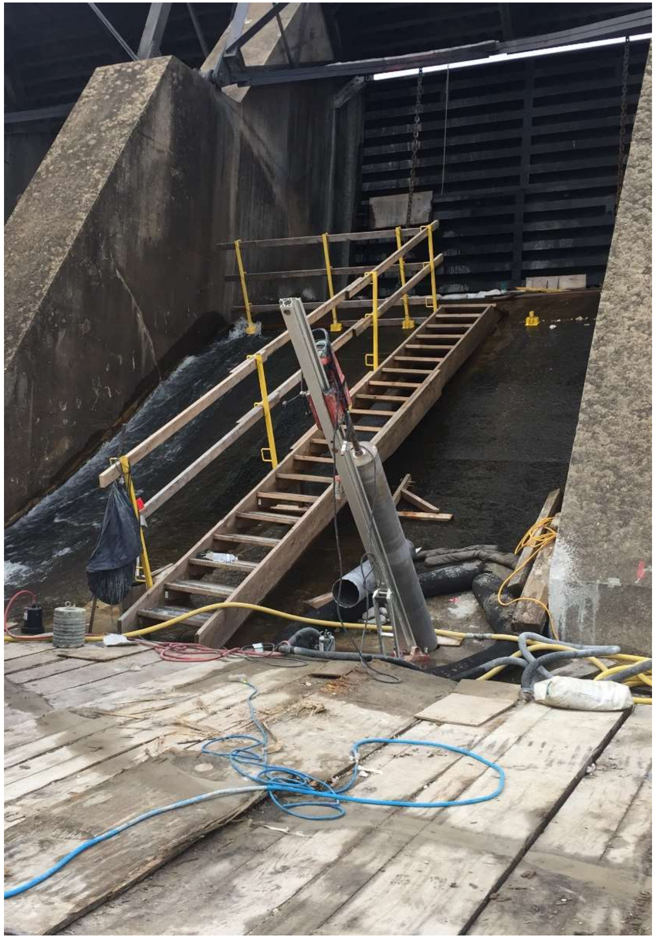
TEST PILE TP-T1
TENSION TEST



Construction

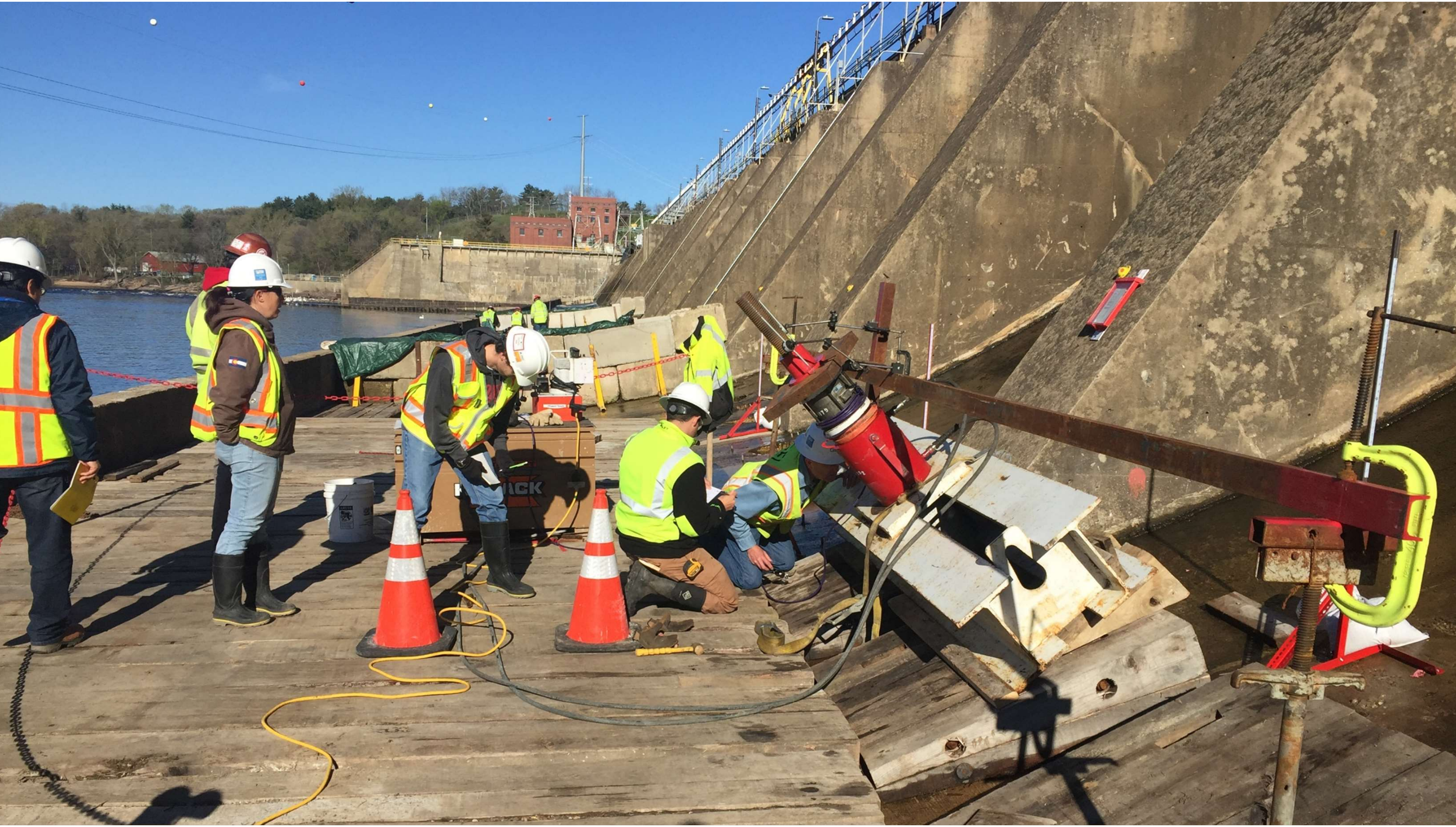
