New Zealand Underground Asset Register

Sector Data Maturity Assessment

Prepared for Wellington City Council

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Executive summary

The New Zealand Underground Asset Register (NZUAR) project aims to create a comprehensive, accurate, and accessible digital representation of underground assets in New Zealand, beginning with a pilot implementation in Wellington. This report summarises findings from interviews with asset owners, contractors, designers, and governance bodies, to assess the current state of underground asset data management, readiness for NZUAR implementation, and challenges or considerations for the wider rollout of the system.

Key findings:

1. There is a clear need for improved underground asset data management in New Zealand. The current fragmented approach leads to safety risks, project delays, increased costs, and inefficiencies in planning and managing infrastructure.
2. Contractors play a vital role in both generating and using asset data. Improving processes for contractors to report discrepancies and provide accurate as-built information will have a significant impact on improving overall data quality for the sector.
3. While there is general support for NZUAR, stakeholder readiness and enthusiasm vary widely. Some organisations see clear benefits, while others have concerns about data sharing, resource requirements, and disruption to existing processes.
4. The NZUAG Code of Practice provides a potential regulatory lever for implementation, but may require strengthening to encourage NZUAR participation.
5. Major challenges include data quality and completeness, interoperability between systems, stakeholder engagement, balancing commercial interests with public good, and establishing appropriate governance structures.

The report includes a set of 20 recommended actions to address needs expressed by the organisations and participants involved. These recommendations span five key themes: stakeholder engagement and change management, data standards and data quality, data security and sharing, governance and regulatory framework, and national implementation strategy. The actions emphasise developing a comprehensive change management strategy, engaging with regulators and industry bodies, establishing clear data governance roles, and creating user-friendly tools for data input, discrepancy reporting and quality control. They also stress the importance of working with existing regulations, implementing robust security measures, and providing a clear roadmap for national implementation. Many of the recommended actions are already underway as part of the beta pilot implementation, but may need to be reevaluated for national implementation.

NZUAR has the potential to significantly improve underground asset management in New Zealand, leading to enhanced safety, efficiency, and infrastructure planning. However, its success depends on addressing key challenges, particularly around stakeholder engagement, data standardisation, and governance. A shared commitment from regulators, asset owners, and industry participants will be an important element in realising the full benefits of this initiative.

Contents

1. Introduction

The New Zealand Underground Asset Register (NZUAR) is an initiative intended to create a comprehensive, accurate, and accessible digital representation of underground assets in New Zealand, beginning with a pilot implementation for the Wellington region. This report draws from a range of sources, to present a view of the sector's readiness for the implementation of NZUAR, and considerations for its future development.

Operators of utilities such as water services, electricity, gas and telecommunications are the owners and core repositories of the underground asset data that is necessary to NZUAR. In order to understand data maturity levels across utility providers that have assets in the Wellington region, interviews were carried out with 19 representatives from 8 organisations. Interviewees were asked questions about their GIS capability, including the completeness and quality of data held by their organisation, data infrastructure, data management processes, and readiness for data sharing.

Other industry participants have a significant role in the creation, maintenance and use of underground asset data, and support asset owners in their data responsibilities. A smaller selection of people holding relevant roles in this category were also interviewed. These included four representatives from capital works and maintenance contractors, design consultants and surveyors.

Regulators and other authorities also have a core involvement in the use and management of underground asset data, as well as in the creation and operation of NZUAR. Groups with current or potential governance interests in NZUAR were canvassed, through interviews with six people representing the New Zealand Utilities Advisory Group (NZUAG), Te Waihanga New Zealand Infrastructure Commission, Digital Built Aotearoa and Wellington City Council.

This report provides a collated view of these various perspectives. Problems with the current state of the sector are considered, together with identification of the ways in which the proposed future state addresses them, to develop an argument for change. The key user roles that need to be considered as part of the implementation process are explored, followed by a more detailed examination of the contractor role, which is a vital element in the implementation process. A brief analysis of the NZUAG Code of Practice identifies both challenges and potential levers for enabling change. The perspectives of a selection of governance groups with current or potential interest in the project are presented. The core challenges identified during the research are then explained, including aspects identified by all of the various groups involved. Following a brief summary of conclusions, a set of recommended actions is presented that responds to a variety of the needs identified in the preceding sections.

2. Problem statement

The desired future state once NZUAR is implemented is to create a comprehensive, accurate, and accessible digital representation of all underground assets in New Zealand, beginning with a pilot implementation for Wellington. However, a more focused description of the desired changes and motivation for pursuing the project is necessary to generate appropriate responses to the problem. Issues faced as a result of shortcomings in the data and systems currently in use were collated from interviewees, with their ideal future state. Subsequently, Wellington City Council carried out a survey of invited participants to attempt to quantify the scale of the problem in the region.

2.1. Current vs future state

In the maturity assessment research, several participants expressed an attitude about the state of underground assets in Wellington which could be summarised as, “if it ain’t broke, don’t fix it”, where the current environment was not seen to be a problem and change was considered unnecessary. To be able to counter this attitude and generate enthusiasm for change in the sector, it is important to make the shortcomings of the current situation plain, and to identify the ways in which the proposed future state addresses them.

The following table identifies key areas identified by one or more of the interviewees, where the proposed NZUAR system provides a solution to a problem that exists in current practice.

	Current	Future
1.	**Project delays:** Progress on projects is unpredictable, causing disruption; when underground assets are not where they are expected to be, projects may be paused while correct information is obtained and verified, or halted altogether by strikes on assets.	**Reduced disruptions:** Disruptions caused by incorrect data or accidental strikes on underground assets during construction and maintenance activities are minimised; project durations are more certain because asset data is available and correct.
2.	**Direct and indirect hazards**: For all assets, hazards accrue due to works that are more extensive or go on longer than necessary because correct data is not available. Uncertain location data for gas or electricity assets poses a direct safety hazard, with accidental damage during excavation potentially resulting in injuries or fatalities.	**Improved safety:** Public and worker safety is enhanced by reducing the risk of accidents related to underground assets, and through reducing the time and scale needed for underground works.

3.	**Increased costs:** Encountering unforeseen issues during construction and maintenance activities is a common occurrence, leading to additional work and modifications and driving up costs.	**Cost efficiency:** Economic costs are lowered by improving the efficiency of construction projects and reducing costs associated with damage to underground assets.
4.	**Barriers to data sharing**: Lack of transparency in the communication process due to technological limitations, privacy concerns, or organisational policies can lead to mistrust and reluctance to share information.	**Enhanced collaboration:** Cooperation between various stakeholders is improved, allowing utility companies, local authorities, and construction firms to manage and protect underground assets effectively.
5.	**Inconsistent sharing of data**: Asset data is shared using multiple different approaches depending on parties and type of data involved; access to data is often based on pdf documents of underground plans which provide limited information and coverage.	**Centralised data repository:** A "single source of truth" is created with a unified platform where all data regarding underground assets are stored and can be easily accessed by authorised parties.
6.	**Fragmented data sharing**: No common approach exists for storing or communicating data, leading to fragmented and potentially inconsistent exchanges of information. Sharing agreements are ad hoc and diverse.	**Standardised data sharing:** Asset data structures are standardised across different organisations, to facilitate easy sharing and updating of information. Sharing agreements are established and consistent.
7.	**Static information:** Many asset owners only share data in response to a specific request, so the validity of the information is time-limited.	**Regular updates:** Asset owners are able to update data at frequent and regular intervals, ensuring that the information available is always current and accurate.
8.	**No clear approach for feedback:** External parties such as other utilities and their contractors have no route to provide feedback to asset owners on whether asset location data is correct or not, or systems are email based and labour intensive for asset owners.	**Continuous data improvement:** Contractors are able to report discrepancies between recorded asset data and site conditions encountered during excavation or maintenance work, with a clear and standardised process for submitting, reviewing, verifying, and acting upon feedback to ensure that it is captured consistently and dealt with in a timely manner.

