# TECHNOLOGIES TO ASSESS CONDITION OF WASTEWATER RISING MAINS

*Wayne Griffith, WSP Opus*

**ABSTRACT**

This paper discusses the application and limitations of industry leading technologies used to assess the condition of wastewater rising mains. These technologies include destructive technologies (DT) as well as non-destructive technologies (NDT).

Wastewater rising mains are an integral component of the wastewater network. However, they often have no redundancy with a pump station being served by only one rising main. Failures to these critical assets occur in our cities and have the potential to impact the quality of the environment, jeopardize the health of our communities, and cause financial pain by damaging property and requiring costly unplanned repairs. Understanding the condition of these critical assets is paramount to ensure service and performance reliability. It is also necessary to understand the condition of these assets as they age and become vulnerable to failure.

Wastewater rising mains are difficult to properly inspect, as they are under pressure and cannot usually be taken out of service. Faults that cause problems may be very small and are often not possible to identify from the more common inspections that are carried out.

A variety of materials are used for wastewater rising mains. These materials perform differently depending on the application, service conditions, installation, age, and manufacturer. This adds to the complexity of finding the appropriate technology to assess the condition of the wastewater rising main.

Technologies are available to inspect wastewater rising mains which typically involve DT as well as NDT means. However, the application and limitation of these technologies is not well established.

This paper presents a review of available condition assessment technologies for wastewater rising mains. Consideration is given to vulnerability issues with certain materials and particular service conditions. The knowledge gained in the proper application of technology currently available ensures the highest level of confidence as to the condition of the wastewater rising mains. Ultimately, this knowledge informs the owner of a wastewater rising main’s vulnerability, remaining operational life, and provides information needed to effectively plan for renewal of the asset.

This paper describes the process undertaken to survey and apply available technology. The process included the initial compiling, validating and understanding the wastewater rising main system, its characteristics and vulnerability. Options for DT and NDT technologies were considered. Subsequently, a condition assessment programme will be developed to determine condition grade and estimated remaining operational life for each asset.

**KEYWORDS**

**Asset Management, Wastewater Rising Mains, Condition Assessment Technologies**

**PRESENTER PROFILE**

Mr. Griffith is a water utility management professional with experience in the U.S and New Zealand. He promotes and delivers programs to optimize assets and enhance resources, achieving improved levels of performance and service. Mr. Griffith has a unique blend of industry leading private sector operations management and consulting experience.

# 1 INTRODUCTION

This paper uses the rising mains considered typical with any district council to survey the available techniques to assess the condition of the various size, materials and age of the wastewater infrastructure.

This effort resulted in an initial selection of condition assessment technologies that will be used to establish guidelines for the assessment of wastewater rising mains.

Additionally, the effort offers to improve the renewal programme for wastewater rising mains. This is a vital component of a comprehensive asset management program. And the ultimate outcome and benefit will be to help reduce the possibility of raw sewage entering the environment and reduce the risk of public health exposure.

# 2 CHARACTERISTICS OF RISING MAINS

Traditional wastewater networks are mostly gravity systems. Rising mains typically only make up a small proportion of the overall network. There primary use is to transport wastewater over hills and other areas where there is inadequate fall for wastewater to flow via gravity.

## 2.1 MATERIALS

Rising mains can be constructed from a variety of materials. Older mains tend to be ferrous pipe, e.g. concrete lined steel or cast-iron pipes. Newer pipes are often Polyvinylchloride or Polyethylene, with some legacy asbestos cement pipes still being in use. Each of these pipe materials have their own characteristics and issues that need to be considered when developing a condition assessment programme.

## 2.2 DIAMETERS

Rising mains are typically not man-entry size and, require inspection by remote means. According to the data, the majority of the rising mains have diameters ranging in size from 100mm to 600mm.

## 2.3 AGE

Industry estimate from the Water Environment Research Foundation indicates that close to 70% of rising mains are less than 25 years and 30% between 25 and 50 years old.

## 2.4 LOCATION

Rising mains are often installed under roads or the side of the road. They are typically installed in shallow trenches, with less than 2m cover.

