Pipe Pile Wall with Jet Grouting Works

WEBSTER - POSEY

EXTERIOR SEISMIC RETROFIT

Oakland – Alameda

California

Trevilcos : WF George Dam AL-GA (USA)
Jet grouting over water

Jet grouting over water was performed to improve the soil behind a submerged retaining wall

Drilling 2,400 lft - 68 Holes - 1,600 cy grouted

TREVI

WEBSTER St. AND POSEY TUBES

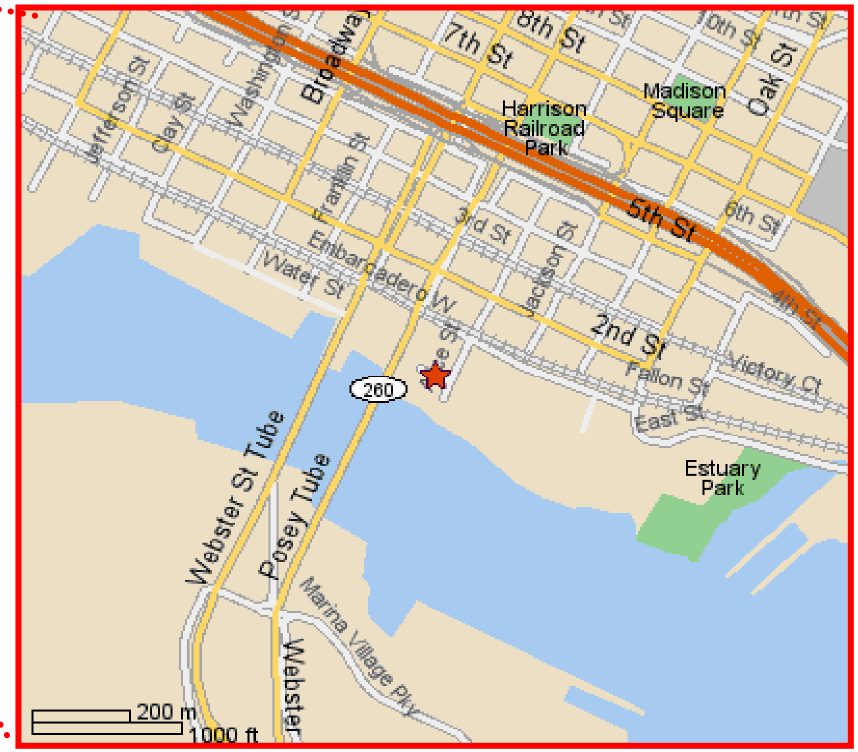
EXTERIOR SEISMIC RETROFIT

PHASE II

- Owner: **State of California - Department of Transportation**
- Contract #: **04-440144**
- General Contractor: **American Civil Construction West Coast Inc.**
- Jet grouting Subcontractor: **Wagner J.V. (TREVI ICOS Corporation)**
- Original contract amount : **$ 30,780,055.00**

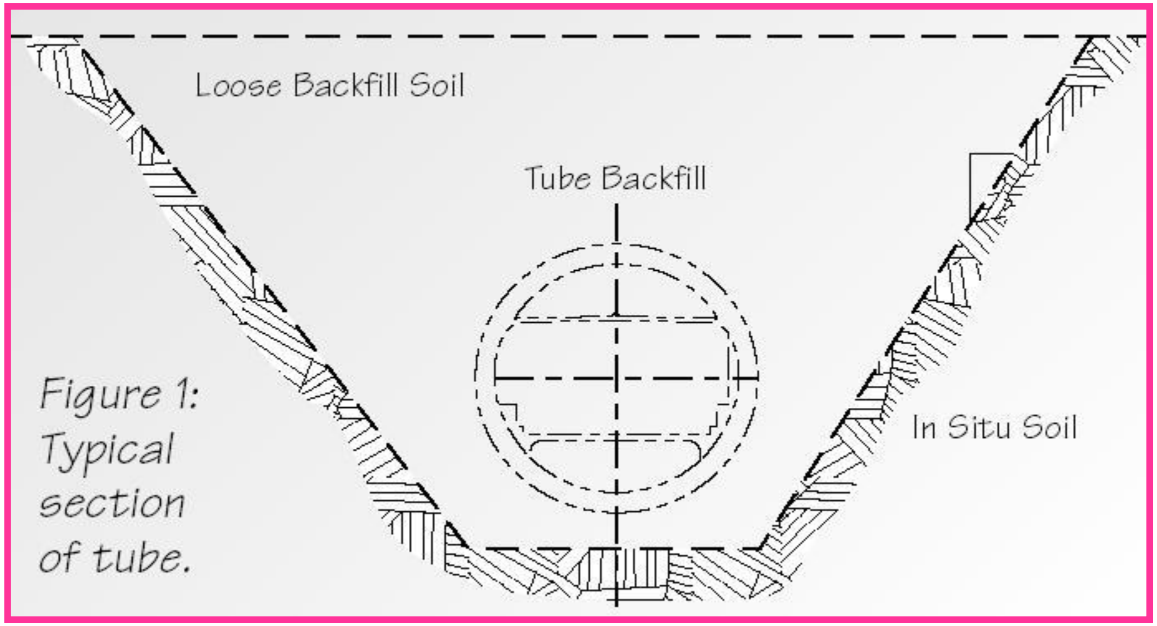
Webster St. And Posey tubes
Project Location

The Webster St. and Posey Tubes are two parallel tunnels that run beneath the Oakland Estuary in San Francisco Bay to connect Alameda Island with Oakland.



The tubes became subject to review as part of the California Department of Transportation (Caltrans) recent seismic retrofit program.

Webster St. And Posey tubes
Project history - Description of the problem



"The tubes consist of precast concrete immersed tube segments connected to cast-in-place concrete cut-and-cover sections at the Oakland portals. When the tunnels were constructed (Posey Tube in the 1920s and Webster Street Tube in the 1960s), the immersed tube segments were placed over a 1.5-m (5-foot) layer of uncompacted clean sand in a trench excavated in the estuary floor. The backfill around Webster Street Tube consists of washed, poorly graded clean sand; the Posey Tube is embedded in soft clay (probably dredge spoil) with sand to sandy silt zones. Figure 1 shows a typical section of the Posey and Webster St. Tubes. "

(PB Network, Fall 1997 • Issue No. 40 • Volume XI • Number 4)

Project history
Isolation Wall Principle

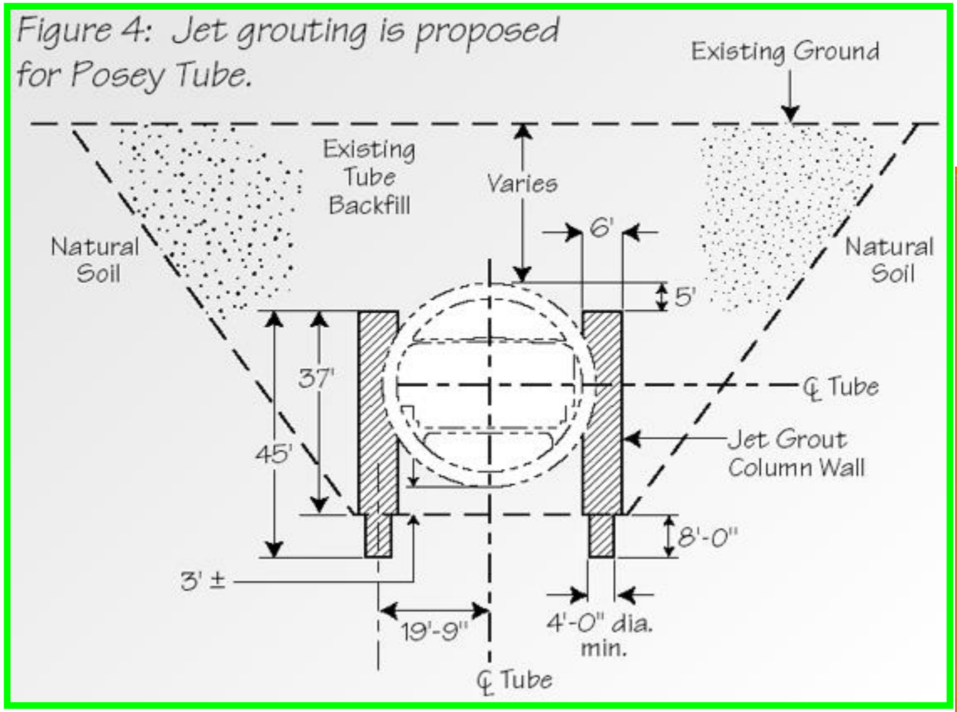
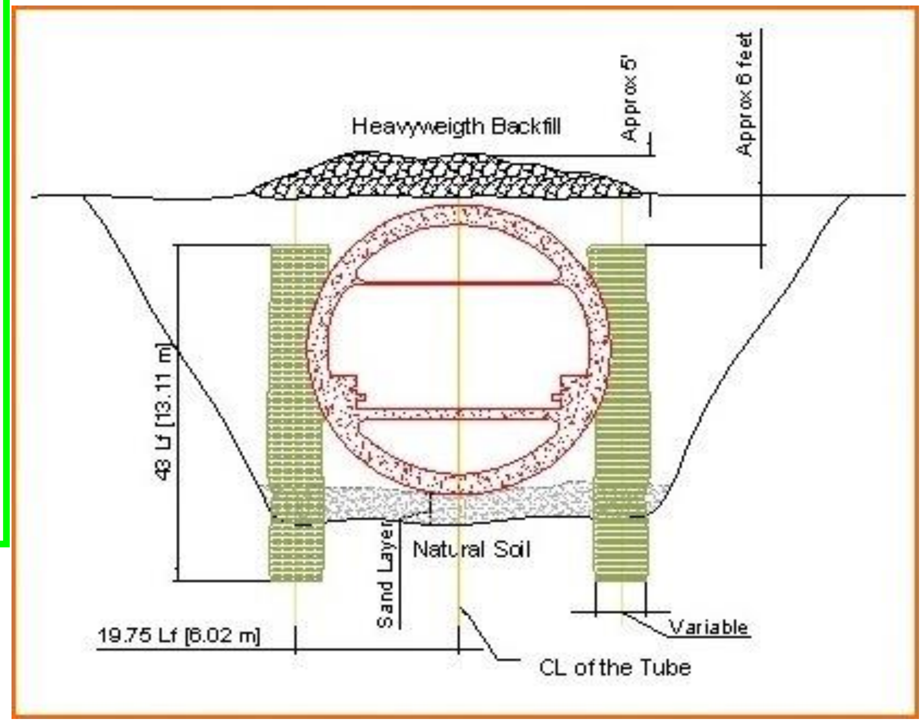


Figure 4: Jet grouting is proposed for Posey Tube.



“Posey Tube. In the clay backfill of the Posey Tube, stone columns would be ineffective. We proposed an “isolation wall” of overlapping jet grout columns (Figure 4)..”

