

York Region

Sanitary Sewer Commissioning Guidelines

Prepared by:

AECOM Hamilton Office
45 Goderich Road, Suite 201
Hamilton, Ontario
L8E 4W8

Project Number:

60116831 / 107304

Date:

February 2010

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report:

- are subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represent Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- have not been updated since the date of issuance of the Report and their accuracy is limited to the time period and circumstances in which they were collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- were prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Unless expressly stated to the contrary in the Report or the Agreement, Consultant:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared or for any inaccuracies contained in information that was provided to Consultant
- agrees that the Report represents its professional judgement as described above for the specific purpose described in the Report and the Agreement, but Consultant makes no other representations with respect to the Report or any part thereof
- in the case of subsurface, environmental or geotechnical conditions, is not responsible for variability in such conditions geographically or over time

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

Executive Summary

An overall inflow and infiltration (I/I) control program involves a number of processes and initiatives including an evaluation of the system, flow monitoring and measurement, source detection, prioritization and remediation, of existing infrastructure. An I/I program should also consider implementing inspections procedures and protocols to ensure that I/I is not an issue when a new pipe is commissioned. New development commissioning practices should consider a combination of the following inspection and commissioning tests:

- Visual Inspection – Visual Inspections identify defects or improper installation that cause leakage or are more likely to in the future.
- Leakage Tests (Infiltration, Exfiltration with water, Exfiltration with low pressure air) – Leakage tests utilizing air or water can be completed on sewer pipes, lateral, and maintenance holes to ensure that the total leakage is within allowable limits. Additionally, new systems can be “blocked” for certain period prior to services coming on line to calculate the rate/volume of infiltration that could be occurring.
- Deflection Testing – Deflection testing demonstrates that the pipe deflection does not exceed the allowable deflected pipe diameter through either visual CCTV observations and/or by pulling a mandrel through the pipe.
- CCTV Inspections - CCTV inspections provide a recorded video account of the condition of a sewer, identifying defects such as cracks, and cross connections which are sources of inflow and infiltration.
- Smoke Tests - Smoke testing utilizes a non-toxic smoke which is injected into a sanitary sewer to indicate the location of broken pipes, maintenance holes, catch basins, or where roof or foundation drains may inadvertently be connected to the sewer system.
- Flow Monitoring - Flow monitoring during dry and wet weather conditions help identify areas that are subject to excessive inflow and infiltration. Flow monitoring in new developments as they are constructed or assumed provides a baseline for flows and construction quality or issues.

The purpose of this document is to provide guidance on the inspection procedures that can be utilized to ensure infrastructure is constructed to be watertight and reduce the impact of extraneous flows in the future.

Table of Contents

Statement of Qualifications and Limitations

Letter of Transmittal

Distribution List

Executive Summary

	page
1. General.....	1
1.1 Purpose	1
2. Gravity Sanitary Sewer Testing Requirements	1
2.1 General Requirements.....	1
2.1.1 Visual Inspections.....	1
2.2 Leakage Tests	2
2.2.1 Infiltration Tests	2
2.2.2 Exfiltration Tests	3
2.2.2.1 Exfiltration Tests - Low Pressure Air	3
2.2.2.2 Exfiltration Tests – Water	4
2.2.3 Joint Tests	4
2.2.3.1 Joint Air Test.....	5
2.2.3.2 Joint Water Test	5
2.3 Mandrel Deflection Testing.....	6
2.4 CCTV Inspections.....	7
3. Forcemain Testing Requirements	8
3.1 General Requirements.....	8
3.1.1 Visual Inspections.....	9
3.2 Hydrostatic Leak Test.....	9
3.2.1 Polyethylene Pressure Pipe	9
4. Maintenance Hole Testing Requirements.....	10
4.1 General Requirements.....	10
4.1.1 Visual Inspections.....	10
4.2 Leakage Tests	10
4.2.1 Negative Air (Vacuum) Test	11
4.2.2 Leakage Test - Water	13
4.2.3 Chimney Seal Leakage Test	13
5. Lateral Testing Requirements	14
5.1 General Requirements.....	14
5.1.1 Visual Inspections.....	14
5.2 Leakage Tests	14
5.3 CCTV Inspections.....	14

