November 21, 2024

Foundation Design & Ground Improvements

Georgia Ports Mason Mega Rail Project

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Vice President/Senior Consultant

Terracon
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GEORGIA PORTS

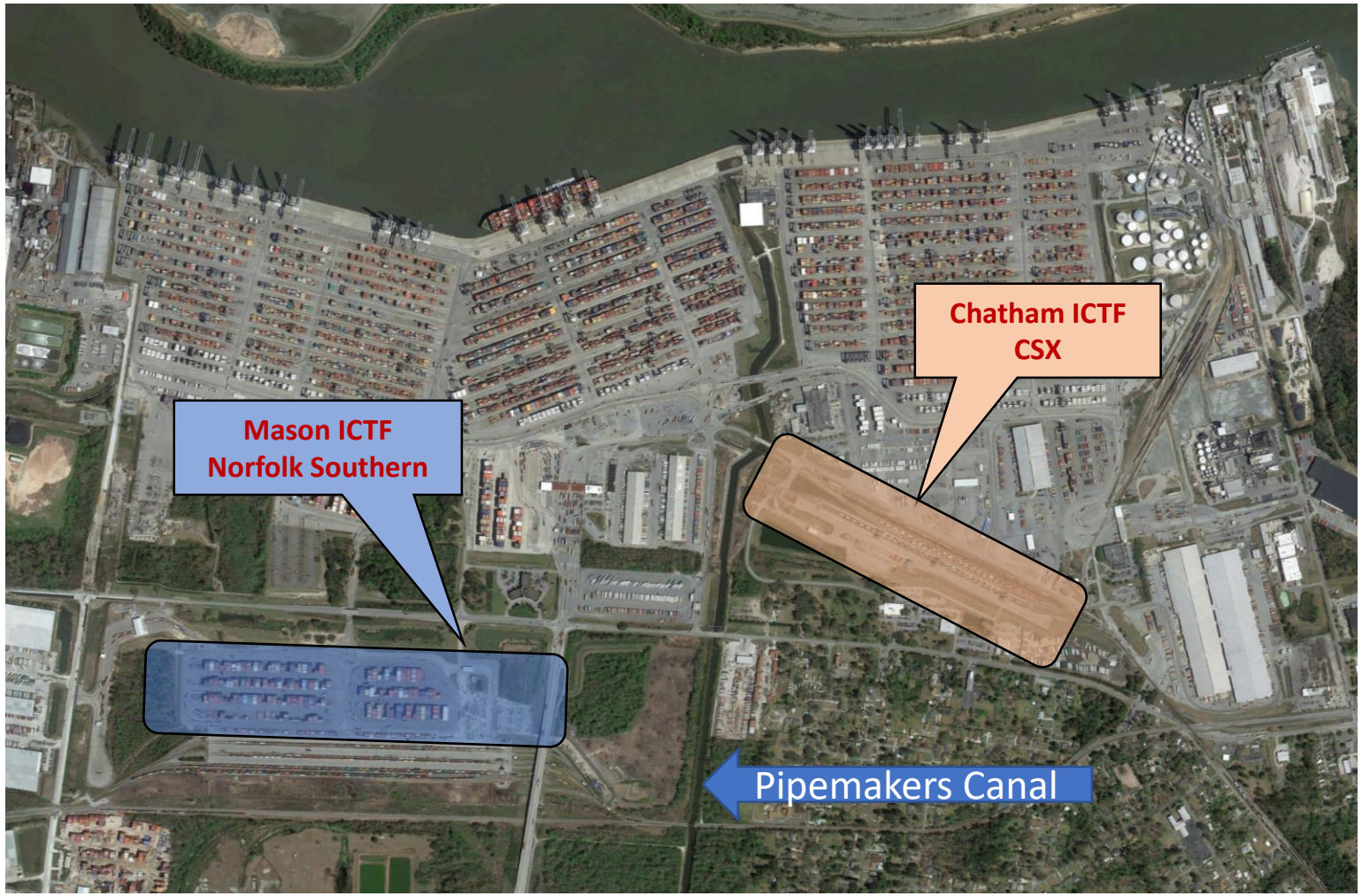
- **Fourth largest in the US**
- **1,345-acres, 10,000 ft berth, largest Single-Terminal in the U.S**
- **Channel Depth of 47 ft**

Outline

- Project Overview
- Geotechnical Challenges
- Ground Improvements & Foundations
  - ✓ Rail Yard and Tracks- dynamic compaction, driven piles, and geocell wall
  - ✓ Drainage Structures - wick drain and preloading
  - ✓ SR 25 Bridge – MSE walls versus pile-supported bridge
  - ✓ Rail Bridge - Rigid inclusions with thermal integrity profiling (TIP)

Garden City Terminal 2018-Two rail facilities

Prior to Mega Rail Construction



Mason ICTF:

- Norfolk Southern
- Top Pick Operation
- 300,000 Lift Capacity

Chatham ICTF:

- CSX
- RTG Operation
- 200,000 Lift Capacity

Mega Rail Project Layout

Project Components:

- Construct 20 miles of new rail connecting two rail facilities
- Rebuild SR 25 Bridge over Pipemakers Canal
- 10 Rail Mounted Gantry (RMG) cranes
- Double lifting capacity while maintaining existing terminal throughput (1M lifts/year)
- The largest on-terminal rail facility in North America

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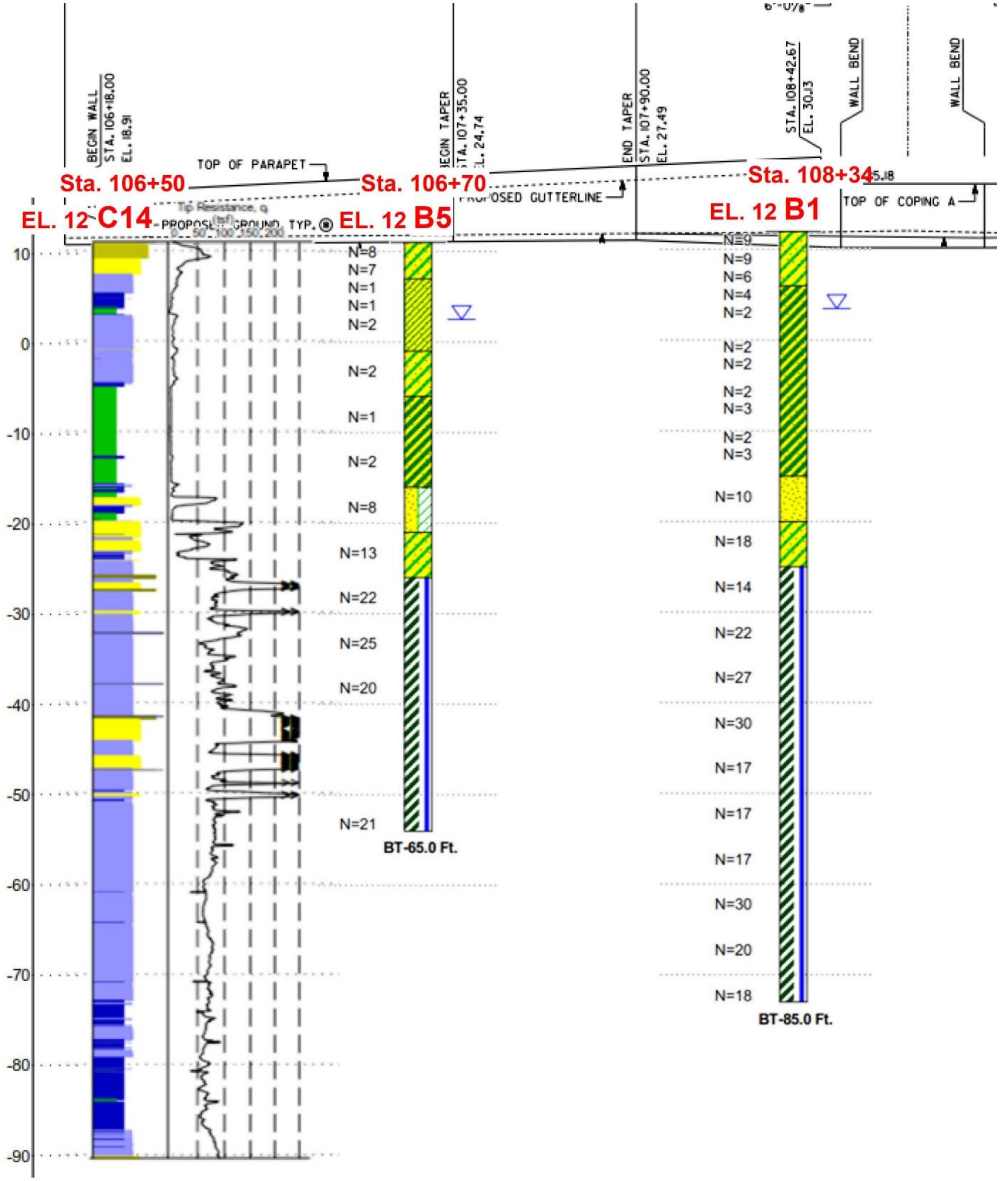
Geotechnical Challenges

- The planned rail yard was an unregulated **landfill-Union Camp**
- About 12 feet of waste
- Waste composed of wood logs, paper, construction debris mixed with soils

Layer	Depths	Thickness (ft)	Material Description	SPT - N_{60}
1	0 to 1	1	Topsoil: silty sands with root	N/A
2	1 to 13	12	Landfill Material (Trash/wood debris mixed with sandy soils)	N/A
3	13 to 30	17	Very soft to soft clays	2 to 4
4	30 to 37	7	Medium dense to dense silty sands to sandy silts	7 to 22
5	Below 37	>50	The Marl formation (sandy clay or clayey sands)	30 to 50+



- Settlements and slope stability.

