Standard and Specifications for Utility Survey in Singapore

Version 1.0

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The document is available on the Singapore Land Authority website.
URL: http://www.sla.gov.sg/Press-Room/Circulars/Land-Survey/.

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Contents

1. Introduction

Executive Summary

This document establishes the standard and specifications for the procedure and practice to conduct utility surveying in Singapore. It is not intended to replace the technical specifications stipulated by the clients of surveyors. In the event of a dispute, this document shall not take precedence over any contractual agreement on specifications entered upon between the surveyor and his client.

This document provides detailed procedures from acquisition to production of utility information/data. It covers the two major elements of utility survey process, that is, the data capturing and the data presentation (output).

For data capturing, to embrace and respond to rapid evolution of technologies, Global Navigation Satellite Systems (GNSS) are covered in the document as a tool to capture high quality data output to produce 3D models with well-defined absolute and relative accuracy. Surveyors shall determine the appropriate equipment and efficiency to satisfy user's requirements.

Objectives

- To create a common understanding on the acquisition and production of utility information.
- To ensure standardised and consistent quality of output using best practices standard and survey techniques.
- To reduce double handling of data.
- To provide documented processes to survey contractors.
- To illustrate all digital information requirements with relevant examples, independently of processing software used.
- To establish a platform where utility information can be easily shared, reused, fused and translated into multiple formats.
- To increase the value of utility survey as a long-term digital asset.

Intended Audience

The document is designed and intended to be of benefit to any party who procures, specifies, or carries out utility surveys. This includes, among others, local utility agencies, utility owners, registered surveyors, engineering consultants, survey companies, and professional institutes involved in utility surveying.

Future Additions to the Specifications

The document is crafted in consultation with professionals on their current practices and government agencies on their needs and priorities. In view of future technology advancements and industry feedback, the specifications will regularly be reviewed for new practices and procedure or changes to existing ones.

Compliance with Land Surveyors Board (LSB) Survey Directives

When executing a utility survey, surveyors are required to, in relation to this document, read and comply with prevailing directives on Surveying Practices, Control Survey and As-built/Topographical Survey stipulated in the LSB Directive on Engineering and Hydrographic Survey Practices.

2. Types of Utility Surveys

Different stages of project life cycle require different type of survey for utility services. This document gives priority to recording accurate three-dimension (3D) location and attributes of newly-laid utility services. Such as-built utility surveys shall be performed after the new services are laid and before backfilling is carried out.

New As-Built Utility Survey

New utility services are laid on ground or underground (excavated) according to the design plan. All required attributes and details of the target utility shall be surveyed by deploying survey techniques (see section 4) which are deemed appropriate by Registered Surveyors. All surveys shall be done in reference to a framework of survey control (see section 3) established earlier to meet the required survey accuracy (see section 5.2).

3. Survey Control Accuracy Standards

For the establishment of both horizontal and vertical controls, the local national grid SVY21 coordinate system shall be in reference for horizontal (easting, northing) components and Singapore Height Datum (SHD) for vertical (elevation) component. This is in accordance with the LSB Directive on Engineering and Hydrographic Survey Practices.

3.1 Horizontal Control

The LSB Directive on Engineering and Hydrographic Survey Practices requires the use of at least four (4) ISN markers to establish the horizontal datum for every survey. The ISN markers shall as far as possible, encompass the site under survey, and should be used only if the residuals in Northing and Easting co-ordinates are within 0.020 m of the recorded ISN values for GPS surveys by taking reference from the Singapore Satellite Positioning Reference Network (SiReNT). A GNSS survey would also be required if there are less than four (4) stable or intact ISN markers. For further details on establishment of ISN markers, please refer to the Guidelines and Specifications for GPS Surveys of ISN Markers.

When a traverse is created, the minimum closure standard for horizontal control is 1:20,000 with angular closure of $5\sqrt{N}$, where N is the number of angle stations. Summary as below:

Minimum Closure Standard	1:20,000
Angular Closure	$5\sqrt{N}$

3.2 Vertical Control

The vertical datum shall be derived from at least one reliable Vertical Control Points (VCP), verified with at least two witness marks established by SLA. All levelling shall be executed by standard precise levelling procedures.

Where a local vertical control is to be established for allowable height accuracy of 5 cm, the geometric geoid model, SGeoid09, established by SLA shall be adopted to

convert ellipsoidal heights, obtained in accordance to the recommended procedure published by SLA, to heights in reference to SHD (https://sirent.inlis.gov.sg/Services-SGeoid09.aspx).

The minimum closure standard for vertical control is 6√k, where k is the distance in kilometres between the two points being considered. Summary as below:

Minimum Closure Standard	6√k

3.3 Singapore Satellite Positioning Reference Network (SiReNT)

GNSS RTK survey (see section 4.2) supplied with real time correction from Continuously Operating Reference Station (CORS) is accepted for establishment of temporary reference marks for both horizontal and vertical components. SiReNT is the only accepted and official CORS network in Singapore. The LSB Directive stipulates the best practices for field survey (see section 4.2) and the following specifications and parameters are to be adopted and documented together with the surveyed coordinates for ensuring the reliability and accuracy of the surveyed outcomes:

(a) Minimum number of 5 satellites are observed during observation;
(b) Mask angle of 15 degrees;
(c) PDOP of less than 4;
(d) Positioning Standard Deviation (quality indicator) of less than 0.03 meter for horizontal and 0.06 meter for vertical;
(e) Minimum observation of 5 epochs shall be used for each point measurement.

