



Classification of subsurface utility information

Part 1: Subsurface utility information



AS 5488.1:2019

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- Dial Before You Dig
- Energy Networks Australia
- Engineers Australia
- Geospatial Information & Technology Association
- National Utility Locating Contractors Association
- NBN Co
- Roads Australia
- SafeWork NSW
- Surveying & Spatial Sciences Institute
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Preface

This Standard was prepared by Standards Australia Committee IT-036, Subsurface Utility Engineering Information.

The objective of this Standard is to provide a framework for the consistent classification of information concerning subsurface utilities for the management of subsurface utilities. This Standard focuses on the classification of Subsurface Utility Information (SUI). AS 5488.2 provides guidance on the management of subsurface utilities, as referred to by Subsurface Utility Engineering (SUE).

This Standard also provides guidance on issues such as how subsurface utility information may be obtained (refer to AS 5488.2), and how that information should be conveyed to the information users. This Standard also 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.

NOTE In countries prone to natural disasters or terrorist attacks, absolute positioning has a major advantage in locating subsurface utility assets and infrastructure after such an event.

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.

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Australian Standard[®]

Classification of subsurface utility information

Part 1: Subsurface utility information

Section 1 Scope and general

1.1 Scope

This Standard provides a framework for the classification of subsurface utility location and attributes information in terms of specified quality levels for the management of subsurface utilities.

This Standard applies to subsurface utilities and associated surface features that facilitate the location, identification and engineering management of subsurface utility infrastructure.

This Standard also applies to all existing (including redundant) and under-construction subsurface utility infrastructure.

For the purpose of this Standard, the term “subsurface” includes “submerged” (see 1.4.28).

This Standard does not apply to utility infrastructure that is above the surface, such as overhead power and telecommunication lines.

1.2 Application

1.2.1 General

This Standard is intended for users of subsurface utility infrastructure information throughout the lifecycle of the utility; including those that collect, represent, map and manage such infrastructure information.

1.2.2 Representation of subsurface utilities

The representation of subsurface utilities on maps, plans and electronic records, in terms of symbology, line types and colours is the prerogative of the entity that owns or operates the utility. Although this Standard recommends how this information should be recorded (see [Appendix B](#)), it is not intended to prevent or encumber an entity that maps subsurface utilities from using its own symbology, line types and colours to depict and record subsurface utilities in its own geographic information systems, mapping databases, plans, drawings or other records.

1.2.3 Retrospective application

This Standard may be applied retrospectively to existing subsurface utilities with regard to classifying information from systems and repositories.

The principles of risk management and continuous improvement in the quality and accuracy of subsurface utility records should be considered.

1.2.4 Currency of subsurface utility information (SUI)

Quality Levels (QL) apply to a subsurface utility at the date that the information was obtained. Due to physical man-made and natural changes that may occur in the area around the subsurface utility since that date, at any future time and without further investigation the relative spatial position only indicates the best information available about the location of the subsurface utility. Similarly, catastrophic events such as earthquakes may affect the recorded absolute spatial position of the subsurface utility.

1.3 Referenced documents

There are no normative references in this document.

NOTE Documents for informative purposes are listed in the Bibliography.

1.4 Definitions

For the purpose of this Standard, the following terms and definitions apply.

1.4.1

absolute spatial position

location of a point on the utility shown by reference to a three dimensional coordinate system from which can be derived horizontal Map Grid of Australia (MGA) coordinates in Easting and Northing, and related to the relevant MGA zone and Geocentric datum, and a vertical position referenced to a datum based on mean sea level (such as the Australian Height Datum)

Note 1 to entry: See also “reduced level”.

1.4.2

as-built record

representation of the utility infrastructure as it exists in the field, showing a relationship to a defined absolute or relative reference system. As-built records can include both hardcopy plans and computer-generated geographic information systems

Note 1 to entry: Also referred to as “work-as-executed” or “as-constructed”.

Note 2 to entry: See also “record”.

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

datum

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

[SOURCE: AS/NZS ISO 19111]

1.4.5

detection

non-intrusive, remote sensing methods used to determine the approximate location of subsurface utilities from the surface including, but not limited to, acoustic devices, electromagnetic technologies, ground penetrating radar and other surface geophysical techniques

1.4.6

dial before you dig (DBYD)

a national not-for-profit organisation consisting of state entities whose member companies own Australia’s underground assets

1.4.7

engineering management

process of interaction between the various utility stakeholders, primarily driven by the utility or design engineer, in managing the utility design component of the project

1.4.8**feature code**

an 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 primary code (see [Table B.2](#)) and a descriptor code.

