

CW 2145 - SEWER AND MANHOLE INSPECTION

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CW 2145 - SEWER AND MANHOLE INSPECTION

1. DESCRIPTION

1.1 General

- .1 This specification covers inspection of sewers and manholes using internal video equipment for the purposes of assessing thoroughness of cleaning, observing and recording structural and service defects and construction features and to verify new sewer construction prior to acceptance.

1.2 Referenced Standard Construction Specifications

- .1 CW 2140 - Sewer and Manhole Cleaning

3. CONSTRUCTION METHODS

3.1 Inspection Unit

- .1 Sewer and manhole inspection units are to consist of a self-contained vehicle with separate areas for viewing and storage complete with the following equipment as a minimum.
 - .1 Cellular telephone and suitable communication system linking all crew members.
 - .2 Fans and blowers capable of removing fog that may be present in sewers at the time of the inspection.
 - .3 Video cameras, lighting, cables and power source.
 - .4 Video monitor, videocassette recorder and digital video recorder.
 - .5 Computer system with video capture card or dedicated unit and other related equipment.

3.2 Video Inspection Equipment

- .1 Sewer inspection equipment is to consist of the following.
 - .1 Video camera capable of panning 360° and tilting 270° with optimum picture quality provided by focus and iris adjustment. Focal range to be adjustable from 100 millimetres to infinity.
 - .2 Sufficient, adjustable, waterproof high intensity light source to allow an even distribution of light around the sewer or manhole perimeter without loss of contrast, flare out of picture, or shadowing. Ensure lighting illuminates the sewer or manhole ahead of the camera to be able to determine general condition, features and upcoming defects. Light heads shall be changed upon the request of the Contract Administrator.
 - .3 Video overlay equipment capable of superimposing a minimum of 15 lines with up to 30 characters per line of alphanumeric information onto the video recording.
 - .4 Equipment shall be capable of continuously capturing digital video from first generation recordings with no frame loss, regardless of the progression of the inspection.
 - .5 Equipment shall be used to acquire continuous digital video images of the sewer for the

entire length being inspected.

.2 Manhole inspections are to be performed using digital panoramic inspection system such as the IBAK PANORAMO SI, RST Helix or equivalent meeting the following criteria:

.1 The inspection camera system must be 100% digital, having submitted software that will provide and allow the autonomous viewing of the chamber to facilitate the Condition Assessment process. Any analog or NTSC video camera will be deemed unacceptable.

.2 The inspection camera system must have two independently or simultaneously controlled digital cameras, one facing in the downward direction and one facing in the upward direction. Each camera must have a minimum of 185 degree field of view.

.3 The inspection camera system must provide sufficient illumination of the interior of the manhole to obtain proper exposure without introducing any motion blur. The light shall be positioned to distribute the light evenly onto the structure walls. The lighting must be able to illuminate manholes without the need of any auxiliary lighting having a recommended contrast set to less than 1.5.

.4 The inspection system shall produce individual images or frames with no more than 0.001 inches (0.025mm) of movement during image or frame exposure to produce crisp, clear images. Inspections showing evidence of corrupt or erroneous imagery, scratched lenses or protective glass plate or similar due to poor handling and application shall be rejected.

.5 The inspection camera must provide a minimum of 3000 line of vertical resolution in the side view and a minimum of 500 lines in the perspective view.

.6 Contractor is responsible for reviewing collected data, coding observations, however the City must have the ability to view the digital film file in the way that the contractor can view them, including full control of the virtual pan and tilt.

.7 The digital film files will be captured to a "High Quality" setting that must include an unfolded view of the manhole with a minimum of 3000 lines of vertical resolution, providing all front, back and wrapped images that will be, at a minimum height and width of 1040x1040 pixels, to a resolution of 96 dots per inch. Latest 4k technologies will also be reviewed for acceptance.

.8 The inspection system must descend to the lowest point within the manhole chamber to a depth that will facilitate accurate perpendicular weir wall measurements' using the software's measuring tools to occur. Any inspection exhibiting an incomplete descent having a distance greater than one (1) metre above the invert or water level resulting to data interpolation, will be rejected unless appurtenances or obstructions are present within the chamber and accepted by the Contract Administrator.

.9 The digital film files must include the capability to produce a three dimensional representation of the manhole structure. This data shall be used to perform geometric measurements. This file shall be exportable to common CAD programs for further analysis.

.10 The digital file files must include a distortion-free virtual pan and tilt allowing the review of the manhole structure from any angle from any depth. The virtual pan and tilt must be able to view 360 degrees in any direction. The virtual pan and tilt must consist of views from the top and bottom camera, any virtual pan and tilts that artificially create this view from a single camera will be deemed unacceptable due to distorted images on the direct side view.

.11 The virtual pan and tilt and unfolded views must be able to be viewable by the City with all the required executable software included for each disc and HDD at no additional cost to

the Contract Administrator or the City of Winnipeg.

