KiwiRail

Subsurface Utility Identification and Modelling

Version 1

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

Reviewers' Name

Reviewer Name	Date	Signature	Position
D Jannings	20/08/2021		Digital Engineering Programme Manager

Signed off by Approvers

Approver Name	Date	Signature	Position
A Lyon	20/08/2021		Programme Director – Digital Engineering

Final Distribution

Name	Position
File	-

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1 Overview

1.1 DOCUMENT PURPOSE

Utility strikes and uncovering unknown existing sub-surface utilities represents a significant project and safety risk to KiwiRail and its supply-chain. This document sets out requirements for the identification and modelling of existing sub-surface utilities on KiwiRail projects to ensure that work is performed safely, effectively and to the highest possible standard.

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
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.
Asset Data Dictionary	Outlines all the possible asset types, and their associated attribution requirements.
GeoDocs Guidance Note	Supplementary document which covers off the correct usage of the CDE, including details of the background processes for those wanting additional detail.
Revizto Guidance Note	How KiwiRail standardise the use of Revizto across the KiwiRail projects portfolio
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.
Project	
Digital Engineering Execution Plan (DEXP)	Outlines how Digital Engineering will be completed throughout the scope of the engagement, responding to the requirements outlined in the EIR. Outlines the roles and responsibilities within the supplier's organisation and can be used as a form of assessment for the tender submission process. Pre-contract is to be prepared by the supplier, and the post-contract is collaboratively developed between KiwiRail, its partners and the supplier.
Project Information Protocol	Provides additional clauses which enable the scope of Digital Engineering to be amended to the contract.
Information Delivery Schedule	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.
Project Information Requirements (PIR)	Includes general project information, including scope, stakeholders and high-level delivery milestones Outline the overarching project specific digital initiatives for implementation on the project. 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. Details the expectations of information delivery against the project milestones. 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)

