THREE WATERS ASSET DATA STANDARDS: A NEW CODE OF PRACTICE

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ABSTRACT

This paper outlines the current state of asset data standards used for three waters, and describes new activities and tools being developed to bring consistency and optimise data use.

The Quake Centre's Building Innovation Partnership has been working closely with key industry players to develop a Code of Practice (CoP) for 3 Waters Asset Data. This CoP is an addendum to the New Zealand Asset Metadata Standards Version 1.0 published by LINZ in August 2017. A CoP for stormwater horizontal assets was published in February 2020 and has since been expanded to include wastewater and potable water horizontal assets. The CoP is aligned with the data standards being developed by the New Zealand Transport Agency.

The CoP focusses on "as-constructed" data and the minimum requirements for recording asset classes and attributes. The CoP provides:

1. a guide to asset owners about the most valuable data to collect on their assets.
2. a basis for benchmarking asset data quality and coverage.
3. a common language for sharing data between asset owners, contractors, consultants and other organisations.

The CoP provides a pathway to implement the data standards, whether that is directly into an asset management system or as a transmittal standard for communicating with other organisations.

KEYWORDS

Asset Data Standards, Metadata, Code of Practice, Storm water, Potable Water, Wastewater

1 INTRODUCTION

With services under increasing pressure including ageing infrastructure, increased demand for higher levels of service and severe constraints on funding, 3 Waters asset management in New Zealand needs to look for ways of improving both outcomes and the value for money. A central place to look for these improvements is in the collection, use and analysis of asset data. If New Zealand is going to maximise the benefits from data then we need to have a national strategy. Fundamental to any strategy should be the development and implementation of national standards for the collection, quality and sharing of data.

Standardisation is essential for driving improvement in data management and decision-making. There are many benefits in having a common data standard when sharing data through the supply chain from equipment manufacture, through design, construction and maintenance all the way to retiring an asset. Effective data sharing has been shown to drive innovation and efficiency in many industries and this is particularly so when considering interdependencies with other classes of infrastructure. A key example for the 3 waters sector is the interdependency of roads and stormwater systems.

Recent high profile asset failures have shown how difficult it is to manage our nation’s wastewater and potable water networks. Often the data underpinning the decision-making processes is missing, of poor quality or in a format that do not easily allow interoperability with other data sets and systems. Councils must collaborate to address shared challenges, including ageing infrastructure, limited capacity, managing costs to the community, and having the right people and skills in their organisations. Sharing data and using advanced analytical processes will greatly improve NZ’s understanding of both the risks and the strategies that mitigate those risks.

Looking to the future, Artificial Intelligence (AI) will deliver greater insights into infrastructure assets and systems, enabling greater efficiency, optimisation of collection system storage capacity to reduce peak flows and the occurrence of overflows. Whilst AI can provide some insights from unstructured data, AI techniques are greatly enhanced when data are standardised and structured.

Maximising the value of 3 Waters assets to our communities requires maximising the value of the data on those assets. To this end a Code of Practice has been developed to create a national data standard for 3 waters pipe networks.

2 DEVELOPING A CODE OF PRACTICE OF POTABLE, WASTEWATER, AND STORM WATER RETICULATION ASSETS

The Quake Centre’s Building Innovation Partnership (BIP) programme has funded the development of data standards for pipe assets for potable, wastewater and stormwater. This has been created by WSP under the guidance of an industry steering group comprising local councils, contractors, consultants, surveyors and suppliers. Applying the 80/20 rule, the Standard concentrates on pipes, chamber and fittings which comprise the greatest combined asset value for most councils. The initial scope includes the following asset classes:

- Pipes
- Valves
- Chambers
- Fittings
- Meters
- Headwalls
- Retention Structures
- Channels

Initially the scope covered described a minimum viable standard to support decision-making for most circumstances. A later increase to the scope also incorporated the needs of surveyors and councils when capturing and ingesting as-constructed data into councils' asset management systems.