1.4.9**line depiction**

line generated by connecting individual points along a located utility

1.4.10**locate**

determine the position of a subsurface utility

1.4.11**Map Grid of Australia (MGA)**

projected coordinate reference system used in Australia

Note 1 to entry: MGA grid coordinates are expressed as Eastings, Northings.

1.4.12**may**

indicates the existence of an option

1.4.13**metadata**

structured information advising specific attributes pertaining to the utility asset

Note 1 to entry: It may include descriptive attribute information about the utility itself and administrative attribute information about when the information was created, access restrictions and archival information.

Note 2 to entry: Refer to ANZLIC Metadata Profile.

1.4.14**non-destructive digging**

using hand digging or sensitive vacuum/water blasting techniques so that the utility service or its protective covering are not damaged or destroyed

1.4.15**point depiction**

attribute information related to a specific point on the infrastructure and stored at the time of data collection

1.4.16**potholing**

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

1.4.17**Quality Level A (QL-A)**

highest quality level, consisting of the positive identification of the attribute and location of a subsurface utility at a point to an absolute spatial position in three dimensions

1.4.18**Quality Level B (QL-B)**

quality level that provides relative subsurface feature location in three dimensions

Note 1 to entry: The minimum requirement for Quality Level B is relative spatial position

1.4.19**Quality Level C (QL-C)**

surface feature correlation or an interpretation of the approximate location and attributes of a subsurface utility asset using a combination of existing records (or anecdotal evidence) and a site survey of visible evidence

Note 1 to entry: The minimum requirement for Quality Level C is relative spatial position.

1.4.20**Quality Level D (QL-D)**

lowest of the four quality levels for which the attribute information and metadata of a subsurface utility can be compiled from any, or a combination of existing records, site inspections, anecdotal evidence

Note 1 to entry: Specific details of the four quality levels are provided within Part 1, item 2, of this Standard.

1.4.21**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”.

1.4.22**reduced level (RL)**

elevation (height) of a point expressed relative to the applicable regional height datum based on mean sea level

Note 1 to entry: For example, on the Australian mainland, this is the Australian Height Datum (currently AHD71), and on Tasmania it is AHD-TAS83.

1.4.23**redundant**

out of service, abandoned, decommissioned, 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.

1.4.24**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) that are themselves capable of being referenced in terms of absolute spatial position

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

1.4.25**shall**

indicates that a statement is mandatory

1.4.26**should**

indicates a recommendation

1.4.27**source**

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

1.4.28**submerged**

utility asset or utility network that is covered or obscured

1.4.29**subsurface utility**

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

1.4.30**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, as well as —

- (a) utility coordination;
- (b) utility relocation design and coordination;
- (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; and
- (h) design around existing and proposed utilities.

1.4.31**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 of the point, as defined in Intergovernmental Committee on Survey and Mapping, Special Publication 1 ICSM SP1.

1.4.32**trace**

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

1.4.33**unknown entity**

utility that is determined in accordance with the quality levels in AS 5488 where no ownership origin nor specific details about the type and composition of the utility can be determined and for the purposes of record

1.4.34**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

1.4.35**utility owner**

owner of the subsurface utility asset, network or infrastructure

1.4.36**validate (Quality Level A)**

direct physical access and verification of the absolute spatial position and detailed attributes of the utility infrastructure

Section 2 Quality Levels (QL)

2.1 Scope of section

This section sets out the characteristics and requirements of each quality level. Each quality level is determined in terms of attribute information and metadata.

2.2 General

A quality level describes the amount and accuracy of information that is collected or held on a subsurface utility. There are four quality levels: D, C, B and A.

NOTE Further detail on quality levels, their application and their limitations is provided in [Appendix A](#).

Quality Level A is the highest quality level. The higher the quality level, the more information is known about the subsurface utility and the more accurate that information is.

The quality level of a subsurface utility may vary along its length depending on the associated attribute information and metadata available.

The amount of attribute information and metadata required by this section depends on the quality level. For example, the attribute location information varies from a simple approximation (Quality Level D) to an absolute location in three dimensions within specified tolerances (Quality Level A).

NOTE Further guidance on how to present attribute information and metadata are provided in [Appendix B](#).

2.3 Utility information without an indication of quality levels

If the metadata does not indicate a quality level, then the utility information shall default to Quality Level D.

2.4 Quality Level D

2.4.1 General

Quality Level D (QL-D) is the lowest of the four quality levels. The attribute information and metadata of a subsurface utility may be compiled from any, or a combination of —

- (a) existing records;
- (b) cursory site inspection; and
- (c) anecdotal evidence.

2.4.2 Attribute information

Quality Level D attribute information shall include —

- (a) the utility owner;
- (b) an indication of the utility type;
- (c) the date of installation (if known);
- (d) condition of the utility (if known); and
- (e) an indicative location of the surface and subsurface features of the utility.

