

AS 5488.2:2022



# Classification of Subsurface Utility Information (SUI)

## Part 2: Subsurface utility engineering (SUE)



AS 5488.2:2022

This Australian Standard ® was prepared by IT-036, Subsurface Utility Engineering Information. It was approved on behalf of the Council of Standards Australia on 14 June 2022.

This Standard was published on 24 June 2022.

The following are represented on Committee IT-036:

- Australian Industry Group
- Australian Institute of Mine Surveyors
- Austroads
- Energy Networks Australia
- Engineers Australia
- Geospatial Information & Technology Association
- National Utility Locating Contractors Association
- NSW Department of Customer Service — Spatial Services
- Roads Australia
- Surveying & Spatial Sciences Institute
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This Standard was issued in draft form for comment as DR AS 5488.2:2021.

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ISBN 978 1 76113 862 1

# **Classification of Subsurface Utility Information (SUI)**

## **Part 2: Subsurface utility engineering (SUE)**

Originated as AS 5488—2013.  
Revised and redesignated in part as AS 5488.2:2019.  
Second edition 2022.

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## Preface

This Standard was prepared by the Standards Australia Committee IT-036, Subsurface Utility Engineering Information, to supersede AS 5488.2:2019.

The objective of this document is to provide a framework for the consistent engineering management of subsurface utilities. This informative Standard is designed to aid in the proper understanding and use of information surrounding such utilities.

This document also provides guidance on issues such as how Subsurface Utility Information (SUI) may be obtained, and how that information should be conveyed to the information users.

This document does not provide guidance on specific methods to determine, manage or apply the spatial position of subsurface utilities. However, it is acknowledged that increasing access to high-accuracy positioning technologies has the potential to drive significant progressive improvements in subsurface utility management. In recognition of these benefits, this document recommends, through the adoption of Quality Level A, the absolute positioning of subsurface utilities in three dimensions, as an improvement upon the current widely adopted method of relative positioning.

This document recognizes the Geocentric Datum of Australia 2020 (GDA2020) as the national “Recognized-Value Standard (RVS) of measurement of position”, supporting legal traceability of positioning in Australia.

This document should be read in conjunction with AS 5488.1. Part 1 focuses on the classification of SUI, while Part 2 (this document) focuses on Subsurface Utility Engineering (SUE).

The major changes in this edition are as follows:

- (a) Updates to terms and definitions.
- (b) Amendments to the Model Schema in [Appendix A](#).
- (c) Recognition of the Geocentric Datum of Australia 2020 (GDA2020) as the national “Recognized-Value Standard (RVS) of measurement of position”, supporting legal traceability of positioning in Australia.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