9.	**Siloed data:** Asset data for each utility is managed in isolation from other relevant geospatial datasets, potentially leading to gaps in planning and design.	**Integrated datasets:** Users can access underground asset data in the context of other geospatial information that may impact on design and management of assets, e.g., groundwater, notable trees, archaeological sites.
10.	**Insufficient use of technology:** The current use of technology for managing and communicating asset information seems in some cases to be insufficient, not fully utilised, or outdated.	**Potential for future technology:** Adoption of mobile apps for easy field access to data and data entry systems provides opportunities for increased productivity. Greater use of GPS and other highly accurate localisation technologies is an immediate improvement available for capturing location data. The NZUAR project also lays the foundation for a transition to digital twin or other technology to support more extensive, dynamic models of the underground infrastructure for use in planning, analysis, and decision-making.
11.	**Inconsistent standards and reporting:** As-built standards and reporting processes vary significantly across different asset owners, and between capital works and maintenance projects, making it difficult for contractors to easily meet their obligations.	**Standardised data collection and reporting:** Clear and consistent standards and approaches are available for contractors and others in the field, to encourage timely and comprehensive reporting.

2.2. Wellington City Council survey

In order to clarify the motivation for the Wellington pilot implementation, Wellington City Council carried out an online survey of 1100 invited participants in May-June 2024, based largely on contacts provided in CAR applications through Submitica (Wellington City Council, 2024).

The survey gained 139 valid responses (12.6% response rate), which was considered sufficient to provide a meaningful view of experience in the field. Survey questions were generally quantitative in format, although the responses are based on respondent's recollections and estimates rather than financial or programme data. Sector-wide impacts were estimated based on survey responses.

The survey data revealed a significant and widespread problem with underground asset data in Wellington. Approximately 70% of Corridor Access Requests (CARs) were estimated to experience data issues, with about 50% resulting in physical issues in the field. The key challenges identified include missing utility data, inaccurate information, insufficient detail, lack of data on other important ground conditions, and difficulty in consuming available data. These issues affect a large proportion of work in the underground space, leading to a range of negative outcomes that can occur simultaneously.

The impacts of these data problems appear to be substantial. In financial terms, projections based on survey responses suggest a potential $66.4 million impact annually across all relevant projects in Wellington. Time delays are significant, with over 10,000 days projected across the sector. The safety aspect is also concerning, with an estimated 3,400 unexpected strikes, near misses, and HSE incidents sector-wide. Other impacts include wasted planning efforts, increased site investigations, alterations to traffic management plans, and job replanning.

3. User types

In the initial WCC briefing presentation document for the development of the underground asset register, several user personas were identified. Personas can be helpful by bringing common user needs to the forefront of planning before design has started, improving understanding of potential requirements, and ensuring the product and process align with user needs and expectations.

Using data collected during the maturity assessment research, the simple, generalised personas that were initially provided have been developed and expanded, to produce the following set of detailed user types. Role, expected skill set, needs and concerns are given for each user type, which provides a basis for development of strategies to ensure users are receptive to the project and engaged with the outcomes, and that it meets the various needs of those involved.

1. **Utility GIS Operator**

   Typical role: GIS/Data specialist responsible for developing and maintaining an organisation's GIS system.

   Skill set: Proficient in various GIS software and databases; strong understanding of asset data standards and best practices.

   Needs: Access to authoritative asset data; ability to upload and manage asset data; tools to efficiently review, investigate, and address reported data issues.

   Concerns: Ensuring data security and reliability for efficient operations; managing workload and resources required for ongoing data updates and synchronisation with NZUAR.

2. **Utility Field User**

   Typical role: Field technician dealing with on-site inspections, maintenance, and repairs of underground assets.

   Skill set: Expertise in locating and identifying underground utilities; proficiency with mobile GIS tools.

   Needs: Easy access to asset information in the field; consistent tools for reporting site observations and feedback on data accuracy.

   Concerns: Safety during excavation and accuracy of asset location; inefficiencies in reporting data discrepancies.

3. **Surveyor/Locator**

   Typical role: Responsible for accurately capturing and recording the location and details of underground assets, both for new installations and verification of existing assets, working on behalf of design consultants, contractors or asset owners.

   Skill set: Expertise in surveying techniques, proficiency with surveying equipment (e.g., GPS, total stations), knowledge of GIS systems, understanding of utility networks and infrastructure.

Needs: Access to up-to-date asset information before beginning fieldwork; tools to efficiently translate field measurements into formats compatible with GIS and asset management systems; clear standards for data capture and reporting, including required accuracy levels for different types of assets.

Concerns: Balancing the use of high-precision equipment with more accessible but less accurate tools for different project needs; dealing with inconsistencies between existing records and field observations.

4. **Project Manager**

   Typical role: Oversees construction projects involving excavation and utility coordination, responsible for complying with all client requirements such as provision of as-built data to client and UAR.

   Skill set: Knowledge of construction practices, utility regulations, and project management.

   Needs: Comprehensive view of underground assets in project area; ability to coordinate with multiple stakeholders; efficient process for project close-out with QA of as-built data.

   Concerns: Project delays and cost overruns due to unexpected utility conflicts or inaccurate asset data; inefficiencies in reporting.

5. **External Contractor**

   Typical role: Performs excavation, construction, or maintenance work on behalf of the utility or third-party clients.

   Skill set: Expertise in safe digging practices, utility locating, and compliance with local regulations.

   Needs: Access to reliable asset data for safe project planning and execution; clear process for reporting what they discover when excavation takes place, including unidentified buried objects, wrongly recorded objects, and validation of observed location of assets.

   Concerns: Personal and worker safety in the event of an accidental strike; liability for damages to underground assets; delays in receiving updated asset information; inconsistencies between multiple data sources.

6. **Design Engineer**

   Typical role: Designs new infrastructure or maintenance programmes that integrate with existing underground assets.

   Skill set: Proficiency in relevant design software; knowledge of engineering design principles; awareness of utility standards.

   Needs: Access to accurate and detailed asset data for design purposes; ability to view and query asset content for planning and analysis and integrate asset data with design tools.

   Concerns: Incomplete or outdated asset information leading to design errors, delays in receiving data from multiple sources.

   Concerns: Gaining insights from asset data for better decision-making; wasted time and resources in carrying out validation of data received from asset owners.

7. **Utility Company System Administrator**

   Typical role: Manages and maintains the software and hardware for the utility company's internal GIS and asset management systems, and coordinates with the central NZUAR system.

   Skill set: Expertise in IT system administration, database management, network security, and integration with external systems.

   Needs: Tools for monitoring internal system performance and availability; ability to manage user accounts, roles, and permissions for utility company staff; procedures for system backups, updates, and disaster recovery; secure and efficient data exchange with the central NZUAR system; ensuring data quality and consistency between internal systems and NZUAR.

   Concerns: Protecting sensitive utility company data and ensuring secure access control; maintaining autonomy and control over internal systems while collaborating with NZUAR; ensuring compatibility and interoperability between internal systems and NZUAR.

8. **NZUAR System Administrator (DBAF)**

   Typical role: Manages and maintains the central NZUAR system on behalf of Digital Built Aotearoa Foundation (DBAF).

   Skill set: Expertise in IT system administration, database management, network security, and user access control.

   Needs: Tools for monitoring overall system performance and availability; ability to manage accounts, roles, and permissions for users; procedures for system backups, updates, and disaster recovery; coordination with individual utility companies' system administrators; ensuring data quality and consistency across the federated system.

