

Horizontal Directional Drilling & Trenchless Construction Capabilities

AECOM



CONVEYANCE PLANNING, DESIGN, AND CONSTRUCTION PHASE SERVICES

OIL & GAS TRANSMISSION | OFFSHORE WIND | POWER TRANSMISSION | TELECOM

SCOPE OF TRENCHLESS PLANNING, DESIGN AND CONSTRUCTION PHASE SERVICES:

- **HDD – Shore Approach and Conventional**
- **Microtunneling, Conventional Boring**
- **Conduit Installation and Operational Stress Analyses**
- **Borehole Stability Analysis and Other Specialty Analyses**
- **Construction Risk Profile and Mitigation Options**
- **Routing Studies**
- **Permitting Support and Documentation – FERC, State, and Local**
- **Site Access, Temporary/Permanent Easement and Staging Options**
- **Construction Inspection, Monitoring, As-Built Documentation**

EXPERIENCE HIGHLIGHTS

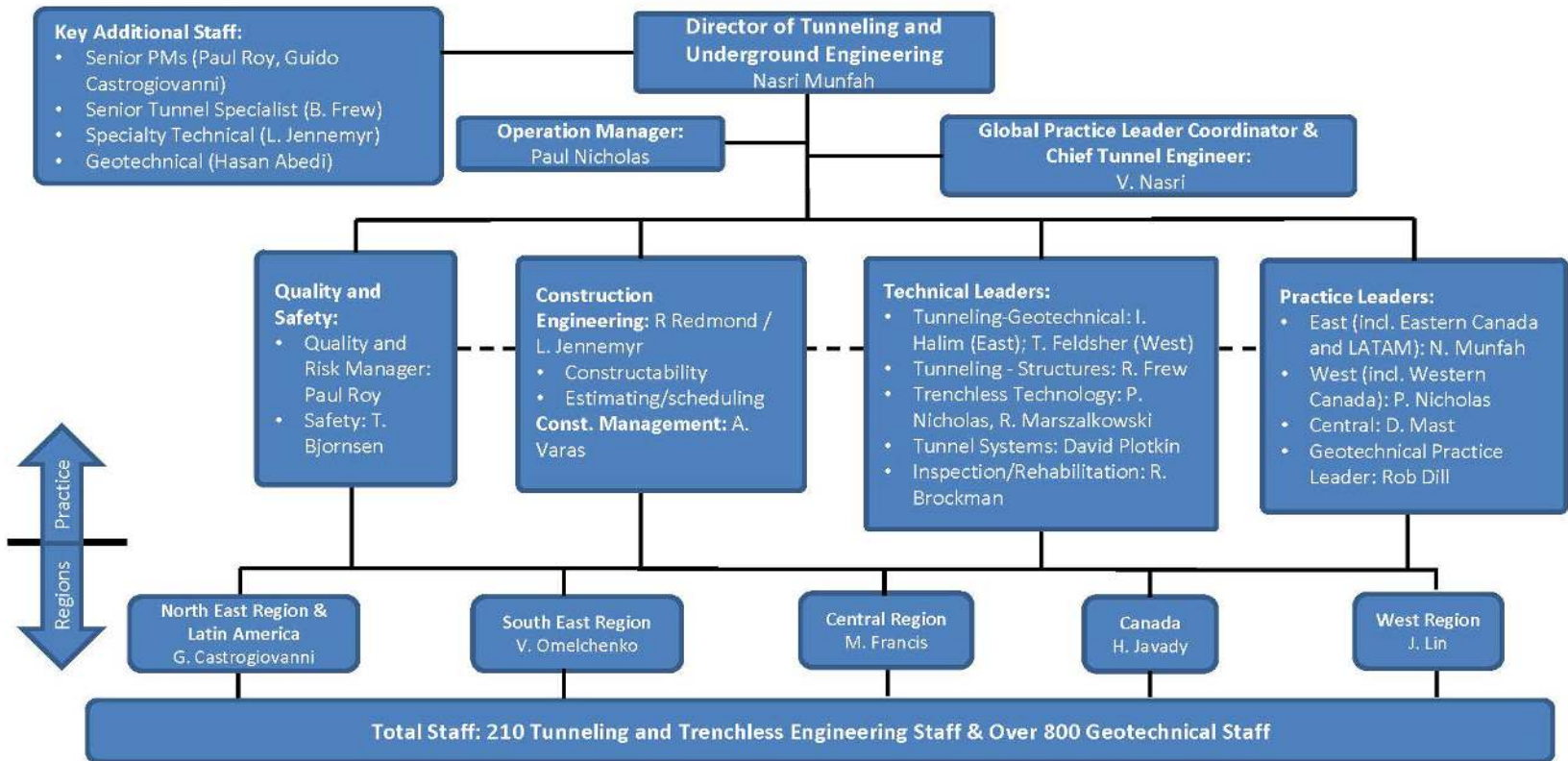
- **Over 2,500 Trenchless Designs Completed To Date**
- **Offshore Power Landfalls, Water Body Crossings, Wetlands, Roadways, Railroads, Utilities, Airport Runways and Similar Natural and Man-made Obstacles; Each With Unique Spatial and Geotechnical Characteristics.**
- **Longest HDD – 7,100' | Conduit Diameters 4" – 60" | Compound Curves | Shore Approaches and Outfalls | Intersect Method**