# Contents

|                                                                                 |           |
|---------------------------------------------------------------------------------|-----------|
| <b>Preface</b>                                                                  | <b>ii</b> |
| <b>Introduction</b>                                                             | <b>v</b>  |
| <b>Section 1 Scope and general</b>                                              | <b>1</b>  |
| 1.1 Scope                                                                       | 1         |
| 1.2 Application                                                                 | 1         |
| 1.3 Normative references                                                        | 1         |
| 1.4 Terms and definitions                                                       | 1         |
| <b>Section 2 Subsurface utility model creation and data naming conventions</b>  | <b>7</b>  |
| 2.1 Justification of a utility                                                  | 7         |
| 2.2 String naming conventions                                                   | 8         |
| 2.3 Specific attribute data                                                     | 9         |
| 2.4 Appropriate level of model creation                                         | 9         |
| 2.4.1 General                                                                   | 9         |
| 2.4.2 Model Level 1                                                             | 10        |
| 2.4.3 Model Level 2                                                             | 10        |
| 2.4.4 Model Level 3                                                             | 11        |
| 2.4.5 Model Level 4                                                             | 12        |
| 2.4.6 Model Level 5                                                             | 13        |
| 2.4.7 Model Level 6                                                             | 13        |
| <b>Section 3 Utility project roles and utility clash detection approach</b>     | <b>15</b> |
| 3.1 General project roles                                                       | 15        |
| 3.2 Design or utility engineer                                                  | 15        |
| 3.3 Project owner                                                               | 16        |
| 3.4 Utility authority                                                           | 17        |
| 3.5 Memorandum of understanding                                                 | 18        |
| 3.5.1 General                                                                   | 18        |
| 3.5.2 MOU purpose and scope                                                     | 18        |
| 3.5.3 Principles of cooperation                                                 | 18        |
| <b>Section 4 Utility clash detection</b>                                        | <b>20</b> |
| 4.1 General                                                                     | 20        |
| 4.2 Options of clash detection                                                  | 21        |
| 4.2.1 General                                                                   | 21        |
| 4.2.2 Option 1 — Design change to eliminate potential utility clash or conflict | 21        |
| 4.2.3 Option 2 — Approval of reduced cover or clearance                         | 21        |
| 4.2.4 Option 3 — Protective treatments to eliminate utility conflict            | 22        |
| 4.2.5 Option 4 — Utility relocations                                            | 22        |
| <b>Section 5 Utility design</b>                                                 | <b>23</b> |
| 5.1 Minimum utility design deliverable                                          | 23        |
| 5.1.1 General                                                                   | 23        |
| 5.1.2 Utility design and coordination throughout a project lifecycle            | 23        |
| 5.2 Conflict management process                                                 | 23        |
| 5.3 Inspection and testing                                                      | 24        |
| <b>Appendix A (informative) Subsurface Utility Information model schema</b>     | <b>25</b> |
| <b>Appendix B (informative) Risk assessment matrix</b>                          | <b>46</b> |
| <b>Appendix C (informative) AS 5488.2 process flowchart</b>                     | <b>47</b> |
| <b>Appendix D (informative) Utility conflict matrix</b>                         | <b>48</b> |
| <b>Appendix E (informative) Public Utility Plant (PUP) conflict register</b>    | <b>50</b> |
| <b>Appendix F (informative) AS 5488.2 legend</b>                                | <b>51</b> |
| <b>Appendix G (informative) Utility coordination spreadsheet</b>                | <b>52</b> |

**Appendix H** (informative) **Utility detection means** .....56

**Appendix I** (informative) **Procedure for asset handover** .....61

**Bibliography** .....62

## Introduction

Due to the age, complexity of the environments in which they operate, and changes in technology and requirements, the information available to (and from) utility owners and operators is often limited. Additional sources of data, including physical checks and determining position at the time of installation and/or inspection, can augment the information available from the utility owner, enabling better decision making when working with subsurface utilities.

Engineers may have received or compiled by various means, a mixture of evidence of the existence, type, condition and location of utilities. Such evidence may vary widely as to its credibility, primarily by virtue of disclaimers from the providers of the information. Application of this document and the establishment of a credible approach to the management of subsurface utilities will improve the critical items of time, cost, quality and safety, and reduce risk across projects involving subsurface utilities.

Any available Before You Dig Australia (BYDA) data should be requested as a first step of interacting with utility authorities.

Accurate location information must refer to a suitable datum or coordinate reference system. In Australia the Geocentric Datum of Australia (GDA2020) and associated Map Grid of Australia 2020 (MGA2020) have improved and replaced GDA94/MGA94. This document advocates, but does not prescribe, the use of GDA2020 for describing the horizontal position of subsurface utilities. For vertical position, the Australian Height Datum (AHD) is the most common datum, but alternatives are also available. More information on datums and models commonly used in Australia can be found at: <https://www.icsm.gov.au/australian-geospatial-reference-system>.

It is important to note that GDA2020/MGA2020 and GDA94/MGA94 coordinates differ by up to 2.5 m horizontally depending on location. Failure to correctly describe datum relegates position information to metre-level accuracy at best, and significantly increases the uncertainties and risks associated with utility infrastructure management. The actual positioning accuracy achieved, and therefore the classification of the infrastructure in question, is subject to limitations of method(s) employed.

For reliable information during design and construction, the following should be confirmed —

- (a) that utilities, whether active, abandoned, or unknown, are identified;
- (b) that the utilities are recorded correctly;
- (c) that the numbers of actual utility pipes or cables under the ground are known or represented by correctly understood multiple numbers;
- (d) that the width of utilities is correct;
- (e) that the depths of utilities are known and utility, clearances and access needs are understood; and
- (f) that the position of utilities, both horizontally and vertically are known to the best reasonable quality, and uniquely and unambiguously identified for both relative and absolute positioning.

