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INSTALLING CRUDE OIL SUB-RIVER PIPELINES, AL FATHAH, TIGRIS RIVER, IRAQ

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Nine months in the planning and logistics, plus six months to implement in an unsecured, hostile and post-war conflicted zone, Horizontal Controlled Directional Drilling was successfully applied to install crude oil sub-river pipelines at Al Fathah Bridge, Tigris River, Iraq in 2004. The project was technically challenged by water-saturated sands and gravels, and water-saturated fractured carbonates and train-box car sized caverns where control of the drill bit was limited at best until significant cement grouting was introduced to stabilize the drilling media.

PROJECT DESCRIPTION

Horizontal Controlled Directional Drilling (HCDD) allows trenchless, subsurface construction beneath highways, buildings, reservoirs, wetlands, rivers, and other areas where there are sensitive land uses or activities, or otherwise impossible logistics to overcome. HCDD is used in the U.S. and Europe for installing electrical, telecommunication, water, and sewer lines, and oil and gas pipelines where burial is required and trenching is impractical if not impossible. There are also security reasons for using HCDD especially in war-zones and post-war conflict areas where utility lines are best secured underground or below river crossings, as the Iraq-Turkey crude oil pipeline at the Al Fathah Bridge, Tigris River crossing, northern Iraq (Figures 1 to 3).

Horizontal drilling has been applied successfully to recover more oil and gas from old fields, expand solution and mining production, and more recently to install water, sewer, fiber optic and other utilities under busy roads and sensitive ecological areas like lakes and wetlands, where it is often called "trenchless drilling."

U.S. water-well driller, consultant, manufacturer, inventor, and innovative thinker Hank Baski of Denver, Colorado, has been dispelling groundwater fallacies and forecasting the future of groundwater development as the National Ground Water Association McEllhiney Distinguished Lecturer in Water Well Technology, 2004. Admittedly "not an easy boss," Baski's motto is "question everything and everyone - including yourself - and be willing to change." Baski predicts horizontal wells will play a greater role in water recovery and injection, and would also be useful in accelerating dewatering and groundwater remediation. The water well industry and its consultants need to develop the analytical tools to predict the yield and impacts of horizontal wells.

During 2003-2004, HCDD was applied at the Al Fathah Bridge under several tens of meters to install several pipelines several 1000 meters each, as an alternative to a river bottom crossing which had failed several times and to a bridge crossing which had been blown up during the U.S.-coalition led Restore Iraqi Freedom in 2003. Al Fathah (Arabic for "The Gap" or "The Divide") is a complex faulting system impacting limestones. It has been a long-time summer field mapping area for the University of Baghdad Geology and Geophysics Department, and was a site where Russian, British, and Iraqi engineers have considered and abandoned plans to construct a large dam at least three times since 1935.

A dozen shallow subsurface soil borings form the 1970s bridge work indicated sub-river conditions as several meters of water-saturated sand and gravel, underlain by tens of meters of water-saturated fractured and cavernous limestones and dolomites. The HCDD construction team estimated that some caverns were as large as box-train cars, 40 by 40 by 10 feet.

HCDD depends heavily on technologies which monitor the real-time location of the drill bit and stem in space by magnetism, electronics, and satellites, as well as often proprietary drill-location controls. For HCDD to succeed, the advancing drill bit must meet solid or nearly solid material. It is virtually infeasible to control the bit when it is drilling in non-solid material, such as air or water.

When HCDD activities encountered unstable and collapsing gravels, then deeper fractured and cavernous carbonates along the proposed pipeline route, four options were proposed and evaluated:

Figure 1. Al Fathah Bridge from west side.

Figure 2. Apaches over KBR Al Fathah Site.

Figure 3. From Al Fathah west looking at east site.

1. Conduct geophysical surveys to map the limestone and perhaps choose an alternative route

2. Increase the drilling mud viscosity and weight with palms, coconuts, walnuts and other additives

3. Solidify the caverns with cement slurry grout, then drill through the cement

4. Temporarily solidify the water in the caverns and collapsing gravels by injecting liquid nitrogen to freeze the water, and then drill through the ice.

These suggestions were consistent with a more detailed online search and discussions with the Drilling Club of the United Kingdom, except for groundwater freezing. Groundwater freezing is a technology developed by Swiss tunneling engineers, and applied world-wide, including in constructing the New York City subway system and even in Texas Gulf Coast emergency response and interim remedial actions at hazardous waste sites.

The HCDD project team made these conclusions with the following results:

1. Surveys - rejected outright by project management in the interest of time

2. Increase mud viscosity and weight - attempted and successful in the gravels, but not the caverns

3. Grout the caverns - successful in the caverns

4. Freeze the in-place groundwater - not needed as suggestions 2 and 3 worked.

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