KiwiRail


# Services & Utilities Identification and Modelling Guidance Note

Version 2

## Document Control

### Version History

| Version Number | Version Date | Summary of Changes | Author |
|---|---|---|---|
| 1.0 | 20/08/2021 | Publish for DE Framework (previous versions have informed this version, prior to inclusion in within the Framework. | D Jannings / S Zoie |
| 1.1 | 24/11/2021 | Colour Scheme Update (3.4) | G Evans |
| 1.2 | 13/05/2022 | Included reference to new Digital Design Management Guidance Note | N Wagner |
| 2.0 | 08/01/2024 | Updates to align with KiwiRail's DE requirements, Tucana references added, Document name change | J Cronje |

### Reviewers' Name

| Reviewer Name | Date | Signature | Position |
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### Signed off by Approvers

| Approver Name | Date | Signature | Position |
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# 1 Overview

## 1.1 DOCUMENT PURPOSE

Utility strikes and the discovery of unknown subsurface utilities pose significant project and safety risks for KiwiRail and its supply chain. This document outlines the requirements for identifying and modelling both existing and new subsurface utilities on KiwiRail projects, ensuring safe and high-quality work.

## 1.2 STANDARD REFERENCE

For dated references, only the edited cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- AS 5488, Classification of subsurface utility engineering
- PAS 128, Specification for underground utility detection, verification, and location
- SCIRT, Best practice subsurface utility location
- KiwiRail Standard S-ST-CW-2143 – Cable Location Code of Practice

## 1.3 REFERENCES

It should be recognised that this framework forms part of a larger document suite, and may draw reference to other relevant standards, requirements, specifications, or guidelines included in Table 1

Figure 1 below covers the DE document structure and the relationships between each of the documents, with Table 1 outlining the content of each document.

*Table 1: Digital Engineering Documentation*

| Document | Purpose |
|---|---|
| **Enterprise** | |
| Digital Engineering Framework | To outline KiwiRail's DE vision and overarching objectives. To provide guidance as to where specific detail can be found in other documentation. |
| Digital Engineering Information Standard – Part 1 (Management) | Outlines the process of how information is managed and consumed within the context of a project. |
| Digital Engineering Information Standard – Part 2 (Technical) | Outlines the details of how information should be produced by an author to meet KiwiRail's information requirements. |
| Asset Information Requirements | Outlines all the possible asset types, and their associated attribution requirements. |
| **Project** | |
| Project Information Protocol | Provides additional clauses which enable the scope of Digital Engineering to be amended to the contract. |
| Project Information Requirements (PIR) | Includes general project information, including scope, stakeholders, and high-level delivery milestones.<br>Outline the overarching project specific digital initiatives for implementation on the project.<br>PIR explain the information needed to answer or inform high-level strategic objectives within the appointing party in relation to a particular built asset project. PIR are identified from both the project management process and the asset management process. (extract from ISO) |
| Exchange Information Requirements (EIR) | Breaks down the overarching project objectives in the Project Information Requirements into the requirements of each engagement within a project at a detailed level.<br>Details the expectations of information delivery against the project milestones.<br>EIR set out managerial, commercial, and technical aspects of producing project information. The managerial and commercial aspects should include the information standard and the production methods and procedures to be implemented by the delivery team. (extract from ISO) |
| Information Delivery Plan (IDP) | Details the level of information need, required against asset data dictionary classifications, throughout the project lifecycle. Specifies the types of asset classifications expected throughout the scope of the project. Outlines an exhaustive list of digital artifacts required for project close out. |
| **Guidance Notes** | |
| Digital Design Management Guidance Note | Outlines how the DE tools & processes of KiwiRail's DE Framework can be embedded within the design phase of a capital project to support & enable design management fundamentals. |
| Revizto Guidance Note | How KiwiRail standardise the use of Revizto across the KiwiRail projects portfolio. |
| Tucana Guidance Note | Supplementary document which covers off the correct usage of the CDE, including details of the background processes for those wanting additional detail. |
| Subsurface Utilities Identification and Modelling Guidance Note | How to identify, model and transmit subsurface utility information to KiwiRail within a project. |
| Spatial Capture Framework | Outlines how spatial information is to be captured, created, referenced, and controlled. |
| **Resources** | |
| Construction Delivery Matrix (CDM) | Helps to facilitate a discussion between the designers and contractors around which piece of information can be used for pricing and construction setout. |
| Minimum Data Requirements | Helps to facilitate specifying the minimum asset data requirements for capture during the project's lifecycle, and who's responsibility it is to provide this information. |