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Dynamic compaction:

Repeated drops of a heavy tamper in a planned grid pattern to densify loose soils and collapse voids.

High Energy Dynamic Compaction

Landfill Site	Compaction Energy=**7 ton–ft/ft^3**
Initial Drop	13 x 13 ft grid
Initial Drop Tamper Weight (tons) and Drop Height	16.5 tons by 60 ft
Number of Drops/Passes	Two passes, 4 or 5 drops at each crater
Typical Crater Depth	4 to 5 ft
Ironing Pass Tamper Weight (tons) and Drop Height (ft)	10 tons by 10 ft
Number of Passes	One pass in 8 x 8 ft grid
Typical Crater Depth (ft)	0.1 to 0.2 ft

High Energy
Initial Pass

- 16.5-ton weight, 60 ft drop
- Two passes
- 4 or 5 drops at each crater
- Crater depth 4 to 5 ft

Quality Control

Proofrolling using a loaded dump truck

Sections passing Proofrolling

- Place a layer of geogrid
- Structural fill and compaction
- Ballast stone for rail tracks

Special Situation
High Water Table and Rain

Problem

- After DC and rough grading, the ground became unstable;
- Pumping under feet;
- Groundwater near the surface

Solutions

- Cut ditches and pump to lower the water table
- Wait two weeks for the ground to regain strength

Sections Failed Proofrolling

- Investigate using test pits;
- Undercut deleterious material like paper and wood;
- Backfill with structural fill with geogrid at the bottom.

Dynamic Compaction Work Area

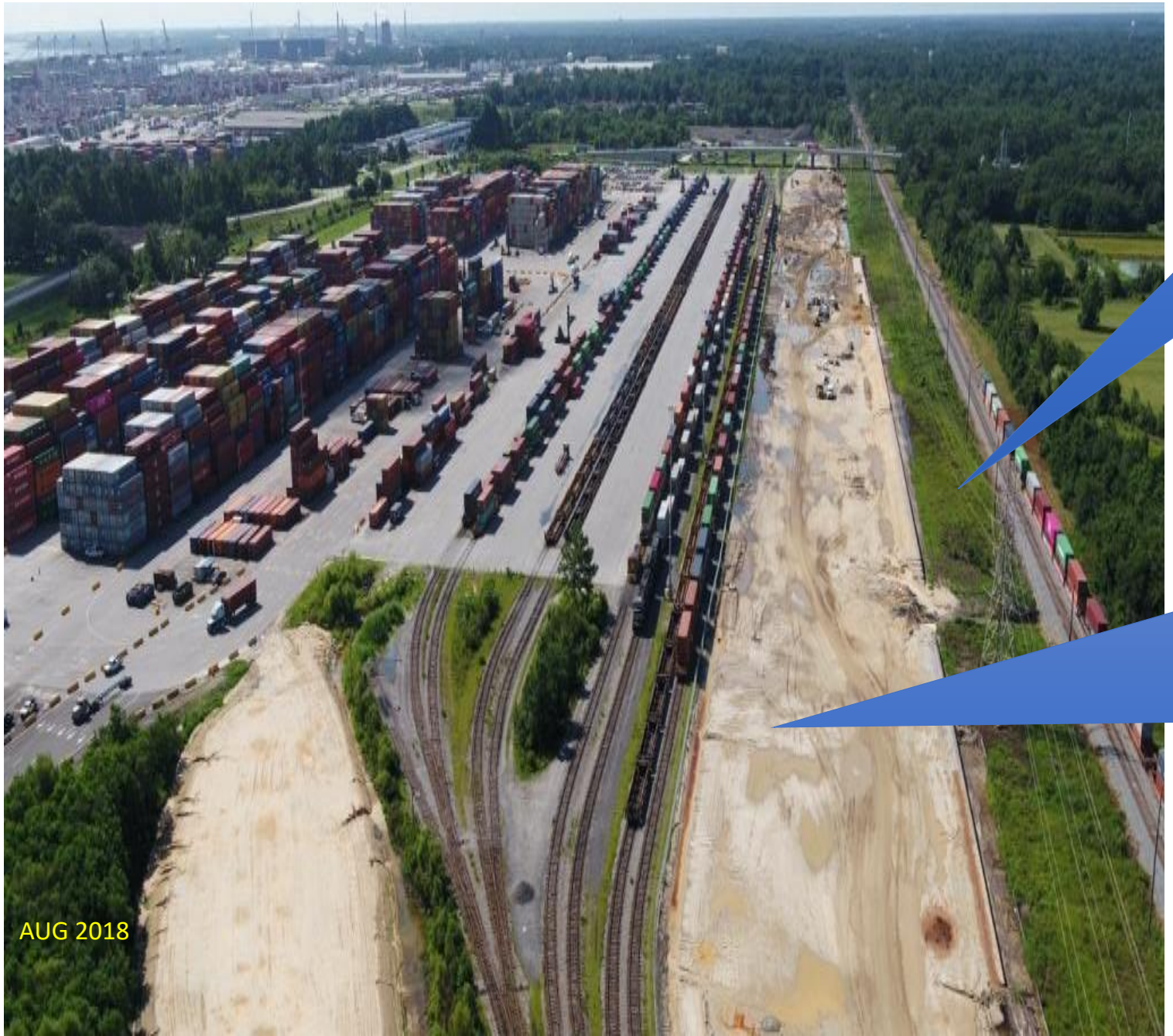
- An unregulated industrial landfill (by a paper mill);
- Low-lying areas next to a drainage canal;
- New rail tracks and chassis parking

New Rail Tracks

Chassis Yard

New Rail Tracks—allow up to 8 inches of settlement

Chassis Yard – very light loads



Wetlands with soft soils

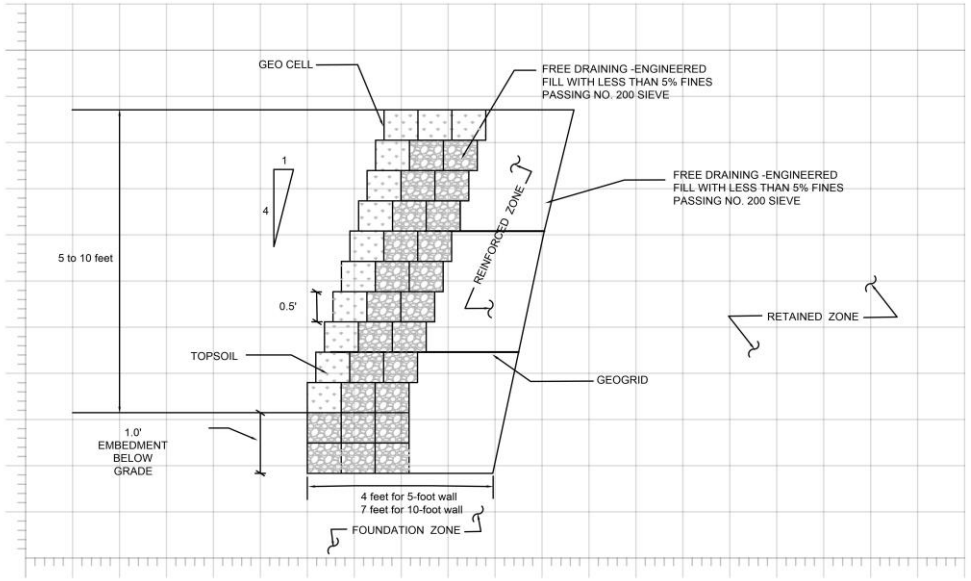
- 4 to 6 ft of loose sands
- Underlain by soft clays;
- Sand layer too thick for vibratory roller;
- Avoiding disturbing deeper clays

Low Energy Compaction of Loose Sand

- 10-ton, 8-ft square steel plate;
- 20 ft high drop;
- 100% coverage of the compaction
- Up to 12” craters

Geocell Wall Along Wetland

- Geocell wall more flexible than the conventional cast-in-place concrete wall;
- Relax subgrade requirements;



