Construction Specification for Closed Circuit Television Inspection of Pipelines

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TS 409.01 SCOPE

This specification covers the requirements for inspecting new and existing sanitary sewers, storm sewers and pipe culverts by closed-circuit television.

TS 409.02 REFERENCES

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

Canadian Standards Association

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

National Association of Sewer Service Companies

PACP	Pipe Inspection
LACP	Lateral Inspection
MACP	Maintenance Hole Inspection

TS 409.03 DEFINITIONS

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

CCTV Survey means the televised inspection of sewers using closed circuit television.

LAPC means the Lateral Assessment Certification Program

MACP means the Maintenance Hole Assessment Certification Program

MH means the Maintenance Hole or Manhole

NASSCO means the standards developed by the National Association of Sewer Service Companies for sewer inspection.

PACP means the Pipeline Assessment Certification Program.

Sewer Section means the length of pipe connecting two (2) maintenance holes.

TS 409.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 409.04.01 Operator Qualifications for Inspection and Coding

Provide a minimum of one operator on the site at all times with each inspection unit who holds a valid certificate from NASSCO for PACP or an equivalent industry recognized alternate training program acceptable to the Contract Administrator. Ensure that each operator is fully trained in all aspects of sewer inspection and capable of making accurate observations and recording all conditions that may be encountered in the sewers and the maintenance holes.

Perform inspection work only when PACP certified operators are on site. PACP certificates shall be available on site at all times.

Perform condition coding using operators who hold a valid certificate from the NASSCO PACP Qualification or an alternate training program acceptable to the Contract Administrator.

Submit a valid copy of the NASSCO PACP Operators Certificate for each operator to the Contract Administrator a 10 Working Days prior to the commencement of the inspection work. Operators shall have been certified or re-certified within five years prior to the start of the Contract.

TS 409.04.02 Sewer Condition Coding

The CCTV inspection shall include condition, feature and defect classification coding according to the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP). Flow type, start and finish depths to be identified in the inspection report.

TS 409.04.03 Sewer Inspection Standards and Defect Coding

CCTV inspection and defect coding shall be carried out by NASSCO PACP certified operators. New operators and operators with an expired PACP certification over three years must provide sufficient evidence of training by an approved entity such as an individual or association that has been approved by the Contract Administrator.

The Contract Administrator may at any time during this contract specify a form of training or certification to be undertaken by inspection operators based on the current standard or any other industry standard the City adopts in the future.

TS 409.04.04 Coding Accuracy

Coding accuracy will be a function of the number of defects or construction features not recorded or omitted and the correctness of the coding and classification recorded. Coding accuracy will satisfy the following requirements.

- header accuracy – 95%
- detail accuracy – 85%

Implement a formal coding accuracy verification system before starting the work.

Verify coding accuracy on a random basis on a minimum of 10% of the inspection reports. Submit coding accuracy checks with the corresponding video recording.

Perform an accuracy verification for each operator for each week working and submit the results to the Contract Administrator for review. Operators failing to meet the accuracy requirements on two occasions will not be permitted to code on the remainder of the Contract until they have successfully re-attained the NASSCO Level of Qualification for PACP Operators.

Re-code inspections not satisfying the accuracy requirements and verify the accuracy of the inspection immediately preceding and following the non-compliant inspection. Repeat the process until the proceeding and subsequent inspections meet the accuracy requirements.

TS 409.04.05 Data Requirements for Pipes

A summary of the data requirements for mainline pipes is provided as follows:

Asset ID	Only Toronto Water officially assigned pipe IDs to be used. Example: SL1475530 Note: IDs are not to be truncated
Video Resolution	Minimum recorded video resolution must be 420 lines with an NTSC size of 720 x 480 at 29.97 frames per second
Video Format of digital CCTV	mp4
Measurement System	Metric for all measurements and settings.
Timestamp	Time and date to be 24 hr military format for all settings.
Database/Data Standard/Data Structure	Microsoft Access Database conforming to NASSCO data model.
Sewer Main Video Files Naming Convention (Ref Appendix B – CSA PLUS4012-10)	*PipeID_StartManhole_DateMilitaryTime_version.mpg* e.g. SL4014758_ MH4621905398_201303011423_V3.mp4
Photograph Files Naming Convention (Ref Appendix B – CSA PLUS4012-10)	*PipeID_DateMilitaryTime_ObservationPosition_DefectCode.jpg* E.g. SL4014758_201303011423_61.2_FL.jpg
CCTV inspection data to be recorded	All mandatory and non-mandatory PACP fields to be recorded

TS 409.04.06 Data Requirements for Laterals

A summary of the data requirements for laterals is provided as follows:

Asset ID	Lateral IDs will have the format: StartManhole_DistanceFromStartManholeToTap_SequentialNumber e.g. MH4180524847_25.4_2_V3 Notes: House lateral or catchbasin leads do not have City-assigned Asset IDs (aka Lateral Segment Reference). The contractor will generate his own unique Lateral Segment Reference by following LACP naming convention (Field 40 pg 10-22) V3: optional suffix to indicate a post-rehab video
Video Resolution	Minimum recorded video resolution must be 420 lines with an NTSC size of 720 x 480 at 29.97 frames per second
Video Format of digital CCTV	mp4
Measurement System	Metric for all measurements and settings.
Timestamp	Time and date to be 24 hr military format for all settings.
Database/Data Standard/Data Structure	Microsoft Access Database conforming to NASSCO data model.

Lateral Video Files Naming Convention (Ref LACP Manual Page 10-22)	LAT_Address_LateralSegmentReference_DateMilitaryTime_version.mpg E.g. LAT_536_MIDLAND_AVE_MH4171924874_75.3_2_201609300224.mp4
Photograph Files Naming Convention (Ref Appendix B – CSA PLUS4012-10)	LAT_LateralSegmentReference_DateMilitaryTime_ObservationPosition_DefectCode.jpg E.g. LAT_MH4171924874_75.3_2_201609300224_1.2_FL.jpg
CCTV inspection data to be recorded	All mandatory and non-mandatory PACP fields to be recorded

TS 409.04.07 CCTV Video Title Screen Information

A sewer information screen in the format below shall be displayed for a minimum of 10 seconds at the start of all inspections. Inspection of the sewer shall not proceed while the information screen is being displayed.

1	Contract No.: 08DCS321	Date: 13 May 2019
2	Asset ID: SL1425917	Time: 11:21:00
3	Street: COLGATE AVE	Sewer Use: SS
4	Start MH ID: MH3560817629	Finish MH ID: MH3558817565
5	Start Addr: 15 COLGATE AVE	Finish Addr: 30 COLGATE AVE
6	Start Depth: 2.5 m	Finish Depth: 2.8 m
7	Survey Direction: U	Height: 300 mm
8	Material: PVC	Width: 300 mm
9	Segment Length: 67.2 m	Pre-Cleaning: H
10	Weather: Dry	
11	CCTV Contractor : Drain Ltd	

During pipe inspection, where possible, the CCTV camera shall be used to perform an internal scan of the start, finish and any uncharted maintenance holes found.

TS 409.04.08 CCTV Video Running Screen

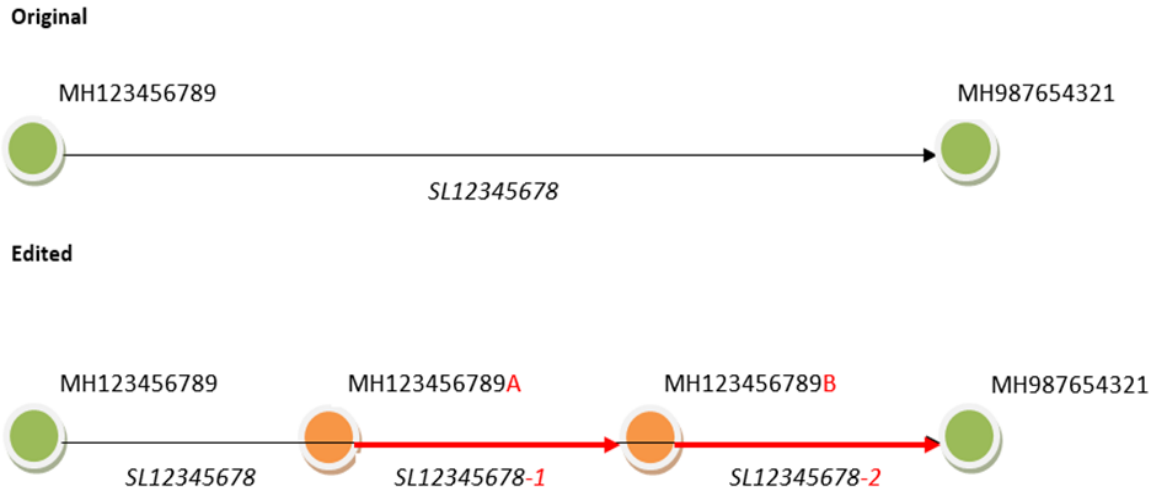
Upon commencement of, and throughout the inspection, the following information shall be continuously displayed on-screen and captured on the screen;

a) street name
b) start maintenance hole
c) finish maintenance hole
d) chainage
e) defect coding at defects

TS 409.04.09 Uncharted Assets Naming Convention

Newly found manholes will be assigned Asset IDs by referencing the upstream manhole and an alpha character starting with "A". Example MH123456789A, MH123456789B for 2 newly found manholes.