| | |
|---|---|
| Asset Information Exchange Template | Helps to facilitate the Asset Information Exchange process between suppliers and DE team. |
| Scan Register | Scan register template to provide KiwiRail with details around the captured scan / survey data. |

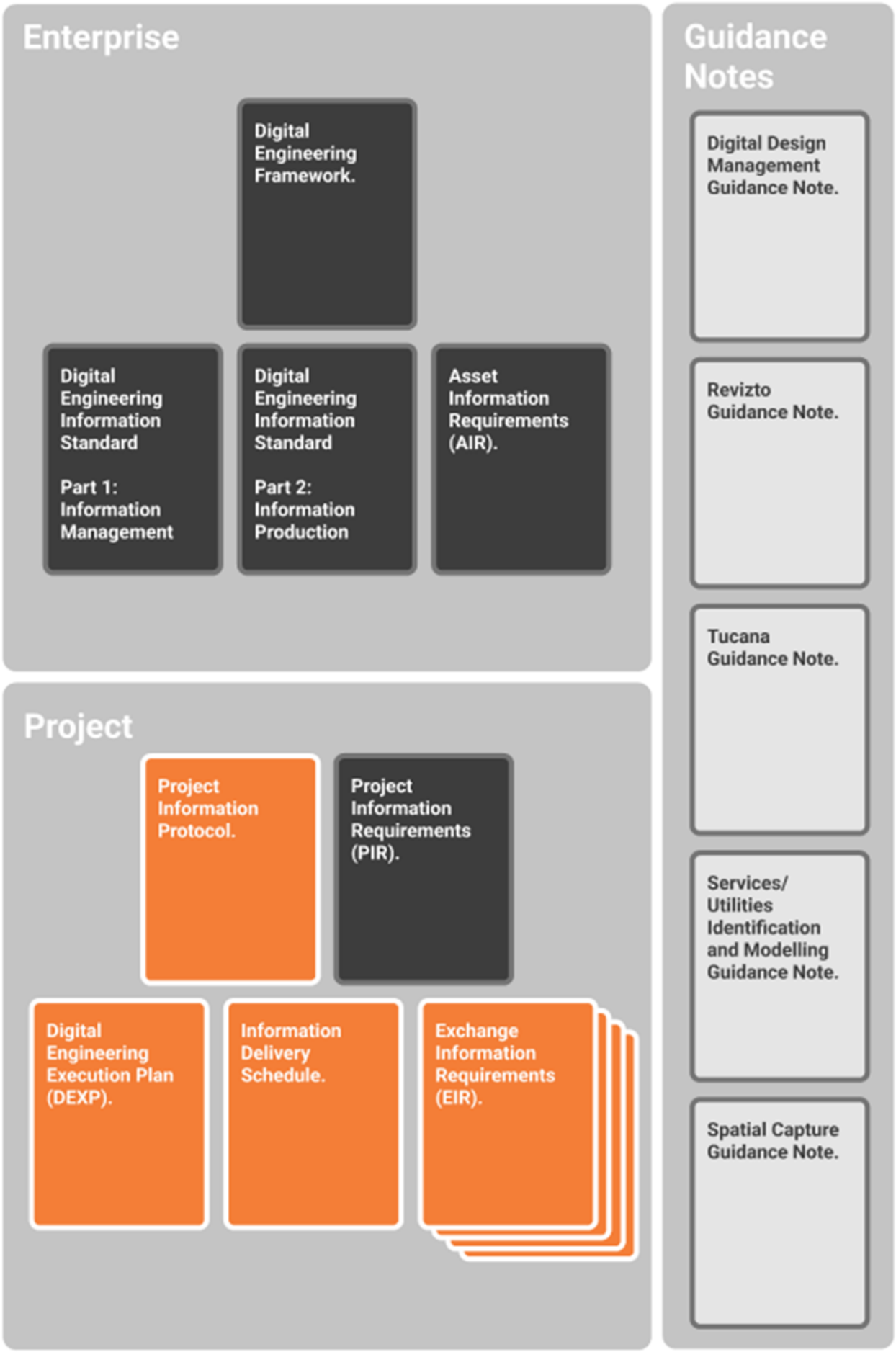



*Figure 1: Digital Engineering Document Structure*

## 2 Data Capture and Model Development

The development of an existing sub-surface utilities model shall be undertaken in stages, with information becoming more granular as each stage is complete. The following steps shall be followed to identify and locate existing services. Each step acts as a hold-point where the 3D model is further developed to incorporate new information.

**Step 1** Dial B4 U Dig and As Built Records

**Step 1a** Develop initial 3D model

**Step 2** Locate underground services

**Step 2a** Revise 3D model using underground services location information

**Step 3** Conflict Identification and Potholing

**Step 3a** Revise 3D model using Conflict Identification and Potholing

Each step has a varying Quality Level (QL) classification in accordance with Australian Standard AS 5488. This shall be documented as part of the transmittal information that is delivered to KiwiRail alongside the 3D model.

A QL applies 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 data, 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.

A description of each QL is in Table 2 below.

*Table 2: Quality Level Classifications*

| Quality Level | Description |
|---|---|
| **Quality Level A** | ***(meets location accuracy standards for minimum risk when excavating)*** Is the highest Quality Level accuracy and consists of 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'. 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 plus or minus 50mm. |
| **Quality Level B** | ***(significant risk reduction)*** Provides relative subsurface feature locations in three dimensions. The minimum requirement for QL-B is relative spatial position, this can be achieved via an electromagnetic frequency locating device. The location of subsurface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of plus or minus 300mm and a maximum vertical tolerance of plus or minus 500mm. |