List of Tables

Table 1.	Exfiltration Test – Low Pressure Air Testing	3
Table 2.	Deflection Testing of Pipe Sewers	6
Table 3.	Test Phase Make-Up Amount for Pressure Polyethylene Pressure Pipe.....	9
Table 4.	Minimum Test Times for Various Maintenance hole Diameters in Seconds	12

Testing and Inspection Guidelines for New Sewer Construction

1. General

1.1 Purpose

This guideline summarizes the recommended requirements for commissioning and testing new sanitary sewer infrastructure including gravity sanitary sewers, sanitary forcemains, sanitary maintenance holes, and sanitary laterals.

This Section provides the testing requirements common to all linear sanitary sewer infrastructure.

- For testing requirements specific to gravity sanitary sewers refer to Section 2
- For testing requirements specific to forcemains refer to Section 3
- For testing requirements specific to maintenance holes refer to Section 4
- For testing requirements specific to laterals refer to Section 5

The contractor shall be required to schedule all testing which is to be performed under the observation of the Consulting Engineer or the Municipality. Results for tests conducted in the absence of the Contract Administrator or Municipality will not be accepted.

2. Gravity Sanitary Sewer Testing Requirements

This section provides the testing requirements specific to gravity sanitary sewers.

2.1 General Requirements

When specified in the Contract Documents, pipe sewers shall be cleaned and flushed just prior to inspection and acceptance.

Leakage tests shall be carried out on completed pipe sewers 600mm in diameter and smaller, and there shall be no visible leakage for pipe sewers larger than 600mm diameter as per Section 2.2.

- Infiltration tests shall be conducted where the groundwater level at the time of testing is 600mm or more above the crown of the pipe for the entire length of the test section.
- Exfiltration tests shall be conducted where the ground water level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

Deflection testing utilizing a mandrel shall be performed on all pipe sewers constructed using polyvinyl chloride (PVC) pipe as per Section 2.3.

When specified in the Contract Documents, pipe sewers shall be inspected using CCTV equipment as per Section 2.4

2.1.1 Visual Inspections

The Engineer of Record shall inspect pipelines during all phases of construction.

2.2 Leakage Tests

Leakage tests shall be performed as either infiltration or exfiltration tests as required and as outlined in OPSS standard 410¹ and below in Section 2.3.1 and Section 2.3.2.

Leakage tests shall be carried out on completed pipe sewers 600mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 600mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including lateral connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections such that the total leakage is within the allowable limits for the combined sections

Pipe sewers shall be repaired and re-tested, as required, until the test results are within the limits specified. Visible leaks shall be repaired regardless of the test results

No part of the work will be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

2.2.1 Infiltration Tests

Infiltration tests shall be conducted on pipe sewers 600mm in diameter and smaller where the ground water level at the time of testing is 600mm or more above the crown of the pipe for the entire length of the test section.

The rate of infiltration into the sanitary sewer system between any two adjacent manholes or entire system shall not be in excess of 0.075 litres/millimeter diameter /100 metres of pipe sewer/hour

Prior to testing, discontinue dewatering operations at least three days before conducting the test and allow the groundwater level to stabilize.

The test section is normally between adjacent maintenance holes. A watertight bulkhead is constructed at the upstream end of the test section. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device is installed at the downstream end of the test section. Infiltrating water is allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow is then measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section.

The Contractor shall be required to repair all visible leaks, even if the allowable infiltration requirements are met. The method of repair shall be per the approval of the Contract Administrator.

¹ Ontario Provincial Standard Specification 410, Construction Specification for Pipe Sewer Installation in Open Cut, Revision Dat2 04/2008

2.2.2 Exfiltration Tests

Exfiltration tests utilizing water or low pressure air shall be conducted on pipe sewers 600mm in diameter and smaller where the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The Contractor shall be required to repair all visible leaks, even if the allowable exfiltration requirements are met. The method of repair shall be per the approval of the Contract Administrator.

2.2.2.1 Exfiltration Tests - Low Pressure Air

The Contract Administrator may allow or require testing by use of air where water is not readily available or the differential head in the test section is greater than 8m or freezing temperatures exist.

