

GeoDrilling International



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Marine drilling

Drilling over water inland or at sea presents a unique set of challenges. Here's how the industry deals with them

Restricted access

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Slope stabilisation

When slope failure looms, drilling techniques can be brought into play that will stabilise the most extreme of potential failures



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DEEP INNOVATORS

Into the digital age

This issue of *GDI* is something of a milestone edition, as it marks a significant change in the way you read the magazine. This edition marks the start of the title's transition to an eMagazine format. The eMagazine will continue to focus on providing the latest updates on every aspect of drilling in soils and rocks: mineral resources exploration, piling, construction, quarrying, site investigation, boreholes, water well, ground consolidation and geothermal work.

Inside this eMagazine you find the usual mix of news and features with a focus on the more difficult jobs the industry has to face: drilling over water, in restricted spaces and slope stabilisation, where there is often the added challenge of limited access.

Meanwhile, a different set of challenges are being addressed in China, where the Shenditake 1 borehole is being drilled past the 1km mark. *GDI* discovers what happens at such extreme depths and what discoveries are being made.

"The start of the title's transition to an eMagazine format"



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North America

COVER

Danbar Drilling Services, a Massenza customer since 2007, using a Mi8 drill rig to install a 324mm casing.

This particular Massenza Mi8 features a mast for 4.5m rods with a maximum pull-up and maximum pull-down of 150kN (33,708lbf). The Massenza rotary head features a maximum torque of 18,307Nm (13,503ftlb) and a maximum speed of 135rpm. The tilting drill pipe box capacity is n°21 Ø4-1/2in (114mm) – length 3m (10 ft). While the telescopic jib boom has a telescopic stroke of 500mm (19-5/8in).
www.massenzarigs.com

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Bachy Soletanche restructures

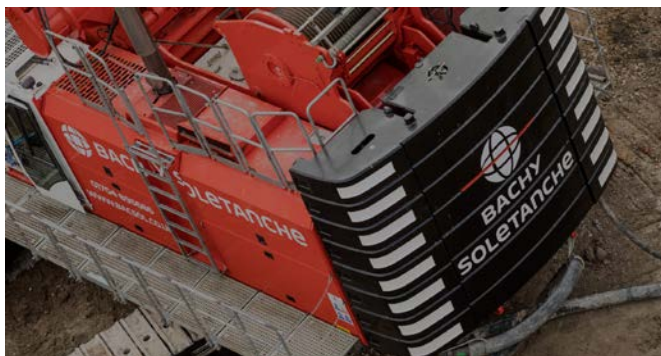
Geotechnical specialist Bachy Soletanche has strengthened its ability to serve clients across the UK and Ireland by restructuring its business into three distinct divisions. It will now operate a regional business formed of Northern and Southern Divisions, along with a nationwide Projects Division.

The Northern Division will specialise in delivering smaller projects for new and existing clients throughout the Midlands, Northern England and Scotland.

The Southern Division will provide geotechnical engineering for clients across the entire South of England and South Wales.

The Projects Division will focus on substantial geotechnical and civil engineering schemes across the UK and Ireland.

A newly formed engineering department will support the three divisions, delivering permanent and temporary works designs, developing effective solutions to complex challenges, and bringing new techniques to the UK market.



Bachy Soletanche has restricted its UK business into three distinct divisions

Hexagon's AI-powered Blast Movement Intelligence

Hexagon, a global specialist in digital reality solutions, has announced the global release of its AI-powered 3D blast movement solution, Hexagon Blast Movement Intelligence (BMI).

In partnership with Augment Technologies and through the integration of an AI-driven blast movement engine, Hexagon BMI has been proven in real-world mining conditions. Boosting blasting efficiency and providing high visibility into ore dilution for informed ore and waste delineation post-blast, it safely produces an accurate block model of the muckpile and ultimately maximises yield.

The ability to generate a Muckpile Block Model, a post-blast representation of the grade control block model, is a distinguishing feature of BMI. Paired with Hexagon Blast Movement Monitors, the AI can be validated and improved as

the engine helps to safely and rapidly produce the Muckpile Block Model. Importantly, the model is produced without personnel having to walk on the muckpile to place or retrieve the monitors.

What also makes BMI unique is its integration with Hexagon's MinePlan Block Model Manager, a data-integrity solution built for collaboration and data sharing across different roles and mining phases, eliminating errors and undue complexity in the block modelling process. By centralising data and using server-based features like block model management, version control, and change notifications, Block Model Manager ensures the integrity and auditability of data. Its application programming interface improves the access, reuse and integration of that data with other systems to enhance mining operations.

Drill rig bought by community college for new apprenticeship programme

Due to an ongoing drought causing domestic water wells in southern Oregon to run dry as the water table recedes, the need for well drilling operators is on the rise. To meet this demand, Klamath Community College, Klamath Falls, Oregon, is set to launch a new apprenticeship programme covering well drilling.

In order to deliver the programme the community

college has purchased a new US\$845,525 drilling rig with funding from the Oregon governor's office and the Oregon Water Resources Department.

KCC was awarded \$975,000 through emergency funding from the state. After the truck's purchase, the remainder of the money will be used to outfit it with necessary equipment.

Apprentices will take classes online from KCC and get hands-on experience in the field with drilling companies in their communities.

"Water Resources approached me a couple of years back when I started as director for the KCC apprenticeship programme," Mark Griffith, director of Apprenticeship Programmes, said. "We hope

the program becomes a hub to serve the entire state."

Griffith is in the process of hiring a geologist as an instructor. Students need to understand basic geology as well as aquifers.

Students must clock at least 15 visits working on a drilling site. Once they pass the exams, they are licensed by the Water Resources Department.

EURODRILL finally celebrates its 25 (+4) year anniversary

After having its original plans postponed in 2020 due to the coronavirus pandemic, EURODRILL was finally able to celebrate its 25th anniversary four years later in September 2024.

With the long wait over, the time had eventually come: EURODRILL has been on the market for over 25 years. In order to celebrate this special occasion with as many retailers, customers and partners as possible, the anniversary was deliberately scheduled for this date. The 25 (+4) years of EURODRILL were celebrated with live cooking stations,

a live band and entertainment in a festive ambience. On September 19, the focus of the event was on international business partners, while a celebration for the local business partners and employees was held on September 20. The festive atmosphere was filled with chatting and lots of laughter.

INSIGHTS

This event took months to plan and organize. The prototype construction hall was transformed into a festive setting, which was extremely well received by the guests. Guided tours

of the production facilities and company buildings provided all interested parties with a greater insight into the production activities at EURODRILL. managing director, Ralf Sönnecken, and sales manager, Andreas Pikowski, reviewed the last 29 years in a detailed presentation. They not only gave insights into the origin and history of EURODRILL, but they also talked about personal highlights from the last few years.

GLOBAL VISITORS

The endeavours and long journeys undertaken by

business partners were very much appreciated. Around 150 retailers, customers and partners from 20 countries took part overall, which confirms the cohesion and trust in the company.

SAVE THE DATE

Preparations for bauma, which will be held in Munich in April 7-13, 2025, are in full swing and EURODRILL is looking forward to welcoming visitors to the trade fair with its new motor concept. The stand party will take place on Wednesday, April 9.



25+4 years

THANK YOU FOR BEING PART OF THE JOURNEY.



Scan for video and more images of our anniversary celebration 2024 or visit our website www.eurodrill.de.



JV to deploy \$18 billion in US underground utility projects



EarthGrid has signed a joint venture with EnerTech to deploy infrastructure projects in four phases across the US, Europe and the Middle East

EarthGrid, a Californian plasma tunnel-boring technology and infrastructure development company, has announced the signing of a joint venture (JV) agreement with EnerTech, a Kuwait Investment Authority (KIA) entity, to deploy infrastructure projects in four phases across the US, Europe and the Middle East.

The first two phases consist of an estimated \$18 billion in US infrastructure improvement projects. Utilising EarthGrid's patented plasma-powered machines, this joint venture will develop a network of underground tunnels designed to upgrade the current power grid and fibre networks with reliability, efficiency, and resiliency while accelerating the clean power transition.

To meet the US goal of reaching net-zero economy-wide greenhouse gas emissions by 2050, more than a million miles of new transmission will be required over the span of three decades. Compounding this challenge is that more than 70% of current transmission

lines are over 25 years old, aged over half their 50-year expected lifetime. Through this JV, EarthGrid will enable more than 100GW of new renewable energy to be added to the US grid while also solving grid congestion in strategic locations.

While overhead transmission lines are time-consuming to complete, traditional undergrounding is also slow, more costly than overhead lines, and performs poorly against hard rock, which can, in turn, result in abandoned or very delayed projects. EarthGrid's plasma-boring technology and proprietary approach can significantly reduce the time and costs of undergrounding methods without harmful chemicals, primarily powered by clean energy.

EarthGrid's cleantech undergrounding approach aligns with EnerTech's goals to deploy breakthrough technology globally, with projects initiated first in the US and, subsequently, in Europe and the Middle East to accelerate the deployment of clean energy options worldwide.

Enlargement operational tunnels without closures

Herrenknecht has developed a solution for enlarging the tunnel profiles of the 426m long Fachingen Tunnel and the 732m long Cramberg Tunnel, which are part of the Lahn Valley Railway connecting the cities of Koblenz and Wetzlar.

The Tunnel Enlargement System (TES) developed by Herrenknecht makes it possible to carry out tunnel renewal during ongoing rail operations. First, the existing tracks are dismantled, and a track is laid in the middle of the existing tube instead. The TES moves forward step by step during excavation to widen the tunnel. At the same time, it serves as a protective enclosure and separates the construction work from ongoing rail traffic.

For the two double-track tunnels of the Lahn Valley Railway, the radius of the tunnel cross-section will be enlarged by a good 2m, thus achieving dimensions corresponding to the current new

tunnels. The TES are equipped for conventional excavation and support work. Depending on the hardness of the rock, excavation is done by chiselling or blasting. First, the old tunnel walls, usually masonry, are broken out. This is followed by excavation of the rock by chiselling or blasting and removal of the material. The excavated material falls to the side of the machine into the tunnel invert and is removed by separate conveyor and loading equipment.

After each drilling and blasting round, a shotcrete manipulator applies the temporary shotcrete support. The rock is also stabilised with anchors. Reinforcement mesh and steel arches, together with the shotcrete and anchors, form the initial support. Once tunnelling with the TES has been completed, the final lining of the tunnel using in-situ concrete is then carried out in a second construction phase.

DBD Centre's new director

The Deep Borehole Demonstration Centre (DBD Centre) has announced the appointment of Andrew (Andy) Griffith as its new executive director.

The not-for-profit operation was established to accelerate the global adoption of the use of deep boreholes for the safe geological disposal of radioactive waste.

Griffith will be responsible for developing and overseeing the delivery of the deep borehole demonstration programme, driving the recruitment of programme and project sponsors, representing and advocating for the DBD Centre, and ensuring transparent and inclusive governance for the programme.

Comacchio Open House showcases CH850 rig launch

Taking place across October 17-18 at Comacchio's new production facility in Castello di Godego, Italy, the company's Open House showcased an exhibition of over 20 rigs, representative of the entire Comacchio offering, ranging from compact and lightweight drilling rigs for soil investigations and environmental drilling, to those for micropiles and anchoring applications, and included piling machines weighing over 90t, without forgetting the machines for water well and geothermal.

The star of the Open House was the CH 850, the latest addition to the Comacchio CH line of piling machines and currently the largest multipurpose unit in the range.

The CH 850 stands out for its unmatched balance between rotary torque and machine weight. The exceptional performance of the machine is guaranteed by the high-torque rotary head, delivering up to 360kNm maximum torque and 60rpm maximum speed. It has a powerful three-gear unit with manual and automatic speed settings for optimal drilling efficiency.

The CH 850 is characterised by an innovative hydraulic system that goes beyond the conventional use of load sensing technology, introducing an advanced electronic control of the pumps and the valve blocks. Thanks to this system, the pump always delivers, with precision, the flow/pressure required according to the functions activated by the operator. The result is a considerable reduction

in power losses and fuel consumption, marking another step forward in Comacchio's ongoing effort to provide more efficient and sustainable solutions.

The new rig features a winch-pull-down system that makes the CH 850 a truly multipurpose unit that can be configured for constructing Kelly piles, CFA piles, displacement piles and soil mixing treatments, easily switching between configurations with minimal changes.

In its Kelly configuration, the CH 850 can be utilised for the construction of piles with up to 3000mm diameter. The maximum achievable pile depth is 91m with the addition of a mast extension. The machine can be easily transformed to install CFA piles thanks to a quick-conversion kit. The CFA configuration allows for the use of augers with up to 1200mm diameter. Installing an 8m long auger extension allows the machine to reach a CFA pile depth of 28m.

As with all the CH-line rigs, the CH 850 is controlled by the Comacchio Control System (CCS), which provides complete electronic control of all machine functions and advanced diagnostics. The system ensures user-friendly operation through a 12in touchscreen, making switching from one machine configuration to another easy.

The rig is fitted with a Volvo diesel engine available in 345kW or 405kW configurations, meeting EU Stage V and US EPA Tier 4F emission standards.

The CH 850 has variable gauge tracks and removable side frames, providing enhanced stability, reduced ground pressure, and ease of transport. The modular design of the counterweight allows for flexible mounting and dismounting with minimum change to the machine outline. Mounting and dismounting operations are made safer and easier thanks to the hydraulic, remote-controlled lifting system of the counterweight installed on the machine. To reduce transport weight and dimensions, the CH 850 can be dismantled in modules up to a minimum

transport weight of 51.5t and a transport width that does not exceed 3m.