Traditionally, projects where subsurface utilities require amendment may encounter issues that are routinely handled through variation orders, insurance payouts, contingency pricing and, especially in the construction sector, after a design has been completed. When problems create significant costs and safety risks, stakeholders may receive blame, for example the person who has documented their designs, regardless of disclaimers. All stakeholders will benefit from improved management of subsurface utilities including the application of modern locating and positioning techniques.

## NOTES

# Australian Standard®

## Classification of Subsurface Utility Information (SUI)

### Part 2: Subsurface utility engineering (SUE)

#### Section 1 Scope and general

##### 1.1 Scope

This document provides a framework for the management of information and decision-making tools for projects that may impact subsurface utilities. It has been written primarily from an engineering perspective, and applies to all existing (including redundant) and under-construction subsurface utility infrastructure and associated surface features.

This document does not apply to utility infrastructure that is above the surface, such as overhead power and telecommunication lines. Therefore, any reference within this document to above ground utilities is in the context of spatial constraints of plant and machinery to the overhead utility while working on subsurface utilities.

However, this document recognizes that the same principles of conflict identification may be applied to aerial assets, as their replacement can involve subsurface activities and solutions.

This document describes common methods for locating (i.e. detecting) subsurface utility infrastructure, but does not provide guidance on specific methods to determine, manage or apply spatial position information. This focus recognizes that physically confirming the presence and identity of infrastructure is historically the primary concern when considering safe access or avoidance.

However, the authors of this document also recognize that increasingly accurate and accessible positioning methods, coupled with progressively improving catalogues of utility positions, have the potential to drive significant improvements in subsurface utility management. GPS/GNSS positioning at decimetre-level accuracy can be obtained using inexpensive mass-market mobile devices, supported by Augmented Reality (AR) applications to make spatial information easily accessible in the field. While not in scope for this revision of the document, positioning methods can be expected to have an increasing role in the improved detection and management of subsurface infrastructure.

**NOTE** Consultation with competent professionals is recommended to identify appropriate methods and satisfy tolerances for absolute spatial positioning and relative spatial positioning where required in this document.

##### 1.2 Application

This document is intended for use by all entities or individuals involved in the management of subsurface utilities. This document, as a reference or as part of a specification, is intended to assist design or utility engineers, project and utility owners and authorities, and constructors in understanding the management of utility data.

##### 1.3 Normative references

There are no normative references in this document.

**NOTE** Documents referenced for informative purposes are listed in the Bibliography.

##### 1.4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 1.4.1

#### **absolute spatial position**

location of a point on the utility shown by reference to a coordinate system from which can be derived horizontal Map Grid of Australia (MGA94 or MGA2020) coordinates, related to the relevant geocentric datum (GDA94 or GDA2020 respectively), and a vertical position referenced to a nominated datum

Note 1 to entry: The Australian Height datum (AHD) is currently the most commonly employed datum for vertical positioning of infrastructure in Australia.

Note 2 to entry: See also, reduced level ([1.4.26](#)).

### 1.4.2

#### **as-built record**

#### **work as-executed**

#### **as-constructed**

representation of the utility infrastructure as it exists in the field, showing a relationship to a defined absolute or relative reference system

Note 1 to entry: As-built records can include both hardcopy plans and computer-generated geographic information systems.

Note 2 to entry: See also, record ([1.4.25](#)).

### 1.4.3

#### **attribute information**

recorded description of the location and physical properties of subsurface utility infrastructure

Note 1 to entry: For example, an attribute may be the owner and type of the utility, the configuration of the asset or the type of constructed material.

### 1.4.4

#### **Australian Height Datum**

#### **AHD**

coordinate reference system used for height in Australia

Note 1 to entry: The Australian Height Datum (AHD) is used to refer collectively to AHD71, defined for use on the Australian mainland, and AHD-TAS83, defined for use on Tasmania. Since 2017, the EPSG:5111 definition of AHD also includes the Christmas Island Height Datum (CIHD) and Cocos (Keeling) Island Height Datum (CKIHD).

### 1.4.5

#### **Before You Dig Australia**

#### **BYDA**

national not-for-profit organization consisting of state entities whose member companies own Australia's underground assets

### 1.4.6

#### **coordinate reference system**

#### **datum**

parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames with respect to the Earth.

Note 2 to entry: See [1.4.4](#) and [1.4.14](#) for common reference systems used in Australia.

