ENVIROSIGHT

WHITEPAPER

INFLOW AND INFILTRATION

COMBATING INFLOW & INFILTRATION FROM THE INSIDE OUT

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A SMARTER APPROACH TO ADDRESSING I&I

Tracking down and fixing excessive inflow and infiltration (I&I) is no small demand. But I&I is a pressing issue, costing cities a tremendous amount of resources every year.

Municipalities continue to see diminishing budgets annually, on top of rapidly aging and deteriorating infrastructure, and financial resources for addressing I&I are often limited. But the issue can't be ignored, and an analysis-driven strategy can dramatically increase the amount of I&I resolved for a given budget. Successfully reducing I&I isn't out of reach, especially when a proactive approach is taken.

WHAT IS I&I?

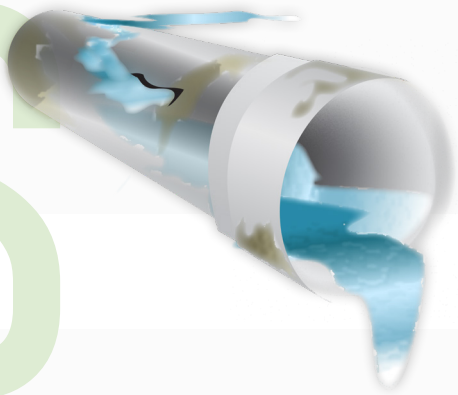
The first step in reducing I&I is understanding it. **Infiltration** occurs when groundwater seeps into defective sewer pipes through cracks, joints or manholes. These defects may result from a number of causes, including age, soil movement, tree roots, or improper design, installation or maintenance.

Inflow occurs when stormwater enters the sewer system through roof drains, basement sump pumps, leaky manhole covers or foundation drains illegally connected to the sewer.

01

INFILTRATION

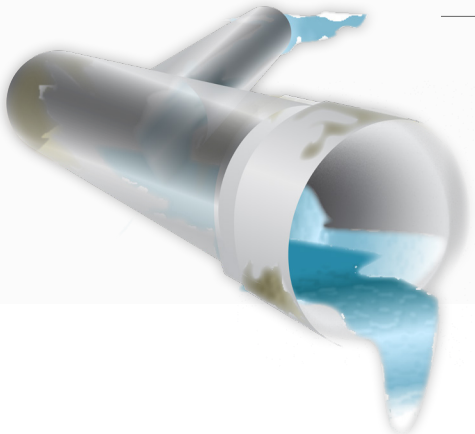
GROUNDWATER ENTERS THROUGH CRACK IN PIPE



VS

02

INFLOW



STORMWATER ENTERS THROUGH IMPROPER ROUTING

WHAT IS I&I? (CONT.)

With time, nearly all systems will experience some I&I. Dirt settles, traffic patterns change, and normal wear and tear can cause leaks, cracks and disruptions to even the best constructed pipes. However, problems begin to arise when I&I becomes excessive.

Wastewater systems are designed to carry a set amount of wastewater. When the flow exceeds that amount, severe damage can ensue, including pipe structure failures and ground subsidence.

Exceeding a collection system's capacity can also result in wastewater being discharged into the environment untreated, threatening the health of surrounding communities.

QUICK FACTS

WHY DO PIPES FAIL?

01 GROUND SETTLING OR FAILURE OF PIPE BEDDING

02 EXCESSIVE MECHANICAL LOADING FROM SURFACE

03 DETERIORATION OF PIPE AND SEAL MATERIALS

04 IMPROPER MODIFICATIONS

05 ROOTS AND OTHER UNDERGROUND DISTURBANCES

FINANCIAL IMPACT

When I&I occurs, the heightened amount of effluent also presents extra costs to treatment facilities, as they're forced to treat otherwise innocuous stormwater and groundwater that has mixed with sewage.

"A single leak from a joint in a manhole or pipe can generate [up to] 7,200 gallons of water each day," according to SEH Water Resources. "After being treated at the wastewater plant, that water can translate into an annual cost of $6,500 for a city. Multiply this cost by the number of leaks across the sanitary sewer system and it could mean a hefty price tag for a city."