   Concerns: System vulnerabilities and potential security breaches; performance issues and downtime impacting user access and data integrity; scalability and capacity limitations as data volumes and user numbers grow; compliance with data privacy and protection regulations; maintaining trust and cooperation with individual utility companies.

9. **Transport Corridor Manager**

   Typical role: Statutory management and coordination of activities within the transport corridor, including road maintenance, traffic management, and utility works. This role is defined in the Code of Practice for Utility Operators Access to Transport Corridors and is provided by the Road Controlling Authority.

   Skill set: Knowledge of transport corridor regulations, traffic engineering principles, and utility installation and maintenance practices.

   Needs: Comprehensive view of all assets within the road corridor; ability to coordinate and schedule works to minimise disruption; tools for monitoring and enforcing compliance with corridor access requirements; efficient process for reviewing and approving corridor access requests.

Concerns: Conflicting priorities and competing demands for corridor space; potential for utility works to damage road infrastructure or cause traffic disruptions; inadequate or inaccurate asset data leading to project delays or safety risks.

10. **Council Planning Officer**

    Typical role: Develops and implements land use plans, zoning regulations, and infrastructure strategies for the local council.

    Skill set: Expertise in urban planning, policy development, and stakeholder engagement; understanding of infrastructure planning and asset management principles.

    Needs: Access to comprehensive and up-to-date asset data for strategic planning and decision-making; ability to analyse asset data in relation to land use, population growth, and development trends; tools for scenario modelling and impact assessment.

    Concerns: Incomplete or inconsistent asset data leading to suboptimal planning decisions; difficulty in coordinating infrastructure planning across multiple utility providers; balancing competing priorities and stakeholder interests in land use and infrastructure development.

11. **Fire & Emergency NZ Personnel**

    Typical role: Responds to emergencies involving underground utilities, such as gas leaks or water main breaks, or including risks from underground utilities.

    Skill set: Trained in emergency response procedures, hazard identification, and safety protocols.

    Needs: Quick access to critical asset information during emergencies, clear indication of asset ownership and emergency contacts.

    Concerns: Inaccurate or missing asset data that could compromise safety and response effectiveness; difficulty in coordinating with multiple utility providers.

12. **Climate/Resilience Researcher or Consultant, or RCA resilience staff**

    Typical role: Studies the impact of climate change or other environmental challenge on underground utility infrastructure and develops resilience strategies.

    Skill set: Knowledge of climate science or other relevant area of science; capability in infrastructure vulnerability assessment and geospatial analysis.

    Needs: Access to comprehensive asset data for risk modelling and scenario planning; ability to analyse asset data in relation to climate and environmental data.

    Concerns: Lack of standardised and interoperable asset data formats; limited access to asset condition and performance data for resilience assessments.

4. Contractors' role

Contractors play a significant role in both the production and use of underground asset data. Collaboration between asset owners and contractors is therefore vital to ensure effective asset data management.

Based on interviews with representatives from four contractor organisations, as well as input from the asset owners, the contractor role established in the list of User types (Section 3) has been further developed to articulate the diverse activities of this user group, and the associated issues.

Data collection: Gathering detailed information during the construction phase, which includes the precise location, type, and specifications of the underground assets. Contractors are generally responsible for installing or repairing the assets, so they have direct access to the most accurate information about the asset's location, type, and specifications.

- Asset owners often described contractors as viewing data collection as a secondary priority, compared to completing the physical work. This was disputed by the contractors interviewed, who recognised it as an essential part of their contract.
- Quality and consistency of data collection can vary depending on the technology used (e.g., GPS, total station, manual measurements)
- Different asset owners have different requirements for data collection, adding complexity for contractors working across multiple projects.

Coordination: Actively collaborating with asset managers to ensure there is clear communication of requirements, expectations, and any changes or issues that arise during the course of the work. Effective coordination between contractors and asset managers is essential to ensure that the data collected meets the utility organisation's needs.

- Contractors' primary relationships are typically with project managers or contract administrators rather than data teams, which can lead to miscommunication about data needs or delays in coordination. In some cases, this can lead to contractors and data teams circumventing reporting processes, which may have contract implications.

Record keeping: Preparing as-built records of the assets installed or modified, ensuring that the information reflects the actual built environment. As-built records prepared by contractors are a key source of data for utility organisations' GIS and asset management systems, and are commonly digitised to form part of the asset record.

- Quality and timeliness of as-built records can be variable, with asset owners asserting that it can take considerable effort to get some contractors to comply with draughting standards in the drawings provided, or provide complete and accurate information.

Compliance with standards: Ensuring that the data collection and record-keeping practices comply with standards specified by the asset owner, including requirements around quality checking and timeliness of processes.

- Compliance with standards is not always enforced by contract administrators, potentially leading to inconsistencies in the quality and format of data provided by different contractors.
- Different asset owners use different standards, so for contractors working for multiple organisations there is an added layer of complexity to understand which requirements apply.
- Some asset owners do not provide documented standards.

Utilisation of technology: Using technologies such as GPS, RFID tagging, scanning or other systems where appropriate, to improve the accuracy of the asset data. A range of technologies are available to contractors and others in the sector, whether through in-house or third-party expertise.

- Upgrading to digital methods was identified by asset owners as having the potential to significantly improve data quality.
- Adoption of these technologies is not yet widespread, and many contractors still rely on manual measurement and record-keeping methods.
- Contractors believe asset owners and others may have unrealistic expectations of what can be achieved through technology adoption.

Updating asset data: Amending the GIS/asset register to reflect the work carried out. A number of contractors have service agreements with asset owners that includes responsibility for updating the asset data. In these cases, a data team from the contractor is given direct access to the asset owner's GIS.

- Quality assurance processes are necessary for the asset owner to ensure that data entered by the contractor is correct and complete.
- Updated asset data is generally limited to the specific elements related to the contracted work. The wider data set collected and validated by contractors at the outset of a project, potentially also including rich 3D information, often remains siloed within their own systems without being fully integrated into the asset owners' records.

Reporting discrepancies: Informing the utility operator when errors or omissions in their records are identified. This is a specific responsibility placed on contractors by the NZUAG Code of Practice.

- Contractors are often uncertain about what constitutes a reportable discrepancy when they encounter differences between plans and reality.
- Contractors often lack clear, accessible processes for reporting unknown or incorrectly recorded assets.
- There's scepticism among contractors about whether reported discrepancies are actually used to update asset records.
- Time constraints, especially in maintenance or emergency work, can make it difficult to properly document and report discrepancies.

5. NZUAG Code of Practice

The New Zealand Utilities Advisory Group (NZUAG) Code of Practice for Utility Operators' Access to Transport Corridors is a national framework that governs how utility operators and corridor managers work together. The Code of Practice was developed as an industry-led initiative with collaborative involvement from representatives of asset owners, transport authorities and local government. It applies to all industry players and is mandated under the Utilities Access Act 2010. The Code is reviewed every three years and was updated most recently in 2019; its third review round is underway at present.

The NZUAG Code of Practice provides a framework that is directly relevant to the development of NZUAR, and also has some implications for how it may be presented to, or received by, asset owners. Key elements from the Code of Practice that are particularly relevant include:

Nationally consistent approach: The Code of Practice emphasises the requirement for a nationally consistent approach to managing access to transport corridors. The beta pilot for the NZUAR federated model approach is Wellington-based; some asset owners are concerned that it may result in an approach and set of requirements for work carried out in Wellington which does not align with the requirements for other areas of their networks. Although there is an intention that the Wellington pilot of NZUAR will serve as a test case for a national model, the lack of a national plan is a potential barrier for some organisations.