The cabin of the CH 850 boasts TOPS and FOPS-1 certification, ensuring robust protection against external impacts, along with a protective grate on the front and top for added security. The fully glazed cabin, equipped with automatic sliding doors, offers excellent visibility, while the soundproofing ensures a quieter, more focused working environment. For enhanced safety and visibility, the cabin is equipped with four AI-powered cameras that offer an all-around view displayed on an in-cab monitor.



Comacchio used its Open House event to debut its latest large-diameter piling rig – the CH 850

Epiroc's new PowerROC T35

The new generation PowerROC T35 features fuel consumption up to 40% lower than the previous PowerROC T35. This is due to the Auto engine speed control, which enables automatic optimisation

of the engine speed for all operations.

The PowerROC T35 will also boost production. It is 45% faster at changing rods than the previous version, decreasing the total time needed to finish the hole.



The new generation PowerROC T35

Laing O'Rourke's HVO100 trials

Working towards its Net Zero goals, Laing O'Rourke is championing hydrotreated vegetable oil 100% (HVO100) trials.

HVO100, derived from vegetable oils such as rapeseed or waste-based feedstock used as cooking oil, can significantly reduce greenhouse gas emissions compared to diesel derived from fossil fuels.

As a significant contributor to global emissions, the phase-out of diesel is critical to Laing O'Rourke achieving its net zero goals, given construction is a known hard-to-abate industry.

The METRONET Byford Rail Extension project was the first project in Western Australia to trial the use of

renewable diesel. The renewable diesel powers four on-site pieces of equipment with HVO100 hydrotreated vegetable oil. The trial is being run in partnership with METRONET, the Department of Transport and Curtin University, which will undertake studies to understand implications for fuel efficiency, emission reduction and impacts on engines.

Hollie Hynes, GM – Sustainability and Environment, said: "The adoption of renewable liquid fuels, like HVO, is critical to achieving our 2030 near-term targets. As the construction industry is heavily reliant on diesel, the transition to electric heavy machinery and plant will take time – beyond 2030."

ABB to collaborate with Codelco

Codelco and ABB have signed a letter of intent to explore a long-term strategic collaboration looking into ways to further decarbonise the Chilean state-owned mining company's operational sites by deploying digitalisation, automation and electrification solutions.

The companies aim to work together to identify Codelco's innovation needs as the miner continues to fulfil its commitments to achieve its net-zero targets. These could include digital systems for more sustainable operations and operational excellence, electrification and automation of various

mining operations, including fleet electrification, to achieve decarbonisation targets. Existing and future mining projects are under consideration in the scope.

ABB has a track record of developing technological innovation studies and will target objectives that aim to improve safety, productivity,

operational expenditure, and availability across Codelco's open-pit and underground mines and processing facilities in Chile. Decarbonisation and technological innovation projects may also involve the handling or transport of materials in mines utilising ABB eMine solutions.

TBMs breakthrough at Sydney Olympic Park site

In Sydney, Australia, two TBMs have broken through at the Sydney Olympic Park metro station site.

The TBMs completed their 18-month tunnelling journey, creating the 11km tunnels from The Bays to Sydney Olympic Park. Over the course of their journey, they have excavated a total

of 2,052,119t of material while installing 72,456 tunnelling segments to line the new tunnel walls.

Work inside the 200m long, 37m wide, and 27m deep station box at Sydney Olympic Park will now shift to dismantling the TBMs and getting the box ready for station construction.

Meanwhile, work in the tunnels will focus on the completion of cross passages, which are crucial safety features that allow passengers to move between the two tunnels in case of an emergency.

The tunnelling is part of the city-shaping Sydney

Metro West project that will double rail capacity between Greater Parramatta and the Sydney CBD, making it easier and faster to travel around western Sydney, linking new communities to rail services, and supporting employment growth and housing supply.

Three, two, one

VC Drilling working on behalf of Structural Soils on a project for Atkins in central Manchester. The job involved the use of three cable tool rigs, two rotary rigs, a CPT cone rig, a window sampler and one hand pitting crew working alongside ground radar.

Photo: Tristan Rendell



The 'Picture of the Month' showcases our readers' best drilling-related snapshots. If you would like to see your picture featured here, please send it to duncan.moore@aspermont.com with a brief description.

Bridging the gap from offshore oil and gas to wind and CCS

As offshore wind expands rapidly and oil and gas resurge, supply chains are being stretched ever further. Signe Hansen investigates how equipment and expertise essential to both markets can be efficiently shifted between the industries – as well as the offshore CCS market – to help meet global energy demands and renewable targets

During the last decade, many companies that were born to service the offshore oil and gas industries have successfully moved into offshore wind and (carbon capture and storage) CCS. However, with wind continuing to expand rapidly, a growing demand for CCS, and an upturn in oil and gas activity, trying to serve all industry sectors requires an optimal transfer of equipment and expertise between industries.

With over 30 years of expertise in oil and gas-related services, Geo-data specialist Fugro is one of the companies that has successfully evolved technology and talent to meet the needs of both industries, with approximately 50% of all offshore wind farms having benefitted from some kind of Geo-data provided by Fugro.

"A significant challenge for companies working in both sectors is developing safe, low-carbon, market-agnostic technologies that can be utilised throughout the project-asset lifecycle. Although oil and gas and offshore wind have similarities, they are fundamentally different sectors with different engineering needs, so it can sometimes be a complex challenge to develop flexible and futureproof technologies that appeal to both sectors, especially when those technologies are utilised in site exploration, design, manufacturing, construction and monitoring," Brian Bell, global director offshore wind, Fugro, said. "It is, therefore, essential that all stakeholders continue to work together to synchronise and standardise where possible."

FROM OIL TO WIND

While a decline in oil and gas activity has long been expected due to global renewable targets, recent geopolitical events have led to a surge in both sectors. The gradual decline expected leaves a window of opportunity for existing assets to complete their productive lifetimes, paving the way for a transition to offshore wind.

However, this shift presents a key challenge: aligning investments with the needs of the wind sector while adapting operational models and retraining personnel. Successfully navigating this transition will be critical to leveraging the expertise and infrastructure of the oil and gas industry in offshore renewables.

Fortunately, many companies are doing just that. Global engineering and construction company Saipem is one of them. Having contributed to the installation of 8GW of offshore wind projects over the last decade, the company has successfully transferred much of the EPCI know-how developed through decades in the oil and gas sector. A company representative explained: "To fully capitalise on this transferable know-how, specific investments and a cultural shift in our fabrication sites have been already implemented. The challenges in this transition include adapting to the different scale and volume of production and the unique requirements of wind energy projects. We are actively focused on transforming these sites into serial production plants capable of delivering large volumes of standardised products within reduced timelines.

Fugro's uncrewed surface vessels, like Fugro's Blue Essence, are one of the easily adaptable robotic and autonomous solutions that have benefitted the rapidly developing wind industry



"Additionally, we can leverage our offshore installation expertise and part of our offshore fleet, including heavy lifting vessels (HLVs) like the Saipem 7000, which are essential for installing large foundations and electrical stations."

While the sectors share some similarities in engineering needs, several significant changes exist, especially regarding the sites they occupy and how developers wish to understand them.

"Offshore wind developers are particularly interested in the composition and properties of the upper 50m to 100m of seabed across the entire site to ensure robust foundations can be designed which last the 30-year plus lifespan of the wind farm," Bell explained. "To provide these insights across a wide variety of seabed conditions, we have developed several in-house geotechnical technologies such as enhanced soil penetration capacity using our SEACALF MkV Deep Drive advanced seabed cone penetration test (CPT) system and higher weather workability with our SEADEVIL wireline coring system."

One challenge of the wind industry is the speed by which demands change and evolve. Changing foundations, increasing depths and more considerable distances are all factors that constantly require engineering companies to adapt and apply new solutions. One important factor enabling this development has been the availability of easily adaptable technologies and equipment providing robotic and autonomous solutions.

One such is Fugro's uncrewed surface vessels (USVs) equipped with electric remotely operated vehicles (eROVs), which conduct visual or sensor-based subsea inspections. "Having utilised this technology in oil and gas, we are also able to offer similar services in offshore wind to map, model and monitor the natural and built environments," Bell said. "Furthermore, as floating wind

matures, we are able to harness our oil and gas expertise to provide engineering insights, which support site exploration, mooring design, condition monitoring strategies and more."

FILLING OUT THE GAPS

While many companies are successfully navigating the shifting waters of oil and wind projects, with renewable targets comes a sea of other demands. According to Saipem, meeting this challenge will require fine-tuning investments to align with the offshore wind segment's requirements and the development of a wider spectrum of technological solutions. The company explained: "Saipem has developed industrialised solutions for energy transition projects, including Bluenzyme 200 for CO₂ management, with already 10 active CCUS projects, IVHY 100 for hydrogen generation, as well as the proprietary Star1 technology for offshore floating wind projects."

Most offshore CO₂ storage sites are selected using legacy oil and gas exploration data, which is primarily focused on the deep subsurface located several kilometres beneath the seabed. This leaves a gap to be filled by companies like Fugro, which have developed expertise in providing geophysical data through decades of doing so for the oil and gas industries.

"This data often provides limited information about the shallow subsurface and the seafloor, leading to uncertainties. Here, the geophysical data we're able to capture as Fugro lets us resolve existing data gaps and improve legacy subsurface interpretation models," Yosmel Sanchez, Global CCS Lead, Fugro, said. "Clients' expectations around data delivery have also changed. As technology and connectivity improve whilst timelines accelerate, many stakeholders now expect insights in near real-time. This provides opportunities for

machine learning, AI and cloud-based data management services such as our integrated Virgeo platform, which improves operational efficiency by giving development teams a full geospatial overview of field acquisition activities so they can react quickly to new insights."

BUILDING ON THE PAST

Though often seen as opposing markets, wind and CCS projects are commonly operated by oil and gas developers aiming to fulfil renewable targets. This makes the ability to quickly adapt and translate technology and expertise from one sector to the other especially beneficial as clients bring their experiences and expectations with them.

Indeed, expectations and demands might be growing by the minute, but when asked if existing capacities can be transferred or modified to meet the rising demands, the answer is uplifting. Bell said: "Absolutely, yes. For many years, we have developed and refined our offshore CPT technologies to meet the evolving needs of our oil and gas clients, and over the past decade, we have applied what we have learned to our renewables projects. This includes deeper CPTs with minimal manual handling, improved ground modelling through seismic inversion technology, and enhancing offshore laboratories to accelerate delivery."

With its ongoing CCUS projects and a strong focus on the offshore wind sector, Saipem is equally confident that the company's continuous innovation and investment in capabilities will help it meet the challenges of integrating new technologies and adapting to the specific requirements of wind energy. "Our established competencies not only allow us to respond quickly to market demands but also reassure stakeholders of our readiness to adapt to the evolving industry." ▼

"We have applied our learnings to our renewables projects"

Data-driven solution for pile refusal challenges in offshore renewables

Writing on behalf of Acteon, a marine energy and infrastructure services partner for the energy transition industry, Justin Carpenter discusses the data-driven solutions the company is developing to allow it to overcome offshore pile refusal



Samples collected by Benthic using thin kerf rotary corer
Photo: Leonel Mello

Mitigating the challenges of pile refusal in various soil conditions is a critical aspect of subsea installation project planning. Pile refusal is a situation where a foundation pile encounters significant resistance or difficulty during the installation process. This resistance can occur for various reasons, such as encountering hard or rocky seabed conditions, encountering obstacles like boulders or debris on the seabed, or due to challenging geological formations.

When pile refusal occurs, it can lead to delays in the construction timeline and increased costs as additional equipment and techniques may be required to overcome the resistance.

To overcome this challenge successfully, a comprehensive strategy aimed at quantifying and mitigating the risk of pile refusal can be put in place.

OPTIMISED DATA

Understanding the soil conditions at each pile location is the first step toward addressing the risk of pile refusal. While nearby data can provide some indication of expected conditions, site-specific data is indispensable for accurately assessing the risk at a particular location. Acteon, a marine energy

and infrastructure company, has geo-services experts to begin this process with the acquisition and interpretation of geophysical data, which serves as the basis for a geotechnical site investigation. Conducting surveys of the seabed using sonar or other imaging techniques can help identify potential obstacles such as boulders or debris that might interfere with pile installation. The samples collected from a site investigation provides information about soil strength, skin friction, and physical properties, which are crucial in assessing pile capacity and the penetration resistance a pile might encounter during installation.

Choosing a provider capable of delivering all necessary geo-services elements ensures better data continuity, smoother operations, and the establishment of a detailed knowledge base.

INTELLIGENT ENGINEERING

Data from previously driven piles can be valuable in developing site-specific driving resistance models and calibrating standard driving methodologies. This data can be consolidated into an integrated ground model, often created within a geospatial information system (GIS), and a foundation hazard register (FHR) is established to detail ground risk, both in terms of in-place stability and installation performance specific to the proposed foundation solution.

The assessment of risk involves various aspects, including pile stability analysis, and an evaluation of driveability and the risk of pile refusal and/or pile run. Stability analysis determines the

required penetration for safe support and the removal of the pile gripper. A driving (SRD) model, developed using recognised industry methodologies and site-specific data underpinned by practical experience, helps establish a blow count versus depth profile, fatigue assessments, and risk identification. This informs the selection of the optimal hammer size and other equipment to minimise offshore risks and maximise safety.