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Project Specifications
Technical requirements

WEBSTER TUBE

Core recovery	%	≥ 85%
Strength@28	MPa	≥ 6.89
Unit weight	kg/m^3	≥ 1842

POSEY TUBE

Core recovery	%	≥ 85%
Strength@28	MPa	≥ 4.13
Unit weight	kg/m^3	≥ 1600

Tolerances

- Ground heave: > 2.5 mm requires more frequent check
- Placement of insertion of monitor:
  - Horizontal tolerance: ± 75 mm
  - Vertical tolerance: ~ 0.8%

Jet Grouting
Triple Fluid - Parameters

TREVI

Range of grouting parameters utilized during treatment

	Withdrawal rate	*cm/min*	**12 to 20**
WATER	Pressure	*MPa*	**40 to 45**
		psi	5800 to 6525
	Flow rate	*l/min*	**172 to 190**
		GPM	45 to 50
AIR	Pressure at gauge	*bar*	**5 to 8**
		psi	70 to 116
	Flow rate (Average)	*l/min*	**5000 to 7500**
GROUT	W/C ratio		**0.80**
	Density	*t/cum*	**1.60**
	Pressure at drilling rig	*MPa*	**22 to 32**
		psi	3190 to 4640
	Flow rate	*l/min*	**270 to 330**
		GPM	72 to 88

Jet Grouting
Work Performed – quantities

Location		Webster	Posey	Subtotal	Total
Land	Oak	112	195	307	**950**
	Ala	210	433	643	
Water			535	535	**535**
		322	**1163**	**1485**	**1485**

DESCRIPTION	TUBE	SIDE	Vertical JG length	
			[meters]	*Total [meters]*
JET GROUTING ON LAND	WEBSTER ST TUBE	OAKLAND	1,000	3,700
		ALAMEDA	2700	
	POSEY TUBE	OAKLAND	2,400	7,500
		ALAMEDA	5,100	
JET GROUTING OVER WATER	POSEY TUBE		7,300	7,300
TREMIE PLATFORM	POSEY TUBE	ALAMEDA	350	350
			18.850	

EQUIPMENT
Jet grouting Rig: Soilmec SM 525

Multipurpose drilling rig suitable for:

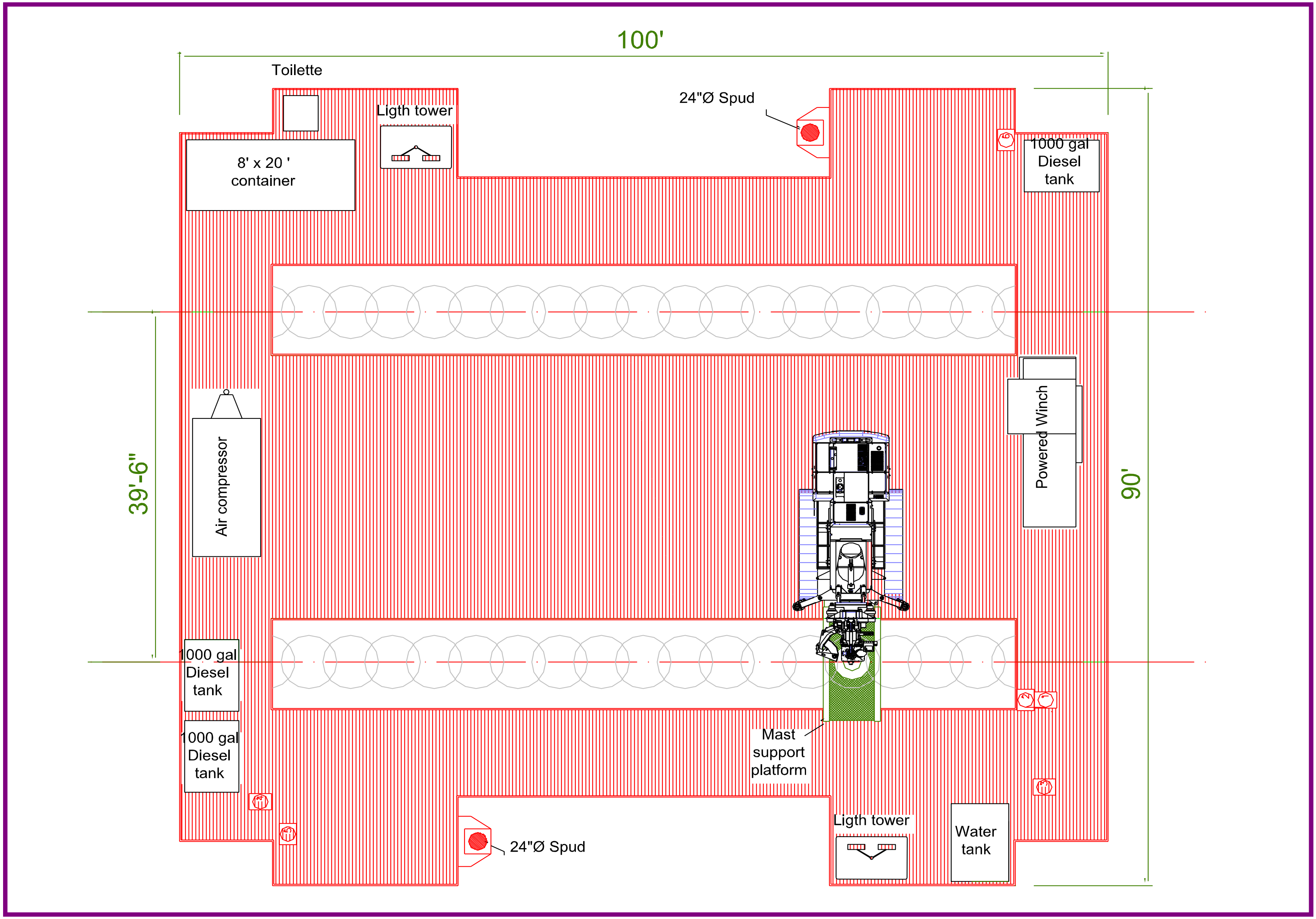
- Micropiles
- Anchoring
- Jet Grouting
- Coring
- Drain hole/soak-aways
- Water wells