Cooperative framework: NZUAG outlines a cooperative framework for corridor managers and utility operators, promoting collaboration which is crucial for the success of NZUAR. The Code of Practice requires that the applications process for any work carried out in the transport corridors is streamlined, and delay is minimised—which can be achieved through information sharing by means of a federated underground asset model. Engaging with this model allows asset owners to demonstrate that they are meeting their obligations under the Code of Practice.

Rights of access: The Code of Practice defines the rights of access to transport corridors for utility operators, which are necessary for managing underground assets effectively. However, it also recognises the need to balance access rights with public interest and safety, so that any disruption to the transport corridors is minimised. Participation in NZUAR would demonstrate compliance with the Code of Practice because it provides a framework for utility operators to coordinate their activities, communicate effectively with corridor managers, and follow best practices for safety and efficiency.

Quality management: The Code of Practice includes provisions for quality management and compliance, ensuring that the data and processes meet high standards. Currently there is considerable variability in data quality and quality management processes across different asset owners, which mean that not all of these standards are met.

Minimising disruptions: One of the goals of the Code of Practice is to keep disruptions to transport corridors and utility services caused by work by another party to a minimum

while maintaining safety, aligning with the objectives of NZUAR to improve planning and design and reduce accidental strikes on underground assets.

Updating records: The Code of Practice requires anyone working in the corridor to notify asset owners of errors or omissions in their records, and for asset owners to update their records when they are alerted to such an issue. This was identified by both asset owners and contractors as a difficult requirement to meet.

6. Governance interests

The implementation of a shared infrastructure project such as NZUAR sits across a range of governance interests, funding, and stakeholder management. A key aspect of the governance structure for NZUAR is the potential need for an independent entity to oversee its development and operation. This approach could help ensure that the project maintains its focus on public good outcomes while balancing the interests of multiple stakeholders. The complex nature of this initiative also requires careful consideration of various governmental interests and economic regulators.

The following sections explore the perspectives and roles of various key stakeholders in the beta pilot of the NZUAR project and those with interests in further development into a national implementation. Interviewees included two representatives of Wellington City Council, one of the trustees of DBAF, two representatives of NZUAG and one representative of Infracom. Other information was drawn from publicly available resources on the relevant organisational websites. Interviewees were primarily concerned with their own organisations, but in some cases expressed views on other stakeholders. The following discussion is based on analysis of the collected data, and does not necessarily represent the views of the organisation described.

6.1. Wellington City Council (WCC)

Wellington City Council (WCC) has been instrumental in the development of the NZUAR to date. Together with Digital Built Aotearoa Foundation (DBAF), they are the developers of the beta pilot that is operating in the Wellington region.

6.1.1. WCC project motivation

In 2020, WCC conducted a survey of 16km of the city using GPR, LiDAR and other technologies to provide a better understanding of underground infrastructure. This was inspired by lessons learned from Sydney Light Rail, and aimed to reduce risks and improve efficiency for future infrastructure projects. About 100 anomalies were identified, including a collapsed water main that was able to be replaced efficiently due to the knowledge gained in the survey. Recognising the benefits of that exercise, WCC decided to develop a more comprehensive underground asset register. Key objectives were to make it accessible for all parties, to manage access and storage in a standard way, and to provide for improving and updating of information in perpetuity. It was also intended to be independent of the people working on it, so that future generations can build on and access the information.

6.1.2. Pilot programme governance structure

The Wellington pilot programme was initiated with $4 million in funding from the Department of Internal Affairs in the previous Labour Government's Better Off funding programme, to create a pilot implementation in Wellington that could potentially be scaled nationally. Support was continued by the current coalition Government. A governance group within the council oversees the project, to ensure robust processes, solid reporting, and proper expenditure. The governance group provides input on areas

such as auditing, procurement, finance, and technology. A technical reference steering group includes representatives from various sectors and stakeholders and provides direction on prioritisation of the development roadmap. The project team is working with national bodies such as NZ Utilities Advisory Group (NZUAG), National Utility Locating Contractors Association (NULCA) and Civil Contracting NZ, as well as individual utilities companies and contractors, to develop principles and standards for the system. They have also established MOUs with key stakeholders including Wellington Water and Powerco, that set up pathways for collaboration. The project has been written into Wellington City's Long Term Plan and Infrastructure Strategy.

Wellington was one of 10 cities internationally chosen by the Bloomberg Harvard City Leadership Initiative this year, with the NZUAR forming a key focus. The WCC project team believes that involvement in the initiative provided valuable methodological support, particularly around change management, which has been a significant focus of their work. The programme helped them to look beyond just local value for ratepayers, which was important for a project with national implications, and allowed them to access best practices from other locations that have dealt with complex problems. They consider that association with Harvard and Bloomberg also lent credibility to the project and helped gain attention from stakeholders who might have been otherwise hesitant.

6.1.3. Considerations for programme expansion

At the current stage of the beta pilot project, the WCC team is considering how the governance structure might need to adapt to support national implementation. The team has developed the project based on the Gemini Principles (see Appendix A) to establish a robust framework to guide the system's development and operation. This principles-based approach, developed in collaboration with key stakeholders such as NZUAG, ensures that decision-making remains aligned with the project's core objectives as it evolves. It also provides a connection with other projects around digital resources that are based on the same principles. The emphasis on public good outcomes, rather than purely commercial interests, highlights the project's commitment to creating lasting value for the broader community.

The WCC team recognises that they may need to explore alternative rollout strategies or “lift and shift” ownership of the programme to another entity for it to scale nationally. Other RCAs have been approached, to explore their interest in the system and identify what changes may be necessary to meet their needs. This forward-looking perspective, combined with the project's collaborative approach and its integration into Wellington City's long-term planning documents, would appear to position it well for future growth. However, it also highlights the complexity of managing a system that must serve multiple stakeholders while maintaining its focus on public good outcomes in the long term.

The team envisage a number of longer-term applications that could be developed from the NZUAR. The underground asset data may be used as a “mesh” to which IoT devices could be attached, opening up possibilities for real-time monitoring and smart city applications. There may also be opportunities for software developers and asset managers to create new tools that make this data available for improved asset

management planning. As the data set grows, companies may be able to offer advanced analytics services, helping utilities and city planners gain deeper insights from the data.

6.2. Digital Built Aotearoa Foundation (DBAF)

Digital Built Aotearoa Foundation (DBAF) is a charitable trust established to provide a repository of digital artifacts in the construction sector that have a significant benefit if managed as a public good.

6.2.1. Purpose of DBAF

DBAF was established to create an independent entity that could take responsibility for hosting and maintaining systems with national value, rather than having them owned by a government department or commercial entity whose focus may shift. The trust structure is designed to provide enduring capability that is not influenced by changing priorities or interests. As well as collaborating in the development of the NZUAR, DBAF also hosts the National Forward Works Viewer (NFWV), a platform used by a number of city councils, utility companies, developers and construction companies across New Zealand, to support information sharing for better coordination and planning of infrastructure work. A long-term vision for DBAF is to integrate NFWV and NZUAR into an integrated system.

In relation to the NZUAR project, DBAF contracts out operations to Open Plan, a Christchurch-based consultancy, while retaining stewardship and control of the platform and associated intellectual property. Under this framework, any data provided for NZUAR remains in the ownership of the asset owner supplying it, with DBAF and NZUAR providing a platform for federating the data and facilitating access and management.

As well as holding the intellectual property of the technical platform, DBAF also operates as a Data Trust. Under this framework, data owners can allow the Data Trustee to make decisions about the data on their behalf. This will generally be related to how and with whom the data may be shared. In this manner, DBAF has agreements with asset owners specifying access to the owners' data for the express purpose of operating the NZUAR. This approach is intended to reduce the administrative burden on the data owner, while providing security.

