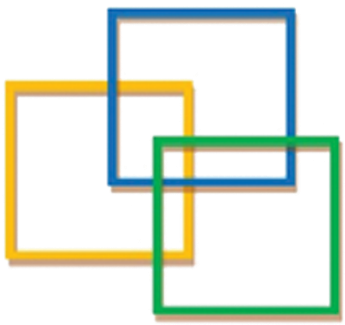
Accreditation Organisations:

Hong Kong Institute of Utility Specialists

International Institute of Utility Specialists

Particular Specification For Conduit Condition Evaluation, CCE, (CCTV and Man-Entry Survey) 2020 Edition, Version 1.0



Publisher:

UTILITY TRAINING INSTITUTE (UTI)
A trade name of UTI (International) Ltd. 管綫學院

Foreword

It's been 25 years since the disastrous landslip that occurred in Kwun Lung Lau on Hong Kong Island on 23 July, 1994. Since 1995, the Government of HKSAR has awarded hundreds of millions of dollars in contracts related to detection of leakage from buried water carrying services (BWCS) both on slopes and on the roads throughout the territory. As expected, this sequence of events generated an increasingly large pool of "Utility Specialists (US)", with most working almost independently, devoid of any standardized surveying methods, quality requirements (on survey results) and the "registration" of operation professionals in the market before the establishment of HKIUS in 2002.

In view of the availability of the multitude of method statements, specifications, training manuals, and the contracts documents produced for the vast number of underground utility survey contracts (by government and private projects), the following sections try to provide a comprehensive set of method statement, by addressing the following topics in general and where the abbreviation can be found in the Appendix:

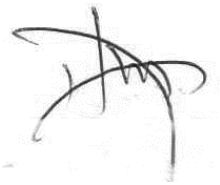
(1) Utility Services Information to be investigated

(2) Level of Accuracies

(3) Types of Deliverables and Schedules

(4) Requirements for Deliverables

You are welcome to take reference to this Particular Specification for your contract and in case you need further information, please refer to relevant manuals or publications by HKIUS/IIUS or send an e-mail to info@hkius.org.hk or call Ir Dr. King Wong.



Ir Dr. King WONG, FHKIUS, FIIUS, RPUS
黃敬 博士、工程師、管綫專業監理師(院士)、管綫專業監察師,

Editor in Chief

January, 2020

Ir Chun-keung NG, FHKIUS

伍振強工程師、管綫專業監理師(院士)

President, HKIUS (2019-2021)
January, 2020

Ir Prof Eric MA, GBS, JP, FIIUS

馬紹祥 教授、工程師、金紫荊星章、太平紳士、管綫專業監理師(院士),

President, IIUS

January ,2020

If any error or mistake is found in this particular specification, please kindly contact us.

Tel: (+852) 2967 0000 Fax: (+852) 2618 4500 Email: info@uti.hk

Table of Content

List of Figures

List of Tables

A1 Introduction

The Utility Specialist (US) shall conduct the preliminary visual inspection and CCTV surveys at or between the two prescribed points to discover evidence of their structural, service and integrity condition in accordance with the Code of Practice for Conduit Condition Evaluation Using CCTV (Conduit Condition Evaluation Codes, 5th Ed. 2019 (CCEC), published by UTI or the Manual of Sewer Condition Classification (MSCC), 4th Ed., 2004 of WRC.

The Utility Specialist shall perform CCTV surveys at all associated branches from the drains (if any) of size not less than 80mm in diameter within the corresponding Zone of Influence/survey boundary as confirmed by the client.

The Utility Specialist shall report to the Client for any signs of leakage and/or damages of the drains/sewerages without delay in view to prevent for any chance of further damage and hence to prevent life injury.

The utilization of CCTV survey has been broadly adapted in the utility surveying industry for a long time and the mechanical assembly and procedures have been refined and created. There is presently an expanding utilization of CCTV for the review of street seepage frameworks as an upkeep apparatus and distinguished advantages as far as future consumption to utilizing this procedure amid the development procedure.

A2 Personnel Requirements

In order to maintain the Utility Profession's requirements for the consistency, reliability and accuracy of the inspections and reports, the Conduit Condition Evaluation shall be performed by a properly trained and accredited personnel:

- Operational works shall be conducted by Operative/ Manager Member of HKIUS (管綫專業監理員/師) (CCE- CCTV&ME) (at least 3 years' post-training experience) or AMHKIUS (助理管綫專業監理員)(at least 2 years' post training experience) with supervision by OMHKIUS,
- The whole operation shall be supervised by OMHKIUS/ MHKIUS/ FHKIUS.
- Report and survey result checking shall be completed by Manager/ Fellow Member of HKIUS (管綫專業監理師),
- And receive endorsement from Recognized Professional Utility Specialist (RPUS) (管綫專業監察師) where necessary or instructed.

Personnel responsible for recording, identifying and classifying defects, features and other observations for the purpose of report preparation shall hold a certified qualification issued by a Registered Training Organization (RTO), such as Utility Training Institute (UTI) or The Hong Kong Polytechnic University or equivalent, which are approved by HKIUS.

A certified qualification shall be either:

(1) Degree/ Higher Degree, or

(2) Diploma/ Professional Diploma, or

(3) Professional Certificate, or

(4) Accredited by Hong Kong Accreditation Services (HKAS), or

(5) Equivalent approved by HKIUS in Utility Surveying and Management or related subject awarded by a RTO.

Note*: (1), (2) and (3) shall be of Surveying/ Engineering/ Applied Science with specialization in underground-utility (UU) survey(s) with practical on-site training.

In addition, a minimum of 3-year post-training experience will be necessary for a person to become competent. Besides, qualified personnel are required to attend refreshment course in every 3 years to strengthen and enhance their knowledge.

All works carried out within sewers, manholes, inspection openings or other confined spaces shall be performed in accordance with the requirements for works stipulated in Cap. 59AE Factories and industrial Undertakings (Confined Space) Regulation and Cap. 509 Occupational Safety and Health Ordinance, as well as any additional precautions that may be specified by the asset owner.

Note**: Designated Certified Workers (DCW) and Designated Competent Person (DCP) are required for DSD's confined space works inspection and risk assessment report preparation. For details on requirements of DCW and DCP, please refer to "*Safety Manual"* by DSD (2018).

For comprehensive information, please refer to the Appendix B – Requirements for Personnel Carrying Out Inspection in this Particular Specification.

A3 Statutory Requirements

This Section outlines the legislations in force that are relevant to CCTV and Man-Entry Survey. The Utility Specialists are responsible to comply with the relevant ordinance or regulations listed below.

(1) Cap. 28 Land (Miscellaneous Provision Ordinance)

(2) Cap. 59AE Factories and Industrial Undertakings (Confined Spaces) Regulation

(3) Cap. 358 Water Pollution Control Ordinance

(4) Cap. 374 Road Traffic Ordinance

(5) Cap. 446 Land Drainage Ordinance

(6) Cap. 509 Occupational Safety and Health Ordinance

For detailed information, please refer to the latest verified legislation in Hong Kong at the website of Hong Kong e-Legislation https://www.elegislation.gov.hk/ .

A4 Survey Equipment

A4.1 General Equipment

The Utility Specialists shall equip the team undertaking the CCTV and/ or man-entry survey work for conduit condition evaluation with the following:

(1) Equipment for easing and lifting manhole covers;

(2) Sewer or other confined space facilities/ safety equipment;

(3) Road work safety equipment.

A4.2 Equipment for confined space

All works carried out within sewers, manholes or other confined spaces shall be performed in accordance with the requirements for works in the vicinity of Confined Space and Occupational Health and Safety Legislations, as well as any additional precautions that may be specified by the asset owner.

A4.3 Personal Protective Equipment (PPE)

It is a statutory requirement for Utility Specialists to provide guidance, instruction, training and supervision for operators to use PPE properly and to ensure that they have sufficient knowledge in usage, maintenance, replacement schedule and limitations of PPE.

The Utility Specialists shall provide sufficient PPE and ensure that they are readily available.

In general CCE works, PPE shall include but not limited to the following:

(1) Steel toe cap, rubber safety boots

(2) Safety helmet

(3) Safety vest (reflective at night)

(4) Safety goggles/Anti-glare glasses

(5) Harness and fall arrester

(6) Gloves

(7) Ear muffs/ Ear plugs (if applicable)

(8) Handy gas detector

Note that other PPE shall be provided depending on the specific site conditions after completion of risk assessment under safety procedures.

A4.4 CCTV Survey Equipment

A4.4.1 Typical Components of CCTV Survey Equipment

The typical components of a Remotely Operated Vehicle (ROV) with CCTV include: (1) control unit, (2) display device, (3) text input device, (4) data storage device, (5) image capture device/ video recording device, (6) mobility unit, (7) illumination device; and (8) distance measurement device.

For detailed introduction for the function of the components, please refer to the Conduit Condition Evaluation Codes (CCEC) 2019 Edition or the operation manual(s) of your particular equipment.

A4.4.2 Requirement for the technical specifications for Image Capture Device/ Video Recording Device of the CCTV Survey Equipment

The CCTV survey equipment shall be equipped with a camera with a minimum of lens resolution of 1 Megapixel and be able to provide a minimum picture quality of 1 Megapixel, it shall be able to pan, tilt and zoom for focusing at locational defects or interests of attention. The pan & tilt camera shall be cable of 360 °rotation and tilt up to 90 ° from the horizontal.

A4.4.3 Requirement for the technical specifications for Image Capture Device/ Video Recording Device and the display device of the CCTV Survey Equipment

The electronic systems, camera and monitor shall achieve the following Image Quality Factors:

A4.4.3.1 Shades of grey

The grey scale shall show equal changes in brightness ranging from black to white with a minimum of five clearly recognizable stages.

A4.4.3.2 Colour

With the monitor control adjusted for correct saturation, the six colours plus black and white shall be clearly resolved with the primary and complementary colours in order of decreasing luminance. The grey scale shall appear in contrasting shades of grey with no tint.

A4.4.3.3 Linearity

The background grid shall show squares of equal size, without convergence/divergence over the whole of the picture. The centre circle shall appear round and have the correct height/width relationship (±5%).

A4.4.3.4 Resolution

The live picture must be clearly visible with no interference with a minimum resolution of 1 Megapixel. The resolution shall be checked by the Utility Specialist with the monitor colour turned down.

A4.4.3.5 Colour constancy

To ensure the camera shall provide similar results when used with its own illumination source, the lighting shall be fixed in intensity prior to commencing the survey. In order to ensure colour constancy, generally no variation in illumination shall take place during the survey.

A4.4.3.6 Focus/iris/illumination

The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The adjustment of focus and iris shall provide a minimum focal range from 150mm in front of the camera's lens to infinity. The distance along the drain in focus from the initial point of observation shall be a minimum of twice the vertical height of the drain. The illumination must be such as to allow an even distribution of the light around the drain perimeter without the loss of contrast, flare out of picture or shadowing.

A4.4.4 Requirement for the technical specifications of the connection cable/ towing device of the CCTV Survey Equipment

The surveying equipment shall be capable of surveying a length of drain up to 350m where entry to the drain may be obtained at both ends and up to 30m by rodding, or up to 200m where a self-propelled unit is used where entry is at one end only.

A4.4.5 Requirement for the data storage device

When recording the conditions of the drain, the data storage device shall have adequate available storage capacity depending on the length and quality required for the videos (a minimum of 32 GB is recommended). The video quality has a positive relationship against storage usage, the Utility Specialists shall check the required storage to fulfil the video quality as specified in this Particular Specification or as required by the Client. Note that part of the capacity on the data storage devices is used for formatting or other functions and thus not available for data storage.

A4.4.6 Other Requirements of CCTV Survey Equipment

The Utility Specialist shall maintain this plant in full working order and shall satisfy the client at the commencement of each working shift that all items of plant have been provided and are in full working order and fully calibrated in accordance with the manufacturer’s recommendation.

Each survey unit shall contain a means of transporting the CCTV camera in a stable condition through the drain under inspection. Such equipment shall ensure the maintained location of the CCTV camera on or near to the central axis of the drain which all dimensions of drain sizes shall be Metric.

For the purpose of metrication, imperial sized drains shall be converted on the basis of 1 inch = 25.4mm.

Measurement of drains shall be on nominal diameter dimensions quoted to the nearest mm.

The CCTV camera shall have suitable illumination and shall be capable of providing an accurate and clear record of the drain's internal condition.

A4.4.7 Recommended Maximum Water Level for CCTV Survey Equipment

The CCTV survey data shall provide a visual representation of the internal condition of the specified pipeline to be surveyed above the water surface. High flow rates may obscure the view of the pipeline. If the CCTV ROV is travelling upstream, the water may also surge in front of the camera, creating turbulence and block the view of the pipeline.

