ONTARIO CLEAN WATER AGENCY
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Report to the Township of Ramara for the Bayshore Excess Flow Reduction

SUBMITTED BY

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STATEMENT OF CONFIDENTIALITY

OCWA's Report to
Township of Ramara for the
Bayshore Excess Flow Reduction

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Statement of Confidentiality

1 Overview

1.1 Project Background

The Township of Ramara (Township) recognizes that there is inflow and infiltration (I&I) contributing to excess sewer flows in their Bayshore Village wastewater system and have been taking steps to reduce these excess flows by conducting:

- Smoke (Fog) testing to identify possible downspout and sump pump connections to the sanitary system
- CCTV video inspections of sewer mains and laterals
- Private property sump pump inspections

Results from this testing had identified that the laterals were a major contributor towards the excess flows and as such, a lateral rehabilitation program was implemented in 2019/2020. Other isolated issues such as sump pump connections and mainline sewer defects were also identified and possibly remediated.

In light of wastewater treatment capacity issues, the Township has contracted OCWA to develop an excess flow reduction plan/road map to determine a path forward for addressing I&I over the long term.

1.2 Project Approach

The Township provided the following information for OCWA's review:

- C.C Tatham & Associates Ltd. 2018 "Sanitary CCTV Inspection Assessment". Note that this was the only data related to the CCTV of the mainline sewers available as the original inspection reports and videos from the inspection company were not provided.
- OCWA 2021 "Bayshore WWTP FOP Report"
- Lateral Pipe CCTV Inspection Reports for 2019 (MMS) and 2020 (Sewer Technologies Inc.)
- "2019 private lateral repairs" spreadsheet
- MH44 to MH43 on Bayshore Drive CCTV Inspection 2020 (Sewer Technologies Inc.)
- "Sump Pump Inspection Results_Bayshore Village_2019" spreadsheet
- Excerpts from the Fog Testing Report 2018 (Robichaud)

In addition to the above documentation, OCWA reviewed available flow data for both the water and wastewater systems from 2017 to 2021, and the daily precipitation during the same time period for Shanty Bay as provided by the Government of Canada historical weather website. Normally, precipitation information would be taken from the Lagoon City data source, however, this data was incomplete for the examined time period.

Once the available data was reviewed, it was analyzed to determine:

- Any gaps in the data needed for an effective I&I analysis
- Any obvious sources of excess flow

Using the information described above, an I&I Reduction Program was developed with a focus on spring thaw activities. This program was customized to the Township's infrastructure and is presented with a task-by-task road map (Section 4.2) and high level budget (Sections 4.3) for planning purposes.

2 Inflow and Infiltration (I&I)

Inflow and infiltration (I&I) occurs when excess rainwater or groundwater enters the sanitary system through defects in the sanitary system. These flows cause a number of challenges for the municipality including increased costs for treatment and the maintenance of infrastructure with larger-than-necessary capacity. Overflows can lead to public health issues, cleanup costs, unhappy residents and insurance complications.

Additionally, although inflow and infiltration are often discussed as a single entity describing excess flows into a sanitary system, they are in fact two very specific types of flows with different remedies. Inflow is generally a result of excess stormwater entering the system that is addressed through best stormwater management practices and bylaw enforcement while infiltration results from groundwater entering the system as a result of infrastructure deterioration and design challenges. Infiltration issues are normally remedied through infrastructure improvements. Figure 1 illustrates the differences in inflow and infiltration.

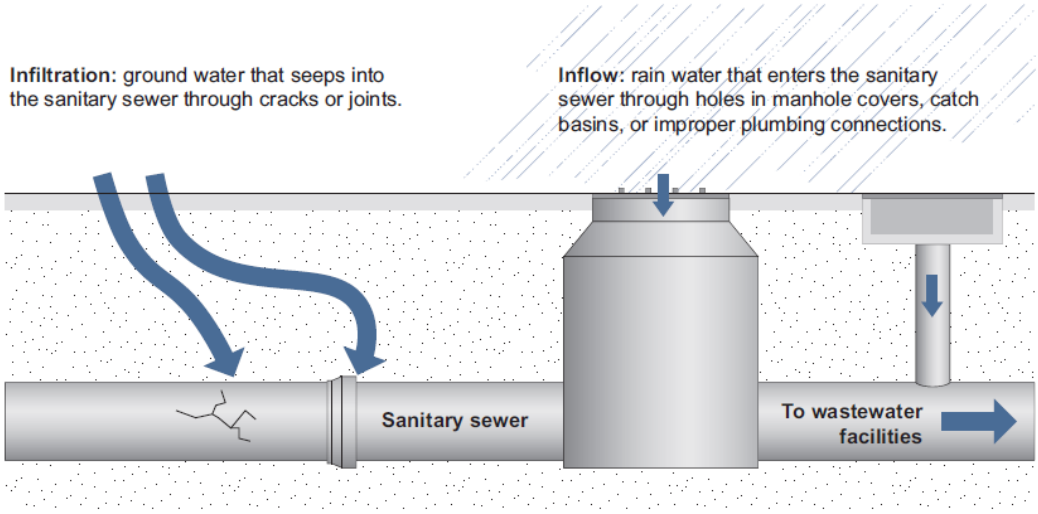

Figure 1 – Simplified depiction of Inflow vs Infiltration (Kesik, 2015)

To resolve excess flows into a sanitary system, the sources of I&I must be confirmed and appropriately addressed.

2.1 Identifying I&I Sources – Desktop Flow Analysis

In some municipalities, it is possible to determine where the majority of the excess flows are entering the sanitary system (i.e. via inflow or infiltration) by examining and comparing the flows of treated water into the municipality, the flows of raw wastewater entering the sanitary treatment system, and precipitation over the same time period. In a perfect system, the amount of treated water produced would be equal to or greater than the amount ultimately entering the wastewater system.

The Township's treated water flow (blue) is plotted with raw wastewater flow (orange) and precipitation (grey) in Figure 2. The water flow data reflect typical usage patterns, higher in the summer months as lawn watering and other seasonal activities occur and lower in the winter. However, Figure 2 also shows that the Township's sanitary flows are significantly higher than the treated water flows. As OCWA has been informed that the number of drinking water users is equal to the number of sanitary users, this confirms that excess flows are entering the sanitary system via groundwater or storm water.