6.2.2. Advantages of a charitable trust

An independent structure such as DBAF provides a range of advantages in the establishment of NZUAR. The primary benefit, as noted above, is ensuring that critical infrastructure data and systems remain in the public domain rather than being controlled by commercial or government interests. Without the pressure of short-term commercial or political goals, the trust can focus on long-term outcomes that benefit the entire sector and country. Being separate from government departments provides a level of consistency and means the trust's priorities and funding are less likely to be affected by changes in political leadership or policy. By being independent, DBAF can provide a neutral platform that different stakeholders (utilities, local governments, contractors) can trust and participate in, without concerns about competitive advantage.

Trustees emphasise that as a charitable trust, any surplus funds DBAF generates are available to be reinvested into improving the system, expanding its use, or reducing subscription costs for users, rather than producing a profit or dividends as would be required of a commercial entity. DBAF is also committed to using open-source software, which can promote transparency and allow for broader collaboration and innovation. DBAF's independence may allow it to be more agile and able to adapt to new technologies and approaches than councils or central government; however, this depends on it having sufficient resources for development.

6.2.3. Future governance considerations

The trustees believe that DBAF needs to take a stronger leadership role as NZUAR expands beyond Wellington, with WCC stepping back to a supporting role. At the moment, the system is perceived as a WCC initiative; increasing the independence of NZUAR is likely to support uptake in other regions. DBAF is currently scaled for the pilot development of NZUAR and thus has limited resources and lacks visibility in other regions; this constrains its ability to promote the project and engage with stakeholders across the country. Although the NFWV has been in existence for over 10 years, DBAF is a relatively new entity, and it is still developing connections with the infrastructure sector to achieve wider support for NZUAR. It was suggested that endorsement from central government for NZUAR, while not essential for the long-term success of the project, would significantly help adoption, and would be welcomed by DBAF.

DBAF currently has two trustees, who believe that the current governance structure and processes are appropriate to the age and stage of the foundation; however, they expect more members will be brought onto the Trust Board in due course. New members will not necessarily be drawn from parties involved in NZUAR or NFWV, but will be selected to support the needs of DBAF as it expands.

With the development of NZUAR beyond the Wellington beta pilot, an element of tension is emerging between the Trust Board's intention of maintaining DBAF's independence, and the desire of stakeholders (e.g., NZUAG or asset owners, regulators) to be represented in the decision-making around NZUAR. Effective stakeholder engagement will require DBAF to manage the asset register in a way that balances the diverse needs and interests of asset owners, regulators, local governments, and industry groups, without compromising the autonomy of the Trust. This may involve creating advisory boards or committees with stakeholder representatives to ensure the different perspectives are included. Accountability and transparency will be essential in this process to maintain trust and credibility. Clear reporting structures and performance metrics, open communication about decision-making processes, and robust policies for identifying and managing potential conflicts of interest will all play a part in establishing DBAF as it engages with the various stakeholder interests.

6.3. New Zealand Utilities Advisory Group (NZUAG)

The New Zealand Utilities Advisory Group (NZUAG) is responsible for developing and maintaining the National Code of Practice, and has an advisory role for corridor managers

and utility owners/operators. Two representatives of NZUAG were interviewed for this report.

6.3.1. NZUAG support for NZUAR

The NZUAG representatives expressed support for NZUAR initiative, recognising its potential benefits for the utilities sector. They see NZUAR as a valuable tool that could enhance cooperation and efficiency in managing underground assets. They expressed a willingness to facilitate the project's adoption among members and to help guide national changes that would support its implementation.

However, NZUAG's support is tempered by a realistic understanding of the challenges involved and the limitations of their own advisory role. While they are enthusiastic about the concept, there is caution regarding the specifics of implementation and governance. NZUAG sees varying levels of readiness among different stakeholders and potential resistance from some industry players. Their support includes advocating for broader governmental and regulatory backing, acknowledging that their endorsement alone is insufficient for the project's success.

NZUAG is interested in how they can contribute within their existing framework. This includes looking for ways to align NZUAR with the Code of Practice, facilitating industry discussions, and potentially helping to develop or endorse related standards and frameworks. While they do not believe it is appropriate that they mandate adoption of NZUAR, NZUAG is open to the project's evolution and is prepared to adapt their support as the tool develops, so that they play a constructive role in its development.

6.3.2. NZUAG challenges or concerns

The NZUAG representatives identified several challenges and concerns that they feel need to be addressed for successful implementation of NZUAR. A primary concern is the varying levels of data maturity and readiness across different utility operators and regions. NZUAG believes that some organisations, particularly in less urban areas, may struggle with the technical and financial requirements of participating in a national asset register. This disparity could lead to inconsistent adoption and data quality, potentially undermining the effectiveness of the system.

Another significant challenge is the issue of data governance and security. There are worries about the potential misuse of data, and questions about liability if shared data leads to incorrect decisions or actions. Some NZUAG members, especially those in the telecommunications sector, have also expressed concerns about sharing what may be considered commercially sensitive information. NZUAG emphasises that clear protocols for data sharing, use, and protection need to be established to address these concerns and build trust among participants.

NZUAG also highlights the challenge of sustaining engagement and ensuring ongoing data quality improvement. The current lack of enforcement mechanisms for data reporting and quality management is seen as a potential weakness. While the Code of Practice provides a framework for cooperation, NZUAG's limited authority means it cannot compel compliance or improvements. The group believes that there is a need for utility

owner membership as part of the project governance group, to ensure their interests are represented.

6.4. Infrastructure Commission (Infracom)

Te Waihanga, the New Zealand Infrastructure Commission (Infracom) is a Crown entity tasked providing advice to the government on infrastructure planning and strategy, including identifying priorities for infrastructure and providing support services to current and proposed infrastructure projects. It is responsible for developing the National Infrastructure Plan.

6.4.1. Context

The strategy document *Rautaki Hanganga o Aotearoa 2022–2052 New Zealand Infrastructure Strategy* (New Zealand Infrastructure Commission, 2022) stresses the importance of reliable information to support good decision-making in infrastructure development. To support this, the strategy recommends improving infrastructure performance reporting and analysis across projects, networks, and systems. This need is directly connected with the goals of NZUAR. While the described future state of NZUAR (see Section 2.1) is primarily directed at delivering the information requirements of those responsible for and working within the transport corridors, it also makes information on existing utilities infrastructure available to support wider decision making. In the recent report *Paying it Forward* (New Zealand Infrastructure Commission, 2024), similar themes were noted around the need for a better understanding of what infrastructure already exists, to help drive efforts around renewing existing infrastructure, developing new infrastructure, and improving resilience to natural hazards.

Rautaki Hanganga o Aotearoa also places a strong emphasis on accelerating adoption and use of digital technologies in infrastructure planning, delivery, and management. The strategy document notes that investing in digital innovation may deliver better returns than investing in physical infrastructure, because digital solutions can help operators and regulators to manage existing infrastructure systems more effectively. This is also explored in an earlier report *Preparing for technological change in the infrastructure sector* (Beca Ltd and Polis Consulting Group*,* 2021) which suggests that the Infrastructure Commission needs to both prepare for and facilitate technological change in the sector. A key recommendation of that report was to move to an open data environment and create an independent data trust to govern information collected, which aligns with the NZUAR development and the role of DBAF. Another issue raised in both this report and the strategy document was the need to consider data ownership and sovereignty issues, with a particular focus on incorporating Te Ao Māori and mātauranga into the management of infrastructure data.