Sometimes, modifying the design of the foundation pile itself can help mitigate pile refusal. This may involve changes in pile geometry to better suit the seabed conditions. Acteon's expert geotechnical and structural engineers provide site characterisation, geotechnical and structural consultancy services through 2H, an independent advanced systems engineering company owned by Acteon, to determine a realistic, cost-effective solution based on individual project requirements.

MITIGATING RISK

Addressing pile refusal effectively may involve using specialised equipment, such as vibratory hammers or drilling techniques delivered through Acteon's marine foundations business line, to break through the resistance and securely position the piles into the seabed.

Impact hammers can be equipped with various types of pile caps and cushions to optimise energy transfer and reduce the risk of pile refusal. Additionally, the blow count can be monitored to assess the pile's penetration progress. If the installation is performed using vibra-

tory hammers high-frequency vibrations are used to reduce the friction between the pile and the seabed, making it easier to install the pile. This technique is particularly effective in loose or sandy seabed conditions and can minimise the risk of pile refusal.

In cases where pile refusal is expected due to challenging geological formations or obstructions, drilling techniques may be employed to help overcome obstacles and reduce resistance. In extreme conditions equipment such as hydraulic drill rigs or underwater excavation tools, may be used to remove obstacles or hard layers before pile installation. High-pressure jetting techniques can also be used to fluidise the seabed sediments around the pile, allowing for easier penetration in certain types of soils.

During installation, real-time monitoring of pile penetration is essential. Sensors and monitoring equipment are used to assess the pile's progress, ensuring that any issues related to pile refusal can be addressed promptly.

OPTIMISED SOLUTIONS

Managing pile refusal is a critical aspect of subsea installation projects in the offshore renewables and oil and gas industries. Acteon combines practical knowledge with data-driven solutions to navigate the complexities of challenging soil conditions. Understanding of the risks associated with pile refusal underpins optimised, efficient, and commercially effective solutions that enhance project delivery while reducing overall development risk.

Early engagement with its customers is central to Acteon's approach. This allows insight into the unique challenges of each project and development of efficient strategies to address the risks associated with the proposed foundation solution. Combined with in-house knowledge and experience, this proactive approach enables Acteon to meet or improve development schedules while mitigating commercial risk. ♥

“Stability analysis determines the required penetration for safe support”



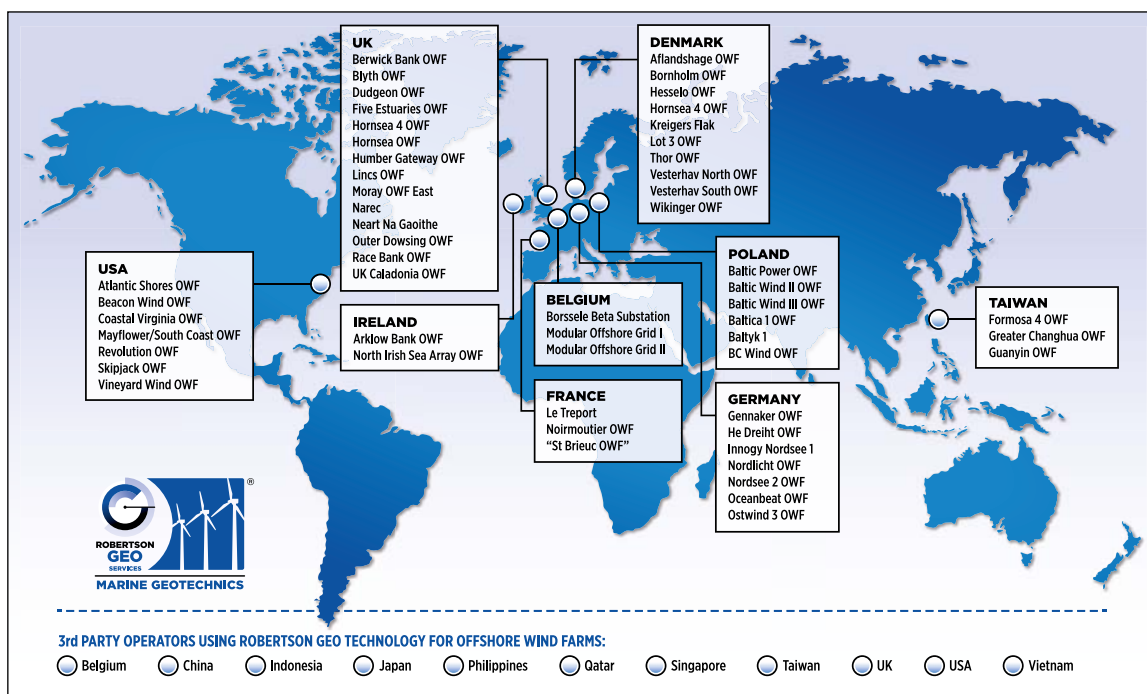
Drill Rigs for Micropiles and Anchors



Data acquisition for offshore wind farms

Robertson Geo, has a great deal of experience gained from early involvement with offshore wind farm development, and here Graham Comber the company's Geotechnical Adviser, discusses the importance of product supply and training or global deployment of engineers and equipment for full-service data acquisition to support the development of wind farms

Robertson Geo
Services Global
Offshore
Experience



Offshore wind farm (OWF) development is now on the agenda for any nation with a coastline as the world moves inexorably away from fossil fuels toward renewable energy. The exponential growth plans for OWF, driven by the acceptance of human-caused climate change and exacerbated by the recent energy crisis are now being revised upwards.

BACKGROUND

Robertson Geo has been supplying equipment and services to the OWF market since 2008, most notably the PS Logger® probe, which has established itself as an essential part of OWF site geotechnical investigation. From 2008 to the present day, Robertson Geo Services (RGS)

has undertaken 65 OWF projects across 55 wind farms globally. In addition, RGS has provided rental systems for OWF, with on-site training, and equipment and technologies purchased from Robertson Geo have seen action on many global OWFs.

Wireline logging provides unique, high-quality in-situ data, which is used in the complex design process required for OWF turbine installations. The PS Logger® is used to determine P and S wave velocities which feed into stiffness calculations for these designs. This data is complementary to that from CPT and SCPT by providing data in harder formations where CPT methods cannot penetrate. With its integral source and consistent energy delivery the PS Logger® can collect

data from any depth required for geotechnical investigation.

As wind farms have, by necessity, moved ever further from shore geotechnical investigation methods have had to evolve to meet these challenges. This has seen moves away from jack-up platforms, still used for nearshore investigation, to complex heave-compensated drill ships with dynamic positioning. The wireline method has similarly evolved to work efficiently on these complex vessels with the advantage of being able to deploy a range of probes from the same surface set-up in a single borehole.

As clients demand ever more and better cost-effective data to streamline their design processes, the wireline method

and specifically the PS Logger® will continue to evolve to meet these requirements.

EQUIPMENT AND SALES

For remote OWF geotechnical site investigations it is economically vital that all equipment performs reliably to eliminate costly downtime and to avoid the need to run to port due to equipment failure.

Robertson Geo designs and manufactures all its own equipment from its base in North Wales using ISO 9001-accredited processes. An integral part of this process is a strong feedback loop from customers and RGS which drives product development to improve reliability and meet the challenges from OWF.

This need has seen the development of a marine version of the popular Robertson Geo 2000m Winch, which is usually mounted on the rooster box for heave-compensated vessels. The marine version uses high-grade stainless steel wherever possible and features plug-in sub-modules for rapid field swaps and revised electronics for reliability and ease of maintenance.

The PS Logger® has also continually evolved to better meet the needs of the OWF environment. Changes to the power system, electronics, hardware design and sensors have all been implemented alongside changes to materials whereby titanium components are now replacing stainless steel for enhanced corrosion protection.

All equipment manufactured by Robertson Geo goes through an extensive testing regime prior to release. For probes, this includes an ISO 9001-accredited multi-part process of calibration and borehole testing before a conformance certificate is issued.

For equipment sold for offshore environments, Robertson Geo offers comprehensive pre-sales advice based on direct experience from RGS and can supply standardised spare packages to mitigate any problems that may

arise from working in harsh conditions on offshore vessels.

Often equipment will be supplied from stock for OWF applications, always with a valid conformance certificate. Selling to over 140 countries Robertson Geo has the expertise to ensure shipping is organised efficiently and takes account of the complex import requirements found in different countries. Training and commissioning will always be offered to clients, often at their own sites, and for ongoing support a help-desk facility is provided. Specifically for the PS Logger®, a data processing service is available as well as a QC function for clients, particularly important given the critical nature of the PS Logger® data.

In addition to the PS Logger®, probes that have been used for OWF site investigation include the 3-Arm Caliper (for QC purposes and for natural gamma), the High Resolution Acoustic Televiewer (for imaging fractures and bedding in harder formations and for core depth control and orientation), the Formation Density probe (for in-situ bulk density) and for the future the Nuclear Magnetic Resonance probe is being actively considered (for detailed porosity and pore space evaluation).

GLOBAL RENTAL SERVICE

Robertson Geo Services maintains a large pool of OWF equipment for its own turnkey service including marine winches, Microloggers, PS Loggers, 3-Arm Calipers, High Resolution Acoustic Televiewers and associated accessories and spares. This same equipment is also available for rental worldwide, generally for customers with experienced personnel or for shorter projects where buying is not economical. In all cases, RGS can provide pre-contract advice, particularly important if the work is to be performed on a heave-compensated drill ship where the winch may be mounted on the rooster box.

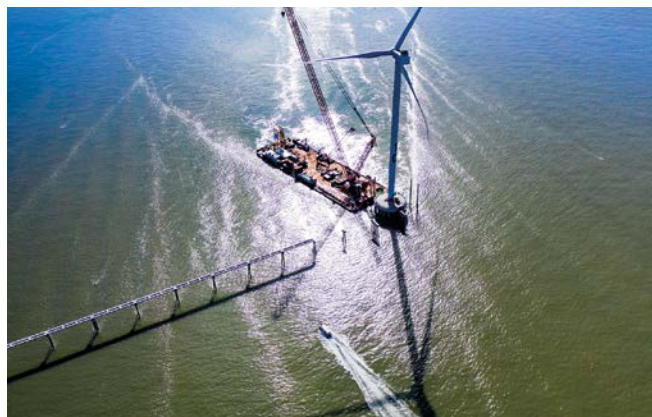
From direct experience, RGS understand the isolated nature and harsh conditions usually found on OWF and, therefore, ensures that all rental equipment undergoes stringent checking before shipping. This includes recommendations for which spares should be carried, conformance certification for probes as well as a full system check on all equipment. For the winch, this includes full testing of spares including temporary fitment to the winch to guarantee they will work should they be needed.

The level of training required will vary, usually based on the experience of the engineers. In some cases, clients will send their engineers to Robertson Geo for an intensive training course. Training at the customer site is also available in many cases as well as training via a videocall, though the latter is not ideal for inexperienced engineers. For rental clients who have longer-term needs but inexperienced staff, RGS would recommend that one of our engineers be present for the first "hitch" as on-the-job training and supervised operation are undoubtedly the preferred way to learn best practices.

RGS offers unparalleled multi-level equipment backup for all rental customers. Spare probes are strongly recommended for OWF applications as operating on heave-compensated drill decks is, by necessity, a hazardous business even under the best health and safety regimes. For inexperienced operators, the drill deck is a daunting environment requiring

Offshore wind turbine in a wind farm under construction off the East Sea in Asia

► Photo: Shutterstock





Windmill Park ▶ constant vigilance, especially
Westermeerwind, at night in bad weather.
 the largest The recommended spares have
 offshore wind evolved to include everything
 farm in the that should be required to be
 the Netherlands. able to keep working. If any
 The equipment is damaged RGS
 wind farm can can usually ship out, same day,
 produce 1.4TWh replacements from its stock
 of electricity, pool without disruption to vessel
 enough to operations. Should RGS not have
 provide electricity a replacement immediately
 to over 400,000 available, a call-off can usually
 households be made on sales stock, or repairs
 can be fast-tracked, all this from
 the Robertson Geo manufacturing
 unit without any recourse to
 external suppliers.
 Photo: Shutterstock

As the rental job commences it may be anticipated that there will be initial teething problems operating in the difficult OWF environment. RGS provides a hotline, manned by an experienced engineer, for the real-time resolution of problems, usually most relevant to the first boreholes being logged.

Due to the complex nature of recording and interpreting seismic data, experience counts, especially for the PS Logger® where P and S waves must be identified and arrival times picked. For rental clients RGS offers either a complete data processing service or can provide a QC service for already picked data. Again, this is particularly useful for customers for the initial boreholes.

GLOBAL TURNKEY SERVICE

Robertson Geo Services has been providing a global turnkey wireline

logging service to OWF for many years and has an unsurpassed successful experience. On all these projects the PS Logger® has been deployed for P and S wave determination. Over this period RGS has developed its OWF service, with special regard to heave compensated drill ships, based on the principles of a high-quality service level throughout the contract process. This includes zero-attributable downtime, competent, fully trained engineers capable of working autonomously, quickly, safely, and flexibly and finally the provision of the highest quality data possible.

At the pre-contract stage, RGS can provide information to customers regarding probe selection, winch emplacement, scheduling, equipment delivery, engineer competence, health and safety matters, and data outputs. This is mostly for less experienced clients, whereas for regular clients, this stage is mostly an exchange of relevant information. Flexibility is key here, as equipment profiles, start dates and durations may be subject to late changes.

