HHD CUTOFF WALL CONSTRUCTION LESSONS LEARNED

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SAME Presentation
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Agenda

- Background
- Acquisition Strategy
- Construction Methods
- Specifications
- Lessons Learned
- Summary





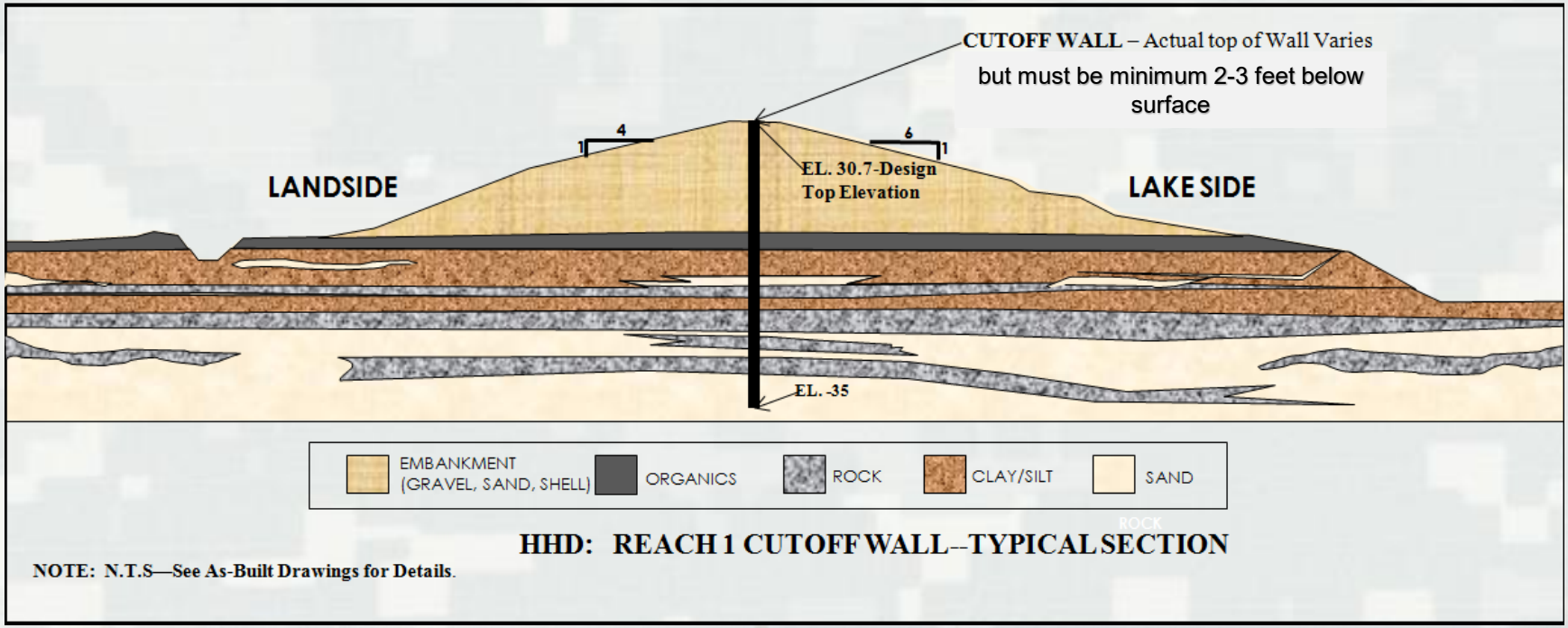
Background



Lake "O"

- 720 square miles
- Average depth is nine feet
- Water volume about 180 billion cubic feet
- Drainage area is 5,600 square miles
- One foot of rain in the basin can equate to a three to four-foot rise of the lake
- Dike is 143 miles
- Limited discharge capacity

Seepage Barrier Section









Acquisition Strategy

MATOC Contract
(Multiple Award Task Order Contract)

- Base contract that contains the technical specifications. Plans for multiple task orders within one contract
- Performance contract with wall acceptance criteria specified
- Solicit Request for Proposals (RFPs) on means and methods for cutoff wall construction
- Evaluate/rank and select three contractors
- Task orders competed among selected contractors

Successful Performance

- Requires clearly defined acceptance criteria
- Need well developed execution plans from Contractor
- Partnering critical for success
- Need to give Contractor QC flexibility
- Demonstration section a MUST!!!



Construction Methods

MATOC 1 Successful Methods











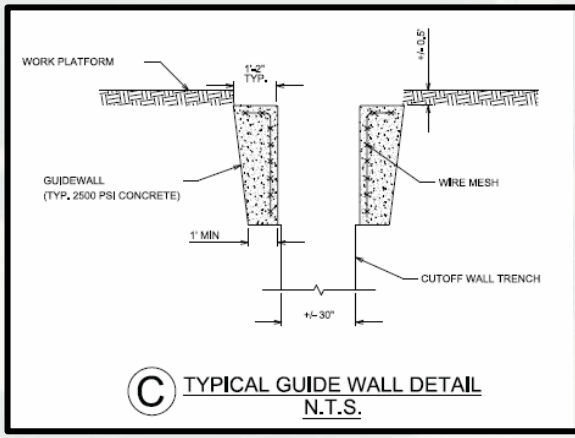
Clamshell and Hydromill

Clamshell to remove peat









Guidewall (pendulum)

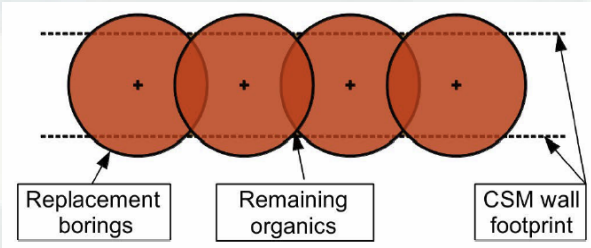
CSM and Pre-Drill

- Casing drilled into the embankment
- Peat extracted with smaller diameter auger bit