COORDINATION WITH CONTRACTORS AND SUBCONTRACTORS

- **AECOM has worked with all NATIONAL HDD/Trenchless Contractors and many Regional and Local Drillers**
- **Typical Subcontracted Services - Surveying, Bathymetry, Geophysics**
- **Geotechnical Drilling Services - In-house and Locally Subcontracted**

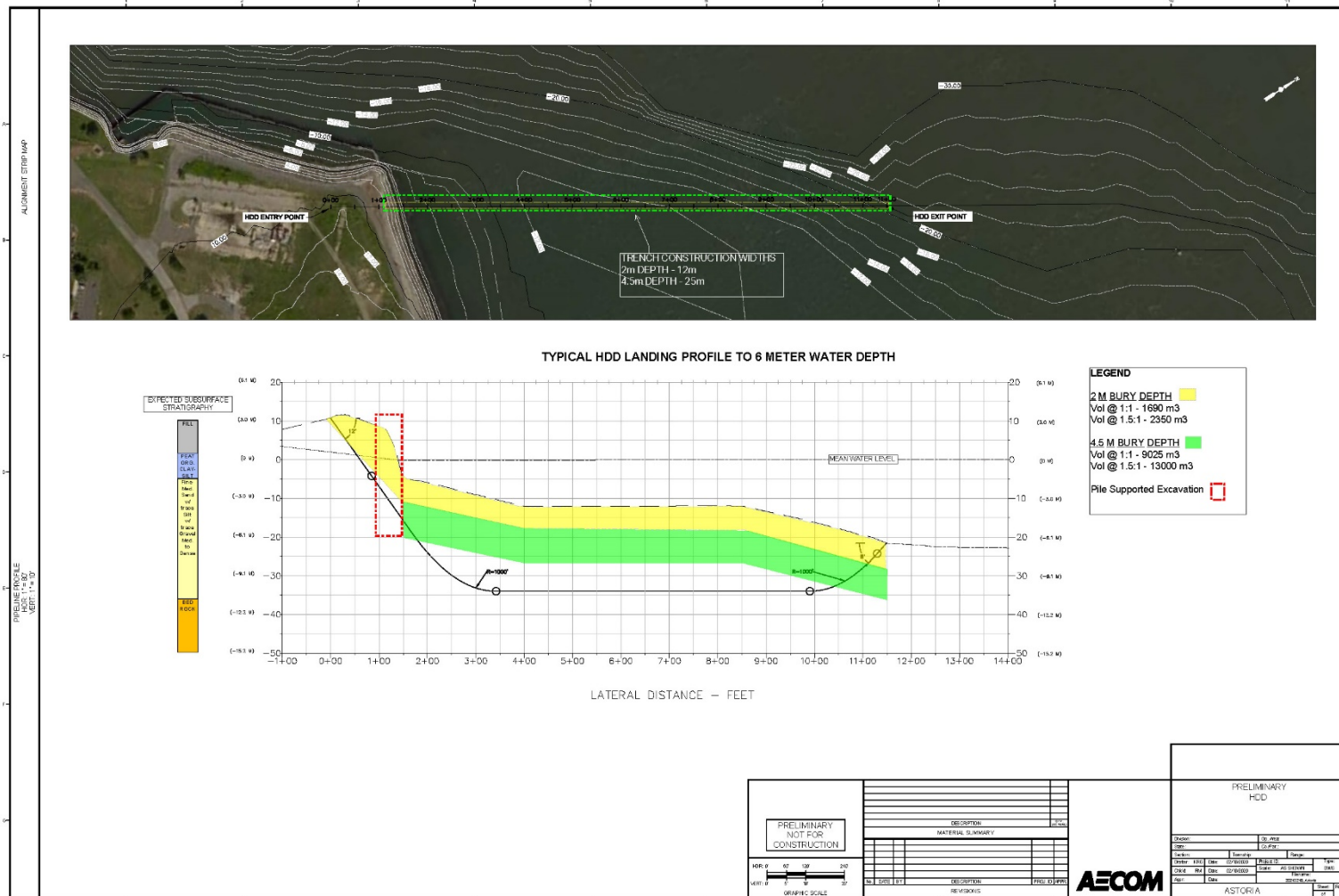
ORGANIZATION CHART

AECOM National Tunnel and Underground Engineering Organization Chart