GEOCELL MSE WALL TYPICAL SECTION

SCALE: NOT TO SCALE

No rigid concrete footing -- MSE

No metal wires for corrosion – Gabion Wall


Hydraulic hammer
Predrill auger
Wetlands with soft soils


KOMATSU


Geocell Walls
Separating
Wetlands
Maintenance vehicles
9 tracks under the
RMG Crane
Largest in NA
PSC piles supported
RMG
Little settlement
tolerance
PSC piles supported
RMG
Rail Tracks on Dynamic Compacted Subgrade
KONECRANES
GEORGIA PORTS
GAPORTS.COM
EVERGREEN

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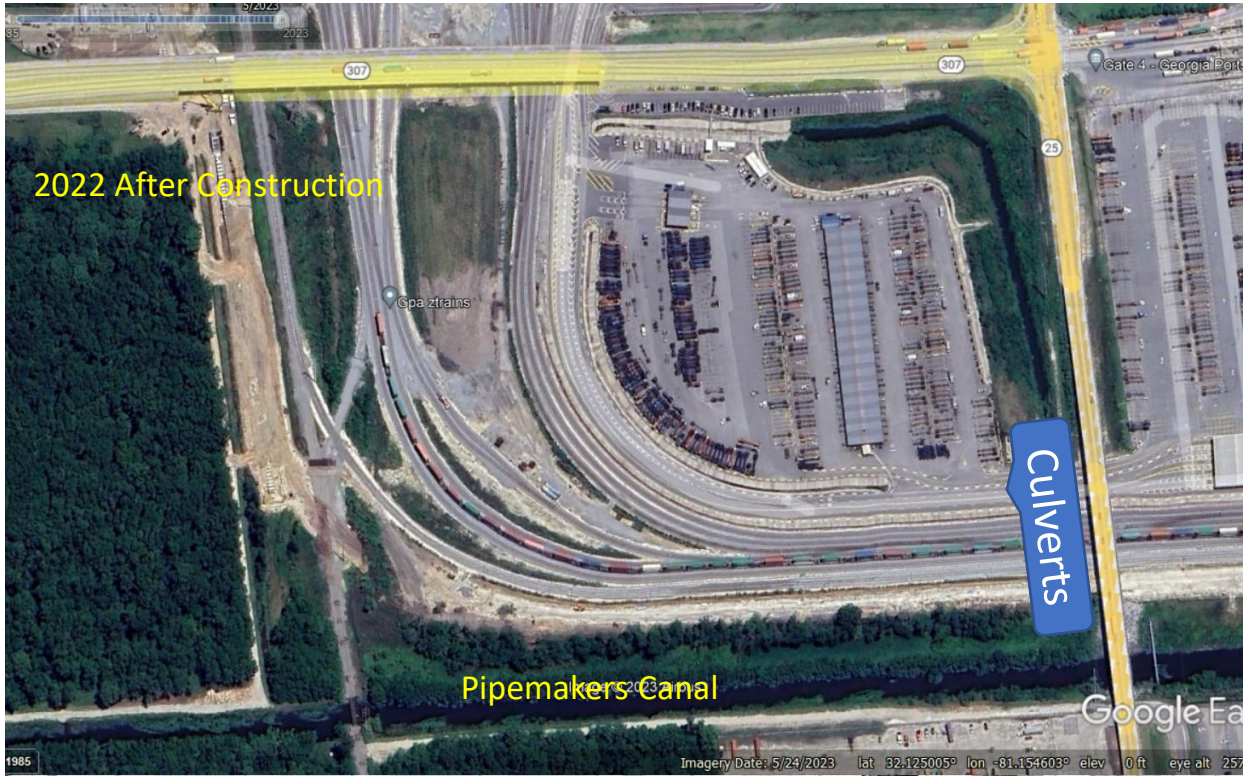
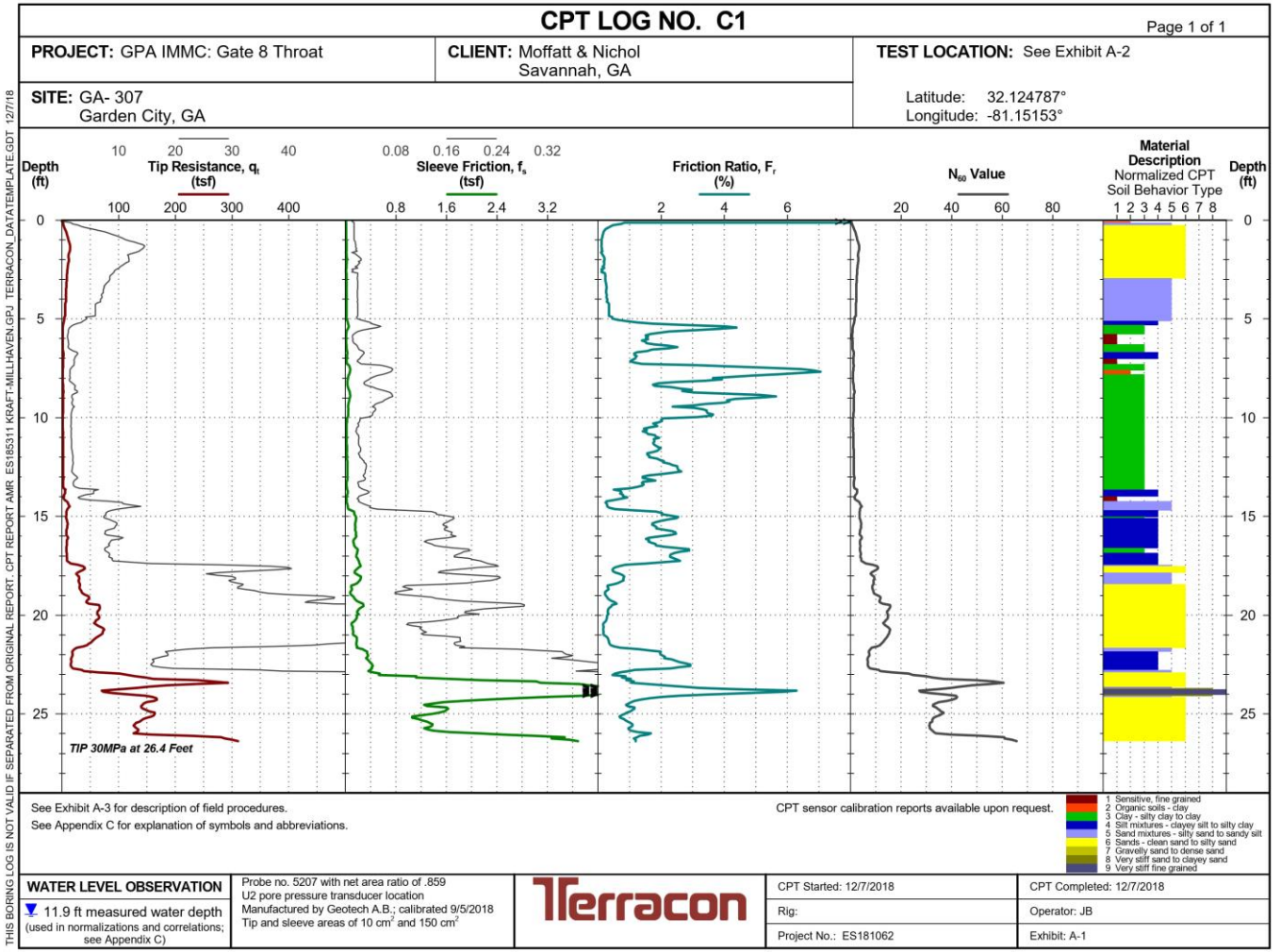
2017 Before Construction
Ditch
Pipemakers Canal
Image © 2023 Maxar Technologies
Imagery Date: 5/14/2016