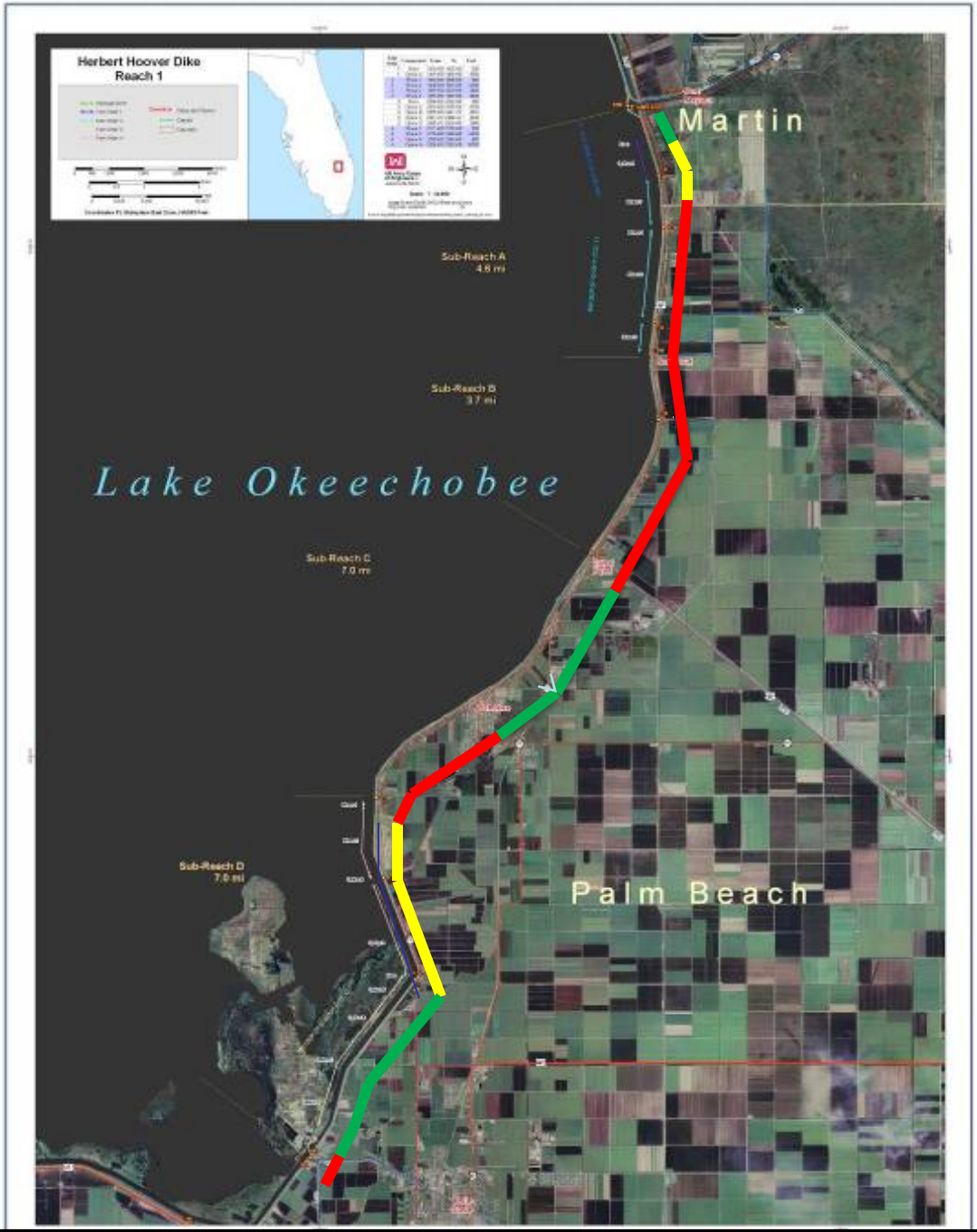






Trench Cutting and Remixing Deep Wall Method (TRD)





MATOC 1

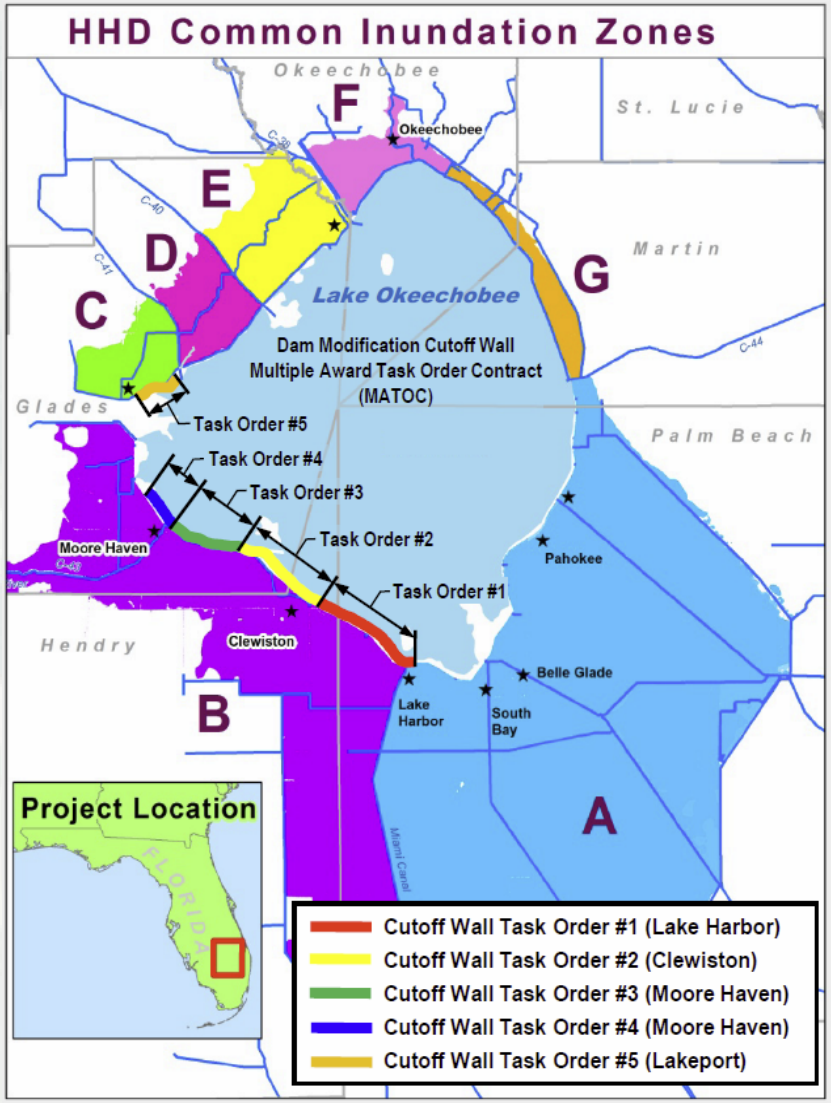
21.3 miles of total wall constructed (nine task orders)

TRD

CSM

Hydromill

MATOC 2 – 28.6 Miles



BUILDING STRONG

Multiple Award Contract Task Order (MATOC)