[SOURCE: AS/NZS ISO 19111]

**1.4.7****datum****coordinate reference system**

parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames with respect to the Earth.

Note 2 to entry: See [1.4.4](#) and [1.4.14](#) for common reference systems used in Australia.

[SOURCE: AS/NZS ISO 19111]

**1.4.8****detection**

non-intrusive, remote sensing methods used to determine the approximate location of subsurface utilities from the surface

Note 1 to entry: This includes acoustic devices, electromagnetic technologies, ground penetrating radar and other surface geophysical techniques.

Note 2 to entry: See [Appendix H](#) for information on various utility detections means.

**1.4.9****ellipsoidal height**

height of a point above the ellipsoid (a simplified mathematical representation of the Earth, often used as a reference surface for positioning, navigation, map projections and geodetic calculations), measured along a straight line perpendicular to the ellipsoid

Note 1 to entry: A fall in ellipsoidal height does not take into account local gravity variations and may not indicate the direction of water flow.

**1.4.10****engineering management**

process of interaction between the various utility stakeholders in managing the utility design component of the project

Note 1 to entry: Examples of utility stakeholders are utility or design engineers.

**1.4.11****EPSG Geodetic Parameter Dataset**

published and widely adopted registry established by the European Petroleum Survey Group (EPSG), now maintained by the International Association of Oil and Gas Producers (IOGP), which uniquely describes coordinate reference systems (CRS) or spatial reference systems (SRS), map projections and transformations

Note 1 to entry: Available via <https://www.epsg.org/>.

**1.4.12****feature code**

identifier used by a utility owner that indicates the feature, type and nature of the utility service

Note 1 to entry: The feature code comprises a utility type code (see [Table A.3](#)) and a utility sub-type code ([Table A.4](#)).

**1.4.13****locate****location**

act or method of detecting and/or identifying a subsurface utility

**1.4.14****Map Grid of Australia  
(MGA94 or MGA2020)**

projected coordinate reference system used in Australia

Note 1 to entry: MGA94 and MGA2020 are the projection from GDA94 and GDA2020 respectively, expressed in Easting and Northing grid coordinates in a nominated MGA zone. MGA94 and MGA2020 coordinates differ by up to 2.5 m.

Note 2 to entry: GDA2020 is the current “Recognized-Value Standard (RVS) of measurement of position”.

**1.4.15****may**

indicates the existence of an option

**1.4.16****metadata**

structured information advising specific attributes pertaining to the utility asset

**1.4.17****non-contestable works**

relocation or protection of one or more utilities owned by a particular authority due to the commencement of a new project, whereby that particular authority chooses to undertake the work themselves

Note 1 to entry: Any pipes located might contain assets owned and controlled by another utility (e.g. conduits might contain cables owned and operated by other carriers), as is often the case with telecommunication utilities. Such a situation would require interfacing with all those multiple entities when resolving non-contestable works.

**1.4.18****position**

determine the horizontal and/or vertical coordinates of a subsurface utility, or the coordinates themselves of that utility

**1.4.19****potholing**

excavation technique to locally expose and validate a subsurface utility at a point

**1.4.20****Quality Level A****QL-A**

Note 1 to entry: Refer to AS 5488.1:2022 Clause 2.

**1.4.21****Quality Level B****QL-B**

Note 1 to entry: Refer to AS 5488.1:2022 Clause 2.

**1.4.22****Quality Level C****QL-C**

Note 1 to entry: Refer to AS 5488.1:2022 Clause 2.

**1.4.23****Quality Level D****QL-D**

Note 1 to entry: Refer to AS 5488.1:2022 Clause 2.

**1.4.24****Recognized-Value Standard (RVS) of measurement of position**

positions (coordinates, velocities and uncertainties expressed as 95 % confidence intervals) of the geodetic stations in the Australian Fiducial Network (AFN) which define the Geocentric Datum of Australia, as per the *National Measurement Act 1960* (NMA Act 1960)

Note 1 to entry: The Geocentric Datum of Australia 2020 (GDA2020) is the current RVS for measurement of position, as defined by the *National Measurement (Recognized-Value Standard of Measurement of Position) Determination 2017*, <https://www.legislation.gov.au/Details/F2017L01352>.