4. Specifications for As-Built Utility Survey Techniques

As-built surveys shall be performed using survey techniques as follows:

4.1 Total Station

(a) Standard operating procedures

Control points must be measured and noted immediately on the data collector and/or in the field book after the instrument has been set up and levelled. When making observations for an extended period of time at a particular instrument location, the control points should be re-observed from time to time, and also before the instrument is relocated.

(b) Positioning Utility Features with Total Station

Utility features are usually observed by multiple radial sideshots from primary project control points. This is usually a straightforward process: the remote point is occupied with the prism pole, the height of reflector and feature code recorded, and the angle and slope distance observed and recorded. If necessary, supplemental feature attributes may be added. The process is similar when using a reflectorless total station or robotic total station where the data collector is at the prism pole.

Where objects cannot be directly occupied with a prism pole or targeted with a reflectorless total station, off-centre (or eccentric) corrections are automatically available in most data collectors. Offset cases include circular pipes or tanks where only direction to the centre of the circular object can be sighted; or a distance to the circumference and a direction to the centre of the circular object.

4.2 GNSS Real Time Kinematic (RTK)

Real-time Kinematic surveying is a GNSS carrier phase surveying technique that allows the user to rapidly and accurately measure baselines while moving from one point to the next, stopping only briefly at the unknown points, or in dynamic motion such as in a survey boat or aircraft. By taking reference to SiReNT stations, a remote, or rover, receiver traverses between the unknown points to be positioned. The data is

collected and processed real-time to obtain accurate positions to the centimeter level. Real-time phase are referred to as "real-time kinematic" (RTK) surveys. RTK survey techniques require some form of initialization to resolve the carrier phase ambiguities. This is done in real-time using "On-the-Fly" (OTF) processing techniques. Periodic loss of satellite lock can be tolerated and no static initialization is required to regain the integers. This differs from other GNSS techniques that require static initialization while the user is stationary. A communication link between the reference and rover receivers is required to maintain a real-time solution. In terms of best practices, the survey pole shall be held vertically all the time during observation by reference to a plate bubble attached to the pole. Direct RTK measurement to target features without survey control is acceptable given that the specific conditions are satisfied (see section 3.3). For further details on RTK Survey, please refer to the section on GPS RTK Survey in the LSB Directives on Engineering and Hydrographic Survey Practices.

Figure 1: Surveyor recording GNSS observation on a gas main
(Michigan Department of Transportation, 2015)

4.3 3D Laser Scanning

Laser scanning technology has been prevalent in recent years and is quickly becoming the new industry standard for accurate three-dimensional (3D) measurements in complex environments. There are two types of widely deployed laser scanning in the industry: Static Terrestrial Laser Scanning and Mobile Laser Scanning. For further details, please refer to the Standard and Specifications for 3D Topographic Surveying (Mapping) in Singapore.

5. Data Acquisition and Observation Standards

This section sets out the observation requirements for as-built surveys.

5.1 General

As-built surveys shall be performed on all new utilities and structures listed in Table 1 below:

No.	Utilities and Structures
1.	Telecommunication
2.	Sewerage
3.	Water Supply
4.	Electricity
5.	Gas
6.	Drainage

Table 1: Utilities and Structures subjected to As-Built Surveys

All as-built surveys shall be performed under the direct supervision of a Registered Surveyor with a valid practising certificate. The name of the Registered Surveyor who performs the data acquisition is also to be recorded in the data submission (see Section 6).

5.2 Survey Accuracy

All as-built surveys shall be performed to the following absolute accuracy:

- Horizontal Accuracy: ±100mm
- Vertical Accuracy: ±100mm

(Note: The same requirement has also been stipulated in Appendix B of the LSB Directive on Engineering and Hydrographic Survey Practices)

5.3 Direct Observation

To achieve the required accuracy, as-built surveys shall be performed directly on the utilities prior to backfilling. As such, stakeholders (e.g. Utility Owners, Contractors, Registered Surveyors) are advised to closely plan and coordinate the execution of actual site activities.

5.4 Observation Standards

The eventual deliverables for the as-built surveys come in the form of Point, Line or Polygon output in GIS format. For each of the output type, surveys shall be carried out at the following positions:

a. Point Output (Manholes, chambers, valves, etc.)
    i. *Easting*, *Northing* and *Top / Ground Level* shall be surveyed from the top centre of the structures, while *Invert Level* shall be surveyed from the bottom as shown in Figure 2.