The Contractor is responsible for assuring that the test is conducted in a safe manner and all applicable safety procedures are followed. Do not enter, or allow anyone to enter, the manhole during testing.

The test may be done immediately after final backfill is placed in the trench.

At a minimum the following equipment shall be provided:

- Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35kPa with minimum divisions of 0.5kPa and accuracy of approximately 0.25kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0kPa for each 300mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5kPa shall be recorded.

The time taken for a pressure drop of 3.5kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the Length for Minimum Time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

Table 1. Exfiltration Test – Low Pressure Air Testing

Nominal Pipe Size mm	Minimum Time min:sec	Length for Minimum Time m	Time for Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893

Nominal Pipe Size mm	Minimum Time min:sec	Length for Minimum Time m	Time for Longer Length sec
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	30.040
825	15:35	22	42.397
900	17:00	20	50.450

2.2.2.2 Exfiltration Tests – Water

The test section shall be slowly filled with water making sure that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed before starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600mm minimum over the crown of the pipe or at least 600mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8m. In calculating net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable limit calculated for the test section of 0.075 litres/millimetre diameter / 100 metres of pipe sewer/hour. An allowance of 3.0 litres per hour per meter of head above the invert for each maintenance hole included in the test section shall be made. Maintenance holes shall be tested separately, if the test section fails.

2.2.3 Joint Tests

Joint testing using air or water, shall be conducted on all precast concrete pipes greater than 600mm in diameters utilizing rubber gasket sealed joints as outlined in ASTM C 1103².

If the groundwater pressure is equal to or greater than the test pressure, and the sewer line or joint is not leaking, the sewer line or joint is acceptable and no additional testing is required. If one or more joints are leaking, but the total amount of leakage in the sewer line being tested is equal to, or less than the allowable leakage rate identified in Section 2.3.1 and Section 2.3.2, the line is acceptable and no additional testing is required provided visible leaks are repaired.

The Joint test may be done immediately after backfill is placed.

Equipment used shall be made specifically for joint testing of pipelines.

² ASTM International C 1103, Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

The joint in the sewer line to be tested is covered on the inside of the pipe by a ring with two end element sealing tubes. Air or water, at low pressure is introduced through a connection on the ring into the annular space between the ring and joint. The amount of air, or water, loss is used to determine the acceptability of the installed sewer line.

The Contractor is responsible for assuring that the test is conducted in a safe manner and all applicable safety procedures are followed.

The joint and interior joint surfaces shall be cleaned to eliminate debris prior to wetting and testing.

Move the joint test apparatus into the sewer line to the joint to be tested and position it over the joint. Make sure the end element sealing tubes straddle both sides of the joint and the hoses are attached. For the water test, the bleed-off petcock must be located top dead centre.

Inflate end element sealing tubes with air in accordance with equipment and manufacturer's instructions.

2.2.3.1 Joint Air Test

Pressurize the void volume with air to 24kPa greater than the pressure exerted by groundwater above the pipe. Allow the air pressure and temperature to stabilize before shutting off the air supply and start test timing.

If pressure holds, or drops less than 7kPa in 5 seconds, the joint is acceptable.

If the joint being tested fails, it shall be retested, or repaired if necessary, and retested. The method of repair shall be per approval of the Contract Administrator. Grouting is not an acceptable method of repair.

After the joint test is completed, exhaust void volume, then exhaust end element tubes prior to removal of apparatus.

Use or failure of the joint air test shall not preclude acceptance by appropriate water infiltration and exfiltration testing or other means.

2.2.3.2 Joint Water Test

Introduce water into void volume until water flows evenly from open petcock. Close the petcock and pressurize with water to 24kPa above the pressure exerted by groundwater above the pipe. Shut off the water supply.

If the pressure holds, or drops less than 7kPa in 5 seconds, the joint is acceptable.

If the joint being tested fails, it shall be retested, or repaired if necessary, and retested.

If the joint being tested fails, it shall be retested, or repaired if necessary, and retested. The method of repair shall be per approval of the Contract Administrator. Grouting is not an acceptable method of repair.

After the joint test is completed, exhaust and element tubes which will automatically release water from the void volume, prior to removal of apparatus.