Note 2 to entry: The RVS provides the basis for legal traceability of position in Australia, when position is derived through well-defined connection(s) with the RVS (usually via authoritative survey mark(s) and geodetic infrastructure) and derived using suitably calibrated equipment.

**1.4.25****record**

collection of information relating to the subsurface utility infrastructure, including attribute information such as geospatial data and asset attributes that can be reproduced and maintained

Note 1 to entry: See also, as-built record ([1.4.2](#)).

**1.4.26****reduced level****RL**

elevation (height) of a point expressed relative to the nominated datum

Note 1 to entry: The Australian Height datum (AHD) is currently the most commonly employed datum for vertical positioning of infrastructure in Australia.

**1.4.27****redundant**

utility that is out of service abandoned, decommissioned or not in use

Note 1 to entry: In its application to subsurface utility infrastructure, redundant includes infrastructure that may be heritage-listed or contain environmental hazards, such as asbestos. The utility owner that placed the infrastructure is responsible for redundant infrastructure and does not relinquish ownership unless the utility owner no longer exists or cannot be traced; or the infrastructure has been sold.

**1.4.28****relative spatial position**

horizontal and/or vertical location of a point on the utility related by the relative measurements to physical structures (e.g. kerbs, fences, retaining walls, ground level)

Note 1 to entry: Physical structures can move or cease to exist over time.

**1.4.29****should**

indicates a recommendation

**1.4.30****source**

metadata information that indicates how and by whom the location and attribute information was obtained

**1.4.31****subsurface utility**

utility asset or utility network beneath ground or surface level, including exposed or submerged utilities

**1.4.32****Subsurface Utility Engineering  
SUE**

engineering management process that involves engineering, geophysics and geospatial disciplines and technologies to manage certain risks associated with utility mapping at appropriate quality levels

Note 1 to entry: The process may include —

- (a) utility positioning;
- (b) utility relocation design and positioning;
- (c) utility condition assessment;
- (d) communication of Subsurface Utility Information (SUI) utility data to concerned parties;
- (e) utility relocation cost estimates;
- (f) implementation of utility accommodation policies;
- (g) utility designs, giving regard to non-contestable works (see [Clause 1.4.17](#)); and
- (h) design around existing and proposed utilities.

**1.4.33****tolerance**

amount by which the recorded location can deviate from the actual location of the utility and still meet the requirements of the quality level

Note 1 to entry: It is an expression of the local uncertainty or positional uncertainty of the point, as defined in Intergovernmental Committee on Surveying and Mapping, *Special Publication 1* (ICSM SP1).

**1.4.34****trace**

physically locate a known service by applying an electromagnetic signal along or within the utility to a known or visible point, not limited to the area of interest, where practical

**1.4.35****utility**

publicly, privately or jointly owned and operated asset, located on either public or private property, the purpose of which is to transport for either the public or a private party a service or commodity

**1.4.36****utility coordination**

engineering process that involves Subsurface Utility Engineering, conflict analysis, communication about project requirements, and construction observation or inspection of utility relocations

## Section 2 Subsurface utility model creation and data naming conventions

### 2.1 Justification of a utility

It is important to understand where along a utility the positional location is being recorded (e.g. invert, obvert or centre). However this is often only possible for Quality Level A (QL-A) investigations. Quality Level B (QL-B) investigations usually involve locating a copper or metallic cable or wire (i.e. telecommunications or electrical) inside a conduit: it is difficult to identify where the cable or wire is sitting inside the conduit or how big the conduit is. If the material being located is cast iron or steel, the signal emits from the centre of the pipe. This affects the electronic location and is partially an issue when locating pipes greater than 450 mm in size.

Where measuring directly to the utility (Quality Level A and some Quality Level B), the following information should be used in the various utility design documents:

- (a) The measurement should always be taken from the top of the exposed conduit when possible. This can be measured by a surveyor (absolute spatial positioning, Quality Level A) or by a taped depth from the existing surface or ground level to the top of the utility. Metadata which captures the date of survey and the nature of the existing ground surface can be useful when assessing potential changes in the existing surface or ground level over time. Absolute spatial positioning is recommended over relative spatial positioning by this document.

If there is a bank of conduits, then the overall width and sides of the conduits should be exposed so the bank can be accurately measured and recorded as well as enable the configuration of the conduits to be identified.

