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INFLOW AND INFILTRATION: A NEW APPROACH

Inflow and infiltration costs money and damages public trust. Water expert **Andy Gibson** explains how AECOM's innovative new process is helping municipalities improve traditional management methodologies.

Aging infrastructure, increasing populations, expanding cities and climate change are just some of the issues that are exacerbating inflow and infiltration, a condition that occurs when underground wastewater conveyance systems become susceptible to damaging wet weather inflow and groundwater ingress, through direct stormwater connections and deteriorating pipes. Inflow and infiltration are costly to municipalities and the communities that they serve, causing issues such as increased sewer overflows, flooded basements, sinkholes, polluted waterways, public beach closures, and can ultimately result in higher sewer charges.

However, a new approach to managing inflow and infiltration can help municipalities address this costly and damaging issue.

The innovative process, which combines optimization, advanced analytics and engineering knowledge, has been developed by AECOM to improve on traditional inflow and infiltration management methodologies by reducing costs and decreasing flood and overflow risks to municipalities and city residents.

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A costly business

The American Society of Civil Engineers estimates that inflow and infiltration cost cities in the United States around $100 billion annually. The results of inflow and infiltration are expensive and impactful. Managed improperly, increased water volumes related to inflow and infiltration can raise treatment and pumping costs.

Additional to the costs of the construction improvements needed to control inflow and infiltration are the indirect costs that stem from inconvenience to businesses and residents due to basement flooding and overflow. Overall mismanagement also erodes public confidence in a city's ability to manage the water system, a trust that can be difficult to regain.

Furthermore, municipalities that don't comply with regulations can be forced to act through a consent decree process. If these decrees are not met, the municipality can be party to large daily fines from the Environmental Protection Agency.

The advantages of a different approach

Inflow and infiltration are not new phenomena. Municipalities have grappled with these issues for years, traditionally using flow metering, smoke testing, dye testing and hydraulic modelling data to identify and prioritize sewer catchment areas and rehabilitative initiatives.

However, this approach is reactive and can be inefficient as it targets catchments that are already failing and performing poorly. In addition, prioritization generally only considers a small number of constraints or 'business questions,' such as 'which pipes do I fix for least cost?', or 'what are my leakiest pipes?'.

In contrast, AECOM's optimization approach is proactive, combining new technology-based analytics, global expertise and optimization. It uses data in a new way to look at the risks and benefits of addressing the issue in a more holistic way. The method combines predictive analytics with engineering knowledge to help guide the decision-making process. As a result, we can identify improvements to capital, operational and maintenance regimes that will enable municipalities to identify, plan and execute intervention plans that reduce inflow and infiltration based on a blend of business questions.

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As a result, municipalities can balance competing organizational priorities while making the most of the limited resources available to manage their buried water systems.

Promising result

By moving their business from a descriptive analytics space (reactive maintenance) to a prescriptive analytics space (proactive maintenance), this new method can deliver significant advantages.

For example, we performed comparative analysis with three different jurisdictions — two in the U.S. and one in Australia — where we were provided with access to previously defined capital programs. Using the same input data as the municipalities' own, we generated three bespoke 'proof of concept' 15-year intervention plans that all met the regulatory objectives but for significantly less investment dollars.

Recently, the new method was also used in Asia Pacific and Europe. The results have shifted plans for water system management from reactive to proactive, saved substantial amounts of money and preserved the integrity of buried water systems far into the future. While savings on construction depend on individual program goals, this new approach may well save between 10 to 15 percent over costs related to traditional methods.

Looking to the future, we are just getting started. As cities continue to do more with less, we will continue refining our approach helping municipalities deliver solutions that will protect communities across the United States and around the world. WL

HOW IT WORKS: OPTIMIZATION

In the simplest terms, optimization is a mathematical technique that allows municipalities to find 'the best solution' from a given set of options (or other bounded problem). It follows that 'the best' is defined by the problem that needs 'optimizing' or 'solving'. For example, municipalities may wish to minimize operating costs, minimize the number of asset failures or maximize asset life.

The use of an optimization engine is typically only required when the problem grows too big or complex to be solved easily. The aim of the problem-optimizing process is to arrive at what's known as the 'objective function' — a quantitative measure (or metric) that needs to be either maximized or minimized to achieve 'the best' outcome.

The perfect example would be a large sewerage asset base with 44,000 independent pipe segments and over 1,000 pump stations, where each asset has multiple proactive investment options to address inflow and infiltration that can occur in different years or months: the problem suddenly becomes very large and much more difficult to solve. Municipalities may also wish to achieve certain levels of service and add these as constraints. Or, they may wish to compare the solutions to different questions, such as: what is the minimum that can be spent in order to maintain current levels of service?; what is the minimal whole life cost over the next 20-year period to meet the desired level of inflow and infiltration?; how much can service levels improve if $X is spent per year over the next 10 years?

Our optimization approach — based on our understanding of inflow and infiltration, how assets deteriorate, innovative pipe rehabilitation or replacement methods, risk-based approaches and optimization techniques — allows us to find the optimal answers to those questions and provides municipalities with long-term tactical intervention strategies to meet regulatory requirements.