Cooperative Manhole Restoration

"There is a clear regional need for low-cost alternatives for II reduction through manhole rehabilitation."

By Don Newman and Karl Sauereisen

For municipalities struggling to deal with sewage overflow issues, simply getting started can be a major challenge. The journey typically starts with assessment of existing wastewater collection infrastructure, progresses to some form of rehabilitation program, and is followed by a period of monitoring to ensure the effectiveness of corrective measures utilized. Once a program for rehabilitation is established, there are often obstacles that arise during implementation. As such, the ability of municipalities to access innovative solutions is critical to successfully addressing manhole rehabilitation in a cost-effective manner.

One interesting example of mobilizing multiple parties to innovatively address wastewater infrastructure issues is evident in the Lowries Run Interceptor Project. This project took place in several Western Pennsylvania communities just northwest of Pittsburgh. Lowries Run is a story of successful sewershed stewardship, and it illustrates what is possible through the collaboration of civic leadership, the engineering community, and local industry.

Impetus: Protect Public Health

The Lowries Run Project's beginnings date back to the 1990s when the owners of the Lowries Run Interceptor, a regionally important conveyance facility serving over 20,000 persons, began to proactively confront the environmental concerns of water inflow and infiltration (II). A series of manholes, 84 in all, were known to exhibit various levels of deterioration along the Lowries Run Creek. Most of the manholes were about 40 to 50 years old and had suffered from the effects of freeze/thaw cycles over the years. Observed conditions included open mortar joints within brick manholes and spalling within pre-cast and cast-in-place concrete structures.

The condition of these manhole structures, combined with Western Pennsylvania's climate and topography, made the Lowries Run manholes a potential point of entry for excessive II. As is frequently the case in the region, the interceptor sewer roughly paralleled the course of Lowries Run along a valley bottom. Consequently, inflow from the residential sources and pipe defects, the local groundwater table, and local streamflow in the low-lying creek created capacity problems over and above normal sewage flows as the 5.5-mile long sewer line fed into the Allegheny County Sanitary Authority (ALCOSAN) treatment plant along the Ohio River. ALCOSAN, the regional conveyance and treatment provider, typically treats about 200 mgd of wastewater; in wet weather conditions the need for treatment capacity can exceed 875 mgd.

The necessity for rehabilitation is evident in this Lowries Run manhole.

The Pittsburgh region's frequent rainfall makes an otherwise out-of-sight, out-of-mind problem highly visible. Untreated sewage pours into waterways, overflows from manholes, or backs up into homeowners' basements. This problem not only poses a detriment to recreational activities, but also underscores a potential regional public health issue.

Lowries Run wasn't the only watershed area of Pittsburgh wrestling with this problem. In 1995, the EPA and the U. S. Department of Justice began to focus on Pittsburgh and the other 82 communities in the ALCOSAN service area for sewer overflows and potential violations of the federal Clean Water Act. Following the conclusion of a Section 308 monitoring program as directed by the EPA, rather than pursue litigation or administrative action against both the municipalities and ALCOSAN, the EPA and state and county regulators have pursued an innovative course of action in negotiating consent agreements with the 83 munic-

The majority of lining applications within Lowries Run manholes utilized spincasting technology from ground level.

ipalities of the ALCOSAN Service Area. Using the 3 Rivers Wet Weather Demonstration Program, a regional non-profit collaborative corporation as a facilitator, the regulators were able to implement a unified regional sewer assessment, rehabilitation, and monitoring program with the end objective of the formulation of a regional wet weather plan in 2012.

Fiscal Considerations

Aside from the environmental issues, corrective maintenance of the Lowries Run collection system made good fiscal sense. The North Hills of Pittsburgh is an area of rising population and development activity. Maintenance of existing sewer capacity is needed for serving the existing residential areas as well as new neighborhoods. Although the neighborhoods along Lowries Run had not experienced overflow conditions like communities elsewhere, they wanted to keep it that way. It became apparent that unless investment was made in maintaining interceptor capacity, a squeeze in sewage conveyance could be expected within the next decade. Consequently, it was deemed a priority to restore the existing system and avoid needing to replace it in advance of a clearly defined regional wet weather plan for the ALCOSAN service area.