6.4.2. Infracom perspective on NZUAR

At a conceptual level, Infracom recognises the potential of NZUAR to improve infrastructure productivity, but is still considering what its role could be. There are concerns about appearing to favour one specific solution or provider, so the current direction is more inclined towards a championing or convening role rather than a prescriptive one. If a more prescriptive approach was needed for NZUAR implementation,

it was suggested that another agency, for example MBIE, may be better positioned to lead that.

Infracom requires more information and clarity on various aspects of the project before determining the level of involvement or support it could provide for a national rollout of NZUAR. A clear accounting of costs and benefits would be necessary, as well as answers to several key questions.

- Why hasn't a national underground asset register been implemented before now?
- What has been the barrier to adoption of this type of system previously?
- Is a national model necessary, or could a regional approach work?
- Who is best positioned to champion this initiative at a national level?

The upcoming National Infrastructure Plan was noted as a potential pathway for building out the NZUAR nationally.

6.5. Land Information New Zealand (LINZ)

Land Information New Zealand (LINZ) is a government department responsible for a variety of functions related to land and geographic information, including geodetic and cadastral survey systems and topographic information. It maintains a range of services for managing and sharing geospatial data. No-one from LINZ was interviewed for this research; information has been drawn from other interviewee's comments and the LINZ website.

6.5.1. Industry concerns

LINZ has been included in this review because several interviewees suggested that it provides an apparently logical location for NZUAR. Despite this evident fit, interviewees went on to express concerns about the future of NZUAR if it were in LINZ ownership.

It was implied that LINZ's core competencies and priorities would not align well with the needs of managing an underground asset register system. Because of the range of activities already undertaken by LINZ, the addition of the NZUAR would stretch the resourcing available and potentially lead to limited development and support. There is no confidence across the sector that NZUAR would thrive under LINZ stewardship, because it is not connected to their existing operations.

7. Challenges

A variety of challenges were identified from the maturity assessment research across the selected set of asset owners. Almost all of the challenges noted apply across the board, although not always to the same degree for every asset owner. None of the organisations could be considered to be managing their data to the desired standard, but each of them is performing well in at least one aspect.

Several additional challenges were identified following interviews with contractors, designers and other parties involved; some of the challenges faced by asset owners were expanded to include the perspective of these groups. Further points were raised in interviews with bodies with direct or indirect governance interests.

Many of the challenges identified several or all of the groups interviewed, and very few are unique to one type. They will all require a coordinated effort from regulatory agencies (local and central government), public and private companies, contractors, designers and other stakeholders, to create a robust and efficient federated underground asset model.

1. **Data quality and completeness:** Ensuring the data is accurate, up-to-date, and complete is a primary challenge.
    - Data may be required from different sources within an asset owner's databases, and need to be consolidated. For example, some organisations' data completeness relies on availability of as-builts or underground maps for data that is not included in the GIS; some have potentially relevant data recorded in inspection or maintenance records that are not fed back to the GIS.
    - Older records may be missing or incomplete. This is a minor challenge that will be improved through use of the NZUAR as most asset owners are confident that they have the vast majority of their records included in their GIS, and missing or inaccurate data will be improved through the use of the system.
2. **Interoperability and standardisation:** Different organisations use various formats to manage their asset data, to meet their specific needs. Adopting a standardised format for data sharing is essential for the interoperability of the system, but may require changes within a company's operations that do not directly serve the company's asset data needs.
    - Asset owners do not typically include a data quality attribute in their GIS records. Within the NZUAR, this attribute is necessary for the progressive improvement and reliability of the data.
3. **Stakeholder engagement:** Gaining cooperation and buy-in from stakeholders, including asset owners and contracting firms, is crucial. This requires aligning interests and overcoming resistance to change.
    - Within asset owners' organisations, asset data is sometimes viewed as the responsibility of GIS teams, without recognition of the role played by project management roles in implementing and enforcing contracts that prescribe data standards and processes.

- QA processes tend to focus on the data entry and completeness of records, with limited checking to ensure that records match the reality of the built asset.
- If NZUAR is to become a “one stop shop” for users, it needs to provide at least the level of functionality currently available through other systems.
- Many asset owners are experiencing “request fatigue” from various initiatives requiring their data or participation, most commonly around resilience or emergency response. NZUAR needs to clearly differentiate its value proposition and minimise additional burdens on already stretched resources within these organisations.

4. **Legislative support:** While the requirements of the NZUAG Code of Practice and the responsibilities of the corridor owner provide leverage and authority for instigating NZUAR, policies and contracts to support the sharing and utilisation of underground asset data will also be necessary.
   - Commercial and security concerns related to digital data access will need to be addressed.
5. **Technology adoption and integration:** For those organisations that are in transition from legacy GIS systems to new digital platforms, the change management task is likely to be already complex, requiring training and adjustments in operational procedures. Adding changes driven by the implementation of NZUAR may place additional pressure on the transition.
   - Most asset owners will not face this issue as they are using GIS tools that are well-established within their organisations. However, several organisations interviewed have either identified a need to change their current GIS in the near future, or have recently undertaken a change.
6. **Security and privacy concerns:** Security of the data is important to asset owners, especially when it involves critical infrastructure.
   - Unauthorised access, malicious damage and cyber threats were all factors raised.
   - Commercial sensitivity of data was identified by several organisations as an important concern, particularly for the telecommunications sector. However, others noted that this was more of a perceived risk than an actual risk because much of the data considered commercially sensitive could be accessed through other routes.
7. **Cross-boundary projects:** Projects that span areas or jurisdictions managed by multiple councils need to be considered and managed appropriately.
   - Given the initial NZUAR implementation is focused on Wellington, asset owners and contractors working across New Zealand are wary of regional solutions that may require them to use different processes in different areas.
   - Asset owners and contractors would like clarity about sharing data across jurisdictional boundaries, particularly if different areas have different levels of data security, data standards or sharing agreements, or require coordination with multiple asset owners and corridor managers.
8. **Reporting discrepancies:** Contractors face significant difficulties in reporting discrepancies between recorded asset data and actual field conditions, and asset

owners have challenges in effectively handling and acting on discrepancy reports from contractors.

- Many asset owners do not have easily accessible, standardised methods for contractors to report discrepancies observed during excavation or maintenance work. Where systems do exist, they may vary between asset owners, adding complexity for contractors who work with multiple utilities.
- Contractors are often unsure about what level of discrepancy warrants reporting. The NZUAG Code of Practice requires reporting of errors or omissions, but doesn't specify thresholds (i.e., how far off does a location need to be to qualify as an error?).
- Contractors consider they are not resourced to report discrepancies outside of formal as-built processes. For example, when unexpected assets are found, there may not be time in the job to bring in a surveyor before work needs to be closed up.
- Contractors often don't receive confirmation that their reports have been received or acted upon, leading to scepticism about whether reporting is worthwhile.
- Asset owners' uncertainty about the accuracy of reported discrepancies, and the associated safety or legal implications, leads to reluctance to update records, particularly when based on single point observations.
- The high volume of reports with varying quality and detail can overwhelm GIS and asset management teams. Verifying reported discrepancies generally requires resource-intensive field checks, and integrating point observations into existing systems can be technically challenging.

9. **Data reuse and integration:** Valuable data collected during projects, including rich 3D data, often remains siloed within design consultants and contractors, without being shared or incorporated into central asset records.
    - The databases created by designers and contractors during projects is often more detailed and accurate than what the asset owners themselves have, with rich 3D data.
    - There is currently no mechanism for this project data to be fed back into the central asset register, resulting in a missed opportunity to improve overall data quality and create a more comprehensive digital representation of assets.
10. **Enforcing standards and data quality:** While data standards and requirements are often specified in contracts, enforcement of these standards is inconsistent.
    - Compliance with standards is not always enforced, potentially leading to inconsistencies in the quality and format of data provided by different contractors.
    - The development of automated solutions to validate submissions against a structured schema was suggested as an approach to improve data standards, similar to the Land Online system for land records.
11. **Balancing commercial interests and public good:** Developing NZUAR as a public system creates a tension with existing commercial systems, including beforeUdig and Reveal.