EQUIPMENT
Jet grouting Rig: Soilmec Euro 40

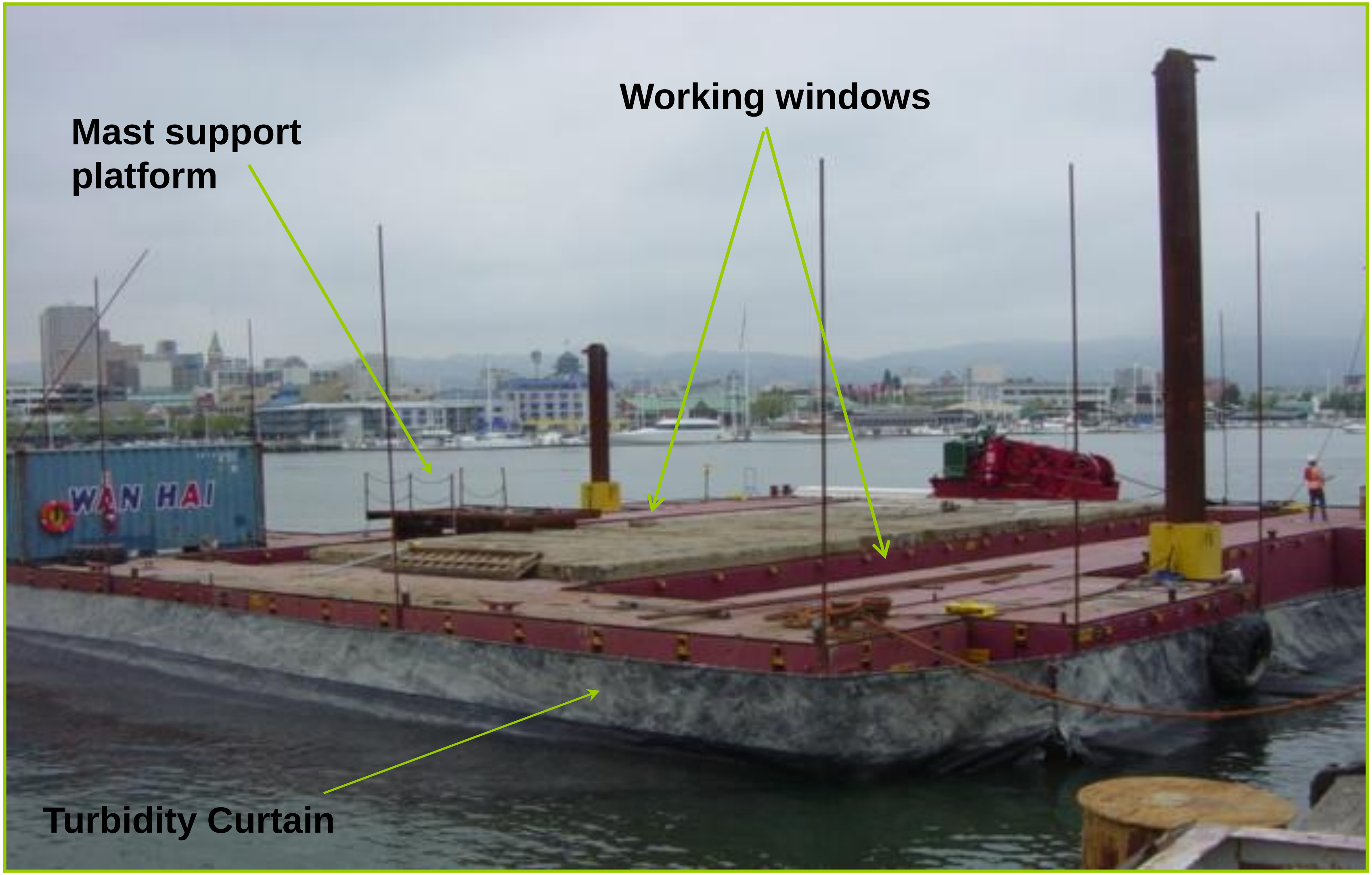
- Micropiles
- Jet Grouting

- Self-erecting 110 feet long mast
- 5 tm nominal torque

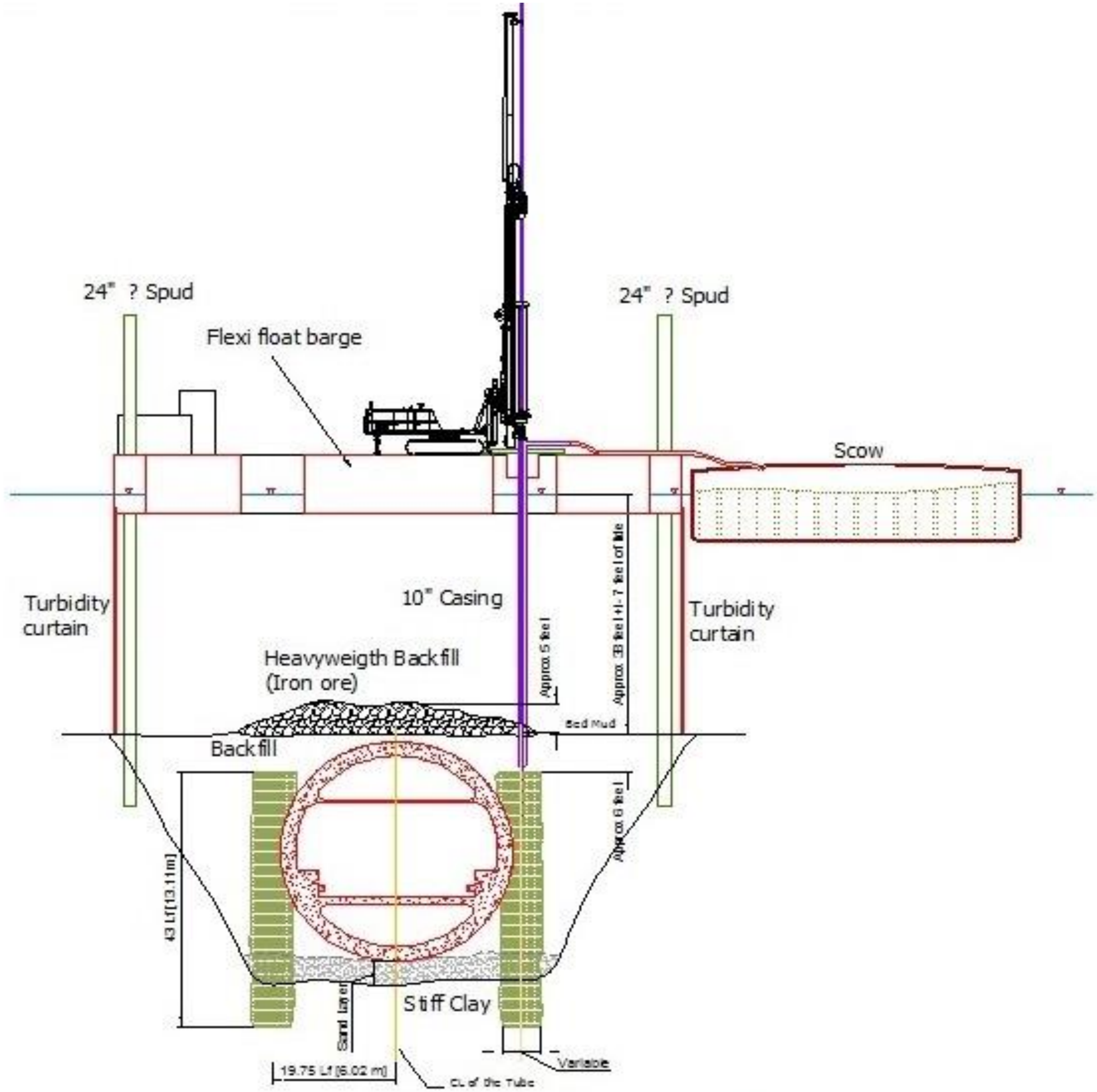
EQUIPMENT
Euro 40 Barge – Plan View



EQUIPMENT
Euro 40 Barge



EQUIPMENT
Euro 40 Barge- Section



EQUIPMENT
Euro 40 Barge

POSITIONING SYSTEM
2 GPS

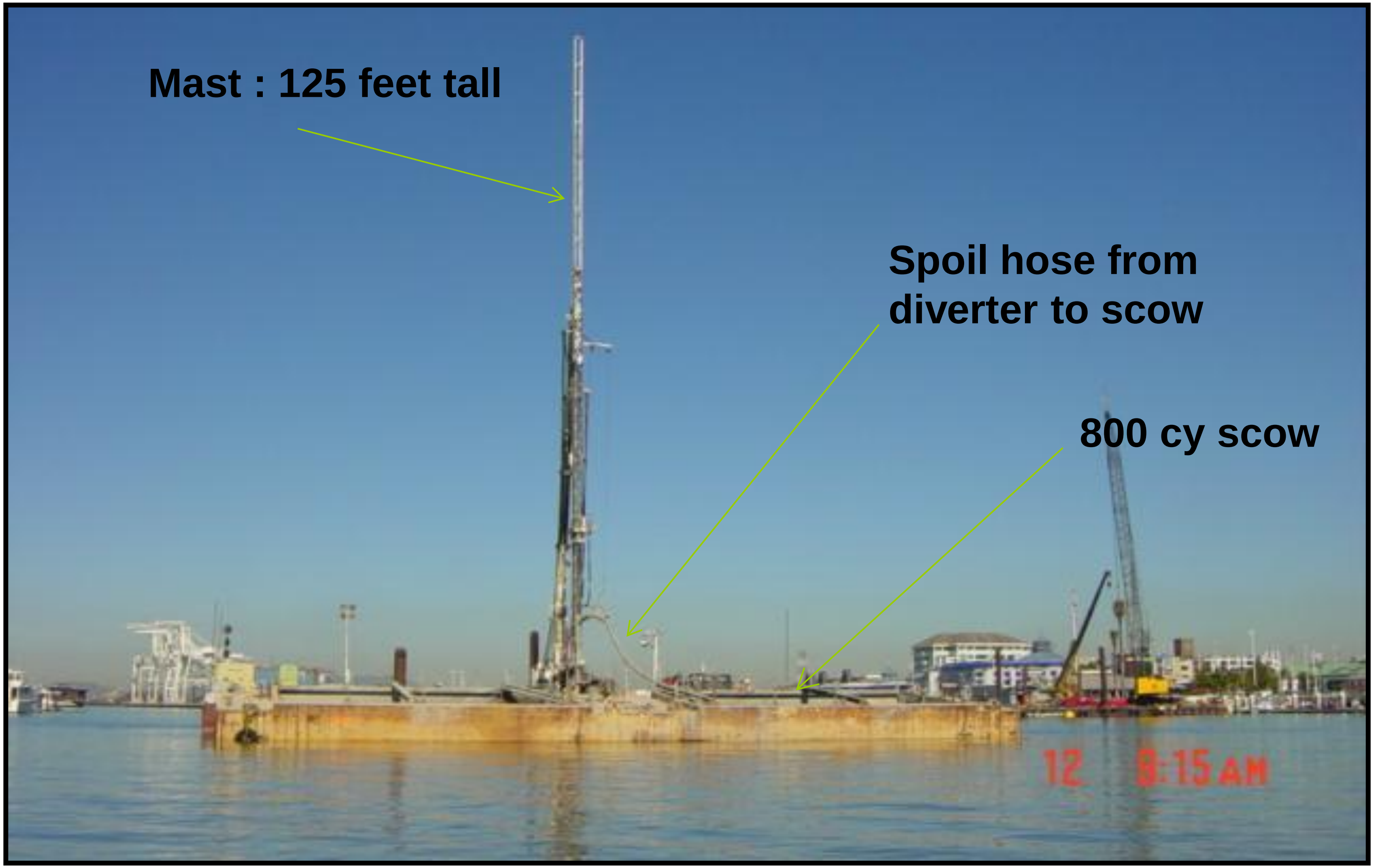
10 in CASING

SECONDARY SPOIL
CONTAIMENT

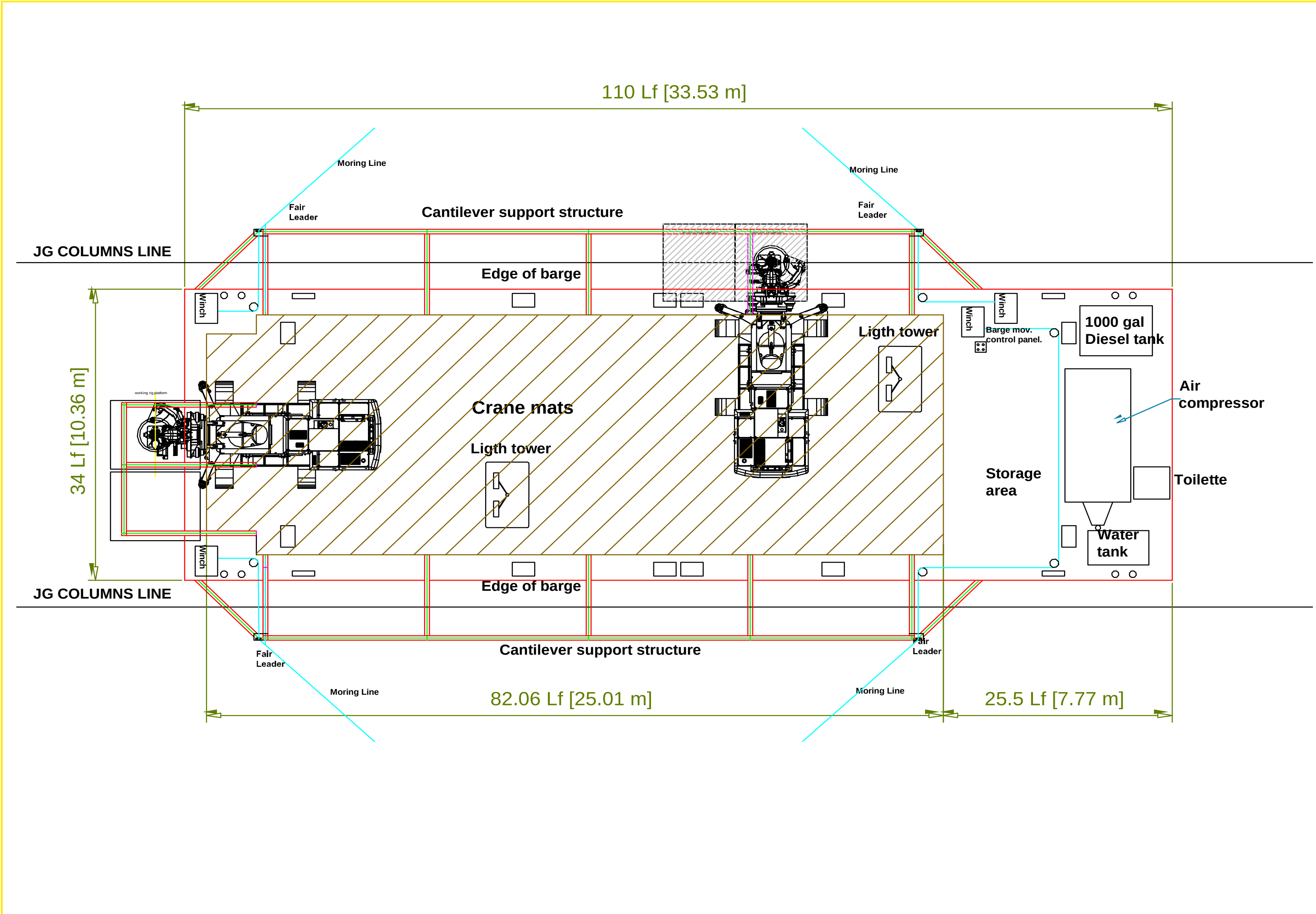
10 X 80 Feet
WORKING MOON POOL

EQUIPMENT

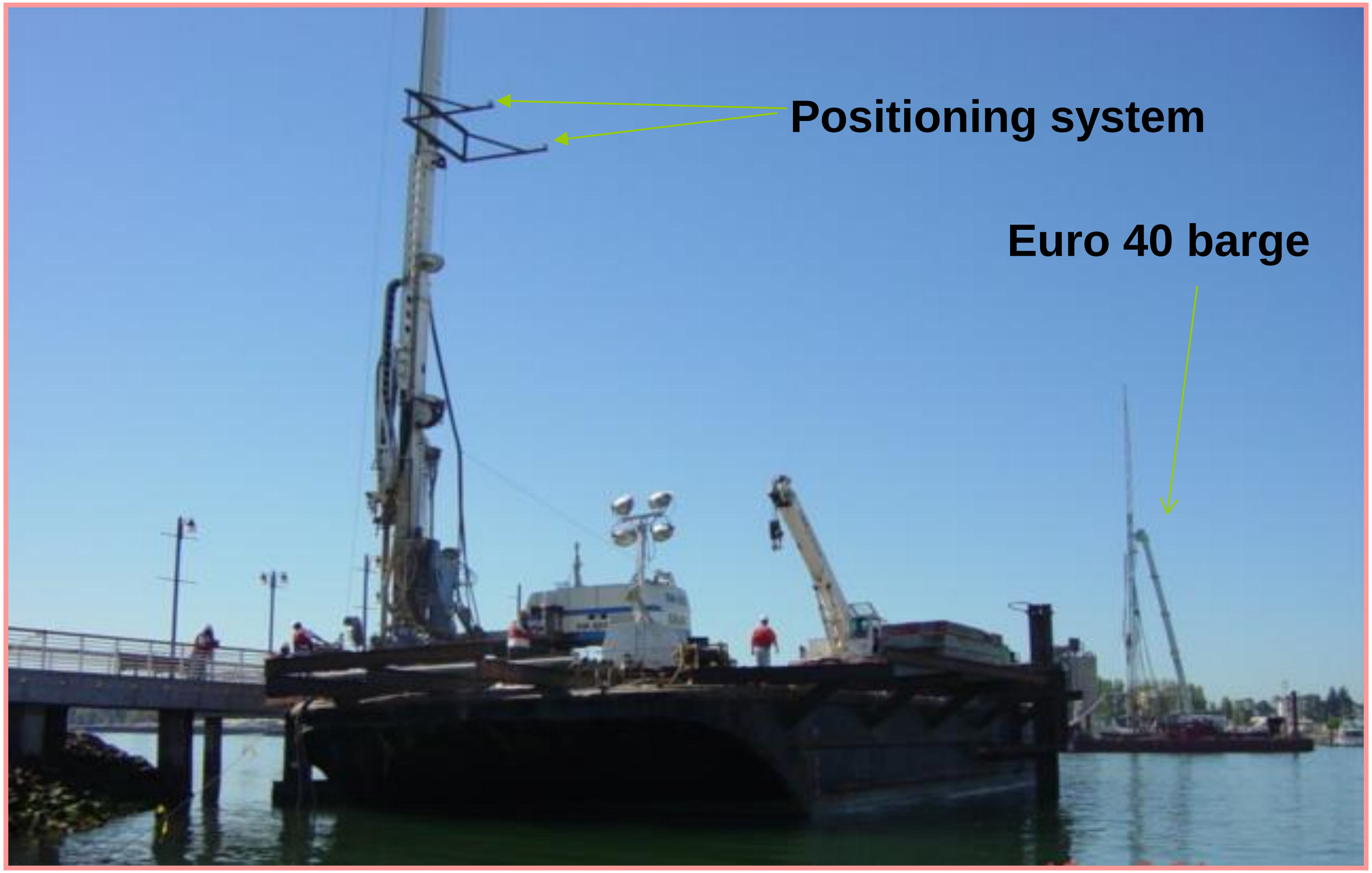
Euro 40 Barge



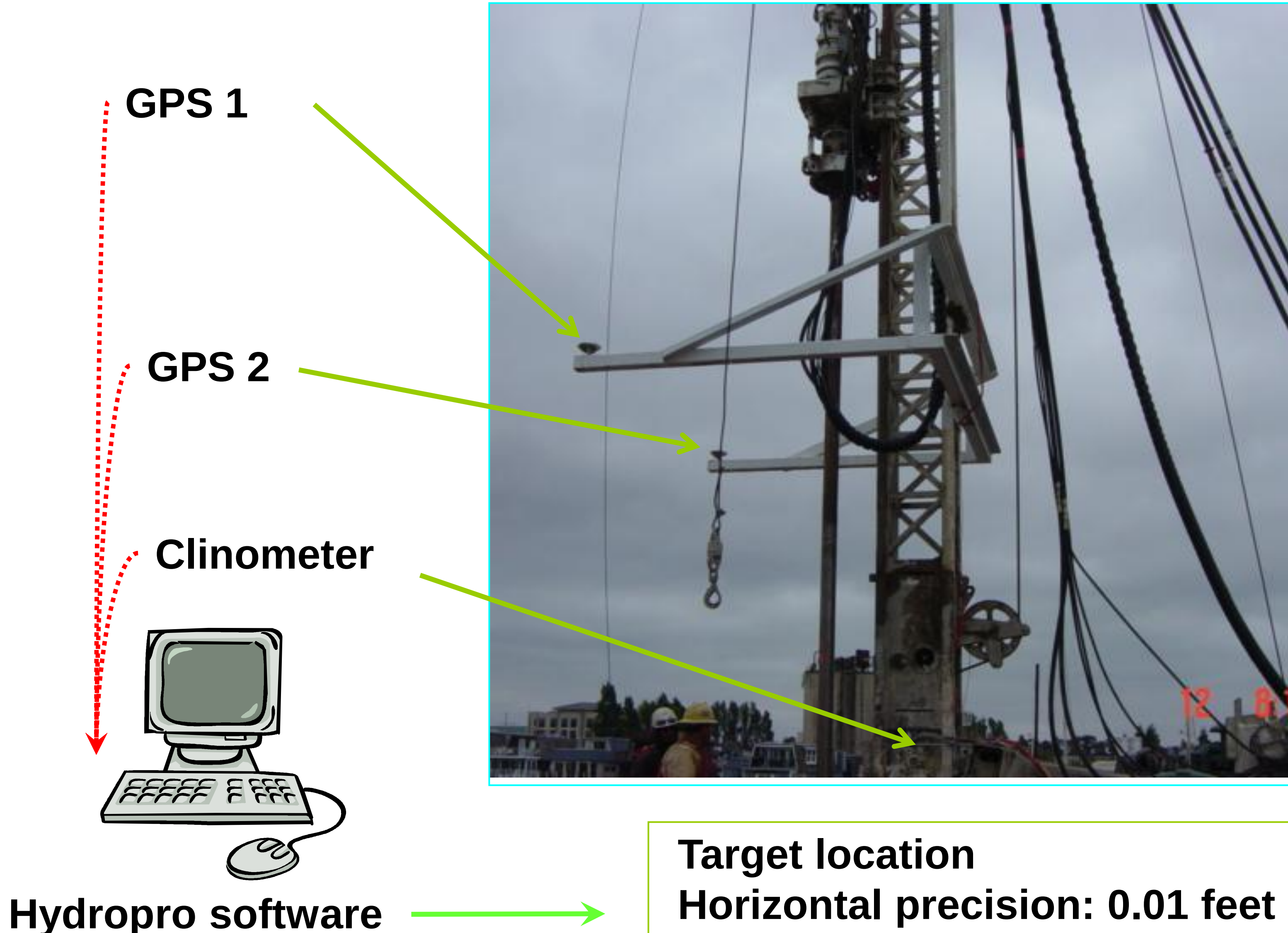
EQUIPMENT
SM 525 Barge – Plan View



EQUIPMENT
SM 525 Barge

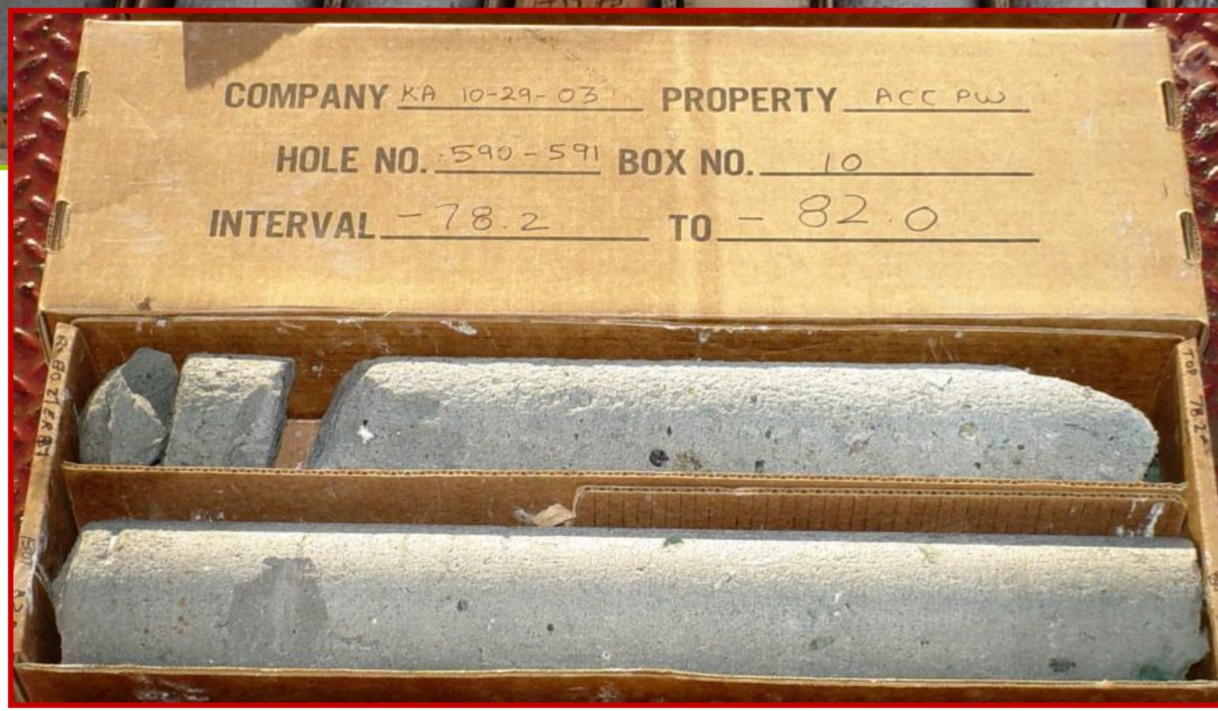


Quality Control
Real time Monitoring – Satellital Positioning



Target location
Horizontal precision: 0.01 feet
Vertical precision: 0.04 feet

Quality Control
Core 590-591



SELA 22 PROJECT – NEW ORLEANS (USA)

NEW ORLEANS & surroundings are the perfect environment for the development of geotechnical solutions for:

- ❑Poor overall mechanical properties of the foundation soils
- ❑Abundance of organic layers
- ❑Extremely shallow groundwater table
- ❑Depth of competent layers

Soil type	General description
Fill	Clay, organics and shell fragments
Lean Clay	Soft to very soft lean clay and silt, saturated
Silt; silty and clayey sand	Soft silts and silty fine sands, saturated
Sand	Fine to poorly graded gray sands