- .12 All chambers that exhibit weir wall or spill pipe weir levels as observed within the field or identified, but not limited to control structures or manholes identified by the Contract Administrator, must be measured from manhole rim to weir crest where possible and detailed within the Inspection Comments field. Chambers exhibiting weir walls with no coded depth observations shall be rejected.

3.3 Video Camera Transport Equipment

- .1 Video camera transport equipment to consist of the following.
 - .1 Self-propelled rubber tired or tracked crawler tractor capable of manoeuvring around bends and passing over minor surface imperfections including but not limited to broken joints and solid debris up to 40 millimetres in height.
 - .2 Mount camera to float or skid and tow through sewers where the condition of the sewer prevents the use of a tractor. Obtain the Contract Administrator's approval before using a float or skid. Position the towing equipment to not impede the view of the sewer from the camera and ensure the float or skid is stable to provide a smooth progression and steady video recording.
 - .3 Operable under partially or fully submerged flow conditions, capable of inspecting a minimum distance of 200 metres of sewer from a single access point and the complete inspection of the sewer from the start manhole to the finish manhole.
 - .4 Operable in sewers of various cross-section, and constructed of standard pipe materials including brick, clay, concrete, PVC, HDPE, and steel.
 - .5 Tethered to facilitate the conveyance and extraction of the platform from the sewer, without causing damage to the sewer infrastructure, in the event the equipment fails or otherwise becomes uncontrollable within the sewer.
 - .6 Transport equipment must be capable of allowing for adjustable camera height.
 - .7 A device for manhole inspections that will securely orient the camera with the 12:00 video position facing north and capable of moving the camera through the entire vertical length of the manhole.

3.4 Operator Qualifications for Inspection and Condition Coding

- .1 Ensure each operator is fully trained in all aspects of sewer and manhole inspections and capable of making accurate observations and recording all conditions that may be encountered in the sewers and manholes.
- .2 Perform inspection and condition coding using certified operators in accordance with the National Association of Sewer Service Companies (NASSCO) having attained and retained their "Pipeline Assessment Certification Program" (PACP) and "Manhole Assessment Certification Program" (MACP) certification.

3.5 Sewer Condition Coding

- .1 Perform sewer condition coding in accordance with the requirements of the NASSCO PACP and to version 7.0.0 of the manual or greater in general accordance with Section 3.4 of this specification and with the following additional requirements.

Pipe Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
General Information	1	Surveyed By (<i>Operator / PACP User Name</i>)	Yes	Yes
	2	Certificate Number	Yes	Yes
	3	Reviewed By	No	No
	4	Reviewer Certificate Number	No	No
	5	Owner	No	Yes
	6	Customer	No	Yes
	7	P/O Number (<i>Contract No.</i>)	No	Yes
	8	Work Order	No	Yes
	9	Media Label	No	Yes
	10	Project	No	Yes
	11	Date	Yes	Yes
	12	Time	No	Yes
	13	Sheet Number	Yes	Yes
	14	Weather	No	Yes
	15	Pre-Cleaning	Yes	Yes
	16	Date Cleaned	No	No
	17	Flow Control	No	No
	18	Purpose of Survey	No	Yes
	19	Direction of Survey	Yes	Yes
	20	Inspection Technology Used	No	Yes
	21	Inspection Status	Yes	Yes
	22	Consequence of Failure	No	No
	23	Pressure Value	No	No
Location	24	Drainage Area	No	Yes
	25	Pipe Segment Reference (<i>Asset ID</i>)	No	Yes
	26	Street (<i>Name and Number</i>)	Yes	Yes
	27	City	Yes	Yes
	28	Location Code	No	Yes
	29	Location Details	No	Yes
Pipe	30	Pipe Use	Yes	Yes
	31	Height (<i>Diameter</i>)	Yes	Yes
	32	Width	Yes	Yes
	33	Shape	Yes	Yes
	34	Material	Yes	Yes
	35	Lining Method	No	No
	36	Coating Method	No	No

Pipe Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
	37	Pipe Joint Length	No	Yes
	38	Total Length (Steel Tape Measurement)	No	Yes
	39	Length Surveyed	No	Yes
	40	Year Constructed	No	No
	41	Year Renewed	No	No

Measurements	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
	42	Upstream MH No.	Yes	Yes
	43	Upstream MH Rim to Invert	No	Yes
	44	Upstream MH Rim to Grade	No	No
	45	Upstream MH Grade to Invert	No	No
	46	Upstream MH Northing	No	No
	47	Upstream MH Easting	No	No
	48	Upstream MH Elevation	No	No
	49	Downstream MH No.	Yes	Yes
	50	Downstream MH Rim to Invert	No	Yes
	51	Downstream MH Rim to Grade	No	No
	52	Downstream MH Grade to Invert	No	No
	53	Downstream MH Northing	No	No
	54	Downstream MH Easting	No	No
	55	Downstream MH Elevation	No	No
	56	MH Coordinate System	No	No
	57	MH Vertical Datum	No	No
	58	GPS Accuracy	No	No
	59	Additional Information	No	Yes*

Yes* - when required.