Tolerance shall not apply to an indicative location that is attributed to Quality Level D.

2.4.3 Metadata

Quality Level D metadata shall include the following:

- (a) The identifier acronym, QL-D.
- (b) The date that the data was captured.
- (c) The source of the information.

2.5 Quality level C

2.5.1 General

Quality Level C (QL-C) is described as a surface feature correlation or an interpretation of the approximate location and attributes of a subsurface utility asset using a combination of existing records (and/or anecdotal evidence), a site survey of visible evidence, and/or methods to indicate the existence of an undefined entity. The minimum requirement for QL-C is relative spatial position.

2.5.2 Attribute information

Quality Level C attribute information shall include —

- (a) the utility owner;
- (b) an indication of the utility type;
- (c) the date of installation (if known);
- (d) condition of utility (if known);
- (e) an interpolation of the location and direction of the subsurface utility using surface features as points of reference;
- (f) feature codes of surface features, including but not limited to pits, access chambers, poles, valves and hydrants; and
- (g) the location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of ± 300 mm.

2.5.3 Metadata

Quality Level C metadata shall include the following —

- (a) the identifier acronym, QL-C;
- (b) the date that the data was captured;
- (c) methods to indicate the undefined entity; and
- (d) the source of the information.

2.6 Quality level B

2.6.1 General

Quality Level B (QL-B) provides relative subsurface feature location in three dimensions by tracing (see [Clause 1.4.32](#)) or physical measurement that does not satisfy the spatial tolerance of Quality Level A. The minimum requirement for Quality Level B is relative spatial position.

2.6.2 Attribute information

Quality Level B attribute information shall include —

- (a) the utility owner;
- (b) an indication of the utility type;
- (c) the date of installation (if known);
- (d) condition of the utility (if known);
- (e) the location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of ± 300 mm; and
- (f) the location of subsurface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of ± 300 mm and maximum vertical tolerance of ± 500 mm.

2.6.3 Metadata

Quality Level B metadata shall include the following —

- (a) the identifier acronym, QL-B;
- (b) the date that the data was captured;
- (c) the source of the information; and
- (d) the locating method(s) used to obtain the attribute information.

2.7 Quality Level A

2.7.1 General

Quality Level A (QL-A) is the highest quality level and consists of the positive identification of the attribute and location of a subsurface utility at a point to an absolute spatial position in three dimensions. It is the only quality level that defines a subsurface utility as “validated”.

Where the whole line segment cannot be verified by line of sight, Quality Level A shall not be attributed to the line segment between validated points.

2.7.2 Attribute information

Quality Level A attribute information shall include —

- (a) the utility owner;
- (b) the utility —
 - (i) type;
 - (ii) status;
 - (iii) material;
 - (iv) size; and
 - (v) configuration;
- (c) the date of installation (if known);
- (d) condition of utility (if known);

- (e) feature codes of surface and subsurface features including but not limited to pits, access chambers, poles, valves, hydrants; and
- (f) the location of points surveyed on surface and subsurface features measured in terms of absolute spatial positioning with a maximum horizontal and vertical tolerance of ± 50 mm.

2.7.3 Metadata

Quality Level A metadata shall include the following —

- (a) the identifier acronym QL-A;
- (b) the date that the data was captured;
- (c) the source of the information;
- (d) the survey and locating method(s) used to obtain the attribute information; and
- (e) survey control information used to determine the absolute spatial position of the utility.

Appendix A (informative)

Quality Levels

A.1 General

The information required for each quality level may be attained by various methods of data collection. Recommended methods and potential uses for each quality level are listed below. The lists are not exhaustive.

A.2 Quality Level D

A.2.1 Potential uses

Quality Level D information may be used to establish the potential presence of subsurface utilities within an area of interest (see [Figure A.2](#)).

A.2.2 Recommended sources of attribute information and metadata

The information required for Quality Level D may be sourced through the following methods:

- (a) Utility owner's records.
- (b) A "Dial Before You Dig" (DBYD) inquiry.
- (c) Design plans.
- (d) As-built or work-as-executed plans.
- (e) Engineering mark ups.
- (f) Existing survey plan information.
- (g) GIS database.
- (h) Anecdotal evidence.
- (i) cursory site inspection.

A.2.3 Limitations

Quality Level D information does not encompass any field verification involving direct measurement and as such may only be considered to be a broad indication of the location and type of the utility.

