

PEOPLE, PRODUCT, AND PROCESS:



Planning and Execution of a Large Diameter Multi-Sensor Pipe Inspection Project

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It was only a little over 20 years ago that Boston Harbor was known as the “dirtiest harbor in America” while today, it has been transformed into a jewel. The \$3.8 billion invested in the treatment facilities at Deer Island and nearly \$1B in other infrastructure upgrades have proven to be a great success and the harbor clean-up is widely recognized as one of the nation’s greatest environmental achievements.

The City of Boston’s sewerage system dates back to the 1870s when State Legislators approved the construction of the Boston Main Drainage System. The new system, built between 1877 and 1884, diverted sewage from 18 cities and towns to Moon Island in Boston Harbor. There sewage was held for release with the outgoing tide.

In the late 1800s the Metropolitan Sewerage District (MSD) was formed to

build one of the first regional sewerage systems in the country. Expansions to the sewerage system continued through the early 1900s. The system soon became recognized as one of the best in the country, though it provided no treatment - it merely collected the wastewater and sent it out into the harbor.

The Massachusetts Water Resources Authority (MWRA) is a public authority established by an Act of the Massachusetts State Legislature in 1984 to provide wholesale water and sewer services to 2.5 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities. In 2000, many of the collection and conveyance upgrades, along with the Deer Island Treatment Plant and Ocean Outfall were completed with sewer service provided to more than half of Massachusetts’s residents, over 2 Million people.

MWRA’s North Metropolitan Sewer, specifically sections 4, 5, 6, and 186, convey flow from the Caruso Pump Station in East Boston along with several local connections to the Winthrop Terminal Facility at the Deer Island Treatment Plant in Winthrop. This gravity sewer meanders through the neighborhoods and narrow streets of the Town of Winthrop. Sections 4 (5,711 linear feet), 5 (4,600 linear feet), and 6 (4,112 linear feet) were constructed in 1891 and are 108-inch brick sewers varying from circular to slightly oval to horseshoe. Sections were rehabilitated between 1992 and 1995 with 4 inches of shotcrete and then coated with an epoxy. Section 186, a 600 linear foot section, is a 108-inch sewer constructed in 1999 and has sections lined with various lengths of embedded plastic liner, bolted plastic liner, and plastic liner installed with an adhesive.

“I could not possibly be more proud of the project team, their relentless commitment to keeping each other safe in challenging conditions and to delivering the highest quality inspection data to our client is what keeps me going. And to see them do it with a smile on their face, and a high five when they come out of a manhole, tells me we have some pretty special team mates”.

- MATT TIMBERLAKE, PRESIDENT, TED BERRY COMPANY

Since 2011, the MWRA has been experiencing liner failures which were identified when a large piece of plastic liner was found at the intake screens of the Winthrop Terminal Facility. Subsequent manned entry and CCTV investigations determined that the sections were

experiencing significant deterioration of the various lining technologies. These sections are critical to the conveyance of almost 18 MGD of average daily flow to Deer Island.