| **Quality Level C** | ***(low accuracy and a high risk of damage)*** 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 site survey of visible evidence – for example you can see the pit lids shown on the plan but the actual position of underground connection between pits is still assumed. The location of surface features measured in terms of relative spatial positioning with a maximum horizontal tolerance of plus or minus 300mm. |

| | |
|---|---|
| **Quality Level D** | ***(least accurate level and if used on its own has a high risk of damage)*** QL-D information is generally obtained from existing records provided by utilities as a result of a Dial B4 U Dig enquiry being lodged. In many cases the asset depicted on the plan is in a schematic format only and intended only to indicate its presence. |

## 2.1 STEP 1 – DIAL B4 U DIG AND AS BUILT RECORDS

This step is undertaken to develop an initial picture of the underground services. Data is derived from a variety of sources and is generally considered to be unreliable. Models created are to be marked as Quality Level C or D based on the definitions in Table 2 above.

Dial B4 U Dig and As Built Records are considered to be either Quality Level D or Quality Level C depending on the information source as described below.

**Quality Level D**

Quality Level D is applicable to models that are developed from existing 2-dimensional records.

**Quality Level C**

Quality Level C is applicable to models that are developed using a combination of existing 2-dimensional records with site surveys to validate surface assets. For example, validating a manhole location through a measured site survey but the actual position of sub-surface pipework that connects into the manhole is based on existing 2-dimensional records.

## 2.2 STEP 1A – DEVELOP INITIAL 3D MODEL

Once the Dial B4 U Dig information has been collated and its Quality Level confirmed, an initial 3D model shall be developed based on the record information to the best possible accuracy including the horizontal and vertical location of sub-surface utilities.