- .2 Record place names in accordance with Clause 3.9.4 of this specification.

3.6 Manhole Condition Coding

- .1 Perform manhole condition coding in accordance with the requirements of the NASSCO MACP and to version 7.0.0 of the manual or greater in general accordance with Section 3.4 of this specification and with the following additional requirements
- .2 The following fields shall be used when completing the “Header” details in the manhole inspection header form. By default, Field 5 the “Owner” is City of Winnipeg and Field 6, the “Customer” will be the Contract Administrator
 - .1 Field 38 – 43 data shall be collected using a hand-held GPS device to achieve Nearest (N) or sub-meter (M) accuracies dependent upon available satellite coverage.

Manhole Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
General Information	1	Surveyed By (<i>Operator / MACP User Name</i>)	Yes	Yes
	2	Certificate Number	Yes	Yes
	3	Reviewed By	No	No
	4	Reviewer Certificate Number	No	No
	5	Owner	No	Yes
	6	Customer	No	Yes
	7	P/O Number (<i>Contract No.</i>)	No	Yes
	8	Work Order	No	Yes
	9	Media Label	No	Yes
	10	Project	No	Yes
	11	Date	Yes	Yes
	12	Time	No	Yes
	13	Sheet Number	Yes	Yes
	14	Weather	No	Yes
	15	Pre-Cleaning	Yes	Yes
	16	Date Cleaned	No	No
	17	Purpose of Survey	Yes	Yes
	18	Inspection Level	Yes	Yes
	19	Inspection Status	Yes	Yes
	20	Consequence of Failure	No	No
Location	21	Drainage Area	No	Yes
	22	Manhole/Access Point Number (<i>Asset ID</i>)	Yes	Yes
	23	Street (<i>Name and Number</i>)	Yes	Yes
	24	City	Yes	Yes
	25	Location Code	Yes	Yes
	26	Surface Type	Yes	Yes
	27	Inflow Potential from Runoff	No	No
	28	Location Details	No	Yes
Manhole	29	MH Use (<i>Use of Access Point/Structure</i>)	Yes	Yes
	30	Access Type	Yes	Yes
	31	Year Constructed	No	No
	32	Year Renewed	No	No
	33	Evidence of Surcharge	Yes	Yes
Measurements	34	Rim to Invert (<i>Outgoing</i>)	Yes	Yes
	35	Rim to Grade (<i>Outgoing</i>)	Yes	Yes
	36	Grade to Invert (<i>Outgoing</i>)	Yes	Yes

Manhole Header Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
	37	Rim to Grade Exposed	No	No
	38	Northing (Y Coordinate)	No	Yes
	39	Easting (X Coordinate)	No	Yes
	40	Elevation (Z Coordinate)	No	Yes
	41	Coordinate System (Nearest Meter)	No	Yes
	42	Vertical Datum (Elevation)	No	Yes
	43	GPS Accuracy	No	Yes
	44	Additional Information	No	No

The following fields shall be used when completing the "Manhole Component Observation Section" details in the manhole component observation form.

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
Cover	45	Cover Type	Yes	Yes
	46	Cover Shape	Yes	Yes
	47	Cover Size	Yes	Yes
	48	Centre Cover Size	No	No
	49	Cover Size Width	Yes	Yes
	50	Cover Material	Yes	No
	51	Hole Diameter (Vent)	Yes	No
	52	Hole Number (Number of Vent Holes)	Yes	No
	53	Cover Bearing Surface Diameter	Yes	No
	54	Cover Bearing Surface Width	Yes	No
	55	Cover/Frame Fit	Yes	Yes
	56	Cover Condition	Yes	Yes

Cover Insert	57	Insert Type	Yes	No
	58	Cover Insert Condition	Yes	No

Manhole Cover Adjustment Ring	59	Adjustment Ring Type	Yes	Yes
	60	Adjustment Ring Material	Yes	Yes
	61	Ring Condition (Adjustment Ring)	Yes	Yes
	62	Adjustment Ring Height	No	No

Frame	63	Frame Material	Yes	Yes
	64	Frame Bearing Surface Width	Yes	No
	65	Frame Bearing Surface Depth	Yes	No
	66	Frame Clear Opening Diameter	Yes	No
	67	Frame Clear Opening Width	Yes	No
	68	Frame Condition	Yes	Yes