The provision of the equipment and engineer to the vessel at the start of a contract in a timely manner is one of the challenges RGS faces. It can be difficult for clients to specify exactly when they will be departing for the OWF and even the port of departure may be subject to a late change.

Delivering equipment by freight is a necessity outside of Europe whereby contingency needs to

be added to cover for delays in customs and changes to flights. For European operations, RGS invariably deliver the equipment directly to the port of departure as this allows a much higher degree of control over the process, effectively a just-in-time system.

Brexit has also influenced decisions regarding how best to deliver equipment as Carnets are now required for Europe. The engineer may travel with the equipment or can fly out separately, whichever is the most cost-effective.

Offshore vessels undertaking OWF geotechnical investigations naturally always strive to eliminate or at least minimise downtime. As vessels operate on a 24/7 basis any lost time has a commercial impact. There is also potentially a knock-on effect to downtime for vessels with dynamic positioning as they can only operate within specified weather limits, i.e. "weather windows". Downtime could cause an entire window to be missed given the time it takes to complete a borehole. Full system checks are performed prior to mobilisation (including spares testing), and where time allows a full system check will be conducted at the dockside once the kit is onboard. RGS fully understands the implications of downtime and has mitigated the possibility of attributable downtime by providing fully tested equipment with spares and spare probes and engineers trained to find solutions that allow them to keep working. While operational problems with shipborne equipment cannot always be avoided RGS downtime across the projects undertaken is minimal and never has a vessel had to run to port due to RGS equipment failure.

Prior to the commencement of logging operations, a set of RAMS would be provided, and once onboard the vessel, a kick-off meeting will take place covering logging operations and safety. At this meeting the important

matters of winch emplacement and how a shooting plan will be conducted will be discussed, including the provision of data pertaining to depth control.

Depending upon the heave compensation set-up, the winch will either be emplaced for the duration of the project or will be emplaced and removed for each borehole, the latter being the most common approach.

The shooting plan meeting before each borehole will involve the drilling team, the geoengineers and the OPM representative, whereby all available information goes toward deciding how many individual runs (or casing pulls) will be required based on the depths of any weak layers identified. Protocols for safety and toolbox talks will also be put in place and reiterated for each borehole.

Operations on a heave-compensated drill deck are managed by the driller or drilling supervisor who has full responsibility for a series of complex hazardous operations. These operations take place in a limited space that contains many prime movers and a lot of heavy equipment. Operations are 24/7 which means working at night and in the windy weather conditions prevalent on wind farms. When drilling is complete and it is time for the wireline logging, the RGS engineer takes control of the logging operation with the lead driller maintaining oversight.

Client confidence is only inspired by the competency of the engineer and his ability to work together as part of the drill deck team. The engineer is responsible for setting up the winch and surface recording system and ensuring the safe ingress and egress of the probes in the borehole. Once depth has been set, the engineer will lower the probe(s) into the borehole and commence logging, providing real-time QC monitoring throughout.

A typical wireline operation on a heave-compensated drill ship should easily be completed

within a single 12-hour shift, even with multiple probes. Upon completion, the equipment is rigged down and needs to be stored quickly as the drill pipes will immediately be withdrawn and the vessel prepared for the move to the next borehole.

The challenges that face the logging engineer are many and varied but include responsibility for safe operations, correct setting of probe parameters, real-time quality control of the data, dealing with harsh weather conditions, communicating effectively with the drill crew, and solving any problems with the equipment that may arise. RGS only select engineers that are capable of this autonomous working within the team environment.

WIRELINE DATA

The provision of high-quality data safely and in a timely manner from the wireline operation is its *raison d'être*. This data feeds into the wider developer data set, allowing design optimisation, which should eventually lead to reduced costs. Confidence in the data provided is also very important, which is achieved by using the best equipment, with valid conformance certification, operated by highly trained, competent engineers.

RGS engineers always process their own data onboard the OWF vessels, usually within 24 hours, and the data is then sent back to the RGS QC team for final checking and confirmation. The feedback loop from processing the data highlights the care and attention that must be applied by the engineer throughout the logging to achieve the best results.

The PS Logger® probe has been deployed on all RGS OWF projects to date, giving P and S wave profiles, which allow Poisson's Ratio and small strain moduli to be calculated. This data is important to characterise the ground/pile interaction of the overall turbine structure. Where CPT refusals in harder formations are encountered the PS Logger® continues to provide a stiffness profile.

In conjunction with the PS Logger® a 3-Arm Caliper probe may also be run. This gives a profile of borehole diameter and provides natural gamma data for the formation. The diameter is used to provide QC for any other probes, most importantly the PS Logger®, so that any washout zones in the borehole are identified. The natural gamma can give high vertical resolution of the bed boundaries within the formation.

The High-Resolution Acoustic Televiewer probe may also be deployed, usually where harder formations are expected, to provide an unwrapped borehole wall image from which fracture and bedding dips and orientation can be easily derived. A "pseudo core" image is also produced, used for depth control and for orientation of rotary cores.

A Formation Density probe measuring in-situ bulk density is a desirable complement to the PS Logger® data for stiffness calculations. However, due to the difficulties around regulations and the impracticality of retrieving a probe lost downhole, this service is usually declined by developers.

THE FUTURE OF WIRELINE LOGGING

Offshore wind farm development continues globally as the electric age replaces the fossil fuel age. The trends are toward bigger turbines for greater efficiency and a gradual move away from the shore, as the easily attainable near-shore sites are being consumed. Floating and hybrid systems are now in the early stages of commercial development and can operate in deep water beyond the range of fixed bottom designs.

Wireline logging will continue to provide data unobtainable by other means, by adapting where necessary to the deeper water environments. New methods and technologies, such as NMR, are now being actively considered to provide data to support the design of anchorage systems, infrastructure, and cabling placements. ▼

"The challenges that face the logging engineer are many"

Drilling horizontally under a reservoir

In order to create the most direct and environmentally friendly district heating connection for a public outdoor swimming pool, a German contractor utilised a Grundodrill 18N HDD rig from Tracto to bore under a reservoir

Lake Mertsee on the north-eastern outskirts of Eggenfelden in the lower Bavarian district of Rottal-Inn is a reservoir on the river of the same name, Mertsee, which was built in 1961 for flood protection and as a local recreation area. The dam, built as an earth embankment, essentially consists of an artificial embanked area and rock fill. With a water surface of up to 23 ha and a height of 15m above the base of the foundation, Lake Mertsee has a water storage volume of around one million cu.m.

In the early 2020s, a small group of intelligent minds founded the "Energy Corporation

Karl-Rolle-Strasse e.G." among other things, for the "construction and operation of plants for the generation and supply of heat to members as well as the operation of a heat supply network". For a few years now, an idea has been spreading around the city to build and operate a sustainable combined heat and power plant that, in addition to the planned residential blocks and various buildings for the Karl Rolle business park in the north of Eggenfelden, would also heat the outdoor swimming pool located there. The latter was to guarantee that the developed concept would work, as a heat

consumer for the summer ahead was badly needed; the open-air swimming pool seemed to fit into this concept perfectly.

Construction started in November, the heat storage tank was installed in early March 2022, and the construction of the district heating pipes began in mid-March. The first section was also the most urgent – the connection line to the outdoor pool, as the pool water is to be heated with "the new district heating" as early as the 2022 swimming season.

THE SHORTEST ROUTE

The shortest and most sensible route for protecting the

A view of Lake Mertsee, under which part of a 1.2km long district heating pipe was partially installed for the open-air swimming pool on the right-hand side



environment and nature and the most economically favourable route for this district heating connection line to the open-air swimming pool was clearly across Lake Mertsee. Directly across the reservoir naturally meant, from a technical point of view, directly underneath and, therefore, applying the trenchless horizontal flush drilling method. A conventional open trench construction method was not even up for discussion.

With many years of experience and the high standards it sets itself, the TPP (Trenchless Pipe Pulling) GmbH & Co KG team is a proven specialist in horizontal drilling technology. When things get tricky, everyone can rely on their professional know-how and experience working hand-in-hand. Last but not least, the team trusts its technical equipment and reliable and precise machinery.

For the planned length of the bore, the expected height difference and the well-known complicated structured subsoil, the team chose to bring a Tracto HDD rig, the Grundodrill 18N with twin rods type TD82 and maximum torque of 10,000Nm from its fleet. Additionally, the bore diameter and the diameters of the necessary expanding heads for the PE OD 280 SDR 17 protection pipe to be pulled in helped to influence the decision to choose the Grundodrill 18N, commonly known as the "King of Rock".

TOOL SELECTION

The usual work and preparations for the jobsite set-up took place in early March 2022: construction of the starting and target pits on the dam crest at the level of the combined heat and power plant in the Karl-Rolle-Strasse, respectively, at the outdoor swimming pool on the other side of Lake Mertsee. Selection of the appropriate drilling tools and expanders and production of the drilling fluid in a ratio of 35kg/cu.m.



According to the planning, its total distance from the starting point on the crest of the dam level to Karl-Rolle Strasse 43 to the end of the undercrossing on the opposite bank at the open-air swimming pool site was measured at 180m. The bore head had a diameter of 190mm. And off it went: The Grundodrill 18N worked its way through the embankment to at least 4m below the lake's water level with a total height difference of 15m in relation to the starting pit. Despite difficult soil conditions, the pilot bore progressed at a nice speed with a torque of approximately 6000Nm and an average push/pulling force of up to 75kN; the drilling fluid requirement was just about 90l/min.

BORE EXPANSION

After precisely 180m, the bore head reached the target pit on the opposite bank of the dam as planned. Now, it was time to retrieve the bore head and replace it with a stepped reamer Ø 350mm for the first expansion process. A stepped reamer with Ø 44 mm for the second expanding process and the connection to the protection pipe PE-OD 280 SDR 17 (12m rods welded together) to simultaneously pull

in the pipe length, then demanded the full power of the Grundodrill 18N. with a maximum torque of 10,00Nm and 55kN pulling force the completion of the culvert was successfully completed under Lake Mertsee. The insertion of the district heating pipe Duo 75/75, Ø 202 mm, into the protection pipe, seemed almost a minor issue after the actual culvert construction.

Crossing underneath Lake Mertsee, for which the TPP team and the "King of Rock" did a really great job, has fulfilled the expectations of the energy cooperative – the open-air swimming pool opened on time for the start of the season and both the heating plant and the construction of this district heating connection fully met the sustainability criteria. The new combined heat and power plant will save about 83t of CO₂ emissions alone and use local wood chips for its operation.

In contrast to the construction of the pipeline with the open trench method, which would have been unreasonably long and complicated, the under crossing of Lake Mertsee has resulted in significantly lower costs and also minimal fine dust and noise emissions. ▼

The maximum torque of 10,00Nm and 55kN pulling force of the Grundodrill 18N made light work of completing the culvert under Lake Mertsee

Photo: Josepha und Markus

"The TPP team and the "King of Rock" did a really great job"

Solving Restricted Access Sampling

Dan Spencer, vice president operations at Aquifer Drilling & Testing, a Cascade Company, gives *GDI's* readers an insight into how the company faces and overcomes the challenges around drilling at sites that offer restricted access, whether they be on land or in water

If you have been in the drilling industry long enough to have a cup of coffee (or tea), you know that restricted access challenges are diverse and widespread. From urban project

sites to marine settings, drillers face mobility constraints, spatial limitations, and environmental obstacles that require technological flexibility and operational creativity.

I'm going to take a look at three common challenges we encounter here at Aquifer Drilling & Testing (ADT) on our restricted access projects and the solutions we implement to overcome them. These techniques can also be employed throughout Cascade. Before we dive in, a note: while there is a distinction between the terms "restricted access," an area that's difficult to get equipment to, and "limited access," an area that limits the tools that can be used, there is enough overlap in how we approach problem-solving in these scenarios that we will explore both.

ACCESS AND MOBILITY

One of the most common challenges in restricted access drilling is navigating tight, constrained environments, particularly in urban settings, steep terrain, or confined spaces like basements or sub-basements. These environments pose significant operational hurdles, but ADT's experience and specialised equipment allow us to overcome them efficiently.

Take, for example, indoor drilling projects in basements or sub-basements. These areas often come with three primary concerns: access, ventilation, and temperature control. Without the proper equipment and a well-considered plan, setting up safely in these situations can be quite dangerous. Lack of proper ventilation when drilling indoors can lead to hazardous air quality and trapped heat, causing temperature fluctuations that may affect both personnel and equipment. To counteract this, ADT utilises high-efficiency particulate air (HEPA) filtration systems and strategically placed ventilation systems to maintain air



Compact rigs can offer a solution when the available working space is limited, such as when a limited geographical footprint is an issue

quality and manage temperature in enclosed spaces.

Additionally, limited overhead clearance, especially in urban settings or inside buildings, can prevent the use of standard drilling rigs. When clearance falls below 15ft, specialised, low-clearance drill rigs with short towers are employed. ADT's fleet includes compact rigs that are designed for such situations, allowing us to carry out site characterisation and geotechnical drilling in spaces where traditional equipment would not fit.

SPACE-RESTRICTED PROJECTS

These challenges are not limited to indoor environments – steep terrain or dense urban landscapes pose equally complex mobility issues.

With limited room to manoeuvre, the challenge becomes maximising the space's efficiency while ensuring the project's safety and productivity. In these scenarios, ADT employs portable rigs and modular drilling setups that can be disassembled, transported and reassembled on-site.

This approach allows us to drill in difficult-to-reach areas while minimising disruption to surrounding operations or communities.