Use or failure of the joint water test shall not preclude acceptance by appropriate water infiltration and exfiltration testing or other means.

2.3 Mandrel Deflection Testing

Mandrel deflection testing shall be performed on all pipe sewers constructed using plastic pipe according to OPSS 410³.

The mandrel deflection test shall be done no sooner than thirty (30) days after final backfill has been placed.

The mandrel shall be cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter \pm 1mm. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs. This length shall not be less than that shown in Table 2.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter \pm 0.1mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

For pipes 100 to 750mm in diameter, the allowable deflected pipe diameter is 7.5% of the base inside diameter of the pipe. For Pipes greater than 750mm in diameter, the allowable deflected pipe diameter is 5.0% of the base inside diameter of the pipe. The base inside diameter is defined in the CSA or ASTM standard to which the pipe is manufactured.

Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

All sections of pipe that fail the deflection test shall be repaired and retested.

Table 2. Deflection Testing of Pipe Sewers

Nominal Pipe Size mm	Mandrel Contact Length mm
150	100
200	150
250	200
300	250
350	300
375	300
400	300
450	350
500	400
525	450
600	500
675	575
750	675
900	750
1050	900
1200	1050

³ Ontario Provincial Standard Specification 410, Construction Specification for Pipe Sewer Installation in Open Cut, Revision Date 04/2008

2.4 CCTV Inspections

When specified in the Contract Documents, pipe sewers shall be inspected using CCTV equipment according to OPSS 409⁴ to identify any existing defects such as debris, cracks, and possible cross connections.

The CCTV inspection of the pipeline shall include the preparation of all video, digital, and written reports and be conducted by a NAAPI certified

A fixed camera may be used for pipelines less than 300mm in diameter. For pipelines equal to or greater than 300mm, a pan and tilt camera shall be used. Each camera must 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 shall be implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection.

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 surveyed, 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 the pipe sewer length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer

The metre reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the survey to the cable calibration point such that the metre reading at the start of the survey is zero. In the case of surveying through a maintenance hole where a new header sheet is required, the metre reading shall be set at zero with the camera focused on the outgoing pipe entrance.

At the start of each maintenance hole length, 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 information:

- Automatic update of the camera's metre reading position in the pipeline from adjusted zero
- Pipeline dimensions
- Maintenance hole and pipe length reference numbers
- Date of survey
- Road name and location
- Direction of survey
- Time of start of survey
- Pipeline use

Once the survey of the maintenance hole length is underway, an automatic update of the camera's metre 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 on the coding sheet.

Defects in each pipeline length shall be recorded according to the Water Research Centre Publication Manual of Sewer Condition Classification, 4th Edition, December 2003. Any variation from the manual shall be noted in the survey report.

The survey shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.

⁴ Ontario Provincial Standard Specification 409, Construction Specification for Closed-Circuit Television Inspection of Pipelines, Revision Date 11/2005

Inspections shall be recorded in colour. Digital video recordings may be saved to a computer hard drive and transferred to a compact disc or digital video for submission. An analog format video recording of an inspection shall be recorded at standard play speed, SP mode, on a video cassette tape using an analog digital video recorder. 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 computer system and a video capture card shall be used to capture the recording continuously regardless of the progression of the inspection. Before submission, the raw digital data shall be edited to remove pauses where the inspection progress was not continuous.
- A computer system and a video capture card shall be used to intermittently capture the recording. Before submission, the raw digital file shall be edited to form one continuous file.
- 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.

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 $\pm 10\%$ of the vertical pipeline dimension. In all instances the camera lens shall be positioned looking along the longitudinal axis of the pipeline.

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

- 0.1 m/s for pipeline of diameter less than 200mm;
- 0.15 m/s for diameters exceeding 200mm but not exceeding 310mm; and
- 0.20 m/s for diameters exceeding 310mm.

A suitable metre-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The metre-reading device shall be accurate to $\pm 1\%$ of the length of the sewer being surveyed. 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 survey:

- Cable calibration device
- 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 resurveyed using the new measuring device.

3. Forcemain Testing Requirements

This section provides the testing requirements specific to forcemains and low pressure systems.