## 2.5 REDUNDANCY

There is, typically, no redundancy with rising mains. Normally, pump stations are serviced by only one rising main. Thus, if there is a problem with a rising main, the pump station will need to be shut down and a potential for overflows need to be managed. It may also be difficult to take the rising main out of service for inspection and testing.

# 3 PIPE DATA MANAGEMENT

The ability to objectively prioritise wastewater rising main renewals is partly inhibited by the lack of confidence in the pipe data and understanding of the pipe's performance, criticality and condition. It is also inhibited by the lack of understanding of cost and/or appropriateness of condition assessment technologies for wastewater rising mains.

Wastewater rising mains are generally categorised as "medium to high criticality." They are inherently a medium to high risk type of asset.

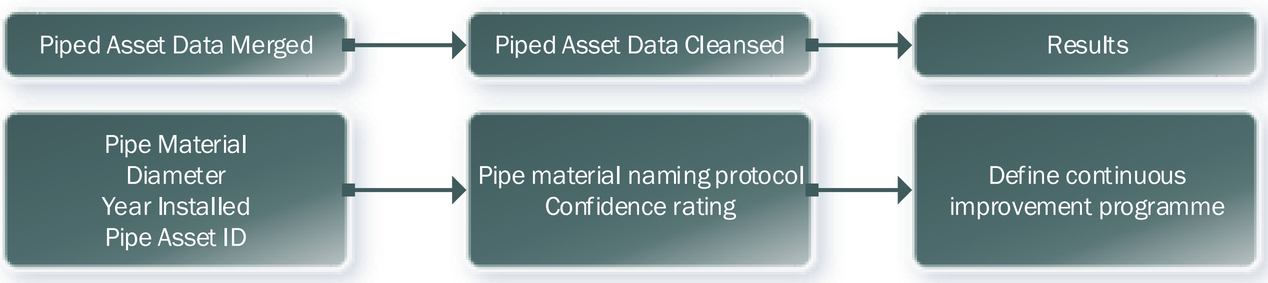
Before medium to high risk assets such as rising mains are prioritised for renewal, a high level of confidence is needed in the data used for the assessment of consequence and probability of failure.

When data confidence is low to medium and the risk is medium to high, the requirements dictate the collection of more data when planning renewals.

## 3.1 PROCESS FOR PIPE DATA UNDERSTANDING AND CONFIDENCE

Figure 1 presents the process for understanding the pipe data and establishing a data confidence rating. When considering condition assessment techniques, it is important to understand the material, age, and diameter. These are the key factors that are considered when establishing an approach for condition assessment.

Figure 1: Process for pipe data understanding and confidence



## 3.2 CONTINUOUS IMPROVEMENT PROGRAM

The process to understand the wastewater rising main data and assign a data confidence grade provides valuable insight into developing the strategy and positioning for an appropriate condition assessment technique. Material, age, and diameter are all critical dimensions that go into the decision process for establishing the strategy to assess condition. Identifying assets with high levels of confidence allow the program to be prepared knowing the information is accurate.