One of the most frequent issues we encounter is the need for a small geographic footprint. The available drill site is often constrained by surrounding infrastructure – such as buildings, roads, or utility lines – limiting the space for equipment and personnel. In these scenarios, ADT relies on compact drill rigs specifically designed for urban settings. These rigs are smaller, more agile, and can operate in tight spaces without sacrificing performance.

Working in crowded urban areas also requires careful logistical planning to ensure materials and personnel are



When clearance falls below 15ft, specialised, low-clearance drill rigs with short towers are employed by Aquifer Drilling & Testing

efficiently coordinated. With years of experience navigating tight urban spaces, ADT's teams are adept at developing traffic control plans, coordinating with local authorities, and managing onsite operations with minimal impact on pedestrian and vehicular flow.

OVER WATER DRILLING

Drilling over water, in general, presents its own unique challenges, and this is especially true in tidal zones. The rise and fall of water levels at these locations makes these project sites inaccessible without specially designed marine vessels known as shallow draft lift boats. Not only do these specialised vessels offer a stable working platform, but they are capable of operating in areas with water depths as shallow as 3ft.

Timing is everything when working in tidal zones. To access the drill site, we strategically plan our operations around high tide, "sneaking in" when water levels are at their peak. Once on site, the lift boat deploys stabilising legs to secure the platform above the fluctuating water, allowing our team to carry out boring activities safely. This method not only ensures the safety of our crew but also prevents any

equipment from becoming inappropriately stranded when the tide recedes.

Additionally, working in these environments often involves coordination with local marine regulations and environmental protection protocols to safeguard aquatic ecosystems. ADT's experience in navigating these regulations, combined with our use of environmentally sensitive equipment, ensures that our operations have minimal impact on surrounding waters and marine life.

CONCLUSION

Restricted access challenges are a constant in the drilling industry, but they become opportunities for innovation and success with the right approach. At ADT, our expertise, combined with a versatile fleet of specialised equipment – including track and truck-mounted rigs for difficult-to-reach areas, low-clearance rigs for tight spaces, and marine vessels for over-water projects – enables us to overcome even the most demanding environments. By leveraging advanced technology and operational creativity, we ensure that no site is out of reach. With a focus on safety, efficiency, and environmental responsibility, we are committed to delivering. ♥

"Restricted access challenges are a constant in the drilling industry"

Dan Spencer is the vice president of operations for Aquifer Drilling & Testing (ADT), a Cascade Company. He oversees environmental and geotechnical drilling projects in the greater New York City metropolitan area. ADT provides a full range of environmental and geotechnical drilling services with an extensive fleet of sonic and conventional drilling rigs and specialty equipment. Aquifer Drilling & Testing has been proud to serve the greater New York City area since 1989.

Digging deep in tight spaces

Joe Haynes, Little Beaver president, discusses soil sampling in confined areas with an auger drill rig

An auger drill rig makes soil sampling easier in restricted access locations by offering a compact, manoeuvrable design that is precise to control and safe to run with only one operator

Soil sampling is a critical step in construction, urban agriculture and foundation repair projects. However, not every project has the space to accommodate a big soil sampling rig. For projects in confined spaces – such as a basement, backyard or on a sensitive historical site – finding equipment that can dig deep enough while fitting into these tight areas can be challenging.

An auger drill rig makes soil sampling easier in restricted access locations by offering a compact, manoeuvrable design

that is precise to control and safe to run with only one operator.

MANOEUVRABILITY

The right equipment can make or break a soil sampling project with space limitations. Handheld samplers might seem like a good solution for tight spaces, but they do not always reach deep enough to procure the samples you need. Alternatives, such as automated options, can be costly, while truck- or trailer-mounted rigs cannot fit into small work areas.

Another challenge is that these projects often take place in urban developments near or beside houses and fences. Contractors need portable, gentle equipment that does not damage turf, sod or landscaping with its tyres or heavy weight.

Some auger drill rigs are compact enough to fit into an elevator and through a doorway or gate and short enough to stand upright under the eaves of a house or other areas with low overhead clearance. Some models even offer an auger tilt that can angle up to 15 degrees to get as close to a structure as possible. These drills can also be light enough to minimise damage to lawns and landscaping.

DEPTH PRECISION

Each soil sampling project requires collecting the soil at a different depth. Some projects, like soil sampling for a home garden, only require sampling to about 4in deep. This can be completed with a simple hand sampler, but many projects require deeper digging. Construction and foundation repair projects can vary between 3ft and 100ft deep.

- Utility: 3-10ft deep
- Foundation repair: 3-30ft deep
- Construction: 10-100ft deep

These depths vary based on soil type, the project being carried out, and local regulations. Some local agencies require certain soil sampling depths to be tested before construction takes place. Industry-leading auger drill rigs can dig to 30ft with a 16in auger and up to 100ft with a 6in auger, depending on the soil conditions.

SAFE DRILLING

Look for an auger drill rig that allows for safe one-man operation with a torque tube to redirect dangerous kickback away from the operator to the power source. The torque tube should have multiple connection points to allow operators to position the drill in the most convenient way possible.

It is important to protect against noxious fumes in basements or other enclosed spaces. Removing the engine fumes from the area protects against health hazards while working in close quarters. If the drill rig does not have a separate power unit, make sure the exhaust is ducted outside. If the drill has a separate hydraulic power unit, place the engine carriage outside with an extension hose running to the drill. When doing so, operators should anchor the drill to the floor with screw or concrete anchors. This protects the operator from counterrotation by preventing the drill from jerking or tipping when encountering an underground obstacle.

SOIL SAMPLING

Restricted spaces should not hold up a soil sampling project. When automated, trailer- and truck-mounted options just do not work, an auger drill rig makes projects easier, safer and more precise. ▼



Bridging the skills gap

Pierre Bekker, director at Quyn International Recruitment & Staffing Solutions, discusses how HR outsourcing transforms talent acquisition in remote mining and renewable energy projects

South Africa's mining and renewable energy sectors face significant challenges in recruiting and retaining staff for remote projects. Shortages of skilled, semi-skilled, and unskilled workers, particularly in isolated areas, hinder project progress and drive up costs. Many skilled professionals prefer urban areas, leading to labour gaps in remote projects.

To address these issues, workforce outsourcing has emerged. Specialised companies offer comprehensive temporary employment services to ensure projects have the right staff at the right time, improving efficiency and cost-effectiveness.

CHALLENGES

The isolation and lack of urban infrastructure at remote project sites pose substantial challenges to workforce acquisition. Skilled professionals, such as engineers and electricians, are often reluctant to relocate to these areas, even temporarily, due to lifestyle and financial considerations.

Moreover, securing a consistent supply of semi-skilled and unskilled labour from local communities can be problematic, as these regions may lack the necessary population density or workforce skills to support large-scale projects.

As a result, companies frequently need to recruit from more populated areas, incurring additional costs for relocation, accommodation, and living allowances. This reliance on external labour pools can also strain local resources and infrastructure.

TAILORED SOLUTIONS

Resource placement firms have developed specialised strategies to address the challenges of recruiting and retaining talent for remote projects, with these companies employing a

comprehensive approach to deliver skilled workforces to these isolated locations. These firms identify and attract suitable candidates from metropolitan areas by leveraging extensive networks and advanced recruitment technologies. They emphasise the project's significance and create compelling opportunities to entice talent to remote sites.

Thorough onboarding is crucial to prepare new hires for the unique demands of remote work. Manpower outsourcing companies implement comprehensive orientation programmes covering safety protocols, cultural awareness, and project-specific requirements, ensuring a smooth transition into the project.

To optimise project efficiency, outsourcing firms conduct rigorous skill assessments to match candidates precisely with specific project needs. This meticulous approach guarantees that the workforce possesses the necessary competencies to deliver optimal results.

Beyond talent acquisition, labour outsourcing providers offer a full suite of human resource management services, including payroll, benefits administration, and industrial relations.

Recognising the challenges of remote work, HR outsourcing firms often incorporate flexible work arrangements to enhance worker satisfaction and retention. This includes options such as shift work or rotational assignments, granting employees greater control over their work-life balance.

THE BENEFITS

By partnering with a workforce outsourcing firm, mining and renewable energy companies can reap numerous benefits. Outsourcing firms have the expertise and resources to attract



and secure the required talent, even in challenging remote locations. Streamlined HR processes and a dedicated workforce enable companies to optimise project timelines and avoid contractual penalties associated with manpower shortages. Additionally, outsourcing mitigates employment-related risks, such as compliance issues and labour disputes.

Outsourcing the manpower component of remote mining and renewable energy projects leads to significant cost savings, as companies avoid the expense of establishing their own HR, industrial relations, and payroll departments. By focusing on core operations and strategic goals while outsourcing workforce management, these companies can improve project outcomes and achieve timely and budget-conscious completion.

In essence, outsourcing provides a comprehensive solution to the challenges of talent acquisition and management in remote mining and renewable energy projects. By bridging the gap between available talent and remote project demands, outsourcing firms drive project success and sustainability. ▼

South Africa's mining and renewable energy sectors face significant challenges in recruiting and retaining staff for remote projects

"The challenges of talent acquisition and management in remote mining and renewable energy projects"

Dewatering pumps optimise lithium extraction process at a Chilean mine

Dewatering pumps not only provide an improved rate of lithium extraction at a Chilean mine but also reduce maintenance costs

A mine in northern Chile has doubled its lithium extraction rate since installing Atlas Copco's WEDA drainage pumps. Operators at the South American mine wanted to improve their lithium extraction process and turned to Atlas Copco's distribution partner, Trile, for expert advice and a reliable solution. In addition to optimising its process, the mine has reduced its maintenance costs by 60%.

IMPROVING THE PROCESS

Battery-grade lithium carbonate is produced by refining brine. Lithium extraction involves pumping brine from underground reservoirs to the surface and through a series of evaporation ponds. The brine level in each pond must be carefully controlled to achieve efficient evaporation rates. Rapid evaporation is crucial to facilitating lithium's concentration, and shallower ponds have a faster evaporation rate.

The Chilean mine was achieving brine depths of 25cm in its ponds using existing dewatering pumps but wanted to reduce this level to improve operational efficiencies and optimise its lithium extraction process. Those responsible for the mine approached Atlas Copco's regional distribution partner, Trile, to find the most suitable solution.

"We worked closely with our mining client to fully understand their requirements. Product reliability in reaching low brine levels was key," Enzo Altamore, sales manager at Trile, said. "We have vast experience with Atlas Copco's submersible drainage pumps and were able

to design an optimal solution based on the WEDA D line for this application."

ROBUST AND RELIABLE

Trile suggested the mine used Atlas Copco's WEDA D80N submersible pumps as they incorporate state-of-the-art wear deflector technology to deliver best-in-class performance over a long lifetime. This pump is designed to minimise wear in its key components, which enables exceptional performance and a low total cost of ownership. The WEDA D80N features design innovations such as high chrome (55 HRC) vanes that, combined with its solid-redirecting auxiliary vanes, protect the wear-resistant impeller, reducing operational downtime and significantly extending the model's average lifetime.

"The WEDA drainage pumps handle either clean or dirty water, even with small solids, with reliable performance and efficiency," Pablo Romero, sales manager Dewatering Pumps South America at Atlas Copco, said. "The reparability of our products is also integrated from the design phase. This minimises downtime and reduces the environmental footprint, proof of our commitment to sustainability as a company."

The drainage pumps have been built to last with maintenance and serviceability foremost. Thanks to the smart modular design and a unique sealing system, the pumps are among the most flexible on the market. Users can install the pumps themselves, easily carrying out inspections and maintenance, reducing downtime and associated costs.

The WEDA D80N model has a maximum pumping height of up to 40m, a maximum flow rate of 100l/sec, and can transport solids up to 12mm. Considering the challenges in the Chilean mine, it was decided that one pump would be installed in each pond for a potential installation of 200 operative units.

FASTER EVAPORATION

Since installing the WEDA pumps, the mine has been able to reduce the level of the brine in the ponds to just 15cm, which enables faster evaporation and increased lithium production. The mine has also been able to reduce maintenance and associated costs by 60%.

"Throughout the process, we have maintained the objective of providing the best solution to our client's needs. Our knowledge and experience in mining, as well as Atlas Copco's expert technical support, allowed us to deliver a solution that was not only successful but also exceeded the client's expectations. Aligning our objectives allowed us to make a difference," Altamore explained.

"The mine operator has been so impressed with the performance of these submersible units that it is now looking to further optimise the extraction process by scaling it up with the larger WEDA D100N pumps on site, too," Romero said. "The WEDA D100N has a maximum pumping height of up to 42m with a maximum flow rate of 280l/src. The technical support that we have been able to provide in conjunction with Trile's commercial expertise has been essential to the project's success." ▼

"A solution that was not only successful but also exceeded the client's expectations"

Keeping the train lines open

Train services resume after three weeks of major resilience work by Network Rail on the Newport to Gloucester line in the UK

Train services resumed after nearly three weeks of round-the-clock work by Network Rail to help protect the Severn Estuary line from extreme weather. The railway was partially closed between Newport and Gloucester to allow teams to safely work on the third phase of Network Rail's multi-million-pound resilience programme.

The exposed location of the line means it is prone to landslips, so Network Rail is undertaking a five-year programme to help make the railway more reliable for future generations.

The work focuses on a steep cutting between Purton and Awre in the Forest of Dean, where, over three weeks, engineers drilled more than 800 holes, each between 4m and 5m deep, before installing rock bolts on the lower slopes. The teams also carried out reprofiling work on parts of the slope to prevent rock and soil from reaching the track.