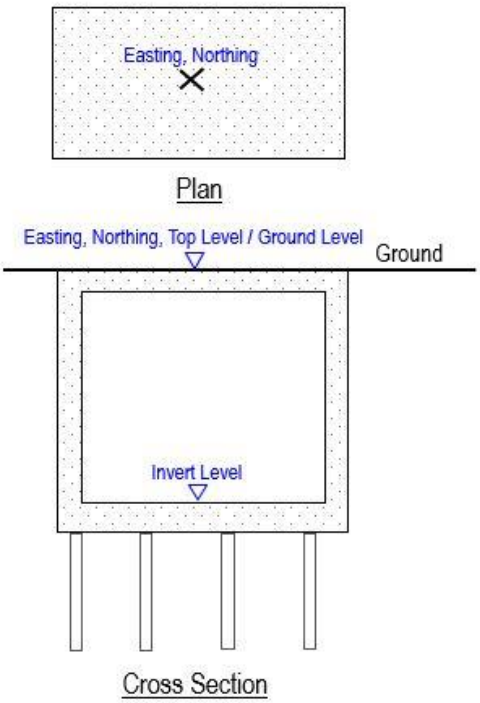


Figure 2: Manholes, Chambers, Valves
(Note: Full diagram please refer to Appendix)

b. Line Output (Pipes, cables, drains, etc.)

i. *Easting*, *Northing* and *Top / Invert Level* shall be surveyed at positions as shown in Figures 3, 4 and 5.

ii. For straight lines, surveys shall be carried out at not exceeding 20m intervals.

iii. For curved lines, adequate number of surveyed points (as determined by the Registered Surveyor) shall be captured along the entire length of the curves.

iv. Additional surveys shall also be carried out at the following points, where there are changes in:

- Alignment, at both horizontal and vertical directions.
- Pipes, cables, drains' size or material.

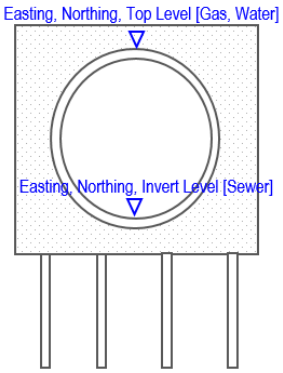


Figure 3: Pipes

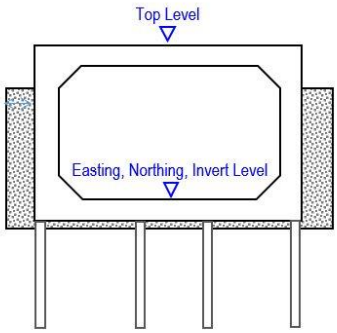


Figure 4: Drains

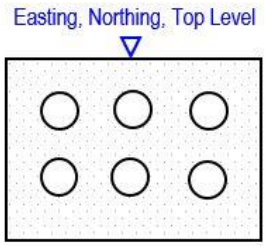


Figure 5: Cable

(Note: Full diagram please refer to Appendix)

c. Polygon Output (Chambers, etc.)

i. *Easting*, *Northing* for the chambers shall be surveyed from all corners (if chambers are rectangular) or from the centre (if chambers are circular), while the *Top / Invert / Formation Level* shall be surveyed at positions as shown in Figure 6.

ii. *Easting, Northing* of both the internal and external wall for drains shall be surveyed.

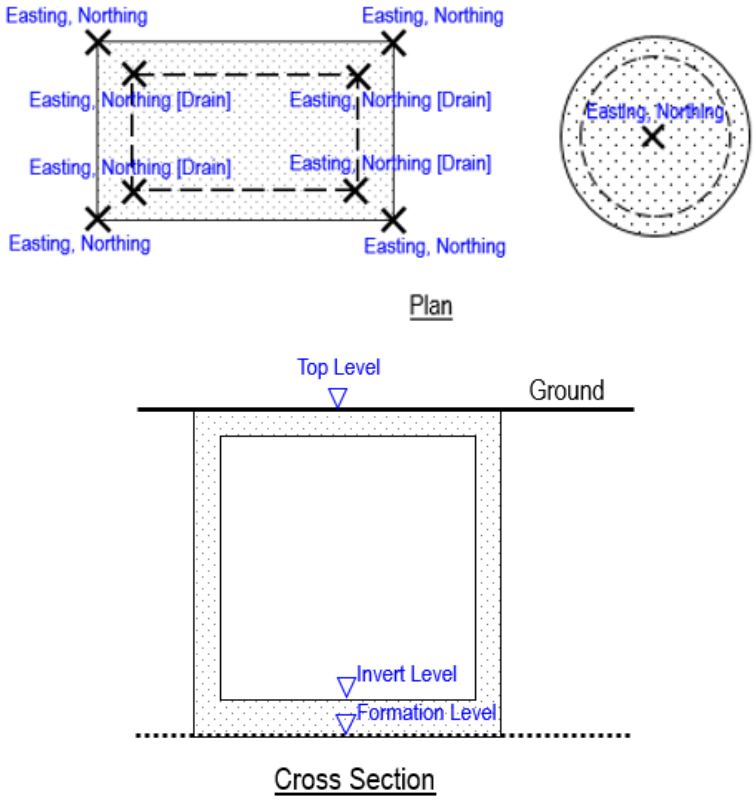


Figure 6: Chambers

(Note: Full diagram please refer to Appendix)

6. Submission Standards for As-Built Utility Survey

This section outlines the submission standards, which include the attributes and format of submission.

