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Overview: Importance of Private Laterals In I/I Reduction Programs

Sewer connections to private buildings, known as building laterals, typically make up about half the total length of the sewer system. A recent survey of 316 municipalities from across the country revealed that 69% have identified problems with infiltration and inflow (I/I) originating from privately owned sewer connections. For almost half of these communities, private connections were believed to account for between 5 and 50% of the I/I problem. (Water Environment Federation, *Control of Infiltration and Inflow in Private Building Sewer Connections*, 1999). This finding supports similar studies and leads to the conclusion that the effectiveness of I/I removal efforts may be limited in many collection systems if private sources of I/I are not addressed.

JCW Sewer Facts

Sewer system serves 500,000 in 22 towns

Largest private I/I disconnection program in U.S.

SSOs reduced overall and eliminated up to the 2.5-inch 24-hour storm

In Johnson County, Kansas, a successful private lateral disconnection program was shown to account for almost 40% of the total I/I reduction achieved, or 110 million gallons per day (mgd) during the 10-year storm event. This program, together with a collection system rehabilitation, reduced I/I by as much as 280 million mgd during the 10-year storm and has led to significant reductions in the number and severity of sanitary sewer overflows (SSOs).

SSO History: Regional Growth and Complex Hydrology

Throughout the early 1980s, the Johnson County, Kansas sewage collection system suffered numerous SSOs, mostly affecting residential and commercial buildings. The system was so heavily influenced by I/I that even moderate amounts of rainfall

exceeded its capacity.

In 1985, Johnson County Wastewater (JCW) implemented a dual inspection program. Concurrent with their collection system evaluation, they went house-to-house and business-to-business, inspecting private connections in more than 55,000 structures. The result of both surveys was repair or replacement of 17,000 manhole structures, and disconnection of more than 15,600 unpermitted sources of storm water inflow on private property.

These efforts have paid off with a drastic reduction in volume of flow in the collection system, as well as the number of SSOs. Today, capacity-related SSOs are virtually eliminated for smaller storms. Sewer complaints are limited to severe weather events, such as the 100-year storm that occurred in 1993. This progress is being maintained and improved upon through JCW's ongoing Backup Prevention Program (BUPP).

JCW Service Area

Click for a larger image of Johnson County and the JCW service area

JCW's service area is a 20-square mile section of eastern Kansas that shares a border with Kansas City, Missouri. The region is dominated by single family homes, commercial business, and some light industry. The service area encompasses 22 communities with a population of about 500,000; 1,650 miles of sewer line; nine wastewater treatment plants processing 38 million gallons per day of dry weather flow; and 32,000 manholes.

More than half of the sewer collection system is located in the northeast corner of the county, where most of the population lives, and where the most concentrated economic growth has occurred over the last 40 years.

This is also where the oldest portions of the system are located. More than 80% of components in this area were installed between 1947 and 1966. Nestled between three receiving streams, the region's flat topography further aggravated the problems associated with I/I.

JCW's staff and resources were focused on responding to emergencies, with little emphasis on routine preventive maintenance. Customer complaints had been mounting for years, but the impetus for improvement came after a series of intense storms in the early 1981 and 1982 resulted in widespread SSOs in the northeast sector. Sewage was backing up through manholes, into buildings, and into receiving streams. Water quality was impacted and the property damage was extensive.

JCW performed a system evaluation in 1983 that included flow monitoring and smoke/dye testing of the sewer lines and

manhole structures. This showed that while some parts of the system would require capacity upgrades, I/I was a major factor leading to wet weather SSOs. The Johnson County Board of Commissioners committed to upgrading and rehabilitating the system with additional relief lines; manhole, sewer, and pump station repairs; a routine maintenance program; and elimination of unpermitted private connections. The collection system rehabilitation would provide additional capacity and reduce groundwater infiltration, while the private source disconnection program would primarily help reduce storm water inflow.

For the disconnection program, JCW developed a phased investigation/implementation plan that divided the northeast sector into 11 zones, prioritized according to flooding frequency and severity. The Johnson County Board of Commissioners set the groundwork for the program by passing a county ordinance making it illegal for residents to have connections from surface or ground water sources to the sanitary sewer system. This ordinance gave JCW the legal authority to require removal of unpermitted sources and to prohibit any new ones.

Funds were set aside to reimburse owners for direct costs associated with removal of foundation drains, storm sump pumps or pits, area drains (driveway, patio, yard, window well, and basement entry), downspouts, and defective service line cleanouts. Maximum payments were published for each type of connection.

The Local Solution: Eliminate Inflow One House at a Time

JCW kicked off the private property inspection program with a public notice in neighborhood newsletters and area newspapers. The notices explained the new ordinance and how it would help prevent SSOs. Owners were advised that if sources were found on their property, they would have to be removed, but no enforcement action would be taken unless an owner refused to comply with the ordinance. The notices also explained that inspectors would visit each property to gather information from owners and residents on past backups and other problems with the collection system, and that assistance would be provided to help the owners arrange for any needed disconnections.

