



Vortrag

Freitag, 2. Oktober 2026, 09:30 Uhr

Zurück zur Donau:

Technische Umsetzung einer Bohrung im Festgestein

Vortragender: Maciej Geborys
HDI

Lecture

Thursday, 2nd October 2026, 09:30 pm

**Back to the Danube:
Engineering a hard rock breakthrough**

Speaker: Maciej Geborys
HDI

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Back to the Danube: Engineering a Hard Rock Breakthrough

Maciej Gęborys
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The 1.8 km Danube HDD crossing formed one of the most critical components of the 40" Black Sea Shore–Podișor Gas Pipeline, a strategic infrastructure project developed to connect Black Sea gas reserves to the Romanian and European transmission network. While the project included multiple trenchless crossings, the Danube quickly emerged as the most technically demanding section due to its scale, geology and construction risks. The crossing ultimately became a case study in managing uncertainty and adapting engineering solutions to conditions that differed significantly from the original assumptions.

The available ground investigation data, combined with HDI's successful completion of three parallel HDD crossings (8", 20" and 28") approximately 10 km downstream only two years earlier, initially suggested relatively predictable geological conditions. This led to the expectation that the HDD alignment could be designed and executed primarily within alluvial deposits, avoiding the deeper carbonate bedrock anticipated beneath the Danube River.

At tender stage, the crossing was therefore predominantly interpreted as an alluvial HDD installation.

However, the contractor secured a contractual provision permitting a reassessment of the geological model and design basis through supplementary site investigations.

Concerns regarding the reliability of the geological interpretation emerged at a very early stage, as the first results from the supplementary investigation programme became available. Particular uncertainty existed around the fault-controlled geological setting beneath the Danube and its branch channel, as well as the predicted elevations of the carbonate bedrock surface. The new data significantly refined the ground model and ultimately led to major revisions of the original geological interpretation and drilling methodology.

The supplementary surveys included additional boreholes, detailed geotechnical and geophysical campaigns and supporting engineering studies.

Despite the extensive supplementary investigations, the geology continued to challenge expectations. Although the revised ground model successfully captured the overall bedrock profile and the principal geological features along the crossing, drilling operations revealed localized anomalies and complex transitions that could only be fully understood as construction progressed. Geological interpretation therefore became an ongoing activity throughout the project, continually informing engineering decisions and refining the understanding of subsurface conditions.

Significant variations in rock abrasivity became apparent during pilot-hole drilling, directly influencing drilling performance and downhole tool wear. The subsequent reaming stages provided a more representative picture of the geology, as larger recovered samples revealed extensive zones of dolomitized limestone, iron-rich formations and rapidly changing lithological conditions along the alignment.

The principal challenge was not simply drilling through hard rock. Hard formations could be addressed through appropriate tooling and operational practices. The greater challenge was geological variability over the crossing length of more than 1.8 km.

A particularly challenging discovery during execution was the presence of large limestone boulders within the alignment. Several boulders recovered during drilling and fishing operations exceeded the cutting dimensions of the hole openers deployed, despite the use of some of the largest tools available in the HDD industry. These localized features created significant operational challenges, increasing torque, reducing drilling efficiency and requiring repeated conditioning and reaming passes. Their occurrence further demonstrated the complexity and unpredictability of the geological environment beneath the Danube.

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As understanding of the ground conditions evolved, engineering support became fully integrated with construction activities. Geological models, operational assumptions and project risks were continuously reassessed using information obtained directly from the field. Rather than treating design as a pre-construction exercise, engineering became an ongoing activity supporting decision-making throughout the execution phase. This close interaction between field operations and engineering proved to be one of the key factors contributing to the successful completion of the crossing.

The project's defining challenge emerged during pipeline installation. Despite extensive borehole conditioning and the deployment of a Pipe Pusher unit to assist pullback operations, the first and second installation attempts failed. These events prompted a fundamental reassessment of borehole conditions, installation mechanics and project assumptions. As the investigation progressed, it became clear that the difficulties could not be explained by conventional installation risks alone, pointing instead to a more complex interaction between geology, borehole conditions and pipeline behavior.

Following the second unsuccessful pullback attempt, a comprehensive re-evaluation of the crossing was undertaken. A final steering-tool re-survey was performed to establish the as-drilled and as-reamed geometry of the borehole and to verify its actual spatial configuration against the design assumptions.

The updated bore profile became the basis for a detailed three-dimensional contact analysis. As no existing HDD engineering software was capable of adequately assessing the complex interaction between the 40" pipeline and the final bore geometry, a dedicated modelling tool, later known as Bend Wizard, was developed specifically during the course of the Danube crossing project. The software was created to quantify pipe-to-borehole contact conditions and visualize localized installation constraints that could not be identified through conventional HDD profile visualizations.

Analysis of the final bore geometry revealed several localized sections where pipe contact forces and installation risks were significantly higher than elsewhere along the alignment. Importantly, the modelling demonstrated that these constraints were concentrated in isolated areas and did not require full-length borehole enlargement. Instead, targeted reaming to 56" was recommended for selected sections, while the remainder of the crossing remained at the original 50" diameter.

Following completion of the localized remedial reaming works, a physical verification programme was undertaken using 40" dummy pipe runs. The objective was to validate the analytical findings, assess borehole condition after remediation and confirm installation readiness prior to the next pullback attempt.

The dummy runs provided important physical verification of the borehole condition following the remedial works. While the results were generally encouraging and supported the findings of the Bend Wizard analysis, they did not completely eliminate uncertainty regarding the final installation behavior of the 40" pipeline.

Although the third pullback attempt ultimately resulted in successful installation of the 40" pipeline, the project highlighted the significant engineering and operational challenges associated with the selected crossing location. The successful outcome should not be interpreted as evidence that the original crossing alignment represented the optimum HDD solution from either a geological or constructability perspective.

One of the key outcomes of the project was a recommendation to the Investor to consider alternative crossing locations for future pipeline installations in this section of the Danube. Comparison with three HDD crossings completed by HDI approximately 10 km downstream demonstrated that more favorable geological conditions can be found elsewhere along the river corridor, where thicker alluvial deposits provide greater separation from the underlying carbonate bedrock and reduce exposure to geological uncertainty.

The Danube crossing therefore demonstrates not only the importance of managing geological uncertainty during project execution, but also the value of rigorous route selection during the early stages of project development. The experience confirms that optimization of crossing location can be as important to overall project success.