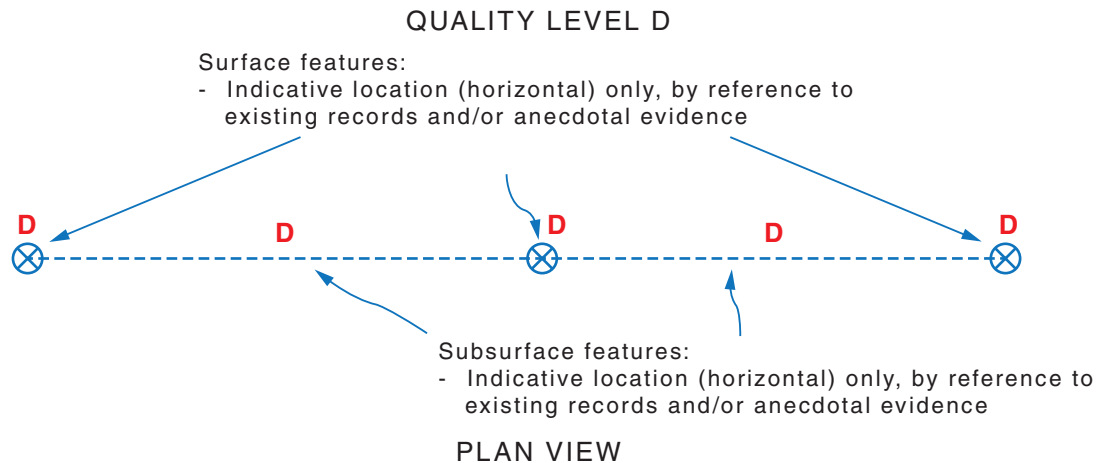


Figure A.2 — Quality Level D

A.3 Quality Level C

A.3.1 Potential uses

Quality Level C information provides an improved indication of the location of a subsurface utility than that obtained using Quality Level D techniques, by supplementing Quality Level D information with a feature or detail survey of visible utility assets and/or methods used to indicate the existence of an undefined entity. Quality Level C information is collected in order to interpolate the approximate location of subsurface utilities within an area of interest (see [Figure A.3](#)).

A.3.2 Sources of attribute information and metadata

The information required to attain Quality Level C may be sourced through the following methods:

- (a) Visible information obtained from surface features.
- (b) Other sources as listed above for Quality Level D.
- (c) Other methods to obtain proof of the existence of an undefined entity that do not utilize physical measurement or tracing that satisfy Quality Level B or Quality Level A spatial tolerances (for example: ground penetrating radar; acoustic; photographic; or other).

A.3.3 Limitations

Quality Level C information is compiled from field observations and/or survey of surface features indicating that a utility of unconfirmed attributes may reside in the proximity. It does not indicate the location of the subsurface utility with respect to the surface feature (e.g. a subsurface utility line may be offset from the position of the surface feature and is not necessarily directly below it), nor its depth.

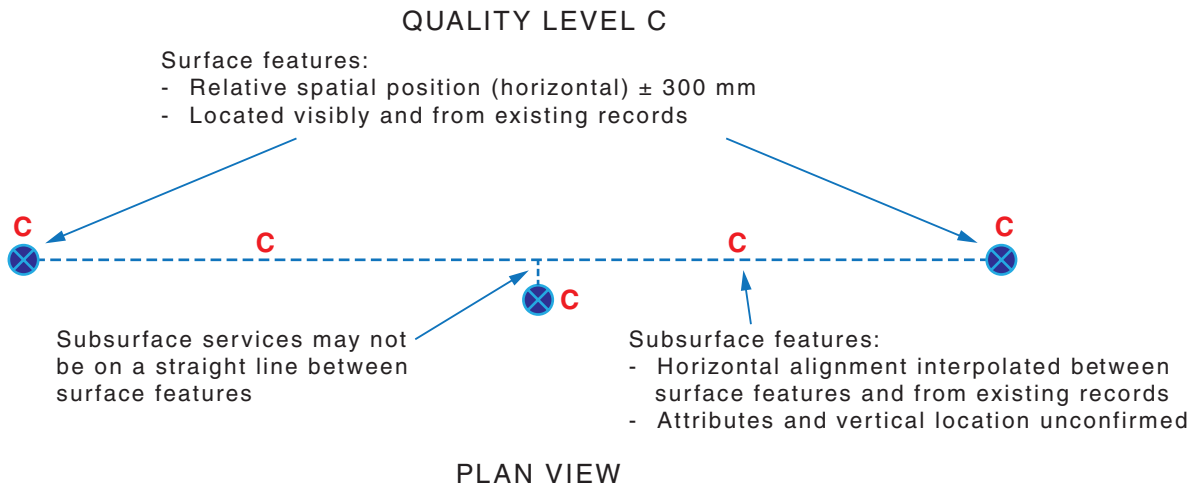


Figure A.3 — Quality Level C

A.4 Quality Level B

A.4.1 Potential uses

Quality Level B data may be used to indicate the existence and location of subsurface utilities in three dimensions (see [Figure A.4](#)).