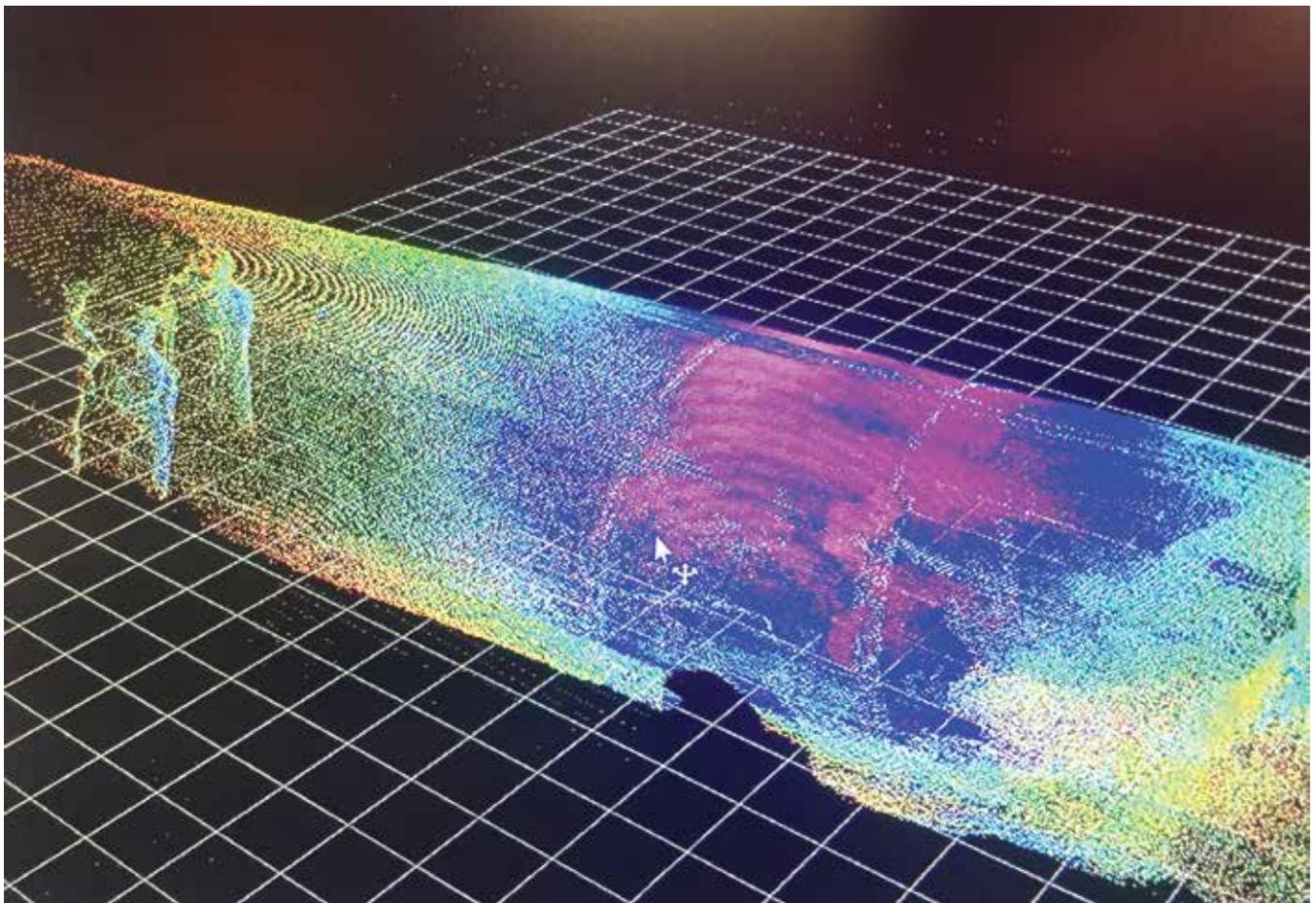
In 2016, the MWRA retained Hazen and Sawyer to perform a comprehensive

evaluation of the entire length of these interceptor segments and the variety of interior pipe lining technologies and provide recommendations for rehabilitation.

With significant experience and reputation throughout New England, the Ted Berry Company was retained as a specialty subcontractor to complete the critical manned entry inspection, core sampling, sounding, and 3D multi-sensor inspection of the entire length of these sewer segments.

Seasoned collection system experts know the challenges and limitations of inspecting large diameter sewers. With limitations on cleaning and bypassing of base flows, critical assessment of the entire pipe diameter is always difficult and in the case of the North Metropolitan Sewer segments identified by MWRA, additional challenges included the narrow streets and neighborhoods that the sewer segments were located under.