- 28.6 miles of cutoff wall construction using 5 task orders

Cutoff Wall Task Order #1

- 8.35 miles of cutoff wall from S-354 to S-310
- STA 2907+78 to STA 3348+50 (44,072-ft)
- DSMR Segments 4 and 5-2

Cutoff Wall Task Order #2

- 7.04 miles of cutoff wall from S-310 to S-279
- STA 3348+50 to STA 3720+00 (37,150-ft)
- DSMR Segments 5 and 6 (partial)

Cutoff Wall Task Order #3

- 5.19 miles of cutoff wall from S-279 to S-77
- STA 3720+00 to STA 3994+00 (27,400-ft)
- DSMR Segments 6 (partial) and 7

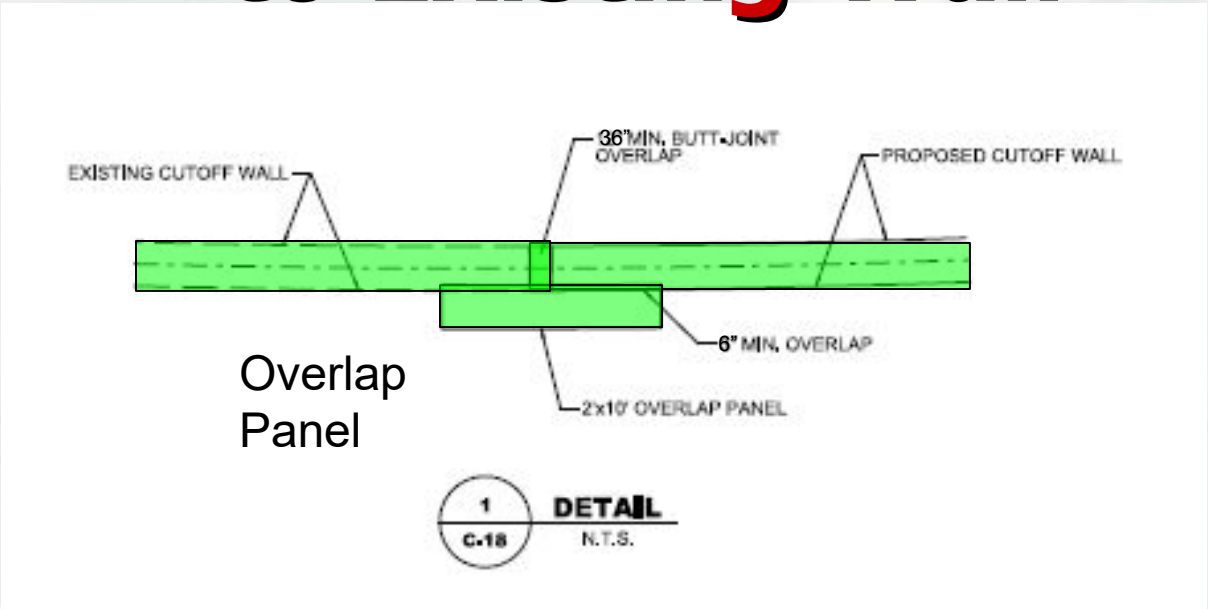
Cutoff Wall Task Order #4

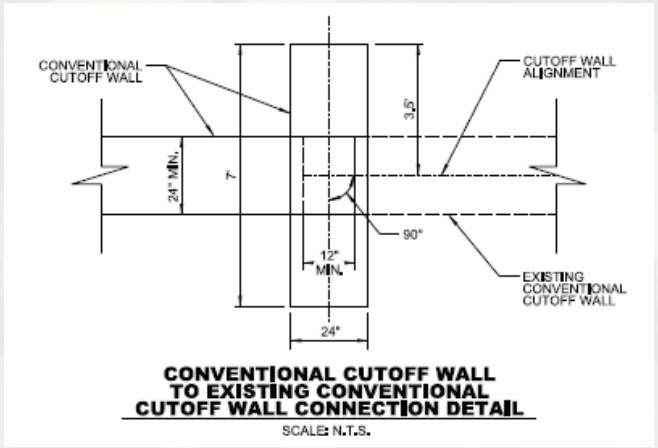
- 3.93 miles of cutoff wall from S-77 to S-281
- STA 3994+00 to STA 4201+31 (20,731-ft)
- DSMR Segments 8 and 9 (partial)

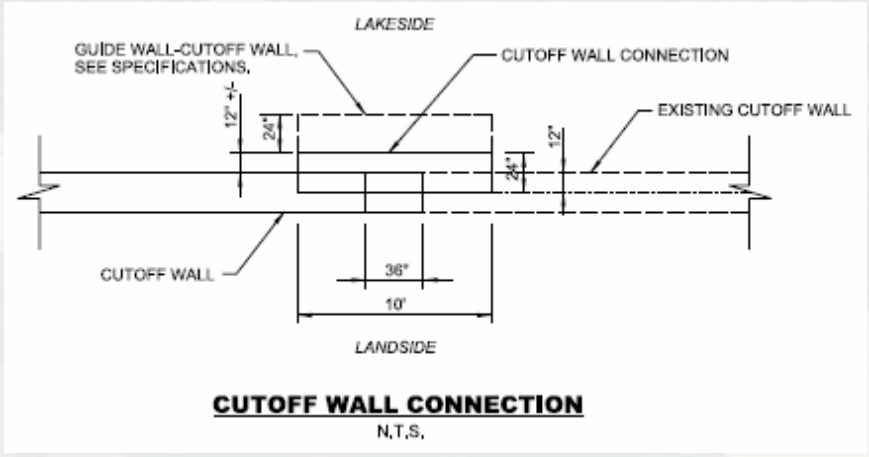
Cutoff Wall Task Order #5

- 4.11 miles of cutoff wall from S-283 to East S-131
- STA 4515+70 to STA 4665+00 (21,701-ft)
- DSMR Segments 12 and 13