Unless otherwise agreed by the asset owner, the depth of water in sewer shall not exceed the values tabulated in *Table 1*:

Table 1 Maximan water level of pipeline for CCTV Survey with the corresponding pipe diameters

Pipe Diameters	Water Level (%)
Less than 300mm	20
300mm to 600mm	25
Above 600mm	30

In case where the water level is higher than the recommended in *Table 1* or at a level agreed by the client, the inspection progress shall be temporarily suspended and flow diversion shall be adopted.

For trunk sewer or major sewer where diversion measures are not appropriate, CCTV Survey may still be carried out with consent from the client or using alternative measures such as CCTV itself or combined sonar and CCTV Camera on floating device.

If the survey purposed on the condition assessment which require a particular interest at the invert of the pipe, it may be necessary for the pipeline to have no water; or if instructed by the client, to use in conjunction with other technologies such as sonar.

If the client request for a more comprehensive pipeline internal condition, the Utility Specialists shall recommend the clients to consider incorporating different innovative technologies used in conjunction with inline CCTV inspection, such as laser profiling, sonar, LIDAR, infrared technologies and in-line ground penetrating radar etc., which shall be measured separately.

A4.5 Pre-cleaning Equipment

Pre-cleaning of the sewer system is a preparatory measure to remove any blockage of the view of the CCTV camera. The deposits were loosen, conveyed to an access point, removed and deposed.

High pressure water jetting is one of the most adopted possible methods.

A4.5.1 Pressure jetting equipment

The pressure jetting equipment used shall be sufficient for the purposes of attaining the degree of cleanliness specified due to availability of wide range of equipment. In general high flow rates are associated with lower pressures and low flow rates with higher pressures.

For details of pressure jetting equipment, please refer to *Appendix C – V* of this Particular Specification.

A4.5.2 Winching equipment

The Utility Specialist shall provide conventional power winching equipment (approved by the client) together with ancillary equipment, winching buckets, breakers, scrapers, etc. tools and safety apparatus for cleaning the drain for purpose of inspection and accurate assessment of the conditions of the internal fabrics of the drain. The Utility Specialist shall demonstrate the successful cleaning of a cleaned drain by CCTV survey.

For details of winching equipment, please refer to *Appendix C – VI* of this Particular Specification.

A4.5.3 Manual Cleaning with supplementary apparatus

Manual cleaning is always not recommended as man-entry is required. However, for sewers which are safe and accessible, manual cleaning with supplementary apparatus is still an available choice, especially when the preparation for assessment work and rehabilitation can be done in line with the cleaning. To remove the deposits, pickaxes, scrapers, compressed air hammers and hand grinders etc. can be used. No power tools with voltage higher than 110V AC shall be used inside sewers or drains with man-entry.

A5 Survey procedure

This Section outlines the general survey procedures for Conduit Condition Evaluation (CCTV and Man-Entry Survey). The Utility Specialists are expected to use their professional judgement and experience for MHICS.

For detailed information, please refer to the latest version of Work Procedure and Method Statement published by UTI.

A5.1 Planning for the Inspection

A5.1.1 Desk study

Obtaining all information available regarding the asset from the asset owner (usually the client)

Including extra details in order to enhance readability for whom might concern, the extra details should include:

(1) A map indicates geo-information of the asset

(2) The locality

(3) Information of pipes (size, material and present condition)

(4) Date of construction

(5) Depth of manholes, surface and invert levels

(6) Coordinates of manholes or other nodes

(7) System name or descriptor

(8) Name of qualified operators and checkers and name of specialist firm

A5.1.2 Preparation for Master Programme and Progress Schedule

Before execution of any works, The Utility Specialists shall prepare a Survey Progress Schedule agreed by the Client. Any survey work without confirmation with the Client for execution may be considered as invalid.

A5.1.3 Site reconnaissance survey

The Utility Specialists shall conduct site visits or walk over survey to collect preliminary information such as the location, availability, accessibility and site conditions of the proposed access points. The Utility Specialists shall observe and record the site characteristics which may poses potential problems to be encountered. Notes, photos and videos can be taken or recorded for better representations and presentation of the site conditions, which are crucial for later planning.

A5.1.4 Risk Assessments and Safety Plans

The Utility Specialists shall conduct risk assessment to identify high risks or hazards particular to that site and react with corresponding safety plan before issuing Permit to Work. Typical high risk works/ environment of CCE (CCTV & ME) are included but not limited to *Table 2*:

Table 2 Typical items for Risk Assessment of CUS (CCTV &ME) and corresponding safety precautions

Tasks/ environment with high risk	Corresponding safety precautions
Heavy traffic	Apply for Temporary Traffic Arrangements (TTA) for traffic diversion
Man-Entry to Confined Space	Safety precautions for confined space
Hazardous/ flammable gases	Gas Detection Provide masks or BA if required
Work on-slope	Safety harness with fall arrestor
Work at height	Working Platform Safety harness with fall arrestor
Insufficient lighting	Head torches
Water level > 1.5 m	Certified Divers

A5.2 Manhole Internal Condition Survey (MHICS)

The MHICS serves as a preliminary survey to assess the feasibility to use certain manholes as the entry point for CCTV/ME survey, which include the spatial and aspatial information of the manhole surveyed, gas detection readings for hazardous gases, the measurements, pipe connections, internal conditions and photos etc.

For comprehensive details on MHICS, please refer to the Particular Specification, Method Statement, Work Procedures for Manhole Internal Condition Survey or any latest version of Manhole Condition Evaluation Code (MHCEC) published by UTI.

A5.3 Decision of entry points

The entry points of the CCTV survey shall be connected to the specified pipeline, either by direct connection or side entry. The entry points shall be safe to access, special safety precautions shall be included in the Safety plan if the access point is:

(1) On-slope

(2) 2 metres above ground

(3) With hazardous gases

(4) On main road where TTA is required

When the specified survey sections were agreed and assigned by the client, there are normally ~~four~~ five ways to classify the entry point for the conduit survey:

(1) Survey through one end to another end

(2) Survey through intermediate or uncharted node in the record plan

(3) Survey through intermediate minor node

(4) Survey through intermediate major node

(5) Survey from both ends and terminates at a common, readily recognizable feature (e.g. pipe junction/ intermediate manhole etc.), defects or any other recognizable points agreed by the client.

The utility specialist shall select the best available survey entry points according to the availability of manholes to be surveyed; site restrictions; limitations of survey equipment (e.g. length of cable); time required and cost. By conducting reconnaissance survey, the Utility Specialists can have bettering understanding on the site conditions and constraints, which affect the decision of choosing the entry points and adopting corresponding safety precautions required for specific sites.

The requirement of CCTV inspection can be referred to Section *A6.3* of this particular specification.

The operation of CCTV survey include lifting of covers in manholes/ inspection pits to inspect the conditions of the entry point for CCTV survey. MHICS shall be conducted if requested and paid by the client as a part of the preliminary survey.

Entry into confined space requires professional training and safety equipment. Man-entry is not recommended unless it is a last resort. Modern manhole inspection instruments such as manhole cameras can be utilise as assisting manhole survey in MHICS.

For details on manhole inspections, please refer to the latest version of Particular Specification for Manhole Internal Condition Survey published by UTI.

A5.4 Direction of CCTV Survey

In general, the preferable direction of inspection shall be starting at upstream access point along downstream direction so as to reduce the impact of having high surges of water in front of the camera, creating turbulence and blocking the view of the pipeline.

However, due to practical challenges, CCTV survey may travel toward upstream direction. Typical challenges include but not limited to the followings:

(1) Limited availability and accessibility of access points connected to the specified pipe section, which are able to be lift and survey

(2) Limited cable length of the equipment

(3) Steep gradient and backdrops

The Utility Specialists shall recommend the client to conduct flow diversion or dewatering if necessary.

A5.5 Preparation of the sewer/ drain

Pre-cleaning of sewer/drain before inspection commence can be requested by client. Cleaning prior to CCTV survey would make observations and identification of the defects and features of the conduit easier as the obstacles are removed.

Safety precautions required and detail operation of high pressure water jetting can be referred to Code of Practice for Sewer Jetting or *Appendix C – Drain Cleaning in* this particular specification.

A5.6 Testing and calibration of CCTV survey equipment

To ensure both the camera and the monitor of the control panel are in good condition, the following testing and calibration procedures shall be performed before inspection on each working day: (1) monitor test; (2) camera test; (3) camera cable calibration and (4) Illumination test.

The Utility Specialists shall test the display device prior the commencement of CCTV survey following the procedure below:

Play a video display screen test video to test the performance of the recording and playback equipment, and the video display screen.

To calculate the optical distance from object to the digital sensor at the focal plane in the camera, the focal distance shall be measured before commencing the CCTV survey.

The Utility Specialist shall submit to the client for approval a test device for the CCTV equipment and make available on site throughout the Contract, enabling the tests specified in this Clause to be checked by the client. The test card shall be the Marconi Resolution chart No. 1 or its derivatives with a color bar, clearly differentiating between color with no tinting to show the following:

(1) White
(2) Yellow
(3) Cyan
(4) Green
(5) Magenta
(6) Red
(7) Blue
(8) Black

At the start of each and every working shift, the camera shall be positioned centrally and at right angles to the test card at a distance where the full test card just fills the monitor screen, ensuring that the edges of the test card castellations coincide with the edges of the horizontal and vertical scan (raster). The card shall be illuminated evenly and uniformly without any reflection.

The illumination shall be to the same colour temperature as the colour temperature of the lighting that will be used on the CCTV camera in the drain. The test shall be recorded and submitted to the client daily for subsequent use, the recording time to be at least 15 seconds. The type of camera used is to

be reported on the test recording. The recording must show the camera being introduced into the test device and reaching its stop position. Other test devices may be proposed by the Utility Specialist for use subject to approval by the client with reference to HKIUS.

The electronic systems, television camera and monitor shall be of such quality as to enable the following Image Quality Factors to be achieved:

(1) Shades of grey

(2) Colour Accuracy

(3) Linearity

(4) Resolution

(5) Color constancy

(6) Focus/iris/illumination

For comprehensive details of the above testing, calibration and measurement procedures, please refer to the Guide to Conduit Condition Evaluation (using CCTV in Hong Kong) and Work Procedure for Conduit Condition Evaluation (CCTV and Man-Entry Survey) published by UTI.

A5.7 CCTV survey

This section outlines the general survey procedures for Conduit Condition Evaluation – CCTV and Man-Entry. For detailed information, please refer to the latest version of Work Procedure, Method Statement and Conduit Condition Evaluation Codes 2019 published by UTI.

A5.7.1 Insertion of ROV-CCTV into sewer/drain system

The ROV-CCTV can be lifted and unloaded using vehicle mounted winches or manually depends on the weight and size of the equipment. Tripods and pulleys can be used to assist the manual operation.

If the equipment was inserted vertically (for easier insertion due to limited space of the shaft), make sure the camera lens are not pointing towards the ground, or a 90 degrees flip of the ROV shall be proceed once it enters the chamber, where space is sufficient for the ROV to be placed horizontally.

For manual insertion, make sure to lift and lower the ROV-CCTV with the towing rope, never use the cable.

A5.7.2 Input Screen Header Information

The operator shall input the screen header of the required information listed on section A6.2 of this Particular Specification. The accuracy of the header information will be audited under the procedures in Quality Control and Quality assurance.

A5.7.3 Start of CCTV Survey

Recording shall be started before entering the specified pipe section. Ensure that the distance counter starts to register at the time when the camera start to move forward.

A5.7.4 Control of motion of ROV

The movement of the ROV shall be at constant velocity (constant speed required in section A6.1.1.3 and forward direction). The ROV shall be stopped at defects or features observed by the operator. However, practical challenges may include the following which leads to inconstant speed and unstable movement of the vehicle:

(1) High friction between the flooring and the vehicle

(2) Steep gradient

The Utility Specialists shall control the ROV with caution in order to acquire high quality data.

A5.7.5 Control of camera lens (pan, tilt, zoom)

The operator shall utilise the functions of panning, tilting and zooming of the camera to focus and obtain more details on defects and features observed.

A5.7.6 End of Survey

The survey shall be end at the center of the finishing manhole or access point. Mark the inspection codes on CCTV/Man – Entry Survey Site Coding Form when finishing or abandoning a survey with reasons.

Operation shall be carried out by OMHKIUS (CCE- CCTV&ME) (at least 3 years' post-training experience) or AMHKIUS (at least 2 years' post training experience) with supervision by OMHKIUS.

The whole operation shall be supervised by OMHKIUS/ MHKIUS/ FHKIUS. Detailed Personal requirements can be referred to Appendix B – Requirements for Personnel Carrying Out Inspection of this Particular Specification.

A5.8 Man-Entry Survey

In general situation, man-entry survey is not preferred. Man-entry techniques are usually adopted when pipe diameter is larger than or equal to 1500mm and where it is difficult to carry out a CCTV survey due to the existence of drop steps, excess bends or high silt level.