BOLT INSTALLATION

Work will continue until the end of the year while trains are running to install a further 3200 bolts and rockfall netting to fully stabilise more than 17,500sq.m of the cutting alongside the railway.

The work carried out with contractor BAM Nuttall upgraded part of the temporary netting system, which was put in place in 2022, to a permanent system that holds the slope in place. The closure of the line allowed engineers to fully survey the cutting and complete the design for next year's phase of work.

While the railway was closed, Network Rail engineers also carried out essential drainage work in Newnham Tunnel, renewed almost one mile of track



Rockfall netting being installed with rock bolts along the Severn Estuary line to help prevent further line closures due to slope failures

Photo: Network Rail

on the line and upgraded several level crossings.

EXTREME WEATHER EVENTS

Network Rail Wales and Borders route director Nick Millington said: "The line between Newport and Gloucester is particularly vulnerable to landslips due to its exposed location along the Severn Estuary.

"We are seeing more frequent extreme weather events because of climate change, which is why we are prioritising resilience projects such as this, to protect vital passenger and freight links on the Wales and Borders route.

"The investment we have made – and are continuing to make – will mean fewer closures and speed restrictions in the future, providing passengers and freight customers with a more reliable service."

CrossCountry's regional director Bethan Jelfs said: "We are grateful for everyone's patience while Network Rail completed this work to make the Severn Estuary line more resilient to the weather. "Our passengers depend on reliable train services, and this investment will help deliver this for years to come." ♥

Network Rail's responsibilities

Network Rail is responsible for managing the infrastructure slopes that enable 20,000 miles of track to connect communities across the country.

The UK's rail network operator manages a portfolio of over 190,000 earthwork assets that include:

- Embankments – a construction that allows railway lines to pass at an acceptable level and gradient over low-lying ground.
- Soil cuttings – an excavation that allows railway lines to pass at an acceptable level and gradient through the surrounding ground that is composed entirely or predominantly of soil.
- Rock cuttings – an excavation that allows railway lines to pass at an acceptable level and gradient through the surrounding ground that is composed entirely or predominantly of rock.

Most of its infrastructure slopes are in excess of 150 years old and do not offer comparable levels of capability and resilience to modern engineered slopes.

FUTUREPROOFING INFRASTRUCTURE

As a founding member of the UK Geotechnical Asset Owners' Forum, Network Rail is a recognised expert in earthworks asset management. It uses a risk-based policy for targeting important maintenance work (to drainage and vegetation) and capital investment to strengthen slopes like those on the Severn Estuary line. Its teams of specialist geotechnical engineers use examination data and monitoring results to determine the appropriate intervention at the right time.



Let's talk... slope stabilisation

An insight into the range of slope stabilisation projects undertaken by ground engineering specialist Aarsleff with three diverse examples of its work in the UK

Above: Aarsleff's design principle, of using a contiguous piled wall to help support the failing slope during demolition, on a project at Gibraltar Rock

Intelligent ground engineering solutions can offer mitigation for landslide issues and increase the factor of safety of the slope to ensure development can continue as needed.

Through three worked examples, this feature shows how ground engineering can deliver slope stabilisation, with full design and delivery taking place in-house at Aarsleff.

ALNWICK

In late 2021, Aarsleff was approached to address a slope stabilisation issue during the conversion of a historical secondary school into a hotel in Alnwick in the North East of England. Two walls were needed: one to the west of the site to provide stability and a replacement for the existing failed retaining wall in the car park.

Aarsleff undertook a global stability analysis on the slope and the existing wall on the site to determine the best possible way forward to mitigate any landslide issues. This information was then used to create an adaptable yet

optimised design for both the western wall and the car park wall.

Driven sheet piling was chosen as the ideal method for the work. Its quick and flexible installation capabilities meant that the programme requirements of the scheme could be met despite ongoing changes and adaptations to the scheme after mobilisation to site. The wide range of section thicknesses almost meant that the most cost-effective solution could be provided to the client while ensuring the stabilisation of the slope in both instances.

The work was delivered in two stages as development around the site continued with earthworks and associated civil engineering to facilitate the upgrade of the building. In total, 57.6m of sheet piles were installed to form the western wall and 20m of sheets made up the car park wall.

One of the main challenges on site was the existence of an extant masonry wall around 1m away from the installation site in the car park. The combination of nearby listed buildings, the tourist nature

of the neighbouring site, and the failed wall within such close proximity meant that traditional methods of installing sheet piles would have been too risky in terms of noise and vibration. Therefore, the design was centred around the use of a silent press for installation along with a Movax where needed when ground conditions were tough. This combination ensured the safety of the nearby historical buildings and mitigated commercial damage to the surrounding area.

The solutions provide a safe and clean finish to the site, with the ability to be clad if the end client wishes to finalise the aesthetic of the walls and successfully increased the factor of safety of the slopes to allow the development to progress.

KING EDWARDS BAY

King Edwards Bay is a small sandy beach enclosed by grassy banks and sheltered by cliffs, located at the foot of Tynemouth Priory and Castle – a historical site run by English Heritage. It is one of the most

recognisable landmarks in the North of England. The cliff face had been remediated poorly in the 1980s and was in imminent danger of collapse, threatening local pubs and restaurants on the beach and the cliff. Aarsleff Ground Engineering was one of eight contractors contacted by North Tyneside Council to provide a solution to the failed cliff face's potential landslide issues.

Aarsleff delivered a two-stage solution to develop a scheme design that would provide a 120-year design life to provide slope stabilisation. Stage 1 included ground investigation works with trial pits to determine the nature of the cliff failure and to provide a cost-effective solution.

Stage 2 proposed the installation of a contiguous piled wall, 10m in depth and 300mm in diameter, secured with a capping beam. Aarsleff then provided a scaffold platform to demolish 3m of the failed cliff face, which was done to reach competent sandstone. It then installed 3m long rock bolts to secure back to the cliff, a gabion basket wall within the voided area and shotcrete to the new face of the wall.

Due to the emergency nature of the work, the scope of the final product was not known at the tender stage. However, through detailed design work and early engagement with supply chain partners, as well as the local council, Aarsleff was the only contractor to provide a scheme design that was cost-effective and managed the risks on the project.

The main challenges of the piling work were operating in a tight environment, very close to an unstable cliff, with little space available at the pile locations. This was further complicated by working close to local businesses and an English Heritage site. Aarsleff's technical knowledge and diverse drilling capabilities allowed it to overcome unforeseen ground conditions such as harder bands of sandstone.

Another challenge of the works was demolishing the failed slope

safely in a controlled manner, while reducing the commercial impact on local stakeholders. This was achieved through early detailed engagement of subcontractors to manage risks at tender stage, coming up with appropriate scaffold solutions and demolition sequences to protect the local businesses on the beach below.

Aarsleff and its supply chain delivered a quality product, securing the cliff face for the full 120-year design life of the scheme. The new cliff face is also more aesthetically pleasing than before, with 25m² of the wall being sprayed with shotcrete, carved and dyed to match the existing Victorian-era wall. Aarsleff was the only geotechnical contractor that grasped the complexity and potential solution that was within budget, safeguarded the cliff and improved the aesthetic of one of the North East's most iconic landscapes.

The works at Gibraltar Rock was the first time Aarsleff worked with North Tyneside Council and is one of the largest projects it has undertaken as principle contractor.

Aarsleff's design principle, of using a contiguous piled wall to help support the failing slope during demolition, as well as utilising close cooperation with its supply chain partners from an early preconstruction phase, is now considered by North Tyneside Council as the textbook response to any future issues with slope stabilisation.

NORTHAMPTON

In mid-2023, Aarsleff Ground Engineering was approached to design and install a soil-nailed solution to remediate a failing reinforced soil wall at a distribution centre in Northampton. The soil-nailed solution required an approximate 80m length of slope stabilisation to stabilise the existing gabion-faced wall with retained heights up to 3.5m.

Detailed design was undertaken to back-analyse the existing failure and determine the most efficient arrangement of soil nails

to return the slope to an adequate factor of safety. Soil nailing was undertaken using R32 type hollow threadbar installed into grouted bores constructed using minimum 100mm diameter drill bits. Three rows of 8m long nails were installed through the reinforced soil block and into the underlying Mudstone bedrock. The slope was finished with a hard structural facing comprising A193 reinforcement mesh and 150mm thick sprayed concrete.

Due to the presence of existing buried services passing behind and underneath the slope, the design had to overcome the significant risk of clashing with the services. Detailed 3D visualisation was employed to design bespoke nail orientations; this approach, together with tight setting out and installation controls on-site, enabled the works to be completed successfully without damage to the services.

The solution provided both a structurally sound and clean finish for the distribution centre, with the possibility to clad if the end client wishes. The project overall delivered a comprehensive slope stabilisation result which ensured minimal disruption to the busy site. The combination of detailed design and experienced operational staff ensured that the project ran smoothly and the client was delivered a fully comprehensive solution that improved the factor of safety to an adequate level.

CONCLUSION

These three projects highlight the ways in which ground engineering can be employed to achieve slope stabilisation. There are a range of solutions that can be utilised, but the key factor is comprehensive engagement with an expert contractor. With design and operational expertise in-house, Aarsleff Ground Engineering is a choice contractor for slope stabilisation projects across a range of sectors. ♥

“Detailed 3D visualisation was employed to design bespoke nail orientations”

Critical roadway stabilisation after rainfall

An insight into GeoStabilization International's slope reinforcing work following torrential storm damage in Lynchburg, Virginia

Soil nails being installed by GeoStabilization International to provide robust support to an unstable slope in Lynchburg, Virginia



Lynchburg, nestled in the foothills of the Blue Ridge Mountains of Virginia, US, is known for its scenic views, historical charm, and artsy vibe – its downtown is the city's heartbeat. Having emerged as a hub for cultural and economic development over the years, the city's commitment to improving infrastructure is pivotal for accommodating growth and ensuring public safety.

In July 2023, Lynchburg experienced torrential rainfall that resulted in slope instability at the intersection of 12th Street and Federal Avenue, a crucial transportation artery and route to downtown. To ensure the continued safety of the travelling public, city officials temporarily closed the intersection and brought in GeoStabilization International to aid in the stabilisation of the slope.

SITE REVIEW

Following the storm, the GeoStabilization team conducted site visits to identify problem areas

along the slope, which had a history of instability. More than 20 years ago, the city of Lynchburg installed 640 linear ft of a draped netting system anchored along the brow and the toe of the slope to mitigate previous issues. History that was taken into consideration during the team's initial site review, where multiple potential hazards were found behind the existing draped mesh.

The project team, comprised of GeoStabilization, the City of Lynchburg, and F.L. Showalter (the City's on-call annual contractor), began work immediately. During a follow-up visit, the team undertook critical preparatory steps, including removing tree and ground vegetation, which allowed for a clearer view of the slope's condition. This groundwork was essential in ensuring appropriate value-added stabilisation solutions.

Ultimately, the decision to implement a soil nail and shotcrete approach was made, prioritising both cost-effectiveness and efficiency in addressing

the longstanding instability of the slope. The system comprised a pinned netting system anchored along the brow and toe of the slope, anchoring on the face and a shotcrete covering.

The collaborative effort among team members during this planning phase helped establish a tailored solution for the slope while also anticipating and addressing potential challenges that may arise, laying the foundation for successful project execution.

EFFECTIVE SOLUTIONS

The stabilisation process involved several carefully orchestrated steps to ensure the safety and integrity of the roadway.

Initially, the existing draped mesh was removed to assess the underlying slope condition fully. This was followed by scaling to eliminate loose rocks and create a safe working environment for installing the stabilisation system.

Once scaling was completed, soil nails were installed up to 20 linear ft deep on a grid pattern of 6ft by 6ft and 8ft by 8ft, providing robust support to the unstable slope. Reinforced shotcrete with a nominal thickness of 6in was then applied, covering approximately 27,500sq. ft. This material was chosen for its strength and durability, ensuring long-term stability of the slope. The shotcrete application ensured structural integrity while also meeting the environmental aesthetics. The shotcrete had a grey rough gun finish, with natural and geologic staining, which blended seamlessly with the natural landscape. This choice of materials highlighted a commitment to both functionality and visual appeal.

CHALLENGES ENCOUNTERED

GeoStabilization crews encountered several challenges during work along the slope, primarily due to the steep and unstable terrain, which complicated access and removal of the existing draped mesh and vegetation. To address these issues, the team employed rope access techniques, ensuring safe removal while minimising risk to personnel. Additionally, the need for effective drainage solutions became apparent during the assessment, prompting the installation of both strip and horizontal drains to manage water flow.

Throughout the project, regular communication and collaboration among team members further facilitated real-time problem-solving, allowing flexibility in adapting to evolving site conditions and ensuring that all safety protocols were meticulously followed. This proactive approach

enabled the team to successfully navigate the complexities of the project while delivering a robust and effective stabilisation solution.

SAFETY FRONT AND CENTRE

Paramount throughout the project was the team's commitment to safety. The team implemented comprehensive safety protocols that exceeded industry standards to mitigate risks associated with the challenging work environment.

Specialised training sessions focused on rope access techniques and the safe handling of shotcrete, ensuring all workers were equipped to handle all aspects of the jobsite.

Daily safety briefings were conducted to identify potential hazards or concerns and to reinforce mitigation strategies, while regular safety audits monitored compliance with all jobsite protocols.

Advanced fall protection systems enhanced worker safety on the steep slopes, including strategically placed safety nets and guardrails. These rigorous safety measures protected the workforce and ensured that the project was completed without incident.