A.4.2 Sources of attribute information and metadata

The information required to attain Quality Level B may be sourced through the following methods:

- (a) Survey measurement that does not satisfy Quality Level A spatial tolerances.
- (b) Trace.

A.4.3 Limitations

If Quality Level B information is compiled using electronic detection, it is only an indication of the existence of subsurface utilities and should not validate the utility subsurface location or attributes.

Electronic detection should not be used for obtaining accurate depth information due to the potential for interference from other adjacent services or due to geological conditions.

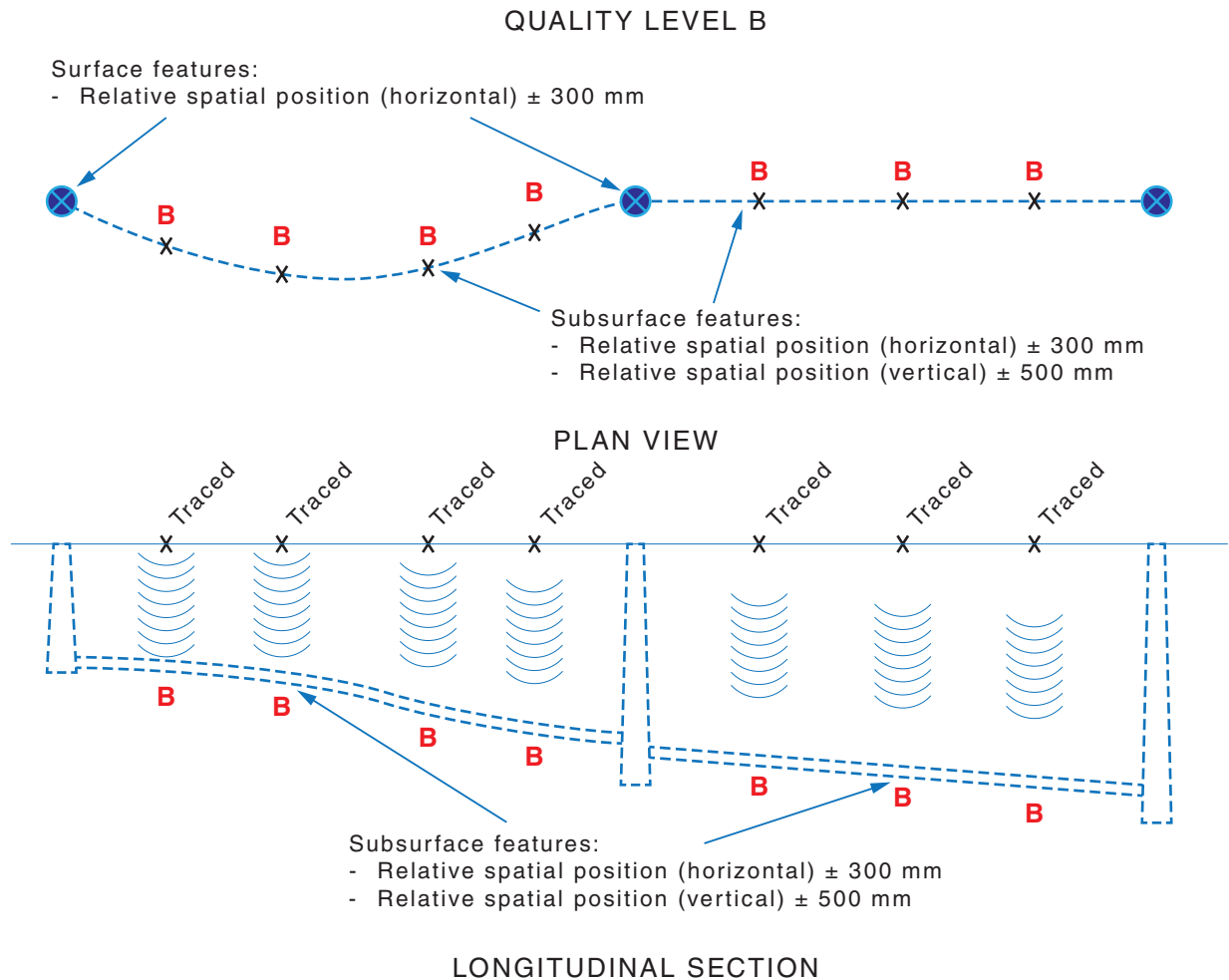


Figure A.4 — Quality Level B

A.5 Quality Level A

A.5.1 Potential uses

Quality Level A information may be used to indicate a utility's precise position in three dimensions and also to confirm the utility's attributes such as size, condition and indicative material type (see [Figure A.5](#)).