The Utility Specialist who enter the conduit should hold the camera head with cable to record the conduit condition of the entire inspection. He/she shall stop at every defects or observations. If no special condition of conduit is found, photographs or video prints shall be captured not more than 10m after the previous photograph or print in the drain as general photograph.

For man- entry survey, personal protective equipment must be equipped. Also, workers, who enter the conduit, must be certified worker under Section 4(1) and 4(2) of Cap.59AE Factories and Industrial Undertakings (Confined Spaces) Ordinance 1999 (amended year 2000) or any other latest revision.

All works carried out within sewers, manholes or other confined spaces shall be performed in accordance with the requirements for works in the vicinity of Confined Space and Occupational Health and Safety Legislations, as well as any additional precautions that may be specified by the asset owner.

A5.9 Documentation

During the CCTV inspection of conduit, the following details should be recorded:

(1) Video/ File No.

(2) Photo No.

(3) Chainage (Distance in meters from the start point)

(4) Code of defects/ observations (if observed)

(5) Location of defect/ observations (if observed)

(6) Intrusion (if observed)

(7) Remarks

A5.9.1 CCTV/Man-Entry Survey Site Coding Form & CCTV Daily Record Form

During the CCTV inspection of conduit, all fields (including header and codes) on CCTV/Man-Entry Survey Site Coding Form C shall be filled. The operator shall record observations or notes on field (64) Comment for details of the operation which requires attention and cannot be covered by any fields.

The Operator shall complete the CCTV Daily Record Form to record the general information of CCTV survey on all pipe sections commenced on the same day.

Sample Forms and blank forms can be downloaded from http://www.uti.hk/ for free.

A5.9.2 Videos

A5.9.2.1 CCTV Survey Videos

Original survey video from start access point/junction to finish access point/ junction/ point of survey abundant filmed by the CCTV.

A5.9.2.2 Location video of the access point (non-mandatory)

Supplementary video(s) indicating the location and orientation of the access point(s) from above ground level to the start point(s) of CCTV Survey.

A5.9.2.3 Videos taken by Manhole Camera (non-mandatory)

Supplementary video(s) recorded by Manhole Camera for site reconnaissance survey or other preliminary uses.

A5.9.3 Photographs/ Video prints

The following defects or observations as defined in MSCC (WRc, 2004) and CCEC (UTI, 2019) or any latest version shall be recorded:

(A) All junctions and connections defective or otherwise

(B) Continuous defects: at the beginning of the defect thereafter at 5m intervals.

(C) General condition at each pipeline length.

(1) Cracks

(2) Fractures

(3) Holes

(4) Broken pipes

(5) Deformation

(6) Collapse

(7) Severe joint displacement or open

(D) All Manholes/Chambers/Pits

The Photographs/ video screenshot shall be under good condition and in proper adjustment, which detail information like defects and conduit internal condition can be clearly identified in relation to the location (minimum requirement manhole start and finish numbers or Prescribed Section length reference numbers), survey direction, chainage, print number, and date when the print was taken. The annotation shall be clearly visible and in contrast to its background, shall have a figure size no greater than 5mm, and be type printed. The annotation shall be so positioned as not to interfere with the subject of the print.

If no special condition of conduit is found, photographs or video screenshot shall be captured not more than 10m after the previous photograph or print in the drain as general photograph.

Other photographs including but not limited to the following shall be taken:

(1) Location photographs of the access point,

(2) Instrument setup,

(3) Survey progress,

(4) Evidence of challenge encountered

A6 Requirements of Survey Deliverables

A6.1 Accuracy of Survey Requirements

The standard of accuracy required in the Survey and the completion of CCTV/Man-Entry Survey Site Coding Form shall be as follows (*Table 3*):

Table 3 Accuracy requirement for CCE (CCTV & ME)

Level 級別	Purpose 目的	Tolerance 公差	Confidence Level 置信水平
I	Header	N/A	95%
	Details (Specified Mean)	N/A	90%
	Details (Specified Tolerance)	N/A	85%
	Dimensions	±20mm or 10%	90%
	Intrusion	±20mm or 10% Dia.	90%
	Clock	±1-hour marking	90%
	Speed	≤0.2m/s	90%
	Height	Centre ±10%	90%
II	**All level I requirements and:**		
	X & Y coordinates	±20mm	95%
	Z coordinates	±20mm	
	Depths	±20mm	90%
	Manhole Connectivity	N/A	90%

*All dimensions are in millimetres and elevations in metres unless otherwise specified.

A6.1.1 Requirements for level I surveys

A6.1.1.1 Header

The header of CCTV/Man-Entry Survey Site Coding Form provides supportive information for the Utility Specialists to register, distinguish, and assess the condition of the pipeline. The accuracy of header information refer to the "completeness" and "correctness" of data. The confidence level of the header shall reach 95%

For comprehensive calculation method of the confidence level of "Header", please refer to A8 of this particular specification.

A6.1.1.2 Details

CCTV survey does not make any direct measurements of the condition of pipes, its output video provides a visual representation of the internal pipeline condition. The accuracy of the detailed data is influenced by the quality of the video and the operators' expertise. The quality of the videos, subjective judgments and manual errors may affect the accuracy of the survey. The codes recorded by the operator shall be randomly selected and audited by a different team to assure the confidence level reaches 90%.

For comprehensive calculation method of the confidence level of "Details", please refer to section A8 of this particular specification.

A6.1.1.3 Dimensions

The dimensions of the pipe includes the measurable extent of the following fields in Form C:

(19) Pipe size (diameters or height x width) (mm)

(24) Pipe length (m)

(25) Total length (m)

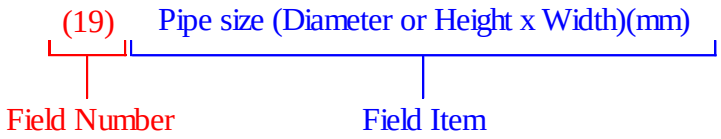
(26) Surveyed length (m)

(48) Chainage (m)

(51) Diameter/ Dimensions (height x width) of junctions/ connections (mm)

The above listed field items shall be measured within the tolerance of ±20mm or 10%. The confident level of these measurements shall be 90%.

* Note: the number in brackets are the field number in Form C, for example:



A6.1.1.4 Intrusion

The dimensions or diameter of the intruding pipe/ drain line and the intruded length shall be within the tolerance of 20mm or 10% of the diameter. The utility specialists could estimate the length intruded by calculating the percentage of intruded pipe against the diameter of mother pipe.

A6.1.1.5 Clock

The position of defects/ observations is recorded in terms of the relative direction of the clock position. The clock reference shall be given clockwise; where 12 o'clock describing the crown of the pipe. The description of the position shall falls within the tolerance of one-hour marking.

A6.1.1.6 Camera Speed

The speed of the CCTV camera in the drain shall be limited to:

(1) 0.1m/s for drains of diameter less than or equal to 200mm;

(2) 0.15m/s for diameters exceeding 200mm but less than or equal to 300mm and;

(3) 0.2m/s for drain greater than 300mm, or such other speed as agreed by the client to enable all details to be extracted from the video

The CCTV shall travel in forward direction as smooth as practicable. There is no restrictions on minimum speed of the CCTV camera. Where the Client consider the operator's ability is insufficient to identify defects and observations due to speeding, he may require a re-survey at the Utility Specialists' own expense.

The camera shall be stopped for a few seconds 5-10 seconds when a defect or observation is identified by the operator. To ensure that an accurate, clear and sharp record is taken whenever defects are being noted on the coding sheet, the operator shall pan, tilt and zoom the camera to focus on the defects/ features being observed.

A6.1.1.7 Height/ Camera Position

Wherever prevailing conditions allow, the camera shall be positioned to reduce the risk of picture distortion. In the case of circular or regular shaped Prescribed Sections, the camera lens shall be positioned centrally within the Prescribed Sections. In all instances the camera lens shall be positioned looking along the axis of the pipeline. A positioning tolerance of ±10% of the vertical pipeline dimension shall be allowed. In addition, the camera shall be positioned so that the long side of the photograph is horizontal.

When a photograph or a video screenshot is taken to illustrate a specific defect during CCTV survey it may be necessary to relax the requirements specified in *A6.1* of this Particular Specification. Where a photograph print is taken to illustrate a specific defect it shall occupy the central part of the photograph print and be clearly in focus and accurately reflect the defect. If necessary a second photograph print shall be taken at the location to put the defect depicted in the specific photograph prints into perspective in the overall context of the drain.

During CCTV survey, the Utility Specialist shall take a photograph to illustrate degree of mortar loss, size of a crack/fracture, size of a void or any other quantifiable defect a suitable metric scale shall be included in the photograph, clearly visible and in focus within the photograph.

A6.1.2 Requirements for level II surveys

All requirements of the level I surveys shall be fulfilled in level II survey; in addition with the following requirements:

A6.1.2.1 X, Y & Z Coordinates

The X and Y coordinates provides information of the horizontal locations of the start and finish manholes/ access points of the CCTV survey. The control shall be calculated on the local grid system (Hong Kong 1980 Grid System) based on HK80 Datum and Transverse Mercator projection. The maximum error of X and Y coordinates shall not exceed ± 20mm. The confidence level of the topographic survey shall be 95%.

The Z coordinate are the vertical coordinate of a node; it refers to the relative level/ elevation of the node. In CCTV & ME surveys, the cover levels (C.L.) of the start and finish manholes/ access points and invert levels (I.L.) of surveyed pipes shall be surveyed and recorded. The C.L. and I.L. shall be

surveyed related to the Hong Kong Principal Datum (HKPD) with a tolerance of 20mm with a confidence level of 95%. The results shall be recorded in metres above HKPD.

A6.1.2.2 Depths

The depth measurements of the pipe shall be physically measured on site with reference to the lowest point of the manhole corners/ edges (i.e. from cover level to the invert level of the pipe/sewer being surveyed) in metres. The measurements shall fall within the tolerance of ± 0.02 m with a confidence level of 90%.

A6.1.2.3 Manhole Connectivity

Manhole/ access points (nodes) are connected by drains/ sewers (edges/ links) in a designated flow direction in drainage/ sewerage networks. The accuracy of the manhole connectivity of the CCTV& ME survey refers to the correct and complete indications of the relationship between the nodes (manholes/ access points), and links (sewers/ drains) with the flow directions in the right layers. The confidence level of the manhole connectivity in CCTV & ME survey shall reach a percentage of 90%.

A6.2 Data Display during Video Playback

At the start of each drain length being surveyed, the length of drain from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of the drain length.

The meter reading entered onto the data display at the cable calibration point must allow for the distance from the start of the survey to the cable calibration point such that the chainage at the start of the survey is zero.

In the case of surveying through a manhole where a new header sheet is required, the chainage shall be set at zero with the CCTV camera focused on the outgoing drain entrance.

The Crew Leader (the qualified person with training equivalent to O/M/FHKIUS (CCE (CCTV & ME)) shall ensure that the distance counter starts to register immediately when the camera moves.

At the start of each manhole length a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alpha numeric form containing the following minimum information:

The following items shall be included in the data display:

(1) Project number and Site number (if any)

(2) Client Reference

(3) Location (Building/ Road name)

(4) Feature reference numbers (From node and To node or the reference number of the asset).

(5) Pipeline dimensions (H. x W. in mm) & material

(6) Pipeline classification (Storm Drain or Foul Sewer).

(7) Direction of survey (D/S or U/S).

(8) Company & Name of qualified operator or HKIUS member~~ship~~

(9) Date of survey (YYYY-MM-DD).

(10) Time of start of survey (HH:MM:SS).

The size and position of the data display shall not interfere with the main subject of the picture. The colour of the text shall be optimally visible and distinguishable from the background.

Once the survey of the manhole length is under way, the following minimum information shall be continually displayed:

(1) Automatic update of the CCTV camera's chainage in the drain line from "adjusted zero".

(2) Pipeline dimensions & material.

(3) Manhole/Prescribed Section length reference numbers.

(4) Direction of survey.

(5) Pipeline classification (Storm Drain or Foul Sewer).

(6) Company & Name of qualified operator or HKIUS membership

The Utility Specialist shall demonstrate the correct adjustment of the recording apparatus and monitor by use of the test tape or other device approved by the client's representative. The Utility Specialist shall then demonstrate satisfactory performance of the camera by the recording of the appropriate test device at the commencement of each day for a minimum period of 15 seconds.

All video recording media data storage devices (e.g. memory cards) shall be supplied by the Utility Specialists/Contractors and shall be best quality high grade (HG) new and unused prior to recording and shall be of DVD/CDR/MP4/AVI or other formats as agreed with client. Provision of facilities to photograph the drain.

When recording the conditions of the drain, the storage device with the format as specified above shall have an adequate storage for a running time depending on the length and quality required for the videos (a minimum of 32 GB is recommended).