Project Example – Shore Landings (Confidential Offshore Wind Client)

❖ HDD and Trenching Landing Options for HVDC Marine Cable/Fiber Optic



Project Example - Dominion Virginia Gas 230kV, 600 MW

U/G Transmission Lines

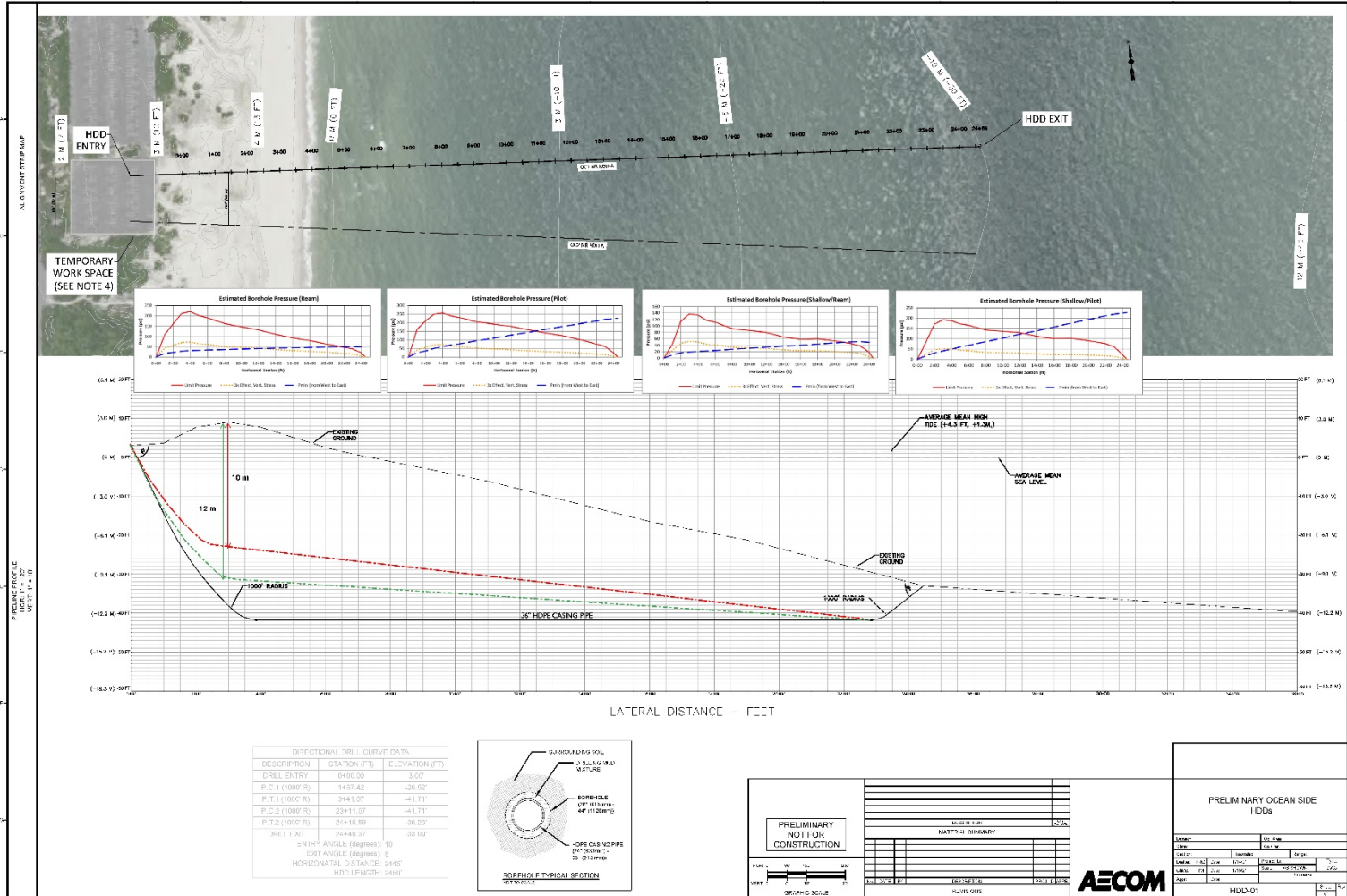
- Full-Time Construction Monitoring Services (MEARS)
- Total of 17,000 FT HDD across York River – 3 Segments