A.5.2 Sources of attribute information and metadata

The information required to attain Quality Level A may be sourced through the following methods:

- (a) Exposure of the subsurface utility either fully or partially to directly validate its attributes. Techniques to achieve this include:
 - (i) If unlimited access to the entire subsurface utility in the area of interest is available, by physical sighting, to obtain the absolute spatial position of the utility at nominated intervals, horizontal and vertical alignments and visible utility attribute information.
 - (ii) If only limited access is available at specified exposed subsurface utility locations, by potholing to obtain the absolute spatial position of the utility at exposed locations and visible utility attribute information.
- (b) Other sources as listed above for Quality Level D, Quality Level C and Quality Level B.

A.5.3 Limitations

Quality Level A may not identify the internal structure or content of the asset. For example, redundant conduits and pipes may be subsequently used by another utility owner for another purpose.

Quality Level A may not be achievable in all field situations due to geological conditions or construction methods such as concrete encasing or trenchless technologies.

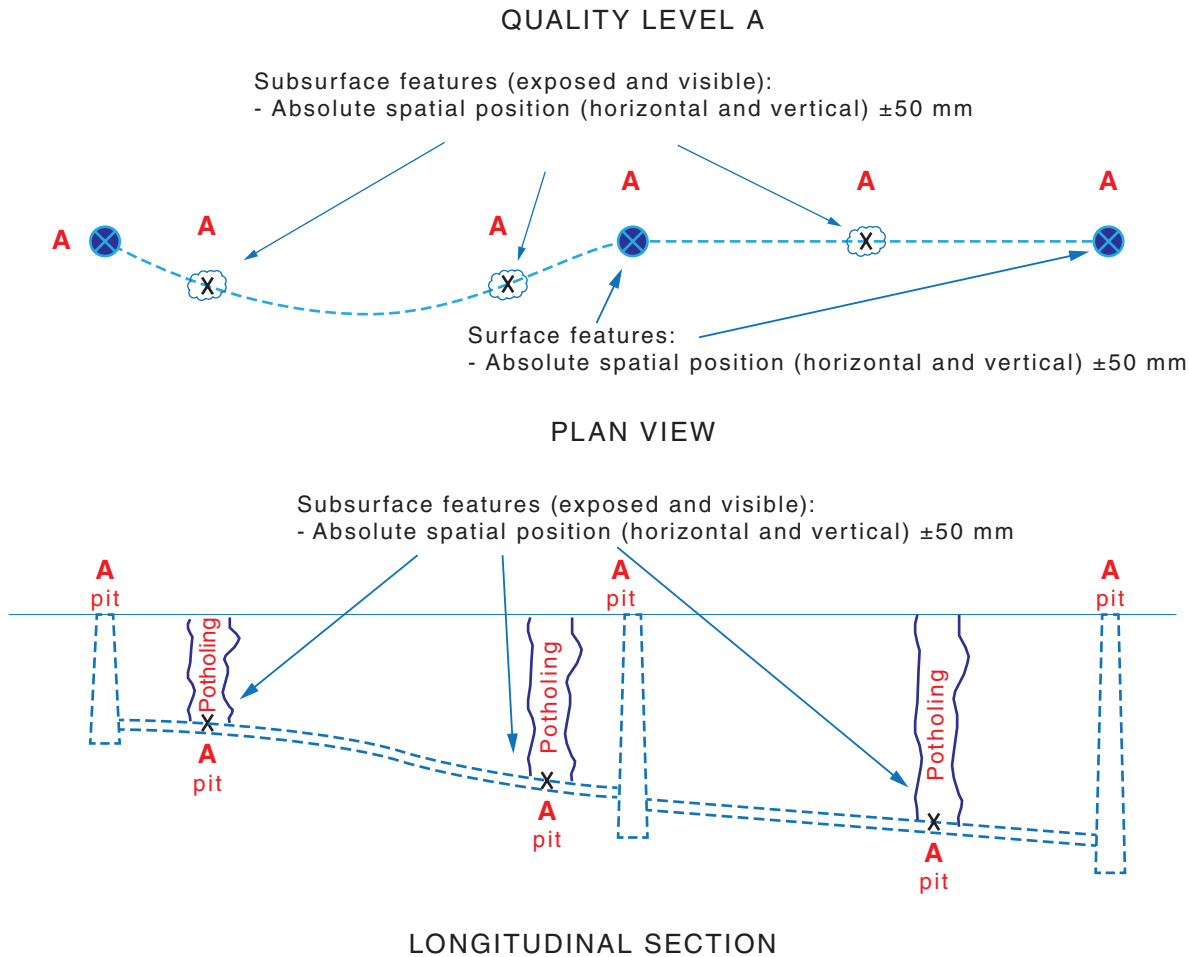


Figure A.5 — Quality level A

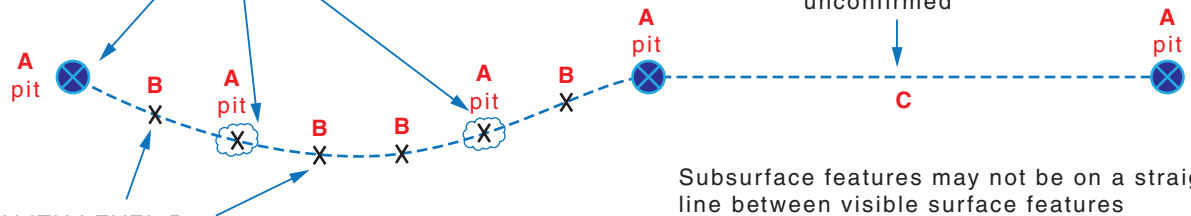
A.6 Varying quality levels

Quality levels may vary on separate sections of a single subsurface utility, depending on the source information available for each section (see [Figure A.6](#)).