6.1 Attributes

In addition to the requirements for surveyed coordinates covered in Section 5 (i.e. *Easting, Northing, Top/Invert Level*), additional information in the form of attributes shall also be included in the submission. The full list of the required attributes is given in the Appendix. Fields shaded in yellow are items where the Registered Surveyor's inputs are required. The Registered Surveyor's interim inputs shall be provided in either Esri Shapefile (.shp), AutoCAD (.dwg) or MicroStation (.dgn) format.

The *Attribute Name* shall strictly follow those stated in the Appendix. Also, inputs for the attributes shall:

a. Be selected from an exhaustive list of pre-determined values, e.g. 1, 2, 3 or 4 for *Quality* (if applicable), and
b. Adhere strictly to the requirements for input format, e.g. *Invert Level* to be in mSHD to 2 decimal places, *Date of Installation* to be in DD/MM/YYYY.

Both the exhaustive lists of pre-determined values and the requirements for input format are also given in the Appendix.

6.2 Format of Submission

The as-built utility data shall be subsequently uploaded onto SG-SPACE by the respective Utility Agencies in Esri Shapefile (.shp) or geodatabase (.gdb) format.

Glossary

Accuracy	The ability of a measurement to match the actual value of the quantity being measured.
Baselines	A line with a specific value that can serve as a basis of comparison or control, for the purposes of measurement, calculation, or location.
Datum	A reference from which measurements are made.
Eccentric corrections	Off-center correction
Elevation	The height of something above a given or implied place, often above datum
Ellipsoidal heights	The height of an object above the reference ellipsoid in use. This term is generally used to qualify an elevation as being measured from the ellipsoid as opposed to the geoid. GPS systems calculate ellipsoidal height.
Geoid	A model of the equipotential surface of the earth's gravity field that is best approximated by the mean sea level over the oceans which extends hypothetically beneath all land surfaces
GNSS	*Global Navigation Satellite Systems* Various operational and proposed satellite positioning systems, including the U.S. Global Positioning System (GPS), the Russian Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS), the European Union Galileo, and others.
GPS	*Global Positioning System* A system of earth-orbiting satellites, transmitting signals continuously towards the earth, that enables the position of a receiving device on or near the earth's surface to be accurately estimated from the difference in arrival times of the signals
Height	The vertical distance from the base to the top of a feature.
Horizontal Control	A system of points whose horizontal positions and interrelationships have been accurately determined for use as fixed references in positioning and correlating map features.
ISN	Integrated Survey Network
Real Time Kinematic (RTK)	A technique used in surveying based on the use of carrier phase measurements of the GNSS signals where a single reference station provides the real-time corrections, providing up to centimetre-level accuracy.
SGeoid09	Geometric geoid model established by SLA
Singapore Height Datum (SHD)	The fixed datum surface set at 0.000 metres of Singapore's historical mean sea level
SiReNT	*Singapore Satellite Positioning Reference Network* An infrastructure set up by the Singapore Land Authority to define Singapore's official spatial reference framework and to support the gazetted cadastral system in SVY21. It is a multi-purpose high precision positioning infrastructure which provides both Post Process Differential Global Positioning System (DGPS) DGPS services and Real Time DGPS services. The system supports all types of GPS positioning modes and formats.
Surveyor	Registered Surveyor with a valid practicing certificate to carry out the utility surveys.
Vertical Control	A series of points on which precise heights, or elevations, have been established. Vertical control stations are typically called bench marks.

Appendix

Legend:

Items where Registered Surveyors' inputs are required

1a. Telco Manholes (Point)		
Geometry	**Requirements**	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Top Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Invert Level	-	
External Length	-	• Unit: mm • Data type: Integer
External Width	-	
Orientation	Yes, No	• Is length of manhole along pipe? • Data type: Boolean
MH Type	-	• To input as JX2, MX1, MX2, MX3, MX4, MX5, etc. • Data type: String
Base Thickness	-	• Unit: mm • Data type: Integer
Surveyed by	-	• RS company name • Data type: String
Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Status	Abandoned, Active	• Data type: String

Ownership	Self-owned, Co-owned, Leased	
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

1b. Telco Pipes (Line)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points
Y	
Z	• Top level • With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • Data type: Double (to 2 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Height	-	• Unit: mm • Data type: Integer
Width	-	
Diameter of Ducts	-	
No. of Columns	-	• Data type: Integer (positive value only)
No. of Rows	-	
No. of Ducts	-	
Haunches	Yes, No	• Data type: Boolean
Surveyed by	-	• RS company name • Data type: String
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances.

		• Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Status	Abandoned, Active	• Data type: String
Ownership	Self-owned, Co-owned, Leased	
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

2a. Sewer Manholes (Point)		
Geometry	**Requirements**	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Top Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Invert Level	-	
MH Type	Nonstd-cir, Nonstd-rec, Std-cir, Std-rec	• Data type: String
Dim1	-	• Unit: mm • If rectangular, input = external length along pipe • If circular, input = largest external diameter • Data type: Integer
Dim2	-	• Unit: mm • if rectangular, input = external width • if circular, input = NULL • Data type: Integer
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Support	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Left-in Structure	Yes, No	• Data type: Boolean
Base Thickness	-	• Unit: mm • Data type: Integer

Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Decommissioned, Existing, Proposed, To be abandoned, Uncommissioned, Unsurveyed, Removed	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)
Sewer Type	Main, Minor, Trunk, DTSS sewer	• Data type: String

2b. Sewer Pipes (Line)

Geometry	Requirements
X Y	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points
Z	• Invert level • With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • Data type: Double (to 3 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Drop Type	Backdrop, Drain-off, Drop, Indrop, Inverted Siphon, Nodrop, Raised junction, Reserved, Saddle connection, Tumbling bay, Unknown, Vortex drop, Weir over, Y-junction	• Data type: String
Internal Diameter	-	• Unit: mm • Data type: Integer
Bedding	Type A, Type B, Type C, Type D	• Pipe Section • Data type: String
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Support	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Left-in Structure	Yes, No	• Data type: Boolean
Pipe Material	Cast iron, Ductile iron, GRP, HDPE, Steel, Stoneware, Thickwall reinforced concrete, Vitrified clay	• Data type: String
Pipe Thickness	-	• Unit: mm • Data type: Integer
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method

		• All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Decommissioned, Existing, Proposed, To be abandoned, Uncommissioned, Unsurveyed, Removed	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)
Sewer Type	Main, Minor, Trunk, DTSS sewer	• Data type: String

2c. Sewer Pumping Chambers (Point)

Geometry	**Requirements**	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Top Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Invert Level	-	
CH Type	Access chamber, Air valve, Air valve chamber, Discharge chamber, Valve chamber, Washout chamber	• Data type: String
Dim1	-	• Unit: mm • If rectangular, input = external length along pipe • If circular, input = external diameter

		• Data type: Integer
Dim2	-	• Unit: mm • if rectangular, input = external width • if circular, input = NULL • Data type: Integer
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Support	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Left-in Structure	Yes, No	• Data type: Boolean
Base Thickness	-	• Unit: mm • Data type: Integer
Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Decommissioned, Existing, Proposed, To be abandoned, Uncommissioned, Unsurveyed, Removed	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

2d. Sewer Pumping Mains (Line)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Points where there is a change of direction
Y	
Z	• Invert level • With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Points where there is a change of direction • Data type: Double (to 2 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Internal Diameter	-	• Unit: mm • Data type: Integer
Bedding	Type A, Type B, Type C, Type D	• Pipe Section • Data type: String
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Support	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Left-in Structure	Yes, No	• Data type: Boolean
Pipe Material	Cast iron, Ductile iron, GRP, HDPE, Steel, Stoneware, Thickwall reinforced concrete, Vitrified clay	• Data type: String

Pipe Thickness	-	• Unit: mm • Data type: Integer
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Decommissioned, Existing, Proposed, To be abandoned, Uncommissioned, Unsurveyed, Removed	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

2e. Sewerage Piling (excl. Bakau & Timber Piles) (Point)

Geometry	Requirements	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Dim1	-	• Unit: mm • If rectangular, input = length • If circular, input = diameter • Data type: Integer
Dim2	-	• Unit: mm • if rectangular, input = width • if circular, input = NULL • Data type: Integer

Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Toe Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Type	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String

2f. Sewer Pumping Main Thrust Block (Point)

Geometry	Requirements	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Formation Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Dim1	-	• Unit: mm • If rectangular, input = length • If circular, input = diameter • Data type: Integer
Dim2	-	• Unit: mm • if rectangular, input = width • if circular, input = NULL • Data type: Integer

Height	-	• Unit: mm • Data type: Integer
Block Type	Vertical bend, Horizontal bend	• Data type: String
Pile Type	Bakau piles, Concrete piles, Pipe jacking, Sleeves steel, Steel piles, Timber piles	• Data type: String
Pile Toe Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 2 decimal places)
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

2g. Sewerage Left-in Sheetpile (Line)

Geometry	**Requirements**
X	• Easting, Northing
Y	

Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Dim1	-	• Unit: mm • Input = length • Data type: Integer
Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Deepest depth	-	• Unit: m • Data type: Double (to 2 decimal places)
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

2h. Sewer RC Trench (Polygon)		
Geometry	**Requirements**	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Dim1	-	• Unit: mm • Input = external length along pipe • Data type: Integer
Dim2	-	• Unit: mm • Input = external width • Data type: Integer
Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Deepest depth	-	• Unit: m • Data type: Double (to 2 decimal places)
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

2i. Sewerage Left-in Caisson (Point)		
Geometry	**Requirements**	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Dim1	-	• Unit: mm

		• If rectangular, input = external length • If circular, input = diameter • Data type: Integer
Dim2	-	• Unit: mm • if rectangular, input = external width • if circular, input = NULL • Data type: Integer
Deepest depth	-	• Unit: m • Data type: Double (to 2 decimal places)
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