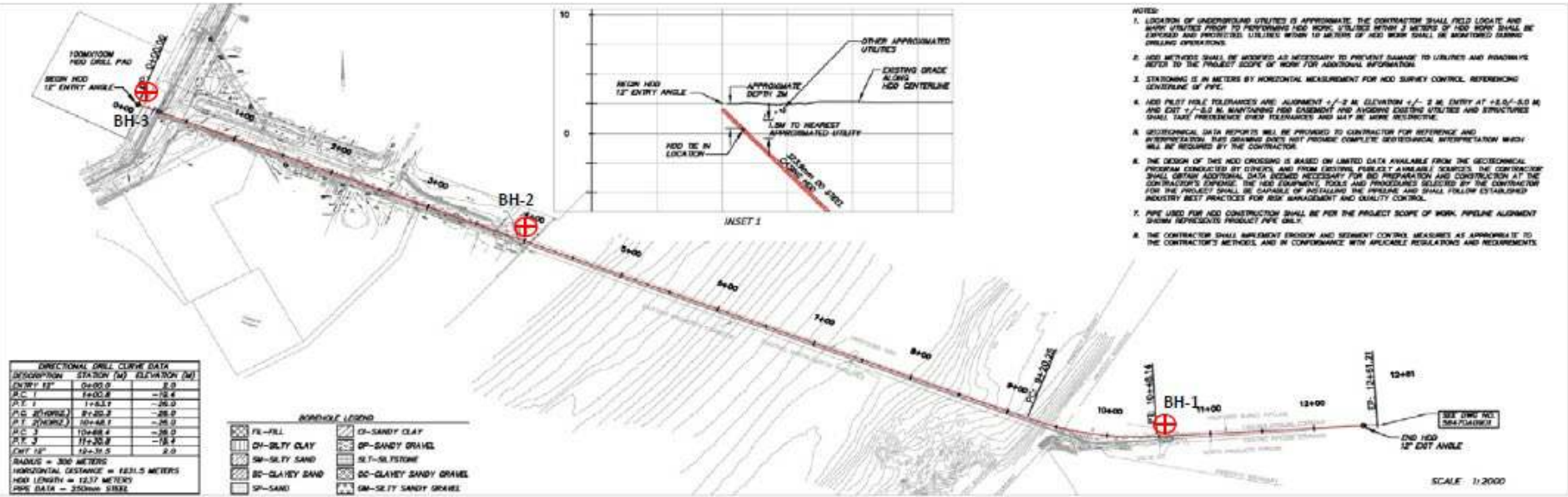
- North Section = 6000 FT
- Central = 7500 FT
- South Section = 3500 FT
- Twin 8-inch lines
- Fixed Platforms in River

Project Example – Shore Landings (Confidential Offshore Wind Client)