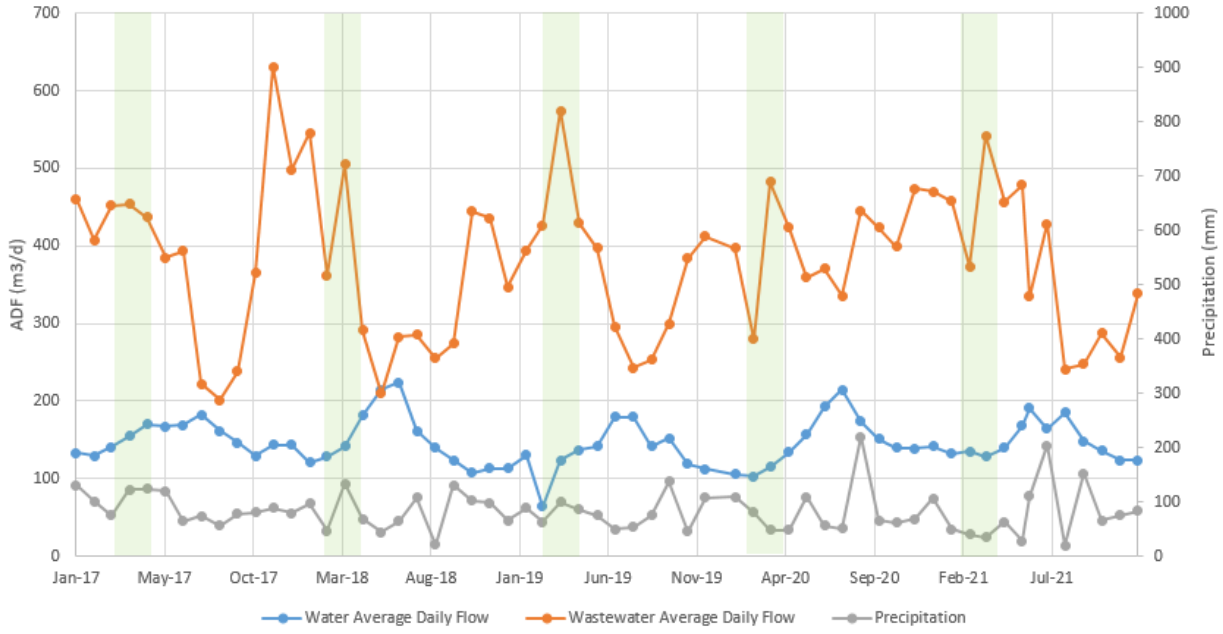

Figure 2 – Comparison of Water to Wastewater Flows

As there are regular peaks in the sanitary flows during the spring freshet (late February to early April, which are highlighted in green), this indicates that there is groundwater entering the system via defects in the underground infrastructure. To determine if there is rainfall entering the system via roof leaders, cross connections with storm sewers, etc., wastewater flows are compared against precipitation (grey). From the monthly data, there is no obvious correlation, however this does not preclude one, it simply means that the data must be recorded and analyzed over shorter time intervals (and ideally, within Bayshore Village) to determine if there is a relationship between rainfall and wastewater flows.

It must be noted that there are limitations to quantifying excess flows from this high level flow analysis due to a number of factors:

1. The flow meter that is currently measuring the raw wastewater entering the pump station does not continuously record flows. Instead, flows must be manually read and recorded by an operator. This introduces two potential issues for proper data collection:

    - **Human Error** – Data can be read or recorded incorrectly.
    - **Averaging Error** – If the data is collected over several days, the total flow between collections is divided by the number of days between collections to obtain an average daily flow. For example, if the flow was collected every three days, the average flow for those three days would be calculated as the total flow divided by three and consequently, the average daily flow would be the same for all three days. This would not capture any instantaneous flow changes due to storm or other rain events.

2. The precipitation volumes shown are for Shanty Bay, which is 28km from Bayshore Village and may not reflect local weather conditions. Additionally, only daily volumes were provided by Environment Canada, which does not capture short duration, high intensity storms.

3. Bayshore Village is almost completely surrounded by Lake Simcoe, whose water levels fluctuate between 0.4 to 0.5 m/year with the highest levels occurring in April to June before the managed drawdown in July of each year.[1] The groundwater table was not examined for this report but should be included in future I&I studies.

2.2 Identifying I&I Sources – Site Investigations

Prior to implementing remediation efforts, the source(s) of the I&I must be identified. This can be done in a variety of ways.

Detailed Flow and Rainfall Analysis – OCWA has conducted a preliminary analysis comparing water flows to wastewater flows, and when available, daily precipitation. Although this can provide a general indication of where flows originate, flow monitors placed in select sewers to monitor flow fluctuation in catchment areas can better characterize and quantify excess flow amounts. This process is scheduled to occur over a period of time that includes a dry period, as well as, some rain events, and ideally, the spring freshet. It also provides data that can be used to direct investigations and remediation, as well as provide quantifiable metrics for tracking the effect of any remediation. As this can take several weeks and requires extensive data analysis, it can be an expensive investigation.

Visual Inspection of Sanitary Infrastructure – Maintenance holes (MH) can be inspected visually from above ground with inspection staff and, optionally, camera equipment. Defects in MHs can often provide cost effective ways to reduce excess flows as they generally do not require invasive repairs. Sewer main pipes and lateral pipes must be inspected using remote-operated equipment with CCTV cameras. A CCTV inspection will reveal visible pipe defects such as cracks and fractures, however, if the sewer is not actively leaking during the inspection, I&I sources can be missed. Consequently, CCTV surveys for I&I should be conducted in the spring when the groundwater levels are higher and the

[1] Lake Simcoe Region Conservation Authority: https://www.lsrca.on.ca/Pages/Lake-Simcoe-Water-Levels.aspx accessed February 7, 2022.

chance of active infiltration occurring is better. The Township last conducted CCTV inspections of their mainline sewer pipe in 2018.

Lateral Sewer Inspection – Repairs in the main sewer are only effective if the connected laterals from the private properties are watertight as well. Laterals can be inspected using a push camera from the cleanout on the property or from inside the house, or alternately, from the main sewer line using a CCTV unit with a lateral launch camera. These inspections should also be conducted during wet weather to increase the likelihood that there will be active infiltration during the inspection. The Township conducted lateral sewer inspections in 2018, 2019 and 2020.

Electro Scan – In situations where there is known I&I and CCTV is not able to identify obvious defects, a technology called Electro Scan can be used. During an inspection, the tool is surrounded by a plug of water and pulled through the sewer pipe using a tethered cable. An electric current is induced through the water and if there is a breach in the pipe, the water (and current) will "leak" through that breach. The lost current is measured by the tool and used to size the leak. This allows the user to find defects causing I&I and prioritize the largest contributors for remediation. Figure 3 shows a 42m section of sewer with four leaks and the CCTV images for the leak locations.

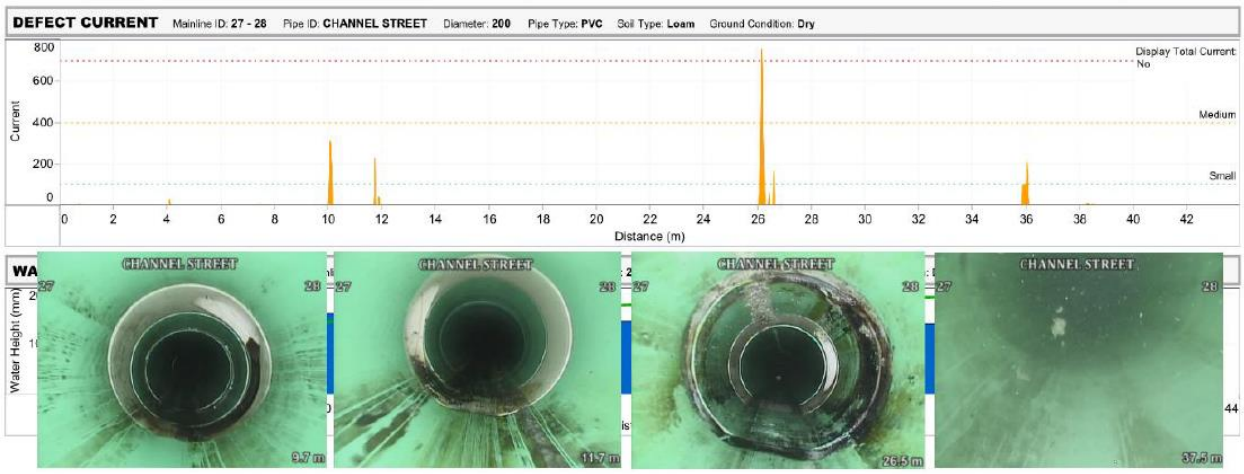

Figure 3 – Electro Scan results for PVC pipe (CCTV image included for comparison)

Electro Scan cannot determine the structural integrity of the sewer pipe but is an excellent option for I&I detection in non-metallic pipe. Note that CCTV videos should be collected for sections that are to be inspected using Electro Scan to correlate leak locations with feature locations.

Note that there is no longer a local Electro Scan service provider in Ontario, however there is currently a provider in Quebec that uses staff and equipment from an office in New York. Consequently, coordination for importing this service may be pandemic-dependent.