2022 After Construction
Culverts
Pipemakers Canal
Imagery Date: 5/24/2023

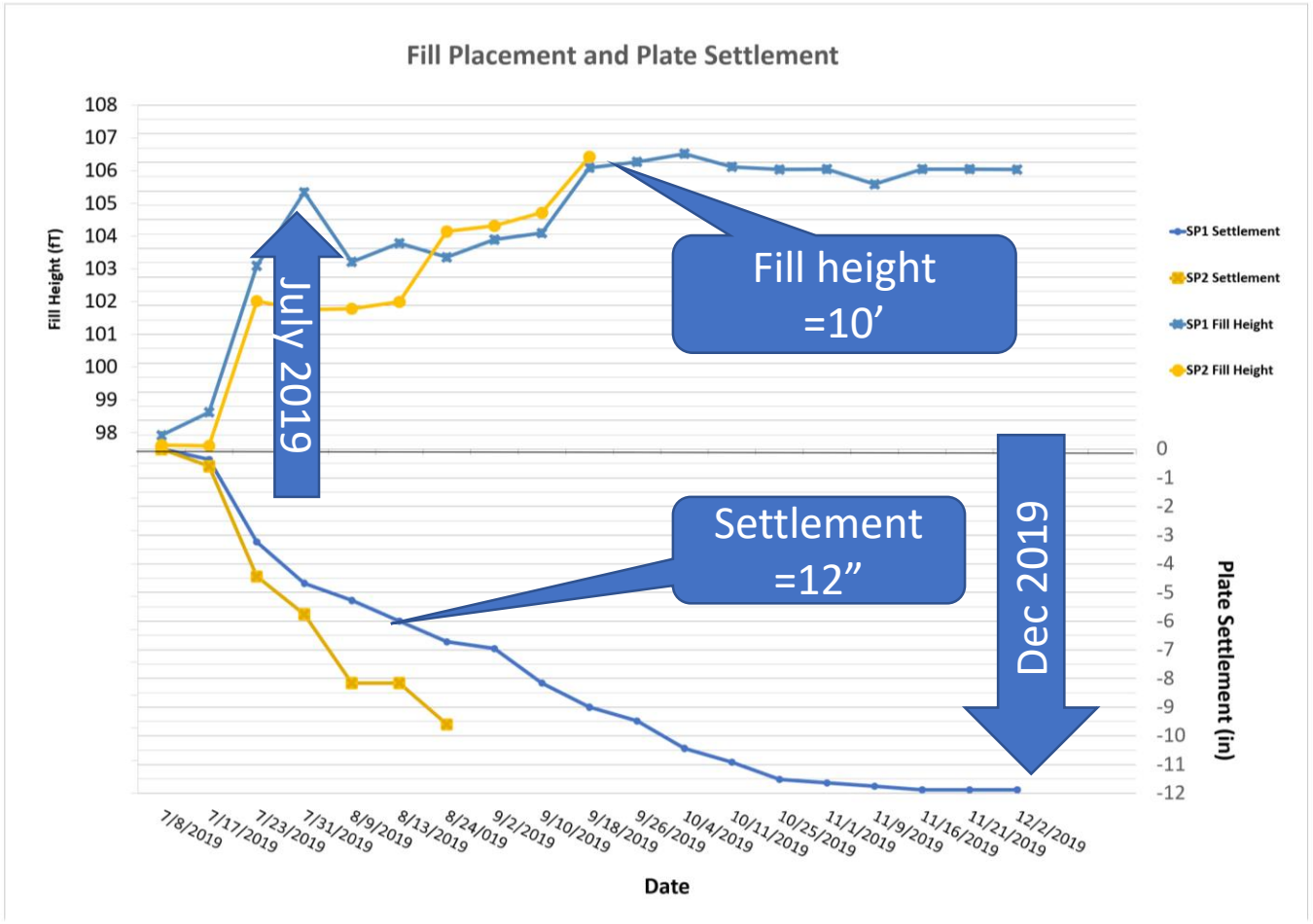

Rail Bed
12 feet
Ditch bottom

Soil Profile below Ditch



Estimated settlements=5 to 12”

Preloading with wick drains




Mason Yard Expansion and New Gate, Nov 2021

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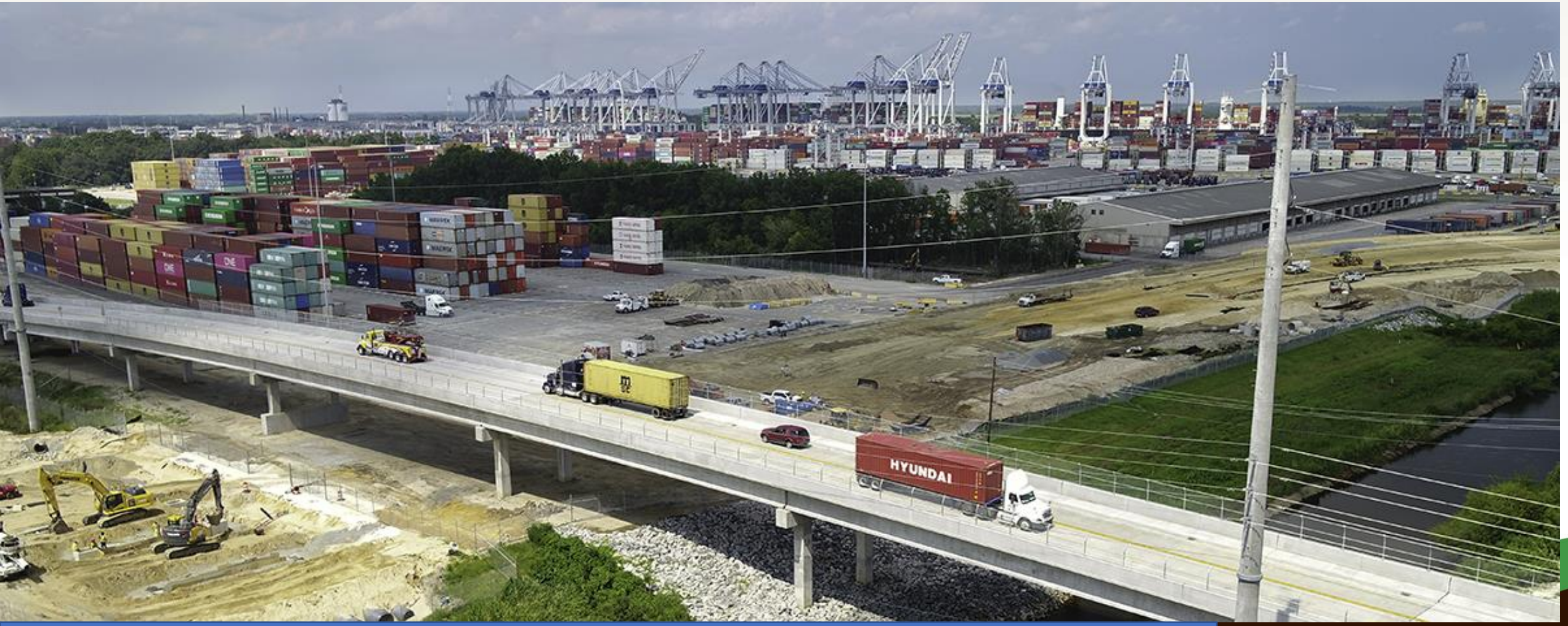
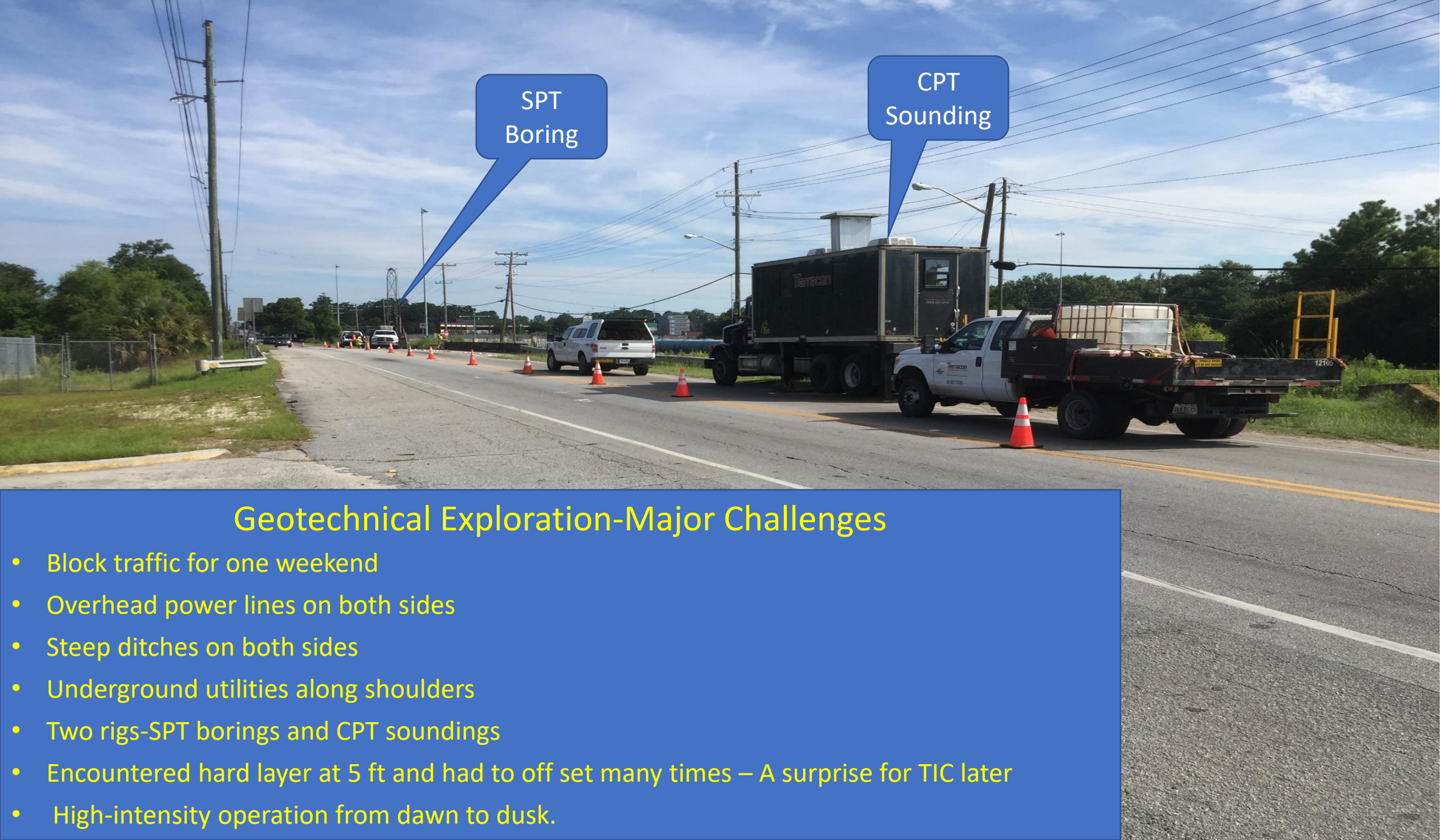
SR25/Main Street over Pipemakers Canal