In addition, the agreements signed between the communities and the regulators required the municipalities to correct defects following their discovery. This requirement created a significant regional financial obligation, as there are an estimated 90,000 manhole structures in the ALCOSAN service area. Of this total, many of these are brick manholes that require rehabilitation or, lacking a cost-effective rehabilitation alternative, replacement. Rehabilitation is also made more complex and costly by the remote location of many structures. Therefore a technique that would permit cost-effective rehabilitation of the interiors of brick manhole structures over the range of access challenges posed by local sewer alignments had particular regional significance.

In the case of Lowries Run, the technique in question had been successfully applied to pre-cast manholes. The question was would it work on brick manhole structures?

Pooling Resources

An obvious dilemma involved identifying a responsible party to take the lead role in rectifying a multi-jurisdictional environmental challenge. It was not a matter of assigning blame since several municipalities held a stake in the issue. Likewise, no single community could be expected to foot the bill. That's where a strong example of civic cooperation unfolded.

Ross Township and the neighboring McCandless Township Sanitary Authority (MTSA), owners and operators of the Lowries Run interceptor, stepped forward to seek preventive measures that would avoid overflows. Bill Youngblood, executive director of MTSA, and Tom Lavorini, manager of Ross Township, expressed a vision for the joint operating committee to address solutions on a service area-wide basis.

Upon conceiving the project, the operating committee authorized the Pittsburgh office of Buchart Horn, Inc. (www.bh-ba.com) to organize and manage the project. Buchart Horn is a multi-discipline firm that provides consulting, engineering, environmental, and project management services. Its clientele includes municipal, institutional, and industrial clients throughout the United States and Europe. An added benefit was that MTSA, Ross Township, and Buchart Horn had worked effectively together in the past as the firm serves as the consulting engineer to the operating committee.

With the project leaders in place, discussions commenced on how the broad-reaching initiative would unfold. Questions about funding, materials, and technology were among the forefront of issues identified for resolution in order to move forward.

The Lowries Run stakeholders realized the importance of seeking commitment in both the public works and public health arenas. The Three Rivers Wet Weather (3RWW) Demonstration Program offered that opportunity for collaboration. At the time, 3RWW was providing federal and state grant funding for regionally significant demonstration projects as a non-profit corporation originally created by ALCOSAN and the Allegheny County Health Department to address Western Pennsylvania environmental issues.

The Lowries Run Joint Committee applied for a grant to assess wet weather abatement strategies along Lowries Run. The Three Rivers Wet Weather organization cooperated in extending matching funds in excess of $270,000 toward the assessment and rehabilitation portions of the project.

A factor in grant approval from 3RWW was the proactive posture of Buchart Horn's proposal and the pro-

Typical Lowries Run manhole, post-application: Sauereisen's lining completely restores and seals the concrete vaults and brick chimneys.

A cement-based resurfacing material is pumped into open mortar joints within manhole chimneys.

ject's ability to serve as a demonstration for other municipalities facing the same challenges. Furthermore, 3RWW recognized the merit in supporting the co-owner's investment given the significant benefit to the entire watershed and region.

Partnering with Private Enterprise

Selection and installation of restorative materials was another matter to address. The cured-in-place pipe (CIPP) method was utilized for the smaller sewer lines and trunklines. Additional rehabilitation by sliplining, fold and form, and grouting ensured that many of the problem areas in sewer pipes could be repaired quickly and with little difficulty.

