Design and Construction for the Record-breaking Lake Sakakawea HDD

Pipeliners Association of Houston

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Speakers

Glenn Duyvestyn, PhD, PE, PEng

Glenn Duyvestyn has a PhD in Civil Engineering and has over 21 years of professional trenchless engineering design and construction experience. His design experience includes over 800,000 feet of HDD and 160,000 feet of tunneling, microtunneling, Direct Pipe, open shield pipe jacking, pilot tube microtunneling, auger boring, and guided auger boring installations. He is experienced in performing feasibility studies, design, trenchless design calculations, geotechnical evaluations, risk assessments, cost estimation, value engineering, constructability workshops, claim review, contractor pre-determination qualification, bid services, and construction administration/management. He has worked on projects governed by FERC, NOAA, USACE, and other regulatory agencies.

Mr. Duyvestyn served as a contributing author to ASCE's Manual of Practice 108 (second edition) entitled "Pipeline Design for Installation by Horizontal Directional Drilling" and is currently assisting in the writing of the ASCE's Manual of Practice for Direct Pipe installations.

Matt Smith

Matt Smith is an accomplished leader in trenchless construction disciplines, including horizontal directional drilling (HDD), Direct Pipe®, and tunneling. Since 2019, Matt has served as General Manager of Contracts and Business Administration for Michels Directional Crossings Operations.

Matt has spent the majority of his career in trenchless construction. He joined Michels in 2010 as an intern on tunneling projects, assisted with many significant tunneling projects, and advanced to become a Project Engineer and Project Manager. In 2013, Matt was promoted to Manager of Direct Pipe operations.

In 2018, Matt received the prestigious Ralston Young Trenchless Achievement Award, for demonstrating excellence making valuable contributions to the trenchless technology industry. Inspired by Michels' success and innovation with other trenchless construction techniques, Matt established Michels as an international leader and champion of emerging technology.

Background

- Hiland Partners Holdings, LLC needed to connect stranded gas production to process facilities in North Dakota, USA
- 178-mile long Lake Sakakawea, managed by US Army Corps of Engineers
 - 1.8 to 3 miles wide
- Sensitive habitat/weather
- Steep terrain
- Access close to shorelines possible
- Minimal suitable stringing areas





World-Class Problem, World Record Solution



- Three routes all with long HDD installations
- Hiland Partners Holdings, LLC partnered with Mott MacDonald, Merjent, and Michels Directional Crossings for successful design, permitting, and construction execution
- World record (13,247 feet) for 20-inch diameter gas pipeline

Project Permitting

- USACE Jurisdiction
- Primary triggers:
 - Section 10 of Rivers and Harbors Act
 - Section 33 USC 408
 - North Dakota Sovereign Lands
- Notable Considerations
 - Section 106 of the National Historical Preservation Act
 - NEPA
 - Tribal Consultation
 - North Dakota State Offices
 - NEPA/Section 7 Endangered Species Act
 - Section 401 of Clean Water Act

Geotechnical Investigation

- Geotechnical Investigation
 - 2 land based, 10 barge based borings
 - Limited completion depths
- Findings
 - ASTM SM & CL Alluvial Deposits for first ~20'
 - Lacustrine Clays (CH), some coal seams
 - Sentinel Butte Formation (weak mudstone, shale, coal seams)
 - SPT of bedrock clays over 90





Key HDD Design Characteristics

- Heavily focused on convincing USACE an HDD could be completed without drilling fluid inadvertent return
 - Factor of Safety of 1.5 negotiated
 - HDD Design with defined drill and intersect zone provided a Factor of Safety of 1.75
- HDD Design Characteristics
 - 265ft below lake
 - 525ft below north side drill rig
 - 320ft below south side drill rig
 - 990ft dry hole
 - 13,158ft design length
 - 13,247ft true length
- Staging area of 7,000 ft identified
 - One intermediate weld





HDD Design





HDD Design



















Early Contractor Engagement

- Michels was approached by Mott MacDonald and Kinder Morgan to assist in the early planning and design of the Lake Sakakawea crossing.
- This was highly beneficial in the success of the project.



Design Challenges

- Original design approved by the USACE included 160(ft.) of elevation change from drill entry to drill exit. The design also required drilling approximately 510(ft.) in depth from one side of the crossing.
- This can present problems with managing annular pressure in respect to the drilling fluid downhole.



Figure 2: Hydraulic Fracture Evaluation for Southern Pilot Bore

Michels Construction Tasks

- HDD (Intersect Pilot Hole(s), Reaming, Swabbing, Pullback, Install)
- Access Road and Drill Pad Matting
- Clearing & Grubbing
- Pipe Bending
- Pipe Stringing
- Product Pipe Welding & Coating
- Testing of product pipe.
- HDD Pullback / Midwelds / JEEP
- Site Restoration
- Water Hauling / Procurement

- Land Farming
- Hydrostatic Testing
- Tie-Ins
- South Side Valve Site Installation
- Auto-Launcher Site Installation
- Auto-Launcher Electrical Work
- Receiver Installation
- Install Cathodic Test Stations
- Install Pipeline Markers
- Lower-in & Backfill

Construction Challenges

- The original water supply was inadequate, small pumps were being used to supply water to frac tanks. To alleviate this challenge a 500,000-gallon portable water tank was brought in to supply water during the HDD process.
- Drilling in the winter months provided challenges with keeping the lines that transported water and other fluids necessary for HDD operations from freezing.
- While drilling the pilot hole on the entry side an unanticipated subsurface formation was struck. The entry side was realigned to avoid the formation that was encountered.

Construction Challenges

- To assist with fluid returns on the entry side, the first couple hundred feet were reamed to a 36(in.) hole in comparison to the rest of the bore hole which was reamed to 32 inches.
- Road conditions became a challenge in the winter months. Matting was used on the access roads to help maintain access to the drill sites.

Original Pre-Design





Intersect

- The project used the pilot-hole intersection method which requires two rigs to drill simultaneously toward one another from both sides of the project and eventually meet near the middle.
- Michels pre-selected an intersect zone that made sure that annular pressures remained at an amount in which the USACE determined 1.5x safety factor was not exceeded.
- Brownline Gyro Steering tools were utilized while drilling the pilot holes

Project Highlights

- Michels successfully hit the pilot hole location(s) dead-on during the intersect process. No overlap existed. No radar shots, or other locating measures were utilized in order to determine the location of the pilot holes to complete the intersect.
- Approximately a total of 25,000-man hours.
- Project Duration: ~2 months
- No environmental or safety issues on the project.
- 20(in.) Product Pipe, 13,247(ft.), 268(ft.) below the bottom of the lake.

Completed HDD As-Built



Contacts



M MOTT MACDONALD

Glenn Duyvestyn, PhD, PE, PEng Principal Project Manager +1 (216) 978 2435 glenn.duyvestyn@mottmac.com



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Matt Smith

General Manager – Directional Crossings Operations +1 (920) 269 8757 msmith@michels.us