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
	69	Seal Condition	Yes	Yes
	70	Frame Offset Distance	Yes	Yes
	71	Frame Seal Inflow	Yes	Yes
	72	Frame Depth	No	No
Chimney	73	Chimney Present	Yes	Yes
	74	Chimney First Material	Yes	Yes
	75	Chimney Second Material	No	No
	76	Chimney I/I	No	No
	77	Chimney Clear Opening	No	No
	78	Chimney Depth	Yes	Yes
	79	Chimney Lining Interior (Coating)	No	No
	80	Chimney Lining Exterior (Coating)	No	No
	81	Chimney Condition	Yes	Yes
Cone	82	Cone Type	Yes	Yes
	83	Cone Material	Yes	Yes
	84	Cone Depth	Yes	Yes
	85	Cone Lining Interior	No	No
	86	Cone Lining Exterior	No	No
	87	Cone Condition	Yes	Yes
Wall	88	Wall Diameter (Length)	No	No
	89	Wall by Size (Width)	No	No
	90	Wall Material	Yes	Yes
	91	Wall Depth	Yes	Yes
	92	Wall Lining Interior (Coating)	No	No
	93	Wall Lining Exterior (Coating)	No	No
	94	Wall Condition	Yes	Yes
Bench	95	Bench Present	Yes	Yes
	96	Bench Material	Yes	Yes
	97	Bench Lining (Coating)	No	No
	98	Bench Condition	Yes	Yes
Channel	99	Channel Installed	Yes	Yes
	100	Channel Material	Yes	Yes
	101	Channel Type	Yes	Yes
	102	Channel Exposure	Yes	Yes
	103	Channel Condition	Yes	Yes
Manhole Steps	104	Step Number	Yes	Yes

Manhole Component Section	Field No.	Field Name	NASSCO Mandatory	REQUIRED (Yes / No)?
	105	Step Material	Yes	Yes
Additional Component Information	106	Additional Component Information	No	Yes*
Pipe Connections	107	Pipe Number	Yes	Yes
	108	Clock Position	Yes	Yes
	109	Rim to Invert	Yes	Yes
	110	Direction	Yes	Yes
	111	Material	Yes	Yes
	112	Shape	Yes	Yes
	113	Height (Diameter)	Yes	Yes
	114	Width	Yes	Yes
	115	Pipe Condition	Yes	Yes
	116	Pipe Seal Condition	Yes	Yes
	117	Pipe Type	Yes	Yes
	118	Structure ID (Pipe/Lateral Segment Reference)	No	No
119	Pipe Comments	No	No	

Yes* - when required.

.3 Record place names in accordance with Clause 3.9.4 of this specification.

3.7 Coding Accuracy

- .1 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 is to satisfy the following requirements:
 - .1 Header accuracy - 95%.
 - .2 Detail accuracy - 85%.
- .2 Implement a formal coding accuracy verification system before starting the Work.
- .3 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.
- .4 Perform a minimum of two accuracy verifications for each operator for each week working and submit the results to the Contract Administrator for review. Operators failing to provide copies of their NASSCO certification and / or meet the accuracy requirements on two occasions will not be permitted to code on the remainder of the Contract until they can demonstrate to the Contract Administrator that they can code in accordance with the requirements of the NASSCO PACP and MACP version 7.0.0 of the manual or greater.
- .5 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.

3.8 Recording Resolution

- .1 Provide a minimum of 400 lines of resolution around the periphery of the picture for digital MPEG video playback.
- .2 Confirm recording resolution if requested by the Contract Administrator by recording a RETMA type resolution chart as follows.
 - .1 Set up camera and accessories for the recording to simulate an actual inspection i.e. video signal routed through the cable reel, video overlay system, etc.
 - .2 Record camera being introduced and reaching its final position for the test.
 - .3 Resolution chart is to fill the monitor screen;
 - .4 Resolution chart is to be illuminated evenly and uniformly without reflection and illumination source is to accurately simulate the lighting used in the sewer inspections.
 - .5 Record test for a minimum of 30 seconds.
 - .6 Identify the camera on the recording;
 - .7 Perform the test at the start of a tape or digital recording.

3.9 Screen Information on Video Recordings

- .1 Clearly display in legible letters for 30 seconds on the monitor and video recording at the start of each inspection a video overlay system containing the following alpha-numeric information. Enter this information before beginning the inspection

line 1:	Contract ID	e.g.	CITY OF WINNIPEG, 709-2002
line 2:	Street Name	e.g.	NASSAU ST N
line 3:	Start MH to Finish MH Names	e.g.	MH AT WELLINGTON AV to 1 st MH S OF WELLINGTON

