Vermeer, USA

**How has the HDD process developed, and what relevant developments do you see in the near future?**
Technology is far beyond what it used to be. As a result, at Vermeer, we do not just drill with water anymore and recommend having mud engineers on the job. Pipe handling systems and remote breakout wrenches mean that pipes do not have to be touched like they did in the past.

In the future, we see both the diameter and distance of pipeline jobs increasing, with drills becoming more sophisticated. We predict that smart machines encompassing telematics – which can tell you if you had a good day and what the quality of your work was – will become a common sight on jobsites.

**What training is necessary for HDD operators?**
There is a big difference between an equipment operator and a horizontal directional driller. You can teach almost anyone understanding and building a plan of action that aligns with environmental regulations can help drive down costs and give the crew greater confidence and efficiency while the bore is conducted.

Successful planning can be completed using technology that allows you to preplan a bore or layout of a jobsite before the job even begins.

**How do you approach HDD installations to ensure that they are environmentally friendly and cost-effective?**
The entire horizontal directional drilling (HDD) jobsite is becoming more environmentally friendly. This can be seen through the way technology is helping contractors to better manage and dispose of necessary drilling fluids.

Fluid reclaiming technology allows contractors to capture and reuse fluids to both minimise environmental disruption and drive down the cost of operation by minimising water usage and solids disposal fees. In addition,
how to run a drill. However, understanding the drill in its entirety – including how pump volumes, pressure and steering tools factor into productivity – is a much longer process.

Operators need to have a larger concept of HDD. Since you cannot see work that is being done underground like you could with an excavator, drilling requires an understanding of the instrumentation cause and effect. It is for this reason that Vermeer built the HDD CircuitSM training programme to be a near two week course that covers the abovementioned elements. This is currently the only course certified by an accredited college institution.

**How do you decide between using HDD or open cut trenching?**

This decision really depends on what is in the ground. Existing utilities, surface conditions and geography are all major factors when deciding between HDD or open cut trenching. While it may not be feasible to open cut in highly urban areas or where major infrastructure aboveground is a barrier to installation, it may be against regulations to open cut trench in protected areas. Moreover, it may be too costly to put everything back together after an open cut trenching operation.

Thus, there may be instances where open cut trenching physically will not work, such as with shore approaches.

These are all important factors to consider when choosing between the two applications.

**How do variable geologies, sensitive crossings and extreme environments affect HDD installations?**

HDD installations require agility and planning on the part of both the contractor and drill operator. Because of this, varying conditions will never make a project go faster.

Variable geologies will affect the tooling setup, timeline for a project’s completion, drilling fluid management practices and the initial bid. Extreme environments also affect HDD installations – warm-up times, winterisation plans and keeping both hydraulic and drilling fluids from freezing are a few examples. However, if an operator is able to perform well in variable geologies and extreme environments, it can separate itself from the pack.

**What are some of the methods/techniques used for HDD over vast distances?**

One method used for HDD over vast distances is the use of wireline steering systems, in which a hardwire is put inside the drill rod and is energised to power the transmitter within the drill head. This creates a wireline grid that makes a magnetic field. Other methods include gyro systems, intersect bores, pipe thrusters and Direct Pipe.

**What methods of mapping/surveying are used for HDD installations to ensure accuracy?**

Basic surveying equipment (such as GPS) can prepare a jobsite. While drones are also becoming more popular for collecting information about the initial topography of jobsites, another method is core sampling. Core sampling will give a better idea of what to expect and plan for with regards to the hardness and composition of ground conditions.

**How do you prepare for unclean boreholes, failure of cutting tools and drilling fluid losses during pipe installation?**

Managing a jobsite is no different to managing a sales force or production. Knowing what the capabilities of the equipment are and operating within those specifications is of utmost importance. Preparation for unclean boreholes should include monitoring previous stages of bore, such as prereaming and the pilot bore, which will highlight the capabilities of the tool and the proper guidelines for use.

With respect to cutting tools, each has certain specifications associated with them. For example, there are tools that should not be used in hard rock conditions so operators must be sure to match the right drill to the right soil conditions in order to better prevent failure of cutting tools.
Direct Horizontal Drilling, Canada

**How has the HDD process developed, and what relevant developments do you see in the near future?**
Schedules have been reduced and capabilities have increased in the HDD process. Longer lengths, higher angles and longer blind sections are what we are seeing today. At Direct Horizontal Drilling, we hope that the next development will be the re-introduction of wireless communication steering tools. We are currently in the research and development stage and hopefully testing will begin soon.