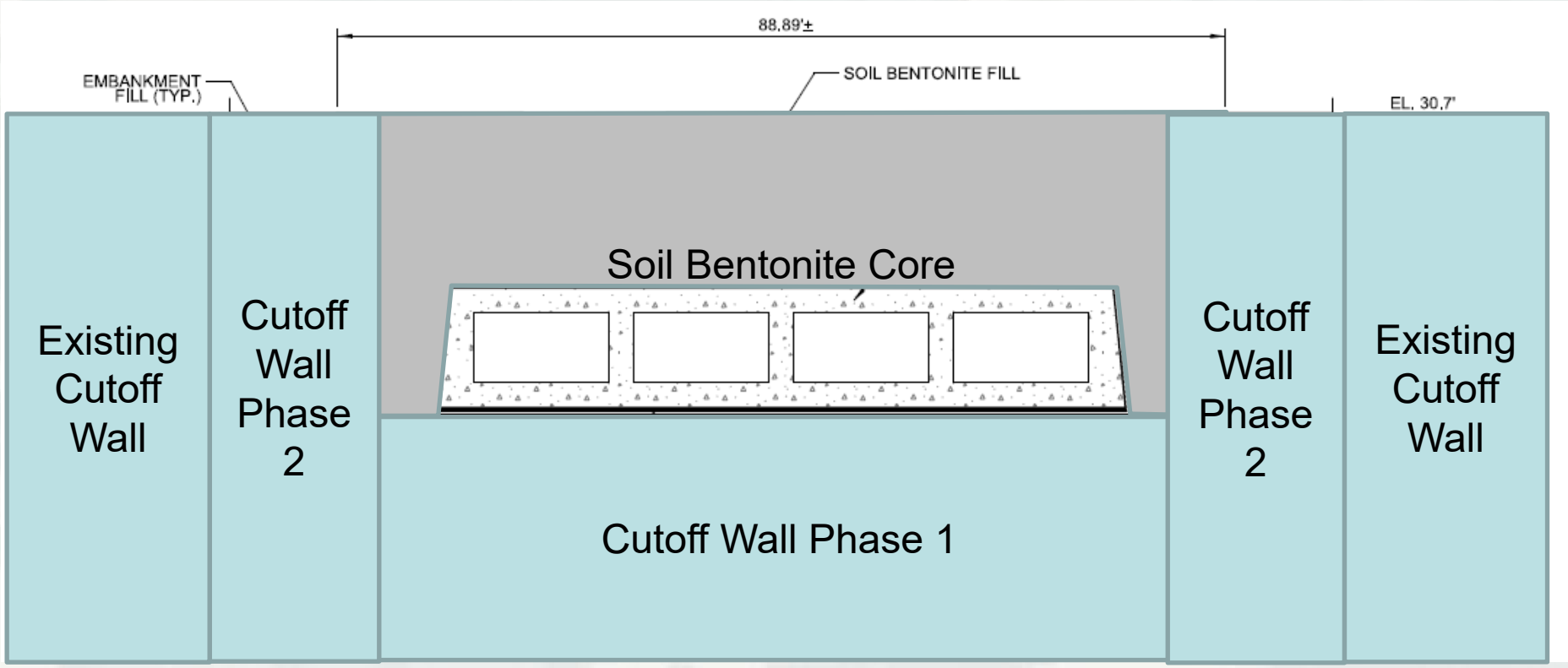
Cutoff Wall Connections to Existing Wall







Cutoff Wall Closures Around Culvert Replacements

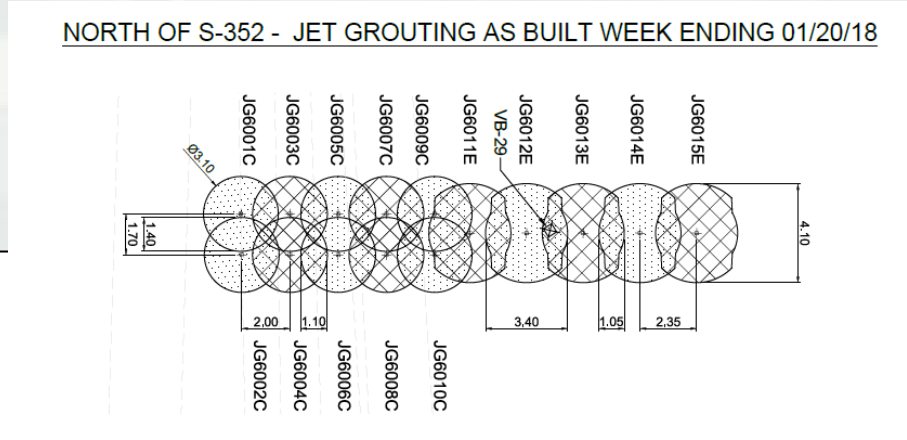


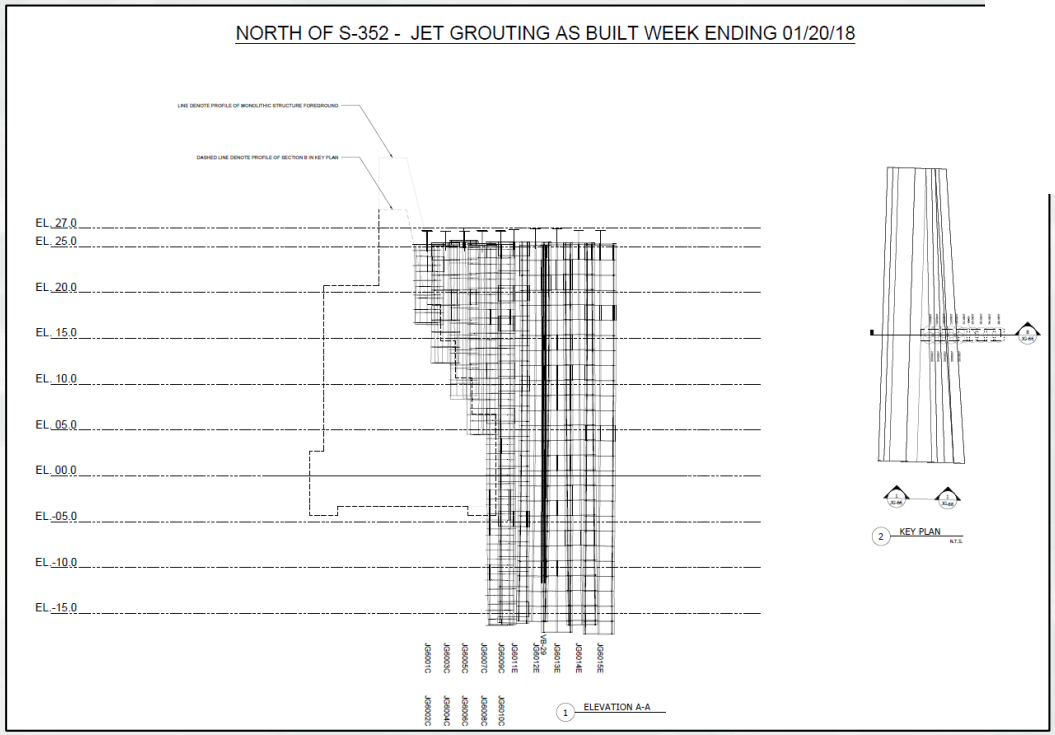
Jet Grout at Existing Structures





Jet Grout at Existing Structures







Performance Specifications

Performance Specifications

- Contractor solely responsible for means and methods of excavation, wall placement, and backfill mix design
- Demonstration section a MUST!
- All new contracts require at least two NTPs, demonstration section, and rest of work
- Partnering critical
- Be flexible when applying acceptance criteria to different means and methods