- Old Bridge 90 ft long--New Bridge 1261 ft long
- 23’-9” max vertical clearance for new rail lines, GPA Mega Rail Project
- **Fast track**: Traffic detoured for **365** days



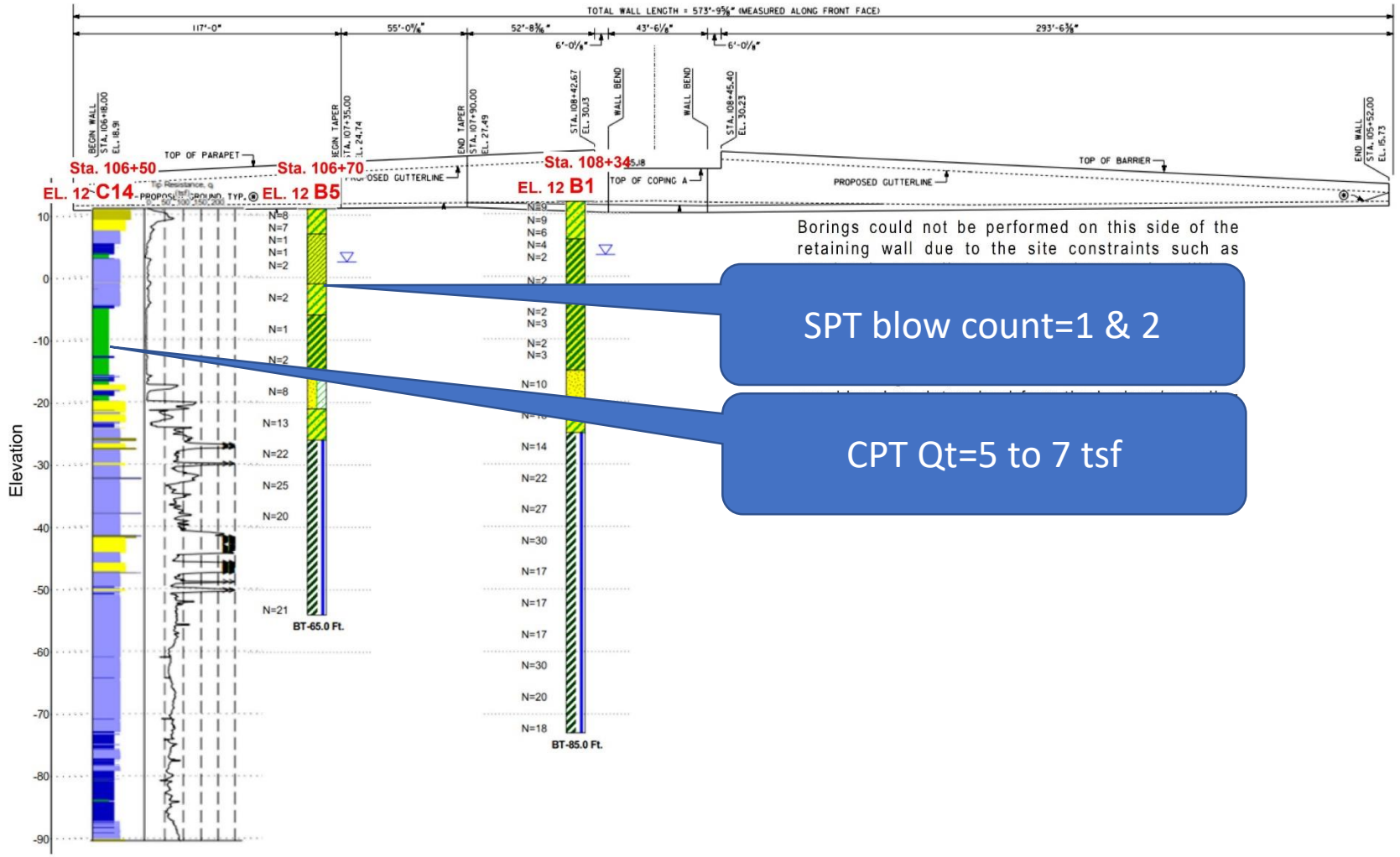
Geotechnical Exploration-Major Challenges

- Block traffic for one weekend
- Overhead power lines on both sides
- Steep ditches on both sides
- Underground utilities along shoulders
- Two rigs-SPT borings and CPT soundings
- Encountered hard layer at 5 ft and had to off set many times – A surprise for TIC later
- High-intensity operation from dawn to dusk.

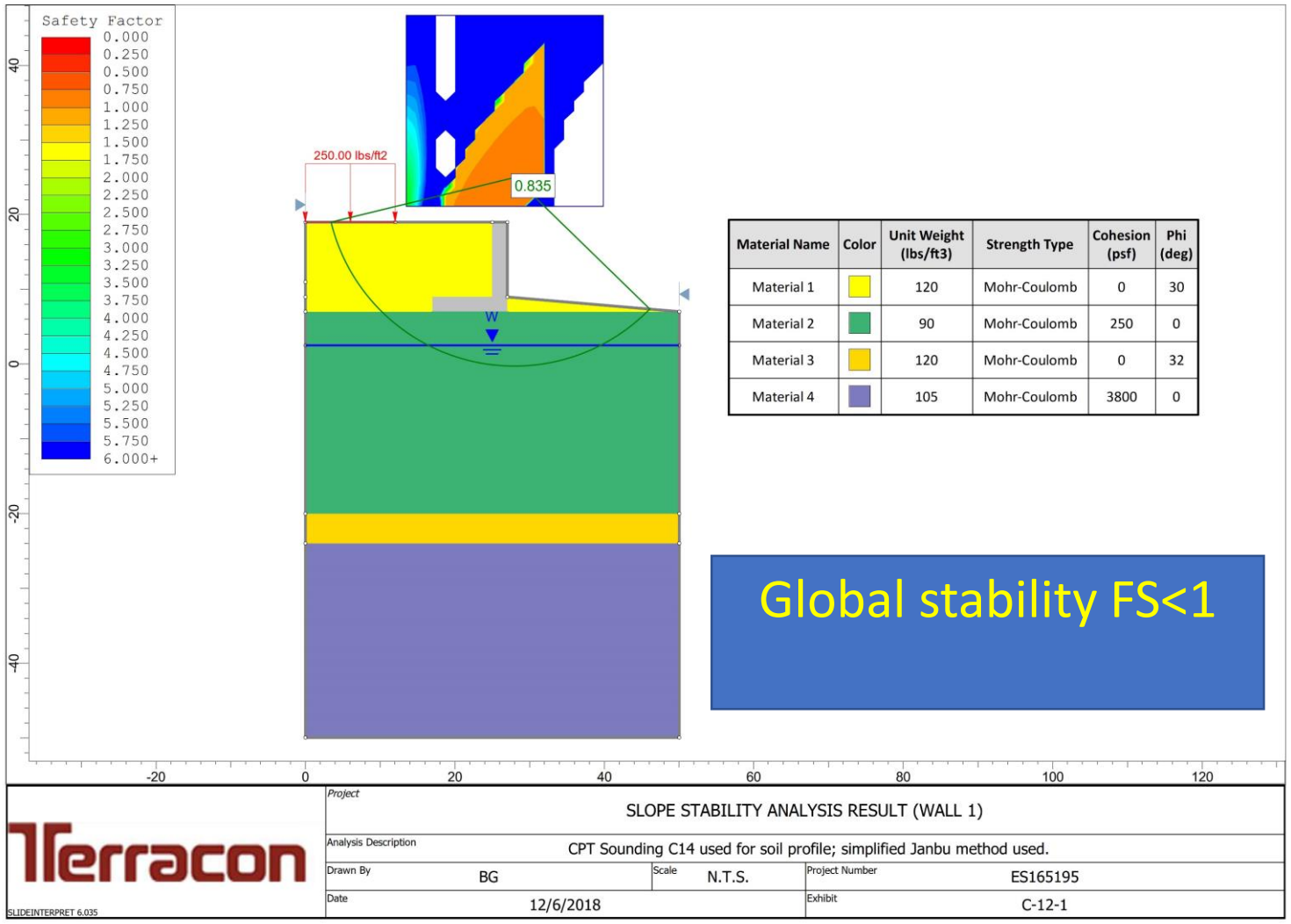
Cone Penetration Test (CPT)

