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Inflow and Infiltration in New Construction: Time to Make Some Big Changes!

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Inflow and Infiltration (I/I) in sewer systems has long been a problem for municipalities, and often a big one. It is costly to treat, uses up capacity in trunk sewer systems (which can lead to development freezes), reduces the life of sewer systems and can lead to structural collapse, and with the advent of climate change, increases the risks of flooding.

New construction includes both new subdivisions or infill development, in which a private developer typically controls the process of installing all new sewers, and sewer replacement, which is typically commissioned and managed by a municipality. Sewers that are constructed on the municipal right of way become "public side" sewers because they are ultimately owned by the municipality. Sewers that are constructed on what is or will later become private property become "private side" sewers.

Professionals working on I/I have traditionally focused on I/I in public side sewers in existing systems. Although there was awareness that I/I existed in private side sewers, this infrastructure was rarely examined. Private side sewer systems are entirely under the aegis of building codes, and design engineers are typically not trained (or even introduced to) these codes.

In recent years, it has become apparent through flow monitoring that new subdivisions are contributing unacceptable levels of I/I to sewer systems. This is occurring within both the public and the private side sewers. It had historically been assumed that new construction was virtually leak free, since I/I has typically been associated with aging sewer systems. Following the discovery in 2007 of unacceptable I/I in a new subdivision in St. Jacobs, Ontario, this phenomenon has been studied extensively.

Beginning in 2015, a group of Ontario municipalities retained Norton Engineering Inc. to investigate this phenomenon in more detail. A two-stage approach was undertaken: first the extent of the problem was evaluated; then the conditions and causes were investigated.

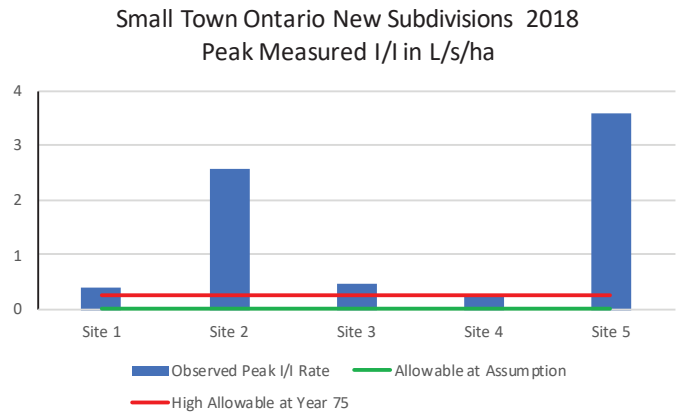
The allowable leakage rate in new sewer systems was taken from the 1984 MOE (now MECP) Design Guidelines for Sewage Works for the public side (the 2008 publication does not provide allowable leakage rates), and the Ontario Building Code (OBC) for the private side. The 1984 MOE Guidelines define allowable leakage at the end of a sewer system's life to be between 0.10 and 0.28 L/s/ha. Ontario Provincial Standard Specifications (OPSS) and the MOE both define allowable leakage during final testing of new sewers at acceptance as 0.01 L/s/ha, or between 4% and 10% of the long-term value. The rate of 0.28 L/s/h a has frequently been misunderstood to mean allowable leakage at acceptance, which it is not.

To determine whether leakage from a new subdivision is acceptable, observed leakage is compared to the sum of allowable leakage rates for the private and public portions of the sewer system. This is then compared to the measured flows. Note that this is not an exact science, since allowable leakage can be calculated several different ways. Furthermore, allowable discharges from other sources, such as high-energy furnaces and water softeners, contribute to sewer flow measurements but need to be distinguished from I/I.

The costs of unacceptable I/I rates are staggering. Many larger municipalities around the GTA anticipate an increase in their serviced populations on the order of 60,000 residents over the next decade. If observed unacceptable I/I values in existing new subdivisions are repeated, the treatment costs alone of the I/I could be $90 million per year. This does not include all the other costs and risks associated with this I/I, such as required expansion of wastewater treatment plants, capacity constraints, and flooding.

To date, data has been collected from 52 subdivisions, 51 of which have shown unacceptable levels of I/I. **Figure 1** depicts recent results from five new subdivisions

Figure 1 – Observed flows in five subdivisions in Ontario (2018), compared to allowable.



received and interpreted in the summer of 2018.