❖ Conceptual HDD Designs for Marine Cable Landings



Project Example - Brisbane River & Runway Crossing Crossing



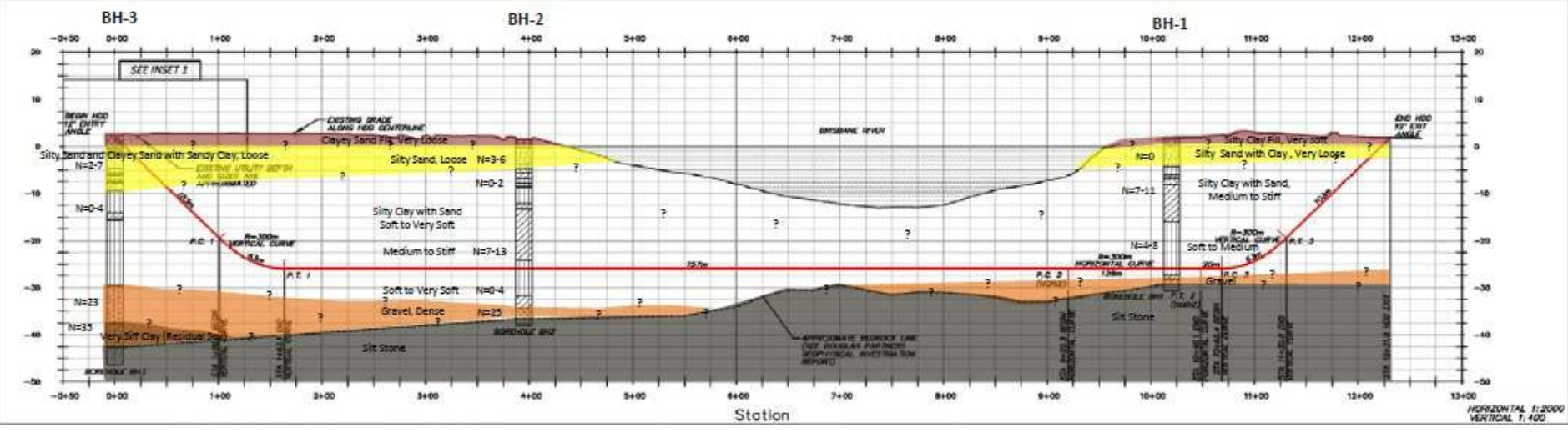
DIRECTIONAL GRILL CLIP DATA

STATIONING	STATION (M)	ELEVATION (M)
ENTRY 12"	0+00.0	8.0
P.C. 1	1+00.0	-12.0
P.T. 1	1+33.7	-25.0
P.C. 2 (START)	2+00.0	-28.0
P.T. 2 (END)	10+48.7	-25.0
P.C. 3	10+48.7	-25.0
P.T. 3	11+30.0	-18.0
EXIT 12"	12+30.0	8.0