AV

line 4:	Sewer Size (diameter or HxW)	e.g.	450 mm
line 5:	Sewer Asset Number	e.g.	S-MA0000001
line 6:	Start MH Asset Number	e.g.	S-MA0000001
line 7:	Finish MH Asset Number	e.g.	S-MA0000002
line 8:	Contractor Name	e.g.	XYZ LTD
line 9:	Date and Time of Inspection	e.g.	08/17/2000-14:15
line 10:	Direction of Inspection	e.g.	WITH FLOW
line 11:	Start MH to Finish MH		
	Steel Tape Measured Distance	e.g.	127.39 m
line 12	Cable Calibration Distance	e.g.	1.5 m

- .2 Clearly display in legible letters on the periphery of the monitor and video recording the following information during the inspection. Arrange the information to minimize interference with the inspection image:

bottom centre:	automatic update of the camera's distance from the centre of the start manhole	e.g.	15.3 m
top centre:	Street Name & Sewer Asset	e.g.	BERRY ST(S-MA0000001)
top left:	Start MH Asset	e.g.	S-MH0000001

- .3 Data/Bit Rate: 6.0 M-bits/sec.
- .2 Obtain digital video inspections from first generation recordings using video capture equipment capable of capture with no frame loss.
- .3 Digital video inspections can to be saved to a hard-drive and later transferred to recordable digital versatile disc, DVD-R media for submission.
- .4 Submit one complete single digital file for each inspection. Produce the final file in one of the following ways.
 - .1 Capture the original recording continuously using a computer system and video capture card regardless of the progress of the inspection. Edit the original raw digital file before submission to remove the pauses where inspection progress is not continuous. or
 - .2 Capture the original recording intermittently using a computer system and video capture card. Edit the original raw digital file before submission to form one continuous file. or
 - .3 Capture original recording with specialized video recording equipment capable of pausing and resuming live recording to produce a single file for submission.
 - .4 Edit digital videos using non-linear video editing software. Do not recompress edited digital files.
- .5 For manholes, provide file names within the 360Player.exe software in alpha numeric order. For sewers, provide file names containing up to a maximum of 64 characters for each digital video file in accordance with the following.
 - .1 TenderNo_E<entity no>_F<from entity no>_T<to entity no>_StreetName_M<measured len>_I<inspected len>_DS or US<inspection dir>_<Letter designating inspection sequence>.MPG

Eg. 910-2000_S-MA0000001_FS-MH0000001_TS-MH0000002_BERRY_M100.0_I39.2_US_B.MPG
(indicates that this is the second or "B" partial inspection of this entity, 39.2 m long)
- .6 Submit digital files of the original video inspections to the Contract Administrator on recordable digital versatile discs, DVD-R format in 5.2 millimetre slim-line clear "jewel cases" capable of displaying a summary sheet containing the information listed in Section 3.14 of this specification.
- .7 Ensure the entire inspection of a particular sewer or manhole is contained on the same DVD-R disc. Record reverse set-up inspections of a sewer immediately after the original inspection where possible.

3.12 Sample Inspection Report

- .1 Submit sample PACP and MACP (version 7.0.0 or newer) inspection reports, digital MPEG DVD-R video recording and corresponding magnetic data file of an actual sewer and manhole inspection performed by each device that will be used to the Contract Administrator for review at least 2 weeks before beginning the inspection work.
- .2 Submit one (1) copy of the MACP data to the Contract Administrator. Provide the appropriate viewing software, associated image and point cloud data and associated files to enable the interactive review of the inspection of the sample inspection for each device to be used as part of the submittal where viewing software will be provided at no additional cost to the Contract

Administrator. The Contract Administrator will review the inspections for completeness and accuracy of content, to ensure that the required information is provided, and the image quality is acceptable.

- .3 Submit one (1) MACP (version 7.0.0 or newer) compliant Microsoft Access, manhole inspection Databases containing inspection and defect information. Manhole condition coding shall be submitted as a MACP.mdb file accordingly. Name the MACP database according to the following file specification: [Contractor Name]_[Contract Number]_MACP_Submittal ##.mdb.
- .4 Submit one (1) pdf copy of the manhole inspection logs to the Contract Administrator. Logs shall record defects according to NASSCO's MACP.
- .5 Submit sample observation photos in the sample submittal.
- .6 Clearly identify the camera make, model and serial number on each video. Demonstrate the resolution of each camera using the recording resolution in Section 3.8 of this specification.
- .7 Use the report submission accepted by the Contract Administrator as a benchmark for subsequent inspection report submissions.
- .8 No inspection work is to be performed until the sample inspection report has been accepted by the Contract Administrator.

3.13 Sewer and Manhole Inspection Reports

- .1 Provide on a weekly basis for the previous week's work sewer and manhole inspection reports in digital format.
- .2 Provide the digital inspection reports in a format that will allow direct uploading into to the City's InfoAsset Manager program (IAM).
- .3 The Contractor shall maintain backup copies of all digital video and inspection data submissions for the duration of the Warranty Period as stated in C13 or as directed by the Contract Administrator.

