Industry Record for Center Rock Canister Drills Set in St. Louis

Vertical shafts will give metropolis control in processing storm water runoff

By Joe Bradfield

Monster drill. The 132-inch (11-foot) Center Rock LP canister hole opener waits to make the final pass of the shaft. This profile shows the seal band around its circumference. One of the return ports is visible just below it, lower right. Two bars were fabricated as a precaution against any larger debris with the potential to impede circulation.

The Metropolitan St. Louis Sewer District (MSD), the country's fourth largest sewer system, is upgrading its storm and wastewater infrastructure in a 23-year-long, $4.7 billion initiative called "Project Clear." The primary goal is to improve water quality and alleviate many wastewater concerns in the St. Louis region by planning, designing, and building community rainscaping, system improvements and an ambitious program of maintenance and repair.

Historically, in times of intense precipitation, rain and snowmelt entered into and overwhelmed the current sewer system. Therefore, part of the system renovation has focused on constructing underground storm-water storage tunnels, permitting controlled drainage of runoff while preventing overflow into rivers and streams.

Construction plans for the storm-water storage tunnels called for nine vertical intake and ventilation shafts to be bored from the surface, eight of them through hard rock. These will then be intercepted at depths ranging from 140 to 160 feet in bedrock during excavation of the 3,000-foot-long, 28-foot-diameter underground tunnel.

On this job the reverse circulation version of the Center Rock Low Profile canister drill set a new industry record for largest canister-drilled bore at 132 inches in diameter. Other bore diameters varied from 72- and 108-inch ventilation shafts to the larger intakes.

The wide-diameter pneumatic percussion tools offer one of the fastest and most precise ways to bore the shafts in hard limestone. Center Rock Inc., manufacturer of air-drilling tools, services, and accessories for the global drilling, oil-and-gas, construction, mining, and foundation industries, supplied the canister drills for this job.

Conventional vs Reverse Circulation

The Center Rock LP drills are not conventional canister drills. Center Rock technician Dan Spiecher, onsite consultant during use of the reverse circulation canister systems, explained advantages of Center Rock's reverse circulation method compared to the conventional canister-drilling technique.

Both the conventional canister drill and the reverse circulation canister drill are based on individual 6-inch, low-volume, down-the-hole hammers positioned in a metal cylinder. Each hammer impacts a 7.875-inch, self-rotating hammer bit.

The operator slowly rotates the canister during drilling to ensure DTH bits impact evenly across the bottom of the hole, to prevent the drill from bottoming out if it were left stationary. Rotation, however, marks one of the differences between reverse circulation and conventional canister drilling: reverse circulation permits continuous rotation.

Reverse circulation's greatest advantage, Spiecher said, is that there is no calyx to empty. "In conventional cluster drilling, every 2 or 3 feet, you empty your calyx. Sure, it only takes five to 10 minutes, but that's still five to 10 minutes of non-drilling time every couple feet of penetration. It adds up to a lot of lost drilling time by the end of a work shift."

Richard Soppe, Senior Drilling Application Specialist for Center Rock

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Shown in the background: the crew prepares to begin reverse circulation drilling with a 72-inch Center Rock LP Canister Drill. Foreground: The half-moon equipment on the ground on the left side of the photo is the 84-inch LP Canister Drill channel, the return flow back to the top of the drills cone.

Tight spaces. A primary planning requirement of all MSD Project Clear phases is minimized impact on traffic and residents. The canister drilling method enables the crew to confine work to the median of a residential boulevard running perpendicular to this side street without detouring traffic.

Temporary retention pool. Cuttings settle out to the bottom. Liquid is returned to the hole. The cuttings are periodically removed by a vac truck and hauled away to disposal off site.

downhole drilling products, said, "As we've seen here, a hole that takes two weeks to drill with a calyx system can be drilled in three days on reverse circulation, without working the rig hard at all."

St. Louis Project

John Deeken is a geotechnical engineer with Black & Veatch Corporation, the construction manager for the Maline Creek project. Deeken said drilling and blasting technique for creating the shafts here was ruled out, as the project was located in a residential neighborhood.

"We could have used rock coring or a cutter head, but the drop shaft of this project is constructed within 10 feet of an existing 108-inch-diameter sewer main," Deeken said. "We had to take precautions to avoid damage to it."

Canister drilling offered a highly precise means to create the shafts, leaving a smooth-sided bore right on target.