Continuity & Homogeneity

- Demonstrated thru
  - Cores (>90% recovery)
  - Optical televiewer logs
  - CCTV video with borehole under hydraulic loading (pumped out)
- Cores required every 250 feet of wall





In-Situ Permeability

In-Situ = 1x10E^{-6} cm/sec
(falling head borehole test)



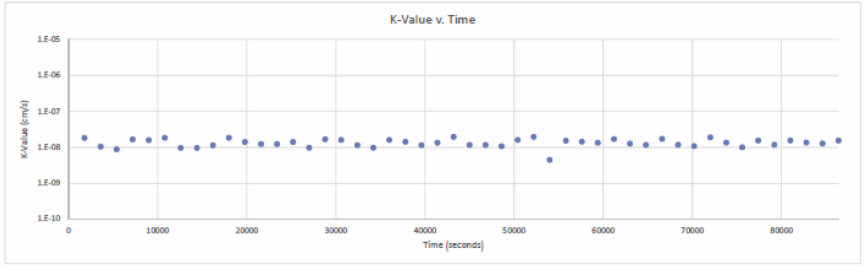




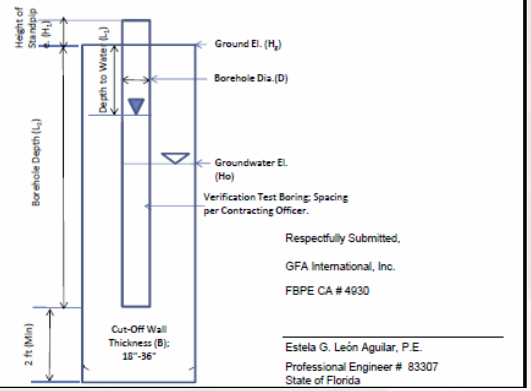
REPORT OF FALLING HEAD PERMEABILITY TEST

PROJECT NAME:	HHD DAM MODIFICATION MATOC TASK ORDER 1	CONTRACTOR:	BAUER FOUNDATION
HOLE NUMBER:	TO1-VB4-2919150	BOREHOLE LOGGER:	Mike Steen PG
STATION:	2919+15.0	DRILLER:	Brian McCord
TEST DATE:	20-Dec-2019	CT #:	CT00023
LOCATION:	N659610.6 E718138.8		

ELEVATION OF GROUND SURFACE (H_0): (Elevations in NAVD88)	39.2 ft.	ELEVATION OF GROUNDWATER (Ho): (Lake level as reported by USACE Jacksonville Lake Okeechobee Water Level web site)	11.68 ft.(NAVD)
STAND PIPE HEIGHT ABOVE GROUND (H_1):	0.86 ft.	ELEVATION OF TOP OF CUTOFF WALL	25 ft.
DEPTH TO WATER @ TEST START (L_1+H_1):	11.48 ft.	ELEVATION OF BOTTOM OF CUTOFF WALL	-15 ft.
DEPTH TO BOTTOM OF BOREHOLE (L_2+H_1):	53.5 ft.	BOREHOLE DIAMETER (D):	4.8 in.
DEPTH TO WATER @ TEST END (TROLL):	12.21 ft.	WALL THICKNESS (B):	25.2 in.
MANUAL DEPTH TO WATER @ START:	11.58 ft.	MANUAL DEPTH TO WATER @ END:	12.2 ft.
ELEVATION OF TOP OF CASING	40.06 ft.		



Hydraulic Conductivity Calculation		
$A = \pi / 4 \times D^2$ =	116.7	cm^2
$L = (L_2 + H1 - L_1) \times 30.48$ =	1307.6	cm
B/D =	5.2	-
F/L = (from MATOC Section 02 32 00, Figure 1)	3.4	-
t_1 =	0	sec
t_2 =	86400	sec
W/L @ t_1 =	11.48	ft
W/L @ t_2 =	12.21	ft
$h_1 = (H_1 + H_1 - H_0 - W/L @ t_1) \times 30.48$ =	515.7	cm
$h_2 = (H_1 + H_1 - H_0 - W/L @ t_2) \times 30.48$ =	493.3	cm
$k = \frac{A}{\left(\frac{F}{L}\right) \cdot L \cdot (t_2 - t_1)} \ln \frac{h_1}{h_2}$	Equation from MATOC specifications, section 02 32 00, paragraph 3.3.2.d.	
Hydraulic Conductivity Result		
k =	1.35E-08	cm/s



Respectfully Submitted,

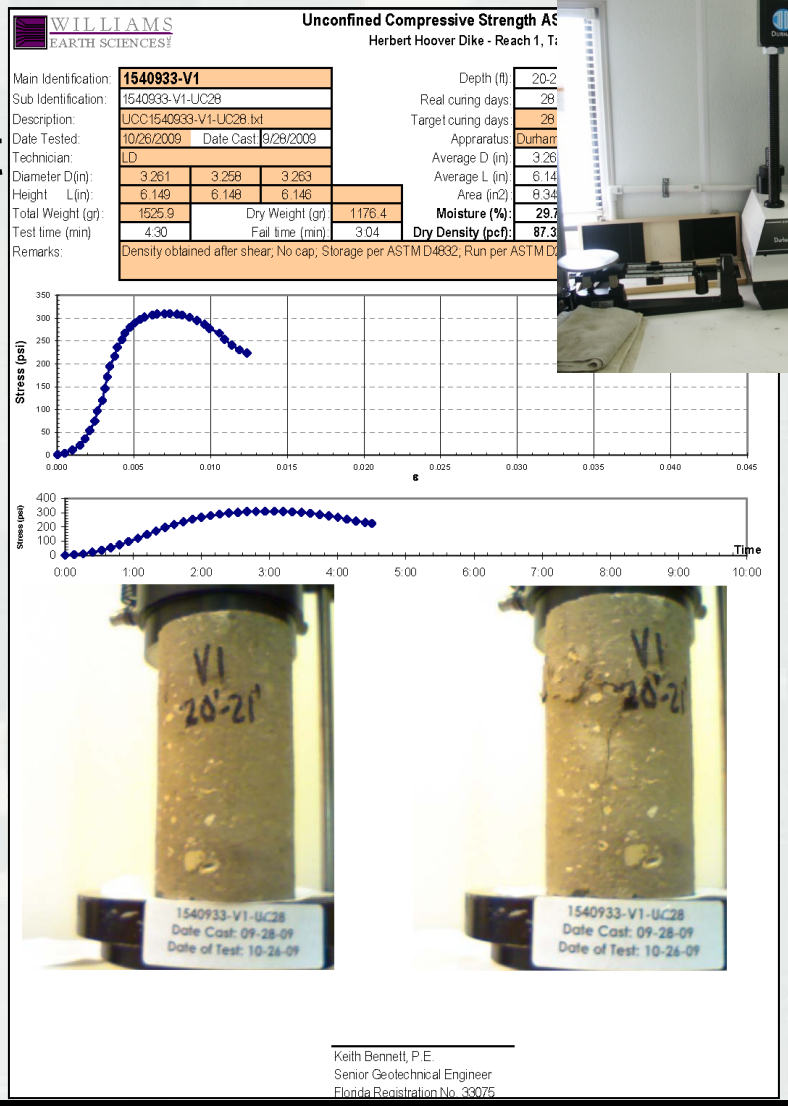
GFA International, Inc.