Coring Into/Thru Dam





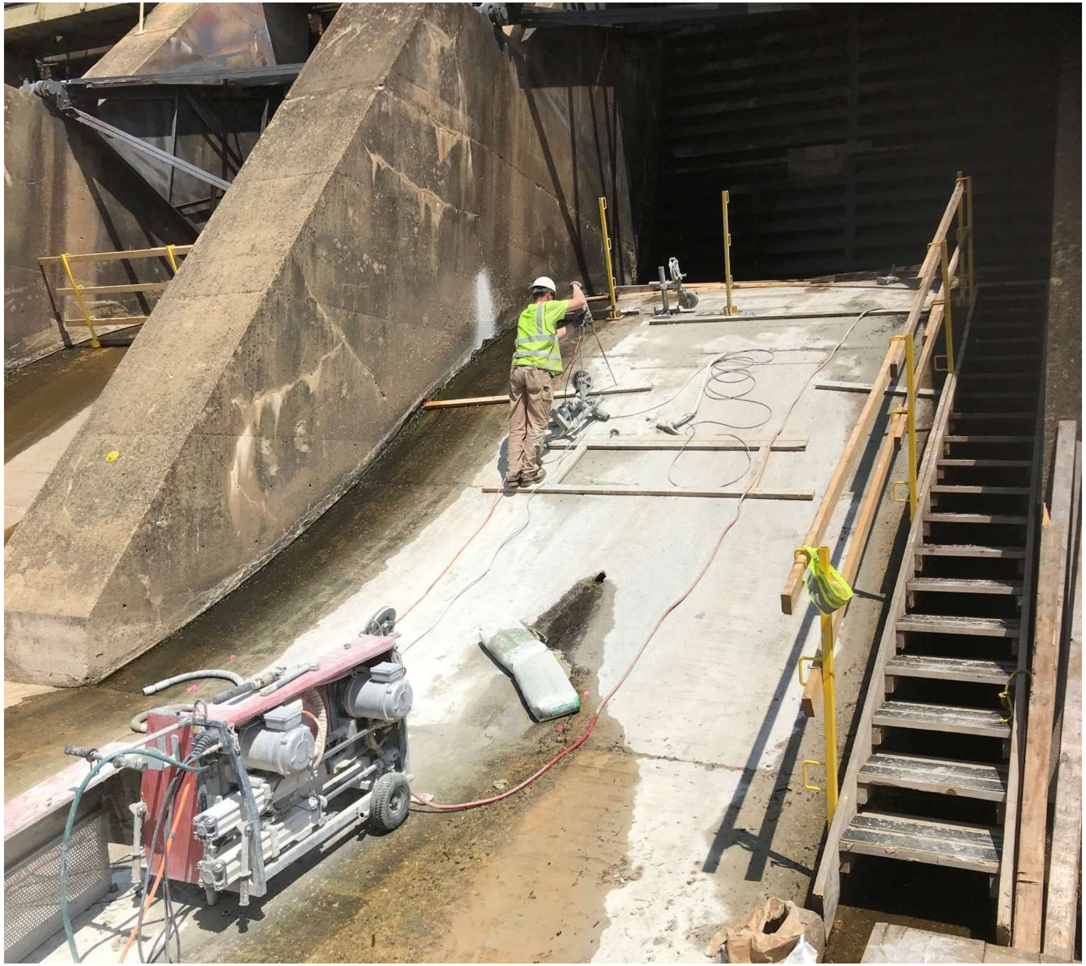

NICHOLSON


MC2201