3.1 General Requirements

All forcemains for lift stations and common force mains in low pressure systems shall be tested for leakage by a Hydrostatic Leak Test

3.1.1 Visual Inspections

The Engineer of Record shall inspect forcemains during all phases of construction.

3.2 Hydrostatic Leak Test

The hydrostatic leak test shall be performed on all forcemains according to OPSS 412⁵.

The hydrostatic test may be done immediately after final backfill is placed and the air and/or vacuum release valves are installed.

The test section shall be subject to the specified continuous test pressure to 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration.

The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2 hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

3.2.1 Polyethylene Pressure Pipe

The test procedure for polyethylene pressure pipe shall consist of initial expansion and test phases. During the initial expansion phase, the test section shall be pressurized to the test pressure, and sufficient make-up water shall be added each hour for 3 hours to return to test pressure. After the initial expansion phase, the test phase begins.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 3, leakage is not indicated. If the amount of make-up water exceeds the Table 3 value, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

Table 3. Test Phase Make-Up Amount for Pressure Polyethylene Pressure Pipe

Pipe Diameter mm	Make-Up Water litre/km
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90

⁵ Ontario Provincial Standard Specification 412, Construction Specification for Sewage Forcemain Installation in Open Cut, Revision Date 11/2009

Pipe Diameter mm	Make-Up Water litre/km
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.9
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1600	7,449.70

The test procedure duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for at least 8 hours prior to brining the test section up to pressure again.

4. Maintenance Hole Testing Requirements

This section provides the testing requirements specific to maintenance holes.

4.1 General Requirements

All maintenance holes shall be tested for infiltration/exfiltration by means of a negative air (vacuum) pressure test or Leakage Test

All internal chimney seals shall be tested by means of a chimney seal leakage test.

4.1.1 Visual Inspections

The Engineer of Record shall inspect maintenance holes during all phases of construction. Each manhole shall be visually inspected for leakage after assembly and backfilling.

4.2 Leakage Tests

All manholes shall be watertight and free from leakage. Each manhole shall be tested for leakage after assembly and backfilling.

Leakage tests shall be performed as either a negative air (vacuum) pressure test per ASTM 1224⁶ or leakage test per OPSS407⁷.

Maintenance holes shall be repaired and re-tested, as required, until the test results are within the limits specified. Visible leaks shall be repaired regardless of the test results

No part of the work will be accepted until the maintenance holes are satisfactorily tested following completion of backfilling. The method of repair shall be per the approval of the Contract Administrator

⁶ ASTM International C 1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

⁷ Ontario Provincial Standard Specification 407, Construction Specification for Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation, Revision Date 11/2007

4.2.1 Negative Air (Vacuum) Test

Negative air (vacuum) tests shall be conducted to test concrete maintenance hole sections utilizing mortar, mastic, or gasketed joints. It is intended as a preliminary test to demonstrate the maintenance hole condition prior to back fill.

All Joints between the top of the casting to the bottom of the manhole base shall be included in the test.

When possible, maintenance holes shall be tested after assembly and prior to backfilling and shall be conducted before the chimney seal is installed and tested.

Equipment used shall be made specifically for vacuum testing manholes.

All lift holes and any pipes entering the maintenance hole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the maintenance hole.

The test head shall be placed at the top of the maintenance hole in accordance with the manufacturer's recommendations.

A vacuum of 33.8 kPa of Hg shall be drawn on the maintenance hole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measure for the vacuum to drop 30.4 kPa of Hg

The maintenance hole shall pass if the time for the vacuum reading to drop from 33.8 kPa of Hg to 30.4 kPa of Hg meets or exceeds the values in the Table 4

If the maintenance hole fails the initial test, necessary repairs shall be made by an approved method. The maintenance hole shall then be retested until a satisfactory test is obtained. Use or failure of the vacuum test shall not preclude acceptance of appropriate water infiltration or exfiltration testing