- (b) If there are protective coverings over the conduit or pipes, then the following information should apply:
  - (i) TOHC — Top of Hard Cover — the thick plastic coating protection typically put over the top of gas and electrical conduits or direct laid cable. Potholes past this hard cover should not be made unless an inspector of the particular utility authority is onsite to represent the utility authority. [Figure 1](#) below shows this TOHC arrangement.



**Figure 1 — Plastic coating protection**

- (ii) TOB — Top of Brick — refers to bricks placed on top of the utility that act as a physical protective barrier. Such barriers are usually only found on electrical and

some old telecommunications utilities for both conduited and direct buried cables or both in ducts or direct buried. [Figure 2](#) shows this TOB arrangement.



**Figure 2 — Brick protection over utility**

- (iii) TOC — Top of Concrete — refers to when the utility is encased in concrete protection. Such protection is used for all utilities. It is also normally used across road crossings and when the utility cannot be laid at the required depth.

## 2.2 String naming conventions

The following string naming conventions should be adopted, to enable a consistent approach across industry when producing design documentation related to the management of projects where subsurface utilities are affected:

- (a) Utility string number, if locating numerous utilities or cables from the same pit or access point e.g. T1, T2, T3, etc.
- (b) Utility type:
  - (i) C — Communications.
  - (ii) D — Drainage.
  - (iii) E — Electricity.
  - (iv) F — Fire Service.
  - (v) G — Gas.
  - (vi) I — ITS (Intelligent Transport Systems).
  - (vii) P — Petroleum.
  - (viii) S — Sewer.
  - (ix) WW — Wastewater.
  - (x) W — Water.
  - (xi) N — Not specified.
- (c) Depth and the point on the asset used as the reference to the surface e.g. top of conduit or protective coating.

NOTE Additional information to that which is specified above will render the resultant drawing cluttered and difficult to read. Any other relevant information should be recorded in the attribute data.

## 2.3 Specific attribute data

The following attribute data should be requested by the design or utility engineer from the field location and survey undertaking to best inform the level of utility design:

- (a) Utility owner.
- (b) Coordinate reference system.
- (c) Date of field works.
- (d) Quality level of investigation applicable.
- (e) Pothole string number.
- (f) Actual utility attributes:
  - (i) Type.
  - (ii) Material type, if able to be determined onsite.
  - (iii) Size, if able to be determined onsite.

NOTE 1 This can be difficult if the pothole depth is over 1.5 m.

- (iv) Configuration, conduit bank measurements.
  - (v) Depth (and confirmation of location, e.g. obvert, or top or crown of utility).
  - (vi) Utility protection, if any.
- (g) Date or age of installation (if known).
 

NOTE 2 This information is unlikely to be available unless working directly for a utility owner. Conduit may show manufacture date which can give some indication of install date.
- (h) Interval or frequency of points to be taken as specified.
- (i) Feature codes of surface and subsurface features, including, but not limited to, pits, access chambers, poles, valves, hydrants etc.
- (j) Location of points on surface and subsurface features measured in terms of absolute spatial positioning within defined Quality Level A tolerances.

NOTE 3 See [Appendix A](#) for a utility schema format as well as a populated example of one. The purpose of the schema is to provide a suggested minimal level of information for the management of SUI data throughout the design, construction and asset management lifecycle. The format of the schema is not prescribed, as this is the project owner's prerogative.

## 2.4 Appropriate level of model creation

### 2.4.1 General

The level of model complexity should be matched with the level of risk that utilities pose to the project. Prior to commencement of utility modelling or clash detection activities, a risk assessment should be undertaken with the outcome of this assessment determining the appropriate level of modelling detail. This process should be carried out throughout the project design and construction phases. Model levels may not be project wide but should be location specific if the risks change from area to area across the project.

It is fundamentally important to identify the appropriate level of model creation for the size and type of project and hence establish an understanding of and manage a pertinent level of risk associated with utility management. This should be in the form of the outcome of a risk assessment. The risk assessment procedure should be a detailed exercise, remembering that the actual risk assessment is project specific. Risk assessments should consider the following factors as a minimum —

- (a) multiple discipline projects;
- (b) criticality;
- (c) complexity and density of utility assets;
- (d) program constraints of project delivery; and
- (e) which phase of the project is being undertaken.