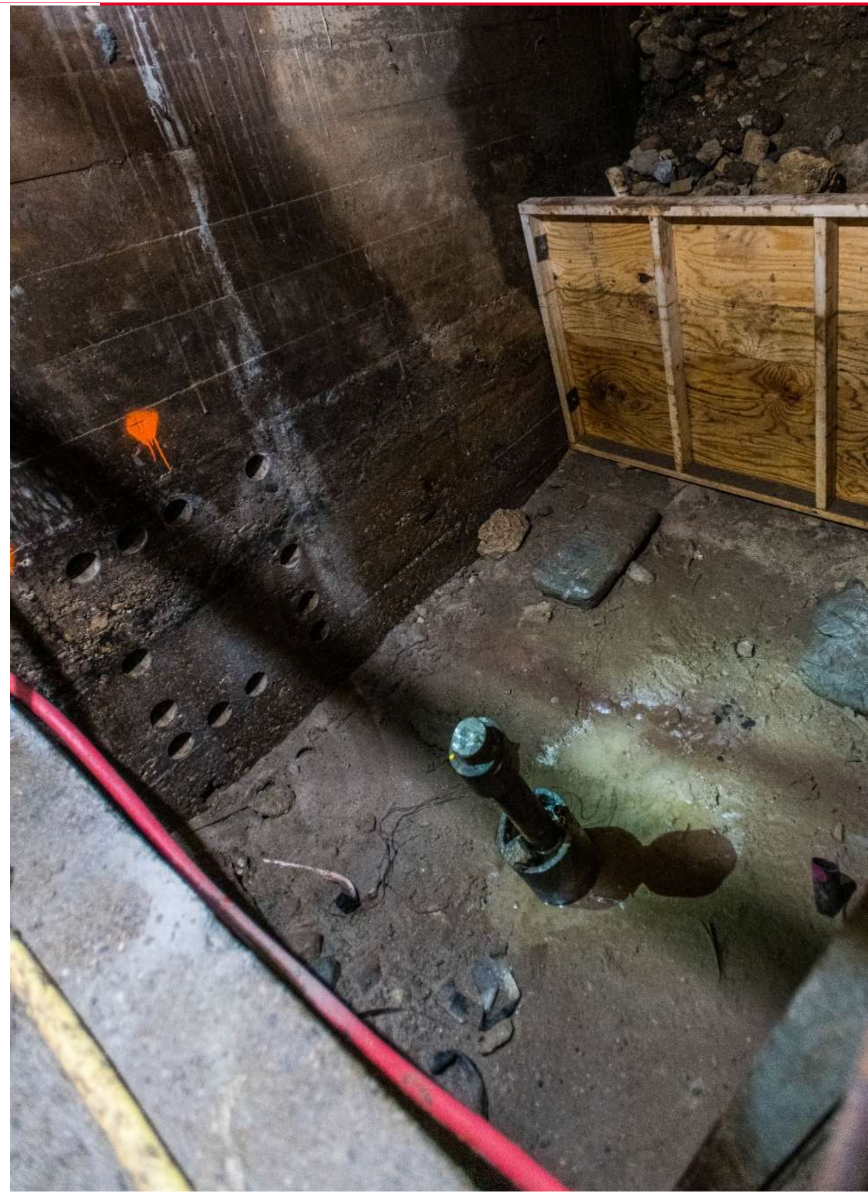



NICHOLSON
805 F
24
23

Gallery Access



Gallery





THANK YOU!
ANY QUESTIONS?
NICHOLSON