3.14 Video Inspection Labelling

- .1 Label inspection reports, diskettes and DVD discs with the following information.
 - Contract Name: e.g. The City of Winnipeg, Bid Opportunity No. 910-2000
 - Sewer Asset Number(s): e.g. Sewer Asset Numbers – S-MA0000001, etc.
 - Submission ID: e.g. Sewers Inspected Week of 08/24/2000 - 1 of 5
- .2 Label DVD-R discs with a marker or using other acceptable means certified by the manufacturer as being compatible with the DVD-R disc material. Do not apply stick-on labels to DVD-R discs.
- .3 Provide a typed summary sheet in DVD-R disc cases containing the following information.

	Entity Asset	From MH	To MH	Street Name	Inspection Direction	Measured Length	Inspection Length
e.g.	S-MA0000001	S-MH0000001	S-MH0000002	BERRY ST	U/S	100.0 m	39.2 m

3.15 Camera Position and Speed

- .1 Position the centre of the camera lens in the vertical centre of circular and egg-shaped sewers and manhole risers or as directed by the Contract Administrator.
- .2 Ensure camera speed does not exceed 9 metres/minute during sewer and manhole inspections.

3.16 Sewer and Manhole Measurements

- .1 Measure the distance between the centres of the start and finish manholes on the ground surface above the sewer to the nearest 0.01 of a metre using a survey grade ISO 16331-1:2012(E) approved outdoor laser distance measurer capable of attaining 150m minimum steel tape distance or alternative approved measuring methods before beginning the sewer inspection. The center of the manhole will be based on the center of the manhole cover regardless of the manhole configuration. If bends are identified to exist within the sewer segment, the Contractor shall approximate the measurement on the ground surface using incremental distances to the approximate alignment of the sewer between the start and finish manholes, to the approval of the Contract Administrator's Site Inspector.
- .2 Measure the vertical distance from the sewer invert to the manhole frame to the nearest 0.01 of a metre with a steel tape before beginning the sewer or manhole inspection.
- .3 Provide a remote reading counter to measure the distance to the nearest 0.10 metre the video camera has travelled within the sewer from the centre of the start manhole during the sewer inspection.
- .4 Distance measurement within the sewer to be accurate to within 0.5% of the above ground steel tape measurement between start and finish manhole centres.

3.17 Sewer and Manhole Inspections

- .1 Notify the Contract Administrator of the locations where sewer and manhole inspections will be performed one full day before starting inspection work at that location.
- .2 Perform sewer and manhole inspections after cleaning (where applicable) is completed and sample inspection report has been accepted unless directed otherwise by the Contract Administrator.
- .3 Use the flusher continuously during inspection and implement flow control measures in accordance with Section 3.13 of CW 2140 where required to ensure the following.
 - .1 The entire cross section of the sewer is visible and no debris is present during the sewer inspection.
 - .2 The manhole invert is completely visible and no debris is present during the manhole inspection.
- .4 Evacuate fog from the sewer and manhole before beginning inspections and keep the sewer and manhole clear of fog during the entire inspection.
- .5 Keep the camera lens clean during the entire sewer and manhole inspection.
- .6 Ensure the picture is in focus and there is adequate, even lighting free of shadows and glare ahead of the sewer pipe or manhole riser at all times to be able to determine general condition, features and upcoming defects. Provide better lighting as directed by the Contract Administrator.

- .7 A skilled and NASSCO PACP certified technician or supervisor who shall be located at the control panel in the mobile data collection studio shall control the operation of the digital CCTV inspection equipment.
- .8 Perform sewer inspections in accordance with the following.
 - .1 With the direction of flow unless a reverse set up is required.
 - .2 From the centre of the start manhole to the centre of the finish manhole.
 - .3 Begin inspections generally with the upstream sewer in the system and proceed downstream in a consecutive manner.
 - .4 Schedule inspection of downstream sewers to be done after the contributing upstream sewers have been cleaned.
 - .5 Ensure the face of the start manhole is clearly visible at the start of the sewer inspection.
 - .6 Record the distance from the center of the manhole cover to the cable calibration location at the start of the inspection and adjust the distance reading so that zero is at the center of the start manhole cover. This distance is known as the cable calibration distance. The cable calibration location is the intersection point between the camera's widest horizontal viewing angle and the pipe's side periphery (03 and 09 o'clock) when the camera is level and looking forward. All defects are to be circumferentially located based on the side periphery only.
 - .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 center of the finish manhole.
 - .8 Stop the camera and position to provide a steady 2 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. Additionally, tap observation distances must occur at the centre of the tap and the side periphery. To determine use and deficiencies of the tap, the camera must continue to travel, camera centred in the perspective view (to capture other observations), to stop perpendicular to the tap and pan so that the camera can view directly into the barrel of the lateral, to enable the inspector to apply modification and descriptor codes to the tap as per NASSCO PACP standards as necessary.
 - .9 Inspection of manholes will use side scanning imagery and point cloud collection equipment only to NASSCO MACP Level 2 inspections for the purposes of assessing thoroughness of cleaning, observing and recording structural and service defects and construction features of existing manhole and control structure assets and to verify new and rehabilitated sewer construction prior to acceptance. A skilled and NASSCO MACP certified technician or supervisor who shall be located at the control panel in the mobile data collection studio shall control the operation of the digital panoramic inspection equipment.
- .10 Perform manhole inspections in accordance with the following.
 - .1 From the top to the bottom of the manhole.
 - .2 From the manhole frame to the centre line elevation of the exiting sewer.