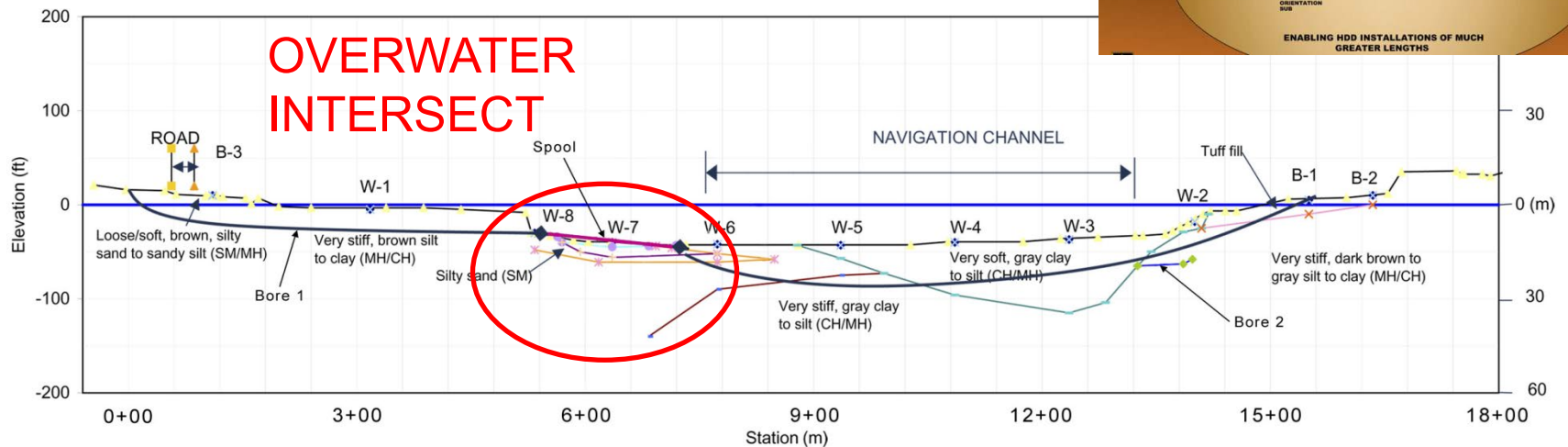
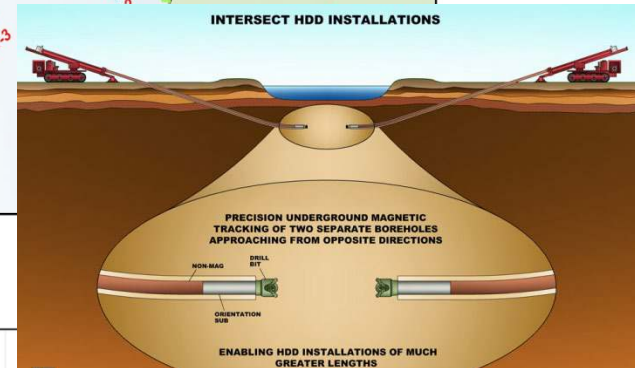
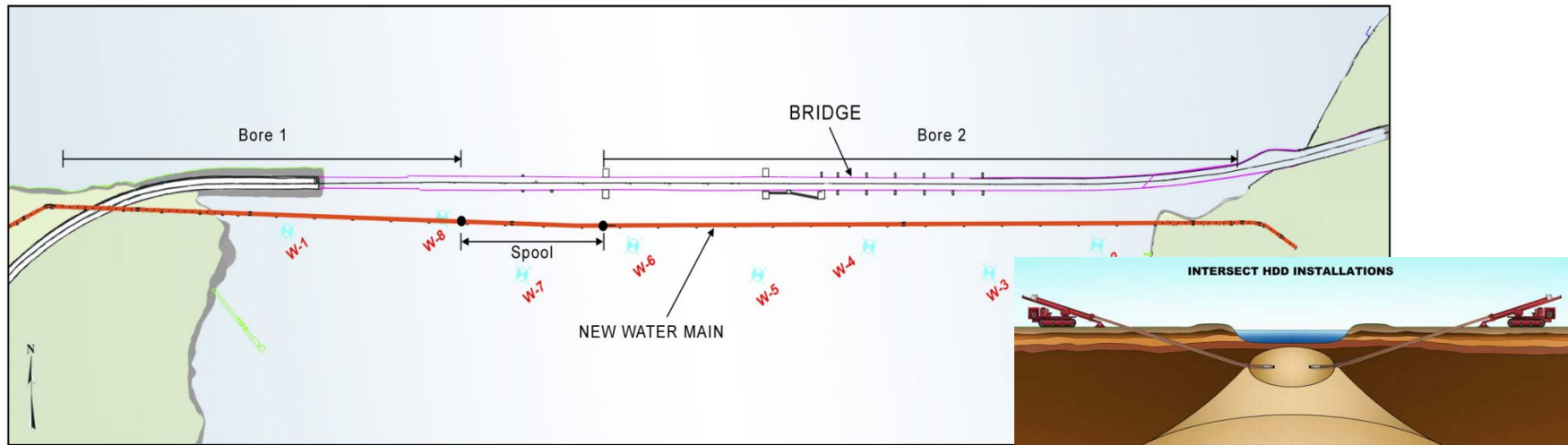
RADIUS = 300 METERS
HORIZONTAL DISTANCE = 223.5 METERS
HEAD LENGTH = 12.37 METERS
PIRE DATA = 250mm SIZES