NOTE [Appendix B](#) is an indication of an appropriate risk assessment matrix that should be used across all projects requiring utility management, in consideration of various project levels of complexity. This matrix also describes an appropriate model level in accordance with the project complexity.

## **2.4.2 Model Level 1**

### **2.4.2.1 Description**

Model Level 1 includes a Quality Level D information overlay in two dimensions.

NOTE Quality Level D information does not provide horizontal or vertical accuracy, so the uses for this level of modelling are limited.

Quality Level D information should not be used to create a 3-dimensional model using draped assumed depths or other methods.

### **2.4.2.2 Setup**

Model Level 1 setup includes digitized Quality Level D information overlaid with the proposed project works.

### **2.4.2.3 Use**

Quality Level D information is appropriate for a project planning study, potential utility impact assessment, and business case. Quality Level D information is also used to —

- (a) identify areas of concern and key risks at a project-planning phase;
- (b) scope a higher level of survey (such as A, B, C);
- (c) create a utility asset register of all assets within the project boundary; and
- (d) act as an input for initial utility owner discussions.

## **2.4.3 Model Level 2**

### **2.4.3.1 Description**

Model Level 2 includes a Quality Level B and Quality Level C information overlay in two dimensions.

### **2.4.3.2 Setup**

Model Level 2 setup includes Quality Level B and Quality Level C utility survey information overlaid with the proposed project works.

### 2.4.3.3 Use

Quality Level B and Quality Level C information is appropriate for —

- (a) project reference design;
- (b) creation of a Public Utility Plant (PUP) conflict register (as per [Appendix E](#));
- (c) identifying likely utility conflicts with the project works; and
- (d) project scoping —
  - (i) for works to provide data for Quality Level A; and
  - (ii) for condition assessment works.

## 2.4.4 Model Level 3

### 2.4.4.1 Description

Model Level 3 includes Quality Level B information that is used to create a 3-dimensional utility asset object model and is supplied as an absolute position and not a relative one.

### 2.4.4.2 Setup

Model Level 3 setup includes Quality Level B utility survey information converted from site data and survey strings into 3-dimensional objects (containers). Model dimensions should be applied to the utility survey string that represent the size, shape and material composition of the utility. Quality Level D information should be used to add knowledge to the interpretation of what has been surveyed.

### 2.4.4.3 Use

Quality Level B information is appropriate for —

- (a) tender design;
- (b) assessment of subsurface utility conflict and project scoping:
  - (i) for works to provide data for Quality Level A; and
  - (ii) for condition assessment works;
- (c) 3-dimensional clash detection and analysis;
- (d) concept and preliminary design;
- (e) construction planning;
- (f) programming design;
- (g) construction works;
- (h) identification of key risks and opportunities; and
- (i) cutting sections.

### 2.4.4.4 Utility capture position

The string location within the utility asset (centre, invert, obvert, top etc.) should be understood by the modeller. This information should be clearly articulated by the subsurface utility engineer or the utility surveyor. When using electromagnetic frequency detection, the signal applied radiates out from the centre of the utility and should be displayed as such.

The utility or design engineer should understand the various means of utility capture within the site works. Examples of this are as follows:

- (a) Multiple ducts containing cables.

NOTE 1 The layout of ducts can change in a particular run by rotating or moving to a horizontal or vertical layout.

- (b) Small cables which typically lay on the invert of the duct.

NOTE 2 The pothole z-value of the cable might not align, particularly if thought to be at the obvert or crown of the utility.

- (c) Direct buried cables.

- (d) Ducts that are located with a traceable rod.

NOTE 3 The pothole z-value might not align.

- (e) Trace wires.

NOTE 4 Trace wires are typically not laid with the utility but 300 mm above, and might even be off centre from the pertinent utility.

- (f) Large diameter pipes.

NOTE 5 The pothole z-value might not align.

- (g) Survey of a visible feature which might not be directly above the utility.

NOTE 6 Quality Level C represents the presence of a utility but not necessarily the accurate position of it.

- (h) Measurement of chambers with limited sight or access.

NOTE 7 Chamber size might not be accurate.

- (i) External walls of chambers measured internally.

NOTE 8 Chamber wall thickness can be 50 mm if formed or moulded but up to 500 mm in some cases.