- .3 Ensure the frame of the manhole is clearly visible at the start of the inspection.
- .4 Provide a chalk or dry-erase-board placed adjacent to the manhole cover, within the inspection imagery, noting the Date, Contract #, Manhole Asset ID # and physical measurement of manhole rim to invert dimension.
- .5 Spray paint a mark (with a colour consistent for the duration of the project and a different colour to the north mark) indicating the 6 o'clock position that is in reference to the first outgoing pipe (taken from north in a clockwise direction, as per NASSCO MACP requirements) visible on the surface and within the manhole frame. All paint colours shall conform to the City of Winnipeg's Underground Structures Branch "APWA Uniform Colour Code for Marking Underground Facilities".
- .6 Block ambient light during the inspection to minimize problems related to lens flare and poor contrast.
- .7 Inspect the manhole to the lowest depth that will facilitate accurate perpendicular measurements using the software's measuring tools.
- .8 Complete all steel tape or calibrated footage counter measurements pertinent to mandatory MACP Level 2 measurements that are located at or around the cover and frame area. In accordance with NASSCO MACP standards, the Contractor shall measure the rim to invert using a steel tape or calibrated footage counter from the surface to validate the measurement available from the panoramic scan.
- .11 Re-perform sewer and manhole inspections where the Contract Administrator has determined the tolerance requirements for camera position and speed and internal distance measurement requirements in Section 3.15 and 3.16 of this specification have not been satisfied.

3.18 Reverse Set - Up Inspection

- .1 Perform a reverse set-up inspection when a blockage in the sewer prevents completion of the inspection from the upstream manhole. Move the equipment to the downstream manhole and attempt to complete the inspection of the entire sewer to the upstream manhole.

3.19 Incomplete Inspections

- .1 Immediately advise the Contract Administrator when a complete sewer or manhole inspection cannot be completed due to collapse, excessive deformation, intruding connections, obstructions or large displaced joints. Jointly decide with the Contract Administrator one of the following alternatives.
 - .1 Abandon the inspection. or
 - .2 Re-perform the inspection subsequent to one of the following actions.
 - .1 Performing solid debris cutting.
 - .2 Removing intruding connections.
 - .3 Modifying the camera setup position or method of transport.
 - .4 Completion of external or emergency repairs.
- .2 Note in a log the sewer or manhole ID number, steel tape measurement, upstream and downstream length or manhole 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.

.1 An "empty header" or "0-m MSA" inspection shall be completed for sewer segment that cannot be inspected for reasons such as high flow, depths or velocities, inaccessibility to the sewer due to inaccessible or unlocated access structures, heavy debris, and at the Contract Administrator's direction, etc. The inspection form header and detail sections shall comply with NASSCO PACP guidelines populating all required header fields. The contractor will abandon the survey at a distance of 0-m inspected and provide a general comment that describes the reason that the inspection cannot be conducted in the Additional Information field. An "empty header" inspection shall also be created for reversal inspections that cannot be completed noting reasons for non-completion. The Contractor shall record at least one photo documenting conditions preventing the inspection of the pipe segment. Empty header records shall be included in the PACP database as submitted by the contractor with adjoining segments. Comments to be included within the header Field 59 to provide further information regarding the incomplete inspection attempt.

3.20 Acceptance of Inspections

- .1 The Contract Administrator will review inspection reports, video recordings, and magnetic data files to ensure compliance with the specifications within 10 working days of submission based on an inspection rate of 1,000m per day, unless otherwise indicated by the Contract Administrator. The review period will be proportionately extended for inspection rates greater than 1,000m per day. The Contract Administrator may adjust the frequency of reviews based on the results of previous reviews.
- .2 Re-perform sewer and manhole inspections where the Contract Administrator has determined the requirements of the specification have not been satisfied.
- .3 Correct non-compliant inspection submissions and resubmit the corrected inspections to the Contract Administrator within 5 working days.
- .4 Repeat the process until the inspection submissions are accepted by the Contract Administrator.