Before report submission, CCTV survey video records shall also be converted to CD-ROM or DVD-ROM in other read-only digital formats as stated in section *A6.4.1* of this particular specification.

A6.3 Submission of Survey Data and Results

A6.3.1 General Requirements

To fulfil the general requirements for CCTV inspection, the followings should be provided:

(1) A continuous video of the entire inspection from the beginning to the conclusion or until the inspection is terminated.

(2) Still images at locations of defects

(3) A record of all the defects and features required to be reported as detailed in this particular specification.

(4) Separate video clips showing features of particular interest.

A6.3.2 Summary of survey results

For each survey extent, the Utility Specialist shall submit, upon the completion of all required surveys of the drains, a summary of manhole references, drain lengths surveyed, diameter/section details, summary ranking scores for cross referencing the manhole survey results to demonstrate that no drains are missing from survey.

The Utility Specialist shall provide the Summary of Pipelines which sum up the peak, mean and total scores and their corresponding grades of the specified pipe section. The grading calculation shall be separated for Service Condition Grade (SCG), Internal Condition Grade (ICG) and Structural Performance Grade (SPG).

The Summary of Defects shall also be provided by the Utility Specialist, which summarize the number of defects, classify the type of defects and provide a general overview of the conduit condition.

These summary shall be auto-generated as Summary of Pipelines (Form A) and Summary of Defects (Form B) by using a computer programme such as the CCTV module under Drainage Condition Assessment System (DCAMS).

For grading threshold for SCG, ICG, SPG and the full list of codes for conduit condition evaluation, please refer to CCEC 5th Edition published by UTI or any updated versions.

A6.3.3 Presentation of Drawings

The Location Plan shall indicate the following information:

(1) Location of the specified survey pipe section and the actual surveyed section

(2) Direction of survey (U/S or D/S)

(3) Location of the manhole/ access point with the manhole reference number/ feature number

(4) Cell number (if necessary)

(5) Survey section reference (if necessary)

Unless specified by the Engineer, the Location Plan shall be plotted in 1:100 scale fitted in A1 drawings or 1:200 scale fitted in A3 drawings on the specified grid and datum approved by the Engineer. The layout shall be either landscape or portrait, considering the area of interest and the requirements form the client. A minimum of 5mm of margins shall be left along the four edges. The title block shall include but not limited to the followings:

(1) The project name and project reference number

(2) The site location and the site reference number/ works order

(3) The drawing title, version and drawing number

(4) Name of client, consultant and contractor (if applicable)

(5) The sheet Designation of the basemap

(6) Legend

(7) The names of the Utility Specialists who prepare and approve the plan

(8) Paper size and corresponding scale

(9) Date of survey and date of the drawing is drawn

(10) Remarks

(11) Number of sheets

A6.4 Requirements of data files, data format and

A6.4.1 Video file format

CCTV survey videos shall be capable of a minimum resolution of 1 Megapixel. Before the report submission, the Utility Specialist shall prepare the CCTV survey's video record in one of the following digital formats: MPEG VIDEO (.mpg), AVI VIDEO (.avi), QUICK TIME FILE (.mov) or other formats agreed by the client.

The video shall be stored as read-only files in:

(1) A CD-Rom encoded to the MPEG 1 format;

(2) A DVD-Rom encoded to MPEG 2 format or AVI format;

(3) Other media and/ or other format specified by asset owners,

Which permanently stores data files, cannot be changed, written over or erased.

A6.4.2 Photographs/ video screenshot file format

High quality colour video screenshot or photographs of a size not smaller than standard 3R (89mm x 127mm) in dimension in the digital format of BMP or JPEG, or others formats specified by asset owner.

A6.5 Report

A6.5.1 Survey Report

The Utility Survey Specialist shall examine, analyse, process and interpret the investigation results and incorporate findings in a report. The report shall include the following essential information:

(1) Introduction
   a. Project name and Location
   b. Site appreciation

(2) Details of Investigation
   a. Date of Investigation
   b. Detailed description of the investigation procedure adopted
   c. All equipment used for the investigation
   d. Identification of supervisor and equipment operators carrying out the investigation

(3) Work Procedures

(4) Investigation results
   a. Summary of results (certified by O/MHKIUS)
   b. Report on examination, analysis and interpretation of the investigation results;

c. Identification of utilities, chambers (including all manholes) and sub-surface anomalies (if possible by GPR survey);

d. Records of on-site verification of data handled by the qualified person (M/FHKIUS) responsible for the Report;

e. Report on difficulties encountered

f. Recommendations to the defects of grade 3 or above made by M/FHKIUS

g. References (if any)

(5) Appendices

a. Drawings of the location plan of the specified survey section

b. Manhole Record Cards, MHICS Assessment Coding Forms (Level 1 or 2) and MHICS Photograph sheets for all manholes used as access points of the CCTV or Man-Entry Survey

c. Condition Survey Report of CCTV by IDMS, including:

Form A – Summary of Pipelines

Form B – Summary of Defects

Form C – Survey Report

Form D – Survey Photograph

d. Survey Progress Photographs

e. Site Coding Records (CCTV Daily Record Form, CCTV/Man-Entry Survey Site Coding Form, Manhole Record Form (mandatory for level 1 & 2 surveys), MHICS Assessment Coding Sheets (mandatory for level 2 survey)

1. Electronic copy of the data files
2. CCTV Survey Video files
3. Brief edited video clips of features (non-mandatory)
4. Location video of the access point (non-mandatory)
5. Brief videos taken by Manhole Camera (non-mandatory)

If the survey have incorporated other technologies used in conjunction with CCTV inspection, such as laser profiling, sonar, LIDAR, infrared technologies and in-line ground penetrating radar etc., the Utility Specialists shall also include the report of the corresponding technology used.

The Utility Specialist shall take reference to the coding (where appropriate) as laid down in the WAA/WRc "Manual of Sewer Condition Classification" Fifth Edition, published 2013 or the UTI's CCEC 2019, "Conduit Condition Evaluation Codes" 5th Edition or its latest version.

The Utility Specialist shall supply the necessary number of copies and types of report for each item as confirmed with the client.

The client may require different sections of the survey to be carried out using different survey methods in which case different survey reports will be required. If the client requires separate survey reports for any section of the survey or requires some or all of the section to be grouped together in a single survey report, this shall be noted in writing prior to the commencement of that part of the work and pay separately.

The client may request that some of the items of the survey report listed in reporting section of the Specification shall be supplied to the client as the survey proceeds. But notwithstanding this, the

Utility Specialist shall comply with reasonable requests from the client to supply the information on some of the items listed in the preamble whilst the survey is in progress.

All CCTV Survey results, drawings and textual reports shall be checked, certified and signed by a professional member of HKIUS (M/FHKIUS) before submission. The professional member shall record the level of accepted quantities which shall not be less than 90% of the total quantities for future reference.

The drawings and textual report will be certified and stamped by the approved qualified person who are responsible for the preparation of the report.

The Utility Specialists shall supply the Survey Report as described fully as in the above. This report shall include all results with a detailed discussion and accompanying plans. It shall be prepared and signed by a qualified person who shall hold one of the following qualifications:

(1) MHKIUS (CCE(CCTV & ME)) with two years local post qualification experience or RPUS if required; or

(2) MICE, or MHKIE or MHKIS with 84-hour-professional level training and 2 years of post-qualification relevant experiences

Comprehensive requirements of personal is included in section A2 of this Particular Specification

A6.5.2 Operator's report

Operator should provide a report on the location (chainage) and characteristics of reportable features including defects and features mentioned in the Code of Practice for Conduit Condition Evaluation Using CCTV in Hong Kong or any other equivalent code or manual.

The report shall include all the mandatory details together with such other informative details as specified by the asset owner.

The operator's report shall be written, printed or in the form of digital format.

A6.5.3 Videos

Where specified by the asset owner the report shall include edited video clips of general condition and significant features. The editing shall be arranged to provide a period of at least 2 seconds "familiarization time" in which the field of view moves from the general sewer/ drain environment and pans, scans or zooms onto the feature of interest.

Upon the request of the client, the location video of the access point shall be included, usually as an evidence of site characteristics or constraints.

Brief videos taken by Manhole Camera could be included upon request as preliminary survey and as a supporting data for MHICS.

A6.5.4 Photographs and CCTV video screenshot

All photographs and video screenshot shall be attached in Form D Conduit Condition Evaluation (CCTV) Survey Photograph. High quality colour video screenshot, are required for the CCTV survey. The minimum size of the video screenshot shall be 3R. All photographs or prints relating to one manhole length shall be kept together and in ascending order by chainage, lowest chainage at the front, highest chainage at the back.

A7 Deliverables and Schedule

The Utility Specialist shall supply for the Site preliminary digital data and paper check plots including a draft technical report with control results within one (1) week after the programmed completion of the works for the Site. The client's representative may direct the Contractor to submit preliminary reports of the Site during the execution of investigation, the utility specialist shall submit the reports within 1 week after the client's representative has given such written instruction at no additional costs.

The client's representative shall return a copy of preliminary data with comments and correction progressively within one week of receipt of preliminary data. The Contractor shall incorporate the Engineer's comments on the preliminary data within the preparation of his Final Survey report.

The Utility Specialist shall submit a Final Report for the investigation within 4 weeks after the completion date of the Works.

A7.1 Preliminary Stage

The following deliverables shall be submitted to the client during the preliminary stage

(1) One set of preliminary digital data checked by M/FHKIUS (CCE(CCTV & ME))

(2) One set of paper drawings in 1:100 scale fitted in A1 drawings or 1:200 scale fitted in A3 drawings

(3) Control results, including simple description of permanent ground markers.

(4) One Copy of brief technical report checked by MHKIUS (CCE (CCTV & ME)) or RPUS (Recognized Professional Utility Specialist) (CCE (CCTV & ME)) if necessary.

(5) One set of photographs.

A7.2 Interim Stage (where necessary)

(1) One set of interim digital data.

(2) One set of paper drawings in 1:100 scale fitted in A1 drawings or 1:200 scale fitted in A3 drawings

(3) One copy of interim technical report drafted by MHKIUS and ~~checked by RPUS~~ checked by MHKIUS (CCE (CCTV & ME)) or RPUS (Recognized Professional Utility Specialist) (CCE (CCTV & ME)) if necessary.

The client may at his discretion issue a written instruction to the Utility Specialist to provide a sample of the photographs and/or video screenshot and/or CCTV videos taken/recorded during the Contract period. The client shall give a written instruction and the Utility Specialist shall provide the information within 5 working days of receiving the written instruction.

The sample photographs video screenshots and CCTV videos supplied by Utility Specialist shall be held by the client for the duration of the Contract and shall be used as a control against which the Utility Specialist's performance shall be measured. If, in the opinion of the client and agreed by the Utility Specialist, any photographs, video screenshot and CCTV videos provided under the Contract fall significantly below the standard of the samples of the Technical Submission, the work in question shall be re-executed. The Technical Submission submitted by the Utility Specialist shall form the base of standard for acceptance.

A7.3 Final Stage

(1) 2 copies of Final Report which is a compilation of all deliverables required under interim stage to incorporate all comments provided by the Engineer.

(2) All reports shall be prepared by O/M/FHKIUS (CCE(CCTV & ME)) on site, checked by O/M/FHKIUS (CCE(CCTV & ME)) in office and if requested be endorsed by RPUS (Recognized Professional Utility Specialist) before submission.

A8 Quality Control and Quality assurance

A8.1 Quality Control of Sewers/ drains inspection

The accuracy of the coding system is highly reliant on the skills of the Utility Specialist (O/M/FHKIUS) who carries out the inspection and produces the report. A quality control system to continuously monitor the standard of coding is therefore required.

The Quality Control Procedures and the level of accuracy required should be agreed with the client prior to the commencement of any contract.

The quality control system should measure the accuracy and completeness of reporting and in particular:

(1) The number of defects and features not recorded (omissions)

(2) The correctness of the coding and classification of each defect or feature recorded in terms of :

- (A) Location of defects and observations (Chainage)
- (B) Position of defect (from...to or at... o'clock)
- (C) Percentage value (to the nearest 5% increment)
- (D) Dimensions and depth values

Reports may fail due to inaccuracies in either the Header or Observation Sections.

A8.2 Methodology

The following is a suggested format for self-assessment of the survey results and a measure for the ongoing professional development of the Utility Specialist. It should also be recognized that there is an element of subjectivity, which needs to be allowed for when reviewing the results. (Industry mean would be 5 %.)

(1) At the end of each week (or day if more appropriate), each surveyed length will be numbered sequentially in the order in which it was conducted and the total noted for each Utility Specialist.

(2) The sample surveys for quality control for each Utility Specialist are then to be selected by the use of computer generated random numbers or other such equivalent method.

(3) The number of lengths selected shall be 5% or minimum one number of the total lengths surveyed (max. 100 as a batch) for desk top check and 1% or minimum one number of the total lengths surveyed (max. 100 as a batch) for on-site checking by an independent team of the same qualifications (O/M/FHKIUS).

