



DROP & VENTILATION SHAFT EXCAVATION FOR A COMBINED SEWER OVERFLOW (CSO) ABATEMENT PLAN

Narragansett Bay Commission (NBC), Providence, Rhode Island

Introduction: The Narragansett Bay Commission (NBC) proposed the construction of seven underground facilities and three deep rock tunnel segments. The underground storage tanks and tunnels would contain the sewerage overflows during rain events so that the sewage could be returned to the system for treatment after the storm. The Drop Shaft and ventilation Shaft needed to be drilled to intersect the tunnel at an exact elevation located approximately 208 feet under the City of Providence, Rhode Island. The site location was located 20-feet from the western edge of the Providence Warf. The area was once a coal dock. A combination method of Foundation drilling under Shore Pac slurry to bedrock then switching to reverse circulation drilling through the bedrock was utilized by Case Foundation to excavate the drop and ventilation shafts.

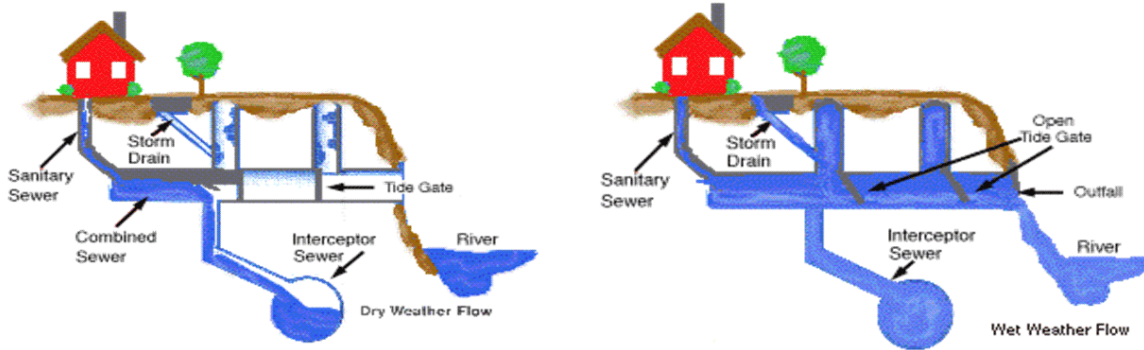


The Phase I of the Combined Sewer Overflow (CSO) Abatement Program consisted of a storage tunnel in rock connected to a near-surface collection system by drop shafts. The tunnel begins near NBC's Field's Point Wastewater Treatment Facility, travels north along the Providence River, turns west to follow the Woonasquatucket River, and ends near Calverly Street. Sixteen-thousand feet long, 26 feet in diameter, and 220 to 280 feet underground, the Tunnel will hold over 60 million gallons of combined sewage. It will reduce the annual volume of CSO discharges by approximately 40 %, and is expected to reduce shell fishing closures by 47% in the northern half of the Upper bay, and 77 % in the southern half.



Combined Sewer Overflow (CSO): At the turn of the century most urban areas across the nation built sewer systems to carry storm water and sewage in the same pipe. This is called a combined sewer. During dry weather conditions the combined sewer works fine. But during heavy rain storms these combined flows frequently exceed their capacity into the sewer system and overflow into local rivers and the Narragansett Bay. The combined sewer overflows into the bay are a violation of the Federal Clean Water Act that regulates polluted discharges from industries and sewer treatment plants into public waterways. According to the Clean Water Act, it is the objective for rivers, lakes, bays, and other water bodies

throughout the country to be fishable. Each year the 66 CSOs in the NBC district release an estimated 2.2 billion gallons of untreated combined sewage into the Narragansett Bay and its tributaries, namely the Blackstone, Moshassuck, Providence, Seekonk, Woonasquatucket, and West Rivers. CSO's pose pollution and public health risks, the sewage comprises residential, commercial and industrial wastes, and other pollution washed or dumped into drains. These overflows carry pollutants in the form of sewage solids, metals, oil, grease, and chemicals which can affect the health of those who swim in CSO polluted water or eat shellfish contaminated with these materials. To protect human health in Rhode Island, certain areas of the bay are permanently closed to shell fishing, and over 11,000 acres are temporarily closed for harvesting when there is more than one-half inch of rainfall.