The CoP has been published in an open-source, machine-readable form (XSD) so that it can be easily integrated into standard drawing, surveying and asset management tools. XSD (XML Schema Definition) is a World Wide Web Consortium (W3C) recommendation that specifies how to formally describe the elements in an Extensible Markup Language (XML) document. (XSD (XML Schema Definition), 2020)

This CoP will support a number of activities including:

- Automated capture of design and as-constructed data
- Standardised methodologies of sharing design and existing asset data
- Data quality assessment and benchmarking
- Large scale analysis of economic life of pipes
- Analysis of pipe performance versus ground and operational conditions
- Risk of failure analysis
- Integration with other data sets and digital twins to facilitate integrated planning; risk assessment, climate change mitigation and adaptation, exposure to natural hazards and environmental performance, etc. To this end the National Pipe Data Portal is based upon the published CoP.

3 CODE OF PRACTICE PHILOSOPHY AND CONTENT

The objectives of the CoP are to:

- Present a minimum viable standard for data collection for as-constructed data.
- Present asset classes, attributes and code lists that are specific and workable for 3 waters assets.
- Provide a standard asset data format, language, and definition.
- Provide a common foundation for sharing and translating asset data.
- Clarify implementation of the New Zealand Asset Metadata Standards (NZAMS).
- Simplify implementation of the NZAMS.

3.1 COP USE PHILOSOPHY

The CoP is in four parts:

Part 1 – Development context and philosophy

Part 2 – Implementation

Part 3 – Attribute tables

Part 4 – Working attribute tables.

Whilst parts 1 and 2 provide background and guidance the heart of the CoP is in sections 3 and 4.

Part 3 of the CoP presents a list of data attributes for each asset class. The list of attributes covers data attributes typically collected for an asset class. Code lists are provided to force standard terminology for select data attribute fields. The philosophy of the attribute tables and code lists broadly follows the 80/20 rule where just 20% of all available data is needed to provide 80% of the value for decision-making.

The lists distinguish where attribute data is deemed primary or secondary in nature. The primary data can be considered a core list of essential attribute data necessary to manage the asset portfolio.

Whilst the CoP provides standard language and definitions, it is up to the asset owner to ultimately determine which attributes are required for collection to fulfil legislative requirements and business needs. Additional attributes can be collected by organisations if desired. Data attributes may serve as a prompt for organisations to collect data they would otherwise not have collected. Over time this approach should lead to a more rigorous approach to collecting and managing data. For instance, it is recommended that only attributes that are of use/future use to the organisation are collected

The CoP does not provide guidance on tailoring data capture based on asset criticality. Organisations may consider applying different data collection requirements depending on the importance of each asset, e.g. more data collected for assets with a high consequence of failure.

Other features of the CoP:

- Validation rules are provided as criteria for ensuring correct data entry.
- The attribute lists and code lists are provided digitally (Excel and XSD format) to be easily compatible with data systems and software.
- The guidance provided in the CoP is system agnostic.

3.2 CURRENT AND FUTURE ASSET AND ACTIVITY COVERAGE

In most three waters networks, approximately 80% of the capital value is attributable to the horizontal infrastructure, i.e. the pipes and chambers dispersed over a large area. For this reason, the CoP focusses guidance on the collection of data for these horizontal infrastructure assets and, in the first instance, is limited to as-built collection and asset management planning activities.

Planned future expansion of the CoP include: Valuation; Operations and Maintenance and Failure Analysis. These expansions are dependent on further funding becoming available.

Once the pipe networks are adequately covered and suitable funding is available, the CoP could be expanded to pump stations, treatment plants and other 3 waters infrastructure.

4 TECHNICAL SPECIFICATION

The CoP provides a minimum viable standard to achieve consistency in the following elements:

- Asset classes
- Attribute names
- Attribute definitions
- Attribute values (specifically through the provided code lists)
- Units of measure
- Data types
- Consistency in physical measurement collection.

Example attribute tables and code lists are presented in Appendices A and B.

4.1 AS-CONSTRUCTED DATA GENERATION AND COLLECTION

There are a number of times or activities where asset data might be collected. Data is generated when an event is undertaken on or to an asset. An event can be any activity or undertaking that is completed in the management of the asset.