VARYING QUALITY LEVELS

QUALITY LEVEL A

Surface and subsurface features (exposed and visible):
 - Absolute spatial position (horizontal and vertical) ± 50 mm



QUALITY LEVEL C

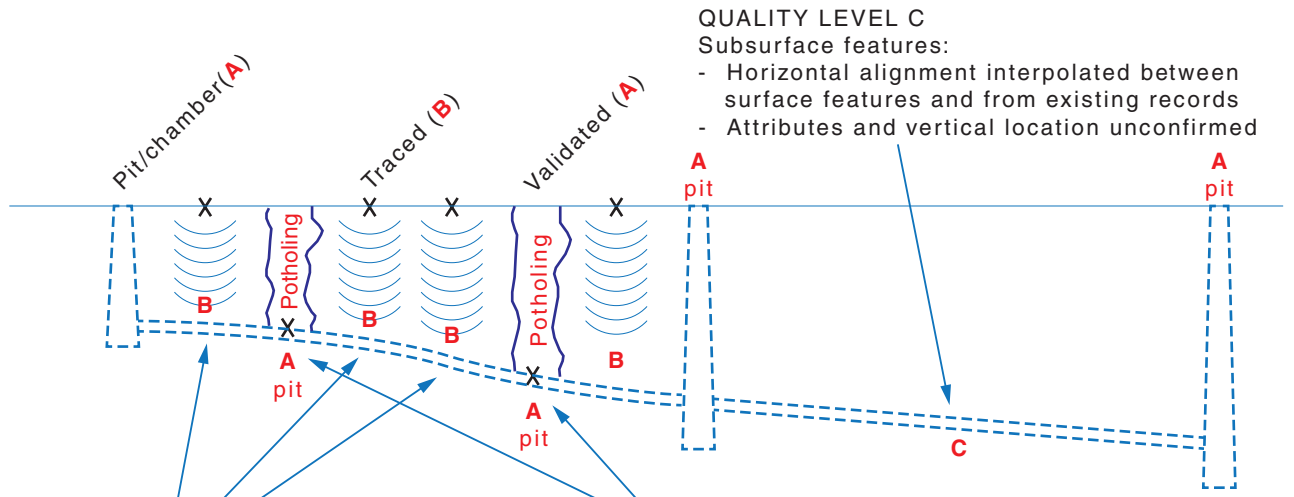
Subsurface features:
 - Horizontal alignment interpolated between surface features and from existing records
 - Attributes and vertical location unconfirmed

Subsurface features may not be on a straight line between visible surface features

QUALITY LEVEL B

Subsurface features:
 - Relative spatial position (horizontal) ± 300 mm
 - Relative spatial position (vertical) ± 500 mm

PLAN VIEW



QUALITY LEVEL C

Subsurface features:
 - Horizontal alignment interpolated between surface features and from existing records
 - Attributes and vertical location unconfirmed

QUALITY LEVEL B

Subsurface features:
 - Relative spatial position (horizontal) ± 300 mm
 - Relative spatial position (vertical) ± 500 mm

QUALITY LEVEL A

Surface and subsurface features (exposed and visible)
 - Absolute spatial position (horizontal and vertical) ± 50 mm

LONGITUDINAL SECTION

Figure A.6 — Varying quality levels

Appendix B (informative)

Recommended formats for attribute information and metadata

B.1 General

[Table B.1](#) suggests formats for the attribute information and metadata required in [Clause 2](#). [Table B.2](#) provides supplementary information.

NOTE The colours and codes in [Table B.2](#) are for suggested use only and conformance with them should not be a requirement of this Standard. Similarly, other subsurface utility types, codes and colours may exist.