Smoke (Fog) Testing - Smoke testing is used to identify areas affected by inflow and potential "quick" fixes (e.g. replacing missing cleanout caps, disconnecting rainspouts from the system, etc.). Larger issues such as cross connections with storm sewers can also be identified during this process, however, dye testing or CCTV may be needed to determine the exact location of the cross connection. The Township has already undertaken smoke testing in the community, however there is no report documenting its

findings and highlighting remedial actions to be taken. Anecdotal evidence indicates that minor defects such as missing cleanout caps were identified but not any significant defects or inflow sources.

Visual Property Inspections – As connections between resident storm collection systems generally account for up to 90% of excess flows into the system[2], property inspections can be useful for determining if there are sump pumps or roof headers connected to the sanitary system. Although the coordination with homeowners is difficult, the actual inspection generally takes less than 10 minutes per household. Note that any private property inspections would require coordination between OCWA and the Township regarding COVID-19 protocols to ensure the safety of both workers and homeowners. Sump inspections of 138 properties were conducted in 2019.

2.3 Previous Investigations

2.3.1 CCTV Inspections

According to the 2018 Sanitary CCTV Inspection Assessment report by C.C. Tatham & Associates (2018), the following inspections were conducted in 2018:

- 31 service laterals (from sewer main line to property line)
- 64 out of 69 sanitary mains

The Township has also provided summaries for service lateral inspections conducted in 2019 and 2020, as well a list of lateral repairs conducted as a result of the 2019 inspections.

Lateral Inspection Results

During the three years from 2018 to 2020, 82 laterals were inspected (22%), some more than once. Of these 82 laterals, 26 had defects that contribute to I&I. A summary of the defects observed that are contributing to I&I is provided in Table 1.

[2] Pawlowski, C. W. et al (2013) *Some Factors Affecting Inflow and Infiltration from Residential Sources in a Core Urban Area: Case Study in a Columbus, Ohio, Neighborhood*, Journal of Hydraulic Engineering

Table 1: Defects Observed from Lateral CCTV Inspection

DEFECT	# OF OCCURRENCES
IW (Infiltration Weeper)	1
ID (Infiltration Dripper)	4
IR (Infiltration Runner)	24
IG (Infiltration Gusher)	13
ISR (Intruding Sealing Ring)	2
H (Hole)	2
JO (Joint Offset)	6
Total	**52**

Of the 26 laterals with observed I&I defects, 16 were repaired in 2019. Of those 16, 12 were then reinspected at a later date and during that reinspection, seven were observed to have new or similar I&I defects.

Main Line CCTV Inspection

The C.C. Tatham & Associates report noted that the sanitary mains and service laterals contained a number of infiltration defects that will contribute to excess flows in the system. Defects contributing or potentially contributing to excess flows are summarized in Table 2.

Table 2: Defects Observed from Main Line CCTV Inspection[3]

DEFECT	# OF OCCURRENCES IN AC PIPE (4.2 KM)	# OF OCCURRENCES IN PVC PIPE (1.17 KM)
IW (Infiltration Weeper)	10	-
ID (Infiltration Dripper)	8	-
IR (Infiltration Runner)	4	-
IG (Infiltration Gusher)	3	-
ISR (Intruding Sealing Ring)	2	2
LFD (Lining Failure Detached)	1	-
IR from Lateral Piping	39	10
Total	**67**	**12**

[3] C.C Tatham & Associates Ltd. (2018), *Sanitary CCTV Inspection Assessment*

As a result of this inspection, a number of grouting and CIPP spot repairs were conducted. Two Sewer Technologies invoices from May 2019 and Jan 2020 were provided by the Township, which included work orders for the repairs. Inquiries were made to Sewer Technologies for any additional invoices/work orders on two occasions and at the time of this report additional information had not been made available. If information is provided prior to initiating any further studies, this report will be updated with the new information.

2.3.2 Sump Pump Investigations

In April and May of 2019, a visual inspection of 138 properties was conducted to determine if there were sump pump connections to the sanitary sewers. The results of this inspection are summarized in Table 3.

Table 3: Sump Pump Inspection Summary

LOCATION	# PROP INSP / TOTAL PROP	# PROP WITH SUMP PUMPS	# CONNECTED TO SANITARY	# CONNECTED UNKNOWN	# NOT CONNECTED
Southview	17 / 57	11	-	1	10
Bayshore	70 / 157	67	1	3	64
Misty	5 / 15	5	-	-	5
Lantern	0 / 11	-	-	-	-
Lavender	5 / 6	5	-	-	5
Thicketwood	11 / 41	10	-	3	7
Park	11 / 24	11	-	2	9
Sandlewood	4 / 23	4	-	-	4
Maplegate	8 / 29	8	-	-	8
Fernwood	7 / 11	6	1*	-	5
TOTAL	**138 / 374**	**127**	**2**	**9**	**117**

* Disconnected during inspection

Approximately 37% of the properties were inspected and 92% of the inspected properties had sump pumps installed. The majority of these (92%) were confirmed to be discharging over ground or to another non-sanitary outlet. Two sump pumps were confirmed to be connected to the sanitary system while nine outlets could not be visually confirmed.

Additionally, the inspection team recorded that

- 7 downspouts had no visible (i.e. above ground) discharge point indicating a potential sanitary connection
- 22 cleanouts could not be accessed
- 5 cleanouts were not capped, which creates an inlet for stormwater into the sanitary system

2.3.3 Smoke (Fog) Testing

Smoke testing was conducted by Robichaud in October 2018. Pages 1-19 of the Robichaud report were provided to OCWA in March 2022. During the investigation, 19 properties had issues with the cleanouts, which would result in rain water (and possibly potable water used for watering lawns) entering the sanitary system. It is unknown whether or not these cleanouts were repaired.

2.4 Information Gaps

During the data review, the following information gaps were observed:

Main line CCTV Inspection - Five sections of main line sewer (listed below) were not inspected with CCTV. Surveys were abandoned due to barriers such as encrustation, which must be removed before reattempting another inspection.

- MH 32 to MH 33
- MH 48 to MH 49
- MH 49 to MH 50
- MH 51 to MH 52
- MH 53 to MH 66

Additionally, as only the Tatham report summarizing the CCTV inspection reports was provided, the CCTV reports and videos from the CCTV vendors may or may not be available. If these reports and videos are not available, a full CCTV re-inspection will be necessary. If these reports and videos are available, only the missing sections and other Asbestos Cement sections will require re-inspection.

Main line Repairs – Repairs were made, however, at present, only two work orders for repairs were provided to OCWA. If there have been additional repairs but no work orders or repairs records, a CCTV re-inspection would identify any previously repaired locations.

Lateral CCTV Inspection – Approximately 22% of the lateral pipes were inspected using CCTV (82/374), meaning approximately 78% are outstanding

Private Property Inspections – Approximately 37% of the private properties have been inspected for connections to the sanitary sewer. There are 236 properties outstanding.

Maintenance Hole Inspections – No inspections of maintenance holes have been conducted.

Smoke Testing Repairs – There was a smoke test conducted, however, it is unknown if repairs to the cleanouts were implemented.

Wastewater Flows and Precipitation Data – These data sets were not accurate enough to quantify excess flows into the system and identify a correlation between storm events and excess wastewater flows. To accurately determine and quantify inflow and infiltration amounts, flow monitors and a rain gauge with data logging capabilities must be installed.

3 I&I Remediation

Depending on the nature, location and frequency of the defect, there are a number of potential repair options. The most common options are summarized below for informational purposes. Once the defects specific to the Township's system are identified, a more detailed remediation plan can be created.

3.1 Remediation Methods

3.1.1 Sanitary Sewer Pipe

Pipeline renewal can be done in a number of ways that can be categorized as either repair, rehabilitation or replacement.

ROOT AND INTRUDING TAP REMOVAL

As trees and plants mature, their underground root systems grow, seeking out moisture, which is readily provided in sewer pipelines. Joints and cracks in the pipe create entry points for the roots, which left untreated, will reduce flow capacity and eventually undermine the pipe's structural integrity.