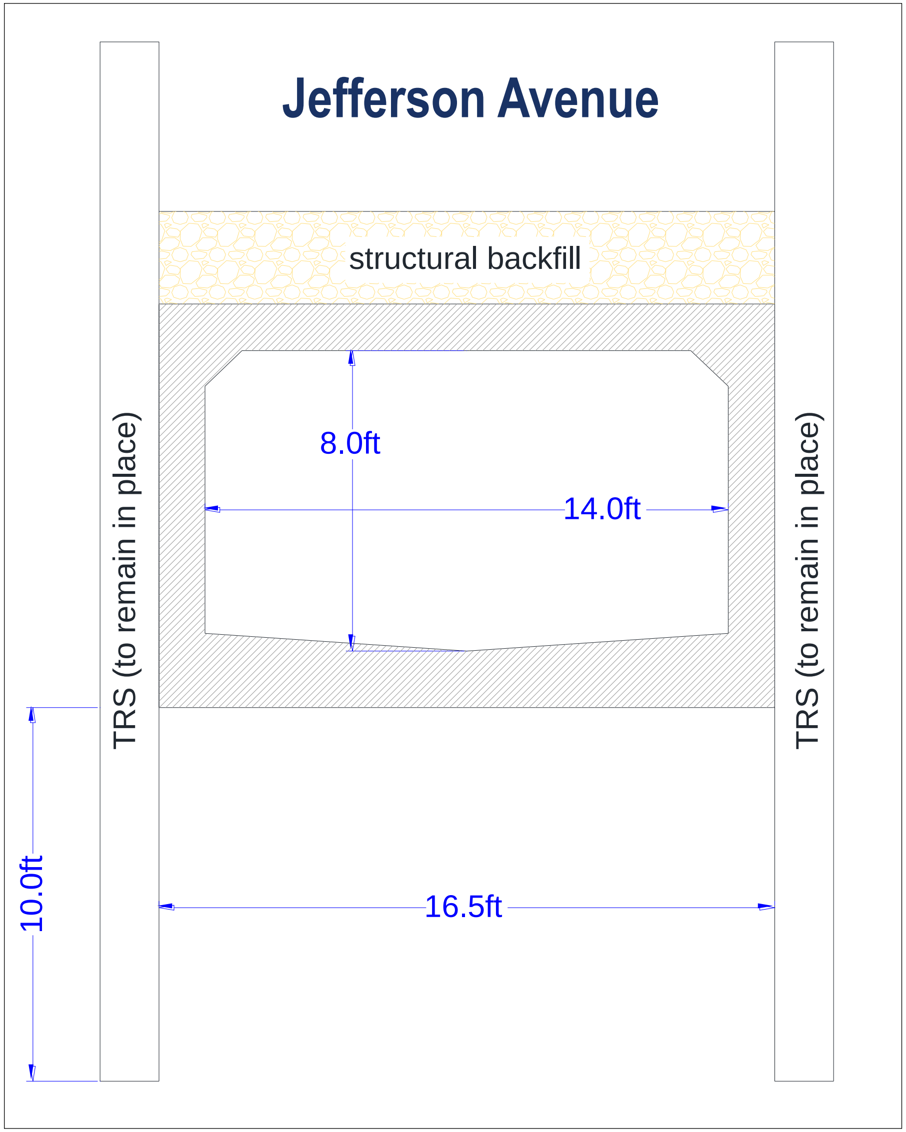
Simplified soil profile

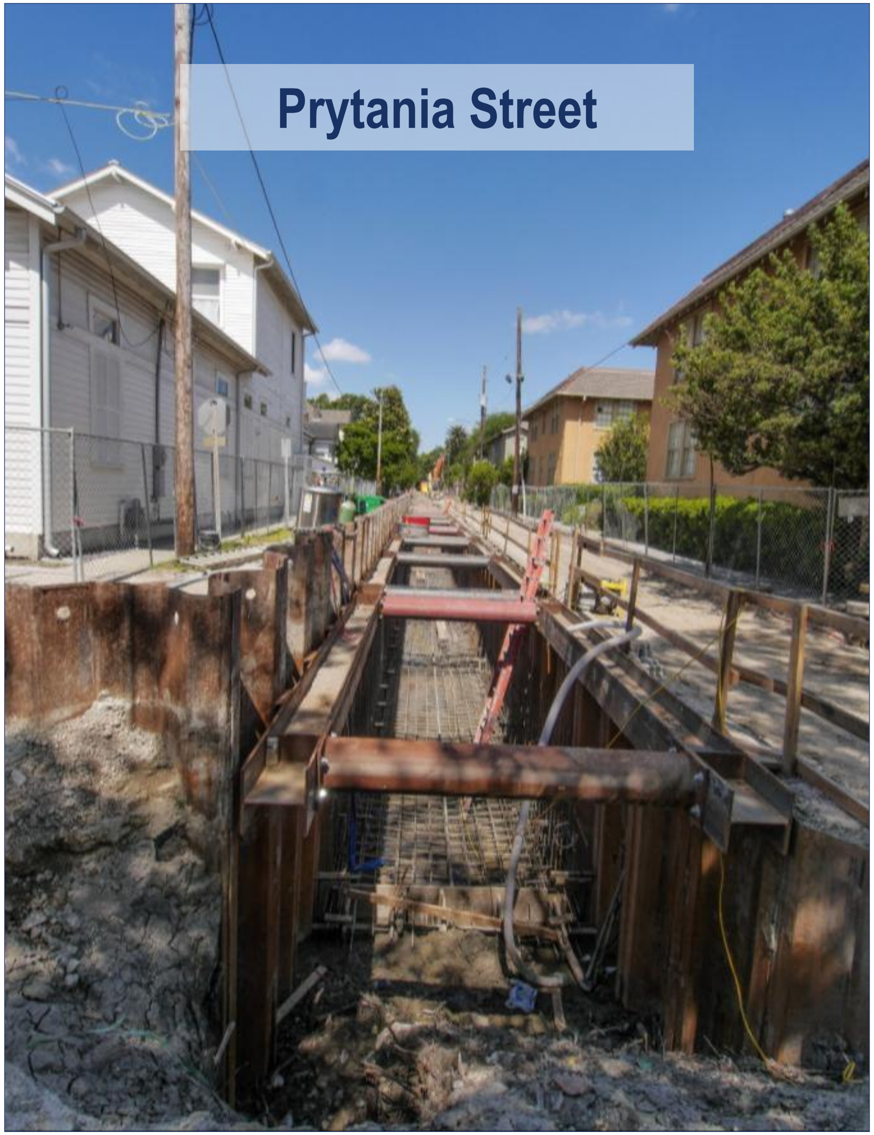
Soil Type	Dry density *[g/cm³]*	Natural density *[g/cm³]*	Water content *[%]*	Organic content *[%]*	LL	PL	PI
S1 - Sensitive Clay	1.158	1.679	29.8÷56.5	2.60	33.7	19.3	14.3
S2 - Transition Layer	1.216	1.775	28.4÷54.8	2.73	29.5	19.5	10.0
S3 - Sand	1.603	1.839	14.7÷43.3	0.63			

Average geotechnical properties

SELA 22 PROJECT – NEW ORLEANS (USA)

Scope of work was the construction of a buried concrete box culvert



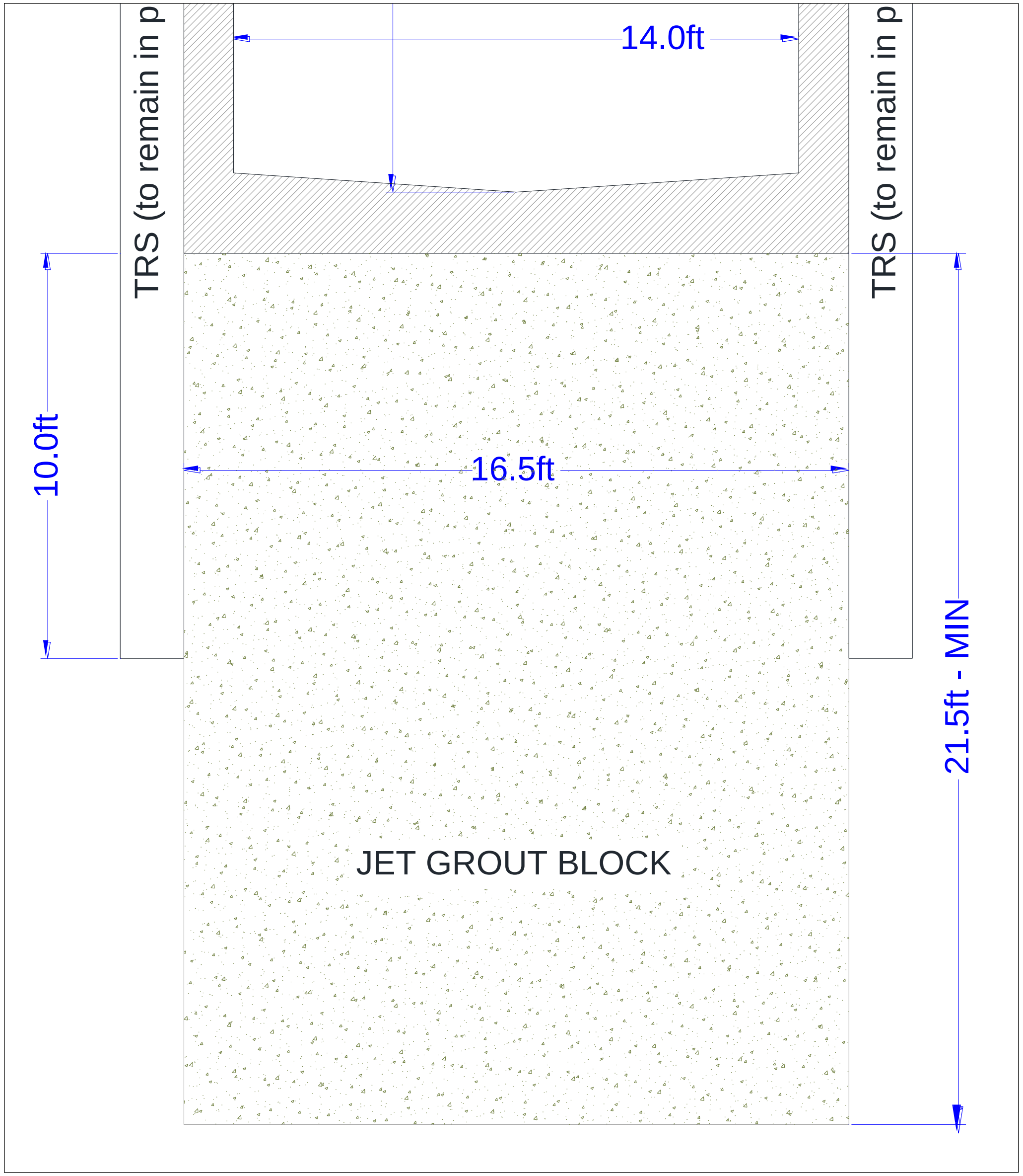


SELA 22 PROJECT – NEW ORLEANS (USA)

Ground improvement to replace soil between sheet piles with a soil-cement mass in order to eliminate under-seepage and provide vertical and lateral support

Project Requirements

- 100% area replacement ratio
- 5% coring
- 1 QC test (UCS, HC) every 3 ft
- 100 PSI minimum UCS
- $1x10^{-6}$ cm/s maximum HC



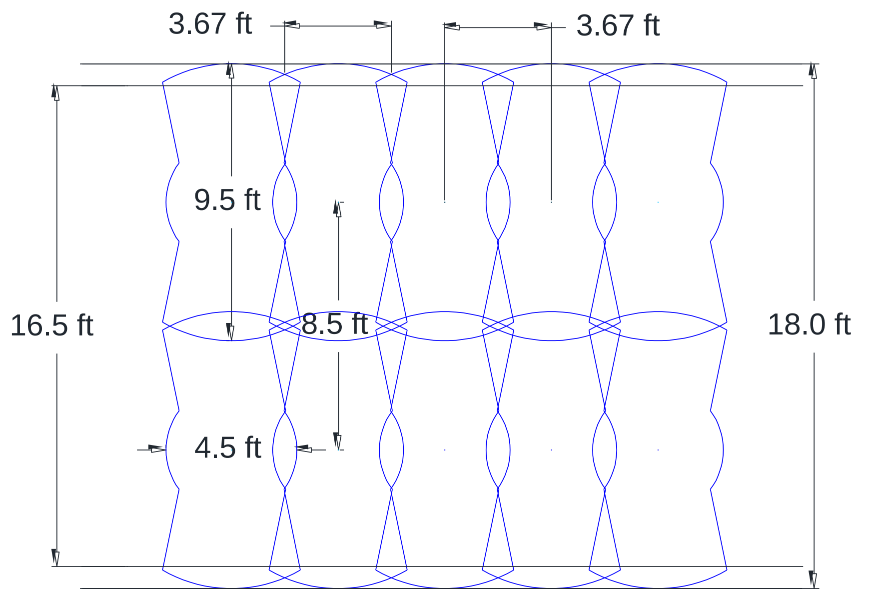
SELA 22 PROJECT – NEW ORLEANS (USA)

Some numbers…

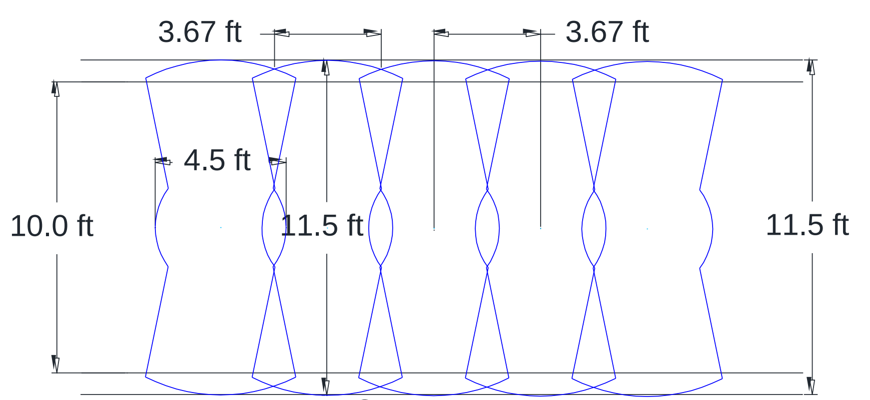
- No. 2,401 JG column installed
- Approx. 16 month of production – from April '14 to July '15
- No. 2 JG units used (since January '15)
- Over 1,500 m of treatment
- Over 57,000 cum of treatment (gross)
- Over 46,000 cum of treatment (net)
- Over 21,500 ton of binder used
- Over 55,000 man-hours

SELA 22 PROJECT – NEW ORLEANS (USA)