ABBREVIATED LEGEND

FE-FILL	CI-SANDY CLAY
CI-SILT CLAY	SP-SANDY GRAVEL
SM-SILT SAND	SLT-SILTSTONE
BC-CLAYEY SAND	DC-CLAYEY SANDY GRAVEL
SI-SAND	SM-SILT SANDY GRAVEL



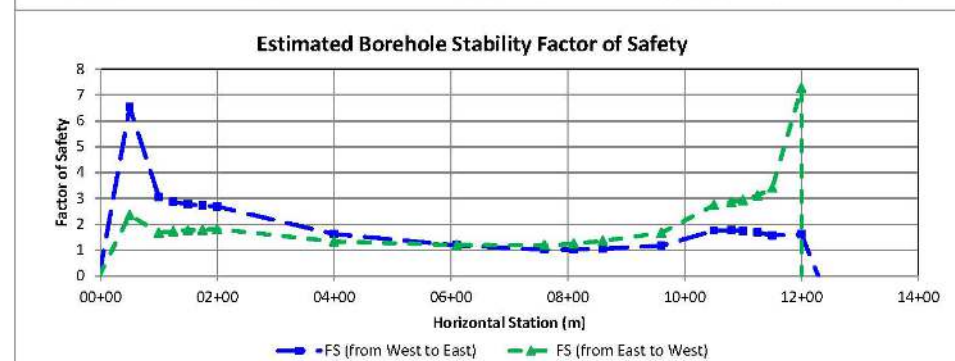
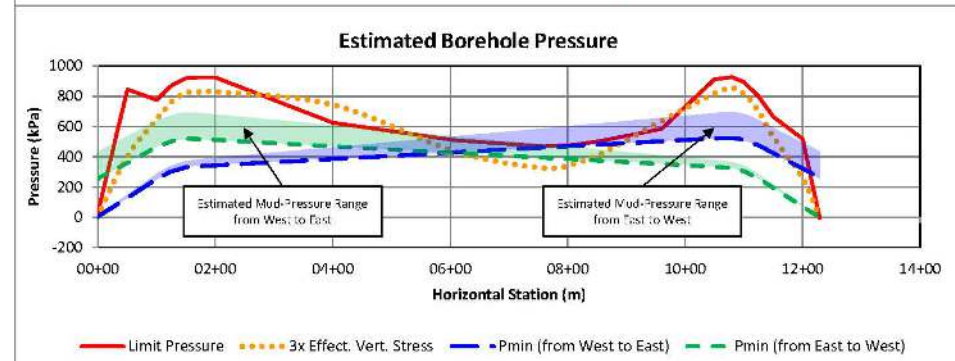
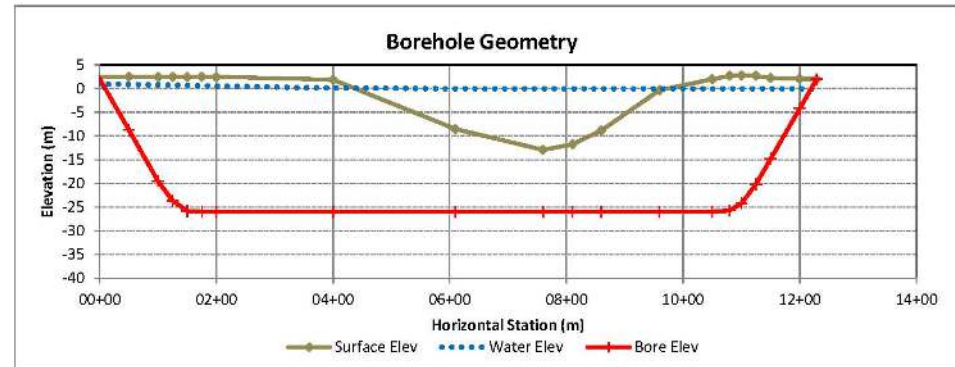
Project Example - Pearl Harbor P534 Crossing



Project Example - Brisbane River & Runway Crossing Crossing Crossing

- In House Programs for Pipe Stress Analysis, Borehole Stability, and Inadvertent Mud Returns
- Full Risk/Mitigation Profile in FS