Data is collected by the actors who undertake the event. Data is collected from actual observations, measurements and design documentation. Data excludes interpolations and modelling outputs.

The initial data generated for an asset is typically as-constructed data. As-constructed data is data on the physical characteristics of the asset which do not change of the life of the asset.It is considered to originate from handover of an asset from the contractor to the owner, but it can also be collected from events undertaken on the asset throughout its life. The Code of Practice provides guidance on typical data to collect for the events listed below

- Asset handover
- Closed-circuit television (CCTV) video
- Asset renewal and rehabilitation.

4.2 DATA COLLECTION RATIONALE

Data is only collected when it is useful to the organisation. The usefulness of data is generally related to the following:

- Fulfilling legislative requirements
- Making decisions to deliver levels of service in a cost-effective manner.

These two reasons should be considered when determining whether a particular data attribute should be collected. Where data do not serve these purposes, there may be justification to stop collecting data and managing that data within a database. This is particularly true for data that is used infrequently, not used at an asset portfolio level, and can easily be retrieved from other sources such as electronic drawings or inexpensive field inspection.

Figure 1below illustrates how three core aspects can be considered together as a rationale for collecting data. This shows the **When** (which event is a good time to collect data), the **What** (which attributes are collected, and in which format), and the **Why** (how the data will be used).

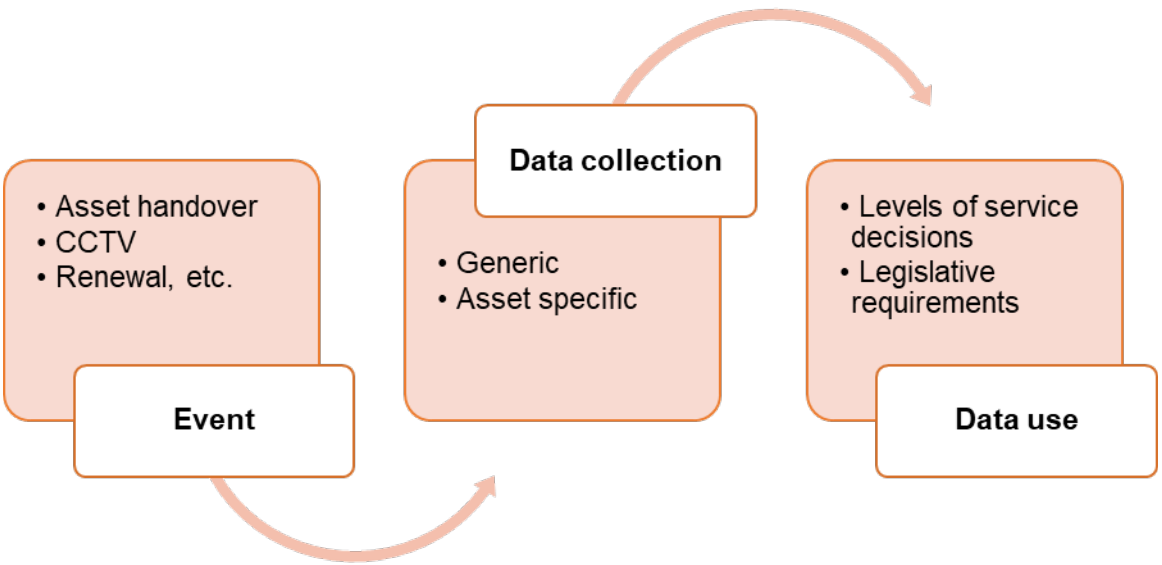


Figure 1: Data journey

The attribute tables within the CoP provide a list of data to be collected based on this rationale. The intent is that they provide a useful starting point for determining core data collection requirements.

Attributes have been categorised with a collection priority of either primary or secondary.

- Primary priority represents essential data
- Secondary priority represents non-essential but high valuable data.

Collection priority is categorised further according to how useful the data is to support different types of decision-making. The categories are:

- Portfolio asset management - how useful the data is when used at a portfolio level to inform asset management decisions across the whole network
- Spatial representation - how useful the data is for users of GIS platforms.

