THE OHIO RIVER FORCE MAIN SYSTEM

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Dual, 24-inch, PVC sewer force main.

During the mid-1980s, the property owners of Northwestern Jefferson County, Kentucky approached the Metropolitan Sewer District (MSD) to obtain sewer service. The area was scattered with small package wastewater treatment plants and on-site septic systems both of which were failing. There was also a desire to continue development, which required that public sewer expansion take place. A sewer Master Plan had been prepared in the late 1960s, and it needed updating before MSD could begin the budgeting, design, and construction processes to sewer Northwestern Jefferson County. Vince Bowlin, P.E. acted as MSD's Project Manager. MSD contracted with the engineering design firm of Proctor, Davis, and Ray to update the Master Plan.

Typical site conditions experienced in the cross-country alignment.

In this Master Plan, two main themes emerged: a conventional gravity interceptor sewer system ($64 million) and a Regional Pump Station/Force Main Pressure System ($15 million). The system as proposed would ultimately accept 13 million-gallons-per-day of average daily flow. The recommended option and plan selected was the Regional Pump Station/Force Main Pressure System called the Ohio River Force Main (ORFM) project.

This project will ultimately consist of 9.5 miles of dual force main and fourteen pump stations. Currently, 8.5 miles of dual force main ranging in size from 4" to 24" and seven pump stations ranging from 10 to 200 HP have been constructed.

Prior to this project, MSD had experienced difficulty with an existing 7.5-mile long, single, 20-inch, cement-lined-ductile-iron-pipe force main system installed in the mid-1970s. Within eight years of the installation of the cement-lined-ductile-iron force main, pipe failures were occurring due to deterioration from the inside. In the design, there had been no provisions for addressing hydrogen sulfide generation and the slime layer that builds up in a force main. The dilute sulfuric acid produced by the hydrogen sulfide generation attacked the cement lining and ductile iron, which resulted in failures.

When considering the ORFM system, the decision makers were concerned about pipe deterioration, odor and hydrogen sulfide control, and the ongoing problems with the cement-lined-ductile-iron pipe. This weighed heavily in their minds when selecting the appropriate pipe material. As a result of this project, MSD standardized on PVC and HDPE pipes for sewage force main applications. Seven projects were bid to construct the system. The successful contractors bidding the project used PVC pipe.

MSD continues to use ductile-iron pipe lined with a Protecto 401 Ceramic Epoxy™, or a similar coating, in wet wells and valve vaults. These are typically locations where piping is exposed or must transition from pipe to couplings/valves, etc. MSD also has miles of cement-lined-ductile-iron pipe that has been in operation for decades without failure. These are typically force mains of shorter lengths and higher flow velocities. This minimizes the potential for hydrogen sulfide generation.

At the time this piping was installed, MSD placed locator tape over the pipe, 12-inch below ground surface, to locate the pipe when another contractor was excavating. Despite this precaution, development - with all the underground work it entails - resulted in contractor damage to the pipe. MSD has since altered its locating standard. It now requires the locator tape, as before, and has added the requirement for a locater wire installed just above the pipe. This allows MSD to locate the pipe for contractors with an electrical current.

At the time of the original design, MSD standardized on Potassium Permanganate as the chemical additive for odor and hydrogen sulfide control. MSD is now using Bioxide®. The use of PVC and HDPE pipe has added additional protection from hydrogen sulfide attacks on the pipe itself.

The Pressure Ratings (PR) of the pipe in the upper third of the project changed from 160 psi to 235 psi. The table below shows the diameter, length, and PR of the PVC piping installed.

When designing force mains of long length, considerable thought should be given to:

- the system operation at the initial stages and in later years as flows change;
- the effects of hydrogen sulfide on piping, valves, and the system when receiving flows;
- the stratification that occurs inside the pipe, which is similar to a sedimentation tank: greases and floatables come to the top and solids drop to the bottom;
- the effects that greases and floatables have on air-release valves; and
- the need for periodic higher velocities to minimize the reduction of the cross sectional area of the pipe from the deposition of solids, which is most critical in the early years when flow is low.

MSD will draw upon its fifteen years of experience with the ORFM, and the other lessons learned in the area, when it budgets the construction of the last phase of the project. That phase will include an in-line-booster-pump station and a 5,000 GPM regional pump station, and 8000 feet of 20-inch, PR 235psi, PVC force main.

Nominal Diameter (Inches)	Length of PR160 psi (Linear Feet)	Length of PR235 psi (Linear Feet)
4	4,984	---
6	4,314	---
12	658	2,660
14	501	---
16	---	7,444
18	13,528	4,506
20	9,050	13,758
24	57,828	---