**How do you approach HDD installations to ensure that they are environmentally friendly and cost-effective?**
We engage with pipeline owners in the early stages of installation procedures to identify risks and solutions, and ensure that plans are thorough in order to reduce cost overruns.

**What training is necessary for HDD operators?**
Training varies from job to job. Both in Canada and across the oil and gas industry, there are minimum requirements for the majority of projects. At Direct Horizontal Drilling, we ensure that each of our employees meet or exceed these requirements.

**How do you decide between using HDD or open cut trenching?**
In Canada, the decision regarding whether to use HDD or open cut trenching is made by regulators. Notably, Canada has a huge focus on the environment, which means that when a project is submitted, HDD is often the primary and secondary method of choice. If these two techniques fail due to geology or other issues, a third method will be planned as an open cut or aerial method.

**What are some of the methods/techniques used for HDD over vast distances?**
Upon reaching lengths of over 2000 m, Direct Horizontal Drilling uses the intersect method to reduce pilot hole drilling times. It then utilises the exit rig for reaming assist. With the varying terrain that is found in western Canada, drill paths can be upwards of 150 m below the surface and double that of the actual rig elevation. Having the exit rig monitor and maintaining a steady pull force reduces pipe string stress.

**How do variable geologies, sensitive crossings and extreme environments affect HDD installations?**
Geologies affect overall schedules. In a softer formation, a company's rate of penetration (ROP) tends to be higher than in a harder rock formation. With softer formations, you can step to a 48 in. ream in one pass, provided that it is the ideal formation.

A harder rock formation requires ream step sizes in order to achieve the final 48 in. Companies must determine whether a PDC reamer or another type of reamer is going to be used before deciding on the step stages.

It is important to note that a rig that does go from pilot to 48 in. is not automatically faster than a rig that will have an intermediate ream. Each and every crossing generally has

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**Figure 1.** A 2000 m pipeline pullback operation under the Peace River in Taylor, British Columbia.

**Figure 2.** An operation in -40°C in new foundland.

**Figure 3.** A rig operation in Nova Scotia for a beach approach project.
a unique challenge that needs to be addressed early on with engineering and construction teams working hand in hand.

With regards to sensitive crossings, all crossings must be treated the same. The reason HDD is used is to limit the amount of disturbance to the area that is being drilled. Every project that we undertake is a snapshot of the overall company. Whether in downtown Calgary or north of Fort McMurray, the company’s operating practices to not defer from the high standards that its management has laid out.

Finally, regarding extreme environments, each rig in the Direct Horizontal Drilling fleet is capable of operating in -50°C. The rigs are elevated with a walkway system, fully integrated boiler, heating system and a fuel circulating system that prevents gelling of the fuels. Each rig has water and fuel storage that can keep the rig operating when weather conditions may limit supplies.

What methods of mapping/surveying are used for HDD installations to ensure accuracy?
We primarily use the Paratrac II system; an alternating current powered loop. We also use DC loops for certain crossings. If, however, neither of these are suitable then we will use gyro technology.

How do you prepare for unclean boreholes, failure of cutting tools and drilling fluid losses during pipe installation?
At Direct Horizontal Drilling, we prepare for jobs knowing what fluid products and parameters will be ideal for the ground conditions in advance. This, matched with the correct pumping and cleaning system, is a proper drilling practice. A clean borehole with reduced annular pressures will extend drill performance and reduce trip times.

As for tooling wear or failure, the tools are also selected by reviewing the geology. We have a vast selection of sizes and cutting types to pick from as each type of reamer performs differently in different ground conditions. The ROP and hours are monitored for each assembly and are replaced when the rig manager feels that the tooling is at its limit.

Describe a recent or significant HDD pipeline project you have undertaken or been involved in.
In 2016, Direct Horizontal Drilling drilled close to 50 000 m of pilot hole with nine Maxi rigs. Final hole size varied from 18 - 54 in. The project took 35 000 hrs of operation to complete and we operated at 0.27% downtime – less than 100 hrs of rig repair.

We drilled 15 000 m using the Baker Hughes AutoTrak™ rotary steerable system as part of a four location drilling programme of beach approaches in eastern Canada. Rock strengths were as high as 50 000 psi.