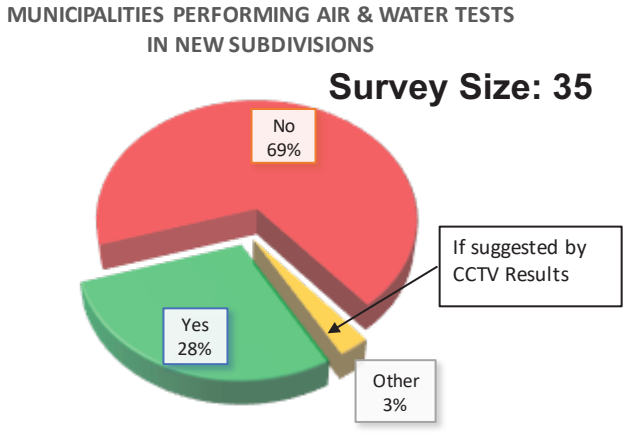
In the example in **Figure 1**, flows are not only orders of magnitude higher than the allowable rates at acceptance, but at several sites, substantially higher than the 0.28 L/s/ha allowable at the end of the life of the sewer (taken to be 75 years). These results are typical of findings in this study. It is unlikely that sewers leaking this badly will have a useful life of 75 years, since I/I undermines the support structure around the sewer, which then leads to more I/I.

The second stage in this ongoing research has focused on the causes and conditions which result in this unacceptable I/I. Information has been obtained from confidential interviews with hundreds of stakeholders working in the development industry, including municipal directors, engineering staff, site inspectors, chief building officials, building inspectors, contractors, consultants, developers, and manufacturers. A survey was undertaken combining both yes/no responses for specific practices, and detailed observations and concerns. For both public and private side construction, unexpected issues were identified.

One of the findings of this research is that the testing recommended by the municipality (public side) and required by law under the Ontario Building Code (OBC) is not always being done. In some regions, it is hardly ever undertaken.

For example, OPSS 410 (November 2012) calls for air or water (leak) testing of all new sewers and maintenance holes. Results as of 2016 for 35 municipalities across Ontario revealed that 69% of them were *not* requiring that these tests be performed. Since leak testing is a very good means of determining if the observed leakage is within published tolerances, this result is puzzling. Municipalities cited lack of understanding of the importance of these tests, staffing limitations, and pressure from contractors to skip the testing as reasons for not performing them. **Figure 2** shows the percentage of municipalities performing air and water testing on new public side sewers systems from the 2016 survey.

Figure 2 – Percentage of municipalities performing air or water test on sewers and maintenance holes (public side sewer system).



Other issues identified on the public side by stakeholders at all levels included:

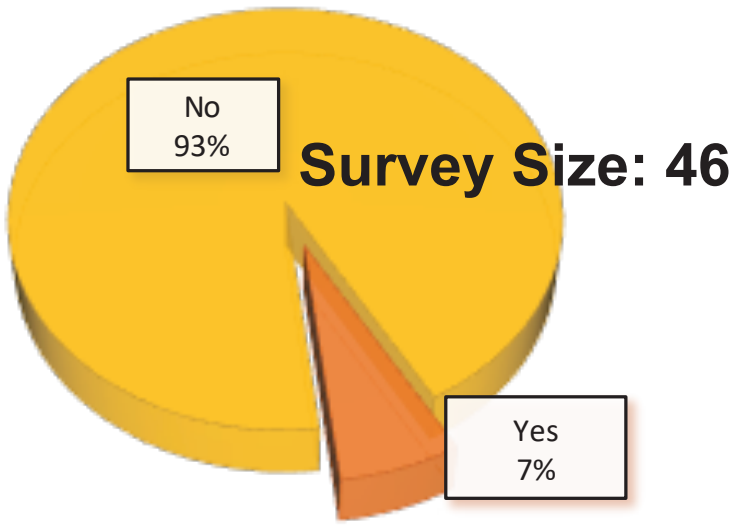
- Inspection of sewer construction on the public side is performed by the developer's engineering consultant, not municipal staff, which is a potential conflict of interest.
- There can be perceived or actual political pressure to approve construction quickly.
- Once the public side sewer is accepted, engineering staff maintain little contact with development projects (i.e., they become the responsibility of the building department), so private side I/I goes unnoticed
- Traditionally, municipalities do not measure flows in new construction to identify unacceptable leakage.