The 3D model shall include the following metadata as a minimum:

*Table 3: Metadata requirements for Quality Level D and C Model Objects*

| Quality Level D | Quality Level C |
|---|---|
| • Unique ID<br>• Quality Level: QL-D<br>• Service Owner<br>• Service Type<br>• Source Data | • Unique ID<br>• Quality Level: QL-C<br>• Service Owner<br>• Service Type<br>• Source Data<br>• Feature codes of visible features including but not limited to pits, access chambers, poles, valves, and hydrants |

## 2.3 STEP 2 – LOCATE UNDERGROUND SERVICES

Following the development of the initial 3D model an underground services locator shall be engaged. The underground services shall be located using standard wand (for cables) and snake (for pipes or empty ductwork) equipment. The located position of the sub-surface utilities shall be GPS surveyed. Models created are to be marked as Quality Level B based on the definitions in Table 2 above.

Underground services information is considered to be Quality Level B as described below.

**Quality Level B**

Quality Level B is applicable to models that are developed from existing 2-dimensional records and then further refined with information obtained from the underground services survey, as mentioned in section 2.3

Sub-surface utilities shall have a maximum horizontal tolerance of plus or minus 300mm and a maximum vertical tolerance of plus or minus 500mm.

Where there are contiguous utilities (e.g. a cluster of Chorus ducts) an indication of the horizontal extent of these shall be recorded to a minimum of Quality Level C.

## 2.4 STEP 2A – REVISE 3D MODEL USING UNDERGROUND SERVICES LOCATION INFORMATION

Once the underground services information has been collated and its Quality Level confirmed, the initial 3D model shall be updated to reflect the new information and Quality Level. This will include updating sub-surface utility locations in the vertical and horizontal planes to improve accuracy.

The 3D model shall include the following metadata as a minimum:

*Table 4: Metadata requirements for Quality Level B and A Model Objects*

| Quality Level B and A |
| --- |
| • Unique ID<br>• Quality Level: QL-B or QL-A<br>• Service Owner<br>• Service Type<br>• Source Data<br>• Supplier<br>• Position<br>• Material<br>• Feature codes of visible features including but not limited to pits, access chambers, poles, valves, and hydrants |

## 2.5 STEP 3 – CONFLICT IDENTIFICATION AND POTHOLING

Following the revision of the 3D model a conflict check shall be undertaken to identify any area where conflicts are considered likely (i.e. within 600mm horizontally of a service, or greater depending on the specific nature of the service and confidence in the alignment).

Services considered to be a high risk shall then be physically identified on site using not destructive digging (e.g. vacuum excavation). In case no underground services are found, any over digging or vicinity digging based on scale of risk and likelihood of conflict needs to be reviewed through a risk assessment process.

Models created are to be marked as Quality Level A based on the definitions in Table 2 above.

Conflict identification and potholing information is considered to be Quality Level A as described below.

**Quality Level A**

Quality Level A is applicable to models that are developed from existing 2-dimensional records, refined with information obtained from the underground services survey, as mentioned in section 2.32.3 and then further refined with potholing information.

The location of a sub-surface utility at a point is accurate to an absolute spatial position in three dimensions.

## 2.6 STEP 3A – REVISE 3D MODEL USING POTHOLING INFORMATION

Once the potholing information has been collated and its Quality Level confirmed, the revised 3D model shall be updated to reflect the new information and Quality Level. This will include updating sub-surface utility locations in the vertical and horizontal planes to reflect known positions.

# 3 Services & Utilities Modelling Standards

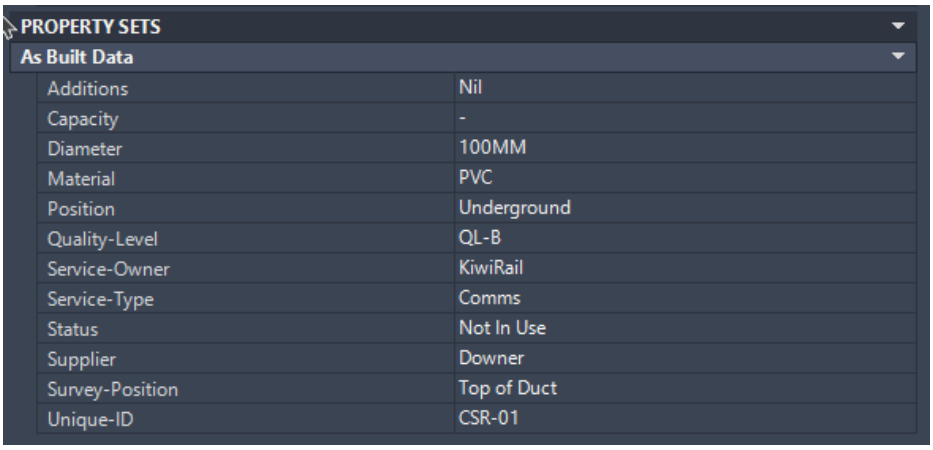
3D models of services and utilities shall be developed in accordance with the following requirements: -