(4) A copy of the relevant section of the video recording relating to the selected lengths should be retained by the contractor for future reference.

(5) Information on the length selected and its contents are entered on a survey selection log.

(6) All header information should be checked to ensure that entries are correctly entered.

(7) All codes or numbers should be checked to ensure that entries are correctly used.

(8) All the compulsory fields completed.

The percentage of accurate entries should be determined and any that fall below the agreed threshold value should be rejected.

In checking the data section, each error or omission should be treated on an equal basis whether or not it is a minor or major error or omission. During the checking, each error or omission should be highlighted on the report from which the following totals are calculated for each report:

(1) The number of actual entries that should have been made.

(2) The number of actual errors and omissions made.

These totals should be entered on the right of the survey report being checked and the individual column totals should be entered on the survey log.

The accuracy of each survey is determined from:

$$\text{Accuracy} = \frac{(\text{The actual number of entries} - \text{The number of actual error and omissions})}{\text{The actual number of entries}} \times 100\%$$

The result should be entered on the survey detail rating form.

It should be noted that all percentage points created by the control procedure should be rounded down to the nearest whole number.

A8.3 Quality Control for operator

Each Utility Specialist shall maintain a record of his survey results and accuracy rating to be inspected by the client in accordance with the quality requirements as contained in the WRc Sewerage Rehabilitation Manual or the UTI's CCEC2019 "Conduit Condition Evaluation Codes" 5th Edition, 2019 or its latest version.

The ongoing accuracy of the specialist (the confidence level) should be calculated by taking the mean of each 5 percentage results (each 5 representing one control unit).

Both the individual survey percentages and the mean results should be entered on to the Specialist's Accuracy Graph. This graph should have 2 boundaries:

(1) Specified mean – The level of accuracy expected

(2) Specified tolerance – The level to which the accuracy can fall before specified action is taken

Any Specialist whose particular report is scored below the tolerance, the report has to be reviewed and re-submitted until achieving the HKIUS requirement.

For the separate survey level which means the particular specialist's accuracy for his each survey or inspection. It should be recorded and submitted by particular specialist's supervisor who shall be RPUS or O/M/FHKIUS.

The on-going accuracy of a particular utility specialist's for each year (confidence level) is an accumulated mean of the specialist's accuracy calculated every 5 percentage results (each 5

representing one control unit). It represents how much confidence the utility specialist can provide to client.

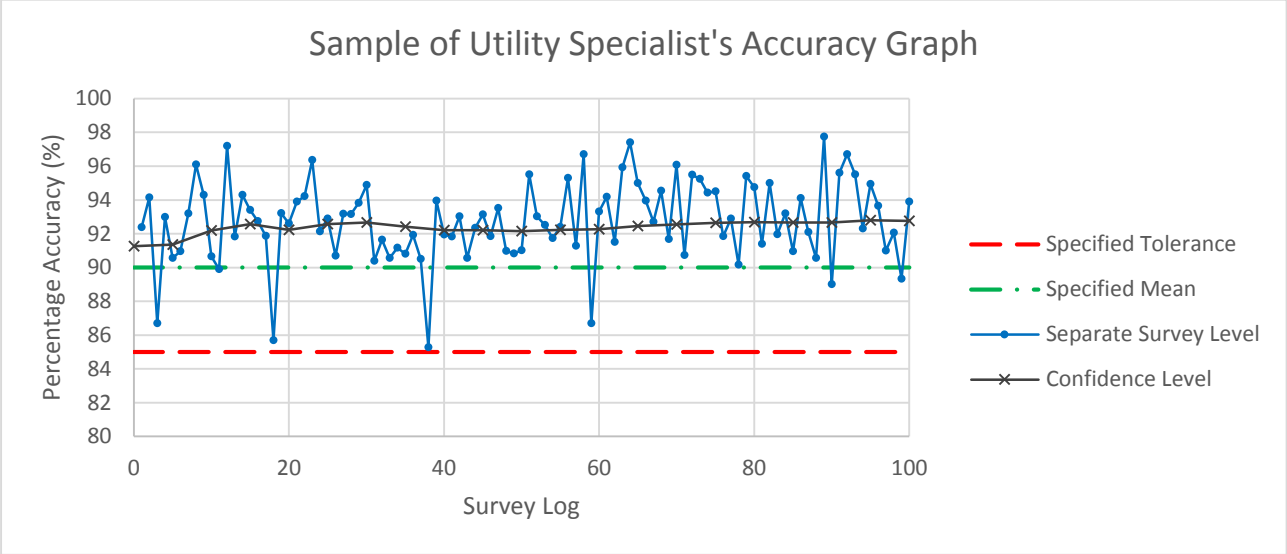


Figure 1 Sample of the utility specialist's accuracy graph

A8.4 Interpretation of Results

Should a report of any survey length fail to achieve the specified standard, it shall be recoded and the report of that length resubmitted.

In addition the coding of the five lengths completed immediately before and after the failed length should also be subjected to rechecking as part of an additional quality control check.

If there are any failed reports in this additional check, these should be recoded and resubmitted. Should any failure occur in the increased sample the selection should be increased by a further five lengths before and after, as above, until the required accuracy is achieved.

A8.5 Computerized Program of Drainage Condition Assessment and Management

The Utility Specialists shall use a computerized Program to systemise the conduit condition codes, scores and grades of conduits and control the quality of survey data. The program shall include 3 levels of quality control and data validation targeting at different users:

In Data Processing Platform, video or photos are inputted with corresponding coding by O/M HKIUS. Computerized coding can reduce human errors on data record and input. Comprehensive grading and scoring system which is compatible to Sewerage Risk Management (SRM), Manual of Sewer Condition Classification (MSCC) published by WRC and Conduit Condition Evaluation Codes (CCEC) published by UTI. The related scores and grades are calculated automatically to avoid manual errors. Inspection reports, Defect Grade Description Report and Structural Condition Survey Report are generated and handed to the Engineer for accuracy checking.

The Engineers exanimate the data handed by operators in the Examiner Platform. The operation performances are checked and a corresponding Tracking Report is generated which compatible to the requirement is specified in section A8.3 of this Particular Specification.

The Senior Engineering Manager validate the data in the Management Platform and prepare the Repair Analysis Report to provide professional advices to clients on rehabilitations, maintenance and management of the assets. The user can check the results of different conduit condition evaluation of the same conduit, e.g. manage the condition of the same conduit over years or before and after the repair or rehabilitation.

Table 4 Platforms of the computerized program for Drainage Condition Assessment and Management

Level	Platform	Targeted users
1	Data Entry	- Contractors – Crews
2	Examiner	- Engineers - Contractor's Checker
3	Management	- Senior Engineering Manager - Asset Owner

A8.6 Non-compliance: CCTV and Man-Entry Survey result

The CCTV and Man-Entry survey result for a site shall be considered as not complying with the specified requirements if:

(1) The number of defects and features not recorded (omissions);

(2) The correctness of the coding and classification of each defect and feature recorded in terms of:

(A) Location of defect (Chainage);

(B) Position of defect (from...to or at... o'clock);

(C) Percentage value (to the nearest 5% increment); and

(D) Dimensions, depth values, positions or levels;

(3) Any defects and observations reported in the preliminary stage deliverables does not comply with the requirements of Manhole Internal Condition Evaluation Codes,1st Edition, UTI, 2019 or its latest version.

If the utility investigation result for a particular site does not comply with the specified requirements, the Contractor shall re-execute utility investigation in the area within a week from receiving notification by the Engineer. The Utility Specialist shall submit the investigation result as deliverables defined in Section A6 & A7 in this particular specification within 2 weeks from receiving notification.

If the utility investigation result again fails to comply with the specified requirements, the Utility Survey Specialist shall repeat the work specified until the result complies with the specified

requirements. The costs for re-execution of utility investigation shall be borne by the Utility Specialist.

A9 References

(1) Civil Engineering and Development Department. (2006). *General Specification for Civil Engineering Works* (Volume. 1). Hong Kong: The Government of the Hong Kong Special Administrative Region.

(2) Drainage Service Department. (2018). *Safety Manual.* Hong Kong: The Government of the Hong Kong Special Administrative Region.

(3) Environment, Transport and Works Bureau. (2006). *Code of Practice on Monitoring and Maintenance of Water-Carrying Services Affecting Slopes*. Hong Kong: The Government of the Hong Kong Special Administrative Region.

(4) Factories and Industrial Undertakings (Confined Spaces) Regulation, Cap. 59AE s7, Laws of Hong Kong (1999).

(5) Labour Department. (2000). Code of Practice: Safety and Health at Work in Confined Spaces. Hong Kong: The Government of the Hong Kong Special Administrative Region.

(6) Lambert, J., Orman, N.R., Cant, J., Trew,J., Moy,F., Drinkwater, A. (2005). Sewer Jetting Code of Practice (Second Edition). Swindon: Water Research Centre

(7) Land Drainage Ordinance, Cap 445, Laws of Hong Kong (1994)

(8) Laven, K., Jones, C., Larsen M. and Payton, R. (2008, July). *Inline CCTV Inspections of In-Service Pressurized Water Mains.* Paper presented at International Pipelines Conference 2008: Pipeline Asset Management: Maximizing Performance of our Pipeline Infrastructure, Atlanta, Georgia, U.S.: ASCE.

(9) New Zealand Water and Wastes Association Inc. (2006). New Zealand Pipe Inspection Manual (3rd Edition). Wellington: New Zealand Water and Wastes Association Inc.

(10) Occupational Safety and Health Council Ordinance, Cap 398, Laws of Hong Kong (1988).

(11) Occupational Safety and Health Ordinance, Cap 509, Laws of Hong Kong (1997).

(12) Road Traffic Ordinance, Cap 374 s11, Laws of Hong Kong (1984)

(13) The Water Jetting Association. (2014). *Code of Practice for the Safe Working and Use of Water Jetting in Drains and Sewers*. Erith, Kent: The Water Jetting Association.

(14) Water Pollution Control Ordinance, Cap 358, Laws of Hong Kong (1981).

(15) Water Research Centre. (2001). *Sewerage Rehabilitation Manual (SRM)* (4th Edition, Volume I Rehabilitation Planning). Swindon: WRc plc.

(16) Water Research Centre. (2005). *Model Contract Document for Sewer Condition Inspection* (2nd Edition). Swindon: WRc plc.

(17) Water Research Centre. (2004). *Manual of Sewer Condition Classification (MSCC)* (4thEdition). Swindon: WRc plc.

(18) Water Services Association of Australia. (2001). *Sewer Inspection Reporting Code of Australia.* Melbourne: Water Services Association of Australia

(19) Wong, K. (Ed.) (2009), Hong Kong Conduit Condition Evaluation Codes (HKCCEC) The Code of Practice on Conduit Condition Evaluation using CCTV in Hong Kong (4th Edition). Hong Kong: UTI

(20) Wong, K. (Ed.). (2019). Conduit Condition Evaluation Codes (CCEC): The Code of Practice on Conduit Condition Evaluation using CCTV (5th edition). Hong Kong: Utility Training Institute.

(21) Wong, K. (Ed.). (2019). Manhole Internal Condition Evaluation Codes (MHCEC): The Code of Practice on Manhole Condition Evaluation (1st edition). Hong Kong: Utility Training Institute.

(22) Wong, K. (Ed.) (2011). Guide to Conduit Condition Evaluation (CCTV & ME). Hong Kong: UTI.

(23) Wong, K. (Ed.) (2011). Method Statement for Conduit Condition Evaluation (CCTV & ME). Hong Kong: UTI.

(24) Wong, K. (Ed.) (2011). Work Procedure for Conduit Condition Evaluation (CCTV & ME). Hong Kong: UTI.