Even with extensive outreach, many of the owners did not respond to JCW's first notice. To reduce the need for repeated reminders, JCW attached a certified response form with each notice. As these were returned, inspectors called the owners to acknowledge receipt and answer questions about the inspection/disconnection process. This approach was successful. Within a year, most of the 55,000 property owners had readily complied with the request for access to their homes and buildings.

While on the property, the inspectors would tour the building

interior and grounds, noting locations of any drains, downspouts, or other connections that appeared connected to the sewer system. Other data included building type, age, and use; flooding history; foundation type and dimensions; and lot drainage adequacy. Data on inflow connections were collected and logged into a geographic information system (GIS) that allowed JCW to identify direct and suspect connections that were contributing inflow to the collection system. Private connections were catalogued according to their size, route of discharge, location in the watershed, and condition. All unpermitted sources were scheduled for disconnection, and those that were suspected of contributing storm water inflow were subjected to smoke and/or dye testing.

The most common sources of inflow were foundation drains, basement drains, sump pumps, cleanouts and downspouts, and outdoor drains.

JCW Analysis of Private I/I Sources

Click to learn about the type and distribution of private I/I sources found by JCW

Concurrently, JCW performed a complete sanitary sewer system evaluation including manhole inspections, sewer line smoke testing, and television inspections, to ascertain the structural condition of the collection system.

Data from the private property inspections were combined in the GIS with those developed through the sanitary sewer system evaluation. A hydrologic model was developed and applied to help JCW prioritize its remedial efforts, starting with the most serious problems first. Implementation of the entire program took just over five years to complete. Thanks to the prioritized phasing, however, the sewer system function improved rapidly once repairs were begun.

Once the first phase of unpermitted disconnections was underway, the private lateral inspection program was expanded to include vacant buildings and occupied structures that were missed in the first round.

The inspection program resulted in identification of many more unpermitted private sources than had been anticipated. JCW hired additional staff to inspect completed disconnections – a step that was required before property owners could be reimbursed for their direct costs. The inspectors were responsible for ensuring that each disconnection met pre-established minimum standards, and that modifications to existing electrical and plumbing systems met the requirements of the local building code.

JCW also established informal fixed-price contracts with local contractors. These contracts were based on standard specifications and set costs for different types of disconnections.

Property owners could either have JCW assign the contractor, or be provided with a list of pre-approved contractors and make their selection through a two-bid process. The standard contracts worked extremely well and relieved a serious project backlog in the first year of the program, tripling the disconnection rate to 4,000 per year. The standard agreements allowed contractors to schedule disconnections in clusters, relieved homeowners of the responsibility of scoping and negotiating the contracts, and ensured consistent construction performance.

Results

Post-Reduction Monitoring

Click here to learn more about the results of JCW's post-reduction monitoring program.

The I/I reduction program was completed in 1994. JCW reports they have greatly reduced capacity-related SSOs by reducing wet-weather flow rates in the system by an average 280 mgd during the 10-year storm. They credit their success to their private property I/I reduction program, which they believe is the most extensive in the country.

Corresponding improvements were seen in the number and frequency of customer complaints. For example, in 1993, Johnson County received approximately 200 complaints of sewer problems during a storm with a 100-year return period - more than 7 inches of rain in 24 hours. By contrast, in the early 1980s, JCW would have received an equal number of complaints during the 2-year storm (approximately 3.5 inches of rain in 24 hours).

Program Costs, Funding Mechanisms

JCW's I/I reduction program cost a total of $60 million. Of that total, the private connection program was the least expensive component, at just under $10.3 million. Another $30 million went to collection system improvements, and the remaining $19.7 million was used to cover program-specific engineering and administrative expenses.

JCW was able to obtain $12 million in grant funds and $18 million in low-interest state revolving loans, but the private connection work was not eligible for public funds. JCW covered the costs with obligation bonds that are being paid for through a tax increase.