## 3.1 MODEL FORMAT

All deliverables must be provided as outlined in KiwiRail's Digital Engineering Information Standard (DEIS) Part 2. All services and utility models must be created as 3D solids, and it is important to note that these should not be mistaken for KiwiRail's GIS requirements. Suppliers should also make refer to section 3.2.3.3 in the (DEIS) Part 2 – Model Specification for Designers.

Please refer to the examples below for the required outputs

### 3.1.1 Model Exchange Examples



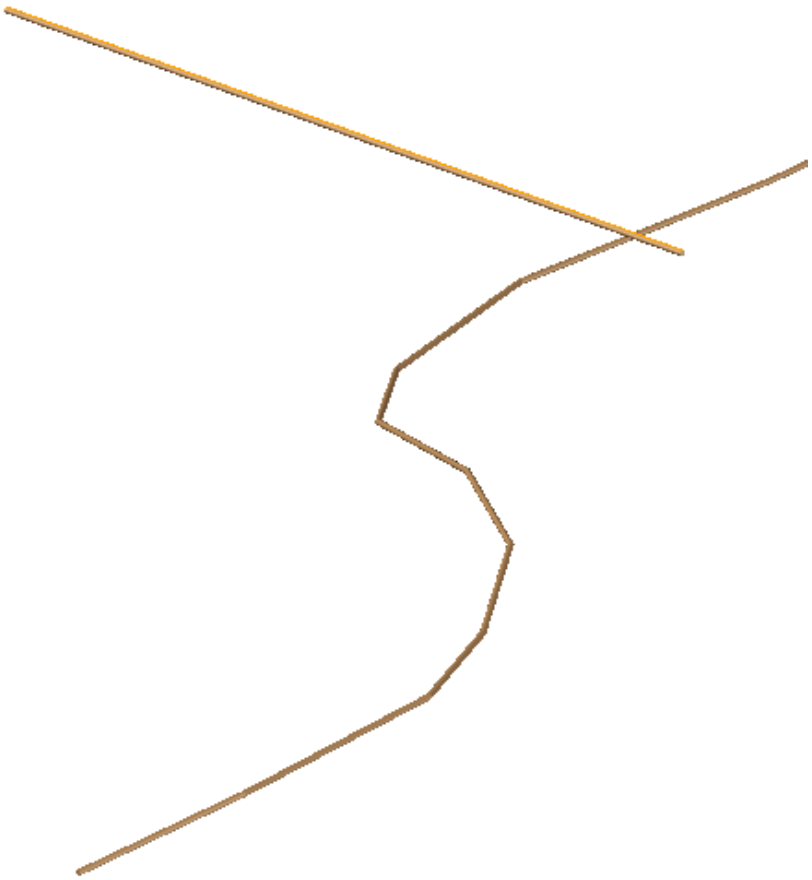



*Figure 2 Example Model Deliverable and Underground Services Asset Attributes*

## 3.2 MODEL COORDINATES

Where supported by the native authoring software, models shall be placed in or navigable to real world coordinates using the KiwiRail approved coordinate systems:

• Horizontal coordinates in terms of NZTM (or an applicable NZGD2000 local circuit where it is approved for a specific project site)

• Heights/levels must be in terms of NZVD2016

This supports the ease of integrating and coordinating various models and/or GIS data sources.

Where model authoring tools do not natively support real world coordinates, the model origin/project base point shall be setup to represent a survey control point centrally located within the site boundaries. All other survey control point(s) shall be visible within the site or model to provide enough information to allow models to be integrated and coordinated with other georeferenced data sources.