- Hydraulically push instrumented cone into the ground
- Four channels of digital data
- Continuous soil profiles
- Operator independent

RETAINING WALL 1 (SOUTH SIDE OF PIPEMAKERS CANAL)



Project Manager: BG	PI No. 0013282	Terracon Consulting Engineers & Scientists	TYPICAL SOIL PROFILE AND PROPOSED WALL	Exhibit:
Drawn by: BG	Scale: N.T.S.	2201 Rowland Avenue Savannah, Georgia 31404	SR 25 at Pipemakers Canal	A-6-1
Checked by: GL	File Name: ES165195	Phone (912) 629 4000 Fax (912) 629 4001	Wall Foundation Investigation	
Approved by: GL	Date: 11/29/2017		Savannah, Chatham County, Georgia	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Material 1		120	Mohr-Coulomb	0	30
Material 2		90	Mohr-Coulomb	250	0
Material 3		120	Mohr-Coulomb	0	32
Material 4		105	Mohr-Coulomb	3800	0

Global stability FS<1

Terracon

SLIDEINTERPRET 6.035

Project	SLOPE STABILITY ANALYSIS RESULT (WALL 1)			
Analysis Description	CPT Sounding C14 used for soil profile; simplified Janbu method used.			
Drawn By	BG	Scale	N.T.S.	Project Number ES165195
Date	12/6/2018			Exhibit C-12-1

Settlement and Stability Analysis

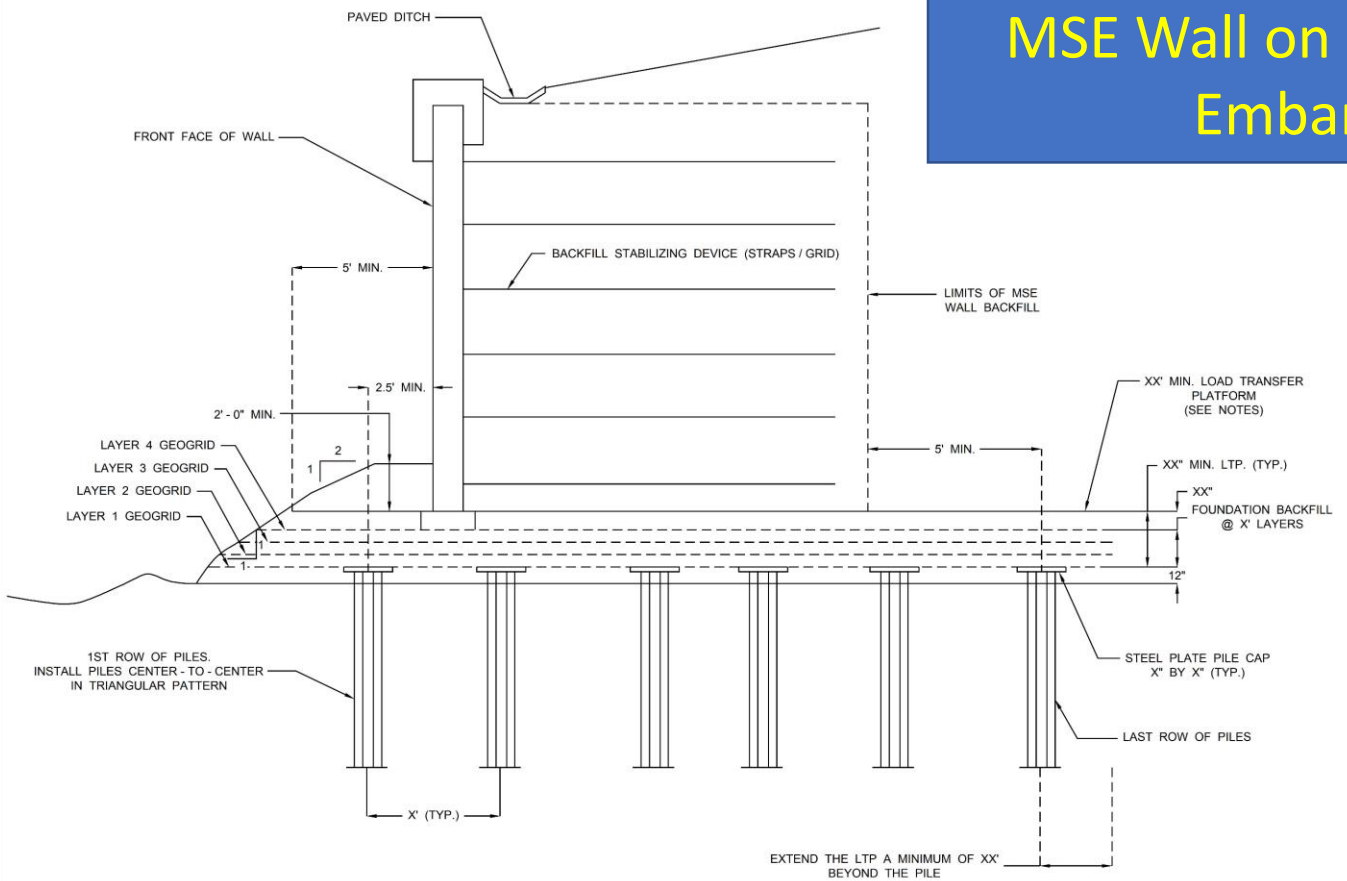
- South wall settlement: 6 to 18 inches;
- North wall settlement: 4 to 15 inches;
- Global stability: FS<1.

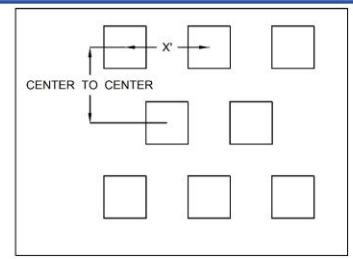
Recommendations:

- Pile-supported load transfer platform (LTP) to support the MSE walls.