The manhole scenario, however, posed a greater challenge. Due to the larger diameter of manholes, CIPP is often cost prohibitive. That left a broad array of substrate repair materials, coatings, and linings to consider. Material selection proved to be a matter beyond mere form and functionality, however. For the sake of practicality, the methods of application proved to be a significant point needing evaluation, too. As a demonstration project, MTSA's intention was to perform the work themselves, without the use of outside contractors, yet they realized that application methods, equipment, and materials constituted a single system. The authority personnel had previously participated in the development of substrate repair technologies. However the challenges of this demonstration project required additional expertise. Consequently, the committee sought a local material supplier capable of coaching them through the installation process and providing detailed guidance on the materials

That material supplier was Sauereisen, Inc. (www.sauereisen.com), a third-generation manufacturer of corrosion resistant products. Sauereisen offered several capabilities to serve as a partner. The company's corporate headquarters is located within ten miles of the Lowries Run watershed, so access to product and technical service was high. And Sauereisen proved willing to innovate along with MTSA personnel in devising new methods of application that would expedite the placement of material, particularly in the problematic brick chimney sections of the manholes. According to Youngblood, "Sauereisen's multiple applications and expertise in applying them was a major part of our decision to choose Sauereisen for our demonstration project."

The company's offerings included a broad array of materials to choose from, including both organic polymers and cementitious formulations. Since there was little evidence of microbiologically induced corrosion present, a phenomenon more prevalent in warm-weather climates, the parties elected to forgo the use of the company's SewerGard epoxy topcoat. Instead, Buchart Horn approved a cement-based restoration material, H_2OPruf No. F-190, upon the manufacturer's recommendation.

H_2OPruf is designed to withstand hydrostatic water pressure on the negative side of below-grade structures. The material bonds tenaciously and exhibits compressive strength of 5,300 psi. These properties indicated it would be strong enough. The key feature, however, was its ability to perform as a waterproofing barrier. In this respect, H_2OPruf withstands 69.2 ft of water head (30 psi) in accordance with ASTM C 497-70.

Innovative Application

With complete confidence in the physical properties of the substrate repair material, Buchart Horn, MTSA's application crew, and Sauereisen turned their attention toward installation procedures. Standard installation of H_2OPruf had always required hand application using a masonry brush. Even though the simplicity of that method was appealing, each party recognized that a more expedient method was needed to meet time requirements.

Another timing challenge involved surface preparation. Something beyond a few cursory strokes of a wire brush was needed to remove unsound concrete and to wash away surface contaminants. Common practice involved the use of a hand-held waterblaster, which is relatively laborious in its own right, not to mention occasionally dangerous to the equipment operator.

In seeking ways to accelerate application, Sauereisen turned to its equipment vendors. Since the company's protective linings are commonly sprayed, pumped, or gunited, there were several options to consider. With brick manholes being prevalent along Lowries Run and particularly challenging to restore, Sauereisen sought some progressive approaches in an effort to offer the most cutting-edge solution.

For the surface preparation, a special robotic waterblaster was sourced. This unit, provided by WaterBlasters, Inc., was called the ManholeMaster™. It enabled high-pressure waterblasting through an extension arm and three-dimensional blasting head lowered into the manhole. The ManholeMaster is also equipped with a plate to cover the lid of the manhole while the blasting head does its work. An adjustment swivel allows for modification of depth and direction so that the spray can reach all areas of manholes regardless of shape and size. Most importantly for the MTSA crew, the equipment enabled complete surface preparation within 15 minutes without requiring human entry into the manhole.

MTSA liked the concept of executing manhole rehabilitation from street-level, and so they worked together with Sauereisen in finding a way to mechanically apply the restoration material. What they conceived was a manner of pumping the H_2OPruf through delivery hoses and then having the product sprayed onto the manhole walls by a rotating spincaster. The air-powered

spincaster was lowered and raised within the manhole until an approximate thickness of 1/8-in. was attained in just 20 minutes.

More than anything, this rotary spray method accelerated production rates dramatically. The MTSA crew went from an average of one completed manhole per day using the old hand application method to being able to spincast eight to ten manholes in the same time period.