Future Plans: Maintain and Expand Private Source Program

JCW is building on its progress through an ongoing Backup Prevention Program (BUPP). Elements of this program include:

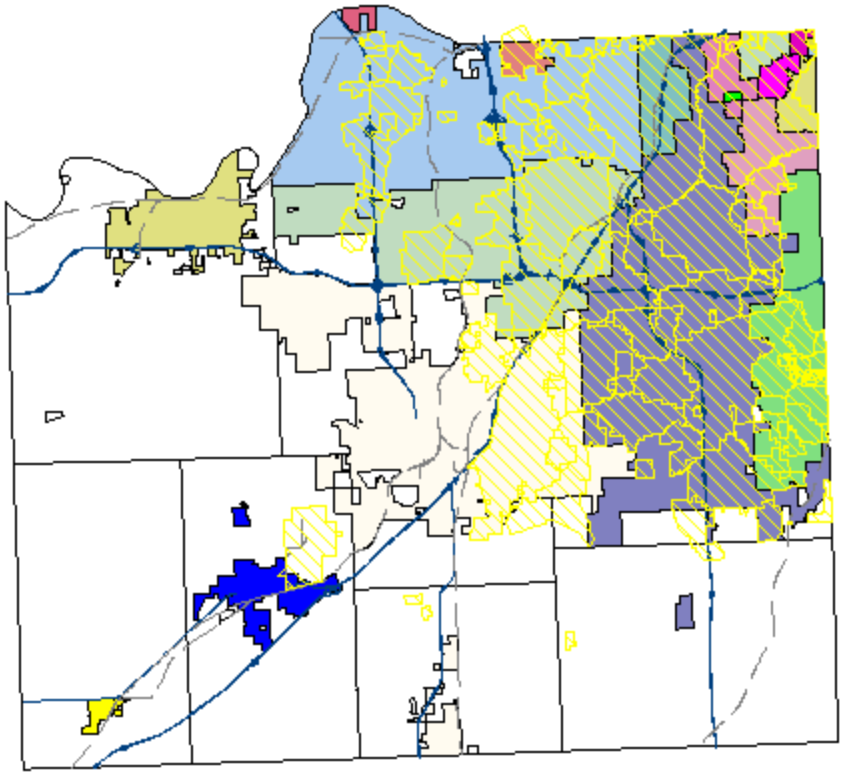
- **Sewer collection system reevaluation**. This periodic re-evaluation includes flow monitoring, smoke and dye

testing, and hydraulic modeling. The results will be combined with other information to help JCW develop short- and long-term operation and management plans for the system.

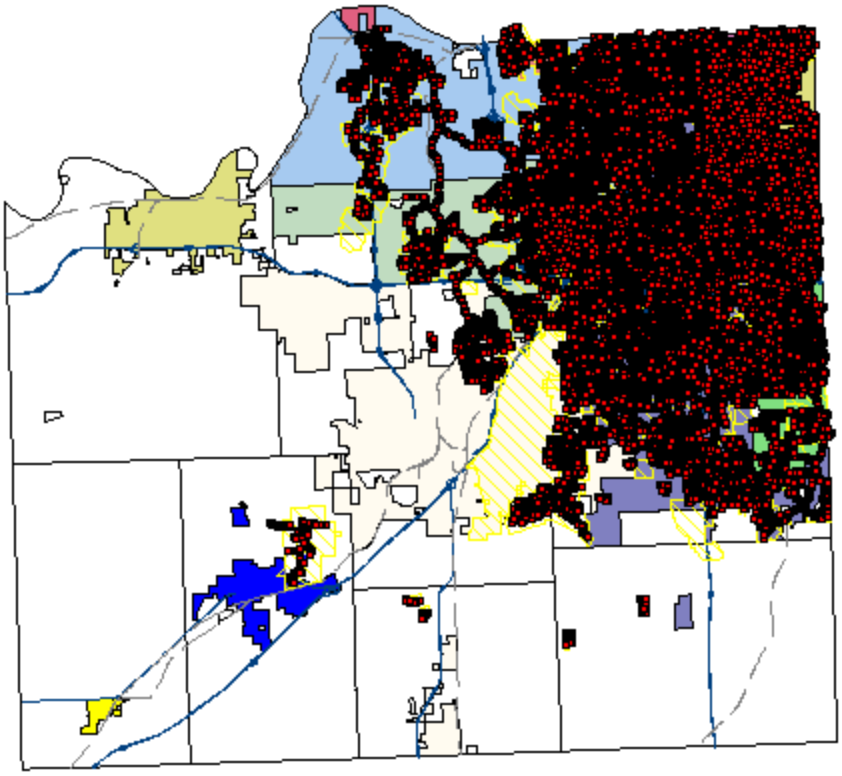
- **Reinspection of previous disconnections**. JCW has implemented a program to periodically reinspect each of the 15,600 source disconnection sites to ensure that no new connections have been established.
- **Flood tracking, analysis, and response**. JCW maintains a full-time flood tracking and response team that tracks and analyzes SSOs to look for backup and flooding patterns that may indicate problems within the collection system requiring further investigation and correction.
- **Expansion of the private source disconnection program**. As development in the service area continues to spread outward, JCW will continue to track the contribution of private laterals to the flow of the system. If needed, the program may be expanded to more communities.