Similarly, for construction on the private side, air or water testing of the private lateral is a legal requirement of the OBC but is seldom being performed. The main reason cited is the difficulty in performing the test. For water testing, a test tee must be installed at property line and achieving the required 3m head of water is challenging. Air tests are also reported to be problematic. The private side lateral is very rarely subject to CCTV inspection, which would also reveal leakage. **Figure 3** depicts results for the number of municipalities performing air or water tests on the private side of the lateral. As with the public side sewer transferred to the municipality, testing of the private side sewer is the simplest way to confirm whether the lateral is leaking.

In addition, the following issues identified on the private side appear to be contributing to I/I:

- The OBC and National Plumbing Code of Canada (NPCC) were not developed to prevent new sewers from leaking so do not prescribe design and installation methods that will result in less leakage.
- Private side sewer pipes are prone to shattering (although they are PVC, the compounds used are different than those used for the public side sewers).
- Private side sewer pipe is often not installed in accordance with the requirements for PVC pipe (i.e., pipes are not embedded and compacted properly on each side). The pipe is also connected by solvent cement rather than by gaskets, which allows for little longitudinal flexion, resulting in potential joint separation.
- Building staff members are not trained in issues around leakage in sewer systems.
- OBC inspections occur only at prescribed times during construction; the balance of the work takes place without third party oversight.
- Inspection of the final connection of the private sewer to the public side sewer at property line (a frequent source of leakage), although technically required, is not explicitly called for in the OBC.
- The OBC is interpreted very differently by building departments across Ontario.

Figure 3 – Percentage of municipalities requiring air or water test on private side laterals.



Results of this work indicate that *age of sewer*, which has long been used as a likely indicator of higher I/I, may not be a valid indicator (except for the fact that foundation drains and roof leaders were legally connected to sanitary sewers until about 1980 in Ontario). A very recent analysis of likelihood of inflow by decade of sewer construction in a small drainage area in a large southern Ontario municipality yielded interesting results. Of the 313 laterals showing evidence above allowable leakage rates, 70% were built from the 1980s onwards. More of this type of analysis needs to be done.

By working closely with stakeholders, dozens of strategies are being developed to minimize the risk of unacceptable I/I. Strategies that municipal staff working on the public side sewers (e.g., engineering and development departments) can consider include:

- Implement mandatory flow monitoring downstream of new subdivisions (beginning as soon as the public side trunk sewer is installed). This permits an assessment of how much I/I is generated as a result of public side sewer installation independent of the private side connection.
- Require that all testing and inspection called for by OPSS and Ontario Provincial Standard Drawings (OPSD) be completed. Consider having these tests performed by a third party paid directly by the municipality.
- Review the requirement for a professional engineer to sign off on the new construction, since engineers cannot verify 3rd party work under the Professional Engineers Act.
- Consider constructing the private side lateral as part of the public side sewer system, constructing it in conformance with MOE Guidelines and OPSS/OPSD. (This is currently being piloted in Ontario).
- Support the update of OPSS/OPSD standards to be more proactive in

preventing I/I (e.g., wrapping the exterior of manholes).
- Encourage engineering staff to learn about the OBC and to observe building inspections related to pipe installation during the home building period.

Similarly, improvements that could be implemented by building departments and other stakeholders on the private side sewer construction include:
- Support improvements to the OBC around pipe design, pipe type, embedment, jointing of the private side pipe, and the connection at property line.
- Ensure that all testing of private side piping is undertaken as per the OBC.
- Insist on the inspection of storm systems on the private side (these are considered as part of the drainage system in the OBC which is defined as including both sanitary and storm sewer systems). This is not current practice in Ontario.
- Add provisions in the OBC to reduce flooding risks.
- Encourage building department staff to learn about inflow and infiltration, how and why it occurs, and why it is essential to minimize.
- Encourage building department staff to learn about municipal standards and specifications and to observe public side inspectors as municipal infrastructure is being constructed.

Finally, municipalities can be more proactive in protecting their sanitary sewer systems from I/I. They can make use of sewer use bylaws, which prohibit the discharge of clean water into sanitary sewer systems. Another approach frequently overlooked is having a strict policy around abandoning unused laterals. These should be either removed or decommissioned in place and inspected by City staff to ensure that they do not create an opportunity for I/I to enter the sanitary (or storm) sewer.

Elected officials need to take a more active interest in the issue of I/I in our sanitary and storm systems. Ultimately, in order to change how things are done within municipalities, political will is required. As residents become more aware of these issues, they can ask their local politicians to take the appropriate steps to improve the situation.