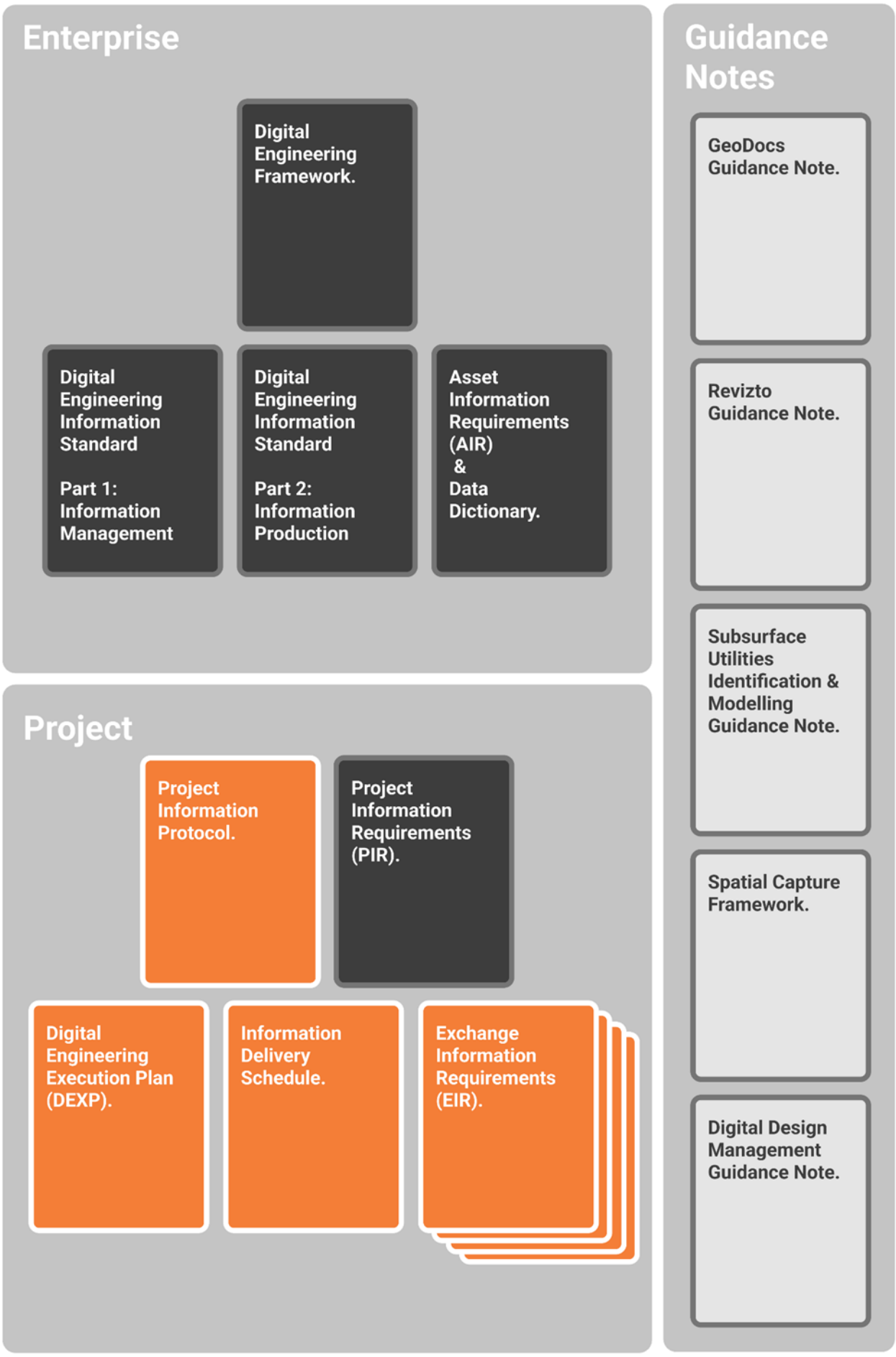

Figure 1: Digital Engineering Document Structure

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 identify and locate the existing services. Each step acts as a hold-point where the 3D model is further developed to incorporate the new information.

Step 1 Dial B4 U Dig and As Built Records

Step 1a Develop initial 3D model

Step 2 Cable Locate

Step 2a Revise 3D model using Cable locate 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'.
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. An electronic location provided by a DBYD Certified Locator to QL-B standard would have 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.
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 Before You 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:

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

Quality Level D	Quality Level C
• Utility owner • Utility type	• Utility owner • Utility type • Feature codes of visible features including but not limited to pits, access chambers, poles, valves and hydrants

2.3 STEP 2 - CABLE LOCATE

Following the development of the initial 3D model a cable 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.

Cable Locate 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 Cable Locate information. 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 CABLE LOCATE INFORMATION

Once the Cable Locate 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:

Table 4: Metadata requirements for Quality Level B Model Objects

Quality Level B
• Utility owner • Utility type • 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 Cable Locate information 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.

The 3D model shall include the following metadata:

Table 5: Metadata requirements for Quality Level A Model Objects

Quality Level B
• Utility owner • Utility type • Feature codes of visible features including but not limited to pits, access chambers, poles, valves and hydrants

2.7 QUALITY LEVEL VARIATIONS

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.

3 Modelling Standards

3D models of sub-surface utilities shall be developed in accordance with the following requirements.

3.1 MODEL FORMAT

All deliverables shall be transmitted in electronic .DWG format and developed in accordance with the KiwiRail Digital Engineering Framework document.

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 6:

Table 6: 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 underground service models shall be coloured in accordance with Appendix 4 of DEIS:2, and the supporting sections within Section 3.

4 Model Structure

All sub-surface 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.

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 SURFACES

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 SUB-SURFACE UTILITIES

This model shall be used to contain all known sub-surface 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)

Table 7: Underground Services / Utilities Asset Attributes

Attribute Name	UG_type	UG_material	UG_position	UG_additions	UG_dia	Capacity	Quality level	Asset owner	Status	Configuration	Indicative location	Interpolated location	Relative Hor position	Relative Ver position	Spatial position
Attribute Full Name	Service type	service/duct material	Position	Additions	Duct diameter	Capacity	Quality level	Service type	Status	Configuration	Indicative location	Interpolated location	Relative horizontal position	Relative vertical position	Spatial position
Format Description	[text]	[size][type][weight]		LIST OF EQUIPMENT FROM KR	[diameter]	[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
Mandatory Field	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
Comment	type of utility/service	material of duct/pipe/service including specification details	Where is the service	additional information such as details of equipment installed	diameter of the duct/service/cable	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	Location information (x,y for QL-C) (x,y,z for QL-B, QL-A)
Examples / Domains	Stormwater	PE100 SDR17	Above Ground				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 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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