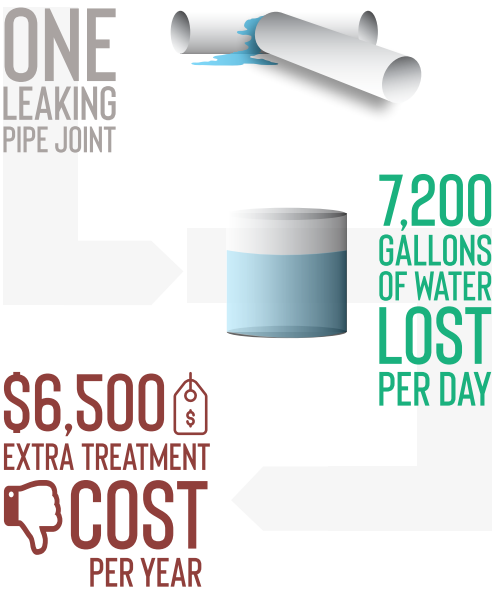
The 1972 Clean Water Act (CWA), as it's considered today, establishes the fundamental structure for regulating discharges into U.S. waterways, as well as setting quality standards for surface waters. Under the CWA, the U.S. Environmental Protection Agency (EPA) has the authority to regulate pollution discharges and set water quality standards.

If a city exceeds the discharge standards set by the CWA, the EPA may enter into a consent decree with the responsible municipality and require a hefty fine in civil penalties to resolve the violations. These fines can actually surpass the cost of establishing a comprehensive inspection program. In some cases, the EPA can waive these fines if municipalities demonstrate they have a strategy in place to address I&I. All to say, not addressing I&I can have catastrophic environmental and financial implications.

> "A SINGLE LEAK FROM A JOINT IN A MANHOLE OR PIPE CAN GENERATE [UP TO] 7,200 GALLONS OF WATER EACH DAY," ACCORDING TO SEH WATER RESOURCES.

THE BREAKDOWN

THE POTENTIAL COST OF A SINGLE LEAK



CURRENT MITIGATION EFFORTS

Many municipalities have some type of program or practice in place to address I&I, but these plans are often resource-inefficient and produce limited results. And they're typically developed as a response to the issue, not as a preventative strategy.

Because financial resources are limited, municipalities tend to address I&I reactively rather than proactively. That is, repairing a leak or crack in a pipe once it's already contributing to I&I rather than identifying and rehabilitating high-risk areas before they become problems. But working reactively can actually end up costing a municipality more and lead to poor outcomes.

SNAP SHOT

MUNICIPAL I&I PRACTICES...

01 TEND TO BE RESOURCE-INEFFICIENT

02 PRODUCE LIMITED RESULTS

03 CAN END UP COSTING MORE FROM A REACTIVE APPROACH

CURRENT MITIGATION EFFORTS (CONT.)

In order to work more proactively, municipalities should take a strategic approach to addressing I&I. This requires

- Understanding the condition of a wastewater system in its entirety using a number of different inspection methods
- Planning rehabilitation efforts accordingly, and
- Developing an asset management plan for the future.

I&I can be reduced significantly with an in-depth understanding and analysis of the entire sewer system. But without taking steps to evaluate the bigger picture, I&I may feel like an uphill battle.

> "I&I CAN BE REDUCED SIGNIFICANTLY WITH AN IN-DEPTH UNDERSTANDING AND ANALYSIS OF THE ENTIRE SEWER SYSTEM."

KEY STRATEGIES FOR MITIGATING I&I

01 GAIN TOTAL INSIGHT

02 COORDINATE REHABILITATION EFFORTS

03 PLAN WELL IN ADVANCE

DIVERSIFY YOUR ASSESSMENT METHODS

Flow monitoring is usually one of the first steps taken to better understand the problem areas within a collection system. Flow monitoring is the practice of measuring wastewater flow in the system over time and comparing it with a baseline flow estimate to determine the amount of I&I in a sewer system. Electronic velocity and depth recording devices (flow meters) are strategically placed throughout the system. Studies generally last 60–120 days. Flow monitoring can be used as a tool in condition assessment: to identify areas for further CCTV inspection (prioritization), and to quantify the severity of I&I identified during CCTV inspection.

