UCT The Underground Utilities Event
25 YEARS
Underground Construction Technology | January 28-30, 2020 | Fort Worth, TX

The Road Less Traveled:

144”Gravity Sewer Tunnel in DOT ROW

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Jeff Farnsworth, P.E. | Project Manager, Kimley-Horn

San Antonio Water System

Agenda

- Project History
- Alignment/Overview
- Tunnel Reaches
- TxDOT Approvals
- Other Approvals/Coordination
- Contractor Outreach
- Geotechnical Considerations
- Tunnel Construction
- Shaft Construction

Project Background/History

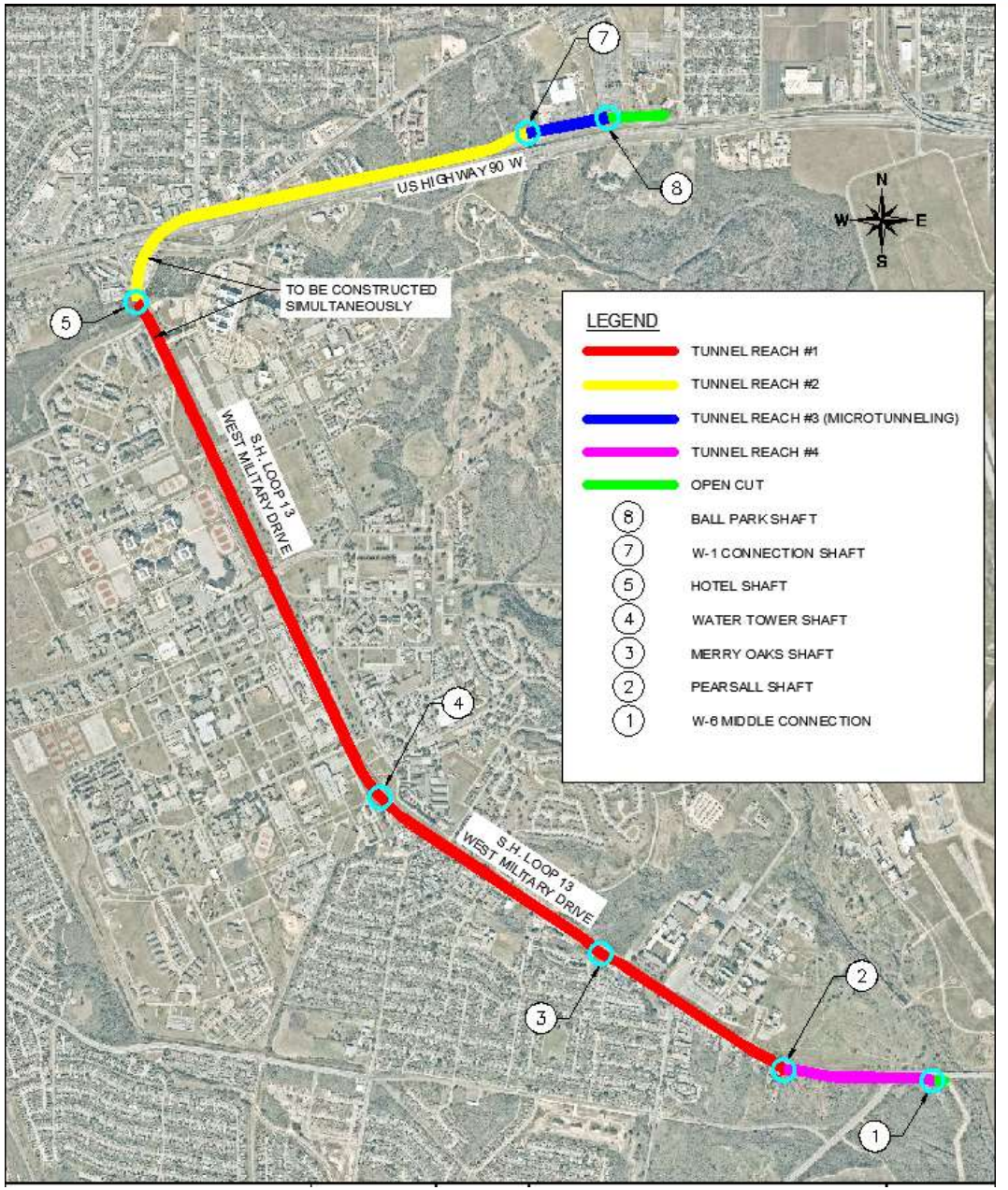
- SAWS Initiated design work in 2007
- Challenges
  - Personnel Changes
  - Former closed landfills
  - Easement terms
  - Risk allocation
  - Alternative alignments
- Congressional action triggered resolution
  - National Defense Authorization Act for FY 2019
  - MOA with USAF Executed August 2019