ANALYSIS OF INSTALLATION LOADS AND STRESSES - PRCI METHOD									
10 In. (250mm) Nominal Steel - X-42 (.365" wall) - Brisbane River - HDD									
URS Virginia Beach Monday, March 10, 2014									
Pipe Material Properties	Installation Properties								
Pipe Outside Diameter (D): 10.00 in	Coefficient of Friction (μ_{soil}): 0.30								
Minimum Wall Thickness (t): 0.365 in	Fluid Drag Coefficient (μ_{fluid}): 0.06 psi								
Modulus of Elasticity (E): 2.9E+07 psi	Drilling Mud Density (γ_{mud}): 89.80 lb/ft ³								
Spec. Min. Yield Strength (SMYS): 42,000 psi	Water Density (γ_w): 62.40 lb/ft ³								
Bending Moment of Inertia (I): 128.21 in ⁴	Ballast Weight (W _b): 29.25 lb/ft								
Poisson's Ratio (ν): 0.30 steel	Displaced Mud Weight (W _m): 48.98 lb/ft								
Dia. to Wall Thickness Ratio (D/t): 27.40	Effective Wgt Ballasted (W _e): 17.83 lb/ft								
Coefficient of Thermal Expansion: 6.5E+06 in/in/F	Effective Wgt Submerged (W _s): -11.42 lb/ft								
Empty Pipe Weight: 37.56 lb/ft	Above Ground Load (W _g): 30,484 lb								
Pipe Interior Volume: 0.47 ft ³ /ft	Allowable Pull Force: 1.86E+06 Newton								
Pipe Exterior Volume: 0.55 ft ³ /ft	Pipe Face Area (A): 11.05 in ²								
	Hydrokinetic Pressure (p): 10.00 psi								
	Hydrokinetic Force (F _{HP}): 1178.10 lb								
Drilled Path Input									
Sta. Drill Entry: 000+00	Drill Entry Angle: 12.0°								
Elev. Drill Entry: 6.56	Entry Tangent: 338 ft								
Elev. Bottom: -85.22	Radius Entry Curve: 984 ft								
Sta. Drill Exit: 040+40	Bottom Tangent: 2,970 ft								
Elev. Drill Exit: 6.56	Radius Exit Curve: 984 ft								
Elev. Obstacle: -45.54	Exit Tangent: 338 ft								
Clearance Check: OK >5'	Drill Exit Angle: 12.0°								
Horizontal Curve?: YES	Horizontal Curve Radius: 984 ft								
	Horizontal Curve Entry Angle: 15.0°								
	Horizontal Curve Exit Angle: 15.0°								
Drilled Path Geometry									
Entry	VPC1	VPT1	HPC1	HPT1	VPC2	VPT2	Exit		
Elevation	6.56	-63.71	-85.22	-85.22	-85.22	-85.22	6.56		
Station	0000+00	0003+31	0005+35	0030+16	0033+73	0035+05	0040+40		
Total Drill Length	0.00	338.00	544.09	3016.08	3373.39	3514.09	3720.18		
Pull Back Forces (SI Units)									
	Above Ground Load	Frictional Drag	Fluidic Drag	Axial Segment Weight	Bending Frictional Drag	Assumed Tension	Average Tension	Section Pull Back	Total Pullback (Newton)
Point 1	135,601	5,038	34,009	3,570	\	0	0	178,218	183,459
Point 2	\	\	20,736	1,094	19,950	200,170	204,349	41,780	225,239
Point 3	\	\	2,097	14,156	\	0	0	16,253	241,493
Point 4	\	\	35,952	4,698	11,567	262,445	267,601	52,216	293,709
Point 5	\	\	37,669	248,723	\	0	0	286,392	580,101
Point 6	\	\	20,736	\	-1,094	609,406	613,698	67,195	647,296
Point 7	\	\	5,038	34,008	-3,570	\	0	35,477	682,773



CONTACT INFORMATION:

Robert Marszalkowski, PE | Norfolk, VA

Direct: +1.757.306.6771

Mobile:+1.703.625.5568

robert.marszalkowski@aecom.com

CONVEYANCE PLANNING, DESIGN, AND CONSTRUCTION PHASE SERVICES

OIL & GAS TRANSMISSION | OFFSHORE WIND | POWER TRANSMISSION | TELECOM