Once target areas have been identified, municipalities should further inspect using CCTV to detect the I&I culprits. Segments of the sewer system shouldn't be designated for pipe lining or rehabilitation without first completing a visual camera inspection. Visual inspections play a critical role in detecting sources of I&I, giving operators a clear, detailed look at defects in real-time. The specific location and cause of infiltration can often be determined by CCTV inspections without the need for supplementary inspection technology, which saves a municipality time and money.

ASSESSMENT WORKFLOW

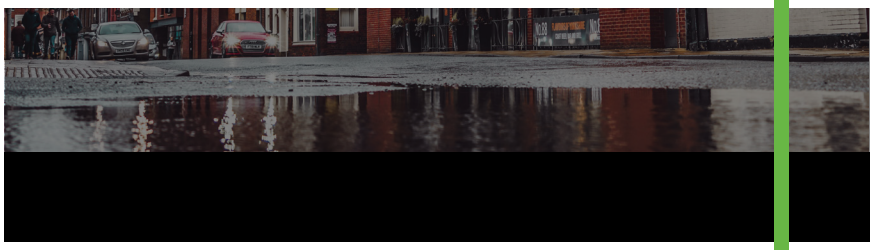
DIVERSIFY YOUR ASSESSMENT METHODS (CONT.)

However, further detection work may be desired if the quantity, size and defect types observed in the CCTV inspection do not seem to justify the amount of I&I identified in the flow monitoring, according to the EPA. Alternative inspection methods can utilize a range of technologies.

SEWER SCANNING EVALUATION TECHNOLOGY (SSET) is an alternative technology to CCTV that takes the responsibility of rating the structural integrity of the sewer away from the camera operator and places it into the engineer's hands. The 360-degree scan allows the entire surface of the pipe to be observed in flat view, and enables the engineer to measure the opening of joints and cracks, as well as pinpoint telltale staining and deposits.

ELECTRICAL LEAK LOCATION identifies pipe defects by measuring the electrical resistance of the pipe wall. Most sewer pipes are electrical insulators and will have high resistance to electrical currents. A defect in the pipe that leaks water will also leak electrical current.

ACOUSTIC/SONAR DETECTION is increasingly used to find leaks. These acoustic technologies rely on measuring devices to detect vibrations and/or sound waves emitted by defects and leaks. Acoustic sensors can be stopped during the inspection and moved back and forth to reinspect a section of pipe or confirm a reading. This provides utilities with real-time verification of potential problems.



PERFORM A SYSTEMWIDE ASSESSMENT

Rehabilitation shouldn't focus solely on sewer mains, but also on laterals, manholes, and the connections between these structures.

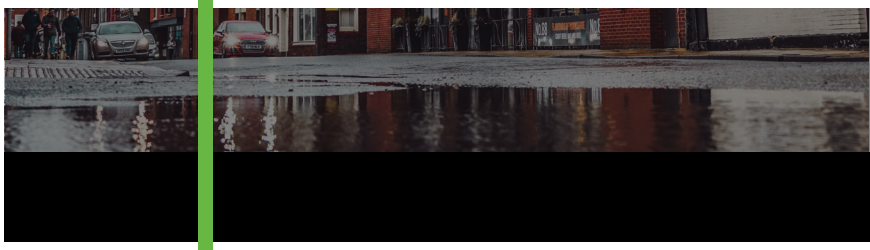
"Failure to reduce I&I is often because of inadequate system knowledge or sporadic application of construction fixes in only a few parts of the sanitary sewer system (i.e., sewer relining) without understanding the water paths, water migration, soil conditions and type of rainfall that contributes I&I to the sanitary sewer system," according to a study by CDM Smith. "It is critical to understand [these factors] to identify the appropriate evaluation method and define an effective scope for rehabilitation work."

According to the study, which evaluated mitigation efforts in several municipalities, I&I is reduced just 10 to 30 percent when solely rehabilitating pipes using cured-in-place pipe (CIPP). When pipes are simply relined, infiltration discovers a new path into the sewer through service laterals and manholes.