Alignment Overview

- Western Sewershed, along US 90 and W. Military Dr
- Pipe Diameter and Segment Length
  - 26,000 LF of ~144” tunnel in Navarro Group and Marlbrook Marl formations
  - 2,500 LF of ~78” tunnel construction
  - Installation along TXDOT right-of-way
  - Eight shaft locations
  - Solids Removal Structure

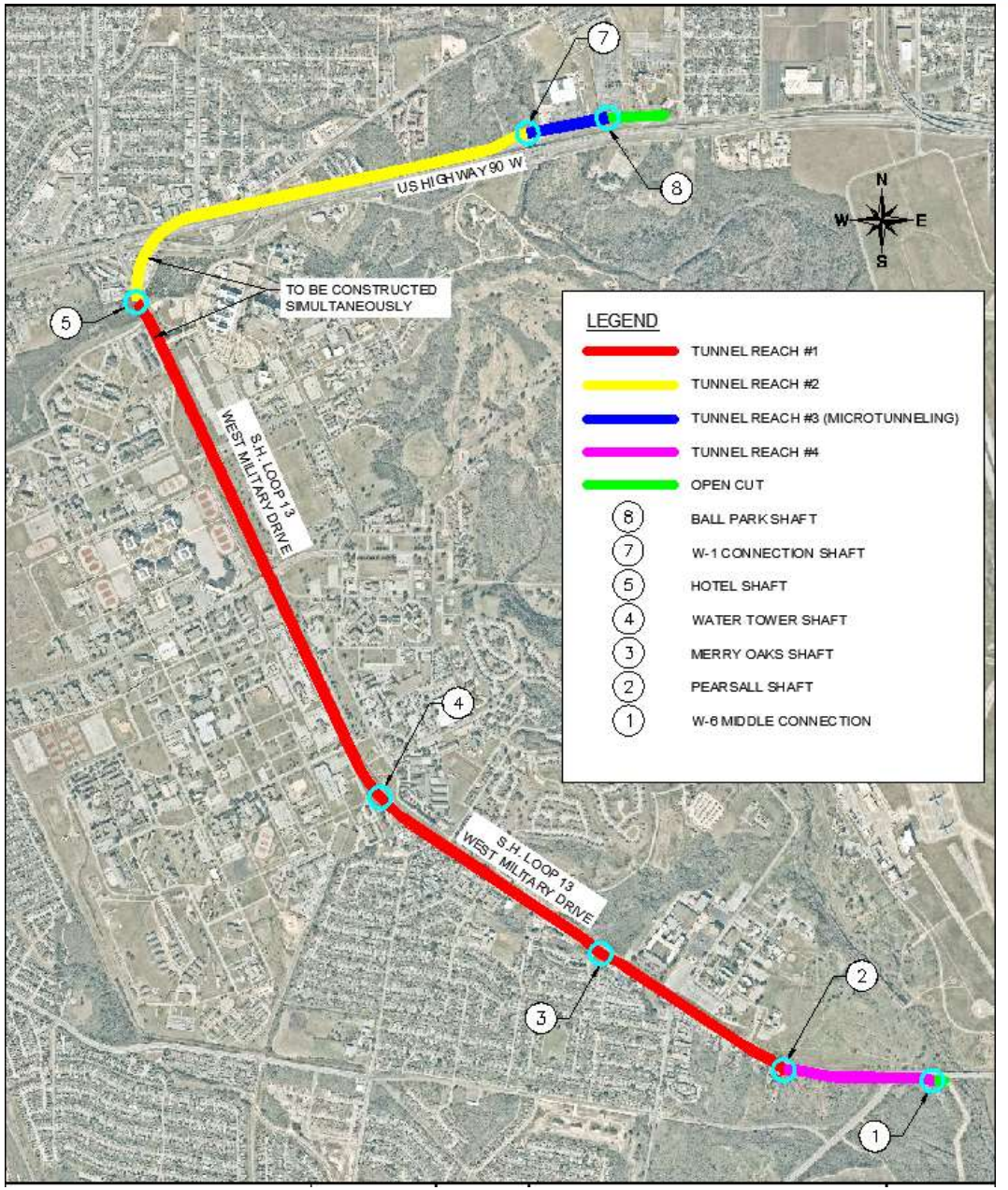
Design Schedule

- NTP – February 2019
- 30% Verification – May 2019
- 60% Design – Sept 2019
- 90% Design – November 2019
- 100% Design – January 2020
- Bid – February 25, 2020
- Construction NTP – July 1, 2020