Similarly, if lateral pipes (taps) intrude into the main sewer, they can interfere with the flow capacity, inhibit inspection/repair work and provide a point to snag debris.

Both roots and intruding taps can be removed by using a robotic cutting tool. If this exposes a hole or other infiltration route, this defect can be either grouted or patched using a variety of spot repair methods discussed below.

Alternately, roots can be removed using a chemical treatment. This can be more effectively than cutting them back as it will take longer for the roots to return, however the point at which the roots have breached the sewer must still be repaired to reduce excess flow.

SPOT REPAIRS

Spot repairs refer to repair work on a pipe for a distance that is less than the distance between the two access points and can be performed externally or internally. For sewer pipe that is easily excavated, an external clamp or sleeve can be installed. For slightly longer sections, it may be more effective to replace the section. If a significant section of pipe must be repaired, full section replacement or lining should be considered.

Internal spot repairs can be conducted by installing seals, short liners and patches. These "trenchless" repairs are done using a remotely operated vehicle and the aid of a CCTV camera. They greatly reduce the amount of construction work as the repair team is smaller and no road or landscaping restoration is needed. In many cases, the repairs can be conducted without affecting residents.

GROUTING

Grouting is generally used to repair cracks or joint gaps when there are no other structural issues. Grouting will resolve the I&I issues by forming a waterproof barrier around the sewer pipe at the crack/gap location.

Holes are drilled from within the structure to allow a conduit for grout injection into the soil/void behind the structure. After injection has occurred, the grout expands to fill the void forming a tight, impermeable elastomeric seal, preventing water flow through the pipe wall. This water-tight collar adheres to the outer surface where it will stay indefinitely unless removed by excavation or exposed to sunlight for long periods of time. If the groundwater pressure increases, the collar will be pressed even more tightly against the structure, increasing its ability to prevent leaks.

Grouting can be accomplished in a few hours and does not disturb the ground/paving surface or interrupt service. One of the drawbacks to this approach is that it can be difficult to predict the size of the void beforehand, which makes cost estimation difficult.

FULL PIPE LINER

Pipe liners can be structural or non-structural. Non-structural liners are generally used when the pipeline appears to be in good structural condition but is experiencing excessive I&I. There are a variety of liners that can be installed via access chambers that create a water-tight barrier and can provide significant cost savings over full pipe replacement, particularly in deeper sewers where significant excavation is required.

Structural liners are used when there is a risk of collapse or failure and open cut is inconvenient or expensive. The existing sewer is used a form for installing the new liner, which is soft when installed and hard when it cures. Once the liner has cured, it acts as a new pipe no longer relying on the integrity of the existing pipe. Laterals that connect to the newly lined sewer are reinstated by drilling through the liner using a remotely operated cutting vehicle.

Structural liners can also be inserted into laterals without disturbing private properties. LiquiForce, an Ontario-based company, cleans existing lateral piping, measures it for a new, custom liner, and installs the lining system all from maintenance holes on the main sewer pipe.

REPLACEMENT

In pipe sections that have already collapsed or in sections where there is sagging, it is difficult to install a structural liner. There are a number of options for full pipe replacement although in most rural or northern communities where there are few underground utilities and a low density of lateral connections, open cut tends to be the preferred approach.

3.1.2 Maintenance Holes

COVER & FRAME REPLACEMENT / ADJUSTMENT

When the cover and/or frame deteriorate, they can be replaced. This process involves some excavation around the frame and possibly the chimney, coupled with surface restoration once the work has been done.

If the frame has moved or settled so that it is not flush with the maintenance hole cone/chimney/wall, it can create an avenue for I&I. If the components are still in good condition and the chamber itself has not shifted, the frame can be removed and then re-seated. This also requires shallow excavation and surface restoration.

SPOT REPAIRS

Depending on the nature of the issue, a number a spot repairs can be performed:

Patching/parging – In areas where concrete or mortar is beginning to deteriorate, specially designed cementitious or polymer coating materials can be applied. Larger voids in areas where no hydrostatic pressure exists can also be patched using similar compounds that are then troweled, sprayed or cast onto existing surfaces.

Crack/leak repairs – If the cracks are small and not resulting from more problematic structural issues, they can be repaired using oakum plugs or grout.

Benching repairs - Benching is the sand and cement surface that fills the space between the maintenance hole walls and the channel pipes and affects the hydraulic flow. Benching can be repaired by chipping away damaged portions and re-pouring a new surface.

GROUTING

As described in the piping rehabilitation section, grouting is generally used to repair cracks or joint gaps when there are no other structural issues. Grouting will resolve the I&I issues by forming a waterproof barrier around the maintenance hole chamber at the crack/gap location.

If the frame is seated well but voids have formed between the frame and cone/chimney, it is also possible to grout or parge the void or install a chimney seal, which essentially functions to prevent leakage into the chamber.

LINER INSTALLATION

There are a number of lining solutions that can be installed to rehabilitate maintenance hole structures:

Polymer Coatings (e.g. SpectraShield) – Mostly used for corrosion protection and I&I control, polymer coatings can also offer some structural benefit depending on the product and application.

Cured-In-Place (CIP) – CIP offers corrosion protection and I&I control in addition to a structural reconstruction. The process includes the installation of a fabric liner that is saturated with a resin that is heat cured under pressure to mold tightly to the existing structure. Alternately, a CIP concrete liner can be created by building an internal form to the pouring of a new concrete maintenance hole from bench to frame that is structurally independent from the original maintenance hole structure.

Panel Liners – Individual panels are installed to create a new maintenance hole wall within the old one. This liner is non-structural and intended to provide corrosion protection and I&I control. Liners can be cost-effective however, companies that provide this service locally are not abundant and costs may therefore increase due to higher mobilization charges.

REPLACEMENT

If the maintenance hole cannot be restored using any of the other remedial actions, it should be replaced. This work can be extensive and will require bypassing the sewer during removal/construction.

3.2 Typical Excess Flow Reduction

The amount of achievable excess flow reduction is dependent on many factors including the source of the flow. For example, is it from the private side or due the deterioration of sewer infrastructure? Disconnecting storm collection sources (via sump pumps, rain leaders, etc) to resolve the former is a more permanent way to reduce rain-derived inflow than a point repair for the latter as the water entering the repaired point defect may migrate to the next available breach in the system. Unfortunately, disconnecting users from the system requires more diplomacy to get public buy in and in some cases, users who are disconnected will find ways to reconnect if the disconnection is not effectively preventing flooding on their property.

Studies conducted by Melbourne Water indicate that rehabilitating 40-60% of the system will result in approximately 30-50% reduction in groundwater infiltration[4]. Table 4 summarizes the results from that study.

Table 4: Levels of Achievable I&I for Different Levels of Rehabilitation

% OF SYSTEM REHABILITATED	RDII REDUCTION (%)	GWI REDUCTION (%)
100	60	80 +/-
80	40	70 +/-
60	15-20	50 +/-
40	0	30 +/-

RDII – Rain Derived I&I, GWI – Groundwater Infiltration

Further these studies indicate that 40-60% of removable RDII can be achieved by renewing private service laterals and conclude that an I&I program targeting reductions greater than 40% should include rehabilitation of private property sources of I&I.

4 I&I Reduction Program

4.1 I&I Reduction Program Overview

There are generally two major objectives for an I&I reduction program:

- Quantify excess flows to:
  - determine geographic source of I&I (i.e. is it coming from one catchment area or several?)
  - determine the water source of I&I (i.e. is it predominantly rain-derived or groundwater?)