> "FAILURE TO REDUCE I&I IS OFTEN BECAUSE OF INADEQUATE SYSTEM KNOWLEDGE OR SPORADIC APPLICATION OF CONSTRUCTION FIXES IN ONLY A FEW PARTS OF THE SANITARY SEWER SYSTEM..."

I&I THAT CAN BE SOLVED SOLELY WITH CIPP

10-30%



PERFORM A SYSTEMWIDE ASSESSMENT (CONT.)

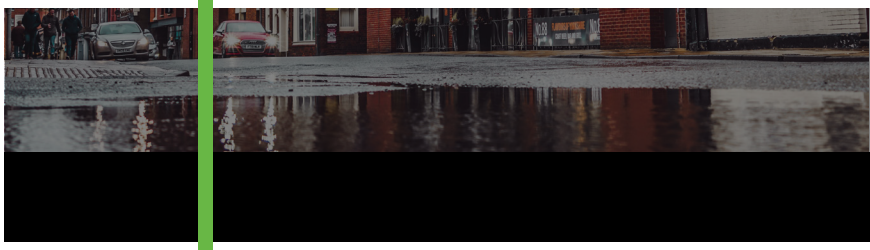
When municipalities instead target high-priority areas for rehabilitation, including sewer mains, laterals and manholes, I&I can be reduced up to 50 to 65 percent, according to the study.

A comprehensive approach to locating defects means inspecting all aspects of a collection system, including

MANHOLES. Old, degraded or leaky manhole structures are major sources of I&I in many systems. During storms or snow thaws, large volumes of water may flow through faulty manhole covers. Field inspectors should evaluate both the manhole lid/frame condition and the frame connection for any defects or leak sources. After manually inspecting the manhole cover, the field inspector should employ a manhole inspection camera to evaluate the interior.

SEWER MAINS. Groundwater seeps into sewers through cracks, leaky pipe joints and deteriorated lines. By far the most detailed means of pinpointing and characterizing I&I in pipes is CCTV crawler inspection. CCTV crawlers employ a video camera mounted on a remote-controlled, self-propelled robotic crawler that is connected to a video monitor. An operator watching the video monitor can stop to study any observed defect and identify cracks, fractures or breaks, root intrusions, leaking water (usually infiltration from groundwater), and general deterioration.

"WHEN MUNICIPALITIES INSTEAD TARGET HIGH-PRIORITY AREAS FOR REHABILITATION, INCLUDING SEWER MAINS, LATERALS AND MANHOLES, I&I CAN BE REDUCED UP TO 50 TO 65 PERCENT," ACCORDING TO THE STUDY.



PERFORM A SYSTEMWIDE ASSESSMENT (CONT.)

LATERALS. Residential service laterals are often sources of heavy I&I, particularly at connection points, where the lateral meets the main line. Lateral inspection can be accomplished from within a property or residence using a push camera, or with a lateral launch crawler that can travel down a main line and then propel a camera head into adjoining laterals.

	CCTV CRAWLERS	ZOOM INSPECTION	LATERAL LAUNCH	SSET (SIDE SCANNING)	ACOUSTIC	ELECTRICAL LEAK LOCATION
APPLICATION	MAINS	MAIN, MANHOLE	MAIN, LATERAL	MAIN	MAIN	MAIN, LATERAL
SIZE	6" AND UP	6" AND UP	4" AND UNDER	6" AND UP	2" AND UP	3" AND UP
SEDIMENT, DEBRIS, ROOTS	●	●	●	●	●	○
PIPE FLAGS, DEFLECTION	●	●	●	●	●	○
CORROSION, METAL LOSS	○	○	○	●	●	○
OFFSET JOINTS	●	●	●	●	○	○
PIPE CRACKS	●	●	●	●	●	●
LEAKS	●	●	●	●	○	●
SERVICE CONNECTION	●	●	●	○	○	○

Inspections should go beyond the sewer infrastructure, too. Municipalities are encouraged to evaluate the geography and its potential impacts on the system. Factors to consider include how the surrounding land is used, how populations and resources are distributed, traffic patterns, and which nearby industries may demand more of the system.