APPENDICES

Appendix A – Abbreviations

Company/ Organization	
Code	Description
BD	Buildings Department, HKSARG
bsi	The British Standards Institution
CEDD	Civil Engineering and Development, HKSARG
DSD	Drainage Services Department, HKSARG
EMSD	Electrical and Mechanical Services Department, HKSARG
EPD	Environmental Protection Department, HKSARG
HD	Housing Department, HKSARG
HKHS	Hong Kong Housing Society
HKIUS	Hong Kong Institute of Utility Specialists, HKSARG
HKSAR	Hong Kong Special Administrative Region
HKURC	Hong Kong Utility Research Centre
HyD	Highways Department, HKSARG
IIUS	International Institute of Utility Specialists
LandsD	Lands Department, HKSARG
LD	Labour Department, HKSARG
PolyU	The Hong Kong Polytechnic University
TD	Transport Department
UTI	Utility Training Institute
WRc	Water Research Centre Limited
WSAA	Water Services Association of Australia
WSD	Water Supplies Department, HKSARG
WTI	Water Training Institute

Personal/ Qualification	
Code	Description
AMIIUS	Associate Member of International Institute of Utility Specialists
CP	Competent Person under Cap. 59AE
CW	Certified Worker under Cap. 59AE
DCP	Designated Competent Person
DCW	Designated Certified Worker
FHKIUS	Fellow Member of Hong Kong Institute of Utility Specialists
FIIUS	Fellow Member of International Institute of Utility Specialists
MHKIUS	Manager Member of Hong Kong Institute of Utility Specialists
PMIIUS	Professional Member of International Institute of Utility Specialists
OMHKIUS	Operative Member of Hong Kong Institute of Utility Specialists
RPUS	Recognized Professional Utility Specialist

Others	
Code	Description
%	Percentage
AVI	Audio Video Interleave (Video Format)
BIM	Building Information Model
BMP	Bitmap (Picture Format)
BWCS	Buried Water Carrying Service
CAD	Computer Aided Design
CCE(CCTV & ME)	Conduit Condition Evaluation (Closed Circuit Television & Man-Entry)
CCEC	Conduit Condition Evaluation Codes
CCES	Conduit Condition Evaluation Specialists
CCTV	Closed Circuit Television
CD	Compact Disc
CL	Cover Level
COP	Code of practice
CSV	Comma-separated values (file format)
DAT	Intersystems Cach é database file
D/S	Downstream
DCAMS	Drainage Condition Assessment Management System
DN	Nominal Diameter
DP	Design Pressure
DVD	Digital Versatile Disc
DXF	Drawing Exchange Format
DPI	Dots Per Inch
e.g.	Exempli Gratia
EPR	Environmental Protection Requirements

Others	
Code	Description
etc.	et cetera
FPS	Frames per second
GIS	Geographic Information System
GL	Ground Level
H	Height
HG	High Quality Grade
HGV	Heavy Goods Vehicle
HK1980 Grid	Hong Kong 1980 Grid
HK80	Hong Kong 1980 Geodetic Datum
HKPD	Hong Kong Principal Datum
HPWJ	High Pressure Water Jetting
hr	Hour
Hz	Hertz
ICG	Internal Condition Grade
ID	Internal Diameter
IDMS	Integrated Data Management System
IFC	Industry Foundation Class
IL	Invert Level
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group (Picture Format)
kHz	Kilo- Hertz
kPa	Kilopascal
m	Meter(s)
MDB	Access Database (File Format)
ME	Man-Entry

Others	
Code	Description
MHICS	Manhole Internal Condition Survey
MHCEC	Manhole Condition Evaluation Codes
mm	Millimetre(s)
Mpa	Megapascal
MOV	QuickTime File Format
MPEG	Motion Picture Experts Group (Video Format)
MS	Method Statement
MSCC	Manual of Sewer Condition Classification, UK
OBJ	Object file (file format)
OHSAS	Occupational Health and Safety Assessment Series
PDF	Portable Document Format (File Format)
PLY	Polygon File Format (File Format)
PPE	Personal Protective Equipment
pptx	PowerPoint Open XML Presentation (File Format)
ppm	Parts per million
PS	Particular Specification
Psi	Pound Per Square Inch
PTW	Permit to Work
QA/ QC	Quality Assurance/ Quality Control
Ref.	Reference
RMSE	Root Mean Square Error
ROV	Remotely Operated Vehicles
RTO	Recognized Training Organization
SCG	Service Condition Grades
SD	Secure Digital

Others	
Code	Description
SOPs	Safe Operator Procedures
SPF	Sun Protection Factor
SPG	Structural Performance Grade
SRM	Sewer Rehabilitation Manual
STP	System Test Pressure
TTA	Temporary Traffic Arrangement
U/S	Upstream
USB	Universal Serial Bus
US	Utility Specialist
W	Width
WLD	Water Leakage Detection
WO	Works Order
WP	Work Procedure
XLSX	Microsoft Excel Open XML Format Spreadsheet file (File format)

Appendix B – Requirements for Personnel Carrying Out Inspection

Training and Experience Requirements for Personnel Carrying Out Inspection (HKIUS standard, 2011)

Title	Role	Minimum Training Requirement	Minimum Years of Practical Experience	Qualification
Project Leader	Responsible for contract administration and preparation, checking and certifying of reports for compliance with the technical specification.	➢ At least 35 hours of CPD every year ➢ At least 14 hours for refreshment training in every three years ➢ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➢ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	10 years in contract administration, preferably in works related to the inspection, survey and in data management.	Either: M/FHKIUS, RPUS plus CP, CW or MHKIE/ R.P.E. plus CP, CW and relevant training in RTO (e.g. PolyU, UTI) for surveys and data management
Deputy Project Leader	Responsible for assisting project leader and acting the post of project leader when project leader temporary not with the team	➢ At least 35 hours of CPD every year ➢ At least 14 hours for refreshment training in every three years ➢ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➢ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	10 years in contract administration, preferably in works related to the inspection, survey and in data management.	Either: M/FHKIUS, RPUS plus CP, CW or MHKIE/ R.P.E. plus CP, CW and relevant training in RTO (e.g. PolyU, UTI) for surveys and data management
Team Leader	Responsible for works arrangement and data processing including checking of raw data for quality and consistency.	➢ At least 35 hours of CPD every year ➢ At least 14 hours for refreshment training in every three years ➢ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➢ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	5 years in works related to the inspection, survey and in data management.	M/FHKIUS, RPUS, CP, CW
Crew Leader	Responsible for supervising the field works and site safety.	➢ At least 35 hours of CPD every year ➢ At least 14 hours for refreshment training in every three years ➢ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➢ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	3 years in works related to the inspection, survey and in data collection	O/MHKIUS, CP, CW
Operators	Responsible for operating equipment and carrying out inspection and survey.	➢ At least 35 hours of CPD every year ➢ At least 14 hours for refreshment training in every three years ➢ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➢ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	2 years in works related to the inspection, survey and in data collection.	AMHKIUS, CP, CW

Note**: Designated Certified Workers (DCW) and Designated Competent Person (DCP) are required for DSD's confined space works inspection and risk assessment report preparation. For details on requirements of DCW and DCP, please refer to "*Safety Manual*" by DSD (2018).

Appendix C – Drain Cleaning

Appendix C – I Description

Drain cleaning will be carried out as instructed by client under a separate paid item. For various reasons, drain cleaning before CCTV survey is not a mandatory item.

When drain cleaning is instructed or required after the initial survey, the followings points are to be noted.

Appendix C – II Objective and extent of works

The supply of water for heavy drain cleaning plant is limited by the size of water meter that can be attached to a WSD hydrant upon WSD's prior approval. There will be no special dispensation on general contract for use of larger hydrants and therefore the Utility Specialist must plan his cleaning operations to take this into account and the time required by the Utility Specialist to apply for the approval of WSD for the use of such hydrants shall be noted by the client. A system of supplying sufficient water to enable the equipment to work efficiently and effectively together with a method of disposal of the arisings will have to be devised and used for by the Utility Specialist.

The objective of drain cleaning carried out under a general Contract is to expose the fabric of the drains by removing silt, grease and debris deposits so that an accurate assessment of its condition can be made by CCTV survey. Drains may not need cleaning before CCTV survey works. However, if instructed or as the Utility Specialist sees appropriate, drains shall be cleaned by high pressure water jetting or by other methods agreed by the client

The Utility Specialist shall clean the drains where required and the rates shall be agreed before commencement of works.

During drain cleaning, the flows in the drain shall be maintained.

On completion of the works the Utility Specialist shall ensure that all equipment is removed from the system and that the drains are free flowing.

Appendix C – III Working area for cleaning

The working area in which plant and machinery operates is to be kept to a minimum. Plant not in use is to be removed from the works as to minimise disruption to traffic and the general public.

The working area is to be free from debris when the Utility Specialist leaves the site at the end of each visit.

Open manholes, machinery and standing equipment are to be protected to ensure the safety and convenience of the public or others at all times.

Appendix C – IV Cleaning units

The Utility Specialist shall only use equipment previously approved by the client.

The Utility Specialist shall provide sufficient suitable cleaning units, of adequate capacity, in good condition, including standby units in the event of breakdown, in order to complete the works within the Contract period.

The cleaning unit(s) provided for cleaning purposes shall be capable of operating up to 200m from the point of access to the drain to be cleaned.

Appendix C – V Pressure Jetting Equipment

Each cleaning unit shall comply with safety requirements defined in the safe working procedures detailed in the Safety Plan approved by the client for the execution of the Works.

The Utility Specialist shall also take due regard of the structural condition of the drain to be cleaned so as to minimise any damage imparted to the fabric of the drain during cleaning operations in accordance with the following criteria:

(1) Preferred working from downstream manhole

(2) Maximum holding/stationary time of nozzle at 60 seconds

(3) Applicable minimum flow rate corresponding to the drain diameters are shown as *Table 5* below:

Table 5 Minimum Flow Rate against Recommended Sizing of Drains

Minimum Flow Rate		Maximum Recommended Drain Diameter (mm)
(L/s)	(L/min)	
0.4	24	225
1.5	90	450
3.0	180	900
4.5	270	1800
5.0	>300	>1800

For details on guide values of minimum flow required to remove deposits, please refer to WRC. (2005).Sewer Jetting Code of Practice 2nd Edition.

(4) For the same power output increase in flow rate can be more effective than increasing the pressure when removing debris from a drain.

(5) The Utility Specialist shall observe limit the maximum pump pressure that can be applied to existing drains with the following properties (See *Table 6*) based on known or estimated structural conditions of pipes:

Table 6 Internal Condition Grade and Drain Material against Maximum Pump Pressure of Jetting

~~Structural~~ Internal Condition Grade (ICG)*	Drain Material	Maximum Pump Pressure
1, 2	Pitch Fibre, brick, masonry	100bar (1500psi)
1, 2	Plastic (PE, PP & PVC)	180bar (2600psi)
1, 2	Asbestos cement, clay, concrete	340bar (5000psi)
3	Pitch Fibre, brick, masonry	100bar (1500psi)
3	Plastic CPE, PP & PVC, asbestos cement, clay, concrete	130bar (1900psi)
4, 5	All	80bar (1200psi)

*Internal Condition Grade is in accordance with the Sewerage Rehabilitation Manual WRc, 2001 or the UTI's CCEC, "Conduit Condition Evaluation Codes" 5th Edition, 2019 or its latest version.

The jetting unit must be capable of jetting a minimum distance of 100m either upstream or downstream from a manhole. Minimum nominal hose size being 25mm diameter.

Successive passes using the pressure jetting technique shall be used with the silt removed at manholes until such time that the drain is clean. No silt shall be allowed to pass beyond the section of drain being cleaned.

Pass rates (rewind speed) for the jetting head shall be at a consistent speed avoiding jerking and excessive variations. Typical pass rates being 100mm to 200mm/second. The hose reel shall be power driven in the rewind direction.

The client shall approve the jetting equipment proposed to be used by the Utility Specialist/Contractor which shall be categorised from *Table 7* below:

Table 7 Limits of Capacity and Pressure of typical Machine Type for Jetting

Category	Machine Type	Capacity (Litres/Minute) Min – Max	Pressure* (Bar) Min – Max
1	High pressure/low volume - trailers	41-155	210-700
2	High pressure/low volume - mini	41-155	210-700
3	High pressure/low volume - non-HGV/HGV jetter/combination	38-160	210-350
4	Low pressure/high volume - HGV	113-213	103-138
5	Low pressure/high volume - combination	110-318	120-210
6	Low pressure/high volume - super combination	340-770	138-180
7	Low pressure/high volume - separate jumbo jetter/suction units	340-700	137-170

*Note: maximum operating pressure for nozzles other than pencil type jets shall not exceed 340 bar

The Utility Specialist shall note the requirements as described in Section A4.5.2 of this particular specification and shall apply the appropriate category jetting equipment including selection of suitable nozzle during the cleaning operation.

The Utility Specialist shall note that the performance of cleaning of low pressure machines is severely reduced when the nozzle is submerged and the Utility Specialist shall reduce the flow in the drain so as to ensure maximum performance when such machines are in operation.

Where a jetting unit is fitted with airflow suction unit for removal of detritus from the drain, it shall be capable of removing materials such as sludge, silt and bricks from depths up to 10m with a minimum suction of $70m^3$/minute.- A tank with minimum capacity of $5m^3$ shall be provided by the Utility Specialist and be capable of decanting off collecting liquors back to the drain. The suction hose of such a system shall have a minimum internal diameter of 150mm.

Jetting equipment shall be calibrated prior to commencing work on site by an approved body such as the supplier/distributor and calibration certificates made available for inspection by the Engineer upon request.

Such equipment, in particular the nozzles and pressure relief valves, shall also be maintained on a regular basis in accordance with the manufacturer's specification. The Utility Specialist shall make available to the Engineer on a monthly basis, copies of his maintenance certificates and/or schedules.