Geometry



JEFFERSON AVE - Typical Layout



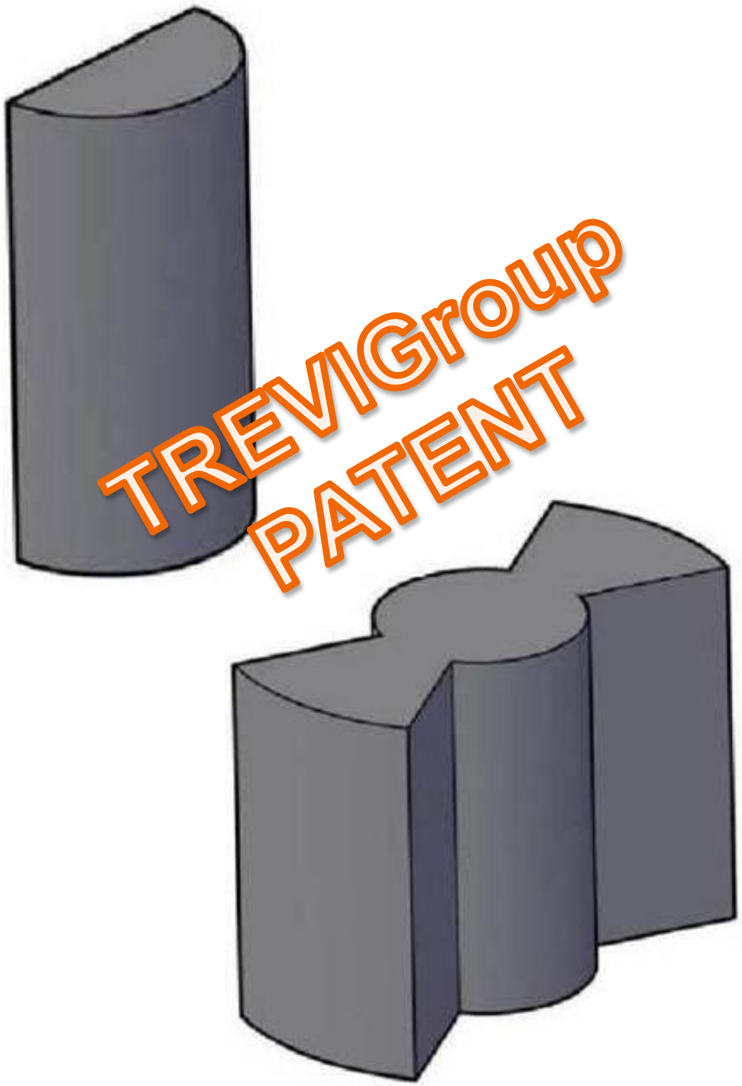
PRYTANIA ST - Typical Layout

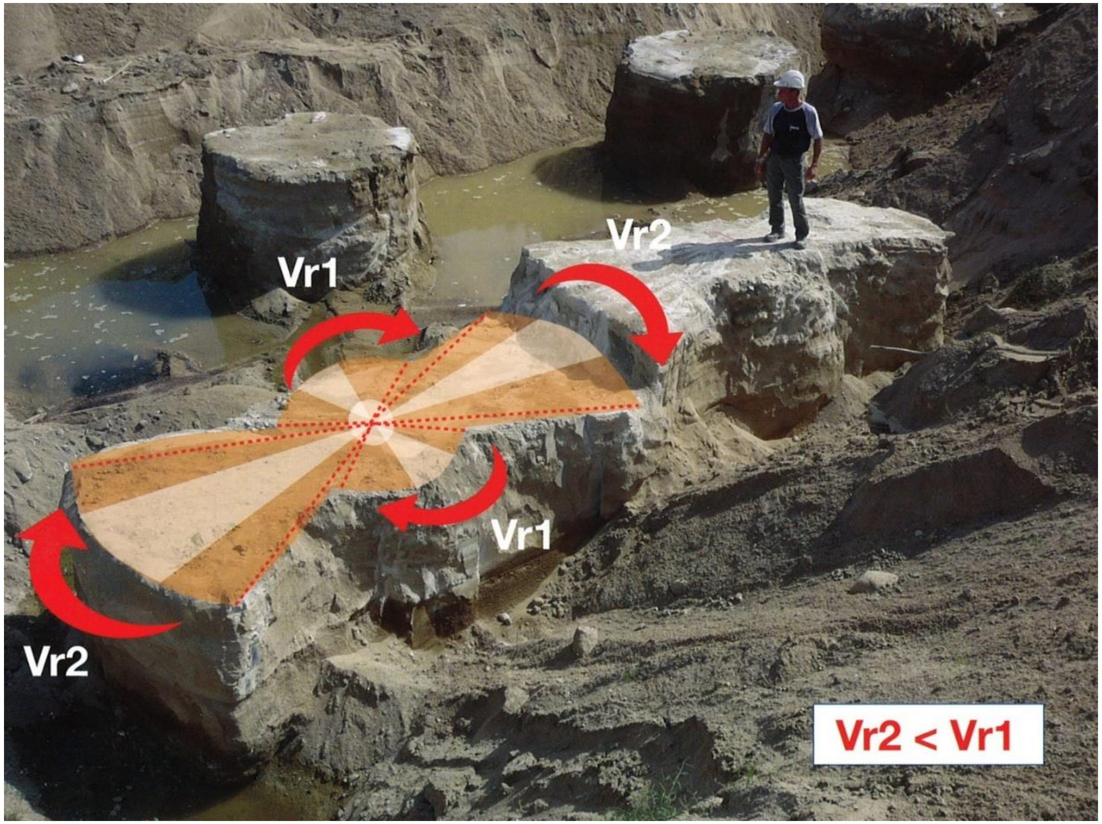
JET GROUTING EXECUTED WITH A VARIABLE SPEED OF THE RODS

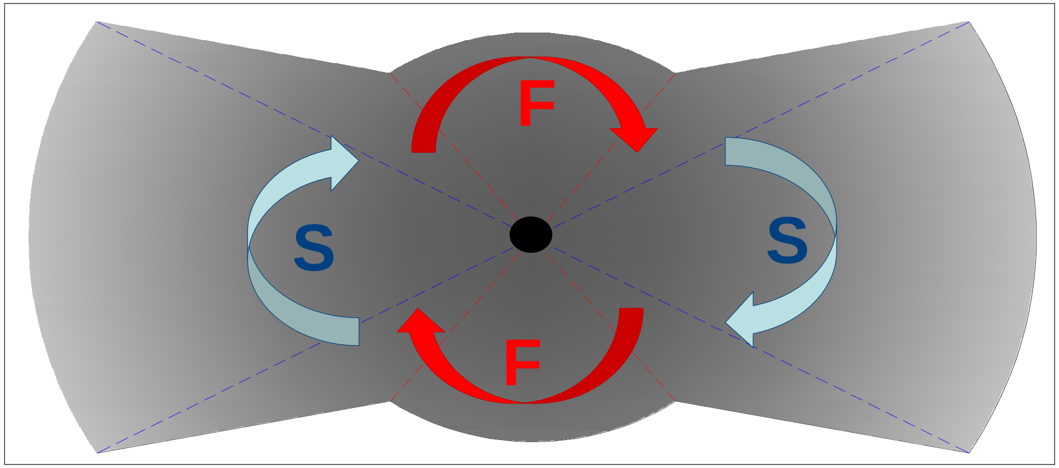
If we vary the rods' rotation speed during the execution of the treatment, what do we obtain?

Vr2 < Vr1

RECENT DEVELOPMENTS



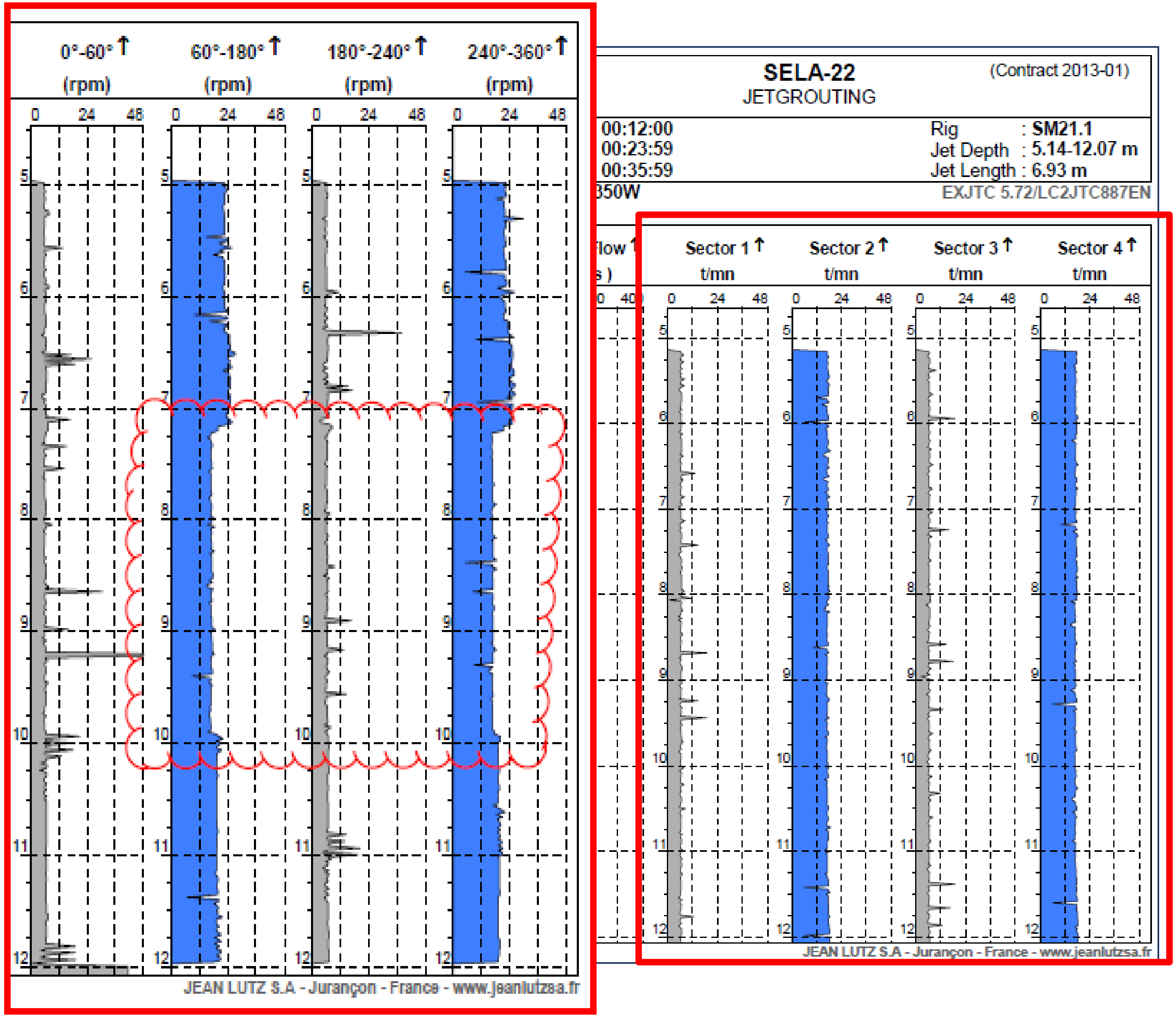




SELA 22 PROJECT – NEW ORLEANS (USA)

Quality Control

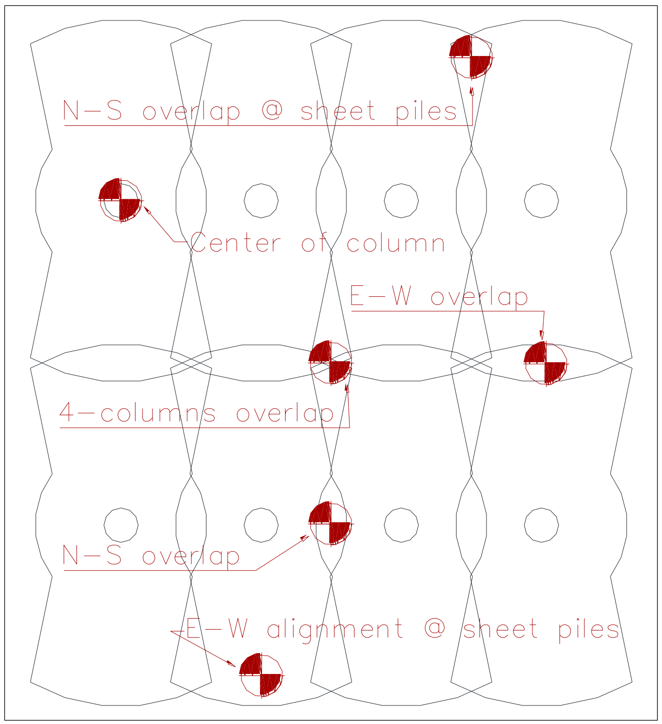
Real-time Monitoring of drilling and jetting parameters