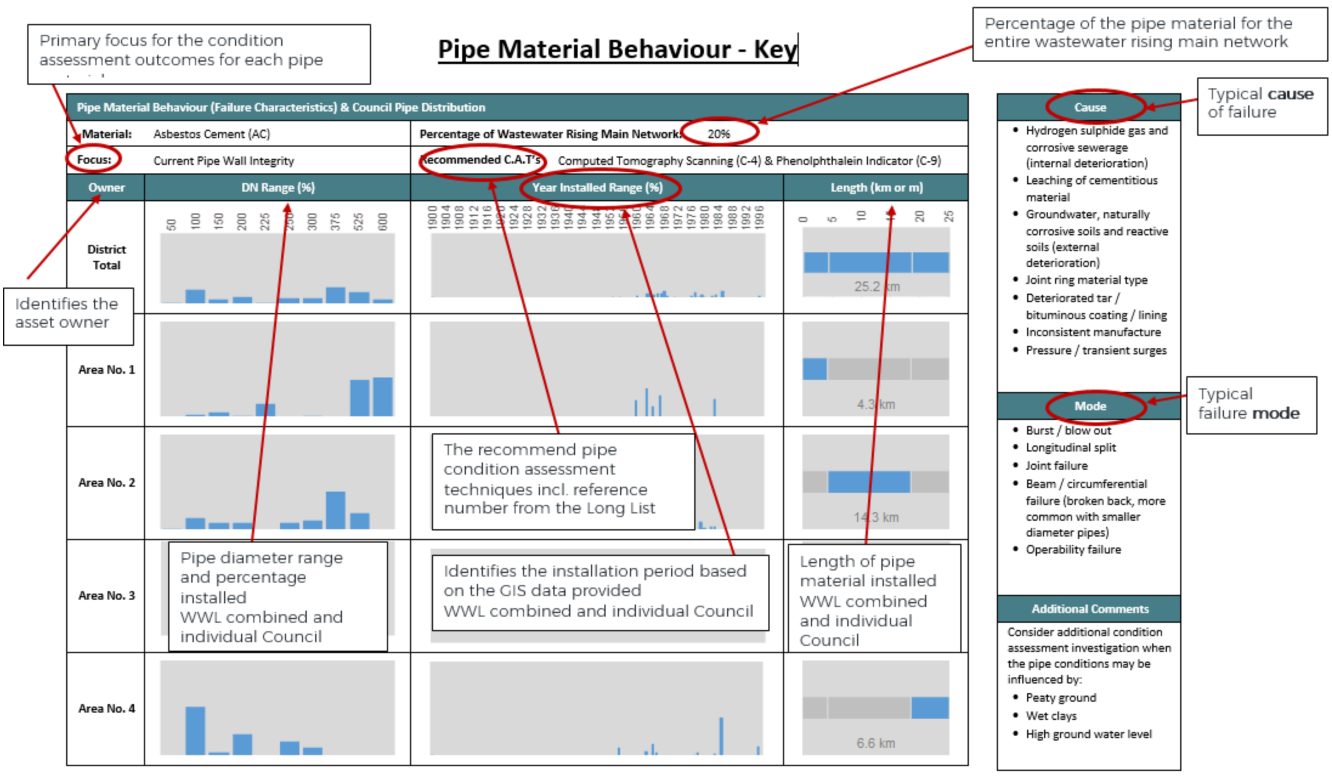
Knowing what assets have low levels of confidence allows for a data confidence improvement program to be developed and implemented in advance of determining the appropriate condition assessment process and technique. Assigning a criticality component to the assets with lower confidence grade will also help to prioritise the data confidence improvement program.

# 4 MATERIAL BEHAVIOUR

After each sewage rising main pipe material has been identified (e.g. AC, CLS etc.) a pipe material behaviours and failure characteristics evaluation was conducted.

In order to evaluate the most effective condition assessment technique, there needs to be an understanding how the materials behave and what would be the focus area for measuring the condition of the rising main.

Figure 2: Pipe Materials Behaviour Key – Example




For each material, a matrix is prepared outlining the key characteristics for each pipe material along with a brief description of how the pipe may degrade and the key issues that should be identified through condition assessment. An example of the matrix is shown in Figure 2: Pipe Materials Behaviour – Example, which is specific to AC. Additional dimensions for the pipe material are called out including the percentage of material that makes up the rising main systems, the range of diameter, range of year installed, and the length.

In summary, the mode of failure is dictated by the materials and thus indicates what to look for in the assessment of the pipe condition. Having an understanding how the materials behave and what would be the focus area for measuring the condition of the rising main is essential in evaluating the most effective condition assessment technique.

# 5 CONDITION ASSESSEMENT TECHNIQUES

The use of condition assessment techniques provide valuable information for asset managers. The information gained can help to more accurately understand the vulnerability of wastewater rising mains and influence forecasts for the replacement in efforts to prevent failures from occurring.

Having validated the data and established a level of confidence the materials that comprise the wastewater rising mains, a review was conducted of the DT and NDT currently available to gain the desired level of knowledge and the highest level of confidence.