3a. Drain Lines (Line)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points
Y	
Z	• Invert level • With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • Data type: Double (to 3 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Cope Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Drain Depth Min	-	• Unit: m • Data type: Double (to 3 decimal places)
Drain Depth Max	-	
Pile Type	Timber piles, H-piles, RC piles, Bored piles	• Data type: String
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 3 decimal places)
Drain Type 1	Open, Close	• Data type: String
Drain Type 2	2-cell culvert, 2-pipe culvert, 3-cell culvert, 4-cell culvert, 5-cell	

	culvert, 6-cell culvert,B1, B2, B3, BLK PITCH u-drain, Box culvert, Box drain, C1, C2, C3, C4, C5, C6, C7, C7A, C7B, C8, C8A, C8B, Closed drain, Conduit Drain,Earth drain, Earth inv trap drain,Outfall, Pipe culvert, reservoir, S1, S2, Slabbed over u-drain, sump,drain, Trap drain, U-drain	
Drain Width	-	• Refers to internal width • Unit: m • Data type: Double (to 3 decimal places)
Pile record	Yes, No	• Data type: Boolean
Left-in Structure	Yes, No	
Base Thickness	-	• Unit: m • Data type: Double (to 3 decimal places)
Wall Thickness	-	
Slab Thickness	-	
Hardcore Thickness	-	
Quality	1, 2, 3, 4, 6	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 6: ±30mm • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Active	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

3b. Drain Outline (Polygon)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • For both the internal and external wall of drains
Y	
Z	• Invert level • With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • Data type: Double (to 3 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Cope Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Drain Depth Min	-	• Unit: m • Data type: Double (to 3 decimal places)
Drain Depth Max	-	
Pile Type	Timber piles, H-piles, RC piles, Bored piles	• Data type: String
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 3 decimal places)

Drain Type 1	Open, Close	
Drain Type 2	2-cell culvert, 2-pipe culvert, 3-cell culvert, 4-cell culvert, 5-cell culvert, 6-cell culvert,B1, B2, B3, BLK PITCH u-drain, Box culvert, Box drain, C1, C2, C3, C4, C5, C6, C7, C7A, C7B, C8, C8A, C8B, Closed drain, Conduit Drain,Earth drain, Earth inv trap drain,Outfall, Pipe culvert, reservoir, S1, S2, Slabbed over u-drain, sump,drain, Trap drain, U-drain	• Data type: String
Drain Width	-	• Refers to internal width • Unit: m • Data type: Double (to 3 decimal places)
Pile record	Yes, No	• Data type: Boolean
Left-in Structure	Yes, No	
Base Thickness	-	• Unit: m • Data type: Double (to 3 decimal places)
Wall Thickness	-	
Slab Thickness	-	
Hardcore Thickness	-	
Quality	1, 2, 3, 4, 6	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 6: ±30mm • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String

Status	Active	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

3c. Drain Piling (Point)

Geometry	Requirements	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Pile Size	-	• Unit: m • Data type: Double (to 3 decimal places)
Pile Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Pile Toe Level	-	• For deepest pile • With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Pile Length	-	• Unit: m • Data type: Double (to 3 decimal places)
Pile Type	RC pile, Bored pile, Timber pile, H-pile, Bakau pile	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

3d. Drain Left-in Structures (Line)

Geometry	Requirements
X	• Easting, Northing
Y	

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Cut-off Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 3 decimal places)
Deepest depth	-	• Unit: m • Data type: Double (to 3 decimal places)
Structure type	Sheetpile	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

3e. Drain Piling Zone (Polygon)

Geometry	Requirements
X	• Easting, Northing
Y	

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Pile Size	-	• Unit: m • Data type: Double (to 3 decimal places)
Pile Length	-	
Pile Type	RC pile, Bored pile, Timber pile, H-pile, Bakau pile	• Data type: String
Date of Installation	-	• Contract closure or handover date for external project • Data type: Date (in DD/MM/YYYY)

4a. Water Supply Mains / Lateral Lines (Line)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points, such as bends, tees, control valves, air valves, washouts, meters
Y	
Z	• Top level of pipeWith respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points, such as bends, tees, control valves, air valves, washouts, meters • Data type: Double (to 2 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Nominal Diameter	-	• Unit: mm • Data type: Integer
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Ins, PPA, APP, ABD	• Data type: String
Type	Buried, Exposed, Pipe-jacking, Tunnel, Encased	• Refers to construction method • Data type: String

Water Type	0, 1, 2, 3	• 0: Industrial 1: NEWater 2: Raw 3: Potable • Data type: Integer
Lateral Type (for lateral lines only)	Hydrant, Meter, Air valve, Washout	• Refers to connection pipes to meters, hydrants, air valves, washouts • Data type: String
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

4b. Water Supply Chamber (Air Valve / / Control Valve / Washout / Meter) (Polygon)

Geometry	**Requirements**	
X Y	• Easting, Northing • To be captured at corners of rectangular chambers or center of circular chambers	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Ground Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Formation Level	-	
Dim1	-	• Unit: m • If rectangular, input = length along pipe • If circular, input = diameter • Data type: Double (to 2 decimal places)
Dim2	-	• Unit: m • if rectangular, input = width across pipe • if circular, input = NULL • Data type: Double (to 2 decimal places)
Height	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Type	Timber piles, Bakau piles, RC piles	• Data type: String
Pile Toe Level	-	• For deepest pile

		• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• For deepest pile • Unit: m • Data type: Double (to 2 decimal places)
Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Ins, PPA, APP, ABD	• Data type: String
		•
Water Type	0, 1, 2, 3	• 0: Industrial 1: NEWater 2: Raw 3: Potable • Data type: Integer
Chamber Type	Std Cir, Std Rec, Nonstd Cir, Nonstd Rec	• Circular or Rectangular • Data type: String
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

4c. Water Supply Tunnels (Polygon)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points, such as change in levels or tunnel dimensions
Y	

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Formation Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points, such as change in levels or tunnel dimensions • Data type: Double (to 2 decimal places)
Dim1	-	• Unit: m • If rectangular, input = length • If circular, input = diameter • Data type: Double (to 2 decimal places)
Dim2	-	• Unit: m • if rectangular, input = width • if circular, input = NULL • Data type: Double (to 2 decimal places)
Height	-	• Unit: m • Data type: Double (to 2 decimal places)
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

4d. Water Supply Thrust Block (Polygon)		
Geometry	**Requirements**	
X Y	• Easting, Northing • Concrete thrust block for bends and tees	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Formation Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Dim1	-	• Unit: m • If rectangular, input = length along pipe • If circular, input = diameter • Data type: Double (to 2 decimal places)
Dim2	-	• Unit: m • if rectangular, input = width across pipe • if circular, input = NULL • Data type: Double (to 2 decimal places)
Height	-	• Unit: m • Data type: Double (to 2 decimal places)
Pile Type	Timber piles, Bakau piles, RC piles	• Data type: String
Pile Toe Level	-	• For deepest pile • With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Pile Length	-	• For deepest pile • Unit: m • Data type: Double (to 2 decimal places)
Block Type	Thrust, Anchor, Haunching, Saddle	• Data type: String

Water Type	0, 1, 2, 3	• 0: Industrial 1: NEWater 2: Raw 3: Potable • Data type: Integer
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

4e. Water Supply Left-in Structure (Polygon)		
Geometry	**Requirements**	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Formation Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Cutoff Level	-	
Dim1	-	• Unit: m • If rectangular, input = length • If circular, input = diameter • Data type: Double (to 2 decimal places)
Dim2	-	• Unit: m • if rectangular, input = width • if circular, input = NULL • Data type: Double (to 2 decimal places)
Height	-	• Unit: m • Data type: Double (to 2 decimal places)
Struc_Shape	Circular, Rectangular	• Data type: String
Struc_Type	Sheetpile, RC caisson	• Data type: String
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

4f. Water Supply Hydrant (Point)		
Geometry	**Requirements**	
X	• Easting, Northing	
Y		
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
RL	-	• To be captured at the top of Double and Triple Pillar Hydrant or ground level of Ground Hydrant chamber • With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Hydrant_Type	GH, DPH, TPH	• GH: Ground hydrant DPH: Double pillar hydrant TPH: Triple pillar hydrant • Data type: String

5a. Power Joint Bays, PT Tanks, Link Boxes (Point)		
Geometry	**Requirements**	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Top Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Height External Length External Width	- - -	• Unit: mm • Data type: Integer
Structure Type	Joint bay, Pressure Tank (PT) pit, Link box pit, Partial Discharge (PD) terminal box pit, Oil Gauge (OG) box	• Data type: String
Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Existing	• Data type: String
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

5b. Power Cables (Line)

Geometry	Requirements / Explanation
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points
Y	
Z*	• Top level • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
Height	-	• Unit: mm • Data type: Integer
Width	-	
No. of Columns	-	• Data type: Integer (positive value only)
No. of Rows	-	
No. of Ducts	-	
No. of Cables	-	• If cables are not laid within duct(s): - To fill in this attribute. - To indicate the 'No. of Columns / Rows / Ducts' attributes as '0' (zero). • If cables are laid within duct(s): - To indicate this attribute as '0' (zero). - To fill in the 'No. of Columns / Rows / Ducts' attributes instead. • Data type: Integer
Haunches	Yes, No	• Data type: Boolean
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method

		• All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Existing	• To indicate as 'Existing', so long as there is at least one live cable within the trench. • Data type: String
Type of Line	LV, Distribution, Transmission	• Data type: String
Date of Installation (Ducts)	-	• Data type: Date (in DD/MM/YYYY)
Date of Installation (Newest Cables)	-	

* Shall be captured in the geometry of the Line feature, or as an attribute in a separate Point feature.