5 INTEGRATION WITH DESIGN AND SURVEY TOOLS

The process of getting a new standard or code of practice into use within an industry faces several challenges. The first challenge is reaching agreement (or at least some level of consensus) across the various industry stakeholders for what should be in the code of practice.

The second challenge is to get people to use it.

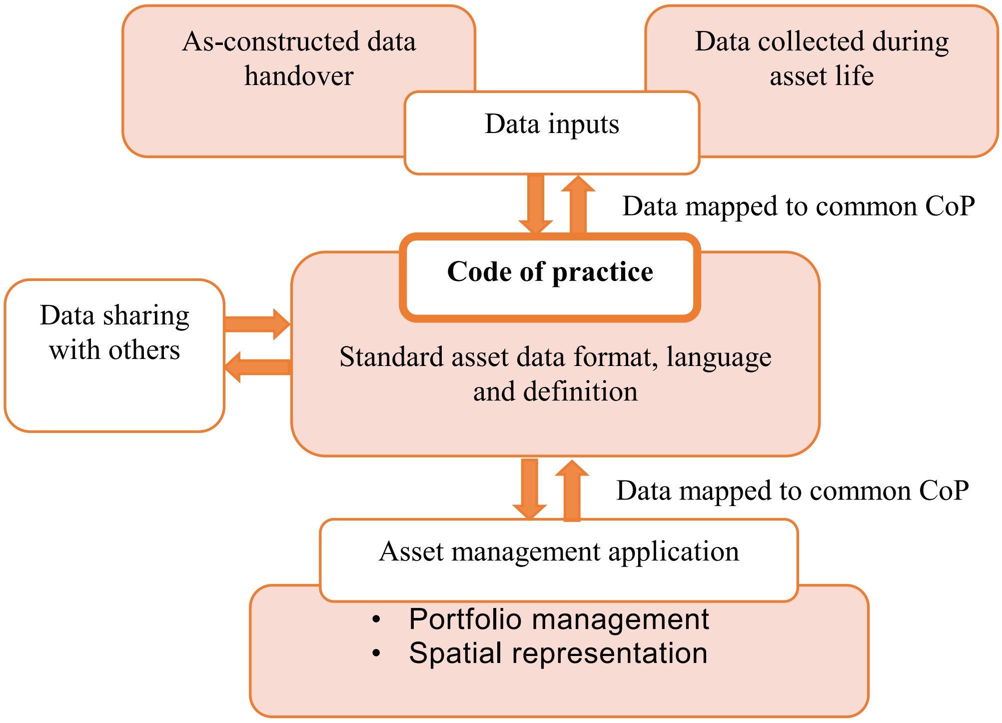
For this reason, the CoP has been produced with a specific target on the as-built data collection and handover process. The process of generating electronic as-built data is where a large portion of asset data is collected and pulled into an asset database for the first time.

This data is generated from designs, likely to be in electronic format, and from field survey. These design and survey users will be operating in their preferred electronic data format. The challenge is to make the CoP available in an electronic format that can be easily translated into the format required for design and survey. The CoP has been created in a generic data format and has been coded into an XSD file format to preserve the data schema, relationships and logic. Industry practitioners in the survey and design fields made it clear through the development process of the CoP that an electronic version of the CoP was absolutely necessary for industry uptake. This electronic format has to be generic and easily integrated with existing software data formats.

Different users will have their own software requirements, so the CoP is not written to fit one particular software. It is software agnostic. Data can be collected in the native format of the survey and design software and then mapped onto the CoP software agnostic format. The mapping routines only need to be created once, and then they can be continuously run to map to and from the CoP.

The philosophy of “mapping” data onto the common data standard of the CoP is illustrated in Figure 2 below.

Figure 2: Mapping data using the CoP



Mapping data to the CoP is easier than having to completely reconfigure survey, design and AMIS tools to the CoP data standard. This easier and more flexible approach is expected to encourage industry uptake of the CoP, resulting in more data able to presented in a common format.

Data be presented in the common format of the CoP can be more readily shared between organisations and across software platforms. Organisation's datasets can also be benchmarked according to the degree that they line up with the data fields highlighted as essential within the CoP.