- Articulating the added value of NZUAR as a part of this ecosystem, without undermining existing investments, is needed to improve industry support. NZUAR needs to be positioned as complementary to these systems rather than competitive, which will require careful navigation of commercial interests.
- Current functions are managed primarily through beforeUdig; asset owners and others who have entrenched support for beforeUdig may be reluctant to support changes.
- Asset owners require clarity about how their data will be used, and several noted that commercial models did not provide certainty of where their data would end up or how it may be exploited or monetised beyond the purpose for which it was provided.
- Commercial systems have developed strong industry connections (particularly in the case of beforeUdig) and can provide advanced features beyond the current scope of NZUAR (e.g., Reveal)
- There are significant risks from a national interest perspective if critical infrastructure information becomes dependent on commercial enterprises.

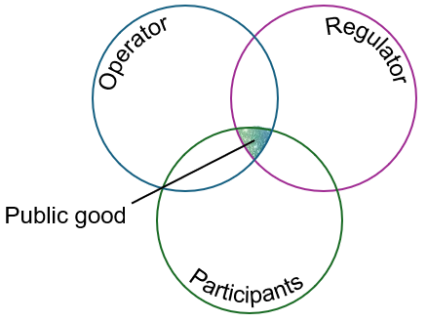
12. **Stakeholder buy-in and engagement:** Gaining support and active participation from a diverse range of stakeholders is critical for the success of NZUAR, but presents several challenges.
    - Major cities play a key role in driving adoption and setting standards for NZUAR implementation. The participation of larger urban centres can start to generate critical mass for the project and influence smaller municipalities and utilities. However, each major city may have unique requirements or existing systems, making alignment challenging.
    - Smaller councils and utilities may struggle to see immediate value in NZUAR participation, especially if they have limited resources or simpler asset management needs. Articulating tangible benefits and providing support for these stakeholders will be necessary to ensure comprehensive coverage.
    - Asset owners may be reluctant to commit resources to what they perceive as another data sharing initiative without clear evidence of long-term sustainability and widespread adoption. Demonstrating a stable governance model and funding mechanism will help to build confidence.
    - Some stakeholders may view NZUAR as duplicating or competing with existing systems they have invested in, rather than as a complementary tool. Careful messaging and integration strategies are needed to address these concerns.
13. **Expansion into other datasets:** To establish NZUAR as a unified repository for underground asset data, additional datasets such as groundwater, notable trees, and archaeological sites could be included**.** While this adds functionality, it introduces greater complexity and risks losing focus on the primary functionality of the system.
    - Expanding the system's scope could potentially divert resources from the core objective of managing and improving underground asset data.
    - Māori interests and data sovereignty need to be considered around the use and application of wider datasets, so engagement with iwi and hapū is an essential part of the development.

8. Conclusions

The initial purpose of this research was to explore the nature and availability of current asset data held by underground asset owners in the Wellington region, and their associated processes. As it became evident that the responsibilities and obligations in this area extended beyond this group, the investigation was subsequently expanded to include representation from contractors, designers and others involved in the process. Input was also sought from the NZUAG and the Infrastructure Commission, as industry bodies with an interest in the outcomes of the project, as well as Wellington City Council and Digital Built Aotearoa who are the parties developing the pilot project.

There is a clear interest in the sector for an improved system to manage underground asset data in New Zealand. The current fragmented approach leads to safety risks, project delays, increased costs, and inefficiencies across the sector. The survey conducted by Wellington City Council quantifies significant annual impacts in terms of costs, delays, and safety incidents. While there is widespread support for the concept of NZUAR among stakeholders, there are varying levels of readiness and enthusiasm. Some organisations see clear benefits, while others are more hesitant due to concerns about data sharing, resource requirements, and disruption to existing processes. The project needs to balance public good outcomes with existing commercial interests in the sector. Careful positioning of NZUAR as complementary to, rather than competitive with, existing systems will be important for gaining industry support. The Wellington pilot provides a valuable starting point, but there is a need for a clear roadmap towards national implementation. This should address concerns about potential fragmentation of approaches across regions.

The governance and long-term management of NZUAR is a necessary consideration. While Wellington City Council has led the pilot, there are questions about the most appropriate entity to oversee a national rollout. The independent structure of the Digital Built Aotearoa Foundation may offer advantages, but requires further development of resources and industry connections. The project has been positioned as a public good undertaking that sits at the junction of multiple interests, including regulators and governance bodies, asset owners and operators, and sector participants such as designers and contractors. Regulatory and policy support will likely be necessary to drive widespread adoption. The NZUAG Code of Practice provides a potential lever, but may require strengthening or clarification to encourage participation in NZUAR.



The success of NZUAR could have far-reaching benefits beyond immediate operational improvements, to support better infrastructure planning, improved resilience and more efficient use of resources at a national level. However, realising these broader benefits will require sustained commitment and collaboration across the sector.

9. Recommended actions

The following set of recommended actions has been developed to identify potential responses to the challenges and influences identified through the maturity assessment research, and includes activities that may already be underway. The list of recommendations was initially developed as part of the pilot implementation led by WCC, but a single authority does not have the scope or access to implement these on a national scale. In order to achieve a roll-out of the NZUAR initiative across New Zealand, wider involvement and coherent action from regulators, operators and other sector participants is needed. This may require a re-evaluation of progress to date so that actions are refocused on national implementation.

The recommended actions have been grouped into five themes, as follows:

9.1. Stakeholder engagement and change management

1. Action: Develop a comprehensive change management strategy to address the cultural shifts required for adopting the new system.

   Need addressed: NZUAR involves multiple stakeholders, each with different organisational cultures, processes, and priorities. The maturity assessment research found varying levels of openness to change and support for the NZUAR project, with issues such as technical readiness, lack of trust in the new system, concern around disruption to existing processes, and resource concerns contributing to resistance.

2. Action: Engage with regulators and industry bodies (NZUAG, Infrastructure Commission, Commerce Commission), to create wider recognition of current vs future practice, and ensure NZUAR is part of/aligned with industry best practices and reporting standards.

   Need addressed: Utility organisations operate within a complex regulatory environment, so if NZUAR is demonstrated to have support of, and alignment with, industry bodies, this will increase buy-in to the process.

3. Action: Engage with project managers and delivery teams within the asset owners' organisations to identify challenges and needs from their perspective, and involve them in the development of processes and service agreements.

   Need addressed: Internal project delivery teams hold responsibility for closing out projects, which includes the receipt of as-built information and/or input of asset data into the asset owners' GIS. The maturity assessment research identified that these roles are often not aware of or engaged with the data management needs of the organisation and may not be managing the quality or timeliness of the data appropriately. Their perspective was not included in the research so specific needs they may face have not been explored. By bringing them into the development process for NZUAR, the project would gain insights into how the asset owner-contractor relationship can be improved and their roles supported, thereby improving the asset data collected.

4. Action: Develop contractor-focused engagement and training processes to establish and share best practices in data collection, coordination, record keeping, compliance with standards, and updating asset data.

   Need addressed: Section 4 identifies several areas where contractors face challenges in their data collection and reporting responsibilities. Targeted training programs with and for contractors are needed to ensure they are engaged in the development programme and to provide clear guidelines for coordination between contractors, project managers, and asset data teams.