## 2.4.5 Model Level 4

### 2.4.5.1 Description

Model Level 4 is a 3-dimensional model based upon Quality Level A. All levels of utility data (Quality Levels A, B, C and D) should be used to prepare a 3-dimensional utility asset object model.

Sometimes Quality Level A data does not provide the best level of accuracy if the levels provided are surveyed on top of a concrete encasement or on top of a protective hard cover. For the highest level of accuracy, the utility asset should be exposed down the sides and the asset surveyed from above. It should also be measured vertically down the side of the asset, unless high voltage direct laid cables are present.

It is important to note that a pothole survey could be taken from the top of the utility, and that a survey of structures could be included for utilities identified at their inverts.

Creation of a Level 4 model requires application of engineering principles and judgement, as many decisions and choices need to be made, taking all the four levels of data into account. It is common to use Quality Level B information to inform the horizontal geometry of the asset in the model, with the asset as-constructed or as-built drawing records being used in conjunction with Quality Level A points to prepare the model.

### 2.4.5.2 Setup

A Level 3 model should be first created as described in [Clause 2.4.4](#). Level B string positions should then be calibrated and changed or updated in horizontal and vertical level to match the Level A quality survey data that is received. Pits, access chambers, and other underground utility structures should also be modelled as solid objects based on internal pit or access chamber surveys.

As-constructed or as-built data should be used as a guide to interpret the survey information. Engineering judgement should be used to determine the most likely asset size and position. Where insufficient information is available to inform this judgement, an additional survey should be conducted. If an additional survey is taken, the asset should also be flagged in the model to show end users that the individual utility object remains unverified.

## 2.4.6 Model Level 5

### 2.4.6.1 Description

A Level 5 model includes a Fabrication (Construction) Model — Quality Level A verified. The surveyor should undertake all surveying requirements so that all conformance requirements can be met, as new or relocated utility assets are constructed.

### 2.4.6.2 Setup

A Level 3 or Level 4 model should first be created as described in [Clause 2.4.4](#) and [Clause 2.4.5](#). The fabricated or constructed model should be checked for the following conformance requirements, as new and relocated utility assets are constructed during a project:

- (a) All relevant construction tolerances have been met.
- (b) Cover and depth requirements have been met.
- (c) Utilities should be contained within relevant assigned spatial corridors.
- (d) Location of constructed utilities should not clash with any subsequent installed utilities.

## 2.4.7 Model Level 6

### 2.4.7.1 Description

Model Level 6 includes an As-Built (or As-Constructed) Model — Quality Level A verified. The surveyor should undertake all surveying requirements to meet Level A survey data prior to backfill of the utility asset, as new or relocated utility assets are constructed. Where the asset is bored, the bore-head is tracked to provide Level B data.

### 2.4.7.2 Setup

The as-built or as-constructed model should be set up to enable transfer of information to the utility owner in accordance with utility owners' requirements, as new and relocated utility assets are constructed during a project. The as-built model should be maintained as an updated version of the Level 3 or Level 4 model that was created prior to construction, as follows:

- (a) The position of existing utility assets should be updated as additional quality level information becomes available during construction.
- (b) If existing utility assets have been removed from the ground, these assets should be removed from the model or placed on a model layer that indicates they have been removed.

- (c) If existing utility assets have been made redundant and not removed (e.g. grout filled and abandoned), these assets should be placed on a model layer that indicates they have been made redundant but retained.
- (d) Where new or relocated utility assets have been constructed, these are to be added into the as-built or as-constructed model based on Model Level 4 or Model Level 5, to match the design model level or client specification requirements.
- (e) Validation for information for Items (a) and (d) above for segments and points can be obtained as follows:
  - (i) A line segment can be validated by interpolation. Interpolation is a method of estimating values between known measured data points. The positional location between measured discrete points along a utility can be interpolated with the following provisos:
    - (A) The utility should be fully exposed (as in an open trench) and can be physically sighted and measured.
    - (B) Measurements should be at every change of grade and change in horizontal direction.
    - (C) Measurements should be made at every change of utility size or configuration.
    - (D) Interpolation in this context should still satisfy the maximum horizontal and vertical tolerance required for QL-A absolute spatial positioning.
  - (ii) Where applicable, interpolated line segments should be attributed as “interpolated Quality Level C”.