3.21 Removal of Equipment That Becomes Stuck in a Sewer

- .1 Advise the Contract Administrator immediately if equipment becomes stuck in a sewer. Attempt to remove equipment that is stuck using whatever means are necessary for at least 4 hours. Advise the Contract Administrator if the equipment cannot be freed after 4 hours and mark the position on the surface over the sewer where the equipment is stuck.
- .2 The Contract Administrator will arrange to have an excavation made to the top of the sewer where the equipment is stuck within 48 hours of notification the equipment cannot be freed.
- .3 Be present during the excavation and once the top of the sewer is exposed and the excavation is secured, do one of the following.
 - .1 Remove the top of the sewer pipe and retrieve the equipment stuck in the sewer or;
 - .2 Defer removal of the top of the sewer and retrieval of the stuck equipment to the excavation contractor. Damages caused to the stuck equipment will not be the responsibility of the excavation contractor. No claim for equipment damages will be made against the excavation contractor.

- .4 The Contract Administrator will arrange to have the sewer repaired after removal of the equipment that was stuck.
- .5 Clean and remove backfill and debris that may have entered the sewer during removal of the equipment and subsequent repair of the sewer.

3.22 Observed Failures During Sewer and Manhole Inspections

- .1 Capture photograph or digital images and notify the Contract Administrator immediately where a flow disparity, clear water infiltration, hole or missing bricks, collapse, void or deformation > 10% is observed during the sewer or manhole inspection. Provide the captured images to the Contract Administrator at the end of each work day.
- .2 Place barricades around the location above the sewer or manhole where a void is visible or suspected to be outside of the sewer pipe or manhole and immediately notify the Contract Administrator. Notify the City of Winnipeg, Emergency Services at 986-2626 after normal working hours if the Contract Administrator cannot be reached.
- .3 The Contract Administrator will arrange for emergency sewer or manhole repairs to be performed if required as soon as possible if the inspection cannot be completed or the sewer or manhole condition poses an immediate operational or safety concern such as a complete collapse.
- .4 Emergency sewer or manhole repairs will be prioritized if more than one emergency repair arises at the same time.
- .5 Carry out inspection of other sewers not affected by the emergency repair and complete inspection of the sewer when notified by the Contract Administrator the emergency repair has been completed.
- .6 Repeat cleaning of the sewer in accordance with CW 2140 if required to remove backfill and debris that may have entered the sewer during emergency repairs.

4. MEASUREMENT AND PAYMENT

4.1 Inspection Coding

- .1 Inspection coding will be included with sewer and manhole inspection.

4.2 Inspection Reports

- .1 Sample inspection reports and inspection reports will be included with sewer and manhole inspections.
- .2 Correction and re-submission of non-compliant submissions will be at own expense.

4.3 Video Recordings

- .1 Digital video recordings will be included with sewer and manhole inspection.

4.4 Sewer Inspections

- .1 Sewer inspections will be measured on a length basis for each size and type of sewer and paid for at the Contract Unit Price for "Sewer Inspection". Length to be paid for will be the total length of sewer inspected in accordance with this specification, accepted and measured by the Contract Administrator.

- .2 Measurement will be made horizontally at grade above the centre line of the sewer from centre to centre of manholes or from centre of the start manhole to the point of abandoned inspection as confirmed by the steel tape measurement.
- .3 The diameter of non-circular sewers will be taken as the largest dimension.
- .4 Payment will not be made until the required report submissions are accepted by the Contract Administrator.
- .5 Payment will not be made for inspections re-performed where the Contract Administrator has determined the requirements of the specification have not been satisfied.

4.5 Manhole Inspections

- .1 Manhole inspection will be measured on a unit basis and paid for at the Contract Unit Price for "Manhole Inspection". Number of units to be paid for will be the total number of manholes inspected in accordance with this specification, accepted and measured by the Contract Administrator.
- .2 Payment will not be made until the required report submissions are accepted by the Contract Administrator.
- .3 Payment will not be made for inspections re-performed where the Contract Administrator has determined the requirements of the specification have not been satisfied.

4.6 Reverse Set Up - Inspection

- .1 Reverse set-up inspection will be measured on a unit basis and paid for at the Contract Unit Price for "Reverse Set-Up Inspection". Number of units to be paid for will be the total number of reverse set-up inspections performed in accordance with this specification, accepted and measured by the Contract Administrator.

4.7 Removal of Equipment That Becomes Stuck in a Sewer

- .1 The City will pay costs for excavating down to the top of the sewer pipe, repairing the sewer after inspection equipment is removed, backfilling the excavation and restoring the surface.
- .2 Removal of the top of the sewer pipe and the inspection equipment that was stuck in the sewer will be at own expense.
- .3 Cleaning and removing backfill and debris that may have entered the sewer during removal of the equipment and repair of the sewer will be measured and paid for in accordance with Clause 4.1.3 of CW 2140.
- .4 No payment or extra time will be given for equipment downtime and attempted equipment retrieval.

4.8 Flow Control

- .1 Flow control will be included with sewer inspection.