## 5.1 SURVEY OF CONDITION ASSESSMENT TECHNIQUES

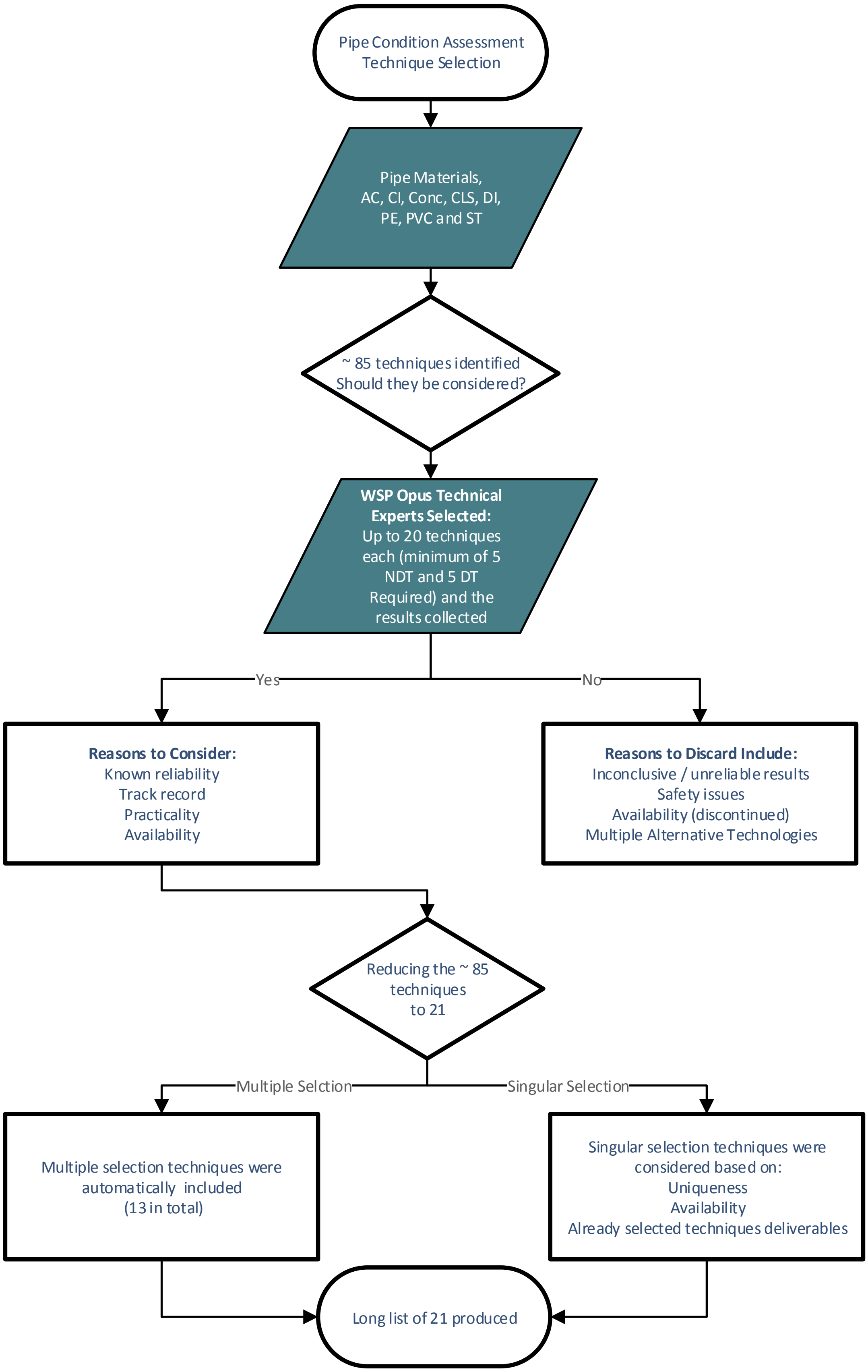
A survey was conducted that determines the range of available technology, methods, techniques (DT & NDT) and options currently available to assess the condition of a wastewater rising main. This effort leveraged the involvement of various technical and subject matter experts and access to industry organizations, research, and project related experience. The techniques were categorized with the understanding that condition assessment techniques for wastewater rising mains have four (4) primary focus areas. They include:

- Current Pipe Wall Integrity/Current Coating Condition – *"C" reference designation*
- Future Pipe Wall Integrity – *"F" reference designation*
- Leakage – *"L" reference designation*
- Operational Risk – *"O" reference designation*

The following rationale was applied in surveying the available techniques also outlined in Figure 3: Condition Assessment Techniques Consideration Process:

- Direct experience of a technique being utilised
- Inconclusive nature of the results
- Very limited application
- Known availability / procurement issues
- Alternative / similar techniques available with minimal procurement issues

Figure 3: Condition Assessment Techniques Considerations Process



By applying this rationale, 36 individual condition assessment techniques were identified. Of the 36 individual condition assessment techniques that were identified, the following ratification was applied:

- Where 2 or 3 subject matter experts agreed, the technique was automatically included (13 in total)
- The remaining 23 were further reviewed, based on previously selected techniques that have the potential to provide similar / comparable results (e.g. multiple CCTV / Laser / Sonar technologies)
- Of the remaining 23 techniques, 8 techniques were taken and added to the original 13 that equated to a total of 21 techniques.

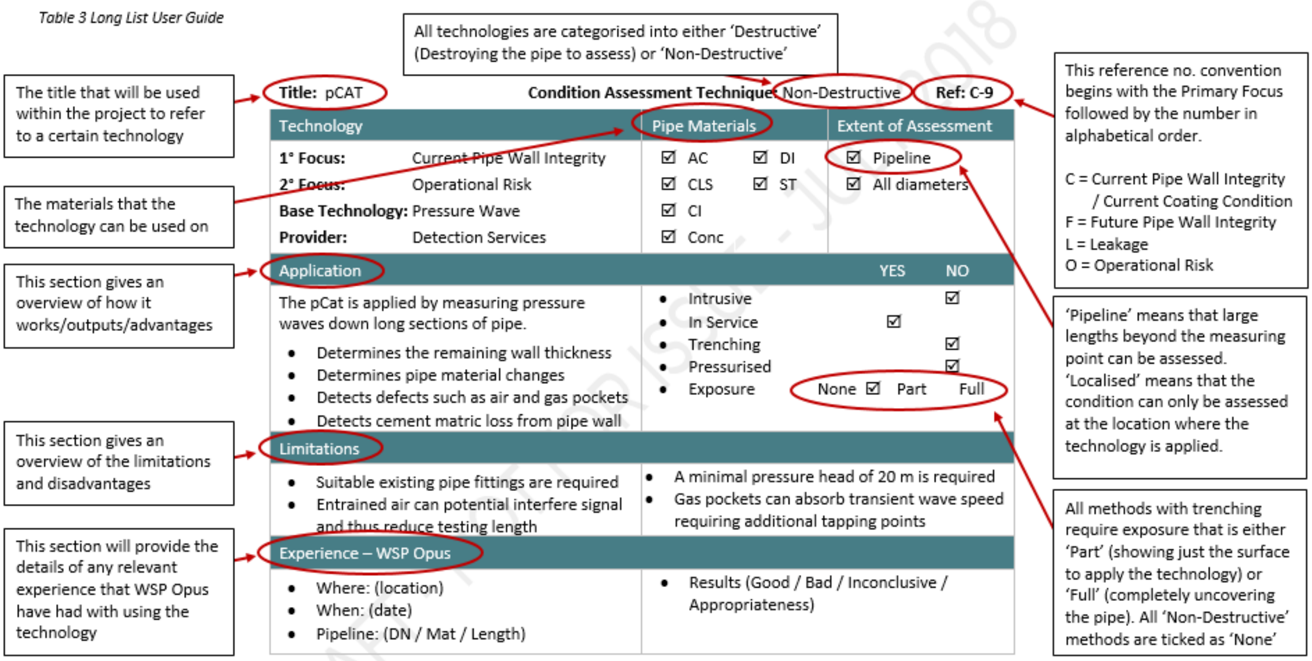
## 5.2 EVALUATION OF CONDITION ASSESSMENT TECHNIQUES

This resulted in the identification of initially appropriate condition assessment techniques. A summary table was developed showing background information and content on the techniques. Information included in the summary table includes:

- Description of the type of information or variables considered for each
- Commentary on the limitations of the condition assessment technique (e.g. can it assess structural integrity or be used to define useful life)

Figure 4: Condition Assessment Techniques Evaluation Key – Example provide a sample of the information summarized for the non-destructive technique referred to as pCAT.