Shore Pac Drilling Slurry: CETCO Drilling Products supplied the polymer drilling slurry Shore Pac that was utilized by the Drilled Shaft contractor Case Foundation out of Roselle, Illinois. Case Foundation had the job of drilling a 14-foot inside diameter, 208 – foot deep drop shaft from the surface, and a 5-foot inside diameter, 206 foot deep, ventilation shaft. The function of the Shore Pac was to hold the holes open while Case Foundation drilled down to bedrock and inserted a permanent 14-foot casing for the drop shaft and a 5-foot casing for the ventilation shaft set into bedrock. At times during the drilling the Shore Pac slurry had to remain in the open borehole for up to two weeks as old wharf wood pilings were removed slowly from the borehole. “On top of the old vertical wharf piling the soil was impacted with various contaminants that effected the viscosity of the Shore Pac slurry, we kept strengthening the Shore Pac until the casing liner could be installed” said Nick Puglia. At approximately 7 feet below land surface wooden piles measuring 8-10 –inches in diameter in the shape of an X were encountered. The wooden piles were rotten at the top, but as soon as groundwater was reached at 17-feet below land surface the wooden piles were solid.



The soil consisted of rubble and fill material at the surface, changing to brown gray moist stiff silt and clay for 50 feet, and then silty coarse sand with gravel on top of the weathered shale bedrock was encountered. The weathered shale located approximately 90 feet below land surface had to be reached with the slurry alone holding the 14-foot diameter hole open.

The Drop and Ventilation Shaft Construction:

Had to be completed exactly according to within 6-inches of the specified location. This milestone was essential for the installation of the dear ration chamber by the tunneling boring contractor. According to the site drilling superintendent Nick Puglia of the Case Foundation Broomall, Pennsylvania office who said “try drilling a 14-foot diameter shaft with an auger to bedrock at 90 feet below land surface under Shore Pac slurry, then switch to reverse circulation drilling for the remainder of the borehole and stop within 6-inches at 202 feet below land surface. Then seal the shaft to allow the safe progression of the underground tunnel boring work to intersect the shaft. It wasn’t easy.” Case Foundation used a Manitowoc 2250 Crane with a Call weld 200 drilling attachment to drill the top portion, for the reverse circulation portion Case partnered with Steven M. Hain of Garland, Texas.



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Tunnel Boring: The tunnel boring contractor was a joint venture between M L Shank and Balfour Beatty Construction Company. The six-hundred-ninety ton tunnel boring machine was constructed in Japan and shipped to Providence, RI. The tunnel boring machine was used to make the 3 mile long 26 feet in diameter 250 foot deep CSO tunnel. The tunnel boring machine consists of the main body and the cutter head. The cutter head is attached to the main body (the shield) by a specially designed boring shield that performs a number of functions. It houses the motors which rotate the cutter head, and the thrust cylinders which provide the forward thrust on the cuttings discs. Because the motors are turning the cutter head, the shield must also resist the opposite forces which are trying to pull the shield in the opposite direction.



Another function of the shield is to protect the workers who are installing the initial tunnel support behind, or inside of the TBM. The main spine tunnel is supported by precast concrete rings assembled inside of the shield, then expanded to fit the tunnel excavation as the shield moves forward the rings come out of the tail. Hydraulic ring erectors are mounted inside the shield and are used to lift and build the rings.

Once a 4-foot long ring is built, the thrust rams push against the leading edge of the ring, propelling the shield and cutter head forward. During the push, the cutter head is rotated, rolling the disc and crushing

the rock. The rock chips, called muck, are scooped into the cutter head through a bucket head as it rotates. The muck is dumped onto a conveyer, inside the cutter head that carries the muck through the shield and into the supported tunnel where it is loaded into rail cars and transported out of the tunnel.