6a. Gas Chambers (Point)		
Geometry	**Requirements**	
X Y	• Easting, Northing	
Attribute Name	**Attribute Domain (Exhaustive)**	**Requirements**
Top Level	-	• With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)
Height	-	• Unit: mm • Data type: Integer
External Length	-	
External Width	-	
Structure Type	Chamber, Gas regulator, Line valve pit	• Data type: String
Quality	1, 2, 3, 4	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Existing	• Data type: String
Type of Line	Distribution, Transmission	
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

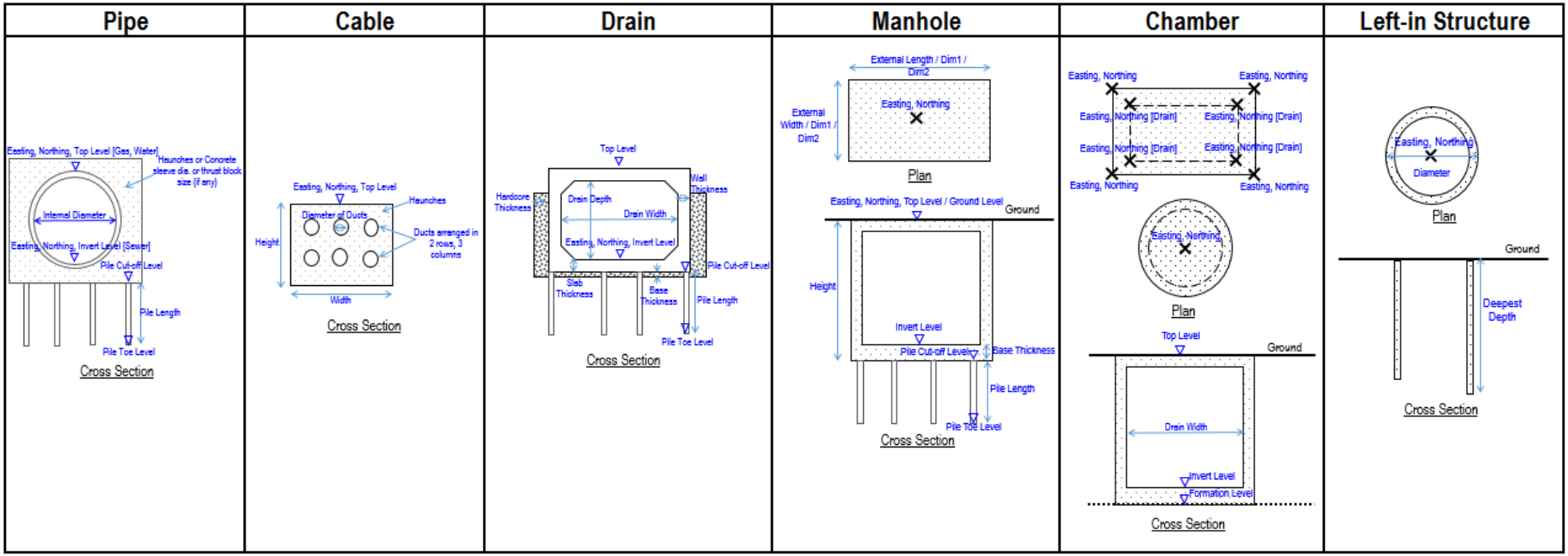
6b. Gas Pipes (Line)

Geometry	Requirements
X	• Easting, Northing • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points
Y	
Z*	• Top level • To be captured at: - For straight lines: Not exceeding 20m intervals - For curved lines: As determined by the Registered Surveyor - Salient points • With respect to Singapore Height Datum (SHD) • Unit: m • Data type: Double (to 2 decimal places)

Attribute Name	Attribute Domain (Exhaustive)	Requirements
External Diameter of Pipes	-	• Unit: mm • Data type: Integer
External Diameter of Concrete Sleeves	-	
Quality	1, 2, 3, 4, 5	• 1: ±100mm 2: ±300mm 3: ±500mm 4: Unknown Accuracy 5: Trenchless Method • All new lines / points must be surveyed to ±100mm accuracy, unless otherwise permitted by the Utility Agencies for special circumstances. • Data type: Integer
Date of Last Survey	-	• Data type: Date (in DD/MM/YYYY)
Surveyed by	-	• RS company name • Data type: String
Status	Abandoned, Existing	• Data type: String
Type of Line	Distribution, Transmission	
Date of Installation	-	• Data type: Date (in DD/MM/YYYY)

* Shall be captured in the geometry of the Line feature, or as an attribute in a separate Point feature.

Diagrams


Pipe
Easting, Northing, Top Level [Gas, Water]
Haunches or Concrete sleeve dia. or thrust block size (if any)
Internal Diameter
Easting, Northing, Invert Level [Sewer]
Pile Cut-off Level
Pile Length
Pile Toe Level
Cross Section
Cable
Easting, Northing, Top Level
Haunches
Diameter of Ducts
Height
Ducts arranged in 2 rows, 3 columns
Width
Cross Section
Drain
Top Level
Hardcore Thickness
Drain Depth
Drain Width
Wall Thickness
Easting, Northing, Invert Level
Pile Cut-off Level
Slab Thickness
Base Thickness
Pile Length
Pile Toe Level
Cross Section
Manhole
External Length / Dim1 / Dim2
External Width / Dim1 / Dim2
Easting, Northing
Plan
Easting, Northing, Top Level / Ground Level
Ground
Height
Invert Level
Pile Cut-off Level
Base Thickness
Pile Length
Pile Toe Level
Cross Section
Chamber
Easting, Northing
Easting, Northing [Drain]
Plan
Top Level
Ground
Drain Width
Invert Level
Formation Level
Cross Section
Left-in Structure
Easting, Northing
Diameter
Plan
Ground
Deepest Depth
Cross Section