Tunneling Reaches

- Construction Sequencing



TxDOT Approvals

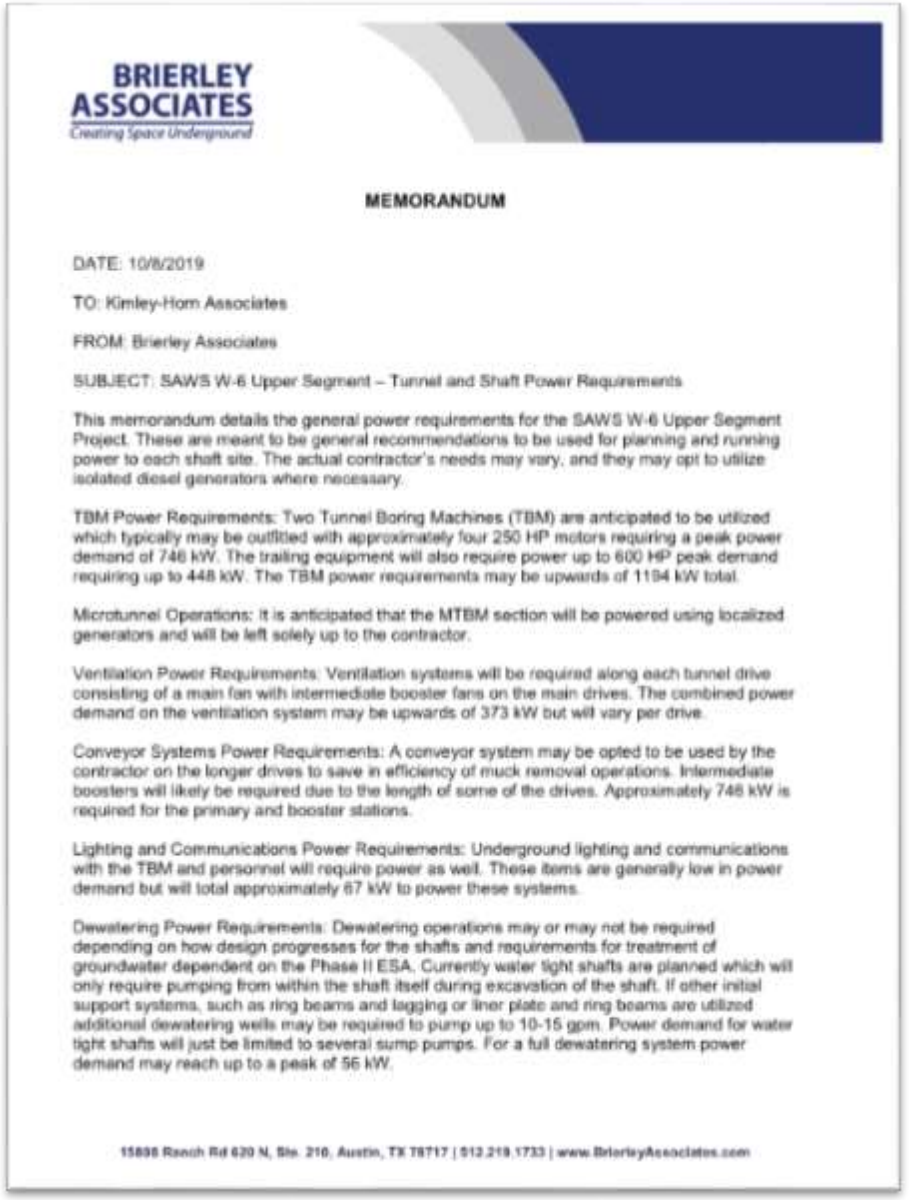
- UIR
- Driveway permit

Other Approvals - DoD

- Memorandum of Agreement (Act of Congress)
- Structural Analysis
- Coordination Meetings
- Fence Relocations
- Abandonment

Other Approvals - CPS Energy

- Gas Coordination (shafts)
- Electric Power Coordination
- Shafts that will utilize generator to supply power to site:
  - Callaghan Shaft
  - Ball Park Shaft
  - W-1 Connection Shaft



BRIERLEY ASSOCIATES
Creating Space Underground

MEMORANDUM

DATE: 10/8/2019

TO: Kimley-Horn Associates

FROM: Brierley Associates

SUBJECT: SAWS W-6 Upper Segment – Tunnel and Shaft Power Requirements

This memorandum details the general power requirements for the SAWS W-6 Upper Segment Project. These are meant to be general recommendations to be used for planning and running power to each shaft site. The actual contractor's needs may vary, and they may opt to utilize isolated diesel generators where necessary.