CONSIDER THE BIGGER PICTURE

Once all of the quantitative and qualitative data has been collected, municipalities can build out a GIS map of their wastewater system to reflect its condition visually. A visual assessment can help you make more informed decisions, with features like heat maps to display cluster areas and high-risk locations for prioritizing rehab work.

The data can also be used for improved asset management as municipalities plan for the future. Wastewater asset management involves strategizing ways to maximize capital and other resources, while keeping the cost of maintaining an aging system to a minimum. The more insight a municipality has into the condition of its system, the smarter budgeting decisions it can make for maintenance and rehabilitation.

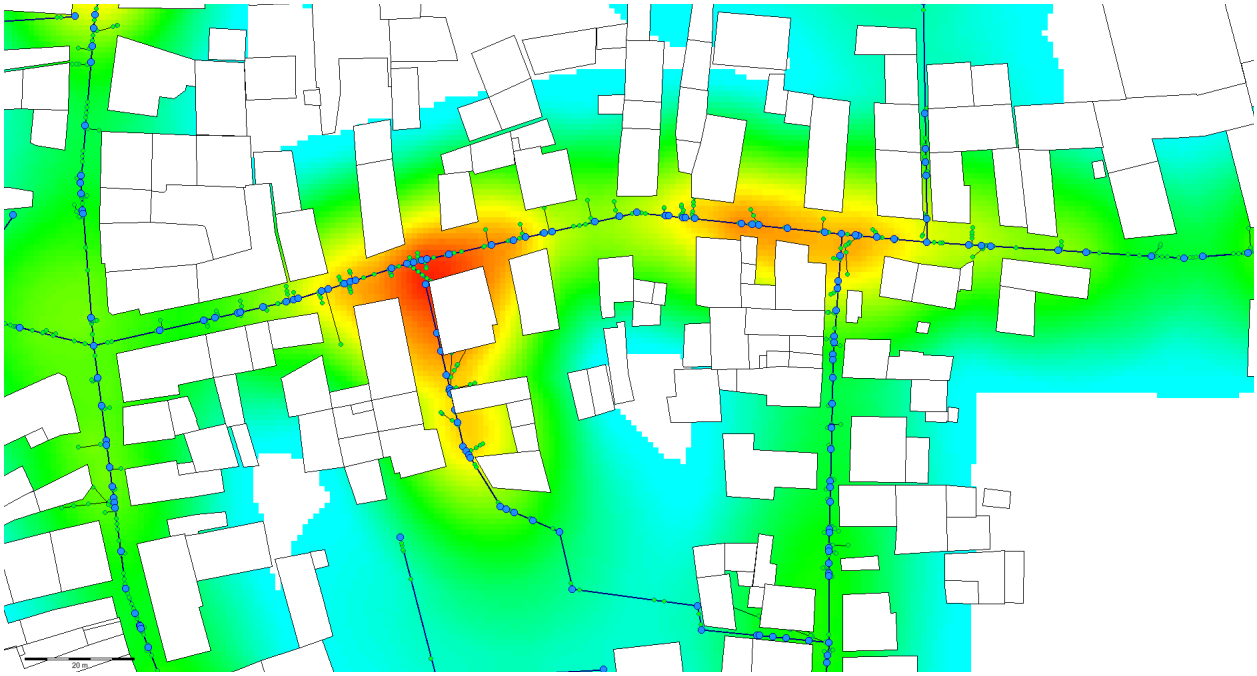


**Photo courtesy of WinCan*

CONCLUSION

With sewer infrastructure aging rapidly across North America, and an increasing need for wastewater system capacity in growing cities, addressing I&I is more critical than ever. But it takes more than just standard rehabilitation procedures.

A comprehensive approach is critical to reducing the presence of I&I both in flow and volume, from the initial inspections to the rehab planning process. And the advantages of reduced I&I will surely not go unnoticed: lower overhead costs for treatment, operation and maintenance; reduced or eliminated regulatory fines; a longer lifespan for each wastewater asset and the system as a whole, and much more.

SO WHAT ARE YOU WAITING FOR?

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