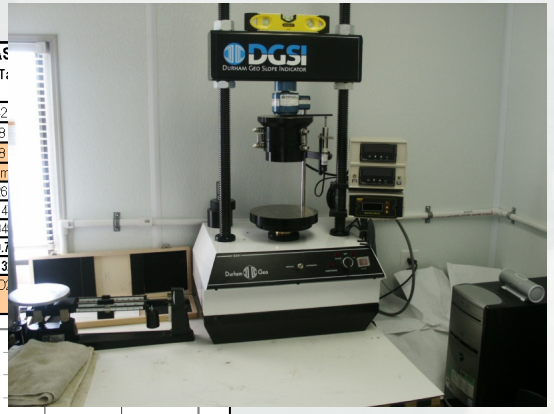
FBPE CA # 4930

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Unconfined Compressive Strength

- 28-day UCS:
  - 100 – 500 psi as 10-pt moving avg. and no single test below 75 psi
  - Testing required on core specimens at three different wall depths (top [**always above water table**], middle, bottom)







Lessons Learned

Wall Compressive Strength

- Original Specifications specified Unconfined Compressive Strength (UCS) of 28 - 200 psi.
- VB drilling in Task Order 1 Demo Section had difficulties obtaining required 95% core recovery.

Lesson Learned: UCS increased to 100 - 500 psi

- Measured as a 10-point running average.
- No single test below 75 psi.
- Consider eliminating maximum strength requirement.
- Cored specimens can show lower than actual strength

Verification Acceptance
Content of Submittal Packages

- Contents of submittal packages for acceptance were not clearly specified, leading to conflict over what data was required.

Lesson Learned: Must specify/define what data and format you want to see in submittal packages (preferably a single PDF):

- Verification boring (coring) log
- 360-degree video recording (Optilog)
- CCTV video recording
- UCS strength test results
- In-Situ permeability test results
- Verticality results

VB Downhole Video Recording (Optilog)

- Original spec did not require the use of a VB down-hole camera (Optilog).
- The Contractor used a downhole video in the first task order to prove the wall was intact and homogeneous.

Lesson Learned:

- After Task Order 1 (of MATOC 1), a downhole 360-degree video recording (Optilog) of the hole was required on all future task orders.
- In addition, CCTV video recording was added to visually observe the borehole under hydraulic loading.

Verification Borings

- Original spec required Verification Borings (VB) drilling and falling head permeability testing 28 days after SCB placement.
- Did not allow Contractor testing flexibility.

Lesson Learned:

- Recommend allowing VB and testing within the range of 28 to 35 days after wall placement.

Verification Drilling
Coring Methods

- Core drilling low compressive strength cutoff walls is not easy, but it can be done.

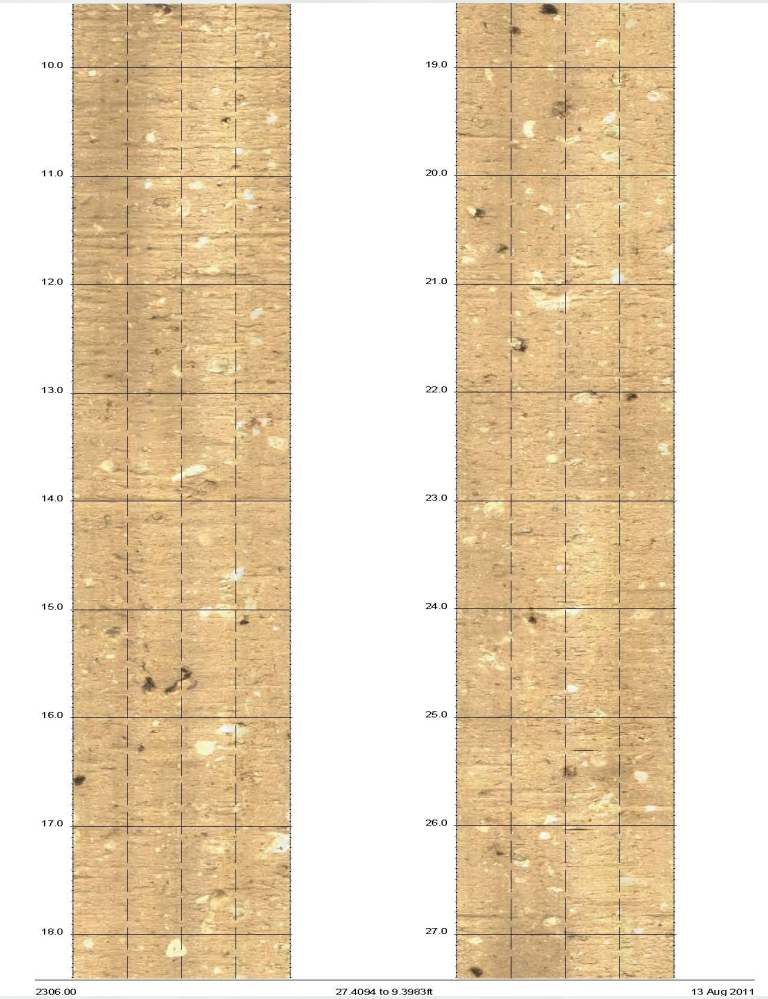
Lessons Learned:

- Experienced drill crew required
- Wireline (HQ, PQ) – The method with the most success
- Preferred drill fluids:
  - Polymer
  - Foam
- Don't allow use of bentonite - Can have an influence on permeability testing by coating boring wall
- Upon testing, flush VB with a chlorine/bleach solution to break down drill fluids
- Allow flexibility to determine best drilling technique (preferably during demo section)