TBM Power Requirements: Two Tunnel Boring Machines (TBM) are anticipated to be utilized which typically may be outfitted with approximately four 250 HP motors requiring a peak power demand of 746 kW. The trailing equipment will also require power up to 600 HP peak demand requiring up to 448 kW. The TBM power requirements may be upwards of 1194 kW total.

Microtunnel Operations: It is anticipated that the MTBM section will be powered using localized generators and will be left solely up to the contractor.

Ventilation Power Requirements: Ventilation systems will be required along each tunnel drive consisting of a main fan with intermediate booster fans on the main drives. The combined power demand on the ventilation system may be upwards of 373 kW but will vary per drive.

Conveyor Systems Power Requirements: A conveyor system may be opted to be used by the contractor on the longer drives to save in efficiency of muck removal operations. Intermediate boosters will likely be required due to the length of some of the drives. Approximately 746 kW is required for the primary and booster stations.

Lighting and Communications Power Requirements: Underground lighting and communications with the TBM and personnel will require power as well. These items are generally low in power demand but will total approximately 67 kW to power these systems.

Dewatering Power Requirements: Dewatering operations may or may not be required depending on how design progresses for the shafts and requirements for treatment of groundwater dependent on the Phase II ESA. Currently water tight shafts are planned which will only require pumping from within the shaft itself during excavation of the shaft. If other initial support systems, such as ring beams and lagging or liner plate and ring beams are utilized additional dewatering wells may be required to pump up to 10-15 gpm. Power demand for water tight shafts will just be limited to several sump pumps. For a full dewatering system power demand may reach up to a peak of 56 kW.

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Other Approvals - TCEQ

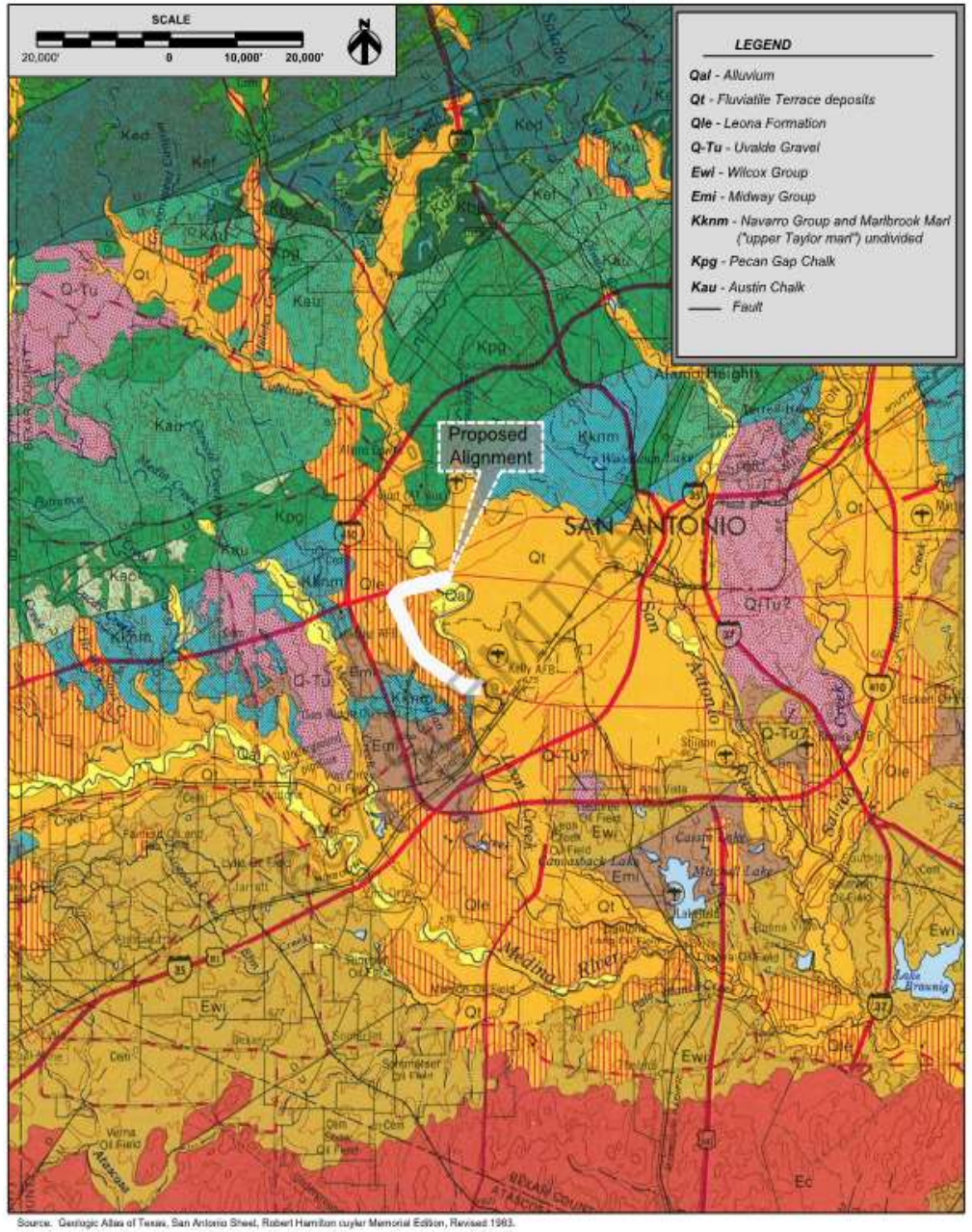
- Environmental Testing and Manifest Requirements:
  - Material Type
  - Amount per Truckload
  - Disposal Locations