Split pipe segments will be assigned an Asset ID by adding a numeric suffix to the original pipe asset id. Example SL12345678-1, SL12345678-2 after 2 new manholes are found.



TS 409.05 MATERIALS

Media storage shall be as specified in the Contract Documents. DVD submissions will no longer be accepted.

USB flash drive and USB hard drives shall be identified with the following information or as specified in the Contract Documents:

a) Owner's name
b) Contract number or project number
c) Maintenance hole to maintenance hole identifier
d) City
e) Street name or park name
f) Inspection date
g) Consultant's/Contractor's name

TS 409.05.01 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 size 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.

TS 409.06 EQUIPMENT

TS 409.06.01 Inspection Vehicle

The inspection vehicle shall contain a separate area for viewing, recording and controlling the CCTV operation. Proper seating accommodation shall be provided to enable two people, in addition to the operator, to clearly view the screen of the monitor screen, which displays the inspection work in the sewer as such work proceeds. All equipment utilized within the sewer shall be stored outside the viewing, recording and control area.

The Contractor shall equip the inspection units and crew supervisor with a cellular telephone utilizing Ontario telephone numbers and will provide the Contract Administrator with the cellular telephone numbers.

TS 409.06.02 Inspection Equipment

The CCTV camera used the inspections shall be colour, pan, tilt and zoom view type capable of radial rotation of 360°, lateral rotation of 270°, and of producing a continuous picture resolution of not less than 420 lines at the periphery of the picture.

Self-propelled rubber tired or crawler tractor capable of passing over minor surface imperfections including but not limited to broken joints and solid debris up to 40 mm in height.

The cameras shall be equipped with a self-contained, adjustable, directed light source compatible with the lens angle and dispersed to create even distribution of the light around the pipe perimeter without the loss of contrast, flare out of picture or shadowing.

The camera shall be self-propelled. The mounting of the camera shall be adjustable such that the central axis of the camera lies at a point equidistant between the invert and overt of the pipe during inspection of the sewer. In the case of egg shaped sewers, the camera lens must be positioned vertically above the invert at a height two thirds of the vertical dimension of the sewer. In all instances, when transporting the camera through the sewer the camera lens must be positioned on, and looking along the central axis of the sewer. For more information on camera start position and focal length corrections, see Section 6.5.3 of CSA – Technical Guide Visual Inspection of Sewer Pipe PLUS 4012-10.

Float or skid for mounting the video camera and towing it through sewers where the condition of the sewer prevents the use of a tractor. Obtain the Contract Administrator's approval before using a skid or float. Position the towing equipment in a manner that will not impede the view of the sewer from the camera and ensure the float or skid is stable enough to provide a smooth progress and steady video recording.

Transport equipment and cable shall be capable of inspecting a minimum of 500 metres of sewer from a single access point and the complete inspection of the sewer from the centre of the start maintenance hole to the centre of the finish maintenance hole. For large diameter and trunk sewers the minimum length of cable shall be 1000 metres.

A remote reading counter shall be used to measure distance travelled from the starting maintenance hole wall and measurements shall be recorded in metres to the nearest 100 mm.

Transport equipment shall be capable of adjustable camera height.

TS 409.06.03 Recording Resolution

Provide a minimum of 420 lines of resolution around the periphery of the picture for digital MPEG video playback.

Confirm recording resolution if requested by the Contract Administrator by recording a RETMA type resolution chart as follows:

a) Set up camera and accessories for the recording to simulate an actual inspection, for example, video signal routed through the cable reel and video overlay system.

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

c) Resolution chart shall fill the monitor screen.

d) Resolution chart shall be illuminated evenly and uniformly without reflection and illumination source shall accurately simulate the lighting used in the sewer inspections.

e) Record test for a minimum of 30 seconds.

f) Identify the camera on the recording.

g) Perform the test at the start of digital recording.

TS 409.06.04 Digital Video Recorder

Digital video recorders shall be able to capture in colour from the live video source with MPEG-4 format. Minimum recorded video resolution shall be 420 lines with an NTSC size of 720 x 480 @ 29.97 frames per second.