With almost 3 miles of interceptor to evaluate Matt Timberlake President, Dave



Combined point cloud covers approximate 72 feet of pipe length



Entry into conduit was for data collection only, no repairs or debris removal

Beauchamp, CCTV Services Manager, and Jack Berry, Project Health and Safety Manager realized that success would be driven by three (3) major components: **People, Product, and Processes.**

Without experienced, competent and passionate field technicians the best technologies and work plans will fail. The Ted Berry Company project team identified the field implementation team needed to accomplish a challenging deployment of multiple assessment technologies which were going to be undertaken overnight to provide access during low flow conditions.

The scope of work required manned entry with sounding and core sample collection, which necessitated a significant work plan for health and safety. With an in-house health and safety manager a robust work plan was developed and practiced prior to field deployment. The entire work plan was prepared

and reviewed by MWRA staff for approval. The Underground Health and Safety Plan (HASP) that was presented described safety procedures that would be implemented for underground operations during all phases of the combined sewer pipe inspection and sample gathering project. Zero injuries, near misses or damage to property or the environment was the first priority of all operations. Entry into the conduit, a Permit- Required Confined Space (PRCS), was for the purpose of data collection only. No repairs or debris removal were performed.

With several technologies available to provide multi-sensor inspections for large diameter active sewer segments, Ted Berry Company evaluated the options and selected the CUES SolidFX Multi Sensor Inspection (MSI) Platform System equipped with the side scanning Digital Universal Camera (DUC), LiDAR and digital Sonar. 3D LIDAR technology



Ted Berry team (L-R): Matt Timberlake-President, Joshua Rackliff-Technician, Eric Gemelli-Field Project Manager, and Mike Cram-Technician

from CUES (SFX-3D) was the preferred inspection solution for the condition assessment scope of the project. SFX-3D uses the same “time-of-flight” ranging principle that is used in every precision, survey grade LIDAR system in military and civilian use. The sensor emits and detects photons of light, calculating the range and intensity of approximately 50,000 points per second. These points are



Manned entry for sounding and core sample collection required a significant health and safety work plan

called point clouds. The LIDAR produces a point cloud every time a SCAN is taken. In addition to providing accurate corrosion and ovality information for identifying failing assets, it is the only technology capable of capturing and modeling shape and size transitions, identifying and measuring bends, capturing lateral and manhole details for CAD modeling, and locating the asset's centerline with respect to manhole locations.

A common reason for collecting 3D LIDAR data is to measure the horizontal and vertical deflections and determine the smallest bend radii (i.e., tightest bends) in the pipe line. To achieve the most accurate results, a 'DUAL LIDAR' setup is used to double the length of the point cloud that is being measured.

In the dual setup, two LIDAR units are placed back-to-back at a known linear offset and then calibrated to correct for any angular offsets. The result is a combined point cloud which can be seen in the image on pg.47. The point cloud is being viewed from above (PLAN VIEW)

in order to make visible the deflections in the horizontal plane.

The point cloud is most dense near the sensor head and decreases in density as you move away from the sensor. This combined point cloud covers approximate 72 feet of pipe length, significantly increasing the measurable length, and providing a dense, measurable cloud at both the upstream and downstream joints.

Several months of work plan development were completed including the important Health & Safety Program development and training. The field implementation was extremely successful and is a testament to the dedicated planning effort of the project management team and the field crew's execution and adaptation to actual field conditions. The inspections were completed over a series of two weeks in the field with a few delays caused by some rain events in the area.

"This was an out of the ordinary project and a tough job. The health and safety plan, sounding techniques, and multi- sensor approach made it a success"
- Kevin Raftery, Hazen and Sawyer. †

ABOUT THE AUTHORS:



Matt Timberlake is the President of the family owned and operated Ted Berry Company Inc in Livermore, Maine. A third generation company founded by Matt's maternal grandfather Ted Berry in 1972.



Adam Slifko is a Business Development Manager with Pipeline Inspection Partners Corp., a division of CUES. Mr. Slifko manages the SFX, multi-sensor line of business, with an emphasis on 3D LIDAR applications. He has a degree in mechanical engineering and over the past decade has helped to develop the platforms, sensors, field practices, and reports that have become known in the industry as 'multi-sensor inspection.'