Contractor Outreach

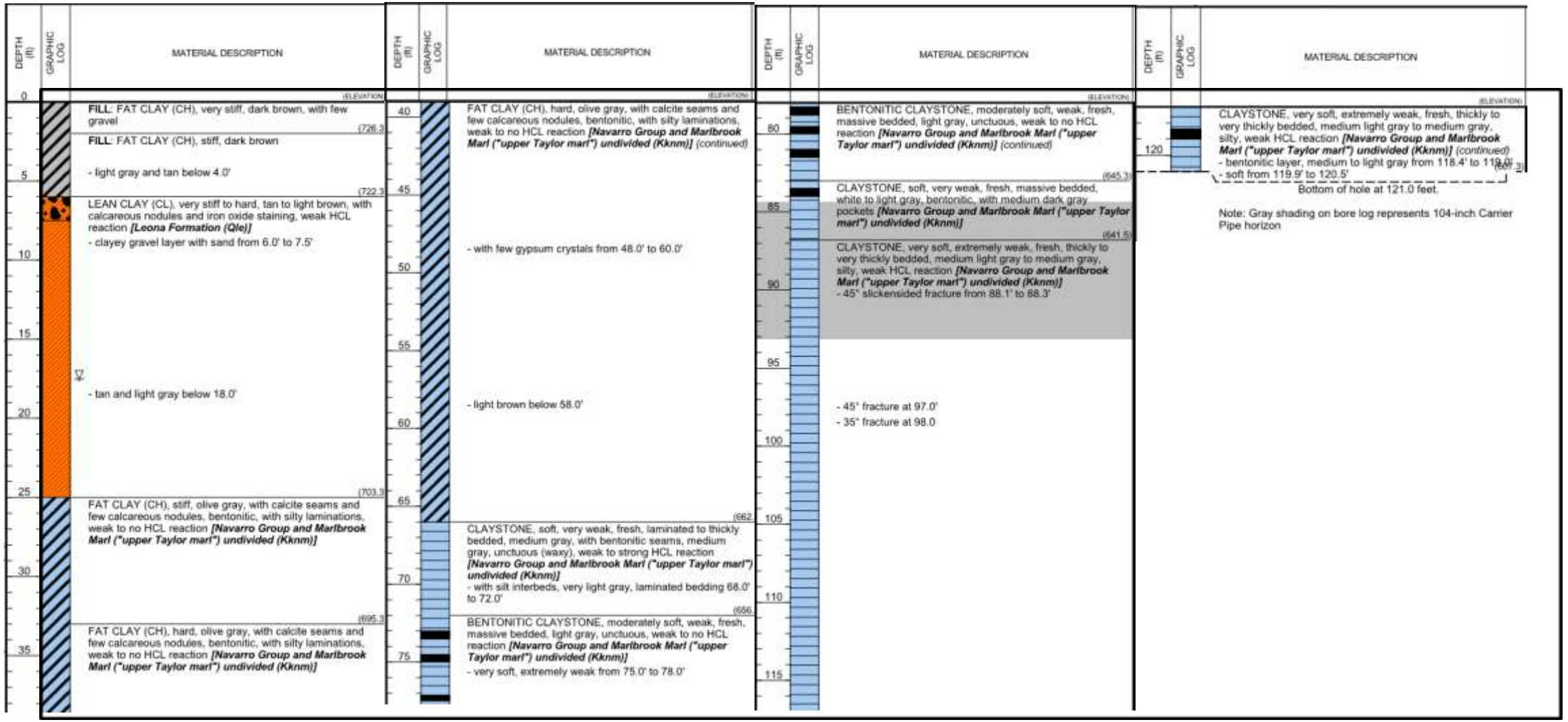
- 96 people in attendance
- More than a dozen prime contractors