Table 4. Minimum Test Times for Various Maintenance hole Diameters in Seconds

Depth m	Diameter mm																
	750	825	900	1050	1200	1350	1500	1650	1800	1950	2100	2250	2400	2550	2700	2850	3000
Time, in seconds																	
<1.2	6	7	7	9	10	12	13	15	16	18	19	21	23	24	25	27	29
1.8	9	10	11	13	15	18	20	22	25	26	29	31	34	36	38	41	43
2.4	11	12	14	17	20	23	26	29	33	35	38	41	45	48	51	54	57
3	14	15	18	21	25	29	33	36	41	44	48	52	56	60	63	67	71
3.7	17	18	21	25	30	35	39	43	49	53	57	62	67	71	76	81	85
4.3	20	21	25	30	35	41	46	51	57	62	67	72	78	83	89	94	100
4.9	22	24	29	34	40	46	52	58	67	70	76	83	89	95	101	108	114
5.5	25	27	32	38	45	52	59	65	73	79	86	93	100	107	114	121	128
6.1	28	30	35	42	50	53	65	72	81	88	95	103	111	119	126	135	142
6.7	31	33	39	46	55	64	72	79	89	97	105	114	122	131	139	148	156
7.3	33	36	42	51	59	64	78	87	97	106	114	124	133	143	152	161	170
7.9	36	39	46	55	64	75	85	94	105	114	1224	134	144	155	164	175	185
8.5	39	42	49	59	69	81	91	101	113	123	133	145	155	167	177	188	199
9.1	42	45	53	63	74	87	98	108	121	132	143	155	166	178	189	202	213

4.2.2 Leakage Test - Water

Leakage testing of maintenance holes shall be conducted. It is intended as a preliminary test to demonstrate the maintenance hole condition prior to back fill.

All Joints between the top of the casting to the bottom of the manhole base shall be included in the test.

When possible, maintenance holes shall be tested after assembly and prior to backfilling and shall be conducted before the chimney seal is installed and tested.

Equipment used shall be made specifically for vacuum testing manholes.

The test shall be performed by plugging all pipe openings in the maintenance hole and filling the maintenance hole with water. After one hour has elapsed, the distance the surface of the water has dropped shall be measured and the leakage determined by calculating the volume of that portion of the maintenance hole formerly occupied by the water.

Leakage shall not exceed a rate of 3 litres per hour per metre of head above the lowest pipe invert in the maintenance hole

Maintenance holes failing the initial test shall have the leaks repaired and be re-tested until the leakage is below the allowable limit.

In areas of high ground water, there shall be no visible infiltration

4.2.3 Chimney Seal Leakage Test

All internal chimney seals shall be tested using a leakage test

The leakage test shall be done after the manhole has passed the negative air (vacuum) test or leakage test described in section 4.2.1 and 4.2.2.

Install the chimney seal and only the bottom expansion band per manufacturer's recommendation. Fully tighten the bottom band. Do not install the top expansion band.

Pulling the top of the seal away from the manhole frame, pour 4 litres of water behind the seal.

Observe the bottom seal for a minimum of 1 minute for leakage.

Drain the water by folding the top of the chimney seal down.

If the chimney seal passes the test, install the top expansion band per manufacture's recommendation.

If the bottom expansion band holds water without leaking, the chimney seal will have passed the test.

If the bottom expansion band has any leakage during the test time, the chimney seal will have failed the test. The Contractor shall be required to remove, replace, or reposition the bottom expansion band and retest.

5. Lateral Testing Requirements

This section provides the testing requirements specific to sanitary sewer laterals.

5.1 General Requirements

When specified in the Contract Documents, laterals shall be inspected using CCTV equipment according to OPSS as per Section 5.2.

Leakage tests shall be carried out as per Section 5.2.

5.1.1 Visual Inspections

The Engineer of Record shall inspect laterals during all phases of construction. The lateral, in its entirety from the foundation to the connection with the sewer, shall be exposed for inspection and be properly bedded to one-half (1/2) the diameter of the lateral with the tracer wire installed (taped) to the top of the pipe.

After the lateral has passed the inspection, the Contractor is responsible for placement of the initial and final backfill.

5.2 Leakage Tests

As identified in Section 2.2, leakage testing shall be carried out from maintenance hole to maintenance hole, including lateral connections. Leakage Test shall be conducted as per Section 2.2.

5.3 CCTV Inspections

CCTV inspections shall be conducted as per Section 2.4.