[4] Carne, S, Le, R (2015) *Infiltration & Inflow Control Manual*, Water New Zealand

- measure I&I reduction for capacity improvement calculations

- Develop and implement effective I&I reduction strategies

The approach for achieving these objectives largely depends upon the available resources. A full I&I Reduction Program would include all or most of the activities listed in Section 2.1, documented within an engineering study that would also include recommendations for repair (Section 3). The Township would then procure a contractor to conduct the repairs. Post-repair flow monitoring would confirm the reduction in excess flows, which would then be used to determine available capacity in the sanitary system. Figure 4 illustrates the general process for a full I&I Reduction program.

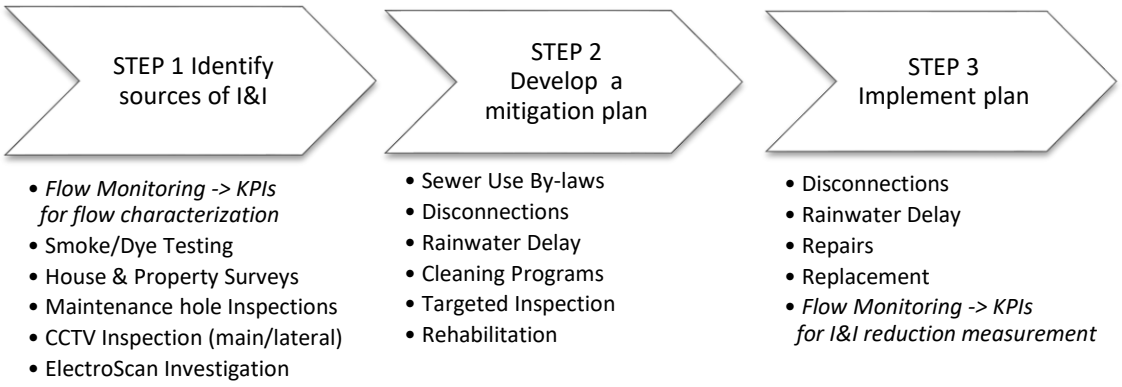

Figure 4 – I&I Reduction Program

4.1.1 STEP 1 – Identify Sources of I&I

This step is predominantly composed of field investigations to determine where excess flows are entering the system (private homes, laterals, maintenance holes, main line sewer pipe) and whether the flows are due to groundwater or rainwater. Using the techniques described in Section 2.2, the collected data will feed mitigation plan so that efforts. For a full I&I study, all investigations are critical to ensure that a full plan can be developed and progress against that plan measured.

If a municipality is limited by budget, items can be selected from the program options to potentially find and resolve larger I&I sources with lower effort. If these opportunities exist, they can provide a good return on investment, however, if they do not, the municipality may spend more time and money by breaking up a larger, holistic effort into smaller, piecemeal efforts. Additionally, as the flow metering component is normally a step that is initially omitted, it is impossible to develop realistic measurements for I&I reduction, which are necessary for:

- calculating excess flow reduction (and consequent treatment capacity improvement)
- determining a return on investment for infrastructure remediation (and consequent decisions to conduct further repairs)
- justifying the costs of the I&I reduction program and/or infrastructure remediation to the public

In any case, if the Township wishes to examine a lower cost approach, OCWA can provide a shortened list of activities that would provide an initial "screening" level of investigation to determine if there are easier gains to be made.

4.1.2 STEP 2 – Develop a Mitigation Plan

Depending on the nature of the I&I sources, mitigation could include:

- Disconnecting private properties from the sanitary system
- Adopting sewer use bylaws to prevent owners from reconnecting to the system
- Building rainwater retention structures to delay stormwater from entering the system all at once when storm events occur
- Conducting minor repairs to maintenance holes and in sewers
- Replacing or renewing sewer infrastructure

In the case of major renovation or replacement, there is often additional planning that must be done before the construction work can be tendered, which may include obtaining approval from the Ministry, producing design drawings and specifications, and obtaining funding. Construction work recommended in the mitigation plan can be broken into smaller projects that can be executed as funding becomes available.

4.1.3 STEP 3 – Implement Plan

Minor repairs and improvements to bylaws can be done as the Township's budget permits with current staff and/or subcontractors. Larger construction projects may be delayed until approvals and funding become available. In any case, once repairs are conducted, a short period of flow monitoring should be conducted again to confirm and quantify the I&I reduction resulting from the improvements.

4.2 I&I Reduction Program Road Map

The three 'steps' listed in Figure 4 are comprised of many individual tasks, which are detailed below. An estimated budget for planning purposes is provided in Section 4.3.

Task 1 – Approval to Proceed

The Township must obtain approval to proceed with the I&I Reduction Strategy from its Council. Although an exact budget for the service providers cannot be obtained until competitive procurement has taken place, the approach and estimated budget should be provided. OCWA can provide a formal proposal and quotation for the program management, MH inspections, property inspections and smoke testing components. The Township should also decide whether or not the subcontracted services (CCTV Inspection, Electro Scan) and/or equipment (weather station, flow monitors) should be contracted directly by the Township or through OCWA.

Task 2 – Procurement & Installation of Rain Gauge and Permanent Flow Meter

Once the I&I Reduction Project has been approved, the rain gauge (i.e. weather station) and flow meter (data logging) should be procured and installed. This way flows can be analyzed for the remaining winter season, the spring melt and the dry summer season when investigations like CCTV and smoke testing are conducted. Additionally, any short duration storm events can be captured and compare to treatment flows. This equipment should be maintained permanently so that excess flows can be examined annually to track improvements/degradation to the system. A weather station has been approved by the Township as a result of the Facility Optimization Plan recommendations and data logging capabilities have been integrated with the flow meter at the main pump station so this item is in progress.

Task 3 – Procurement of Catchment Flow Monitoring and CCTV Vendors

Procurement of a short term Flow Monitoring vendor and CCTV vendor should be conducted as early as possible to ensure they can be available for the spring melt and/or early wet weather when ground water infiltration into the sewer is most likely. The Township can procure these vendors directly or through OCWA. OPSS standards for CCTV are included in Appendix A to assist with the public tendering process.

Task 4 – Wet Weather CCTV and Flow Monitoring

Timing the installation of the weather station and/or CCTV inspections for the spring melt is difficult as the exact time or duration of the spring melt is unknown. In 2021, there were two smaller "melts", while 2020 experienced a significant freshet in April. If the vendor cannot be procured in time for the 2022 freshet, it should be done as early in the year as possible (i.e. April).

If videos of the original inspection cannot be provided, inspection of the full system will be required, otherwise only the AC piping requires re-inspection. If the above investigations do not observe enough defects to explain the current amount of excess flows in the system, an Electro Scan inspection should then be conducted in the entire system (i.e. in both AC and PVC sewers).

For flow monitoring, three consecutive dry days must be captured in addition to a significant rain event. Depending on the results of the first set of flow monitoring, meters may be re-deployed upstream to capture another dry/wet cycle.

Task 5 – Property Inspections, MH Inspections and Smoke Testing

AECOM estimates that 75% to 90% of excess flows into a system are a result of foundation drains and that private side connections can account for a substantial amount of I&I[5]. Consequently, private property inspections and smoke testing of the system can confirm this trend in the Township. Property inspection should include only the residences:

- that were not inspected in 2019,
- where the cleanouts could not be accessed,
- where connections to the sanitary system were confirmed (to determine if they have been disconnected), and
- where cleanout caps were noted as deficient in the 2018 smoke testing (to confirm repairs were made).

As staff will be on site for the property inspections, this is a cost-effective time to conduct MH and property inspections.

[5] Pawlowski, C. W. et al (2013) *Some Factors Affecting Inflow and Infiltration from Residential Sources in a Core Urban Area: Case Study in a Columbus, Ohio, Neighborhood*, Journal of Hydraulic Engineering

The US EPA[6] estimates that 30% of I&I enters the system through maintenance holes, which are much more easily repaired than service laterals or the sanitary main. As such, conducting a visual inspection of the maintenance hole may result in some quick wins. Figure 5 provides examples of maintenance hole defects that are a source of excess flows into the system that can be easily repaired.