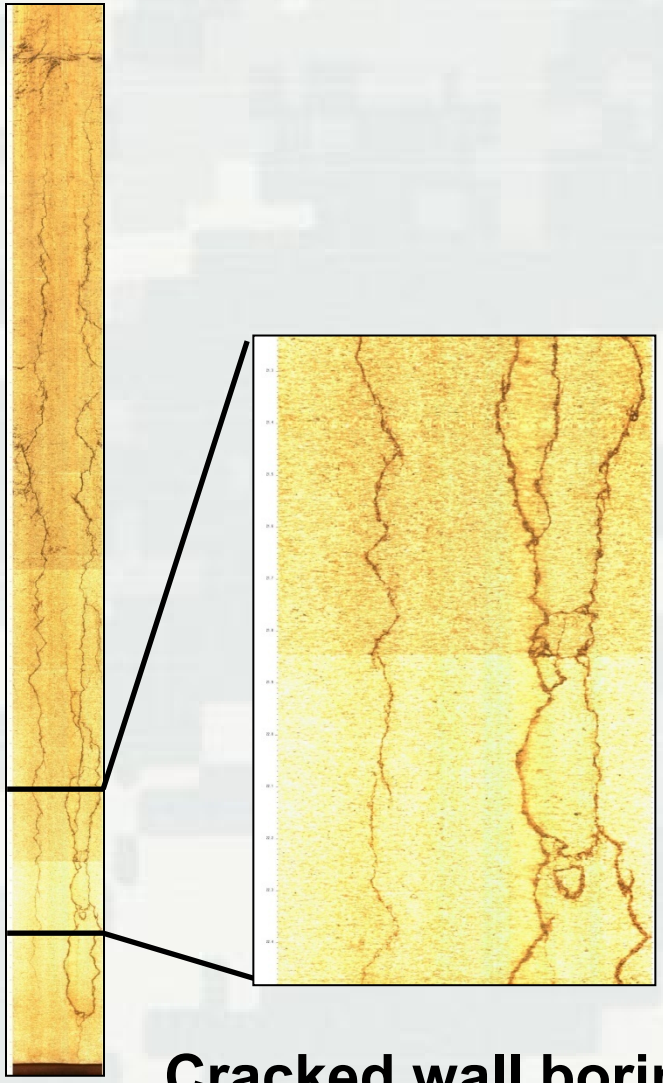
VB Borehole Wall and Transverse Wall Cracking

- All walls with cement have the potential to crack
  - Consider this in the design
- Continuous wall construction methods may have a higher potential to develop shrinkage cracks
  - Recommend to evaluate wall cracking during the Demonstration Section
  - Perform random excavation of wall cover during production to check for cracking