The compression technology (codec) used in creating the MP4 digital video recordings shall be fully compatible with all the mainstream video players listed below:

- Windows Media Player, Windows and Mac
- Apple QuickTime Player, Windows and Mac
- VideoLAV VLC Player, Windows and Mac

Video files that do not play properly and completely on all the above players will not be accepted and will require re-doing the CCTV inspection or other corrective procedure. Ensure that the entire inspection of a particular sewer or maintenance hole is contained on the same USB media. Record reverse set-up inspections of a sewer immediately after the original inspection where possible.

TS 409.07 CONSTRUCTION

TS 409.07.01 Pipe Cleaning

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

TS 409.07.02 Internal Pipe Conditions for Inspection

The sewer section under inspection shall be sufficiently dry so that any remaining fluid does not obscure any part of the interior of the sewer during CCTV inspection. Where required, flow control shall be used to accomplish this clear viewing of the sewer.

The sewer section under inspection shall be free of fog or vapour that obscures the view. Where required, ventilation or other provisions shall be used to eliminate such fog and vapour.

TS 409.07.03 Notice to City of Inspections

Notify the Contract Administrator of the locations where sewer inspections will be performed a minimum of one Working Day before starting inspection work at that location.

TS 409.07.04 Sewer Pipe Inspections

The Contractor to notify the Contract Administrator if any outfall screens, gates or platforms require removal for CCTV inspections to proceed.

Evacuate fog from the sewer and maintenance hole before beginning inspections and keep the sewer and maintenance hole clear of fog during the entire inspection.

Keep the camera lens clean during the entire sewer and maintenance hole inspection.

Ensure that the picture is in focus and there is adequate, even lighting free of shadows and glare ahead of the sewer pipe or maintenance hole riser at all times in order to be able to determine general condition, features and upcoming defects.

Where required for a specific inspection, the CCTV camera shall stop and view each defect or service connection clearly and completely for at least five seconds.

Perform sewer inspections according to the following requirements:

1) Perform sewer inspection after cleaning unless otherwise directed by the Contract Administrator.

2) With the direction of flow unless a reverse set up is required.

3) From the centre of the first maintenance hole to be inspected to the centre of the last maintenance hole to be inspected. Counter should be zeroed at the maintenance hole wall.

4) Begin inspections generally with the upstream sewer in the system and proceed downstream in a consecutive manner.

5) Schedule inspection of downstream sewers to be done after the contributing upstream sewers have been cleaned.

6) Ensure the face of the start maintenance hole is clearly visible at the start of the sewer inspection.

7) Indicate on the monitor screen accurate automatic distance measurement that begins to move immediately as the camera moves. Ensure measurement is accurate from the cable calibration point to the last maintenance hole to be inspected.

8) Stop the camera and position to provide a steady five second perpendicular view of connections, junctions, major branches and major defects including deformed sewers, displaced bricks, holes, large displaced joints, missing bricks, missing mortar, obstructions, and large open joints.

Notify the Contract Administrator of the discovery of the following. Contract Administrator to advise Contractor of next steps:

a) uncharted maintenance holes
b) collapsed sewers
c) buried maintenance holes
d) blocked sewer
e) surcharge sewers or maintenance holes that are holding water above the obvert of the sewer entrance.

Re-perform sewer inspections where the Contract Administrator has determined the tolerance requirements for camera position and speed and internal distance measurement requirements have not been satisfied.

TS 409.07.05 Camera Position and Travel Speed

Position the centre of the camera lens in the centre of circular and egg-shaped sewers and maintenance hole risers.

Ensure camera speed does not exceed 9 metres/minute during sewer inspections.

TS 409.07.06 Sewer and Maintenance Hole Measurements

Measure the vertical distance from the sewer invert to the maintenance hole frame to the nearest 0.10 of a metre with a steel tape before beginning the sewer or maintenance hole inspection.

Provide a remote reading counter to measure the distance to the nearest 0.10 of a metre that the video camera has travelled within the sewer.

Distance measurement within the sewer to be accurate to within 0.5% of the above ground steel tape measurement between start and finish maintenance hole centres.

TS 409.07.07 Sewer Reversal and Abandonment of Inspection Survey

Sewer survey abandonment shall occur for the following reasons:

- Category A – Loose Debris (e.g. silt, sand)
- Category B – High Water Level
- Category C – Hard debris such as encrustation, grease, concrete, roots, and so on.
- Category D – Obstruction in line
- Category E – MH inaccessible; for example private area, off-road, buried, and so on.

- Category F – Line deviates
- Category G – Asset not found

The Contractor shall clearly document the reason for a survey abandonment including a comment in the database file and a photograph. A reversal must be undertaken corresponding to each abandonment. If a reversal must also be abandoned, it too must be documented with a comment in the database and a photograph.