Figure 5 – Examples of Maintenance Hole Defects

Smoke testing must be done in dry weather and can be scheduled as weather permits. In order to optimize smoke testing conditions, this should be scheduled in August, after the Lake Simcoe drawdown activities. If smoke testing identifies cross connections with the storm system, dye testing may be necessary to confirm the location of the connection. Smoke testing is recommended as the results of the previous test are not available. If the Township is comfortable that the previous investigation did not uncover any significant defects, this component may be omitted.

Task 6 – Analysis of Data and Recommendations

The data collected in the above steps must be analyzed, summarized and documented for the Township along with recommendations for remediation. If the CCTV and MH investigations do not observe defects that contribute to excess flows, it may be necessary to conduct an Electro Scan inspection (Task 7). If additional investigations are required, this analysis will be repeated after the additional activities.

Tasks 7 – Additional Investigations (e.g. Electro Scan)

If an Electro Scan inspection is required, it must be procured. Although there is currently only one firm providing this service in Ontario, the Township (or OCWA) may be required to publically tender the work or conduct single-source procurement. Additionally, this inspection requires a jetter, which must also be procured if the Township does not own one.

Once the additional investigations have been conducted, the new data must be analyzed to finalize remediation planning.

[6] EPA (1981) *Procedures for Investigating Inflow/Infiltration*

Task 8 –Procurement of Contractors for Remediation

Repairs that cannot be conducted in house (or by OCWA staff) must be procured according to the Township's policies. Larger, capital work may require design and/or MECP approval.

Task 9A – Minor Repairs

Minor repairs include items such as trenchless spot repairs, maintenance hole chimney repairs, etc. If the road surface will be disturbed (e.g. for chimney repair), this work must be scheduled before the weather gets too cold.

Task 9B – Major Repairs

Major repairs will be conducted as scheduled by the successful contractor.

Task 10 – Re-analysis of Data and Recommendations

Once the approved remediation has been completed, the rain gauge data and wastewater flows from the permanent flow monitor should be re-analyzed to determine and quantify flow reduction. This task can be done in the winter, however, the flows should also be examined during the 2023 freshet to confirm improvements in groundwater infiltration reduction.

4.3 I&I Reduction Full Program Budget

The budget for a full I&I Reduction program as described above is shown in Table 5. Note that this is a Class V estimate to be used for budgeting purposes only and final costs will not be known until quotations are obtained from all vendors. OCWA can provide a proposal for program management (Item 1) and the activities provided in Item 2. The costs of rehabilitation are not included in this report but will be estimated in Task 6. The program management budget assumes the Township will conduct procurement of the CCTV vendor, flow monitoring vendor and rehabilitation contractors.

Table 5: I&I Reduction Program Class V (-50% to +100%) Estimated Budget

#	ITEM	VENDOR	CLASS V ESTIMATE
1	Management of Program Analysis of Data & Report Re-analysis of Data & Report	OCWA	$60,000
2	Mobilization MH Inspection Private Home Inspections GPS Point Collection (optional)	OCWA	$600/night + $2,000 ($9,200) $45/MH ($3,195) $300/hr ($20,000) $10/MH ($710)
3	CCTV inspection Flushing (if necessary) Flow monitoring (3 months)	3rd party vendors TBD	$5/m ($30,000) $5/m ($30,000) $40,000

#	ITEM	VENDOR	CLASS V ESTIMATE
4	Weather Station including Rain Gauge (with Data Logger)		-
5	Flow Meter installation (single, permanent site)		-
		TOTAL	**$181,705**
P	**Provisional:** Electro Scan Inspection Jetter	ElectroScan TBD	$77,500 $12,000
		TOTAL including Provisional	**$271,205**

5 Next Steps

The next steps for 2022 are shown in Figure 6. If the Township would like to take some time to consider the I&I Reduction program approach, the weather station and permanent data logging flow monitor should still be procured and installed prior to the spring melt. Delaying this step may result in missing crucial data collection, which may increase the schedule to include the 2023 freshet.

The I&I Reduction program can then be initiated so that any CCTV inspection and additional flow monitoring can occur before the weather becomes too dry to see active infiltration. MH inspections and property inspections can be done later in the summer when the weather is dry.

Once the data is analyzed, it can be determined whether or not additional investigations are necessary. If they are warranted, they can be conducted before the winter and integrated into the final report, which will identify repairs and rehabilitation needs.

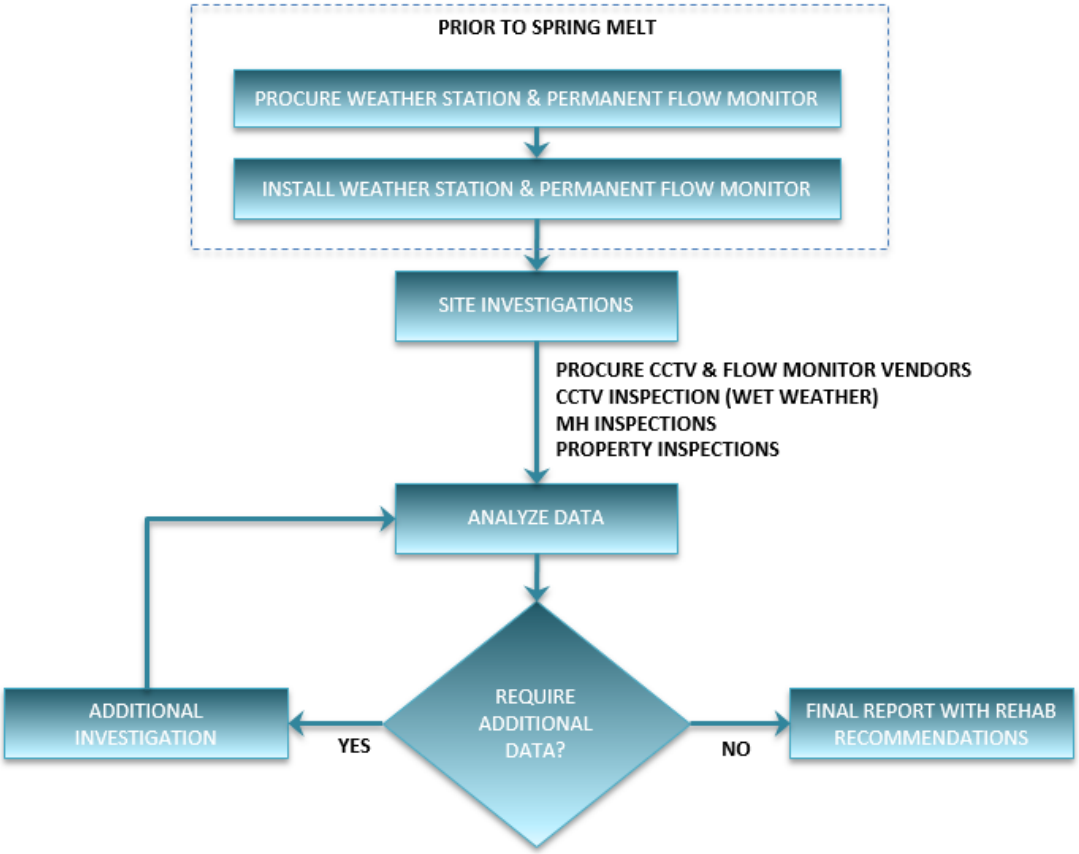

Figure 6 – Next Steps for 2022

Once necessary repairs and rehabilitation are identified and grouped into appropriate projects, the Township can determine which projects can be done in-house or tendered to Contractors. As budgets allow, repairs can be conducted and post-repair flows monitored via the permanent flow monitor to determine the impact of the improvements.

