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INFRASTRUCTURE RENEWAL

Moving from reaction to resilience

Seven 250-hp pumps were installed to create a bypass connection for a Fraser, Mich., sewer that collapsed. Also, upstream a single 500-hp pump (not pictured) is equipped with a chopper blade to help break down solids and eliminate ragging issues. Macomb County (Mich.) Public Works



A new bypass in the Motor City of

'Engineering marvel' created to respond to Michigan sinkhole

Dan Heaton

Featuring a mile and a quarter of pipes, eight massive pumps, and a software package with the latest technology, an engineering marvel in suburban Detroit is preventing untreated wastewater from being discharged into the Great Lakes.

The marvel is a temporary bypass pumping system that was necessary after a massive sinkhole developed on Christmas Eve in Fraser, Mich., a bedroom community of Detroit. The sinkhole measured 91 m (300 ft) long by 18 m (60 ft) wide – about the size of a football field. It developed under a major road after a 3.4-m- (11-ft-) diameter sewer interceptor collapsed for about 22.5 m (74 ft) of its length. The interceptor, which delivered wastewater for about half a million people, more than 40,000 businesses, and a military

base to a water resource recovery facility in Detroit, is buried 18 m (60 ft) deep.

The sinkhole cut off access to a small subdivision of 23 homes – all of which had to be evacuated on Christmas Eve. Two homes eventually were demolished because of the sinkhole. The remaining 21 families were allowed back into their homes after about 2 weeks. During those 2 weeks, the Macomb County (Mich.) Office of Public Works, which manages the system that includes the pipe, built a temporary access road and installed an initial pumping system to bypass the collapsed portion of pipe.

Adding to the confusion, the Office of Public Works had a newly elected commissioner coming into office on Jan. 1 after a particularly hard-fought and bitter campaign. Candice S. Miller, a former seven-term member of the U.S. Congress, defeated the 24-year incumbent commissioner.



Macomb County Public Works Commissioner Candice Miller briefs Michigan Gov. Rick Snyder on the sewer collapse and sinkhole on Jan. 8. To the right of the governor is Macomb County Executive Mark Hackel. Macomb County (Mich.) Public Works

The former commissioner had left the state on vacation for the holidays and could not be reached for his last week in office, even as engineers and contractors began to descend upon the scene.

Quick reaction

With snow and rain falling in the days after Christmas, 49 million L (13 million gal) of wastewater were diverted into the Clinton River, which flows into the Great Lakes, as engineers raced to install a temporary bypass for the interceptor. The bypass – a single pump with a single 800-mm (32-in.) pipe – went into place on Jan. 2, one day after Miller took office and first visited the site.

The Dec. 27 diversion into the river would be the only time wastewater entered the river despite multiple heavy rains. Operators such as Vince Astorino, the acting chief wastewater engineer for Macomb County Public Works, spent many sleepless nights diverting wastewater from one interceptor to another, taking the county's storage capacity right to the max.

Sewer collapse prompts ragging education outreach

As a new public works commissioner dealing with the collapse of a 3.4-m (11-ft) sewer interceptor and a sinkhole that damaged two homes and swallowed a major road, Candice Miller never thought something as simple as a baby wipe would cause her sleepless nights.

"Ragging from wipes and other materials caused us nightmares in getting our bypass pumping up and running," said Miller, who served in the U.S. Congress for 14 years before deciding she would like to stay home in Macomb County, Mich., but still wanted to serve her community. She was elected public works commissioner and took office Jan. 1 – just 8 days after the sinkhole developed in Fraser, Mich.

Miller took to carrying a package of wipes everywhere she went, to show when talking about the importance of disposing them in the trash – not the toilet. Working with several municipalities, she taped interviews and public service announcements. She gave interviews to local media – anything to educate the public.

"I never thought I would be speaking about what to flush and what not to, but this is a national issue that is impacting our communities," she said.

Ultimately, Miller's team developed flyers that were provided to the local municipalities and included in water bills and other mailings to help spread the word.

"I believe it is making a difference, but we will probably always have to continue this educational effort," she said.



During this massive bypass-pumping project, pump clogs caused by ragging were an issue. Macomb County (Mich.) Public Works



Contractors installed ragging screens to protect the bypass pumps. During heavy rains, these screens were being cleaned hourly. To help reduce ragging, the contractors also installed a chopper pump to help break down the materials. Even with that, the screens are still being cleaned several times per day. Macomb County (Mich.) Public Works

pipe crosses three major roads, over several business driveways, and under some other driveways. Next, the flow snakes around a pumping control and finally free-falls 18 m (60 ft) back into the interceptor pipe downstream of the break. The bypass system – which at full capacity could fill a 1.5-m-deep (5-ft-deep), 3.7- × 7.3-m (12- × 24-ft) swimming pool in less than 15 seconds – has operated as designed since construction crews first quickly installed the 800-mm- (32-in.-) diameter temporary discharge pipe around the collapse.