To their credit, the MTSA crew, led by field supervisor Steve Buehler, became experts in staging materials and equipment in a manner that minimized downtime. For transporting equipment to some of the more remote manhole locations, they utilized their fleet of military surplus vehicles that had been purchased economically and refurbished. It helped that the rotor/stator pump used for the H_2OPruf was a fairly small, lightweight model. The necessity of crossing streams and traversing wooded habitats would have been impractical with most of the big and heavy rigs popular in the industry.

Challenges and Success

In addition to the large degree of creativity and cooperation evident in the Lowries Run project, another managerial factor supporting its success was a thorough measure of accountability. The project team maintained a database that included notes on inspections, installation, and material usage. Each manhole was photographed before and after application. The earliest inspections and installations occurred in 2001. Annual inspections have occurred since.

During the installation stage, Sauereisen technical service consultants Greg Maloney and Pete Jansen frequently accompanied Buehler and his crew to troubleshoot unforeseen challenges. In a rare instance where material mixing could not occur in the immediate vicinity of a manhole, the H_2OPruf was successfully pumped 200 ft. On multiple occasions, the crew found it difficult to attain full spincasting coverage on the underside of brick in the chimney section of manholes. In these cases, the spinning nozzle was removed from the end of the hose and an applicator quickly "buttered" open spaces as needed.

Material usage was tracked closely to minimize waste and to predict future requirements. An average of 6.2 bags of material were used per manhole representing only a slight overage to the initial estimation of 5.8 bags. From a labor standpoint, a crew of four averaged 3.8 hours per manhole to accomplish staging, waterblasting, lining operations, and clean up. This even includes time spent clearing paths in the woods and setting up scaffolds for above-ground manholes.

All-terrain vehicles transport materials and lightweight equipment to the more remote locations of Lowries Run.

In September 2004, the Lowries Run manholes were subjected to a test that no one could have imagined. In the aftermath of Hurricane Ivan, torrential rains settled over Allegheny County in what resulted in a nationally recognized state of emergency. Over eight inches of rainfall had occurred in a single day within portions of Pittsburgh's North Hills. The Lowries Run basin was hit hard by flooding of multiple streams within the valley. Some damage occurred within manholes equipped with channels oriented at a right angle. A few above-ground structures located downstream near the Ohio River were toppled over. But despite the accumulation of a great amount of debris within the manholes, the cementitious lining held up well to significant abrasion and impact.

Conclusions

As evidenced by a round of inspections in 2006 to mark the project's five-year anniversary, all of the manholes surviving Hurricane Ivan continue to be structurally sound. There continues to be little evidence of water infiltration through manhole structures.

Water II continues to be a serious issue in the region, however. While all indications suggest that manhole II was largely eliminated within Lowries Run, the problem of excess II into combined sewers and sanitary sewers elsewhere remain a focus of the Three Rivers Wet Weather Program and many municipalities. Consequently, manhole II remains a potential contributor to observed interceptor problems in the region.

Nonetheless, McCandless and Ross Township still have thousands of manholes within their borders, many in need of restoration. Consequently, MTSA and Ross continue their asset management programs utilizing multiple materials and vendors. Their situation is not unlike what other moderate-sized communities and big cities are facing throughout the Northeast, Mid-Atlantic States, and Midwest.

Buchart Horn's final report on Lowries Run states, "There is a clear regional need for low-cost alternatives for II reduction through manhole rehabilitation." Engineers around the country continue to specify spincasting technology and a wide variety of polymer linings. For those communities still assessing their problems, Lowries Run serves as a testament to what can be accomplished through effective planning, civic cooperation, and the right materials and application methodology.

According to Youngblood, "This project allowed the authority personnel the opportunity to gain valuable experience in repairing brick manholes using different products that worked well. The project will add years of serviceability to the operation of the interceptor with a minimal investment." GE

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NOTE: The full report is available on the 3RWW Web site under Municipal Demonstration Projects at www.3riverswetweather.org/f_resources/f_demo.stm.