APPENDIX A

OPSS.MUNI 409
Construction Specification for CCTV Inspection of Pipelines

NOVEMBER 2017

CONSTRUCTION SPECIFICATION FOR CLOSED-CIRCUIT TELEVISION (CCTV) INSPECTION OF PIPELINES

TABLE OF CONTENTS

409.01 SCOPE

This specification covers the requirements for inspecting new and existing pipelines, which include storm and sanitary sewers, watermains, pipe culverts or other accessible conduits by closed-circuit television (CCTV).

409.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

409.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

409.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

CSA Standards

PLUS 4012 (2010) Technical Guide: Visual Inspection of Sewer Pipe

Water Research Centre (WRc) Publication

MSCC, Manual of Sewer Condition Classification, 4th Edition, December 2003

Canadian Standards Association

Pipeline Assessment and Certification Program (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE Visual inspection of sewer pipe;

409.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Business Day means any day except Saturdays, Sundays, and statutory holidays.

CCTV means closed-circuit television.

Digital Storage Device means compact disc (CD), digital videodisc (DVD), flash memory card, hard drive, or other industry-standard digital storage mediums.

Drainage Structure means a catch basin, maintenance hole, or ditch inlet.

DVD means digital videodisc.

MPEG means movie photographic experts group.

NASSCO means North American Society of Sewer Service Companies.

PACP means Pipeline Assessment and Certification Program.

Pipeline means storm, sanitary, watermains, pipe culverts or other accessible pipe conduits.

USB means universal serial bus.

409.04 DESIGN AND SUBMISSION REQUIREMENTS

409.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of the CCTV inspection operations:

a) A copy of the CCTV operator's NASSCO Certification Certificate. A copy of said certificate is required for each CCTV operator working on the Contract. Operators shall have been certified or re-certified within the three years prior to the start of the Contract.

b) A sample inspection report and video recording.

c) resolution tests of digital video recording format, and digital data file. One submission is required for each camera proposed for use on the work. The camera make, model, and serial number shall be clearly identified on each video recording.

d) The details of the coding accuracy verification system that is to be used to verify inspection accuracy.

409.05 MATERIALS

409.05.01 General

Media storage shall be as specified in the Contract Documents.

Digital storage device with minimum USB 2.0 or higher compatibility shall be placed inside envelopes with labels displaying the following information.

a) Owner’s Name

b) Contract Number or Project Name

c) Sewer Identification Number

d) Region or Municipality

e) Street Name, Park Name or Highway Number

f) Inspection Date

The digital storage device shall include a file in either Word or text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points a) and b) above to identify the content. CD and DVD shall be placed in a 5.2 mm slim-line clear jewel case with permanent labels displaying all the information above or as specified in the Contract Documents.

409.05.01.01 Photographs

Digital photograph files shall meet or exceed a resolution of at least 640 x 480 pixels, and be in JPEG format or as specified in the Contract Documents. Printed photographs shall be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.

409.06 EQUIPMENT

409.06.01 General

Inspection and camera equipment used to inspect watermains shall have been used exclusively for work in watermains only.

409.06.02 Inspection Vehicle

The inspection vehicle shall contain a separate area for viewing, recording, and controlling the CCTV operation.

The viewing and control area shall be insulated against noise and extremes in temperature. Cooling and heating units shall be independent from the main vehicle engine and in good working order. External and internal sources of light shall be controlled in a manner as to ensure the light does not impede the view of the monitor screen. Seating accommodation for one person shall be provided in addition to the operator seating to clearly view the monitor screen.

All equipment used within the pipeline shall be stored outside the viewing, recording, and control area.

The vehicle shall include a cell phone or suitable alternative as agreed by the Contract Administrator for the duration of the work.

409.06.03 Inspection Equipment

The inspecting equipment shall be capable of inspecting a length of pipeline up to:

a) 300 m when entry to the pipeline may be obtained at each end of the pipeline.

b) 30 m when rodding is used.

c) 150 m when a self-propelled unit is used when entry is at only one end of the pipeline.

d) 200 m when being towed.

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order.

Each inspection unit shall contain a means of transporting the CCTV camera in a stable condition through the pipeline.

When the CCTV camera is towed by winch and cable through the pipeline, all winches shall be stable during the entire CCTV inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.

Each unit shall carry sufficient number of guides and rollers so that, when inspecting, all cables are supported away from pipe and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a taut manner and set at right angles, when possible, to run through or over the measuring equipment.

409.06.04 Video Equipment Quality

The electronic systems, television camera, and monitor shall be of such quality to enable the following to be achieved.

409.06.04.01 Camera

The pan and tilt camera shall have the capability of panning the pipe at 360° with tilt capability of 275° to ensure complete inspections and view of all laterals and deficiencies.

Resolution:

The live picture shall be visible with no interference and capable of registering a minimum number of lines of resolution at the periphery as indicated below:

a) Fixed view camera 350 lines of resolution, or.

b) Pan and tilt camera 400 lines of resolution.

Colour Constancy:

The lighting shall be set prior to commencing the inspection to ensure the camera provides optimum results when used with its own illumination source. To ensure colour constancy, no variation in illumination shall take place during the inspection.

Focus, Iris, and Illumination:

The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The illumination shall be such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast or flare out of picture shadowing.

409.06.04.02 Monitor

Monitors shall support resolution equal to or greater than the corresponding video camera resolution.

409.06.04.03 Digital Video Recorder

Digital video recorders shall be able to capture in colour from the live video source with the following requirements:

a) MPEG-2 or higher or as required by Owner.

b) NTSC 720 x 480 @ 29.97 frames per second.

c) Data/Bit Rate: MPEG-1 @ 2.4 M-bits/sec.

409.07 CONSTRUCTION

409.07.01 Pipeline Cleaning

When specified in the Contract Documents, pipelines shall be cleaned and flushed immediately prior to CCTV inspection.

409.07.02 Resolution of Videotape and Digital MPEG Video Recordings

Prior to the start of the CCTV inspection, the resolution of digital MPEG video playback for each camera shall be confirmed by recording a resolution chart approved by the Contract Administrator, using the following procedure:

a) Set up the camera as is done for the actual inspection.

b) Show the camera being introduced and reaching its final position for the test.

c) Fill the monitoring screen with the resolution chart.

d) Illuminate the resolution chart evenly and uniformly without reflections ensuring that the illumination source accurately simulates the lighting used in the sewer.

e) Record a test video for 30 seconds.

f) Identify the camera make, model, and serial number on the recording.

g) Record the test at the start of a digital recording.

The resolution test shall be submitted to the Contract Administrator.

409.07.03 Coding Accuracy

Prior to commencement of the CCTV inspection, a formal coding accuracy verification system, based on accuracy as a function of the number of defects or construction features not recorded and the correctness of the coding and classification recorded, shall be developed, submitted to the Contract Administrator, and implemented when approved.

Verification of coding accuracy shall be completed on a random basis on a minimum of 10% of the inspection reports or one per video, whichever is greater. A minimum of two accuracy verifications shall be done for each operator for each week working.

Inspections not satisfying the accuracy requirements shall be re-coded to meet the accuracy requirements and the accuracy of the inspections, immediately preceding and following the non-compliant inspection, shall be verified. This process shall be repeated until the preceding and subsequent inspections meet the accuracy requirements.

Coding accuracy checks shall be submitted to the Contract Administrator along with the corresponding video recording.

409.07.04 CCTV Inspection

409.07.04.01 General

CCTV Camera inspections shall be done by the Contractor in accordance with the pipe condition coding practices as outlined in the MSCC or Pipeline Assessment and Certification Program (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE Visual inspection of sewer pipe or as specified in the Contract Documents

The work shall include a CCTV inspection of new and existing pipelines, which include storm and sanitary sewers, watermains, pipe culverts or other accessible conduits and the preparation of all video, digital, and written reports.

A certified CCTV operator shall be employed to operate the inspection equipment and code the inspection.