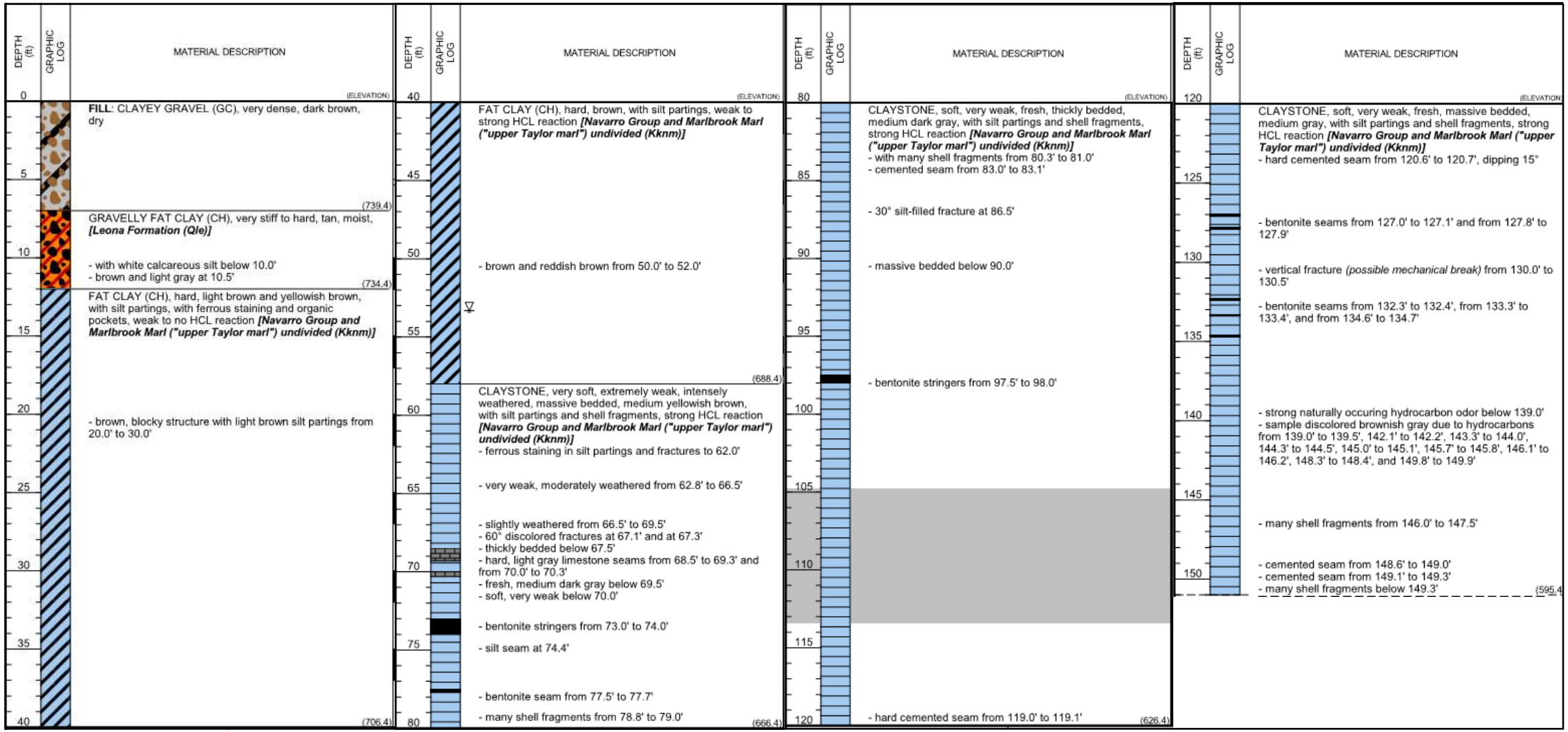
Geotechnical Considerations

- 60 Borings (150-ft depth)
- Geophysical Study
- Groundwater
- Faults
- Sticky Clay
- Naturally Ocurring Hydrocarbons
- Geotechnical Baseline Report
- Geotechnical Data Report