The same data mapping process applies taking data in the CoP format and using it within asset management and analysis tools; for example hydraulic modelling, condition management or risk management software. These tools will have their own native data formats that can be routinely mapped onto the CoP to allow ongoing translation between software types and applications all using the same core data set.

6 FINDING THE CODE OF PRACTICE

The Code pf Practice can be found on the Building Innovation Partnership's website:

https://bipnz.org.nz/3-waters-asset-data-standards/

7 CONCLUSIONS

The Code of Practice for 3 Waters Asset Data defines a minimum viable data standard that aims to provide a common language for pipe and related assets across the whole of an assets life and across the full supply chain. Its initial aims are to:

- Facilitate standard templates across the country for design and as-built data for pipe networks
- Standardise the process of data ingestion into local authorities' asset management systems
- Provide a means of measuring data quality and therefore providing opportunities for data improvement.

- Provide a common language and large datasets for analysis. These analyses will tackle a range of questions current within the industry such as the economic life of pipes, etc.

Other key messages are:

- It is not necessary to collect all attributes described in the CoP, only those that are useful for the organisation or the asset class.

- It is not necessary to reconfigure your organisations asset management system to benefit from using the CoP. Significant benefits can be made by mapping existing data to the CoP data structure. This could be for collecting as-constructed data of for analysis of data and decision-making.

8 ACKNOWLEDGMENTS

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9 REFERENCES

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10 APPENDIX A – EXAMPLE COP ATTRIBUTE TABLE