## 3.3 UNITS OF MEASURE

All models shall be setup using metric units, with key units of measure for geometric data being as per Table 5:

*Table 5: Units of measure*

| Attribute | Object Unit of Measure | | Use |
|---|---|---|---|
| | Unit | Abbrev. | |
| Count | Number | No | Count of an object |
| Length | Millimetres | mm | Length or of an object |
| | Metres | m | |
| Height | Millimetres | mm | Height of an object |
| | Metres | m | |
| Width | Millimetres | mm | Width of an object |
| | Metres | m | |
| Depth | Millimetres | mm | Depth of an object |
| | Metres | m | |
| Perimeter | Millimetres | mm | Length of a perimeter |
| | Metres | m | |
| Area | Square metres | $m^2$ | Single face area of an object |
| Volume | Cubic metres | $m^3$ | Volume of an object |
| Weight | Kilograms | kg | Weight of an object |

## 3.4 MODEL COLOUR CODING

Model colour coding shall be used to assist in identification of assets. All service and utilities models shall be coloured in accordance with Appendix 1: Model Element Colour Scheme

## 3.5 MODEL ATTRIBUTION

All sub-surface utility models must include metadata attributes as specified in Appendix 2: Underground Services / Utilities Asset Attributes.

# 4 Model Structure

All services and utility models shall be created in a structured and hierarchical manner with the intended purpose of allowing specific areas of the model to be editable without the need for the whole model to be ‘reserved’ or ’checked out’ to a single party. Where the Quality Level varies along an alignment the model shall be broken down accordingly. A section of a model with QL-B may appear to be separate from a QL-A model. This is considered best practice as it alerts other users of the data to the varying confidence in the spatial position.

The following sub-models shall be utilised to document site wide assets. Each asset group is maintained within a separate model to allow for easier utilisation in other design documentation as well as other information systems.

## 4.1 GROUND SURFACE

This model shall contain a 3D Triangulated Irregular Network (TIN) surface representing the ground surface. Where TIN surfaces are created for Digitisation Work these are expected to be approximate surface models only.

## 4.2 SERVICES AND UTILITIES

This model shall be used to contain all known services and utilities. It shall be broken down into sub models based on utility type which would typically include, but not be limited to:

- Power/Control cabling and/or associated duct
- Earthing/Earth Grid
- Gas and Oil supply
- Communications / Fibre cables/ducts
- Water ducts (Mains / Fire)
- Wastewater (Sewer)
- Stormwater (Drainage) and Oil Containment
- Compressed Air Lines
- Other/Miscellaneous
- Unknown services (a service its located but its purpose unknown)
- Redundant services (services that are no longer in use but still present on site)

# 5 Appendices

## 5.1 APPENDIX 1: MODEL ELEMENT COLOUR SCHEME

| Classification | Discipline | System | Colour | AutoCAD | R | G | B | Notes |
|---|---|---|---|---|---|---|---|---|
| Services | EL | Earthing/Earth Grid | | 34 | 129 | 64 | 0 | |
| Services | FE | Fire Service | | 1 | 255 | 0 | 0 | |
| Services | EH | Electricity | | 30 | 255 | 127 | 0 | Best estimate of colour within AutoCAD |
| Services | MP | Air | | 92 | 0 | 189 | 0 | |
| Services | ALL | Redundant Services | | 166 | 0 | 25 | 104 | |
| Services | ALL | Other | | 249 | 79 | 53 | 59 | |
| Services | MP | Petroleum (Flammable & Combustible) | | 36 | 104 | 52 | 0 | Best estimate of colour within AutoCAD |
| Services | CC | Sewerage | | 41 | 255 | 234 | 170 | Best estimate of colour within AutoCAD |
| Services | MP | Gas | | 50 | 255 | 255 | 0 | |
| Services | CC | Drainage (Stormwater/Raw Water) | | 62 | 141 | 189 | 0 | Best estimate of colour within AutoCAD |
| Services | CC | Potable Water | | 142 | 0 | 141 | 189 | Best estimate of colour within AutoCAD |
| Services | CC | Recycled Water | | 192 | 94 | 0 | 189 | Best estimate of colour within AutoCAD |
| Services | ALL | Unidentified Services | | 210 | 255 | 0 | 255 | |
| Services | EL | Communications | | 255 | 255 | 255 | 255 | |
| Model type | All | As-Built | | 254 | 190 | 190 | 190 | Used against all model types |
| Model type | All | Existing | | 251 | 80 | 80 | 80 | Used against all model types |