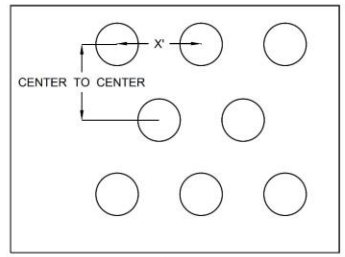
MSE Wall on Pile-supported Embankment

GENERAL CONCEPT





PILES CENTER - TO - CENTER IN TRIANGULAR PATTERN

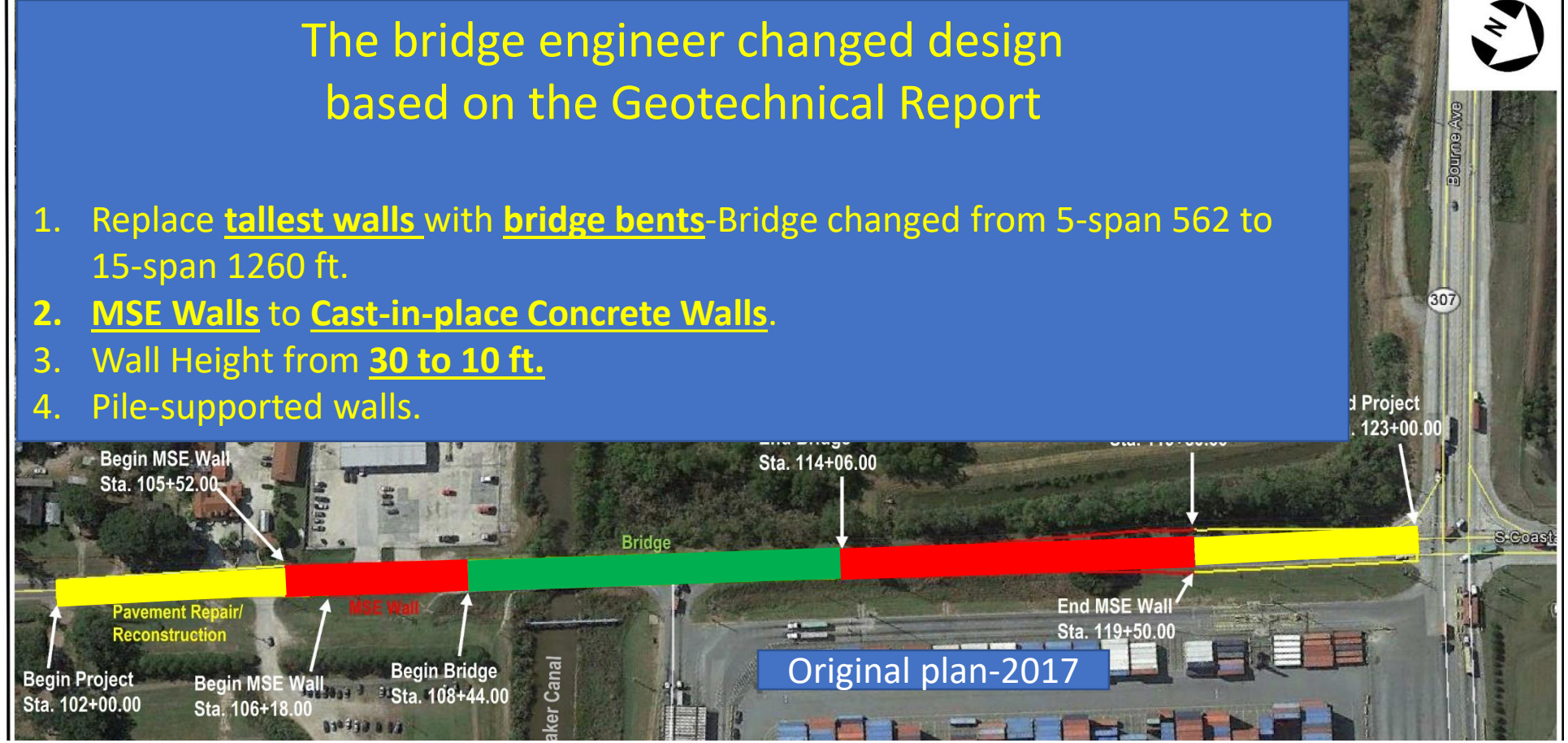


PILES CENTER - TO - CENTER IN TRIANGULAR PATTERN RIGID INCLUSION (TO BE DETERMINED BY THE EXPERIENCED SPECIALITY CONTRACTOR)

Project Mngr: BG Drawn By: VMG Checked By: GL Approved By: GL	PI No. 0013282 Scale: NOT TO SCALE File Name: ES165195.dwg Date: November 29, 2017	Terracon Consulting Engineers & Scientists 2201 Rowland Avenue Savannah, Georgia 31404 Phone (912) 629 4000 Fax. (912) 629 4001	**LOAD TRANSFER PLATFORM DETAIL** **SR 25 at Pipemakers Canal** Wall Foundation Investigation Savannah, Chatham County, Georgia	Exhibit: C-10

The bridge engineer changed design based on the Geotechnical Report

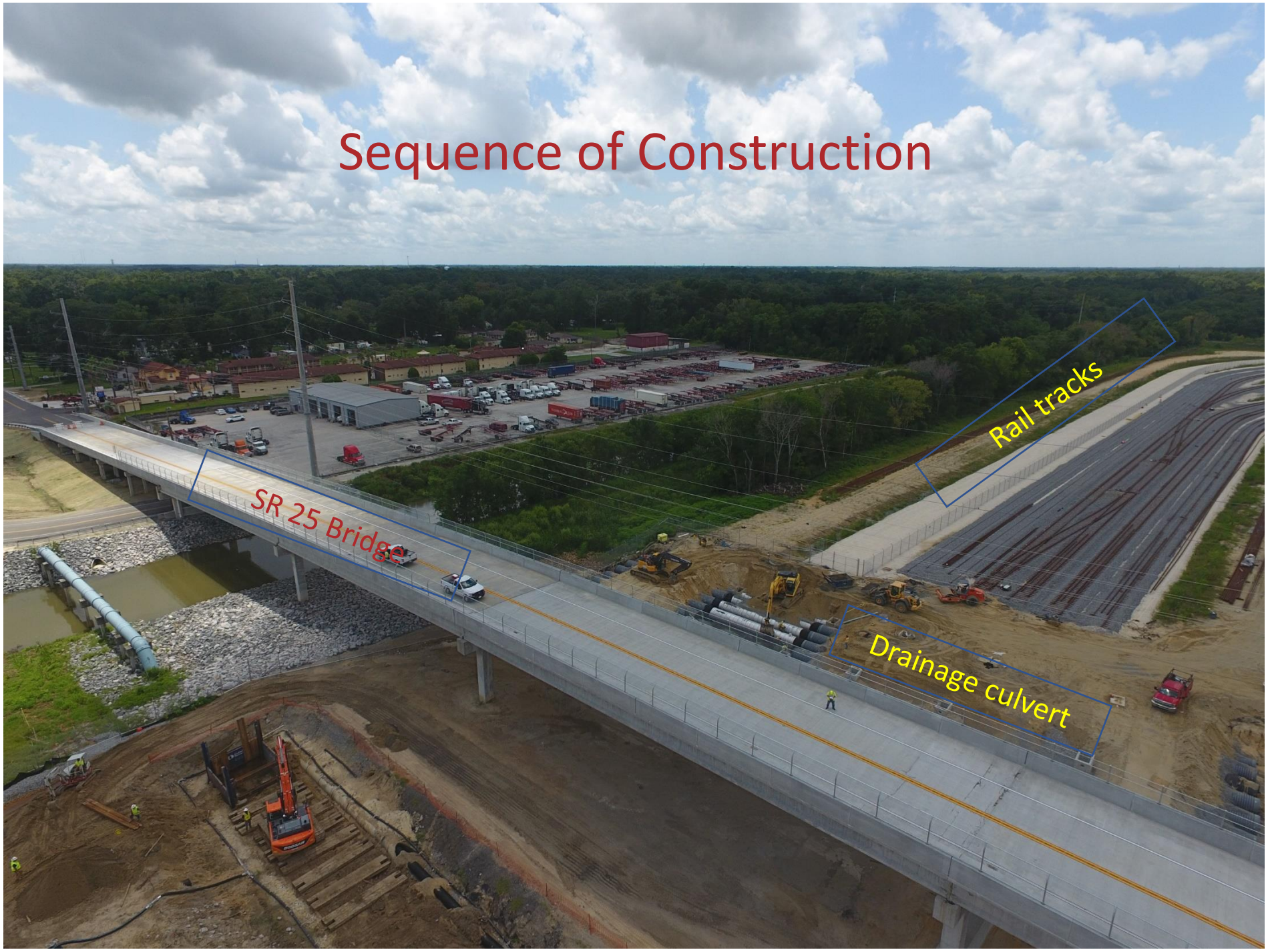
1. Replace **tallest walls** with **bridge bents**-Bridge changed from 5-span 562 to 15-span 1260 ft.
2. **MSE Walls** to **Cast-in-place Concrete Walls**.
3. Wall Height from **30 to 10 ft.**
4. Pile-supported walls.




Prestressed Concrete Piles
7825 LF 18” for bridge
2305 LF 14” for retaining walls

North Bridge under construction

Sequence of Construction



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Two Rail Bridges Across Pipemakers Canal

- Canal was realigned –doubled the bridge length;
- Very soft soils on canal embankments;

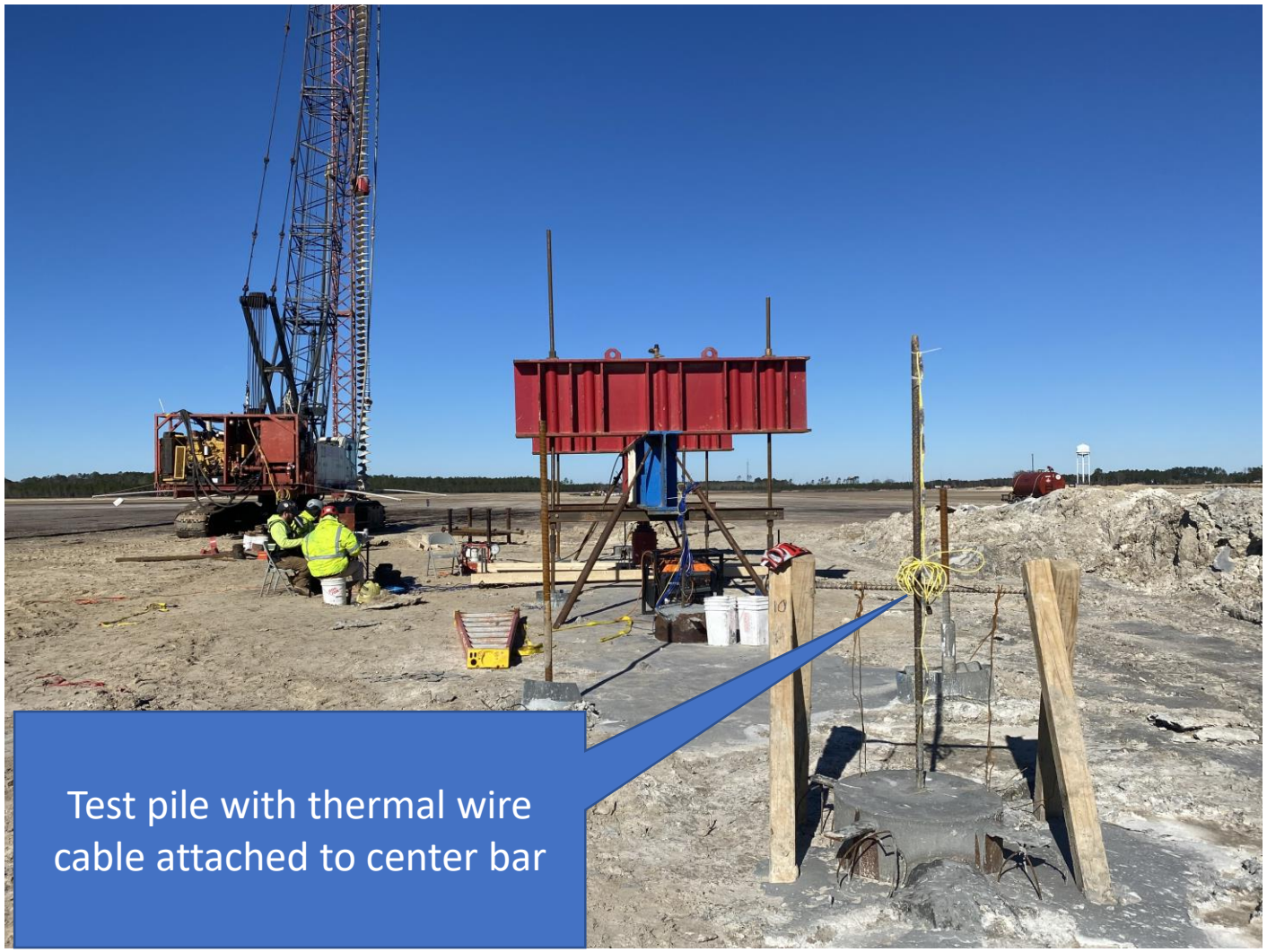
- Rigid inclusion to improve embankment;
- Limited bridge length to new canal-3 spans