JCW's Service Area

These images were generated by JCW's online Automated Image Mapping Service and may not be used for any purpose other than general information. In the first image, JCW's member communities are denoted by the colored shapes. The sewered service area within the county is shown by the yellow lines. The city of Kansas City, Missouri lies just off the map, to the northeast of Johnson County. Historically, population has been concentrated in a small portion of the extreme northeast corner of the county. The sewer system grew from this area outward, as population spread into neighboring farm communities.

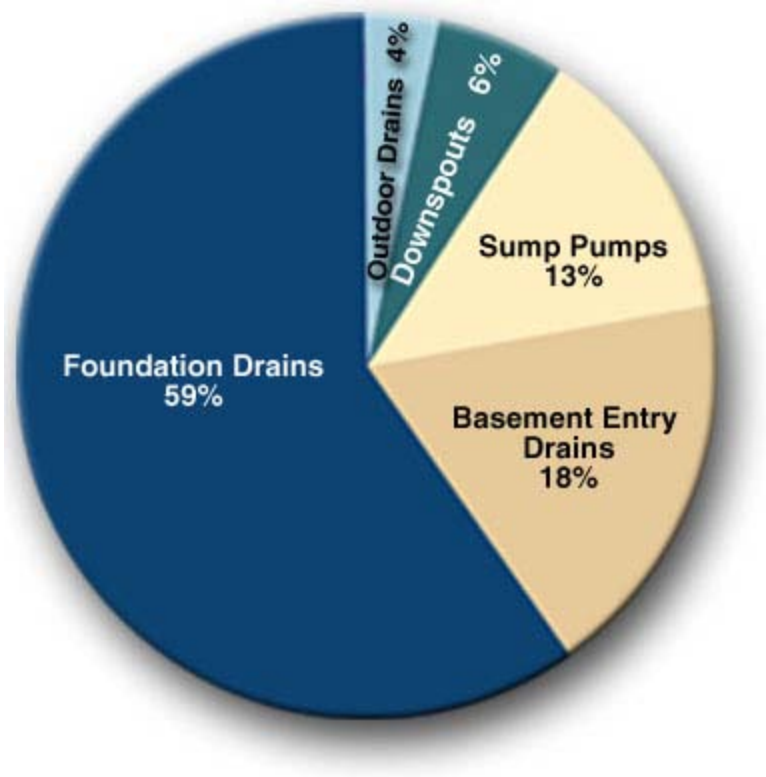


The second image shows the sewer pipe layout. Note the density of the sewer network in the northeastern quadrant of the county.



Types and Distribution of Private I/I Sources

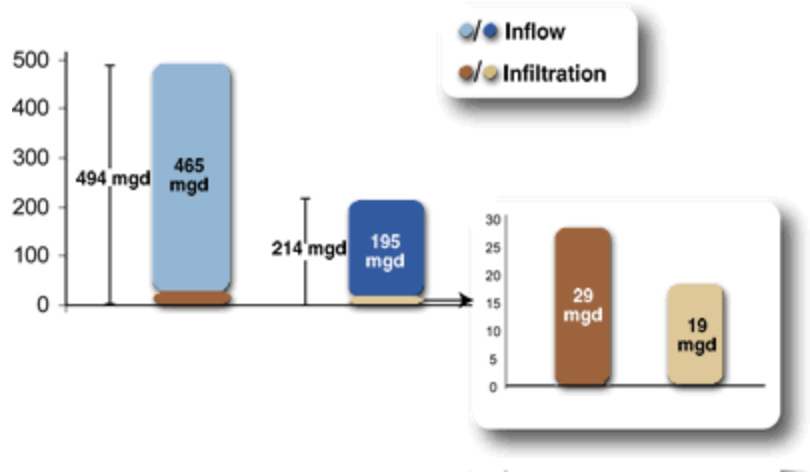
Beginning in 1985, JCW surveyed more than 55,000 residences and businesses, identifying 15,600 private sources of I/I. By recording the data in a GIS as it was collected, JCW was able to assess the types of sources, as shown below.



JCW combined this information with cost-effectiveness modeling to plan its phased private I/I reduction program, beginning with foundation drains and basement entry drains, which accounted for 77% of all private sources.

Results of JCW's I / I Reduction Program

Post-reduction program flow monitoring conducted between 1995 and 1997 revealed that wet weather flows in the target communities had been reduced between 42% and 71% – in every case exceeding the expectations based on the initial surveys. As shown in the before/after graphs below, overall infiltration and inflow during the 10-year, 1-hour storm were reduced by more than half - from a total of 494 mgd to 214 mgd.



Storm water inflow, the dominant component, was reduced by 280 mgd, from 465 to 195 mgd. Private connections were estimated to account for almost 40%, or more than 110 mgd of the inflow reduction. Similarly, groundwater infiltration was reduced from 29 mgd to 19 mgd, largely through collection system improvements.