A fixed camera may be used for sewer pipe or culverts less than 300 mm in diameter. For sewer pipe or culverts equal to or greater than 300 mm, a pan and tilt camera shall be used. Each camera shall have an accepted sample submissions report prior to being used for inspection work. The camera lens shall be kept clean at all times during the inspection.

Flow control measures as specified in the Contract Documents shall be implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection and shall be approved by the Contract Administrator.

All fog shall be evacuated from the pipeline and the pipeline kept clear of fog during the inspection.

At the start of each pipeline being inspectioned, the length of pipeline from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of one of the following:

a) Sewer Pipe length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the sewer pipe

b) Culvert Pipe length from one end of the pipe culvert to the other

c) Watermain Pipe length from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

The position meter-reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the inspection to the cable calibration point so that the meter-reading at the start of the inspection is zero.

In the case of inspectioning through a maintenance hole when a new header sheet is required, the meter-reading shall be set at zero with the camera focused on the outgoing pipe entrance.

At the start of each pipe segment to be inspected, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following minimum header information:

a) Automatic update of the camera’s meter-reading position in the pipeline from adjusted zero.
b) Pipeline dimensions.
c) Maintenance hole and pipe length reference numbers.
d) Date of inspection.
e) Road, Park or Highway name and location.
f) Direction of inspection.
g) Time of start of inspection.
h) Pipeline use.

Once the inspection of the pipe segment is underway, an automatic update of the camera's meter-reading position in the pipeline from zero in metres and tenths of a metre shall be continually displayed.

The camera shall be stopped when defects are being noted and coded.

Defects in each pipeline length shall be recorded according to the MSCC, (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE or as specified in the Contract Documents. Any variation from the manuals shall be noted in the inspection report.
The inspection shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.

Inspections shall be recorded in colour.

Digital video recordings may be saved to a hard drive and transferred to a portable hard disk drive, compact disc, or digital video for submission.

A digital format video recording of an inspection shall be produced in colour from a first generation recording by one of the following methods:

a) A computer system and a video capture card shall be used to capture the recording continuously, regardless of the progression of the inspection. Prior to submission, the raw digital data shall be edited to remove pauses when the inspection progress was not continuous.

b) A computer system and a video capture card shall be used to intermittently capture the recording. Prior to submission, the raw digital file shall be edited to form one continuous file.

c) Specialized video recording equipment capable of pausing and resuming live recording shall be used to capture original recording. A single file is to be produced for submission.

Video capture equipment shall be capable of capturing digital video from first generation recordings with no frame loss.

Non-linear video editing software shall be used to edit digital videos. Edited digital files shall not be recompressed.

409.07.04.02 Camera Position

The camera lens shall be positioned centrally in a circular pipeline and at two-thirds of the vertical dimension in a non-circular pipeline with a positioning tolerance of ±10% of the vertical pipeline dimension.

In all instances, the camera lens shall be positioned looking along the longitudinal axis of the pipeline.

409.07.04.03 Camera Travel Speed

The travelling speed of the camera in the pipeline shall be limited to:

a) 0.10 m/s for pipeline of diameter less than 200 mm.

b) 0.15 m/s for diameters exceeding 200 mm but not exceeding 310 mm.

c) 0.20 m/s for diameters exceeding 310 mm.

409.07.04.04 Camera Position Meter-Reading Device

A suitable meter-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The meter-reading device shall be accurate to ±1% of the length of the sewer being inspectioned. The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the inspection:

a) Cable calibration device.

b) Tape measurement of the surface distance between maintenance holes.

If the accuracy of the measuring device fails, it is to be replaced. The Contract Administrator may require that the lengths of pipeline first inspected with the original measuring device be reinspectioned using the new measuring device.

409.07.05 Final Documentation

409.07.05.01 Inspection Reporting

Inspection reports shall be submitted to the Contract Administrator in the following formats, with the noted number of copies, within 10 Business Days of the completion of the fieldwork:

a) 3 printed hard copies of the inspection report, unless otherwise specified in the Contract Documents.

b) 2 portable digital drives, each containing the identical inspection report information as in the printed copies, unless otherwise specified in the Contract Documents.

c) 2 copies of the digital video recording, unless otherwise specified in the Contract Documents.

Entire inspections shall be contained within one digital file on a digital storage device, as applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

Each digital report and video recording file shall contain the file name, as specified by the Owner and may include the following:

a) Tender, Project, or Contract number
b) E<Entity number>
c) F<From entity number>
d) T<To entity number>
e) Street, Park, or Highway Name
f) M<Measured length>
g) I<Inspected length>
h) <Inspection direction: DS or US> (DownStream or UpStream)
i) <Letter designating inspection sequence> (“A” indicates partial inspection that would include a “B” or more to this entity for a complete manhole to manhole inspection)

For example: “910-200_ESP729_F5328_T5350_BERRY_ST_M150_I39_US_B.MPEG” indicates that this is from contract 910-200, the pipe segment is referred to as SP729, inspection is from MH 5328 to MH 5350 on Berry Street, records say 150m long, actual inspection was 39m in the upstream deployment, and this is the second or “B” partial inspection of this entity, of this video recording.

All required header information fields shall be completed and verified for correctness. The software used to produce the inspection report shall not allow the operator to continue inputting information until the preceding field has been completed. The report shall be printed and presented as specified in the Contract Documents.

All dimensions in the inspection report shall be metric.

The inspection report shall identify major defects and shall include photographs when the need for photographs is specified in the Contract Documents.

409.07.05.02 Drawings

One clean set of the Owner's drawings showing maintenance hole numbers that coincide with the coding sheets and videotapes shall be returned to the Contract Administrator on completion of the inspection. The drawings shall be clearly annotated to show any discrepancies between the drawings and the inspection report. Such discrepancies shall be brought to the attention of the Contract Administrator during the inspection.

409.07.06 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

409.08 QUALITY ASSURANCE

Upon submission, printed and digital inspection reports, and digital MPEG video recordings, magnetic data files, and coding accuracy checks shall be reviewed to ensure compliance with the Contract Documents.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Only inspections with minimum accuracy for header information of 95% and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract, unless they successfully re-attain NASSCO qualification based on the standard being used (i.e., Canadian Edition of PACP or WRc).

409.09 MEASUREMENT FOR PAYMENT

409.09.01 Actual Measurement

Measurement for a CCTV inspection of pipeline shall be measured in metres on the ground surface along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. Measurement for pipe culverts shall be from one end of the pipe culvert to the other end of the pipe.

Measurement for a CCTV inspection of watermain shall be measured in metres on the ground surface along the centreline of the watermain from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

In the event that a CCTV inspection is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

409.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

409.10 BASIS OF PAYMENT

409.10.01 CCTV Inspection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for the appropriate tender item for the installation of pipe sewers, pipe culverts, or the lining of watermains shall include full compensation for all labour, Equipment, and Material to do the work of CCTV inspection.

Non-compliant submissions returned for correction shall be corrected and resubmitted at no expense to the Owner.

Appendix 409-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The type of media storage. (409.05.01)

- Additional or different labelling information for media storage (409.05.01)

- Resolutions of digital photographs. (409.05.01.01)

- Flow control measures. (409.07.04.01)

Flow control measures may include such items as scheduling work for off-peak flow times, plug or block flow at upstream manhole, and temporary by-pass pump flow around inspection section. (409.07.04.01)

- Which standard of coding classification will be followed throughout the CCTV inspection and reference the standard being used, when applicable. (409.07.04.01)

- Required video header information (409.07.04.01)

- Inspection report and video file naming details (409.07.05.01)

The designer should determine if the following is required and if so, specify it in the Contract Documents:

- If the Contractor is to clean and flush pipelines prior to commencement of CCTV inspection. (409.07.01)

- If photographs are required as part of the CCTV inspection. (409.07.05)

- If payment for CCTV inspection is to be included in the Contract price for installing storm or sanitary pipe sewers, or pipe culverts, or if payment will be a separate CCTV item or items. (409.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.