Rigid Inclusions

- Auger cast piles
- Reinforcement along the canal edge to resist shear;
- No reinforcement interior to control settlements;
- Load transfer platform over rigid inclusions (piles)


Load transfer platform
(LTP)
Geogrid and GAB
Bridge end bent on PSC
piles
Rigid inclusions to control
settlement and slope
stability

Pile Integrity Testing using Thermal Integrity Profiling (TIP)

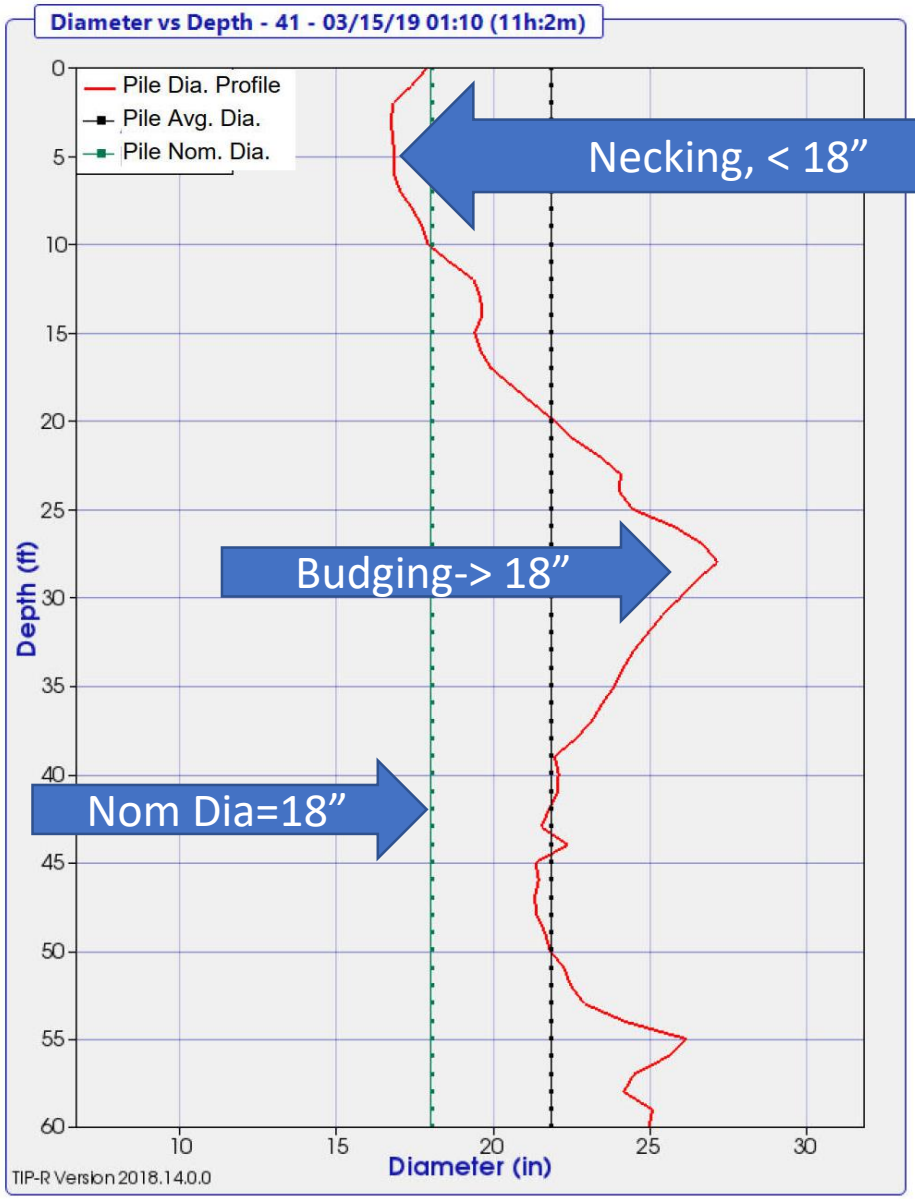


Test pile with thermal wire cable attached to center bar

- Evaluate pile cross-section based on the temperature of heat from concrete curing.

- TIP detected necking at 6 ft below pile top;
- Excavation revealed a layer of geogrid cut into the piles.
- Deemed acceptable.

Southeast Georgia Hospital
Thermal Integrity Profiling (TIP)



TIP Results were field confirmed

A layer of pine tree roots
Cut through the piles


Rail Tracks & Chassis yard
Mason ICTF
SR25 Replacement bridge
Vehicular bridge
Two rail bridges

Summary

- Selection of ground improvements based on effectiveness, cost, and schedule and performance requirements
- Dynamic compaction to compress landfill material for rail yards and chassis parking. Undercut and geogrid reinforcement to stabilize the subgrade
- Driven prestressed piles rail-mounted gantry (RMG) cranes, highway bridges and rail bridges
- Geocell walls for a more flexible wall
- Preloading with wick drains for drainage culverts
- Rigid inclusions for rail bride embankment stabilization and settlement control
- Thermal integrity profiling (TIP) is an effective tool to check pile/draft cross-section and integrity

Acknowledgments

Georgia Ports Authority (GPA)

Moffatt Nichol - Engineer

Astra Group (GC)

Dynamic Compaction:

Densification, Inc.

TerraSystems

Rigid Inclusions: Berkel with Dan Brown & Associates

Civil Engineering Magazine

Feb/March 2023 Feature

MAKING 'MEGA' GROUND IMPROVEMENTS

BY GUOMING LIN, PH.D., P.E., G.E., D.GE, F.ASCE, CHRISTOPHER NOVACK, P.E., OLIVER HIMBERT, P.E., BRAD WOODALL, P.E., DANIEL PEAVY, P.E., M.ASCE, AND HONOR HUTTON, P.E.

The Mason Mega Rail project provided ample room to expand a major shipping container terminal at Georgia's Port of Savannah. But first the geotechnical engineers had to get the ground ready for new tracks and other facilities.

At 1,345 acres, the Garden City Terminal at Georgia's Port of Savannah is the largest single-operator shipping container terminal in the United States. Originally, the facility included two rail yards on the north and south sides of a major waterway, the Pipemakers Canal. These two yards operated as separate facilities for different railroad companies: to the north was the Mason Intermodal Container Transfer Facility used by the Norfolk Southern Railway while to the south was the Chatham Intermodal Container Transfer Facility used by CSX Transportation.

The recently completed Mason Mega Rail project was designed to connect the two yards by adding additional rail trackage, supported by rail-mounted gantry cranes, to increase the intermodal rail capacities and the overall throughput for standard shipping containers, known as twenty-foot equivalent units. The connected rail facility created a 185-acre intermodal facility within the Garden City Terminal that serves Norfolk Southern and CSX simultaneously. This enables the two Class I railroads to assemble six 10,000 ft long unit trains at the terminal, doubling the rail capacity to more than 1 million annual lifts.

Furthermore, the newly connected rail tracks eliminated the need for six at-grade crossings in the nearby residential neighborhoods, which will reduce road blockages and enhance the quality of life for the surrounding Garden City community.

PHOTOGRAPH COURTESY OF EMILY GOLDMAN, GEORGIA PORTS AUTHORITY

Thank you!

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