B.2 Primary code and line colour table

[Table B.2](#) indicates the recommended primary code and line colour for each subsurface utility type. Utility codes and colours facilitate the identification of different subsurface utilities on plans, electronic models and in the field. However, the colour codes should not reflect or indicate the colour of conduits, pipes or cables. The following codes and colours are recommended for adoption.

The feature code to identify the subsurface utility comprises a primary code and a descriptor code. For examples of feature codes refer to [Table B.1](#).

Table B.1 — Formats for attribute information and metadata

Attribute name	Attribute field type	Description of attribute field	Selection list
Unique identifier	Alphanumeric	Unique number to identify the asset	
Asset type	Text	Type of asset identified, e.g. communication	Asset type
Asset sub-type	Text	Sub-type of asset identified, e.g. Coax	Asset sub-type
Asset owner	Text	The owner of the asset	
Feature code			
Size	Number	Size of asset in millimetres	
Size description	Text	Optional Provide further details to explain how the size was determined, e.g. outside or internal diameter	
Status	Text	Status of the asset at the date and time of the survey	Status
Material	Text	Type of material	Can use material picklist specific to asset type
Configuration	Alphanumeric	Optional Reference to a sketch or diagram. Provides details of the configuration of the asset, e.g. if it is a culvert containing multiple pipes, a cross section showing the layout details	

Table B.1 (continued)

Attribute name	Attribute field type	Description of attribute field	Selection list
Indicative location	Location	Conditional The indicative location of the asset if no absolute location can be determined	
Indicative location description	Alphanumeric	Optional Reference to a drawing or diagram that shows the approximate location of the utility with reference to other features	
Interpolated location	Alphanumeric	Optional Reference to a drawing or diagram that shows the location of the utility with reference to other features that was used to interpolate the indicative position	
Relative horizontal position	Alphanumeric	A description of the horizontal position, in metres, relative to a physical structure	
Relative vertical position	Alphanumeric	A description of the vertical position, in metres, relative to ground level or a physical structure	
Depth location	Text	How the relative vertical position or depth is measured, e.g. surface to invert of pipe, surface to top of valve	
Absolute spatial position	Location	Location information as defined in Clause 1.4.1	
Quality level	Text	The quality level achieved, e.g. "QL-D"	Quality level
Source of information	Text	The entity that supplied the information	Information source
Date information obtained	Date	Date information obtained from the information source, e.g. (YYYY/MM/DD)	
Locating methods	Text	Method used to locate the asset, e.g. potholing	Locating method
Survey control information	Alphanumeric	Reference to two or more survey controls used for locating the asset	
Date of survey	Date	The date the survey was carried out, e.g. (YYYY/MM/DD)	
Survey metadata	Text	Details of the survey method used or the metadata report document name	
Asset feature	Text	Optional When the survey identifies a point type asset, the feature asset type that was identified. Use a different list depending on the asset type, e.g. water junction or sewer manhole	Asset feature
Capacity	Text	Conditional Depends on the asset and feature type	Select from relevant capacity selection list
Condition	Text	Reference to a document, drawing or diagram providing descriptions and/or a listing of photographs to best represent the condition of the asset	
Utility install date	Date	Optional Provide if known	
Pit report	Alphanumeric	Conditional Report or document name for a pit report if the survey required the creation of a pit	

Table B.1 (continued)

Attribute name	Attribute field type	Description of attribute field	Selection list
Pot hole report	Alphanumeric	Conditional Report or document name for a pothole report if the survey required the creation of a pothole	
Comment	Text	Any other comments relevant to this asset feature	

Table B.2 — Primary code and line colour








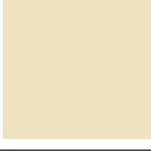


Subsurface utility type	Primary code	Line colour
Communications (drafted on a white background as black) (white)	-C-	
Drainage (Stormwater/raw water) (green)	-D-	
Electricity (orange)	-E-	
Fire service (red)	-F-	
Gas (all pressures) (yellow)	-G-	
Petroleum products (including oil), flammable and combustible materials (brown)	-P-	
Recycled water (purple)	-R-	
Sewer Sewer rising main Vacuum sewer (cream)	-S-	

Table B.2 *(continued)*

Subsurface utility type	Primary code	Line colour
Unidentified services (pink)	-U-	
Water (potable) (blue)	-W-	

Bibliography

AS 4799, *Installation of underground utility services and pipelines within railway boundaries*

AS/NZS ISO 19111, *Geographic information — Spatial referencing by coordinates*

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ASCE 38-02, *Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data*
(American Society of Civil Engineers)

CSA S250-11, *Mapping of Underground Utility Infrastructure*

ICSM SP1, *Standards and Practices for Control Surveys* (Geodesy Technical Sub-Committee, Inter-Governmental Committee on Surveying and Mapping)

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