An automatic pressure relief valve shall be incorporated on the pump discharge chamber to prevent the pressure exceeding the safe maximum for the whole system. This may take the form of:

(1) A pressure relief valve or bursting disc in holder; or

(2) An automatic pressure regulating valve (unloading valve).

The maximum working pressure is defined as the lowest value of the maximum working pressure ratings of all individual components of the system.

All systems shall also comply with the provisions laid down in UK document:

(1) "(2013). *The Water Jetting Association code of practice for the safe working and use of water jetting in drains and sewers*. Erith, Kent: Water Jetting Association. And subsequent revisions and amendments thereto.

(2) "(2005) Sewer jetting code of practice. 2nd edition" published by the Water Research Council. And subsequent revisions and amendments thereto.

All High Pressure Water Jetting equipment shall be operated by qualified and trained personnel such as members of HKIUS.

Appendix C – VI Winching equipment

Dredging of drains shall be undertaken by the Utility Specialist by passing various sized buckets through the drains to physically remove accumulated silt, sludge and other debris. Where conditions dictate, power boring equipment and/or winching equipment including cables, lines, props, tools must be available at all time as required by the Engineer.

The equipment shall be capable of operating efficiently in the sizes of drains stated and in drains up to distances of 200m between adjacent manholes.

Certain sections of drain will be flowing entirely full or in a surcharged condition and the Utility Specialist should be prepared at all times to use manually pushed rods, mechanical boring equipment or other methods to pass a leading line through the pipeline prior to commencing dredging operations with the winching equipment.

The Utility Specialist shall work in such a manner that excessive quantities of debris and silt are not allowed to pass downstream from any section of drain in which work is being carried out.

Any item of plant or equipment associated with the work which may cause obstruction to the flow in the drain must be removed from the drain at the close of work and meal breaks each day. The Utility Specialist shall be permitted to leave a line or winching cable through the drain during temporary breaks in the work.

Dredging operations in a particular section of drain will generally proceed in a downstream direction.

The maximum size of winch bucket used shall have a diameter of 90% of the pipeline up to a maximum of 600mm.

The Utility Specialist's attention is drawn to sizes of manhole covers and access restrictions. It should be noted that the maximum size of bucket may not be practical due to restricted access. The Utility Specialist shall ensure that his working procedure will not be unduly affected by such restrictions.

The winches used to draw buckets and scrapers shall be power driven. They shall incorporate a torque limiting device so as to prevent the breaking of winching lines in the event of the line becoming jammed by obstructions.

Where the operational equipment is towed by winch and bond through the drain, all winches shall be stable with either lockable or ratcheted drums. All bonds shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the equipment. All winches shall be inherently stable under loaded conditions.

Appendix C – VII Operational requirements

Each cleaning unit shall carry sufficient numbers of guides and rollers such that when cleaning all bends are supported away from drains and manhole structures.

Each cleaning unit shall carry a range of flow control equipment, as opposed to over pumping equipment, for use in controlling the flow during the execution of the works. A minimum of one item of each size of equipment ranging from 100mm to 900mm diameter inclusive shall be carried.

Equipment used to clean drains shall be operated in a way to prevent the operation of overflows. Where flows in the drains are such that the overflow will operate during cleaning operations, then the Utility Specialist shall make arrangements to prevent the premature overflow or stop operations until such flows are reduced to allow cleaning to continue.

The system of silt and debris removal shall be capable of operating in such a way as to minimise the obstruction to drain flows and the cleaning operations.

Appendix C – VIII Arisings

The Utility Specialist is to remove silt, grease, debris, detritus, etc to a condition good for the survey that is lodge in the lengths of drain required to be surveyed under the Contract or as directed by the client or his representative. Such material to be caught and collected in a trap located at the manhole or chamber from where the drain is being cleansed.

The arisings shall be deposited into suitable closed containers. The type and capacity of containers to be employed for the holding and transport of the arisings shall be supplied by the Utility Specialist.

The method of working shall be such that drain cleaning work is not held up through a lack of an empty container in which the arisings are deposited.

The Utility Specialist shall bear in mind that it may not always be possible for the container to be sited immediately adjacent to the manhole from which arisings are being raised and should allow for the fact that "double handling" of the arising may be necessary. The Utility Specialist shall provide for such "double handling" to be carried out safely and efficiently.

The Utility Specialist must make his own arrangements for the tipping of material removed from the drains.

Appendix D – Feature Reference Numbering System

All relevant assets (manholes, catchpits, gullies, etc.) shall be referenced as below by the Utility Specialists.

The Utility Specialists shall ensure that each new manhole has a unique reference and is not duplicated in the original datasets provided at the start of the project. The Utility Specialists shall also maintain consistent references for each asset (i.e. an asset shall not be given two different numbers). Where appropriate pipeline assets shall be referred to by the upstream node number plus an appropriate suffix starting from X, Y, Z, Z1 etc. For example, 361738001X and 361738001Y are the first 2 outgoing pipes from the upstream manhole GVMH361738001

Appendix D – I Manhole Number (Site)

The Manhole Number (Site) is designed for the ease of on-site numbering for operators, aiming to distinguish manholes surveyed within a site. This numbering system consists of 2 parts and 4 characters:

(1) The 1-charater alphabetical prefix indicating the function (F for foul and S for Storm)

(2) A 3-digit, 0 filled site reference number starting from 001 to 499 for foul manholes; 501 to 999 for storm manholes existing within the 100-meter grid.

The Manhole Number (Site) are arranged by the operators on site, according to the site conditions; usually assigned from upstream to downstream.

Appendix D – II Manhole Node Number

9-digit grid reference number with an accuracy of **±50m**:

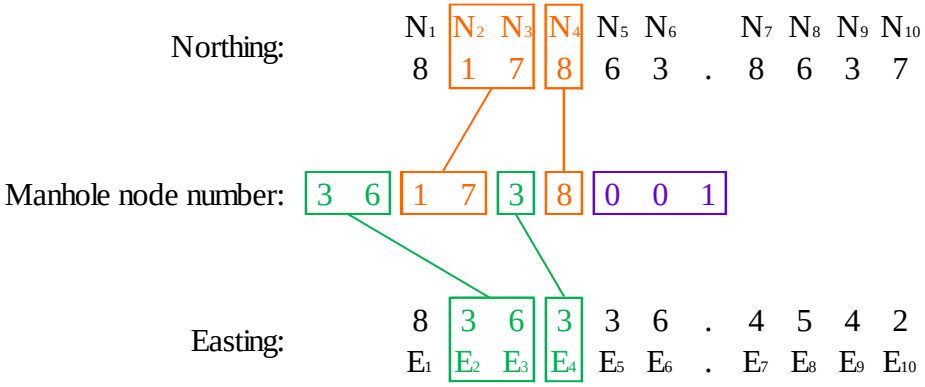
(1) A 4-digit reference number ($E_2E_3N_2N_3$) from coordinates of features in Hong Kong 1:1000 Topographic Map (HK 1980 Grid System);

(2) A 2-digit reference number from the 100-meter grid coordinate (E_4N_4);

(3) A 3-digit registration number in sequential order of the manhole recorded in IDMS starting from 001 – 499 for Foul and 501 – 999 for Storm within the 100-meter grid.

The registration number are arranged automatically by the DCAMS system, the logical sequence assign manholes by XY-coordinates (ascending order of x-value and y-value) automatically.

For example, the first Manhole Node Number of a foul manhole located at 836336.4542, 817863.8637 shall be 361738001.



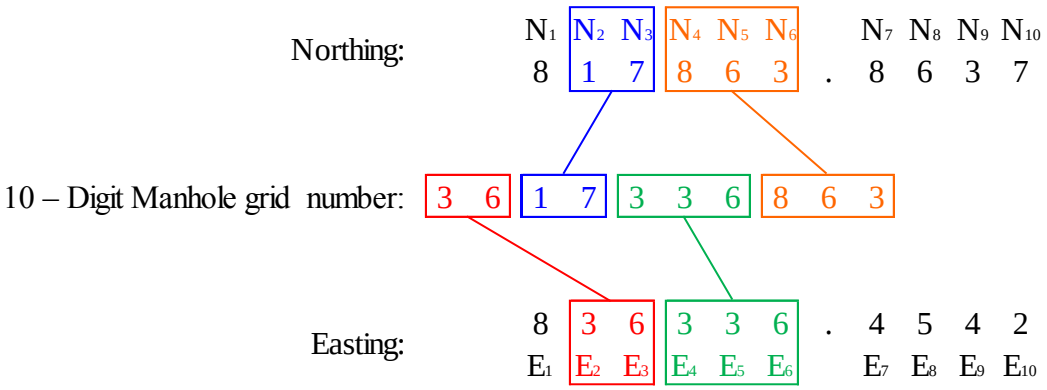
Appendix D – III Manhole Grid Number

10 – digit grid number with an accuracy of ±0.5m:

(1) A 4-digit reference number ($E_2E_3N_2N_3$) from coordinates of features in Hong Kong 1:1000 Topographic Map (HK 1980 Grid System);

(2) A 6-digit reference number from the 100-meter grid coordinate ($E_4E_5E_6N_4N_5N_6$);

For example, the Manhole Grid Number of a manhole located at 836336.4542, 817863.8637 shall be 3617336863.

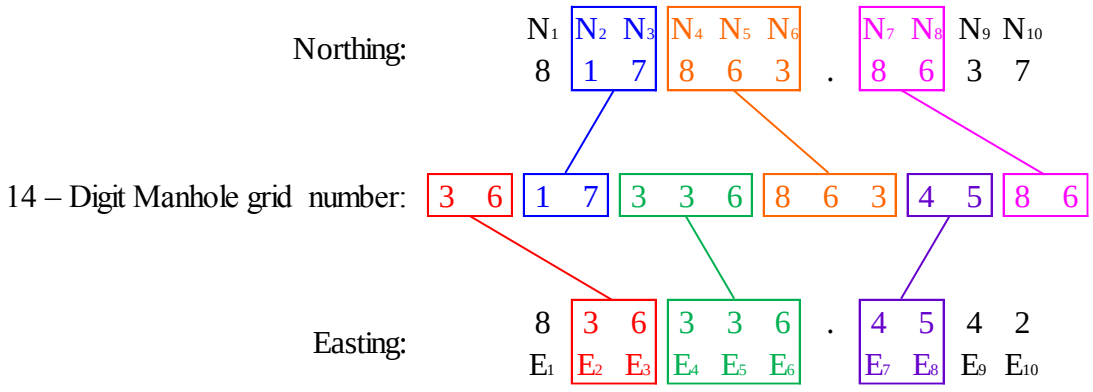


14 – digit grid number with an accuracy of ±0.005m:

(1) A 4-digit reference number ($E_2E_3N_2N_3$) from coordinates of features in Hong Kong 1:1000 Topographic Map (HK 1980 Grid System);

(2) A 10-digit reference number from the 100-meter grid coordinate (E4E5E6N4N5N6E7E8N7N8).

For example, the Manhole Grid Number of a manhole located at 836336.4542, 817863.8637 shall be 36173368634586

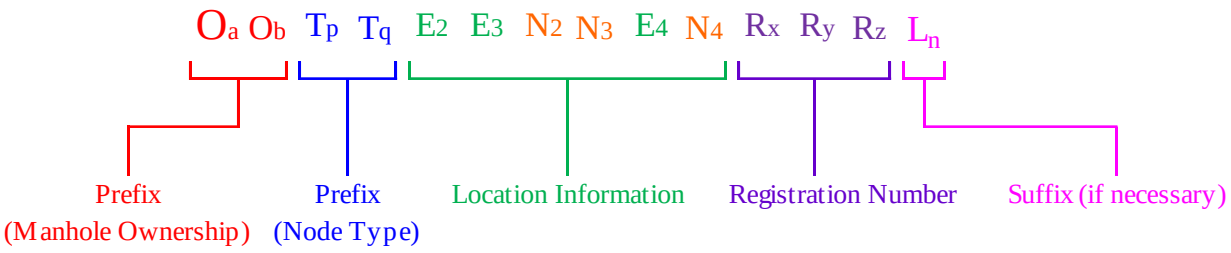


Appendix D – IV IDMS Manhole Reference Number

The IDMS Manhole Reference Number is a unique feature identifier consisting of 3 parts:

(1) A 4-alphabetical prefix indicating the ownership of the manhole and its node type;
(2) Manhole Node Number
(3) A 1- alphabetical suffix assigned ascendingly only if there are more than one manhole covers for the same manhole chamber.