By combining traditional methods with modern technology, the team effectively addressed the complexities of the slope and its history of instability while mitigating risks to the travelling public and enhancing the aesthetics of the roadway. Through innovation, collaboration, and adaptability, GeoStabilization provided a cost-effective, aesthetically pleasing, and sustainable stabilisation solution – ensuring the safety of the vital downtown route and providing peace of mind for the City of Lynchburg and its growing population for years to come. ♥

“The stabilisation process involved several carefully orchestrated steps”

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An example of slope stabilisation using soil nails and mesh, the treated slope is on the left, and the area to the right has yet to be stabilised

Photo: CAN Geotechnical



Let's talk about slope stabilisation

Debbie Darling looks at the different types of slope failure, what causes them and what can be done to prevent them from happening

Gradual and continuing displacements, sudden slope mass failure, and hydraulic upheaval can all lead to major geotechnical issues affecting the stabilisation of both natural and manufactured slopes. Ensuring slope stability is crucial for the safety and success of any geotechnical engineering project.

UNDERSTANDING STABILITY

Slope stability refers to the condition that an inclined slope can withstand its own weight and external forces without experiencing displacement. Even slopes that were once adequately stable may require stabilising because of changes to the slope geometry, soil or rock strength, loading conditions, or environmental conditions.

When slope stability conditions are not met, the soil or the rock mass can experience downward

movement, which can be slow or devastatingly rapid. This phenomenon is known as slope failure or landslide. A landslide can be triggered by natural disasters like earthquakes or rainfall that causes exceeding pore water pressure or degradation of the ground's mechanical properties.

SLOPE STABILITY ANALYSIS

Geotechnical engineers use various techniques to analyse slope stability and assess failure risks. The key methods include limit equilibrium analysis (LEA), finite element analysis (FEA), probabilistic analysis, and empirical methods.

LEA is a common technique that calculates the balance between driving and resisting forces to determine a slope's safety factor. This method identifies potential failure mechanisms. It is suitable for assessing the stability of

retaining walls, shallow and deep foundations, earth and rock dams, surface mining sites, and potential landslides.

FEA is the process of predicting an object's behaviour based on calculations made with the finite element method (FEM). This sophisticated method uses numerical modelling to simulate stress distribution and slope behaviour under different conditions. While FEM is a mathematical technique, FEA is the interpretation of the FEM results. FEA gives engineers insights into complex systems and structures, assisting more informed design decisions. FEM uses maths to break complex systems into smaller, simpler, and more manageable pieces. It then applies differential equations to each element individually, using computers to divide and conquer engineering problems.

"Movement can be triggered by various factors such as heavy rainfall, earthquakes, or human activities"

Probabilistic analysis allows engineers to assess the likelihood of failure by considering varying conditions like soil strength, slope geometry, and external factors such as rainfall or earthquakes. Empirical methods are based on historical data and field observations, providing a quick, albeit less precise, assessment of slope stability.

TYPES OF SLOPE FAILURE

Translational failure can occur when the slope has an infinite slope surface with no definite boundaries. This type of failure is commonly observed in slopes consisting of layered materials or natural slope formations. Translational slope failure describes a landslide where a mass of soil or rock moves downward along a relatively planar surface.

Typically, this type of failure occurs when the shear strength of the slope material is exceeded, leading to materials moving in a straight line along the slip surface, which often involves minimal rotation as the materials slide down. The movement can be triggered by factors such as heavy rainfall, earthquakes, or human activities destabilising the slope.

ROTATIONAL

As the name suggests – rotational failure occurs through rotation along a slip surface, resulting in a curved shape on the failure surface. When rotational failure occurs, the failed surface will begin to move outwards and downwards, causing the slope surface to curve. It can happen in multiple ways, including face, base, and toe failure. Toe failure is the most common situation, and it occurs when the failing surface passes through the slope's toe.

WEDGE FAILURE

Wedge failure, also known as block failure or plane failure, is characterised by the formation of an inclined failure plane. This type of failure occurs when there are fissures, joints, or weak soil layers within the slope or when the slope is composed of two different materials.

The combinations of multiple discontinuities can occur over a wide range of geological and geomorphological conditions.

Wedge failure shares similarities with translational failure. However, a key difference is that translational failure occurs only in the case of infinite slopes, whereas wedge failure can occur in infinite and finite slopes. Wedge failure often occurs in

slopes with distinct layers or different soil properties. The failure plane takes the form of an inclined wedge.

COMPOUND FAILURE

Compound failure refers to a combination of translational and rotational slide. In this case, the slip surface exhibits a curved shape at two ends, resembling a rotational slip surface, while the



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- central portion of the slip surface remains flat, akin to translational failure. This type of failure occurs when the slope consists of multiple soil layers or materials with varying characteristics. Because both translational and rotational movements influence slip-in compound failure, this causes complex failure mechanisms.

STABILISING SLOPES

Slope stability uses soil/rock mechanics principles, geotechnical engineering and engineering geology. Various case studies detailing the behaviour of slopes have led to an improved understanding of slope stability mechanics, the development of complex constitutive models, the recognition of laboratory and in-situ testing limitations and the evolution of new instrumentation techniques to assess the slope's response.

A common misconception is that landslides occur in steep and remote slopes without impacting human infrastructure. However, statistics show that most of the world's regions are affected by some form of landslide phenomena triggered by several factors, including erosion, precipitation, earthquakes, and human activity.

Landslides are common in soils and rock masses with highly fractured or weathered mechanical properties. However, a landslide can also be triggered by deformations along discontinuity layers of strong rocks.

Specialist teams from CAN carrying out stabilisation work on the white cliffs behind the Port of Dover
Photo: RSK Group



STABILISATION

It is important to conduct a thorough geological survey of the area before stabilising a slope. This will help identify potential hazards and determine the best course of action. Some common slope stabilisation methods include retaining walls, soil nails, anchors, grid systems, and drainage. The most appropriate method will depend on several variables, including the type and severity of the slope instability and the site conditions.

METHODS

Flattening the slope or removing the unstable material that lies on the upper layer of the slope is often considered the cheapest and easiest method. Geometrical techniques simply reduce the shear stresses on critical planes. Constructing a level space, shelf, or raised barrier made of compacted soil separating areas vertically at the toe of the slope can provide extra safety against failure.

Processes that attempt to enhance the soil's mechanical properties increasing its shear strength and, thus, the stability of the slope, fall under the soil stabilisation umbrella. The most used techniques include mechanical (compaction, dewatering, mixing, etc.) and chemical (lime, cement, fly ash, etc.) stabilisation.

Reinforcement support covers the application of external elements to strengthen the soil or rock. This can include introducing vegetation, anchoring structures, soil nails, erosion-control matting and rock bolts. Grouting is another support technique, and it is an injection of fluid grout into the rock mass, replacing any water or air present in its cracks and fissures. Though reinforcement tends to be the costliest option, it remains the most widely used.

DRAINAGE

The presence of water in the soil or rock mass causes increased pore water pressure. Water

pressure weakens the ties between the particles, and they tend to slip, which reduces the slope's stability. Drainage systems are a highly effective remedial measure against slope instability in saturated soils. Subsurface drainage systems are widely used and often combined with other stabilisation techniques.

Where landslide depth is shallow, vegetation can be used as a form of bioengineering by reducing the moisture content in the soil through the interception of precipitation and transpiration – increasing the shear strength of the soil. Vegetation also increases the stability of the slope mechanically by reinforcing the soil through plant roots. However, it is important to use native plants that are suitable for the specific slope conditions.

GEOSYNTHETICS

Mechanically synthesised fibrous materials such as geosynthetics and geogrids are highly effective slope stabilisation methods. They anchor soil while supporting vegetation growth, can be installed quickly, reducing project length and expense, and offer a green solution. A geogrid used to reinforce a slope will combine plastic with the least amount of resource (such as aggregate, concrete or asphalt), offering notable environmental advantages.

WHY STABILISE SLOPES?

Failing slopes can lead to catastrophe. Landslides or slope failures endanger lives, damage infrastructure, and cause environmental harm. Factors such as rainfall, earthquakes, or human activities, like excavation, can compromise the stability of any inclined ground surface, making proactive analysis and reinforcement essential. Understanding the risks and implementing proper slope stabilisation methods will likely save money, time, and lives. ▼

XCMG's breakthrough in African mining with the XQZ152 DTH drill

An XCMG drill has achieved a record 416m daily progress in Africa at a Zambian open-pit mine. The site is XCMG's first African mine drilling project

A significant milestone for the Chinese construction industry equipment specialist XCMG Machinery is that the company has successfully completed its first African mining drilling project, marking a new chapter of its mining machine deployment in the region. The project involved using XCMG's XQZ152 down-the-hole drill at an open-pit copper mine in Zambia, Africa.

The venture not only showcased the exceptional capabilities of XCMG's machinery but also set a new standard for efficiency and performance in challenging mining environments.

A FORMIDABLE CHALLENGE

The open-pit copper mine, situated in a region characterised by complex geological formations, presented a formidable challenge. The drilling project required precision and reliability, with borehole diameters of 152mm and depths reaching 16m. The geological conditions included coarse sand, medium sand, clayey soil, and varying degrees of weathered limestone, posing risks of borehole deviation and drill jamming.

The XCMG XQZ152 drill was deployed in June, demonstrating outstanding operational performance. Over nearly two weeks of construction, the drill operated for an average of eight hours per day, achieving an impressive average daily drilling progress of 320m, with a peak performance of 416m in a single day.

DTH DRILL

The XCMG XQZ152 is an integrated down-the-hole drill designed for a variety of open-pit mining applications, including

quarries, limestone mines, coal mines, and iron mines. It features a world-class power system, a top-tier air compressor, and XCMG's proprietary drilling expert system. This combination ensures robust power, high operational efficiency, and fuel savings of over 15% compared to traditional drills, significantly enhancing productivity for miners. The drill is equipped with a specialised XCMG chassis and a two-stage screw air compressor, providing a powerful and reliable air source. The drilling expert system enables fast drilling speeds, reduced fuel consumption, and comfortable operation, meeting the diverse needs of open-pit mining.

The XQZ152 drill incorporates an Atlas two-stage screw air compressor, ensuring a strong and reliable air supply. Its high-strength double V-shaped aluminium alloy feed beam offers excellent strength, guidance, and corrosion resistance. The motor chain pusher enhances reliability and maintenance.

The drill is environmentally friendly, featuring a high-capacity, high-performance dry dust removal system with optional wet dust removal to meet environmental standards.

XCMG's energy-saving expert system automatically adjusts engine speed to match compressed air consumption, optimising load demand and reducing energy consumption.

The drill's high level of automation and intelligence includes an automatic rod changing system, automatic drill rod thread lubrication system, on-the-fly measurement system, automatic anti-jamming system, hole position navigation, and remote control.

The operator's cabin is designed for safety and comfort, with a real-time display of drilling parameters and excellent human-machine interaction.

Earlier in April, the XQZ152 drill also demonstrated remarkable operational capabilities at a South American open pit mine. In terms of construction efficiency, the drill achieved higher perforation efficiency and lower tool wear, outperforming competitors by 3.63m per hour and saving 15.19L of diesel per hour in the African mining project. The drill's performance parameters include superior climbing and passing capabilities, higher air compressor exhaust pressure, and faster drilling speeds.

COMPREHENSIVE SERVICE

XCMG's after-sales service is comprehensive, with service engineers providing continuous "24-hour nanny-style service" for three months, covering operator training, technical instruction, and construction guidance. A well-stocked local inventory ensures the timely replacement of spare parts.

XCMG's XQZ152 down-the-hole drill represents a high-efficiency, multifunctional engineering solution ideally suited for drilling and blasting operations in open-pit mines and quarries.

With Africa and Latin America rich in mineral resources and in urgent need of infrastructure development, XCMG's entry into these markets injects new momentum into local open-pit mining resource development. This case study underscores XCMG's commitment to innovation, quality, and global growth, setting a benchmark for future projects in challenging environments. ▼

"XCMG's XQZ152 down-the-hole drill represents a high-efficiency, multifunctional engineering solution"

A drone photo of the Shenditake 1 borehole in the Taklimakan Desert in the Tarim Basin

Photo: Xinhua/Li Xiang



China's ultra-deep boreholes

China is at the forefront of ultra-deep borehole drilling, having previously drilled the 5000m plus China Continental Scientific Drilling Project at the beginning of the century, and now, with the development of the Xinjiang superdeep borehole with a planned depth of 11,000m

The drilling of ultra-deep boreholes is still a relatively new idea. The world's current deepest borehole is the Kola Superdeep Borehole. Reaching a depth of 12,262m, this borehole was drilled in Russia between 1970 and 1992. Located in the Pechengsky District of Russia, on the Kola Peninsula, the borehole was part of a Soviet scientific drilling project designed to investigate the Earth's crust.

Drilling at Kola began in 1970 as part of the Soviet Union's attempt to understand the geology beneath the Earth's surface. The project's initial goal was to reach 15km, but the project was halted in 1992 due to increasing temperatures and financial challenges. By the time drilling reached the 12km point, the downhole temperature had

reached 180C and was close to the equipment's operational limits, which, along with financial constraints, led to the project's abandonment.

CCSD PROJECT

China was next to take on the challenge of ultra-deep borehole drilling with the ambitious China Continental Scientific Drilling Project (CCSD). It began with a similar aim to the Russian Kola project: to reach similar depths for scientific research, focusing on understanding the Earth's deep crust, exploring geological formations and improving society's knowledge of its structure.