5. Action: Consider expanding publicity and involvement around the development of NZUAR to include services engineers and contractors across the construction industry.

   Need addressed: Although NZUAR is targeted specifically at underground assets within the transport corridor, the location of core assets is not limited to these areas. Historical changes or reuse of existing ducts may mean that public assets that were once within road corridors now cross private land, and may be encountered in excavation for new buildings. Building construction projects also need to connect to underground services, and connection points may provide additional data to improve accuracy of locations.

9.2. Data standards and quality

6. Action: Establish a clear set of open data standards, which include data formats, attribute requirements, accuracy thresholds, and quality assurance processes. If this is intended to evolve as the project develops, communicate the anticipated changes and how they will be staged.

   Need addressed: Each asset owner has their own data standards and structures, some of which may be easily aligned with the NZUAR project needs and others that will require transformation. The contributing organisations should be provided with the standards to be used in the project so that they can understand where their systems are in direct alignment or how their data may need to be transformed. This is particularly important for organisations who retain a significant volume of their data in map-based formats rather than GIS.

7. Action: Set up a process to carry out regular data quality audits and provide feedback to utility providers and contractors on areas for improvement. Benchmarking against other organisations' performance could be included in this.

   Need addressed: Asset owners currently have data of widely varying quality in their systems, and have no recognition of how they compare across the sector. Maintaining and improving data quality requires regular monitoring and feedback, which could be provided through data quality audits to identify issues and provide benchmarks for improvement.

8. Action: Support the development of automated data validation and quality checking systems for contractor-submitted information.

   Need addressed: Contractors often struggle with data quality and consistency in their reports due to time constraints, varying standards across asset owners, and potential human error. Automated checking processes offer the potential of immediate feedback

to verify data completeness, format compliance and logical consistency, in real-time as contractors submit information. By flagging errors or inconsistencies immediately, automated checks allow for on-site corrections, improving overall data quality and reducing the need for time-consuming back-and-forth communications.

9. Action: Develop a standardised, user-friendly tool or system (i.e., mobile app or web-based interface) for contractors to use in the field, to report observations of discrepancies between recorded asset data and field conditions.

   Need addressed: As noted in Action 8, contractors face significant difficulties in reporting discrepancies due to unclear processes, uncertainty about what constitutes a reportable discrepancy, and lack of resources. A standardised tool that can be used on the job site would streamline the reporting process and encourage more frequent and accurate updates.

9.3. Governance and regulatory framework

10. Action: Leverage existing regulations, such as the NZUAG Code of Practice and LINZ Utility Location Standard, to establish and enforce data sharing and quality requirements.

    Need addressed: While some of the asset owners and contractors are enthusiastic about the opportunity to participate in NZUAR, others are less supportive and will require some form of enforcement to ensure their participation. Several mechanisms exist in current regulations that may be used for this purpose, in particular the NZUAG Code of Practice, but they are likely to require legal interpretation to ensure appropriate use. The LINZ Utility Location Standard is a locally developed, non-mandatory framework available to the sector; only one of the utility organisations involved in the maturity assessment research was aware of it and none had adopted it.

11. Action: Explore sector support and mechanisms for making the use of NZUAR mandatory for all underground work.

    Need addressed: As per Action 10, different asset owners have widely varying levels of support or commitment with the NZUAR project. By making it mandatory for all relevant parties to contribute data, the same requirements are levelled at all asset owners and there is less scope for unequal engagement. Although the NZUAG Code of Practice requires data to be made available, it does not specify the format, so does not constitute a mandate for NZUAR.

12. Action: Establish clear data governance roles and responsibilities within the NZUAR programme, including data owners, data stewards, and data quality managers.

    Need addressed: Effective data governance is essential for maintaining the integrity and value of NZUAR over time. Some of the stakeholders are confused about how a federated data model will function in terms of data ownership and management. Clearly defined roles and responsibilities help ensure accountability and ongoing management of the data, and give organisations clarity about the role of NZUAR within their operations.

9.4. Data security and sharing

13. Action: Develop data sharing agreements that provide protections for commercially sensitive and critical asset information.

    Need addressed: Organisations have concerns about sharing data that may be commercially sensitive or reveal vulnerabilities in critical infrastructure. Robust data sharing agreements are needed to alleviate these concerns.

14. Action: Implement security measures to protect the system and data from cyber threats and unauthorised access, and develop clear data protection policies and procedures. Consider adopting industry-standard security certifications or accreditations such as ISO 27001 to build trust and support organisations that already have this in place.

    Need addressed: The NZUAR system should protect an organisation's data at least as well as the organisation does so. At least one of the organisations interviewed in the maturity assessment research identified that they have ISO 27001 accreditation, so the implications of their contribution to NZUAR should be considered in this context.

15. Action: Develop APIs or data exchange mechanisms to enable seamless data flow between systems, and ensure that the NZUAR system can accommodate data from a variety of sources and formats.

    Need addressed: It is likely that data from asset owners will require some form of transformation to meet the requirements of the NZUAR system. The mechanisms used to effect these transformations need to be transparent to the organisations involved so that they can trust that their data will be represented appropriately.

16. Action: Establish a formal process and clear expectation for capturing and incorporating observations and feedback from field staff and contractors on data accuracy.

    Need addressed: Utility organisations currently have limited mechanisms for field staff and contractors to report observations made during project works, whether that be to report inaccuracies (e.g. incorrect location data, unrecorded assets) or to confirm the accuracy of records. This makes it very difficult for organisations to meet the requirements of the NZUAG Code of Practice, and results in missed opportunities to improve both data quality and data confidence.

17. Action: Develop a service commitment that defines the expected level of service for NZUAR.

    Need addressed: Potential users of the system are unsure about the implications of working within the NZUAR. A clear service agreement will help to clarify factors regarding the technical operation of the system such as commitments for continuity of the service, data ownership, backups and updates.

9.5. Wider implementation strategy

18. Action: Provide a roadmap for how NZUAR will evolve from the Wellington-based pilot into a national system in the future.

    Need addressed: Organisations with a national network are wary of regional solutions, so may be reluctant to invest time and resources into supporting NZUAR while it is limited to a Wellington-specific pilot. They expressed concerns that it may require them to

duplicate their data management efforts, given that they will have to use different processes in other regions.

19. Action: Provide clear communication on how NZUAR aligns with and complements beforeUdig, Reveal and other commercial services.

    Need addressed: Some interviewees in the maturity assessment research expressed a strong allegiance to existing systems such as beforeUdig, and concern that the NZUAR project may duplicate or undermine them. Organisations may also worry that NZUAR could confuse users or divert them away from the “tried and trusted” beforeUdig process. Similarly, those viewing the technology solutions of Reveal and others may have raised expectations that NZUAR is unable to meet.

20. Action: Include consideration of te ao Māori and mātauranga, including consultation with iwi and hapū, as part of the project's development and implementation plans.

    Need addressed: As the area covered and datasets included in NZUAR expands, the importance of Māori perspectives on data sovereignty, cultural significance of underground resources, and traditional knowledge also increases. Including consideration of te ao Māori also ensures the NZUAR project aligns with the national infrastructure strategy.

Appendix A

The Gemini Principles

The Gemini Principles originated in 2018 as part of the UK's Digital Built Britain program, developed by the Centre for Digital Built Britain to guide the creation and use of digital twins in the built environment (Bolton et al., 2018). The principles ensure that digital twins and associated information management frameworks are developed and used in ways that are ethical and beneficial to society. By emphasising federation and openness, they also encourage the creation of systems that can work together and share data. While initially UK-focused, organisations internationally now use these principles to align digital twin and information management strategies with broader objectives to meet the needs of society.

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