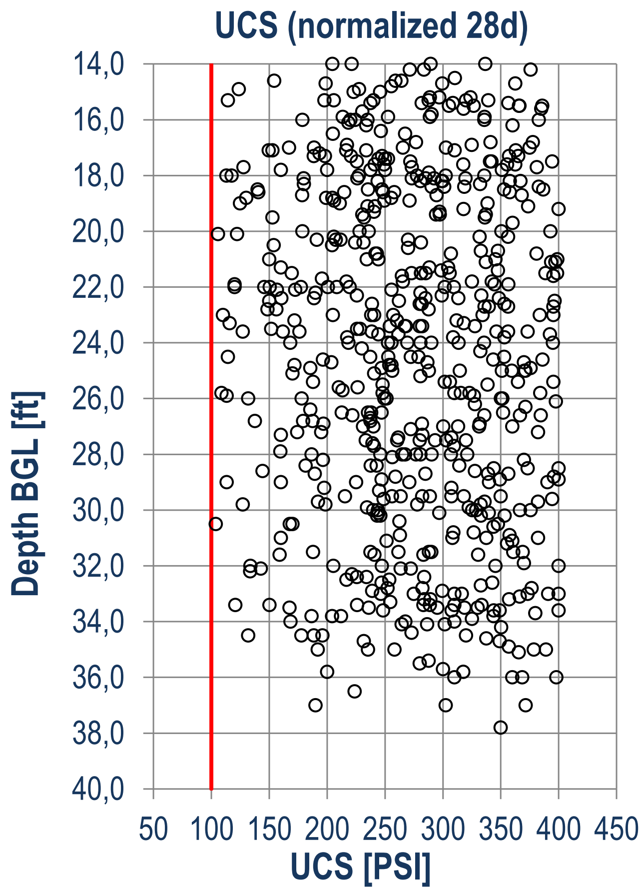


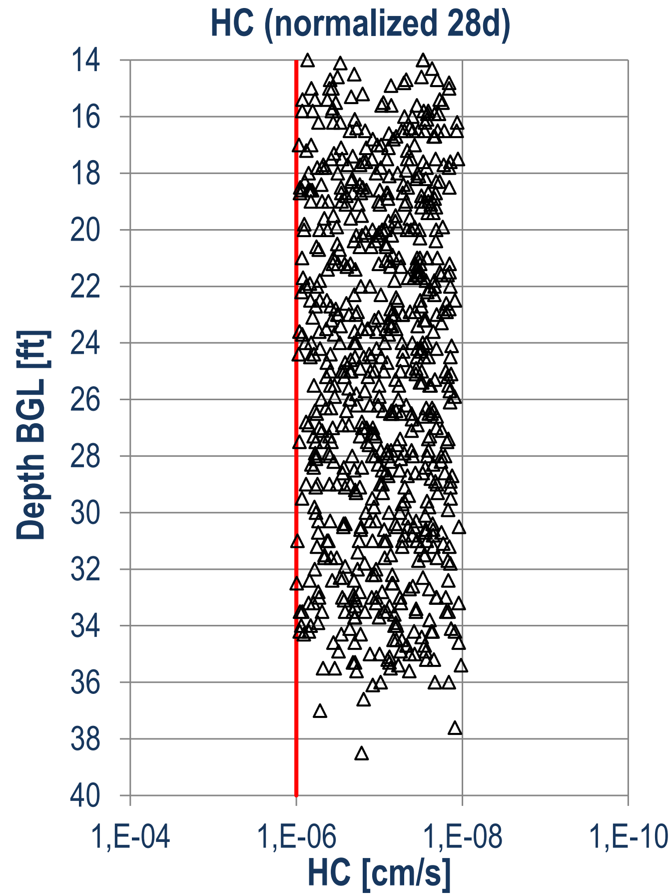
SELA 22 PROJECT – NEW ORLEANS (USA)

Quality control

Coring and lab test (UCS and permeability test)



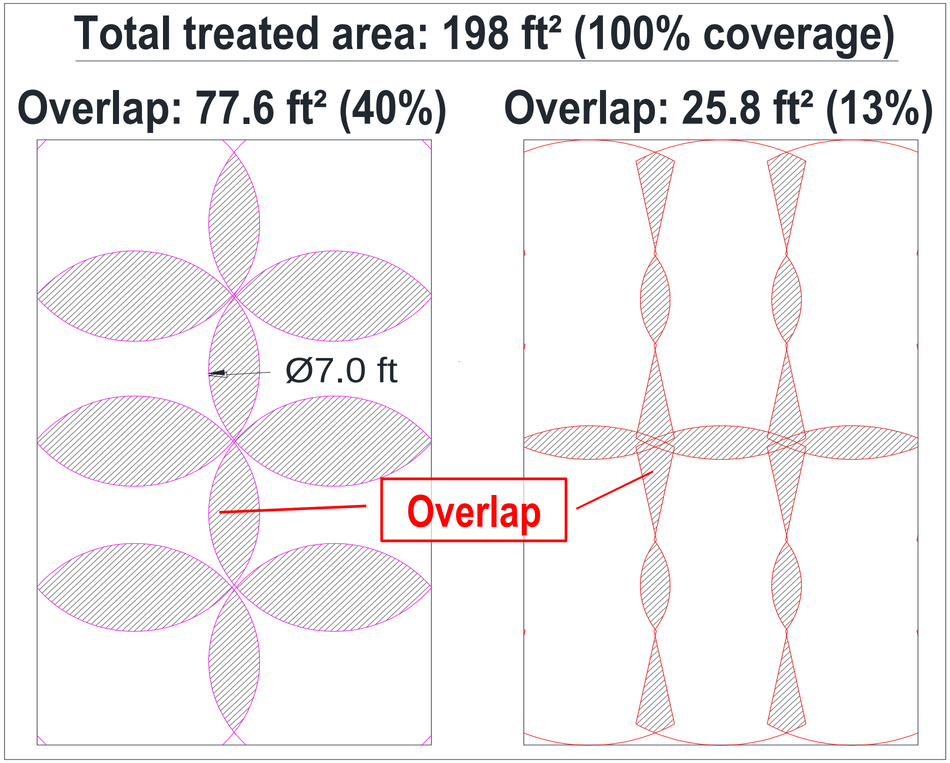




SELA 22 PROJECT – NEW ORLEANS (USA)

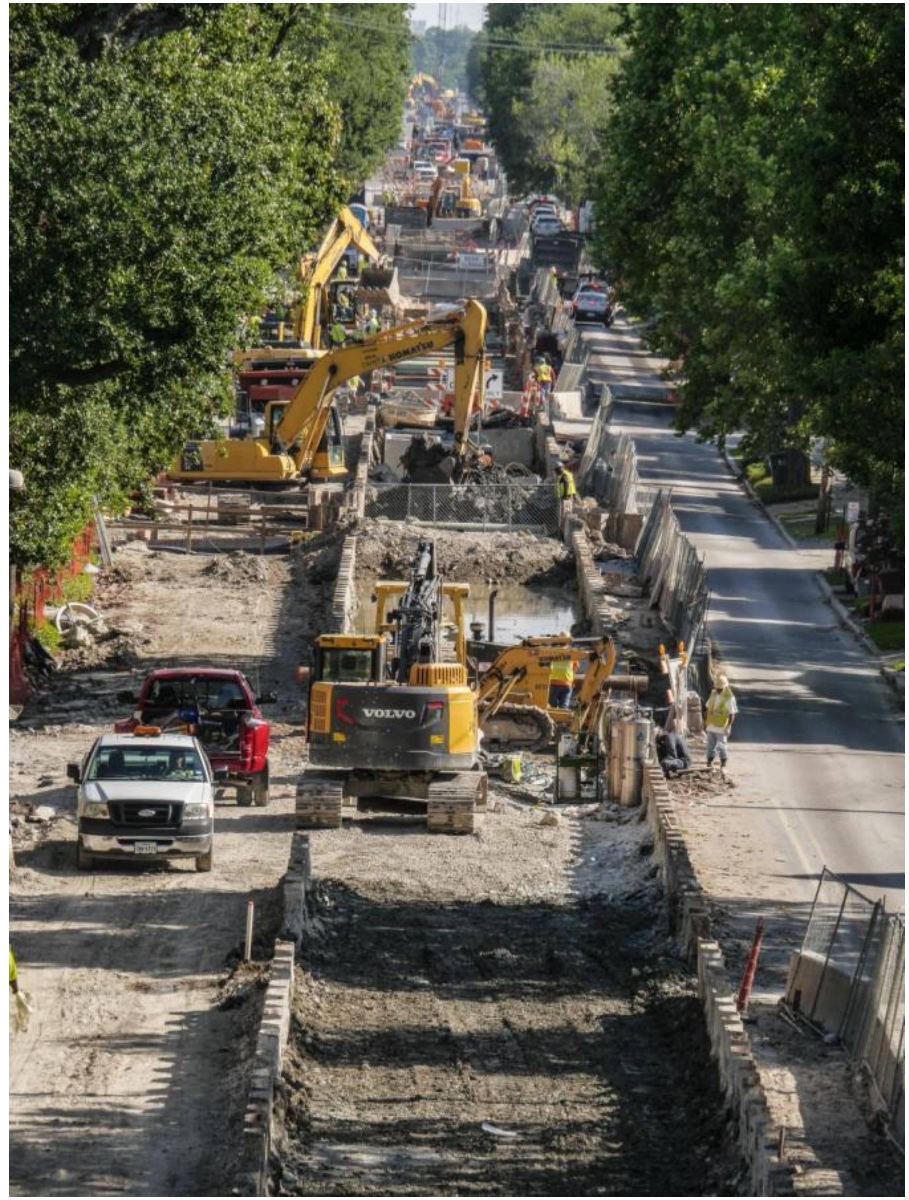
Elliptical vs. Traditional JG

- Increased Productivity
- less installations
- reduced overlap
- reduced binder consumption



SELA 22 PROJECT – NEW ORLEANS (USA)

Final Results



TREVI TURBO-MIX (single and double-axis)

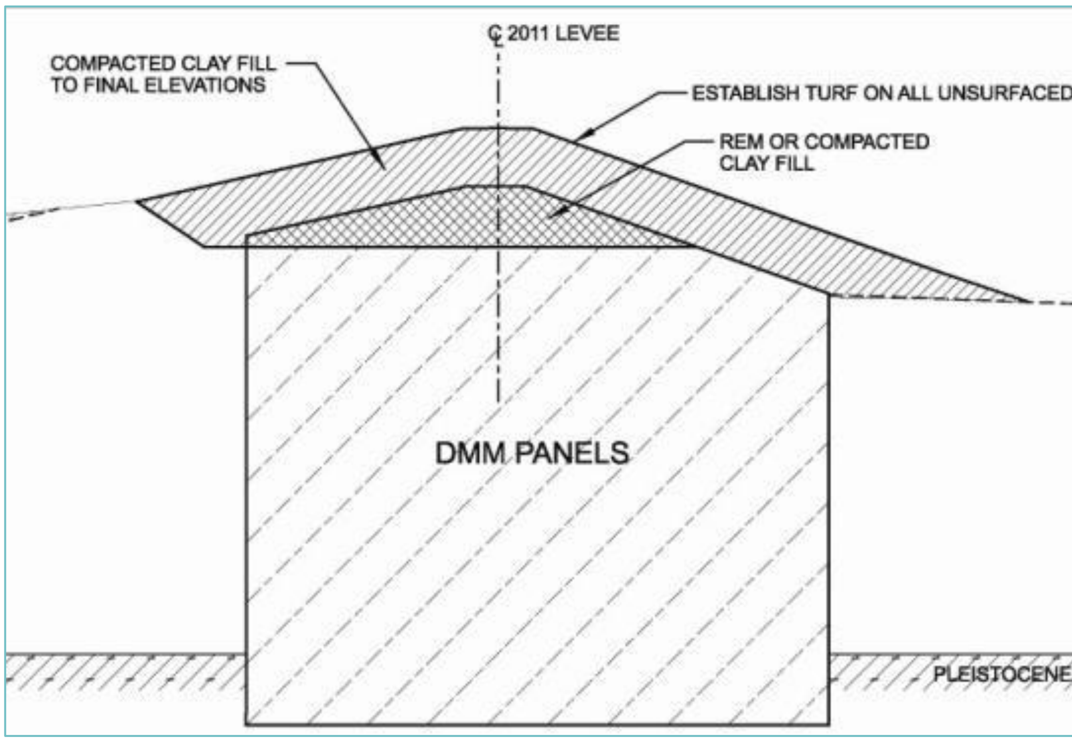
Combines the injection of pre-set quantities of cement slurry at high velocity into the ground with the traditional mechanical mixing of the rotating blades.