“It really is an engineering marvel – the likes of which I certainly have never seen before and, quite honestly, hope to never see again in my lifetime,” said Commissioner Miller. “This is the system that has kept the sewage out of our basements and out of our Great Lakes.

“It is a unique bypass pumping system – a pump station in essence – designed on the fly, built in the open elements, under, at least initially, crisis conditions,” said Gino Mersino. He is president of Mersino Dewatering Inc. (Davison, Mich.), the contractor that arrived on Christmas Eve 2016 in response to the collapse of the interceptor.

“The pressure was high, but we are proud of what we have provided,” he said.

With all eight pumps running at full bore, the system sends nearly 4.3 m³ (150 ft³) of wastewater down the line per second. The flow travels to a water resource recovery facility in Detroit.

Mersino added, “We designed something unique as far as bypass pumping systems are concerned. Due to the depth of the sewer, the flow rates requiring bypassing, and the construction limitations – specifically the space available for pump installation – we built a bypass pumping system ... capable of delivering the flows against heads of up to [26 m] 85 ft.”

The Macomb County Office of Public Works, as the agent

Building a bigger bypass system

The single pump and pipe bypass system has now grown to what the locals call the long-term bypass: a system of eight pumps, and 2 km (1.25 mi) of a 1350-mm (54-in.) pipe that splits into twin 1200-mm (48-in.) pipes.

Final construction on the long-term bypass was completed in April, though engineers say they will likely be making small tweaks to the system on a periodic basis as long as it is in operation. The 2.0 km (1.25 mi) bypass sends the flow on a roller coaster ride around the collapsed sewer interceptor. First, it lifts the flow up from 18 m (60 ft) underground from a manhole facility. Then, the



Metal ribs were installed in the pipe adjacent to the collapsed interceptor. Once the pipe was pumped out, cleaned, and inspected, it was found to be riddled with cracks and leaks. It will be lined as part of the repair process. About 1200 m (4000 ft) of the interceptor – the collapsed portion and another 1128 m (3700 ft) deemed to be in imminent danger of collapse – will either be replaced or lined with fiberglass polymer pipe. Macomb County (Mich.) Public Works

for the Macomb Interceptor Drain Drainage District – a group of 11 Macomb County communities that own the system – has spent nearly \$11 million creating the bypass. The work is part of a roughly \$75 million effort to repair the collapse and damage caused by the sinkhole. It is anticipated that the interceptor replacement will be done by the end of September 2017, with final road repaving and other restoration work done by Thanksgiving.

'Super pump' takes on ragging

Today's completed bypass system features seven 250-hp pumps and an eighth 500-hp pump, which workers on the project have dubbed "super pump."

"One of the biggest challenges that we had initially was contending with the amount of 'ragging' we experienced in the system," Mersino said. "Our pumps are solids-handling pumps, that is, they are capable of passing a 3-in. to 4-in., spherical solid. However, ragging is different." He said ragging refers to rag-like products – primarily disposable wipes, paper towels, and other non-biodegradable items – getting into the sewer system. They tend to twist together, forming long, rope-like slugs of waste that wrap around the strainer basket or the impeller of the pump, impeding flow and potentially damaging the pump.

To combat the ragging, the contractors installed several screens to catch the materials. The screens require cleaning as much as every hour during a rain. Finally, the team added to the equation what is affectionately referred to as the "super-pump." This larger 500-hp vertical turbine pump with a 610-mm (24-in.) column pipe was installed ahead of the temporary screens with a suction intake facing upstream to collect the sewage flow and suspended rag-like solids before they are delivered to the original seven pumps in the temporary pump station. The 610-mm (24-in.) pump is fitted with a specially designed set of chopper blades and an inducer, a



The bypass is about 2.0 km (1.25 mi) in length. Macomb County (Mich.) Public Works

design that helps direct the flow and the rags into the larger pump itself, shredding the rags and passing them through the temporary piping system.

The chopper blades reduce the efficiency of the super pump but collect, shred, and pass the rag-like solid. This action protects the seven smaller pumps, enabling them to operate more efficiently.

Mersino added, "We are still cleaning screens, while constantly monitoring or maintaining the pumps themselves during operation to protect against flow degradation due to ragging. Through diligent maintenance operations, we have been able to maintain good flow rates in the bypass system, even during significant rain events, despite ragging challenges."

Miller, the new public works commissioner, has made ragging the focus of a new public awareness campaign. (See "Sewer collapse prompts ragging education outreach" on p. 64.)

"This really is a national issue but brought to the fore here because of our unique situation," Miller said. "We are clogging up our sewer pumps, costing ourselves thousands in maintenance expenses through the use of these products. You can use the wipes, just don't flush them."

The bypass system will remain in place until all work is

completed on the 21-km-long (15-mi-long) interceptor, in late 2017. Much of the pipes used in the bypass will eventually be re-sold to help recoup some of the costs of operation.

Dan Heaton is the public relations director for the Macomb County (Mich.) Office of Public Works.