Ground conditions in this 132-inch intake shaft were wet due to the proximity to the Mississippi river and high ground water levels. "They've been finding shale in 2- to 6-foot layers between weathered layers of Mississippian limestone," Spiecher said. "The 2-foot layers we can punch through. The 6-foot layers slow us down."

Anatomy of a reverse circulation LP Canister Drill. The 12-inch, carbide button stinger of this 72-inch LP Canister Drill isn't meant to drill but to follow the initial pilot hole. Its interchangeable hammers will be removed for use in the 108- and 132-inch hole openers that follow. The weighted centralizer on the drill string contributes to the stability of the rotating drill.

Spiecher said full-face canisters could have been used, but reaming the hole to size has advantages. "Our canisters in a full-face configuration will drill it, but following a pilot hole adds more precision. And it's also much more feasible. A full-face 132-inch canister would need about 40 hammers. That's a lot of inventory lying around until you need your 132-inch can. This way, you can just use the same hammers you were just using for your 72-inch drill."

The shaft was therefore widened in stages. After a subcontractor drilled a 12-inch pilot hole to 160 feet, the hole was filled with pea gravel. Pea gravel is a comparatively easy medium for a pilot, or "stinger," to follow, yet prevented any debris from entering the pilot hole that could cause deviation during augering and subsequent canister drilling.

Overburden was removed using a Liebherr LB 36 rig with 72-inch auger and 12-inch stinger. The LB 36 is a 106-ton rotary drilling rig with 523 hp engine and 440-ton maximum winching and crowd force capabilities. Then the 72-inch hole was widened by the same rig with a 144-inch auger. A 140-inch casing was set from the surface 3 feet into limestone bedrock.

After all hole locations were augured, the rig's kelly drive was replaced with a rotary top head. The holes were reamed to final depth in the limestone using a series of Center Rock LP reverse circulation hole openers. For the 132-inch hole, the progression was from a 72-inch drill to a 108-inch drill and finally the 132-inch-diameter drill, all reaming performed using reverse circulation technique.

A 72-inch LP Canister can be run on as few as five of the 1,450 cfm, 200 psi Sullair compressors onsite at this job. To ensure ample flushing air for the record-setting diameter of this hole to depths over 150 feet, seven units were used, sending air through 3-inch hoses to a Center Rock air manifold. A 6-inch hose supplied air from the manifold to a divided valve that fed the swivel at the rotary head of the drill rig through two 3-inch hoses. Two air tubes inside the

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drill string sent up to 10,150 cfm of air at 182 psi to the hammers in the LP Canister.

Air exhausted by the hammers flushed fluid and cuttings at the hole bottom up through ports located at the sides of the hammer near its face. Seal bands matching the hole diameter and located on the canister above the ports prevented the returning flow from escaping up the sides of the hammer. The return flow was instead channeled up through the canister ports to a discharge hose carrying the cuttings to a temporary collection pit constructed of cement blocks. A vacuum truck removed the pit's contents as called for, hauling them of for disposal.

The reverse circulation system will work in dry rock, Spiecher said, but keeping the hole wet controls dust and keeps the shale wet. "It's a general rule of thumb in drilling to 'keep a wet hole wet.' It could start to choke us off if we let it get too dry." Center Rock's water injection system with triple piston pump can return water from the pit to the hole at 3 to 22 gpm.

Soppe said reverse circulation canister drilling proved itself much more economical than other methods of boring the vertical shafts. "One would think running seven 1,450 cfm compressors this way would be cost-prohibitive. But consider that we just drilled a hole in three days that would generally take two weeks with a conventional can drill. We're coming out way ahead on operational costs."

Deeken said after drilling the shafts, some of the surface casing will be partially removed to accommodate a 44-foot tall diversion structure and lined drop shaft.

As of the end of February 2017, all nine vertical shafts required by the Maline Creek Project had been completed. In diameter, two of the bores were 132 inches, two were 108 inches and five were 72 inches. The first round of underground drilling and blasting to create the project's storm-water storage tunnel began February 21st.

The Maline Creek Project is the first of three such tunnels to be constructed. The tunnels themselves are just one part of the larger Project Clear initiative. The rainscaping portion of Project Clear makes smart use of precipitation, preventing much of it from entering the wastewater system. The underground storm-water storage tunnels give MSD a way to manage the combined volume of storm water runoff and wastewater system without exceeding capacity during times of heavy rain or significant snow melt.

Dan Spiecher, Center Rock Technician providing onsite consultation on this job stands with the 72-inch LP Canister Drill with 12-inch stinger as it is readied for DTH operations for an intake shaft.

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