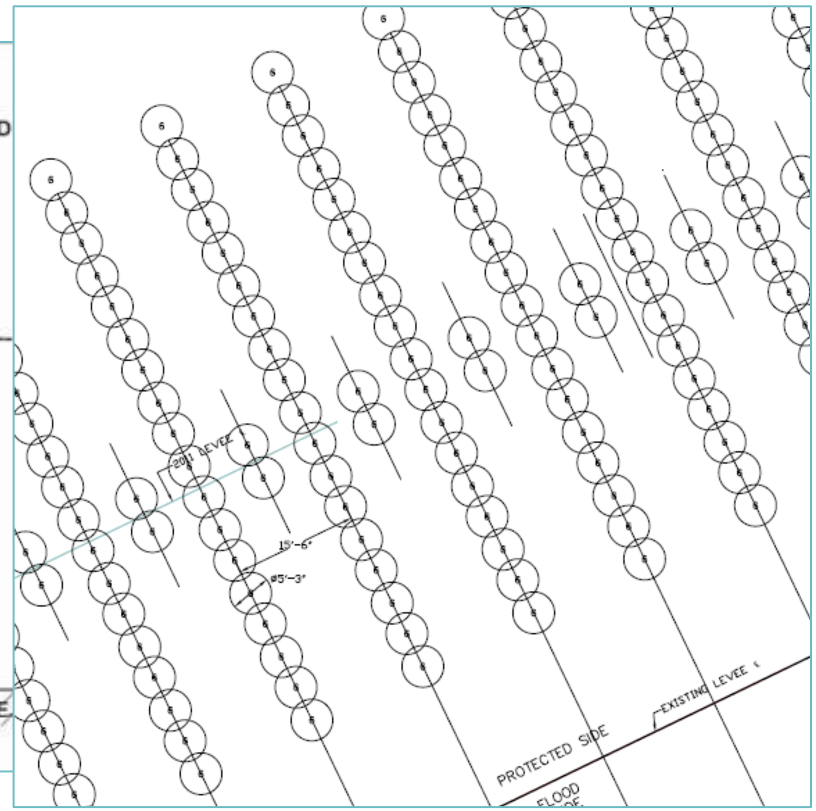
The additional energy :

- **greatly improves the quality of the mixing of the soil with the grout slurry.**
- **much larger quantity of soil can be treated than by conventional soil mixing methods**
- **positive repercussions on production and costs.**

LPV111 – New Orleans East

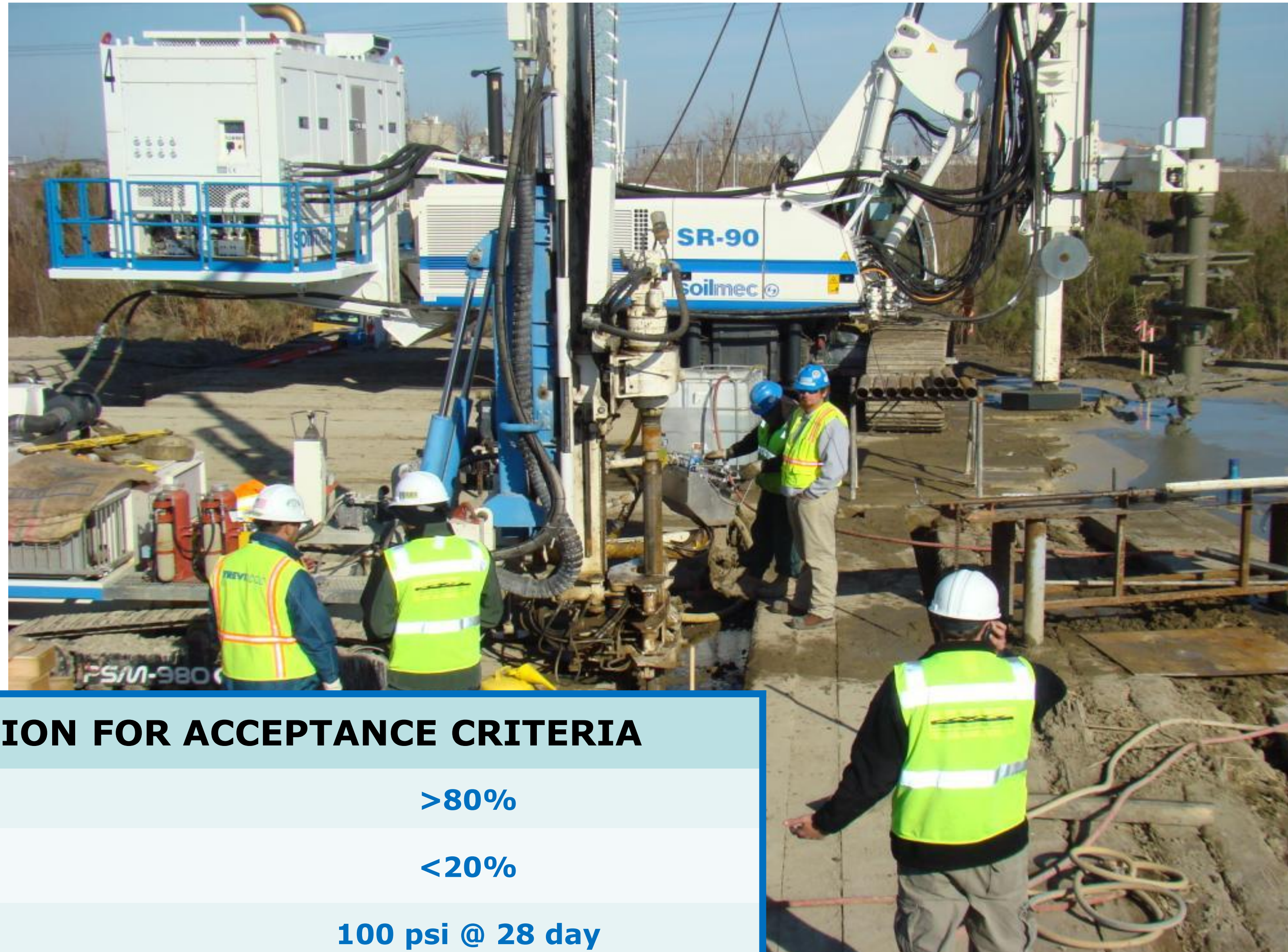
- Soil stabilization, settlement control, structural support (vertical & lateral)
- 1,300,000 cu.m of treated soil (21 m max depth)→ largest ever in western hemisphere (up to 8 rig on site)
- 460,000 ton of binder used → enough to build a sidewalk from NOLA to Rome!





LPV111 – New Orleans East

Coring Operations



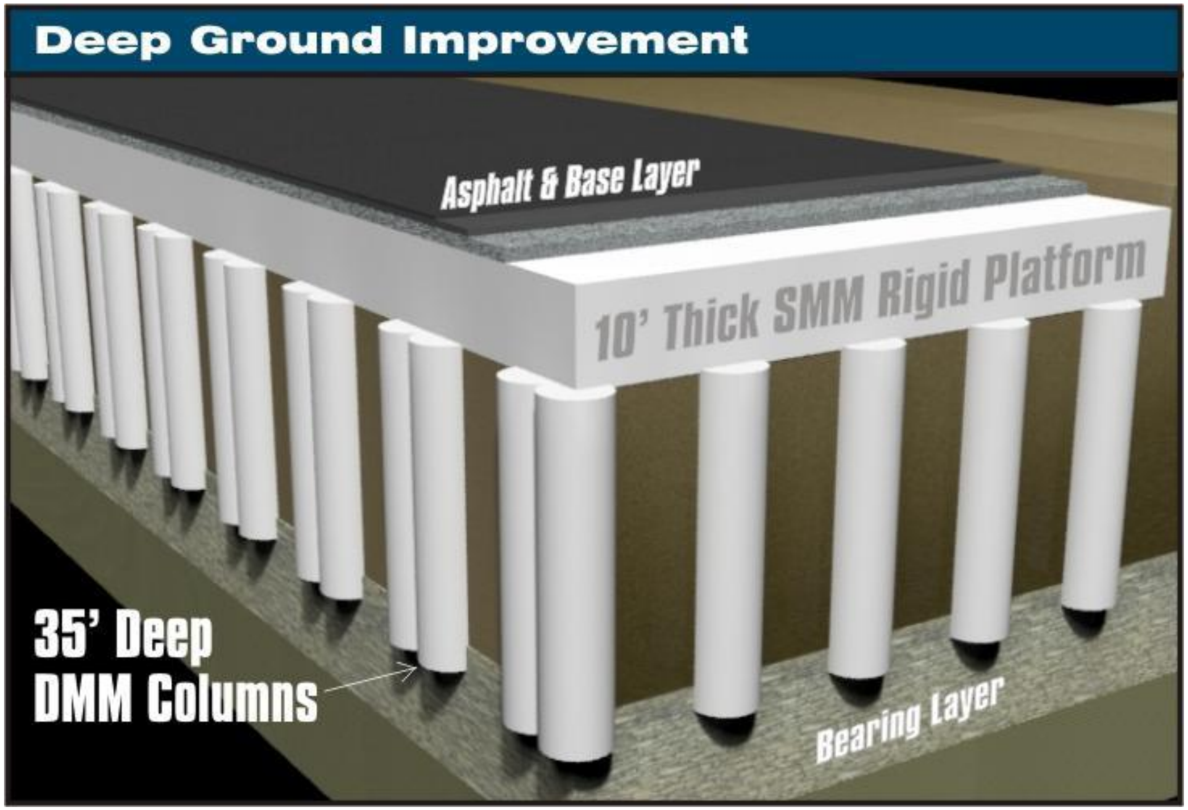
0% failure in excess of 600 cores

TECHNICAL SPECIFICATION FOR ACCEPTANCE CRITERIA	
Core recovery:	>80%
Unmixed material or inclusion	<20%
Strength	100 psi @ 28 day
Allowable % UCS lower then design	10%

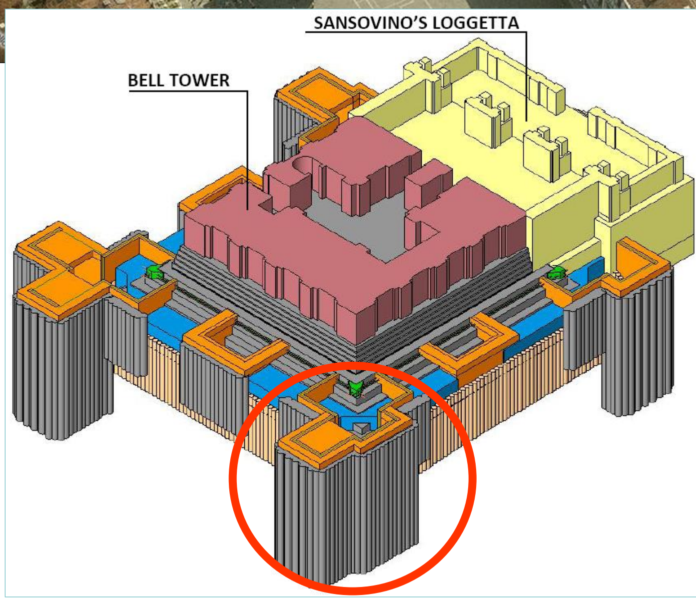
LPV111 – New Orleans East

SR83 over Choctawhatchee Bay– S. Rosa Beach, FL (ongoing)

- Ground stabilization, settlement control for causeway expansion
- Deep & Shallow Mixing Method - Trevi Turbo Mix (double axis)
- 255,000 cy of treated soil (45 ft max depth, 98% area coverage) (random fill, sand, silt)



Rehabilitation of Historical Structures – San Marco bell tower Venice (Italy)



Foundation access chambers (reinforced DMM walls, DMM bottom plug, low-P injections, performed with a small drilling rig)

JET – GROUTING – advantages

The main reasons for a big success ....

- improve the mechanical and permeability features od a wide range of di soils (from gravels to peaty clays);
- obtain columns/panels of consolidated soil with diameter larger than 4 m and lenght deeper than 60 m (dams cut-off), starting from small-size drilling holes (i.e. ø 120÷200 mm);
- go through possible underground obstacles and obstractions (i.e. old foundations, blocks of rock etc.)
- perform treatment also within low-height and/or low-width spaces (i.e. inside cellars, courtyards, buildings etc.), by using small-size and low-weight drilling rigs.

THANK YOU FOR PAYING ATTENTION

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