Attribute Name - Full	Attribute Name - Short	Definition	Example	CODELIST REFERENCE	Collection Priority	Portfolio Asset Management	Spatial Representation	Data Format	Units of Measure	General Validation Rule	Specific Validation Rule	Additional Validation	Data Accuracy	Max Length	Comments
Purpose	**Pipe_Purp**	The purpose of the pipe as lateral, main, fire service etc.	TRUNK	Pipe_Purpose	1 - Primary	1 - Primary	1 - Primary	String	n/a	Field cannot be empty	Entry must be from CODELIST			10 chars	No commas included
Pipe Type	**Pipe_Type**	Pipe type is the type of flow characteristics of pipe i.e. pressure, gravity, syphon.	PRS	Pipe_Type	1 - Primary	1 - Primary	1 - Primary	String	n/a	Field cannot be empty	Entry must be from CODELIST			10 chars	No commas included
From Node	**From_Node**	Start point of a pipe section. For a pressure pipe this may be at the pumping point or a new section of pipe but can be at either end if there is no a dominant flow direction. For a gravity pipe this will be the upstream point.	N00001		1 - Primary	2 -Secondary	1 - Primary	String	n/a	Field cannot be empty				15 chars	No commas included
From Node Invert Level	**From_IL**	Invert of a pipe refers to the lowest point on the inside of the pipe at the From_Node position. Shown in the schematics.	8.41		1 - Primary	2 -Secondary	1 - Primary	Float	Metres	Field cannot be empty	Default = -9999.99		Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
From Node Invert Depth	**From_Depth**	Vertical distance between the From Node Invert Level and the ground surface at the node. Use the Chamber Cover Level as the ground surface of the node if known. This field can be calculated from the invert level RL and the surface level RL if known, or can be measured on site if the RL's are not available.	1.25		2 -Secondary	2 -Secondary	2 -Secondary	Float	Metres	Field cannot be empty	Calculated from the corresponding reduced levels taken at the invert and ground surface if known. Use the Chamnber Cover Level as the ground surface if known.	Field can be manual entered if the reduced levels needed for the calculation are not known.	Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
To Node	**To_Node**	End point of a pipe section. For a pressure pipe this may be at the discharge point but can be either end if there is no dominant flow direction. For a gravity pipe this will be the downstream point.	N00002		1 - Primary	2 -Secondary	1 - Primary	String	n/a	Field cannot be empty				15 chars	No commas included
To Node Invert Level	**To_IL**	Invert of a pipe refers to the lowest point on the inside of the pipe at the To_Node position. Shown in the schematics. For drop structure, it is the pipe invert level at the top of the drop structure.	8.24		1 - Primary	2 -Secondary	1 - Primary	Float	Metres	Field cannot be empty	Default = -9999.99		Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
To Node Invert Depth	**To_Depth**	Vertical distance between the To Node Invert Level and the ground surface at the node. Use the Chamber Cover Level as the ground surface of the node if known. This field can be calculated from the invert level RL and the surface level RL if known, or can be measured on site if the RL's are not available.	1.25		2 -Secondary	2 -Secondary	2 -Secondary	Float	Metres	Field cannot be empty	Calculated from the corresponding reduced levels taken at the invert and ground surface if known. Use the Chamnber Cover Level as the ground surface if known.	Field can be manual entered if the reduced levels needed for the calculation are not known.	Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
Pipe Shape	**PShape**	Shape of the pipe such as circular, U-shaped channel, V-shaped channel.	CIRC	Pipe_Shape	1 - Primary	1 - Primary	1 - Primary	String	n/a	Field cannot be empty	Entry must be from CODELIST	If pipe shape is circular, internal diameter, nominal diameter, external diameter is choosen. Pipe height and width field is made n/a. If pipe shape is rectangular, the pipe height and width is choosen. The internal diameter, nominal diameter and external diameter field is made n/a.		15 chars	No commas included
Length	**Length**	The pipe length is the measure from the one end of the physical pipe to the other. This is also known as the link length. The length of the pipe reflects the horizontal distance.	100.55		1 - Primary	1 - Primary	1 - Primary	Double	Metres	Field cannot be empty	Default = -9999.99		Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
Node To Node Length	**N2N_Len**	The node to node length is the measure from the From Node to the To Node. This node to node length is used to join pipes spatially in a GIS system. The length of the pipe reflects the horizontal distance.	101.60		1 - Primary	1 - Primary	1 - Primary	Double	Metres	Field cannot be empty	Default = -9999.99		Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	2 decimal places
Internal Diameter	**Int_Dia**	The internal diameter of the asset in millimetres. This applies if the pipe is circular.	450		2 -Secondary	2 -Secondary	2 -Secondary	Short Integer	Millimetres	Field cannot be empty	Conditional. To be determined by the asset Default. = -9999.99	If RCP pipes is selected from the codelist. The internal diameter = nominal diameter.	Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	Whole millimetres
Nominal Diameter	**Nom_Dia**	Nominal Diameter of the asset in millimetres. This applies if the pipe is circular.	450		1 - Primary	1 - Primary	1 - Primary	Short Integer	Millimetres	Field cannot be empty	Conditional. To be determined by the asset Default. = -9999			n/a	Whole millimetres
External Diameter	**Ext_Dia**	External pipe diameter. This applies if the pipe is circular.	480		2 -Secondary	2 -Secondary	2 -Secondary	Short Integer	Millimetres	Field cannot be empty	Conditional. To be determined by the asset Default. = -9999	If asset is new PE is choosen in pipe material, exernal diamter is equal to Nominal diameter.	Provide the AS5488-2013(SUI) classification of either: A, B, C or D	n/a	Whole millimetres

11 APPENDIX B – EXAMPLE CODE LIST

Pipe_Type

Code	Description
GRAVITY	Gravity
PRS	Pressure
SYPHON	Siphon
VAC	Vacuum
UNK	Unknown
xyz1	OTHER - Enter Custom Value

Pipe_Shape

Code	Description
CIRC	Circular
EGG	Egg-shaped pipe (touching circle)
RECT	Rectangular
UNK	Unknown
xyz1	OTHER - Enter Custom Value

Pipe_Material

Code	Description
ABS	Acrylonitrile Butadiene Styrene
AC	Asbestos Cement
CI	Cast Iron
CONC	Concrete
DI	Ductile Iron
EW	Earthenware
GALV	Galvanised Steel
PE	Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
STEEL	Steel
SSTEEL	Stainless Steel
FRP	Fibre Reinforced Plastic
N_A	Not Applicable (use this when pipe rehabilitated)
UNK	Unknown
xyz1	OTHER - Enter Custom Value