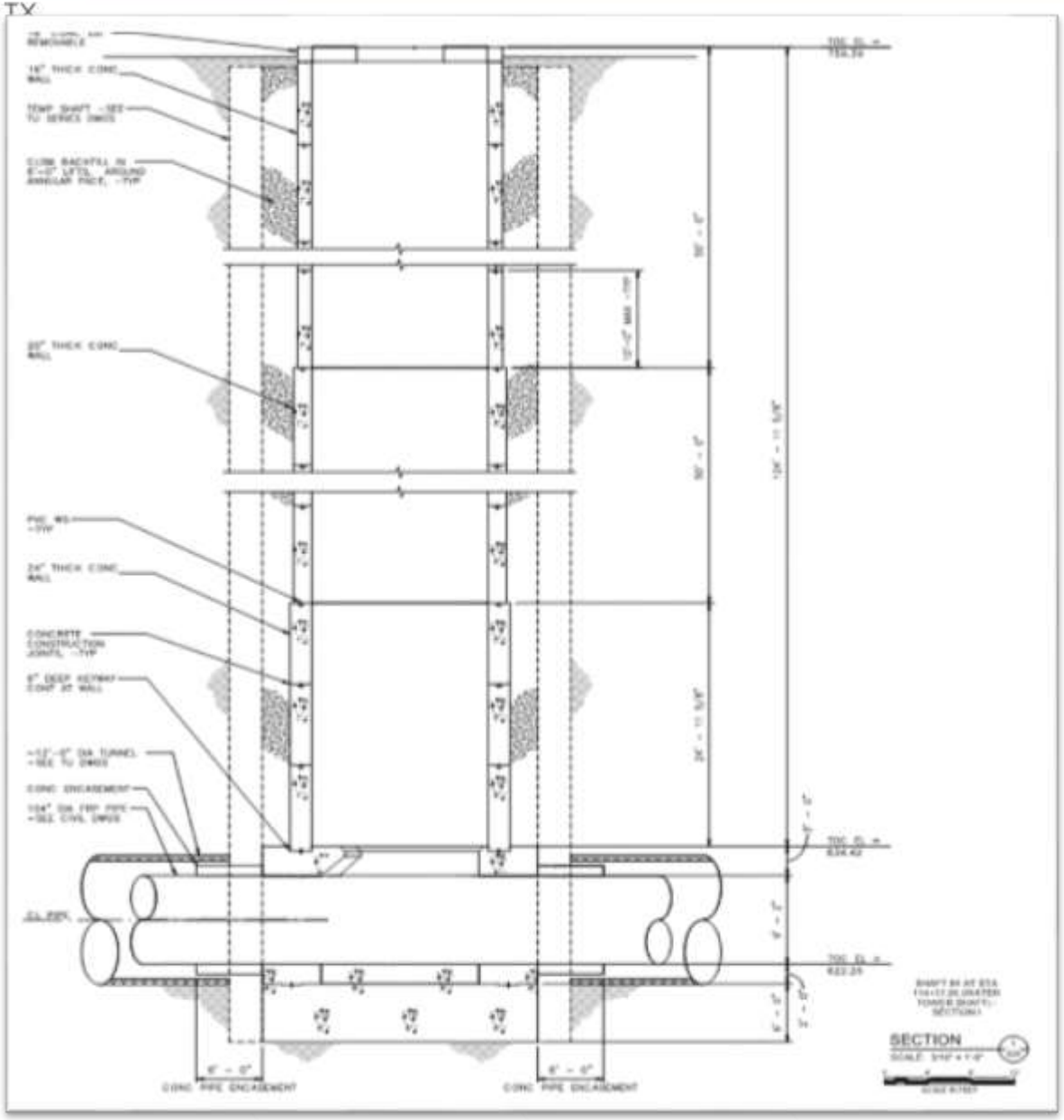
Source: Geologic Atlas of Texas, San Antonio Sheet, Robert Hamilton cuyler Memorial Edition, Revised 1983.


DEPTH (ft)
GRAPHIC LOG
MATERIAL DESCRIPTION
(ELEVATION)
0
FILL: FAT CLAY (CH), very stiff, dark brown, with few gravel
(726.3)
FILL: FAT CLAY (CH), stiff, dark brown
- light gray and tan below 4.0'
(722.3)
LEAN CLAY (CL), very stiff to hard, tan to light brown, with calcareous nodules and iron oxide staining, weak HCL reaction [Leona Formation (Qle)]
- clayey gravel layer with sand from 6.0' to 7.5'
- tan and light gray below 18.0'
(703.3)
FAT CLAY (CH), stiff, olive gray, with calcite seams and few calcareous nodules, bentonitic, with silty laminations, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
(695.3)
FAT CLAY (CH), hard, olive gray, with calcite seams and few calcareous nodules, bentonitic, with silty laminations, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
FAT CLAY (CH), hard, olive gray, with calcite seams and few calcareous nodules, bentonitic, with silty laminations, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)] (continued)
- with few gypsum crystals from 48.0' to 60.0'
- light brown below 58.0'
(662)
CLAYSTONE, soft, very weak, fresh, laminated to thickly bedded, medium gray, with bentonitic seams, medium gray, unctuous (waxy), weak to strong HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- with silt interbeds, very light gray, laminated bedding 68.0' to 72.0'
(656)
BENTONITIC CLAYSTONE, moderately soft, weak, fresh, massive bedded, light gray, unctuous, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- very soft, extremely weak from 75.0' to 78.0'
BENTONITIC CLAYSTONE, moderately soft, weak, fresh, massive bedded, light gray, unctuous, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)] (continued)
(645.3)
CLAYSTONE, soft, very weak, fresh, massive bedded, white to light gray, bentonitic, with medium dark gray pockets [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
(641.5)
CLAYSTONE, very soft, extremely weak, fresh, thickly to very thickly bedded, medium light gray to medium gray, silty, weak HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- 45° slickensided fracture from 88.1' to 88.3'
- 45° fracture at 97.0'
- 35° fracture at 98.0
CLAYSTONE, very soft, extremely weak, fresh, thickly to very thickly bedded, medium light gray to medium gray, silty, weak HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)] (continued)
- bentonitic layer, medium to light gray from 118.4' to 119.9'
- soft from 119.9' to 120.5'
(597.3)
Bottom of hole at 121.0 feet.
Note: Gray shading on bore log represents 104-inch Carrier Pipe horizon