How has the HDD process developed, and what relevant developments do you see in the near future?
In the past, the main principles of the HDD process had not been fundamentally changed for a long time. Pilot bore, several steps of reaming, while a bentonite mixture supports the expanded borehole and removes the soil over the entire length of the crossing. Then, finally, installation of the pipeline.

We have contributed and encouraged advancements in the HDD process with the introduction of several new downhole tools. These tools allow for a new workflow on jobsites by increasing the efficiency of the boring process.

Firstly, our Down Hole Jet Pump cleans the borehole and removes cuttings directly inside the drill string, which is a completely new method of soil conveyance in HDD. Moreover, the tool can significantly reduce the risk of frac-outs when installed directly behind the Full Face Hole Opener.

The Full Face Hole Opener is a tool for excavation diameters of 30 - 72 in. It allows contractors to drill and realise the enlargement from pilot bore to final diameter in a single step in both soft ground and hard rock of up to 350 MPa.

Finally, with longer drilling distances, our Weeper Sub also reduces the risk of frac-outs. It does so by gradually increasing the volume flow in the borehole. Less drilling fluid is required at the drill bit.

How do you approach HDD installations to ensure that they are environmentally friendly and cost-effective?
Using the abovementioned HDD downhole tools, crossings can be carried out quicker and more economically. Concurrently, typical process problems, such as frac-outs or imprecise boreholes, can be solved in an effective way.

We have recently developed a compact rig with a crawler base, the HK80CK. With 800 kN of push/pull force, a number of measures have been implemented to ensure that the rig has a reasonably small footprint and low transportation requirements. It uses a 20 ft drill pipe compared to the standard 32 ft, and the fluid pump is small enough to be fitted on board. It also provides noise and emission protection, which makes the tool ideal for projects in urban areas.

While many of the latest HDD equipment developments point in the direction of reduced noise and energy consumption, technologies that reduce drilling mud consumption are also favourable as these fluids tend to be harder to dump.

What training is necessary for HDD operators?
At Herrenknecht, we offer intensive training to our customers’ personnel in our workshop, as well as assistance on jobsites.
Additionally, if required, we provide service staff for jobsites. If there is a special question or situation on the jobsite, thanks to modern data transfer, the technical parameters of a rig can be analysed to support our customers, even when short notice is given.

Furthermore, we recommend that drilling operators are trained at organisations such as the German Drilling school in Celle, where theory is taught and certification is awarded to those who pass.

What are some of the methods/techniques used for HDD over vast distances?
The Herrenknecht Pipe Thruster enhances the versatility of HDD, particularly when it comes to long pipelines that either have large diameters or that are under difficult geological conditions. With thrust and pulling forces of up to 750 t, the Pipe Thruster can play a key role, being used as a mobile power reserve.

Meeting in the middle is an appropriate solution when drilling long distances. The larger the drill pipe, the more it can be pushed during the pilot. Therefore, longer distances can be drilled. The same can be said during the reaming process, where a larger drill pipe can transfer much more torque than a smaller drill pipe.

How do variable geologies, sensitive crossings and extreme environments affect HDD installations?
To drill through soil formations where HDD is not applicable or risky, Direct Pipe® opens up a new application potential by combining the advantages of microtunnelling and Pipe Thruster technology. A prefabricated pipeline can be installed almost continuously in one step. A cutterhead that is adjusted to the geology requirements and a cone crusher can remove possible obstacles.

In general, the more variable the geology is, the higher the chance of changing to a different trenchless installation method that has a more controlled risk as it is with HDD. All technologies should only be used if the risk can be managed.

Describe a recent or significant HDD pipeline project you have undertaken or been involved in.
In Malmö (Sweden), one of our HK150C rigs was used to drill through hard limestone that also included sections of flint. The contractor needed a very clean borehole due to the tight dimensions, as well as a small annulus between the bored diameter and the 40 in. high density polyethylene pipeline. Our Down Hole Jet Pump, which cleans the borehole and removes cuttings directly inside the drill string, discharged cuttings of up to 50 mm in length. Larger cuttings were crushed into smaller pieces or pushed into softer sections of the borehole by the tool.

Figure 1. The Full Face Hole Opener allows contractors to drill from pilot bore to final diameter.

Figure 2. Herrenknecht's Down Hole Jet Pump cleans the borehole and removes the cuttings directly inside the drill string.