**Notes:**

1. KiwiRail prefers the assignment of model colours to occur within the native authored file, rather than within end products and viewers such as Revizto.
2. Colours have been assigned with Autodesk authoring packages in mind, however, have been provided with RGB values for cross-compatibility. Colour indexes from alternate software may be added to this scheme where appropriate.

## 5.2 APPENDIX 2: UNDERGROUND SERVICES / UTILITIES ASSET ATTRIBUTES

*Table 6: Underground Services / Utilities Asset Attributes*

| Attribute Name | Unique-ID | UG_type | UG_material | UG_position | UG_additions | UG_dia | Source Data | Supplier | Capacity | Quality level | Asset owner | Status | Configuration | Indicative location | Interpolated location | Relative Hor position | Relative Ver position | Spatial position |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Attribute Full Name** | Unique-ID | Service type | service/duct material | Position | Additions | Duct diameter | Source Data | Supplier | Capacity | Quality level | Service type | Status | Configuration | Indicative location | Interpolated location | Relative horizontal position | Relative vertical position | Spatial position |
| **Format Description** | A unique human readable ID | [text] | [size][type][weight] | | LIST OF EQUIPMENT FROM KR | [diameter] | Where and when was the Information sourced & produced from | Who supplied the information | [SHEER]/[MOMENT]/[AXIAL ULS] | [text] | [text] | [text] | [text] | [text] | [text] | [text] | [text] | [text] |
| **Field Type** | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical | alpha / numerical |
| **Mandatory Field** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes for QL-A | Yes for QL-D | Yes for QL-C | Yes for QL-B | Yes for QL-B | Yes for QL-A, QL-B, QL-C<br>Location information (x,y for QL-C)<br>(x,y,z for QL-B, QL-A) |
| **Comment** | Supplier generated unique ID for each service type | type of utility/service | material of duct/pipe/service including specification details | Where is the service | alpha / numerical | diameter of the duct/service/cable | Source of the information, including dates | Supplier name | sheer / moment / axial ULS from pole design schedule | The quality level achieved | The owner of the asset | Status of the asset at the date and time of the survey | Reference to a sketch or diagram. Provide details of the configuration of the asset, e.g. if it is a culvert containing multiple pipes, a cross section showing the layout details. | The indicative location of the asset if no absolute location can be determined | 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 | A description of the horizontal position, in meters (m), relative to a physical structure | A description of the vertical position, in meters (m), relative to a physical structure | **A)** for pits etc, the coordinates refer to the centre of the object for x,y and for the z value this will be to the top of the object.<br>**b)** for pipes / ducts the ducts the coordinates are to the centre of each start and end node point along the route |
| **Examples / Domains** | ST-0125 | Stormwater | PE100 SDR17 | Above Ground | | 100mm Dia | Underground Services Survey Carried out on 09/06/23 | Downer | | QL-A | HCC | In use | Refer to design drawings CS-876c | Refer to detail plan 12345 | Refer to detail plan 12345 | ± 0.3m | ± 0.5m | x,y<br>x,y,z |
| | | Wastewater | PE100 SDR11 | Under Ground | | | | | | QL-B | Powerco | | | | | | | |
| | | Potable Water | Class 2 RCRRJ | Surface | | | | | | QL-C | Chorus | | | | | | | |
| | | Power LV | Class 3 RCRRJ | | | | | | | QL-D | | | | | | | | |
| | | Power HV | Class 4 RCRRJ | | | | | | | | | | | | | | | |

| | |
|---|---|
| Signals Power LV | 110V |
| SignalsPower HV | 240V |
| Fiber Optic | 600V |
| Gas | 3.3KV |
| Telecom | 12 pair |
| | 24 pair |
| | 48 pair |

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