Overview
The structural deterioration of water mains and their failures is affected by a number of factors, including pipe material, pipe size, pipe age, soil type, climate, and pressure zone changes. However, the physical processes that lead to pipe breakage are very complex and not fully understood. One reason is that because most pipes are buried, there is little data available about how they deteriorate and fail (Kleiner and Rajani 2010).

Water utilities can use statistical methods to predict water main breaks by reviewing available data on past failures. They can use this information to identify pipe breakage patterns and extrapolate them into the future. Utilities also can use these data to help forecast water rates (Kleiner and Rajani 2010).

One such statistical method is the deterministic model, which can predict breakage rates based on pipe age and

### Pipe Deterioration Factors
- PIPE MATERIAL
- SOIL TYPE
- PIPE SIZE
- CLIMATE
- PIPE AGE
- PRESSURE
breakage history. This model works best with groups of pipes within a water system (Kleiner and Rajani 2010).

Condition Assessment Technologies and Techniques
A condition assessment is any direct or indirect way to gauge the condition of pipelines and, as a result, better determine the likelihood of failure of those assets. A condition assessment cannot, however, present a specific estimate of the remaining life span of a pipeline.

Because of the extra costs, the science of condition assessment of drinking water systems lags behind those for wastewater systems. Because of the technological limitations of the assessment methods and the cost considerations of pipeline replacement, most condition assessment activities for drinking water systems focus on large diameter pipe.

Water utilities engaged in condition assessment activities have very often experienced large diameter pipe

Condition assessments require extra time, effort, and expense for water utilities, over and above operating and maintaining the water distribution system.

Because of the extra costs, the science of condition assessment of drinking water systems lags behind those for wastewater systems in terms of industry acceptance and use. For example, although direct visual inspection of pipelines by closed-circuit television is a proven and inexpensive inspection technique for wastewater systems, it has only limited application and value for drinking water systems.

Figure 1. Pipeline selection process and condition assessment approach

Source: Zarghamee et al. 2012
failures, and these failures have been disruptive. As such, condition assessments are an important part of a utility’s overall risk management efforts. In Best Practices Manual for Prestressed Concrete Cylinder Pipe Condition Assessment, a graph of pipeline selection process and condition assessment approach is presented for PCCP, which is also applicable for other pipes (Figure 1) (Zarghamee et al. 2012).

Though condition assessments today focus on large diameter pipes, there is work underway to design small diameter pipe condition assessment technologies and to develop practical applications of those technologies. Because there are larger quantities of small diameter pipe, the development of useful technologies in this area can significantly enhance the ability of utilities to make pipeline replacements in their water systems.

Obstacles to the Use of Condition Assessment

When thoughtfully applied, condition assessments have great value for water utilities as they manage deteriorating pipelines and water distribution systems. Yet, though there are useful and commercially available condition assessment techniques available, overall use of these technologies is infrequent. Reasons for this include:

- Concern about the costs and difficulties related to conducting condition assessments.
- Confusion about the technologies available, and their application and value.
- Concern about the inexact nature of the information and data resulting from the condition assessments.
- Lack of detailed analyses of the cost and benefit of this work.

- Delay in conducting condition assessments in hopes of having improved technologies available at a lower or similar price in the future.

References