Figure 4: Condition Assessment Techniques Evaluation Key - Example



## 5.3 CONDITION ASSESSMENT TECHNIQUES REFINEMENT

The refinement of the list of 21 techniques will be conducted to establish the specific application and cost for each of the shortlisted technologies. The additional analysis will result in:

- Determination of the availability of technology in New Zealand including the economic feasibility to import technology that is currently only available outside New Zealand.
- Assessment of the cost for each technology and determine economies of scale
- Consideration for the calibration of each NDT condition assessment technology against DT condition assessment technology

The list of appropriate techniques for condition assessment are shown in the Table 1: Pipe Condition Assessment Technology. The reference designation refers to the technologies focus area.

*C - Current Pipe Wall Integrity/Current Coating Condition*

*F - Future Pipe Wall Integrity*

*L – Leakage*

*O - Operational Risk*

Table 1: Pipe Condition Assessment Technology

| Reference | Pipe Condition Assessment Technology |
|---|---|
| **C-1** | CCTV Pipeline Inspections |
| **C-2** | Corrosion Pit Depth Measurement |
| **C-3** | Crushing Test / Ring Bending |
| **C-4** | Computed Tomography Scanning |
| **C-5** | Field / Visual Inspections |
| **C-6** | inSight |
| **C-7** | Laser Profiling |
| **C-8** | pCat |
| **C-9** | Phenolphthalein Indicator |
| **C-10** | Tensile Tests |
| **C-11** | Inspection of Pipeline Coatings |
| **C-12** | Broadband Electromagnetic |
| **C-13** | Pipeline Current Mapping & Coating Defect Survey |
| **F-1** | Corrosion Properties of Soil |
| **F-2** | Methylene Chloride Temperature Test |

| Reference | Pipe Condition Assessment Technology |
|---|---|
| **F-3** | Notch Bend Back Test |
| **F-4** | Electrical Properties of Soil |
| **L-1** | Acoustic Leak Detection |
| **L-2** | inScan |
| **L-3** | Smart Ball |
| **O-1** | Dynamic Fatigue Stress Assessment |

With the refinement of the appropriate condition assessment techniques for wastewater rising mains, a strategy can be developed for the ultimate application of the technique as part of an overarching condition assessment program. Each pipe material has an approach that will initial comprise a desktop analysis.

The desktop analysis takes into account the determination of such details as remaining useful life, failure history, operational performance, operational condition, class & diameter, ground water conditions, soil properties, fatique assessment, and joint types. Additionally, restrictions and limitations are considered that take into account access, economies of scale and availability of specialized equipment. This information provides the needed guidance to determine whether an non-destructive or destructive testing is required.

If a non-destructive testing is proposed, additional consideration is given as to whether this can be accomplished via an internal view only or whether a section of the pipeline needs to be exposed. If a non-destructive technique is not apprpriate, a destructive testing approach is evaluated. And tyipically, depending on the risk and urgency, a planned or opportunistic destructive testing technique is conducted.

# 6 CONCLUSIONS

The outcome for this work helps to ensure information is available using data with an acceptable level of confidence to make optimal investment decisions for the renewal of wastewater rising mains. Prudent use of condition assessment technology can be incorporated in a comprehensive asset management improvement plan. This plan can be used as a guide for staff and service suppliers. The plan can also be used to refine future renewals and budgets from year to year.

The knowledge gained in the proper application of condition assessment technologies currently available ensures the highest level of confidence as to the condition of the wastewater rising mains. Ultimately, this knowledge informs an owner of a wastewater rising main's vulnerability, remaining operational life, and provides information needed to effectively plan for renewal of the asset.