DEPTH (ft)
GRAPHIC LOG
MATERIAL DESCRIPTION
(ELEVATION)
0
FILL: CLAYEY GRAVEL (GC), very dense, dark brown, dry
(739.4)
GRAVELLY FAT CLAY (CH), very stiff to hard, tan, moist, [Leona Formation (Qle)]
- with white calcareous silt below 10.0'
- brown and light gray at 10.5'
(734.4)
FAT CLAY (CH), hard, light brown and yellowish brown, with silt partings, with ferrous staining and organic pockets, weak to no HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- brown, blocky structure with light brown silt partings from 20.0' to 30.0'
(706.4)
40
FAT CLAY (CH), hard, brown, with silt partings, weak to strong HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- brown and reddish brown from 50.0' to 52.0'
(688.4)
CLAYSTONE, very soft, extremely weak, intensely weathered, massive bedded, medium yellowish brown, with silt partings and shell fragments, strong HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- ferrous staining in silt partings and fractures to 62.0'
- very weak, moderately weathered from 62.8' to 66.5'
- slightly weathered from 66.5' to 69.5'
- 60° discolored fractures at 67.1' and at 67.3'
- thickly bedded below 67.5'
- hard, light gray limestone seams from 68.5' to 69.3' and from 70.0' to 70.3'
- fresh, medium dark gray below 69.5'
- soft, very weak below 70.0'
- bentonite stringers from 73.0' to 74.0'
- silt seam at 74.4'
- bentonite seam from 77.5' to 77.7'
- many shell fragments from 78.8' to 79.0'
(666.4)
80
CLAYSTONE, soft, very weak, fresh, thickly bedded, medium dark gray, with silt partings and shell fragments, strong HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- with many shell fragments from 80.3' to 81.0'
- cemented seam from 83.0' to 83.1'
- 30° silt-filled fracture at 86.5'
- massive bedded below 90.0'
- bentonite stringers from 97.5' to 98.0'
- hard cemented seam from 119.0' to 119.1'
(626.4)
120
CLAYSTONE, soft, very weak, fresh, massive bedded, medium gray, with silt partings and shell fragments, strong HCL reaction [Navarro Group and Marlbrook Marl ("upper Taylor marl") undivided (Kknm)]
- hard cemented seam from 120.6' to 120.7', dipping 15°
- bentonite seams from 127.0' to 127.1' and from 127.8' to 127.9'
- vertical fracture (possible mechanical break) from 130.0' to 130.5'
- bentonite seams from 132.3' to 132.4', from 133.3' to 133.4', and from 134.6' to 134.7'
- strong naturally occuring hydrocarbon odor below 139.0'
- sample discolored brownish gray due to hydrocarbons from 139.0' to 139.5', 142.1' to 142.2', 143.3' to 144.0', 144.3' to 144.5', 145.0' to 145.1', 145.7' to 145.8', 146.1' to 146.2', 148.3' to 148.4', and 149.8' to 149.9'
- many shell fragments from 146.0' to 147.5'
- cemented seam from 148.6' to 149.0'
- cemented seam from 149.1' to 149.3'
- many shell fragments below 149.3'
(595.4

Typical Shaft Design

- Value Engineering
- Polymer Concrete
- 3 Piece Shaft Lid



Tunnel Design

- ~144” Tunnel with 104” Carrier Pipe
- 2 TBMs (Schedule / Geology)
- EPBM Open Face / EPBM Dual Mode
- Maximum Tunnel Curvature (1200’ radii)

- Design currently being finalized
- Release for Bid – February 25, 2020
- Board Award – June 2020
- Construction NTP – July 2020

See you next year, for a Construction Update…

Questions?

Shaft 6: W-1 Connection Shaft