General IDMS Manhole Reference Number:



Where,

Prefix indicating the ownership information of the manhole: OaOb

Prefix indicating the type of node: TpTq

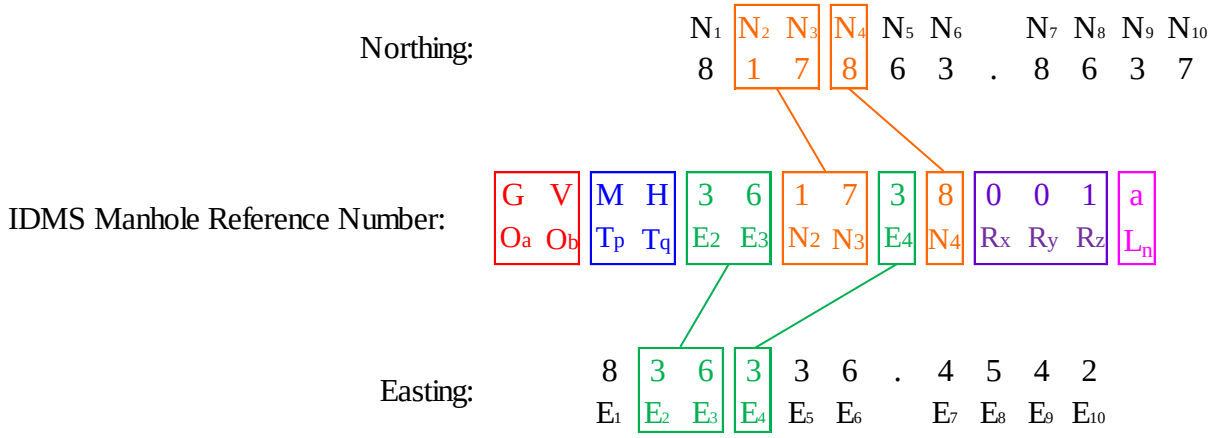
X-Coordinate of Manhole = $E_1E2E3E4E5E6$ .E7E8E9…En

Y-Coordinate of Manhole = N1N2N3N4N5N6 .N7N8N9…Nn

Sequential Manhole Registration Number: RxRyRz

Suffix for identification of manhole covers for the same manhole chamber L_n

For example, the IDMS Manhole Reference Number of a government owned foul manhole first redistricted at within the 100-meter grid; locating at 836336.4542, 817863.8637; shall be GVMH361738001. If that manhole has more than one cover on top of the same chamber, a suffix will be assigned to it starting from a,b,c… etc.



The registration number are arranged automatically by the DCAMS system. The numbering arrangement follows the ascending order of the x- coordinates within the 100-meter grid; if more

than one manholes are along the identical x-axis; the system will arrange the manholes with the same x-coordinates according to their y-coordinates ascendingly.

Figure 2 below shows an example of the numbering arrangements for IDMS Manhole Reference Number

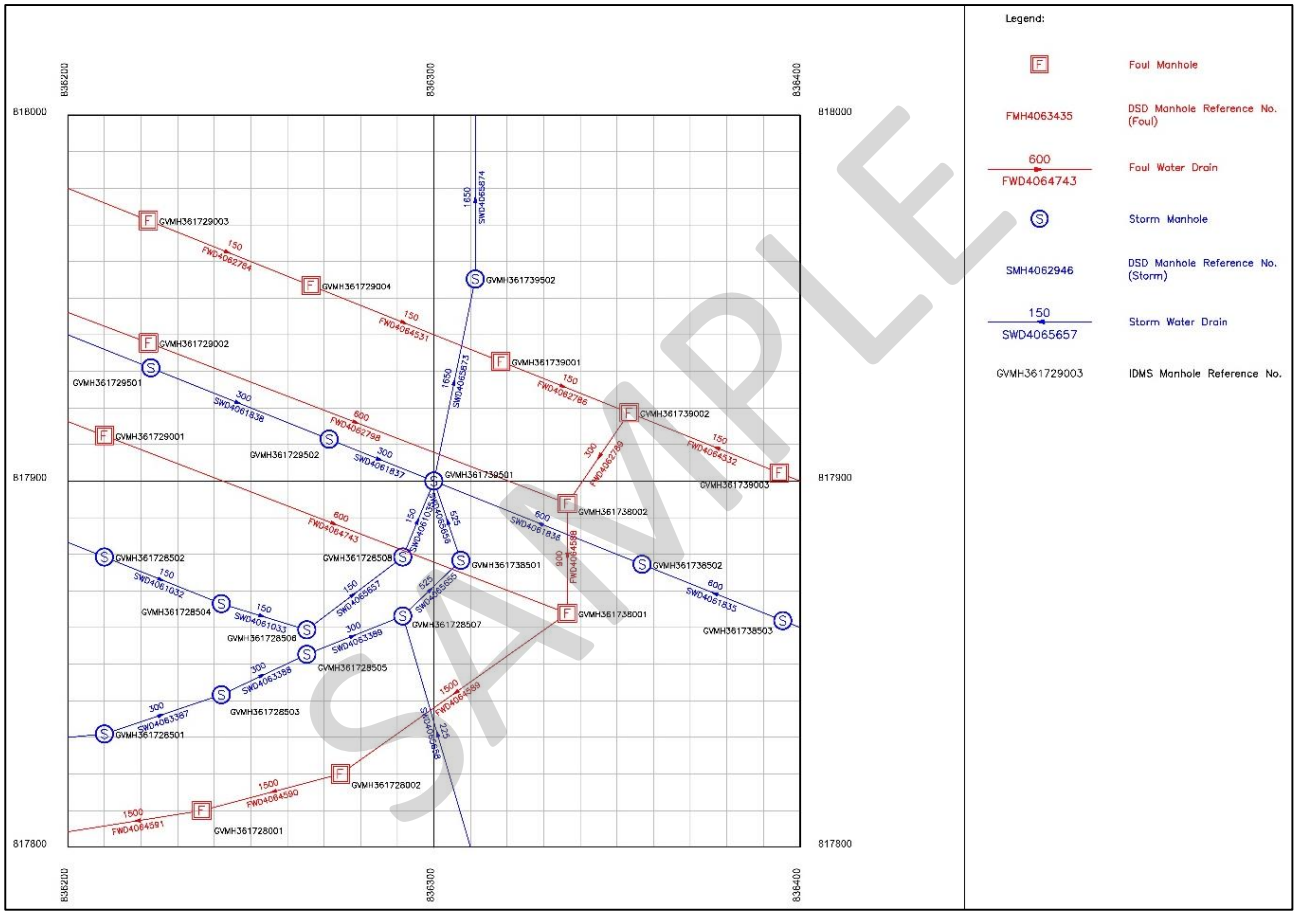


Figure 2 Sample Arrangement of Auto-generated IDMS Manhole Reference Number

Appendix D – V DSD Manhole Reference Number

The DSD Manhole Reference Number is referring to the feature reference number on Drainage Record Plan. It consists of 2 parts:

(1) A 3-alphabetical prefix indicating the type of feature

Table 8 List of feature reference number on Drainage Record Plan

Class	ID	Type of Feature	Prefix
Pipe	1	Storm drain	SWD
	2	Sewer	FWD
	3	Combined system drain	CWD
	4	Multiple pipes-storm drain	SMD
	5	Multiple pipes-sewer	FMD
	6	Gully pipe	SGD
	7	Inverted siphon-storm drain	SSD
	8	Inverted siphon- sewer	FSD
	9	Vacuum sewer	FVD
	N1	Vacuum Storm	SVD
	10	Sewage rising main	FRD
	N2	Storm rising main	SRD
	N3	Multiple Storm rising main	SPD
	N4	Multiple Sewer rising main	FPD
Manhole / Chamber	11	Storm water manhole	SMH
	12	Sewage manhole	FMH
	N4	Sewer Manhole-Unspecified	FUH
	N5	Storm Manhole-Unspecified	SUH
	13	Combined system manhole	CMH
	14	Terminal manhole-storm drain	SLH

Class	ID	Type of Feature	Prefix
	15	Terminal manhole -sewer	FLH
	16	Catch pit	SCH
	17	Special manhole- storm drain	SPH
	18	Tapping point -storm drain	SSH
	19	Sand / silt trap	FSH
	20	Special manhole - sewer	STH
	21	Tapping point-sewer	FTH
	22	Interface valve chamber (for vacuum sewer)	FIH
	23	Sewage chamber	FCH
	N6	Storm Chamber	SBH
	24	Overflow-sewer	FOH
	25	Overflow-combined system	COH
	26	Oil / petrol interceptor	FPH
	27	DWF Interceptor	SDH
	28	Inlet-storm drain	SIH
	29	Valve-sewage	FVH
Gully	30	Gully	SUG
	31	Special gully	SSG
	32	Gully sump	SMG
Outfall	33	Storm water outlet	SOF
	34	Sewage outlet outfall	FOF
	35	Combined system outfall	COF
	36	Sewage submarine	FSF
	37	Outlet- storm drain	SNF

Class	ID	Type of Feature	Prefix
Ghost/ Junction	38	Ghost /Junction-storm drain	FGJ
	39	Ghost / Junction sewer	SBB
	N7	Storm Y-Junction	FBB
	N8	Sewer Y-Junction	SCB
	N9	Combine Y-Junction	CGJ
Boundary	40	Storm water culvert (boundary)	SBB
	41	Sewage culvert (boundary)	SBB
	42	Channel/Nullah (storm water boundary)	FBB
	43	Storm water tunnel (boundary)	SCB
	44	Sewage tunnel (boundary)	STB
	N10	Drainage Reserve	FTB
	N11	Zone of Influence	XRB
	N12	Lot Boundary	XZB
	N13	District Boundary	XLB
	N14	Catchment	XDB
	N15	Service Extent	ZMA
	N16	Engineered Channel Boundary	ZEA
	N17	Flood Pond	SCB
	N18	Boulder Fence	XFB
	N19	District Council Boundary	XBB
	N20	Village Boundary	XIB
	N21	Leach Field	ZHA
	N22	Road	ZRA
	N23	Contract	ZOA

Class	ID	Type of Feature	Prefix
	N24	Incident	ZEA
	N25	Spot Level	ZVA
Path	45	Culvert (sewage, path)	FBP
	46	Tunnel (sewage, path)	FTP
	47	Cascade (path)	SAP
	48	Culvert (storm water. path)	SBP
	49	Channel (storm water, path)	SCP
	50	Decked Nullah (path)	SDP
	51	Surface channel (storm water, path)	SHP
	N26	Surface-Channel Half Channel Nullah (path)	SFP
	52	Nullah (path)	SNP
	53	Stepped channel (path)	SNP
	54	Tunnel (storm water, path)	SSP
	55	U channel (path)	STP
	56	Dry weather flow channel (path)	SUP
Structure	57	Screening plant (structure)	XWP
	58	Sewage treatment plant (structure	XSS
	59	Storage pond (structure)	XTS
	60	Imhoff tank (structure)	XFS
	61	Pumping station (structure)	XIS
	62	Soakaway (structure)	XPS
	63	Protective bund (structure)	XAS
	64	Septic tank (structure)	XBS
	65	Unspecified (structure)	XCS

Class	ID	Type of Feature	Prefix
Hstructure	66	Orifice (Hstructure)	XUS
	67	Weir (Hstructure)	XAY
	68	Compound orfice (Hstructure)	XWY
	69	Fabric-dam (Hstructure)	XCY
	70	Dam (Hstructure)	XDY
	71	Stilling basin Hstructure	XEY
	72	Energy dessipator (Hstructure)	XFY
	73	Fish pass (Hstructure)	XGY
	74	Hydrobrake (Hstructure)	XJY
	75	Contributing area (Hstructure)	XKY
	76	Bar Screen (Hstructure)	XBY
	77	Stop log (Hstructure)	XLY
	78	Stop log shaft (Hstructure)	XSY
	79	Unspecified (Hstructure)	XUY
	N27	H-Structure –Valve	XVY
	N28	H-Structure -Sluice Gate	XNY
	N29	H-Structure Unspecified	XUY
Asset/ Miscellaneous	80	Desilting opening	ZDA
	81	Inspection opening	ZIA
	82	Balancing hole for culvert	ZBA
	83	Machine access	ZMA
	84	Maintenance access	ZAA
	85	Maintenance tunnel	ZTA
	86	River	ZRA

Class	ID	Type of Feature	Prefix
	87	Slope (nature Stream)	ZSA
	88	Pipe bridge	ZPA
	89	Water gauge	ZWA
	90	Railing	ZLA
	91	Fencing	ZFA
	92	Concrete parapet	ZCA
	93	Bank	ZKA
	94	Nullah bed	ZNA
	95	Dummy	ZUA

(2) A 7-digit reference number assigned in sequential order by each division for a new feature. The digit number will not be delete even when the corresponding feature is removed from the system.

Table 9 7-digit number reserved for 3 District Divisions

Divisions	Number
Mainland North Division	10000000-3999999
Mainland South Division	40000000-6999999
Hong Kong and Islands Division	70000000-9999999

Appendix D – VI Manhole

For detailed information on IDMS referencing system and Manhole Reference No., please refer to the latest version of Method Statement For Manhole Internal Condition Survey and Manhole Condition Evaluation Codes published by UTI.