Where it is critical to obtain a full and complete inspection of the pipe, the Contract Administrator shall be notified to assess the possibility of undertaking additional steps to complete the survey. These steps may include hydraulic flushing, mechanical cleaning, connection reaming, cross-bore removal and so on.

TS 409.07.08 Emergency Notification Requirements

Immediately advise the Contract Administrator when a complete sewer inspection cannot be completed due to

- pipe collapse or imminent collapse
- 90% or more pipe blockage
- excessive deformation
- large displaced joints
- gas cross-bores
- missing maintenance hole covers
- collapse maintenance holes or maintenance holes on the verge of collapse
- illegal cross connections, for example sanitary into storm.

Jointly decide with the Contract Administrator one of the following alternatives:

1) Attempt reversal CCTV inspection,
2) Abandon the inspection; or
3) Repeat the inspection subsequent to one of the following actions:
    a) Performing solid debris cutting,
    b) Removing intruding connections,
    c) Modifying the camera setup position or method of transport,
    d) Completion of external or emergency repairs.

Contractor to note in a log the sewer or maintenance hole Identification number, steel tape measurement, upstream and downstream length inspected, length of missing video and the reason the inspection could not be completed and review with the Contract Administrator on a weekly basis.

Where pipe collapse or cross-bores are found during CCTV, the road shall be marked with spray paint. This will allow Toronto Water – District Contract Services to easily identify the location where digging will be required.

TS 409.07.09 Final Documentation

TS 409.07.09.01 *Inspection Reports*

Each CCTV inspection submitted shall be accompanied by an electronic PDF format sewer inspection report that is generated from the sewer.mdb file. The structure of the reports shall be as required by the Contract Administrator. The PDF reports shall be included on the portable hard drive along with the video file and sewer.mdb file.

Prior to the regular contract required submission of CCTV inspections and reports, the Contractor shall submit a trial inspection report in PDF format for approval by the Contract Administrator.

TS 409.07.09.02 *CCTV Inspection Submission*

When a required CCTV inspection has been completed, it shall be submitted to the Contract Administrator on a properly identified USB hard drive. The submission for a sewer service shall include the CCTV inspection video file, the sewer.mdb file and the PDF report file. These three files shall be grouped together on the hard drive along with any other information relevant to the specific CCTV inspection such as images from the inspection. The grouping shall be identified by the street number corresponding to the sewer service inspected.

A single hard drive may include multiple CCTV inspections. The hard drive shall be properly organized with each CCTV inspection submission in its own folder. Such folders shall be clearly and properly identified in regard to the sewer service to which it pertains by the street number corresponding to the sewer service inspected. The hard drive must be USB 3.0 or higher compatible and of reliable quality. The hard drives will become the property of City and will not be returned to the Contractor at the completion of the project.

All hard drives are to be properly labelled and organized with the following information:

a) Contractor's Name
b) Contract number
c) Contract person and phone number
d) Date
e) Inspection Type: V1, V2 or V3
f) Hard drive number: e.g. 1 or 2

TS 409.08 QUALITY ASSURANCE

The Contract Administrator will review inspection reports, digital MPEG video recordings and coding accuracy checks to ensure compliance with the Contract Documents. The Contract Administrator may adjust the frequency of reviews based on the results of previous reviews.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 5 Working 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 Working 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, that is to say the Canadian Edition of PACP.

Re-perform sewer inspections where the Contract Administrator has determined the requirements of this specification have not been satisfied.

Correct non-compliant inspection submissions and resubmit the corrected inspections to the Contract Administrator within 5 Working Days.

Repeat the process until the inspection submissions are accepted by the Contract Administrator.

TS 409.09 MEASUREMENT FOR PAYMENT

TS 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.

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 videotape.

TS 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.

TS 409.10 BASIS OF PAYMENT

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material to do the Work.

Non-compliant submission returned for correction shall be corrected and resubmitted at no extra cost the City.

Appendix 409-A, September 2019
For Use While Designing and Administrating City Contracts

Note: This is a non-mandatory commentary appendix intended to provide information to a designer and contract administrator during the design and construction stage of a contract on the use of this TS specification in a City 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.

Notes to Designer:

The designer should specify the following in the Contract Documents:

– the type of media storage (TS 409.05.01).

– additional or different labelling information for USB media (TS 409.05).

– flow control measures (TS 409.07.02).

Flow control measures may include such things as scheduling work for off-peak flow times, plug or block flow at upstream maintenance hole, and temporary by-pass pump flow around inspection section (TS 409.07.02).

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

– If photographs are required as part of the CCTV inspection (TS 409.05.01).

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