Down Hole Video/Optilog

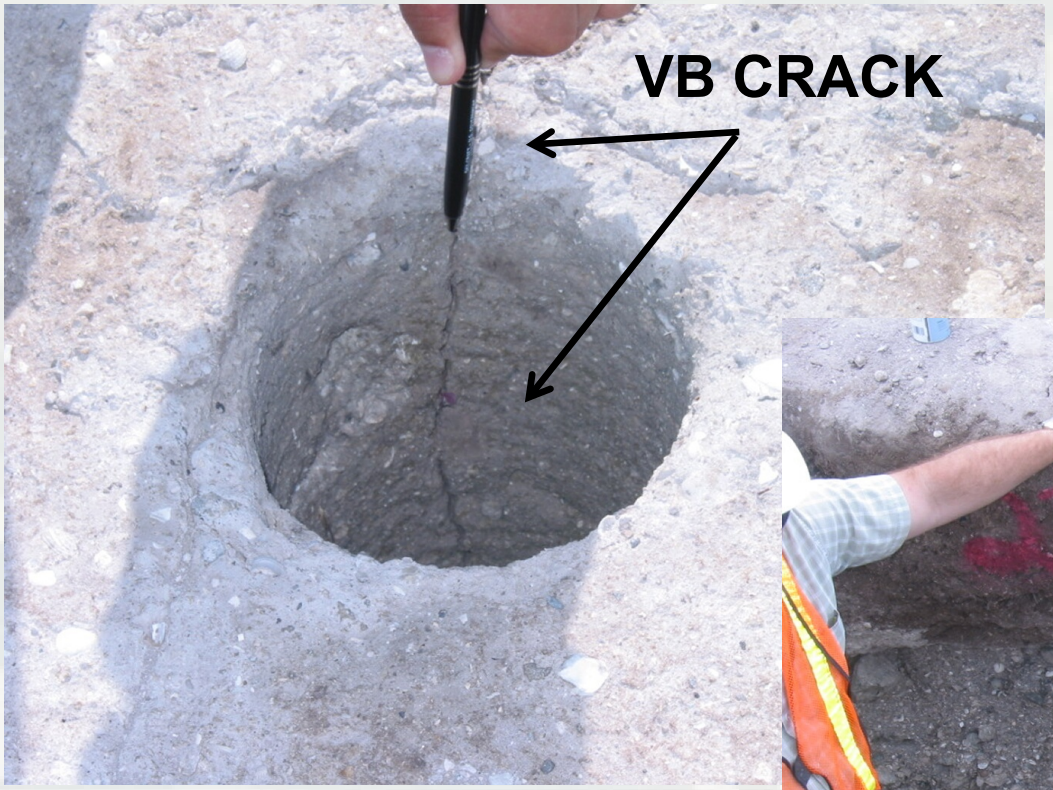


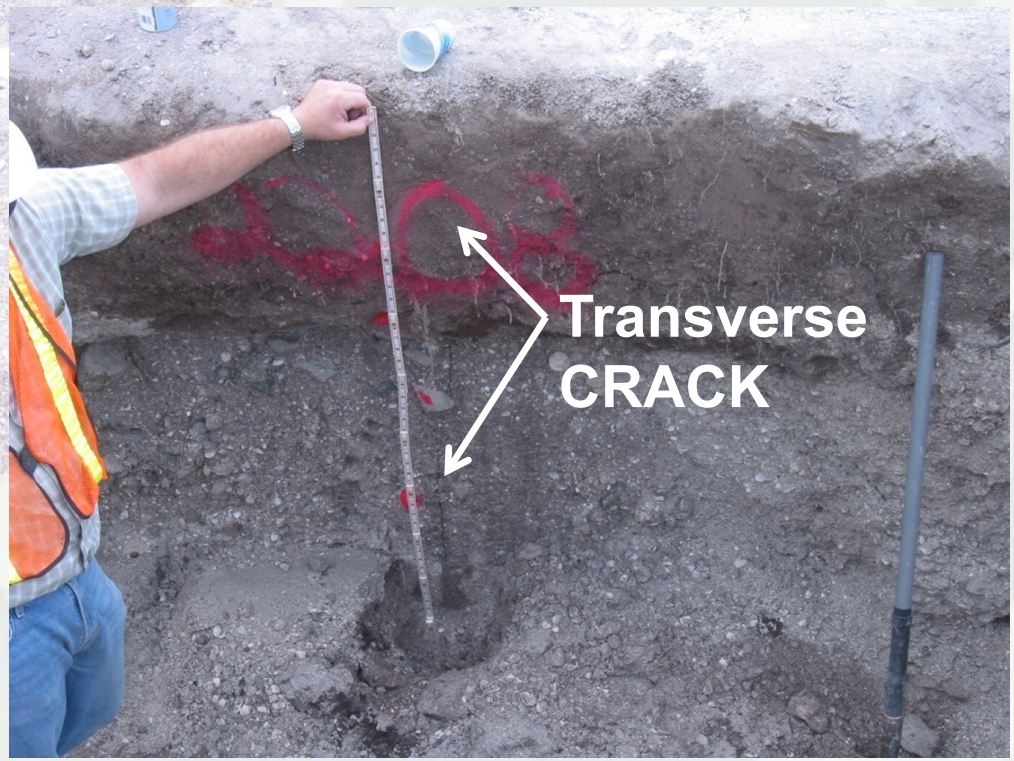
Boring - wall not cracked



Cracked wall boring

Wall Cracking Examples





Wall Cracking

Lesson Learned:

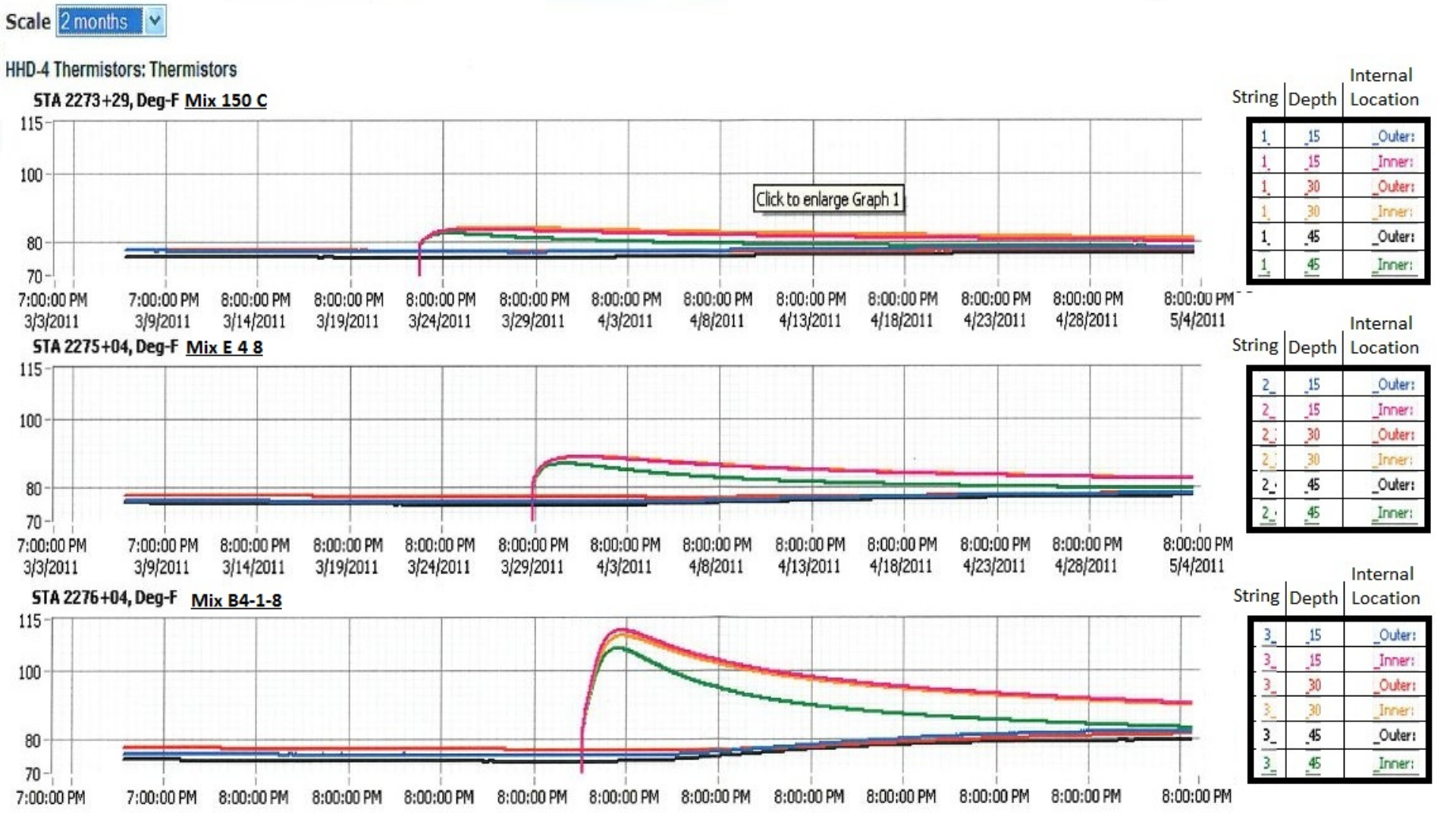
- Control internal stress IN the wall to the extent practical
- Shrinkage occurs due to:
  - Hydration
  - Drying
  - Placement temperatures
- These can be minimized by the selection of mix design and controlling construction techniques

SCB Placement Temperature Control

Lessons Learned:

- Specs should require the Contractor take proactive measures to control fresh slurry temperature:
  - Keep the water tanks covered and/or insulated from the direct sun
  - Use white-painted cement silos and water tanks to reflect the sun
  - Insulate cement silos and water tanks
  - Cover and insulate hoses
  - Use a water chiller or ice chips

SCB Placement Temperature Monitoring



Summary

- **Successful cutoff wall technologies**
  - **Cutoff wall contracting mechanism**
  - **Excellent industry performance**
- **Post-design role**
  - **Need substantial EDC**
  - **Show a strong presence**
  - **Bad news or questionable results do not improve with time. Deal with issues quickly**

Lessons Learned:

- **Adjust as necessary; keep an open mind**
- **Avoid unnecessary conflict**

THANK YOU.

QUESTIONS?

For More Information:

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