The drill site of the CCSD was located in the Sulu orogen region in eastern China, in the Shandong province, which is geologically

significant because it is part of the Sulu-Dabie ultrahigh-pressure metamorphic belt, an area that has experienced deep crustal processes.

The project began in the early 1990s, with the main drilling operations conducted between 2001 and 2005, allowing the main borehole at CCSD to reach a depth of 5158m, which makes it one of the deepest scientific boreholes in continental crust globally, is only about half as deep as the Kola Superdeep Borehole.

However, core samples taken at CCSD included evidence of ultrahigh-pressure minerals like coesite and diamond, which form under extreme conditions and yielded important discoveries regarding continental subduction, which occurs when continental



plates are forced deep into the Earth's mantle and later exhumed.

Samples taken at CCSD have contributed to a better understanding of the geological processes that shape the Earth's crust over millions of years, providing insight into the formation of mountain ranges, tectonic plate movements, and the evolution of the Earth's interior.

Drilling ended at CCSD once the proposed target depth of 5km had been reached. In addition, drilling further would have incurred significant costs due to the increasing technical challenges of extreme temperatures and rock hardness at such great depths.

SHENDITAKE 1

The most recent ultra-deep borehole to be drilled in China, located in the Xinjiang Uygur Autonomous Region, is the

Xinjiang superdeep borehole also known as the Shenditake 1 (Deep Earth Exploration No. 1) project. Initiated in May 2023, this borehole aims to explore the deep subsurface of the Earth and marks China's advancement in ultra-deep drilling technology, following the footsteps of the Kola Superdeep Borehole and the China Continental Scientific Drilling Project.

Situated in the Tarim Basin in the southern part of the Xinjiang Uygur Autonomous Region, which is one of the largest sedimentary basins in the world and known for its significant reserves of oil and natural gas, the borehole is planned to reach a depth of 11,100m, making it one of the deepest artificial points on Earth, close to the depth reached in the Russian Kola project.

10,000M DEEP

On March 5, 2024, the project reached the milestone depth of 10,000m. Min Peng, director of the drilling platform, said: "There was hardly any comparable drilling data for reference at such depths and no technical parameters to rely on, yet we still managed to achieve it."

Chinese news agency Xinhua has reported that since the start of drilling on May 30, 2023, the borehole has penetrated 13 continental strata, with more than 1000 drill pipes driven into the Earth and over 20 drill bits consumed in the process, while the difficulty of drilling has escalated as the depth increased.

"It took nearly five months to drill from the surface to a depth of 8000m, while it took over four months to drill from 8000m to 10,000m," Wang Chunsheng, chief expert of the Tarim Oilfield of China National Petroleum Corporation, which is in charge of the drilling, said.

After exceeding 10,000m, the drilling will face even more severe challenges, such as temperatures of over 200C and formation

pressure exceeding 130MPa, Wang added.

"In such an environment, the drill pipes behave like cooked noodles, making them difficult to control. Workers can only rely on experience to make judgments and carry out operations," Wang said.

However, according to Li Yahui, chief designer of the Shenditake 1 drilling rig, which has a load capacity of over 900t and is capable of reaching depths of up to 12,000m, a number of core technologies for drilling super deep wells, such as ultra-high-temperature drilling fluid, have also been developed.

EVENTUAL GOALS

Ultimately, the project is designed to pass through 10 layers of rock formations, which could provide insight into Earth's geological history stretching back 145 million years. The drilling will allow scientists to access the Cretaceous period rock strata and study geological conditions from that time.

The borehole also aims to advance knowledge about deep Earth processes, such as tectonic plate movements, mineral resources, and subsurface geology. It could have applications in energy exploration, particularly related to the region's oil and gas resources.

As Shenditake 1 progresses, it will likely yield valuable data that will inform not only geological theories but also practical applications, such as improving resource extraction techniques and enhancing sciences' understanding of deep Earth dynamics.

The project may also inspire additional ultra-deep drilling efforts within China and globally, positions the country at the forefront of deep-Earth scientific exploration. The success of Shenditake 1 could lead to technological breakthroughs in drilling technology and pave the way for future exploration in other resource-rich or geologically significant regions. ▼

"In such an environment, the drill pipes behave like cooked noodles"

AI identifies drilling targets to expand mineralised resource

Steve Sullivan, senior geology specialist and technical lead – DomainMCF at Maptek, explains how an artificial intelligence-generated model identified locations for in-fill drilling to refine the mineralisation model for a copper-gold-cobalt miner in South Australia

Maptek machine learning application DomainMCF has been used to help a South Australian miner plan infill drilling for a copper project. The site at Mutooroo is a high-grade open pit and underground copper-cobalt-gold project located to the northeast of Adelaide and 40 minutes from Broken Hill.

The host rocks at Mutooroo are high-grade metamorphics with sulphide mineralisation lying in a shear zone either within amphibolite or at the amphibolite-gneiss contact. The copper-cobalt ore is a coarse-grained, massive sulphide

comprising pyrrhotite, chalcopyrite, pyrite and barren quartz.

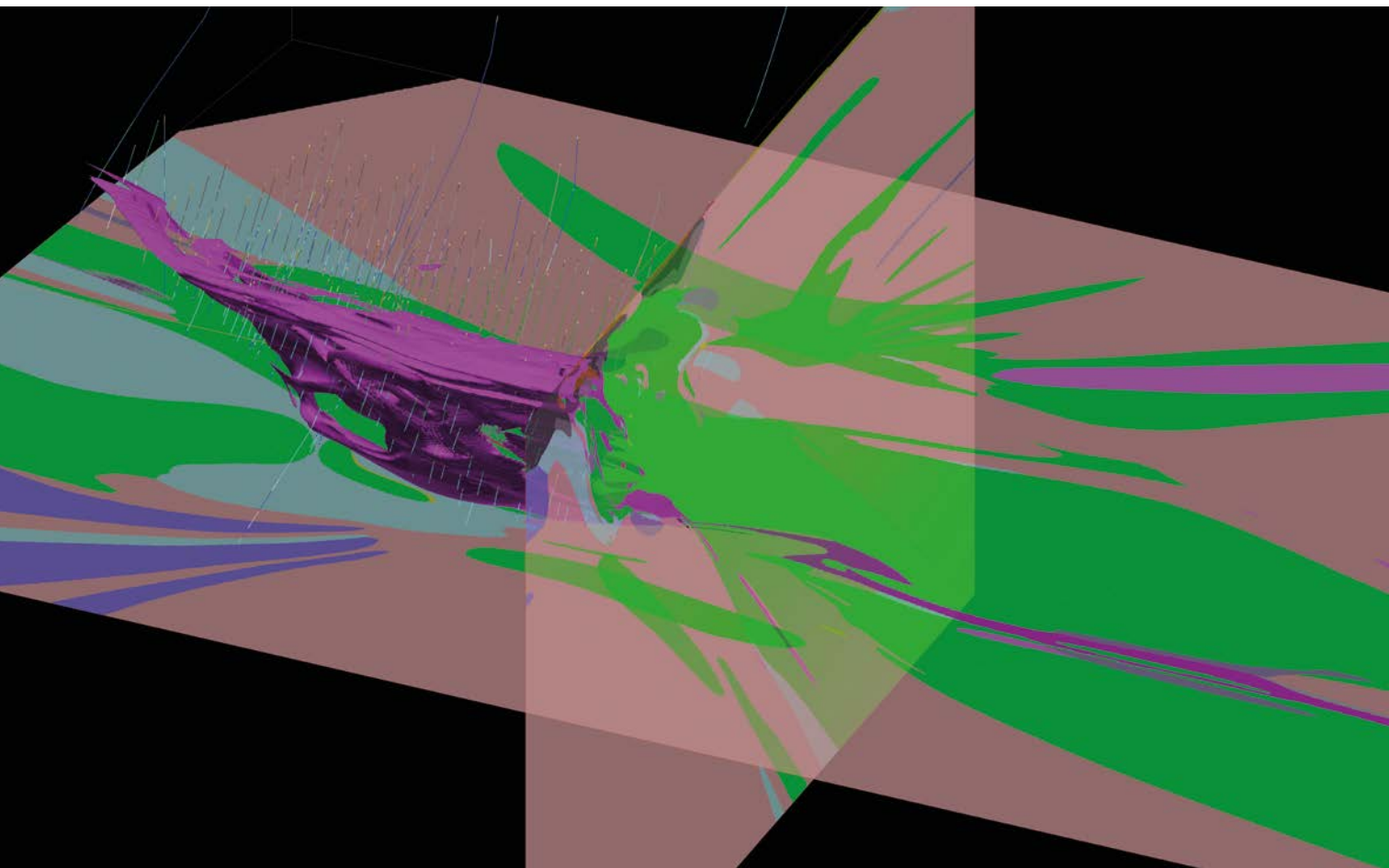
The current resource at Mutooroo is defined by 300 drillholes, including diamond drilling conducted by Broken Hill South Limited in the 1960s. Samples used for resource estimation came from diamond drill core and reverse circulation drilling. Exploration data analysis, variography, block model creation, grade estimation and block model reporting were completed using Maptek Vulcan software, which Havilah Resources has used for over 20 years.

The stated sulphide mineral resource at Mutooroo totals 13.1Mt of 1.5% copper and 0.16% cobalt, with 0.2gpt gold. There is also a small oxide resource overlying the main sulphide orebody.

FINDING COPPER

The forecast global supply shortfall for copper provided justification for further exploration to extend known resources, prompting Havilah to apply artificial intelligence (AI) to target downdip extensions to their copper-cobalt mineralisation.

Perspective view of cross sections with domain interpretations made by DomainMCF, ore lenses in purple, amphibolite in green



Historical and recent Mutooroo drillhole data were combined with topographic surface information and uploaded into the machine learning DomainMCF application, and a model was generated within the region defined by the extents of the resource block model.

DomainMCF uses machine learning to generate domain boundaries directly from sample data. Geologists feed in drilling or other sampling data and obtain domain or grade models in less time than traditional resource modelling methods. This makes the approach ideal for generating resource models with certainty and reporting investment options to stakeholders.

The resulting 3D lithological model shows the complex interaction between the host amphibolite and the sulphide vein lenses.

DETAILED MODELLING

The next step was to model the copper mineralisation in more

detail. Within the database, an indicator was established for samples grading more than 1000ppm copper and modelled using the DomainMCF cloud compute service.

The machine learning application analysed the copper indicators and their spatial distribution in 3D and provided projections for potential extensions to mineralisation. Solid wireframes of the DomainMCF copper indicator were generated in Vulcan.

New drillholes were planned to target the AI-generated extensions to mineralisation, and a drill programme commenced in late 2023. The first four holes successfully intersected copper-cobalt mineralisation close to the depths indicated by the AI model.

In an update in February 2024, Havilah Resources technical director Dr Chris Giles said that expanding the Mutooroo resource base at an increased scale strengthens the project's economic development case and attractiveness to potential investment partners.

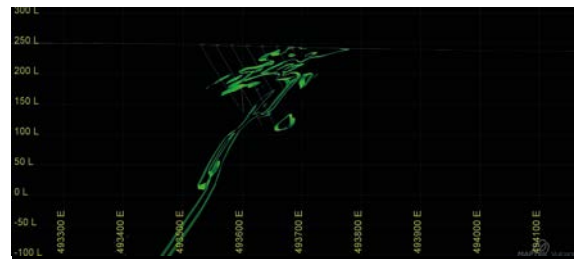
"The drillholes achieved their objective of intersecting copper-cobalt-gold sulphide lodes outside of the current mineral resource envelope and at depths accessible to a conceptual open pit," Giles said.

"The average aggregate 19.3m thickness of copper-rich mineralisation intersecting three drillholes on one section line is an excellent result that confirms the considerable expansion potential of Mutooroo."

GEOLOGICAL INTERPRETATIONS

Giles noted that when Havilah applied Maptek DomainMCF machine learning software to the more than 300-hole Mutooroo drilling database, they found that it produced credible geological interpretations in a very short time.

"Remarkably, it predicted in advance the presence of comparatively thick hangingwall mineralisation at the location of the drilling, which was not immediately obvious



from conventional geological interpretation," Giles said.

The encouraging drilling results were attractive to investors, leading to a binding Memorandum of Understanding signed in August 2024 with JX Advanced Metals Corporation of Japan for an exclusivity period and study programme on the Mutooroo copper-cobalt-gold project. The agreement involves JXAM spending almost AUS\$3 million on resource expansion and resource upgrade drilling and other studies to inform its decision on whether to acquire an interest in Mutooroo.

Cross-section view of the 1000ppm copper indicator model created by DomainMCF showing untested potential extensions at depth

AI MODEL

In addition, the AI model can be used to predict downhole lithologies for newly designed drillholes. The predicted lithology can be uploaded into the drill database and then used as a guide by the logging geologist to compare the AI prediction with the rock types as they come out of the ground and then compare the accuracy of the AI model.

Adjustments can be made to the next drillhole location based on the outcomes of the last hole, as generating a new geological model using DomainMCF takes only minutes. The result is a tighter drilling budget with more targeted drilling, leading to a greater chance of success.

Geological models are always created with the latest data. They can be refreshed in minutes, so the geologist is able to have a high degree of confidence in interpretations and resource predictions.

The machine learning approach to modelling provides a standardised process, producing repeatable and reliable results. ▼

"The drillholes achieved their objective"

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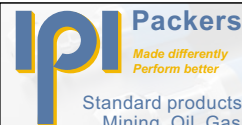
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